The National Energy and Climate Plan for 2021-2030

Objectives and targets, and policies and measures

/emblem:/ MINISTRY OF NATIONAL ASSETS

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1. Overview and the process of developing the National Energy and Climate Plan for 2021-2030

This document along with annexes has been developed in fulfilment of the obligation set out in Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council and will be submitted to the European Commission in connection with Article 3 of the above regulation.

This draft National Plan is an effect of the work of an inter-ministerial working team coordinated by the Ministry of State Assets[1]. The working team consisted of representatives of[2]: the Ministry of Climate, the Ministry of Finance, the Ministry of Development, the Ministry of Development Funds and Regional Policy, the Ministry of Foreign Affairs, the Ministry of Agriculture and Rural Development, the Ministry of Science and Higher Education, the Ministry of Infrastructure, the Ministry of the Maritime Economy and Inland Waterways, the Ministry of Family, Labour and Social Policy, the Government Plenipotentiary for Strategic Energy Infrastructure, as well as the Energy Regulatory Office (Urząd Regulacji Energetyki - URE), the Central Statistical Office (Główny Urząd Statystyczny - GUS), the National Centre for Emissions Management (Krajowy Ośrodek Bilansowania i Zarządzania Emisjami - KOBiZE).

The *National Plan* presents an integrated approach to the implementation of the five dimensions of the Energy Union.

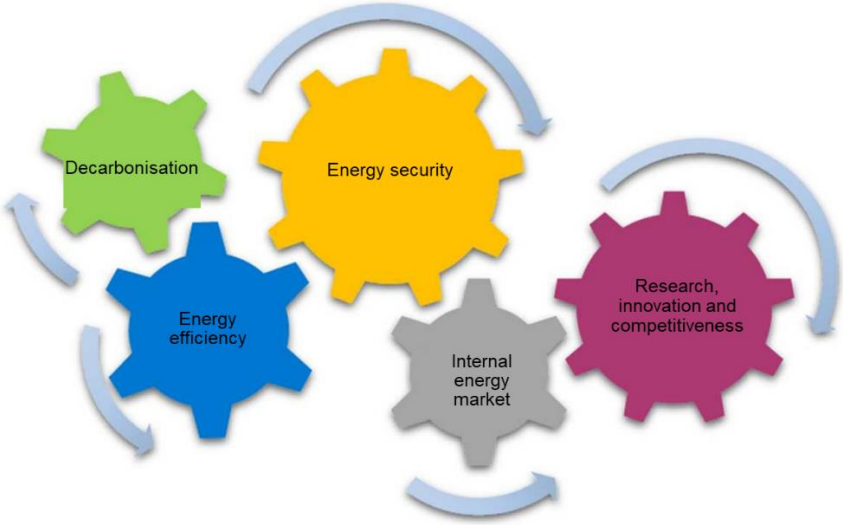


Figure 1. Pillars of the Energy Union

This document presents the national assumptions and goals (chapter 2), as well as policies and actions (chapter 3) concerning the above five dimensions. An analysis of the impacts of the planned policies and measures is presented in Annex 2 to this document, whose structure corresponds to the scope and numbering of Annex I to Regulation 2018/1999. The baseline scenario (i.e. with no policies and measures in place) is presented in Annex 1.

The final version of the National Plan was prepared taking into account the conclusions derived from inter-ministerial work and public consultations, updates of national sectoral development strategies following from the Strategy for Responsible Development until 2020 (with an outlook for 2030), as well as from regional

[1] The Ministry of Energy changed its name to the Ministry of State Assets with effect from 15 November 2019.

[2] The names of ministries have been adapted to reflect the situation in November 2019, in correspondence to the reallocation of powers among the individual ministries.

consultations and Commission Recommendation C (2019) 4421 of 18 June 2019 on the draft integrated National Energy and Climate Plan of Poland covering the period 2021-2030.

The draft is based on applicable national development strategies approved by the central government and draft strategic documents, which are at an advanced stage of preparation. The links between the National Plan and key sectoral strategies relevant for this document are presented in the graph below.

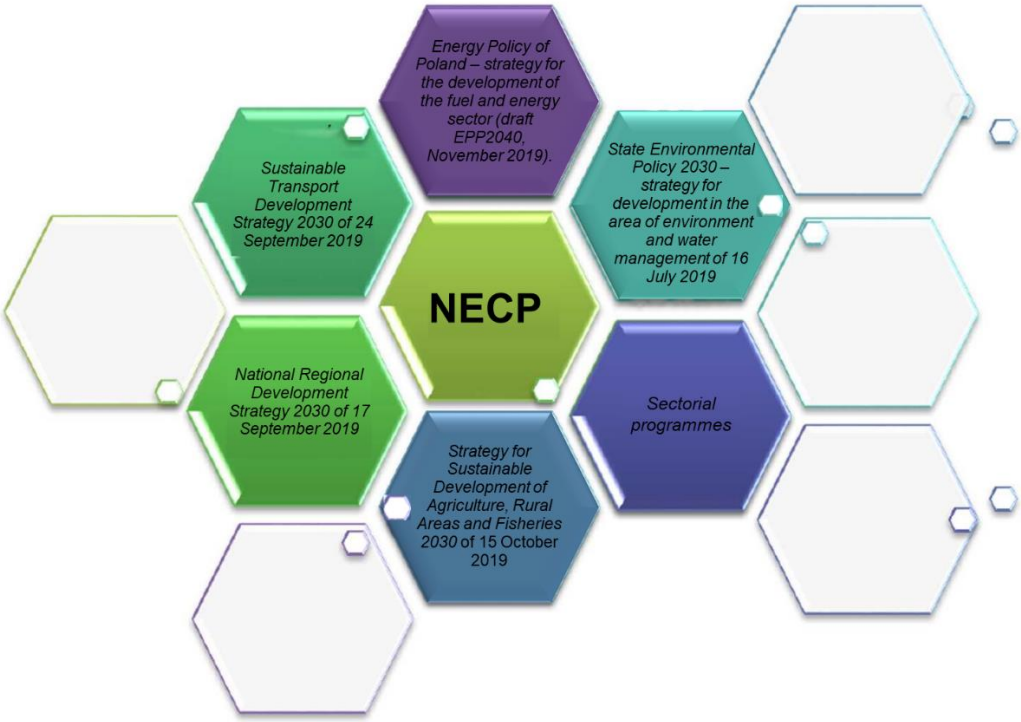


Figure 2. Links between the NECP and development strategies following from the SRD

The above strategies identify the entities responsible for the implementation of individual activities/tasks, and define the funding framework.

In the event of changes of the goals or strategic directions envisaged by the national development policies, draft strategies (e.g. by the draft Energy Policy of Poland until 2040), and new developments in the EU medium- and long-term climate and energy policies, the National Energy and Climate Plan for 2021-2030 will be adjusted accordingly, if necessary.

The NECP presents the key tools and measures, which do not represent an exhaustive and closed list of implementation activities. Given the dynamics of economic developments (including in the energy sector), the list may be expanded to reflect the economic conditions and the effects of measures achieved. The NECP is a response to the EU legislation adopted to date.

As a consequence, the National Plan can be updated in the future as per Article 14 of the abovementioned Regulation 2018/1999, or it can be revised to reflect modifications of the goals or strategic lines of intervention envisaged by the national development policies.

1.1. Consultation of the National Plan with national and EU entities

The draft National Energy and Climate Plan was widely consulted between 14 January and 18 February 2019 with over 80 invited stakeholders, including institutions, industry chambers and associations, employers' and employees' organisations, and NGOs. The draft NECP was made public on the website of the Ministry of Energy (currently the Ministry of State Assets), who invited the general public to submit opinions. Responses from stakeholders were being received until the end of March 2019. The Ministry received approx. 1100 comments from ca. 80 parties, i.e. ministries and offices (7 ministries: the Ministry of Investment and Economic Development, Ministry of the Environment, Ministry of Maritime Economy and Inland Navigation, Ministry of

Infrastructure, Ministry of Family, Labour and Social Policy, Ministry of National Defence) and 4 offices, including the Energy Regulatory Office, General Directorate for Environmental Protection), all major energy sector State Treasury companies (including PGE S.A., Energa S.A., Tauron Polska Energia, Enea S.A., LOTOS S.A., PKN ORLEN), transmission system operators (i.e. PSE.S.A., PERN S.A., Gaz-System S.A.), industry associations (e.g. Polski Komitet Energii Elektrycznej (Polish Electricity Association), Polskie Towarzystwo Przesyłu i Rozdziału Energii Elektrycznej (Polish Power Transmission & Distribution Association), Towarzystwo Gospodarcze Polskie Elektrownie (Polish Power Plants Association), Konfederacja Pracodawców Lewiatan (Polish Confederation Lewiatan), Towarzystwo Obrotu Energią (Association of Energy Trading), Polskie Towarzystwo Nukleoniczne (Polish Nucleonic Association), Polskie Towarzystwo Elektrociepłowni Zawodowych (Polish Association of Commercial Heat and Power Plants), Towarzystwo Rozwoju Małych Elektrowni Wodnych (Association for Small Hydropower Development)), NGOs (including WWF Poland, Client Earth – Prawnicy dla Ziemi foundation, Stowarzyszenie Energii Odnawialnej – SEO (Renewable Energy Association), Forum Energii (Energy Forum), Instytut Spraw Obywatelskich INSPRO (Civil Affairs Institute), local governments (e.g. Provincial Marshal's Offices of the following Provinces – Kujawsko-Pomorskie, Podlaskie, Pomorskie, Warmińsko-Mazurskie, Małopolskie, Podkarpackie, Łódzkie, Zachodniopomorskie, Związek Województw (Union of Provinces), Śląski Związek Gmin i Powiatów (Silesian Union of Municipalities and Poviats)) and individuals interested in the subject. Most of the comments were detailed, expert or technical in nature. The most frequent comments from the stakeholders concerned 'decarbonisation', including the development of renewable energy sources. Other frequently addressed areas of the National Plan included energy efficiency, the role of the heating sector and cogeneration, *inter alia* in energy security, network infrastructure (especially that of distribution networks) and the use of alternative fuels in transport, including electromobility, hydrogen propulsion, and energy storage.

Between 8 and 30 August 2019, regional consultations were held on the draft National Energy and Climate Plan, as required by Article 12 of Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action. Requests for written comments on the draft NECP were sent to 8 countries, including the V4 (the Czech Republic, Slovakia, Hungary), countries with which Poland has a transboundary connection (Germany, Sweden, Lithuania) and Denmark (in connection with the Baltic Pipe investment), as well as Romania (on account of the country's interest in bilateral cooperation, i.e. within the energy working group). During the consultation process, Hungary expressed an opinion in which it considered the goals set by Poland realistic. Hungary expressed its interest in the creation by Poland of a gas transmission and trading hub and in the construction of the North-South corridor, and welcomed the plan to deploy nuclear energy in Poland, emphasizing that this will increase the security of energy supply. Hungary is open to exchange of experience in this area. In addition, minor remarks were made on decarbonisation calculations in the ETS sector by 2030, which have been fully taken into account. The Czech Republic, Slovakia and Romania communicated that they had no comments. The other countries invited did not submit any comments.

Issues regarding draft national plans and regional consultations were also addressed in 2019 by the BEMIP High Level Group, of which Poland is a member.

On 18 June 2019, the European Commission issued Recommendation C(2019)4421 on the draft integrated National Energy and Climate Plan of Poland covering the period 2021-2030, which contains 10 recommendations. Given the wide range of issues they address and their impact on the economy in strategic terms, the Commission's recommendations are chiefly analysed in terms of the interactions between the individual dimensions of the Energy Union, taking into account the domestic conditions, forecasts for the development of the economy and individual sectors, the potential for the development of individual technologies, as well as the evolutionary process of just energy transition and its socio-economic considerations. It must be emphasised that pursuant to Regulation 2018/1999, the Commission recommendations are not binding.

At a request made pursuant to the Act of 8 October 2010 on the cooperation of the Council of Ministers with the Sejm and the Senate in matters relating to Poland's membership in the European Union (Journal of Laws [Dziennik Ustaw] No 213, item 1395), the draft Position of the Polish Government on the above European Commission recommendations was prepared. The draft was prepared jointly by: the Ministry of Energy (leader), Ministry of the Environment, Ministry of Infrastructure, Ministry of Investment and Development, Ministry of Family, Labour and Social Policy, Ministry of Agriculture and Rural Development, Ministry of Maritime Economy and Inland Navigation, and Ministry of National Defence. On 15 October 2019, the Position was adopted by the Committee for European Affairs. The position contains an indicative response to the recommendations.

The conclusions of the national and regional consultations, as well as of the Commission recommendations were taken into account in the preparation of this version of the document.

1.2. National and EU energy system and policy context of the national plan

The Polish energy system is among the largest in the European Union. It is one of the top ten systems in terms of the main macro energy indicators. This corresponds to the potential of the Polish economy, which ranks eighth in the European Union in terms of the GDP (EUR 496.4 billion in current prices in 2018), and sixth in terms of population (37.9 million). As regards the volume of primary and gross final energy consumption in 2018, Poland ranks sixth in the EU.

The total global energy consumption in 2018 was 4490.7 PJ. Gross domestic energy consumption per capita amounted to around 116 GJ, slightly diverging from the European average of 137.1 GJ.

In 2018, direct energy consumption amounted to 3551.8 PJ. Industry was the sector of the economy that had the largest share in direct energy consumption (34.5%). The transport sector, with a share of 27% in 2018 and rising steadily in recent years, ranked second. In 2018, households consumed 23% of energy, agriculture 4.6%, and other consumers 9%[3].

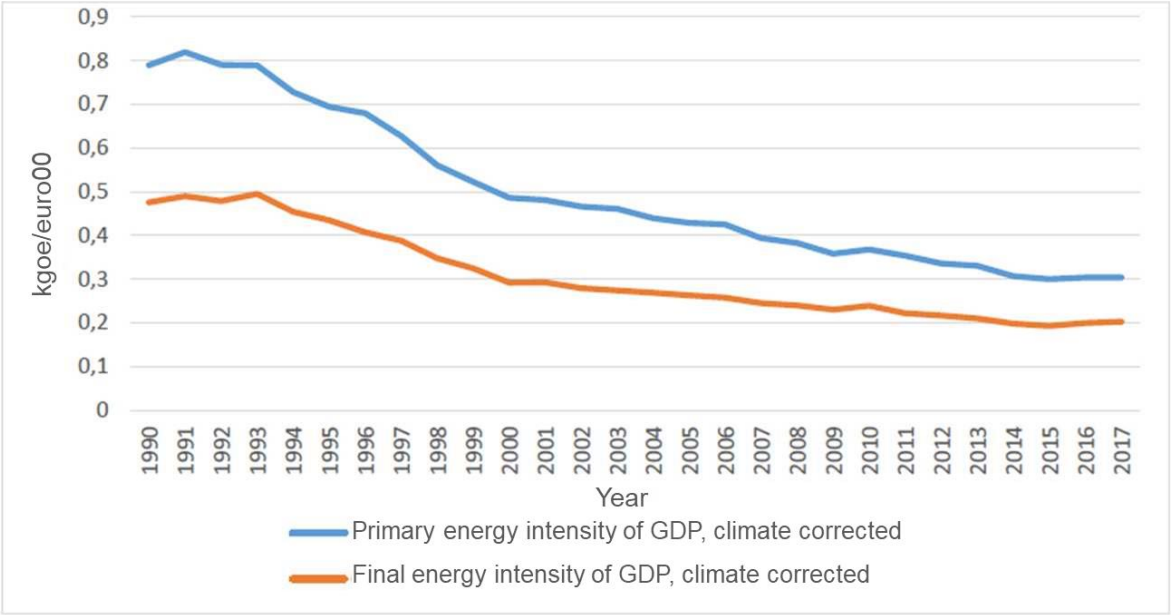


Figure 3. Dynamics of primary and final energy intensity of GDP in the period 1990-2017 (kgoe/euro00)

The primary and final energy intensity of GDP decreased in 2017 compared to 1990 by 61.5% and 57.3% respectively, with the rate of improvement slightly higher after the climate adjustment. Poland has seen a steady decrease in energy intensity, with periods of slight rises in 2010, 2016 and 2017. The decline in primary and final energy intensity is attributable to energy-efficiency measures, improved efficiency of industrial processes, and the fact that the GDP has been growing faster than energy consumption.

Historically, there has been a growing divergence between the increase in GDP and the emission of greenhouse gases in Poland over the last three decades (1988-2018). The rising GDP does not lead to an increase in emission levels, which is shown in the graph below. In 1988-2018, GHG emissions declined by 32%, while GDP grew nearly 3 times.

[3] Fuel and Energy Economy in 2017 and 2018 (Gospodarka paliwowo-energetyczna w latach 2017 i 2018), Central Statistical Office, 2019

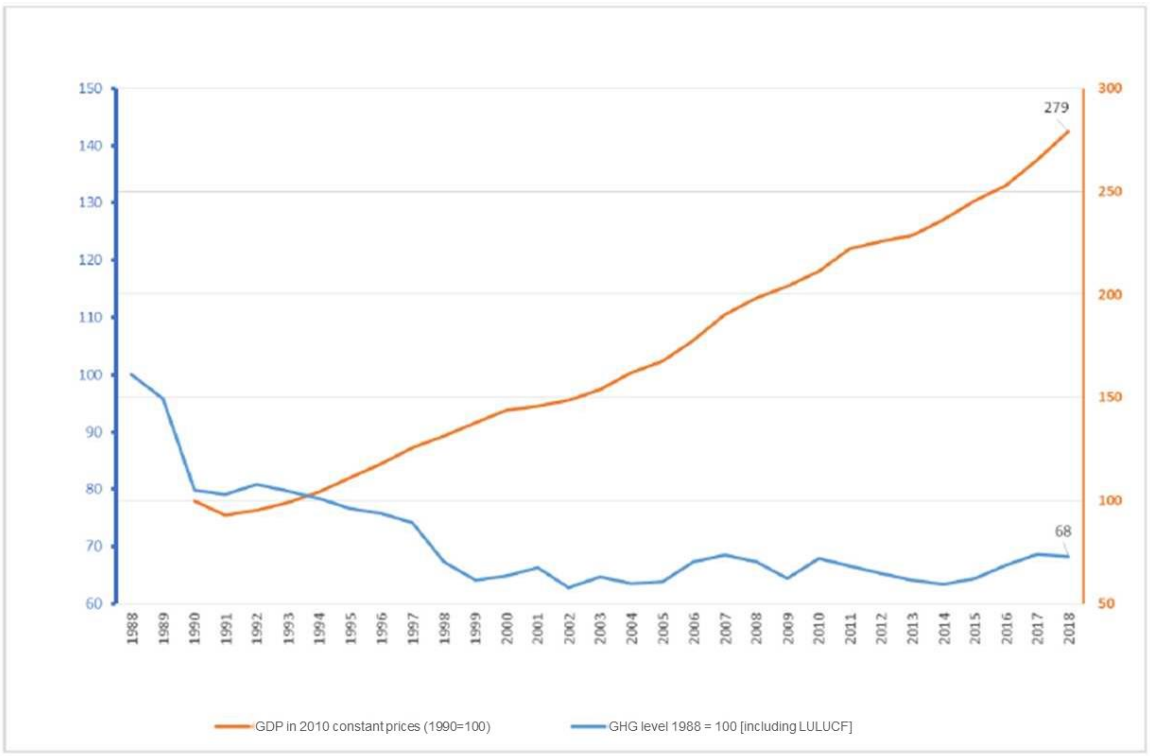


Figure 4. GDP dynamics relative to greenhouse gas emissions (1988-2018)

The sectors of production and supply of electricity, gas, steam and hot water, as well as the mining and extraction sector account for approx. 4.5% of the gross value added of Polish GDP (with approx. 258 thousand employees[4]). As regards the added value dynamics in the sector in 2018, the industry sub-category 'Generation and supply of electricity, gas, warm service water and steam' recorded a 3.6% growth compared with the previous year.

In 2018, the volume of production in the Polish electricity sector amounted to approx. 170 TWh, while domestic electricity consumption reached approx. 175.7 TWh[5]. Electricity imports in the year amounted to 13.8 TWh, while exports to 8.1 TWh. Thus, the annual balance of cross-border electricity exchange was about 5.7 TWh for Poland in 2018. The figure below shows the production structure by carriers.

[4] Statistical Yearbook of Industry, GUS, 2018

[5] Polish Energy Statistics 2018, ME/URE/ARE S.A., 2019

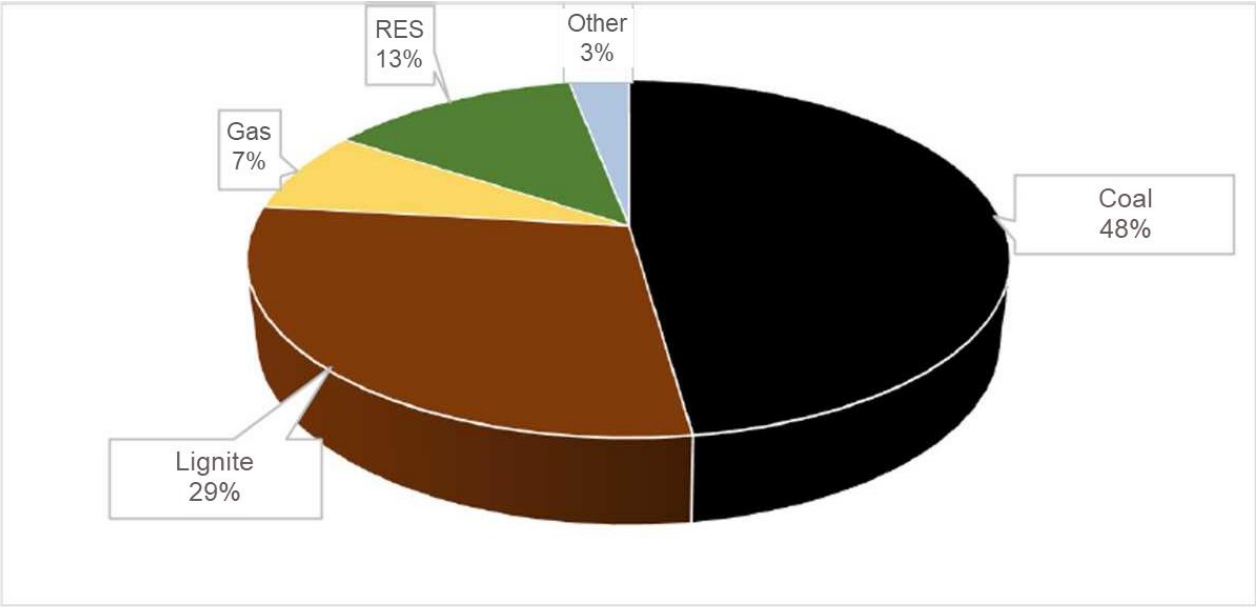


Figure 5. Electricity production structure by carriers in 2018

The above data shows that electricity production is based on coal and that coal provides Poland with an appropriate level of energy security and production stability. The coal mining sector in Poland (lignite and coal) also plays a very important social role. In 2018, the Polish coal mining industry employed directly approx. 135,000 people (compared to 175,000 in 2010). The ongoing energy transition leads to changes on the labour market, which results in miners moving to other industries.

Developments in the Polish power sector lead to an increase in the share of RES in the structure of installed capacity within the National Power System (NPS) and in electricity production. In 2018, the share of RES in electricity production was 12.7%. In 2018, installed RES-based generation capacity increased to ca. 8.5 GW of total installed capacity within the NPS of ca. 44.3 GW in 2018. In 2010-2018, installed RES capacity increased 4 times and RES electricity production doubled. In 2018, Poland was ahead of 16 EU countries in terms of installed RES capacity volume[6].

In the context of the structure of electricity production, of which coal remains an important component, as well as bearing in mind the transformational nature of the present developments, the relationship between emissions from the electricity sector and the dynamics of electricity production, as shown in figure below, should be highlighted. The data shows that the upward trend in electricity production continuing in Poland since 2011 has not resulted in a growth in CO_2 emissions in this sector. On the contrary, emissions from this sector were reduced by approximately 7% in the years 2011-2018. This means that the sector's emissivity has been gradually decreasing.

[6] Renewable Energy Statistics, IRENA, 2019.

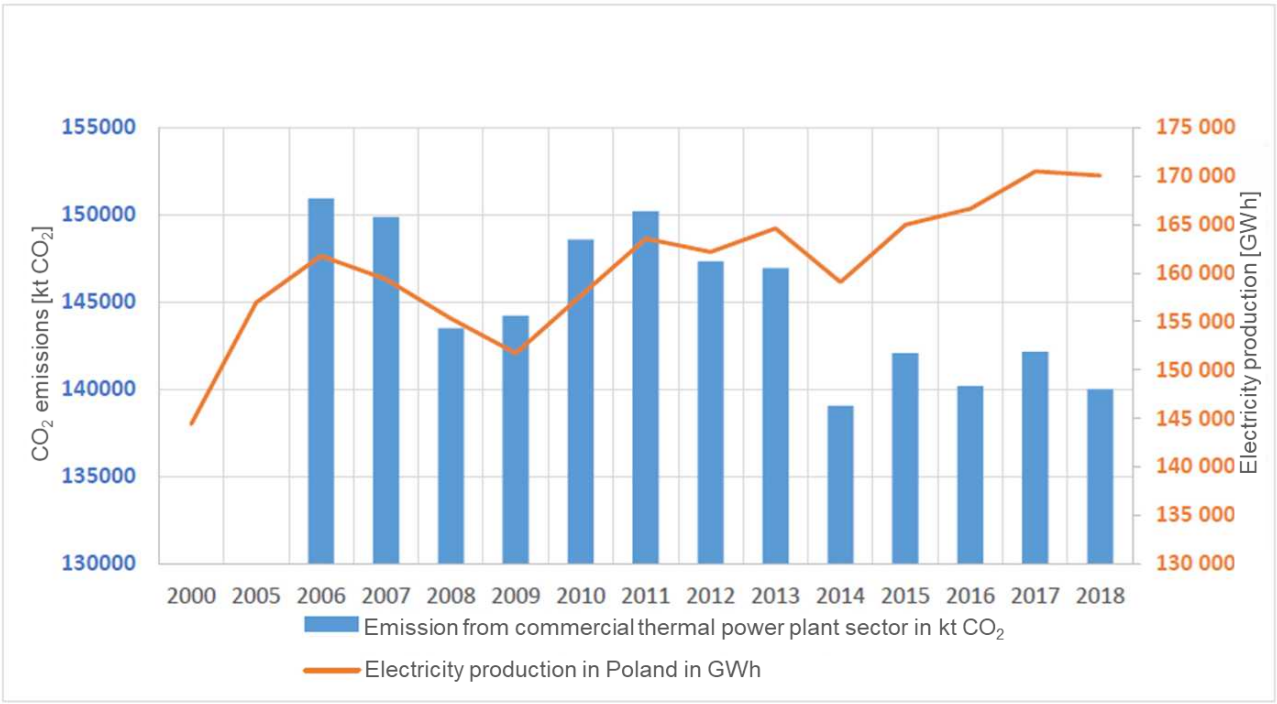


Figure 6. Dynamics of electricity production against GHG emissions from the commercial thermal power plant sector (2006-2018)

Regarding the development of renewable energy sources, their share in gross final energy consumption in 2018 was about 11%, with the nationwide 2020 target at 15%. The graphs below present progress towards the national RES targets for individual Member States. Attaining these targets is a challenge for a number of countries, even those pursuing the most ambitious climate and energy policies, such as France, Belgium, the Netherlands, Germany or the UK. Only 11 out of 28 EU countries have already achieved their national targets concerning the share of renewable energy sources in the gross final energy consumption set for 2020.

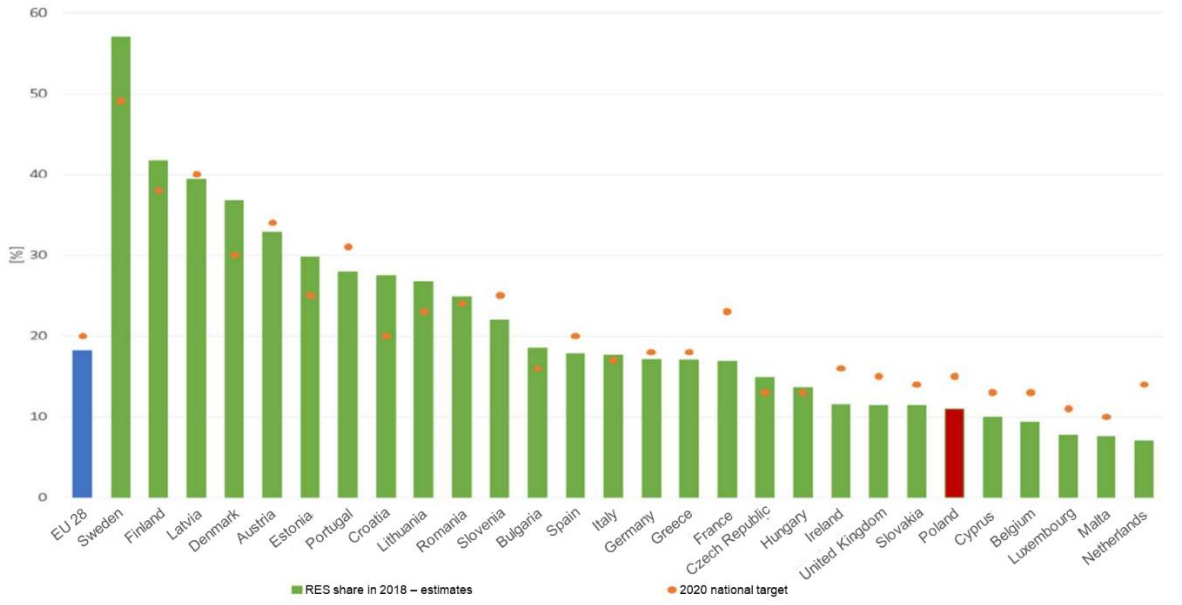


Figure 7. Attainment of 2020 RES targets in individual EU Member States

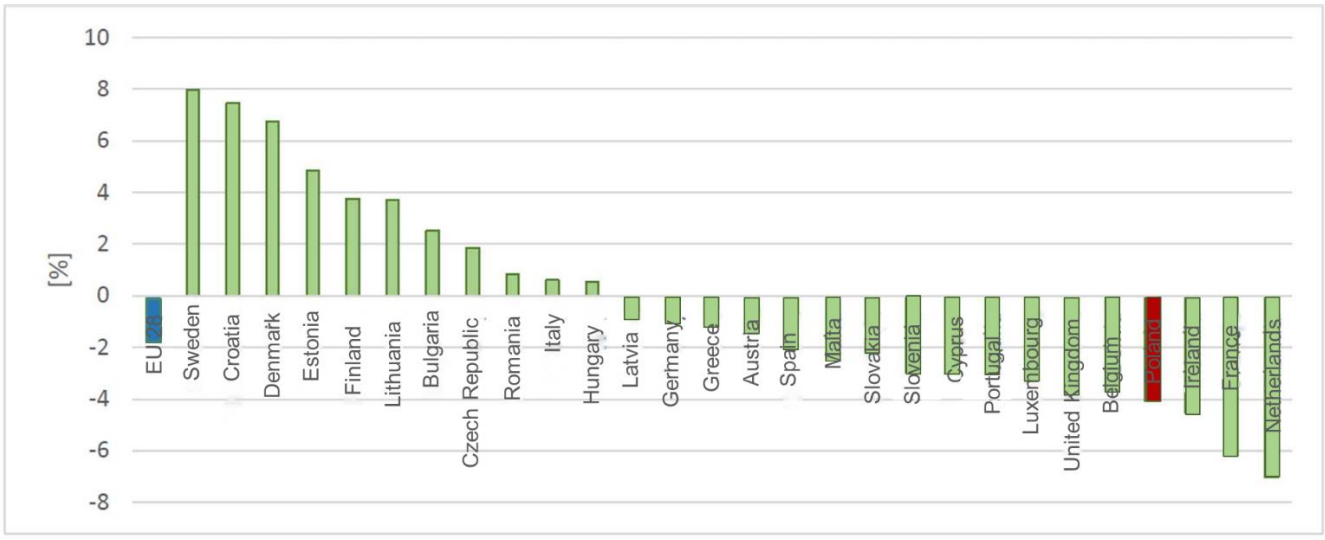


Figure 8. Difference between the share of RES in 2018 and the 2020 target

The deceleration of the increase in the share of RES in gross final energy consumption in recent years has been partly attributable to an increase in final energy consumption, resulting from the good economic situation in Poland and a high increase in the official consumption of diesel and gasoline connected with a decline of illegal trade in these fuels. The temporary stagnation of renewable energy development has been caused, *inter alia*, by a change in the regulatory environment through the Act of 20 May 2016 on investments in wind farms, and by the introduction of a new mechanism of auction-based support. Owing to weather conditions, despite an increase in installed capacity of RES, 2018 saw a decline in electricity production. The above factors slowed down the growth in the share of RES in gross final energy consumption.

Given the large share of domestic energy resources in the national energy balance, Poland is among the most energy-independent EU countries. The energy dependency rate for Poland was 38% in 2017, with the EU average at 55%.

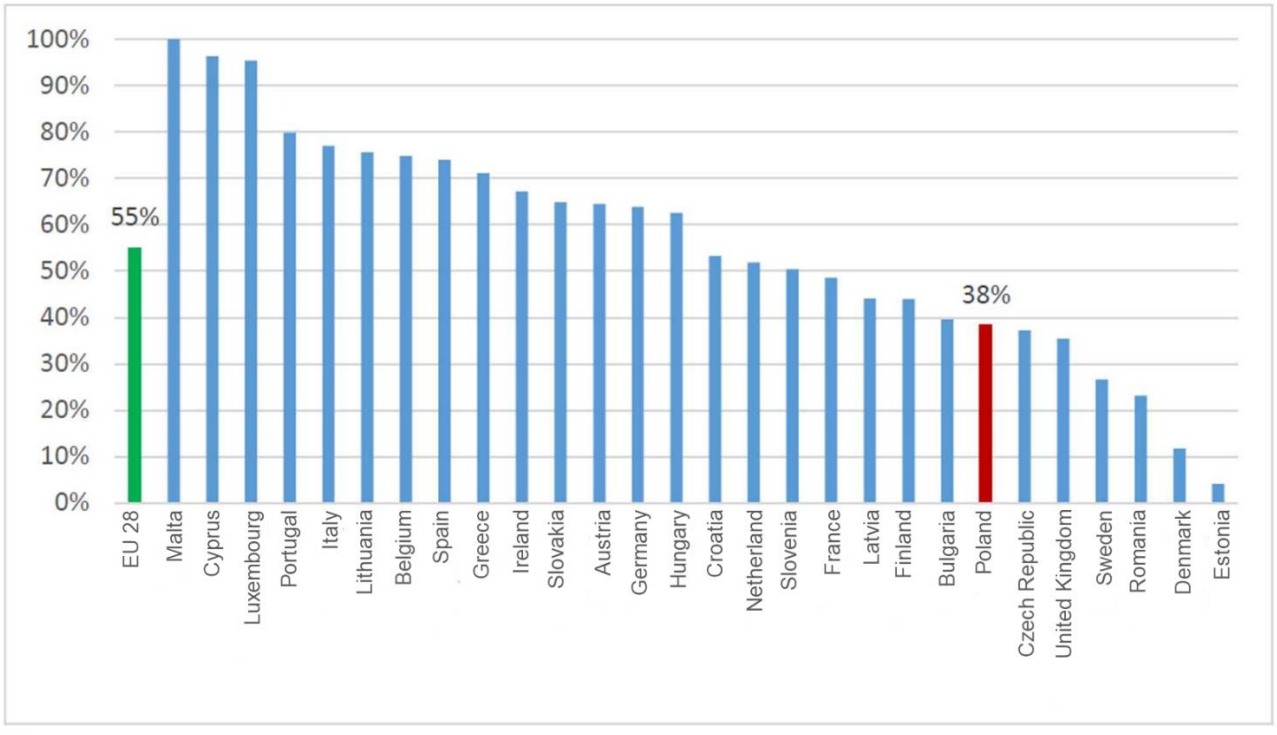


Figure 9. Energy dependency rates in the EU in 2017, Eurostat

At present, there are two strategic framework documents that define the state energy policy. They are: *The Energy Policy of Poland*, which is currently being updated (the public consultation of the draft *Energy Policy of Poland until 2040*, hereinafter *EPP2040*, as part of a strategic environmental assessment has ended), and the *Responsible Development Strategy 2020* – with an outlook for 2030 (adopted in 2017, hereinafter: Strategy for Responsible Development, Strategy or SRD).

The main objective of the Energy Policy is to ensure energy security while safeguarding the competitiveness of the economy and energy efficiency, reducing the impact of the energy sector on the environment and making the optimum use of own energy resources. The draft EPP2040 envisages eight strategic directions, namely: (1) making the optimum use of own energy resources, (2) expanding electricity-production and network infrastructure, (3) diversifying the supply of natural gas, oil, and liquid fuels and expanding the associated network infrastructure, (4) developing energy markets, (5) deployment of nuclear power, (6) developing renewable energy sources, (7) developing the heating and cogeneration sector, (8) improving energy efficiency of the economy.

With respect to the structure of energy carriers, the leading role of coal is planned to be maintained, but given the anticipated increase in the demand for energy, the need to reduce CO_2 emissions and the rule of rational management, which includes, *inter alia*, analysing the cost or resources, CO_2 emissions and use of state-of-the-arts technologies, the percentage share of this fuel in the energy mix will decrease gradually, down to approximately 56-60% in 2030. The above trend will continue in the following decade, i.e. until 2040. At the same time, Poland will prioritise diversifying energy carriers by successively increasing the share of RES (the role of which in electricity generation will be mainly enhanced by wind power and photovoltaics) and by including nuclear power in the energy balance starting from 2033. Increased use of natural gas will play an important role, too. Access to diversified sources and ease of obtaining gas as a commodity at a price acceptable to the final consumer will allow its wider use in the national economy for heat and electricity production. This will reduce the emissivity of the economy while, at the same time, providing an effective tool in fighting for clean air.

The latter of the above documents, i.e. the Strategy for Responsible Development, has a more general nature. In accordance with the Strategy, the main mission of the energy sector is to safeguard stable energy supplies for the economy, institutions and citizens, adapted to their needs as much as possible and at a price acceptable from the economic point of view. According to the SRD, this should be pursued through reasonable and effective use of locally available resources, waste-to-energy, and RES, while exploiting the potential of innovation in the generation, transmission and distribution of energy. At the operational level, the Strategy proposes increasing the share of stable RES, including energy clusters, cooperatives, etc. and giving continued priority to improving the energy efficiency of the economy, which includes eliminating emissions harmful to the environment. It is also essential that energy storage technologies be developed, along with the introduction of smart energy networks, the development of electromobility and the introduction of energy-saving and high-efficiency technologies. The strategy also includes projects supporting its implementation, which include: a capacity market, a regional gas transmission and trading hub, an electromobility development programme, developing and exploiting Poland's geothermal potential, unlocking the hydropower potential, and restructuring the hard coal mining sector,

The provisions of the above national documents are consistent with the energy policy principles formulated by the European Union. They include enhancing energy security, improving energy efficiency, building a stable and efficient internal market, reducing carbon emissions, increasing renewable energy generation and developing innovation in the energy sector.

The strategic directions of development introduced successively to date from the beginning of the current decade, along with the 2030 policy targets, are materialising through the Energy Union. The Union combines the approach applied to date with a new one that is to determine the EU's long-term energy policy until 2050. The Energy Union contributes to integration of efforts and promotes their uniform management, evaluation and assessment.

1.3. Current climate and energy policies and measures across five dimensions of the Energy Union

Poland pursues an active climate and energy policy and undertakes measures across all dimensions of the Energy Union.

The priority within the framework of the five Energy Union dimensions – from the perspective of the Polish raison d'etat and the country's stable development – is '**energy security'.** Two main components of

energy security must be analysed, i.e. electricity generation and gas and crude oil supply. In the former area, Poland undertakes measures to ensure the stability and continuity of electricity generation – based on domestic energy carriers – in order to satisfy internal demand. This includes regulatory measures and measures relating to investments in the generation, transmission and distribution infrastructure. As regards measures supporting electrical power security, attention should be drawn to the introduction of capacity market, which is to guarantee funding for the maintenance of additional capacity at times of increased demand and in peak periods (winter-summer) and secure intermittent energy sources (RES). This mechanism will enhance the stability of the entire electricity system. Additionally, activities are carried out to support the development of high-efficiency cogeneration and renewable energy sources, as well as to deploy nuclear power. Investments in these technologies aimed at restoring and increasing capacity in the electricity system ensure that energy security will be achieved consistently with the horizontal targets of the Polish energy sector, i.e. reduction in the emission of pollutants from the electricity sector, enhancement of energy efficiency and improvement of the competitiveness of the economy. Additionally, in order to safeguard security of supplies the electricity transmission and distribution infrastructure must be upgraded and expanded. The above will make it possible to evacuate power from existing generation sources and to connect new capacity, to improve the certainty of supplies to consumers, to create safe working conditions for RES, to ensure the possibility of reducing unscheduled power flows from the electricity systems of neighbouring countries and thus also to increase international power exchange capabilities, and to implement a uniform electricity market throughout the EU.

In 2017, the EU adopted two legislative acts which have now become the central regulatory pillars of European energy security, i.e. Regulation concerning measures to safeguard the security of gas supply (2017/1938) and Decision establishing an information exchange mechanism with regard to intergovernmental agreements and non-binding instruments between Member States and third countries in the field of energy (2017/684). The former document addresses directly the security of the natural gas market, while the IGA Decision provides for the exchange of information on intergovernmental agreements related to natural gas and oil. In Polish legislation, the security of resource supply is regulated by the Energy Law. The Diversification Regulation[1] (in force since 10 May 2017) is the latest legislative act relevant for the security of supply. It defines the maximum share of natural gas to be imported by an energy company from a single source in a given calendar year. This share may be 70% until 2022, but must not exceed 33% from January 2023 onwards.

The key projects enhancing Poland's energy security include the construction of a gas pipeline connecting Poland and Denmark across the Danish territory with gas deposits on the Norwegian continental shelf, known as the Baltic Pipe, and extension of the LNG terminal in Świnoujście. The projects are part of a wider infrastructure initiative referred to as the North-South Corridor[7]. In addition, two-way interconnections are planned with Slovakia, Lithuania, the Czech Republic and Ukraine. The above projects will enable Poland to establish a gas transmission and trading hub for Central and Eastern Europe and the Baltic states in Poland. Energy security activities will be gradually complemented by further diversification projects and intensified gas extraction by domestic gas companies from foreign deposits.

Poland does not have substantial **crude oil** reserves and mainly covers domestic demand by imports (approx. 96%). For the most part, Poland imports crude oil used by the refining industry from the east, but recently there has been a major shift in the structure of import directions as a result of an effective trade policy, but above all, an increase in Poland's technical capacity to receive and store oil. In order to secure supply, further measures are needed to ensure real diversification of directions and supplies.

Such measures are provided for by Resolution on the Policy of the Polish Government for logistics infrastructure in the oil sector, which was adopted by the Council of Ministers on 28 November 2017.

The main purpose of the Policy is to define actions to improve the fuel security of Poland. In light of the above, the Policy defines the following specific objectives:

1. Construction and development of logistics infrastructure in such a way as to ensure the supply of hydrocarbons to customers in crisis situations and secure smooth trading conditions for trading companies.
2. Construction and development of logistics infrastructure towards diversification of the sources and routes of crude oil supply to Poland.
3. Ensuring that companies fully owned by the State Treasury control the hydrocarbon transmission and storage infrastructure that is crucial for the state's fuel security.
4. In addition, both in relation to crude oil and fuels, as well as natural gas, the security of Poland is ensured by a developed system of intervention reserves based on the Act on reserves of crude oil, petroleum products and natural gas and on measures to be applied in response to threats to national fuel security and

disruptions on the crude oil market.

The diversification of the structure of the Polish energy balance while increasing the role of low- and zero-emission and high-efficiency technologies and solutions in all economy sectors will help to achieve positive results in the area of '**decarbonisation'**. With respect to the 2020 reduction targets, the Effort Sharing Decision defines a 'positive target' for Poland whereby sectors which are not covered by the ETS may increase their emissions by 14% as compared with 2005. In the above context, attaining the 2030 national reduction target in non-ETS sectors, which is set at -7% in the 2018 Effort Sharing Regulation, will be an ambitious challenge. Attaining the reduction goals ensuing from EU legislation, i.e. mitigating greenhouse gas emissions by at least 40% compared to the 1990 level, requires taking suitable actions also in non-ETS sectors, i.e. transport, where the 2030 EU reduction target is set at 30% relative to 2005. In order to meet the reduction goals and satisfy the projected increase in demand for fuels, Poland will support low-carbon transport, *inter alia* by developing alternative fuels, primarily electricity, as well as LNG and CNG, which will contribute to both reducing Poland's dependency on oil imports and to limiting the harmfulness of the transport sector to the environment.

The generation of renewable energy constitutes an important element of measures aimed at decarbonisation, as well as at energy diversification and the satisfaction of increasing energy demand. It reflects care for the natural environment and is an answer to the need to promote sustainable development as well as to strengthen regions and local communities in the European Union. The green energy sub-sector is tasked with supporting the energy security of the country without engaging excessive budgetary resources in a way divergent from real benefits for the public and the economy and the entire energy system. Poland supports the development of renewable energy defined in this way by undertaking a number of specific measures. These measures are implemented on the basis of the Act on renewable energy sources, which has been revised in 2016, 2017, and 2019. The legislation envisages a number of solutions aimed at creating a stable environment for the growth of production in the renewable energy sector. They are: energy clusters, energy cooperatives, an auction system for most of the key RES technologies, interim solutions for the green certificate system, support for prosumers and a range of rules and conditions for conducting activity in the field of electricity generation, agricultural biogas, heat and bioliquids, as well as instruments intended to support them in a systemic fashion. Additionally, the Polish Government supports, by means of legislative acts, distributed energy generation, especially clusters and energy cooperatives, which are designed as a technologically neutral tool available to any local community, which, by self-organising, has an opportunity to safeguard energy independence within the region where cooperation is developed.

The main value of such a bottom-up approach to RES lies in its contribution to the development of specific regions and local economies and stimulation of the labour market, which is achieved through the utilisation of resources available locally in the form of energy substrates, energy carriers, and human and financial capital and leads to their most effective use. At the same time, as a result of measures in the form of regulatory facilitations, as well as the allocation of additional funding, the number of emerging clusters is growing gradually. Ultimately, the energy cluster formula is to be the basic form of developing distributed renewable energy in the sector of medium-sized and partly large installations (selected technologies). Since February 2019, the Ministry of State Assets (formerly the Ministry of Energy), as part of the MENAG scientific consortium together with the AGH University of Science and Technology and the National Centre for Nuclear Research, has been pursuing a research project entitled "Development of distributed energy in energy clusters (KlastER)". The main goal of the project is to develop a "Strategy for the development of energy clusters in Poland". The solution fully implements the provisions of Articles 21 and 22 of Directive (EU) 2018/2.

Energy efficiency is another pillar of the Energy Union. The crucial act of Polish legislation in this area is the Energy Efficiency Act, which requires obliged entities to implement projects increasing energy efficiency (or to purchase white certificates, subject to a limit). The Act covers both the private and public sectors and imposes savings obligations on all entities. It enumerates energy efficiency improvement measures which can be employed by public bodies, including energy performance contracts. In accordance with the Act, the private sector, including large companies, is obliged to conduct energy audits at four years' intervals. The system transposes EU legislation into Polish law. Its main task is to achieve the goal of increasing energy efficiency by 20% in 2020 for the entire EU. For Poland, the target is set at 13.6 Mtoe in 2020 relative to the reference value for Poland calculated on the basis of the baseline scenario in a forecast prepared for the European Commission (PRIMES - Baseline 2007). In absolute terms, the target translates into primary consumption at a level of 96.4 Mtoe and final consumption reaching 71.6 Mtoe in 2020. The 2020 revision to the Act will transpose the provisions of Directive (EU) 2018/2002 of 11 December 2018 amending Directive 2012/27/EU on energy efficiency. Since 2019, this National Energy and Climate Plan has replaced the National Energy Efficiency Action Plan.

Another dimension of the Energy Union in which measures are undertaken is the **internal energy market**, which is being created through actions in the electricity and gas sectors. The area of EU internal electricity market requires a two-track approach and synchronisation. This implies undertaking measures ensuring energy sufficiency as well as expanding and intensifying cooperation as part of the pan-European system.

The responsibility for the transmission infrastructure in the Polish power system lies with Polskie Sieci Energetyczne PSE S.A., whose activity thus determines, to a large extent, the security of the entire energy system of Poland. The investment plans of the Polish transmission system operator are defined in short-, medium- and long-term perspectives. They have been formulated in several documents, including: Annual Tangible Investment Plan (IP) – one year's perspective; Contemplated Investment Plan (CIP) – five years' time horizon, Transmission Grid Development Plan (TGDP) – ten years' time horizon; Forecast concerning the security status of energy supplies – prepared for fifteen years. In the 2030 perspective, improving flow in the synchronous system of interconnections between Germany, the Czech Republic and Slovakia, and the full synchronisation of the transmission systems of the Baltic states will be particularly important. The incorporation and synchronisation of the power systems of associated countries, which are on the track towards closer relations with the EU, should be within the area of interest of the Members States, which are building the Energy Union.

In 2019, pursuant to Article 15 of Regulation (EU) 2019/943, an Action Plan was drafted to fulfil the obligation to provide market participants with cross-zonal capacity of at least 70% of the transmission capacity (CEP 70% target). With the application of the Plan, the deadline for achieving the CEP 70% target is 31 December 2025. The Plan applies to one synchronous area (borders: Poland - Germany, the Czech Republic, Slovakia) and one asynchronous border: Poland - Sweden. The Action Plan does not apply to the second asynchronous border: Poland - Lithuania. Therefore, on the Poland - Lithuania border, the CEP 70% target will be attained as from 1 January 2020, which stems from international obligations.

The programme for building a smart power network is a major project for the next years in Poland. It encompasses work on organisational and legal solutions which will enable the deployment of new technologies such as smart metering. Only then will it be possible to implement electricity demand management mechanisms and, as a result, to use electricity in a more sustainable manner. This will be possible by bridging the gap in knowledge about measures and preferences between energy consumers and its producers and suppliers.

Operator Gazociągów Przesyłowych GAZ-SYSTEM S.A. is the natural gas transmission infrastructre operator, which ensures that the developed transmission infrastructure fosters Poland's energy security. In accordance with EU guidelines and Article 16.2 of the Energy Law, GAZ-SYSTEM draws up a 10-year national development plan. The activities related to gas supply source diversification presented in the 2018-2027 Development Plan assume that the principal new sources of imported gas will be located in the north-west of the country and will include the Baltic Pipe with the capacity of the interconnector of up to 10 billion m^3 per year, and the expanded LNG terminal in Świnoujście with a capacity of 7.5 billion m^3 annually. The operator also focuses on developing interconnections with Poland's neighbours, i.e. Lithuania, Slovakia, the Czech Republic, and Ukraine, and the expansion of domestic transmission infrastructure.

Poland actively participates in the legislative work of the Council of the European Union and its auxiliary bodies on legislative projects related to electricity and natural gas markets. It also partners up with neighbouring countries and international organisations, including the International Energy Agency, the Energy Community, the Energy Charter Treaty, and the Eastern Partnership, to create a secure energy environment. The Energy Regulatory Office, which is the Polish electricity and gas market regulator, cooperates with its counterparts through the Agency for the Cooperation of Energy Regulators (ACER). The goal of the Agency's work is to create an efficient and transparent internal market for electricity and natural gas in the EU. Polish electricity and natural gas system operators are also members of European associations influencing the EU energy market. PSE S.A. is a member of the European Network of Transmission System Operators for Electricity (ENTSO-E), while GAZ-SYSTEM S.A. is a member of the European Network of Transmission System Operators for Gas (ENTSO-G). Immediately after the establishment of the ACER, i.e. in 2011, ENTSO-E proposed the Electricity Target Model. Poland has been engaged in the implementation processes of this model. At present, cooperation is coordinated at the regional level and then a project covering the entire EU is to be launched. By virtue of a decision of the ACER, a central macro-region has been created for coordinating cooperation for the implementation of the market model adopted in 2011. At present, Poland belongs to the recently expanded CORE area that brings together energy systems of thirteen centrally located European countries, working jointly to establish a common energy market. An analogous analysis was carried out by the Council of European Energy Regulators (CEER) for the natural gas market, which resulted in the creation of the Gas Target Model

in 2011. The study was devoted to access to infrastructure on the wholesale market and development needs. In 2014, ACER updated the analysis to promote the introduction of flexible regulatory frameworks on the gas wholesale market in order to increase its liquidity and develop tools to support its integration. As a result of the analysis, work was started on the gas network codes adopted in previous years, to regulate *inter alia* the following issues: congestion management, capacity allocation mechanism in transmission networks, gas balancing rules in transmission networks, transmission tariff structures, interoperability, and information exchange.

The area of "**research, innovation and competitiveness**" is one that is being given an increasing attention. The energy sector sees an ever increasing need for developing a new approach, the most important tools of which will be new technologies and process innovations. Poland's innovation policy is being focused on implementations. State budget resources are used in combination with European funds and energy companies' own funds. The pro-innovation activity of energy companies is a trend that supports the innovation-oriented approach. An ever increasing tendency is developing in Poland – supported by the government's activity – consisting in offering incubation schemes to start-up businesses which create ideas and develop their activity in the energy sector. Leading Polish energy companies have established their own acceleration centres for newly established companies (incubators) and joint venture companies. The newly established entities include: PGE Ventures (a company set up by PGE S.A.), InnVento – a technology incubator (an entity set up by PGNIG S.A.), Tauron Magenta (established by Tauron S.A.), Enea Innovation (a venture capital company set up by Enea S.A.), ORLEN Innowacje&Startupy (a platform and incubator of ORLEN). The activity of Polish energy companies in the area of incubation and acceleration of new projects, as well as the visible role of the state in stimulating R&D activities in the energy sector, is expected to result in a growing level of innovation of the Polish energy sector over the next few years.

The electromobility development project is a flagship initiative in the field of innovative solutions strongly related to the energy sector. It is being developed with a strong participation of the state – in regulatory and funding terms – but it is to become reality through intense cooperation with energy companies, transport sector companies and other players representing the private sector. At present, the direction for the electromobility project is set by the Strategy for Responsible Development, and in more detail by the Electromobility Development Plan 'Energy for the Future'. Subsequently, at the implementation level, the project is delivered under the Act on electromobility and alternative fuels, adopted on 22 November 2018, as well as under a number of supporting legislative acts. The objective of the project is to create conditions for the development of electromobility. This is to be achieved through support for expanding the core infrastructure network and the system of incentives encouraging potential buyers to purchase electric vehicles, and for developing industry towards the use of vehicles with alternative drives. For 2025, the programme sets an indicative target of a million electric-drive vehicles. The programme also envisages an increase in the number of LNG or CNG fueled vehicles, including the construction of 4 installations for gas bunkering for vessels on the Polish coast. Stabilisation of the electricity network will be another positive effect for the Polish power system. Using it to charge so many vehicles, while providing the right incentives to create the desired behaviour on the part of electric vehicle users (e.g. night tariffs for recharging electric vehicles), will help flatten the electricity demand curve and thus stabilise it, which will be beneficial in terms of the operating characteristics of the key power generation units in the Polish energy system. The above-described programme is one of the main strategic development programmes aimed at improving the innovation of the energy and transport sector, changing it to stimulate more sustainable development of the country and joining the world's leader states in the field of electromobility.

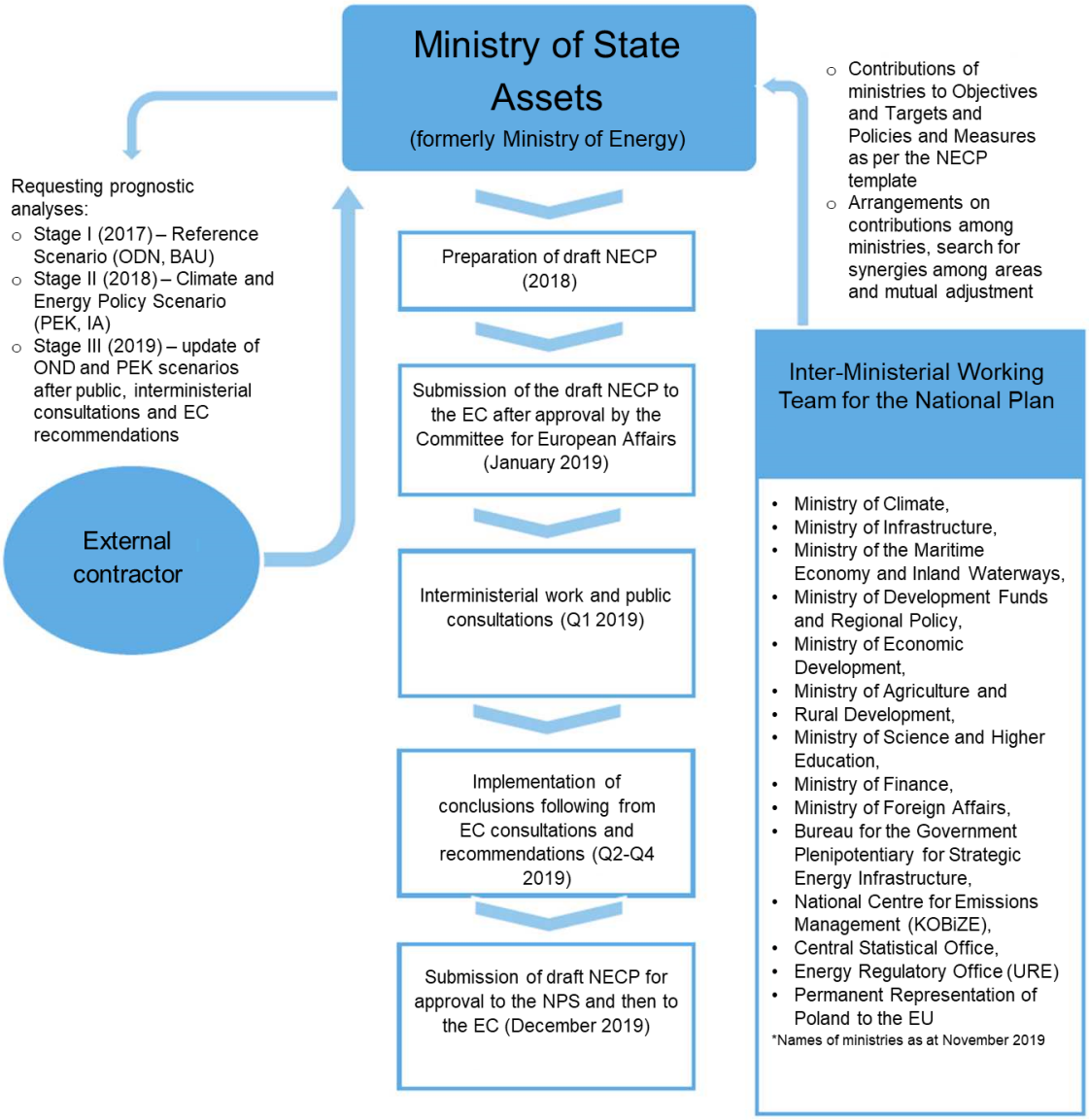
1.4. Administrative structure of the implementation of national climate and energy policies

The National Energy and Climate Plan presents policy lines consistent with and complementary to the country's horizontal development strategy, i.e. the Strategy for Responsible Development, and its integrated sectoral strategies, which were updated in 2019 or are currently being updated, in particular with draft Energy Policy of Poland until 2040, the draft State Environmental Policy 2030 – strategy for development in the area of environment and water management, the Sustainable Transport Development Strategy 2030, and the Strategy for Sustainable Development of Agriculture, Rural Areas and Fisheries for 2030.

The responsibility for implementing measures aimed at meeting the targets set in the National Plan rests on a number of public bodies, depending on their scope of competence, as well as – at the operating level – on private entities.

The graph below presents the structure of entities engaged in the preparation of the draft NECP along with the

chart showing the process of developing it to date.



1.5. Implementing entities

The responsibility for the implementation of the National Energy and Climate Plan 2021-2030 lies with a range of entities: central and local government bodies, government institutions, fuel and energy sector entities, as well as economic operators that fulfil statutory obligations and implement good practices in the field of energy use.

The following entities play a central role in implementing the National Plan. If the Act on divisions of government administration is revised, the competence of individual ministers may change.

- Minister competent for energy
- Minister competent for the environment
- Minister competent for transport
- Minister competent for regional development
- Minister competent for agriculture and rural development
- Minister competent for development, land use planning, spatial development and housing
- Minister competent for maritime economy and inland navigation
- Minister competent for the economy
- Minister competent for foreign affairs
- Minister competent for public finance

- Minister competent for family, labour and social security
- Minister competent for science and higher education
- Minister competent for education and upbringing
- Government Plenipotentiary for Strategic Energy Infrastructure
- Plenipotentiary of the Prime Minister for the “Clean Air” Programme
- President of the Polish Energy Regulatory Office
- President of the National Atomic Energy Agency
- The National Fund for Environmental Protection and Water Management
- Transmission system operators and distribution system operators
- Storage System Operator
- Local governments
- Research institutes and universities
- Enterprises

1.6. Executive summary

The National Energy and Climate Plan has been prepared with a view to establishing a stable framework forming an environment for a sustainable, economically effective and just transition towards a low-carbon economy. This document is to produce synergy through the delivery of activities in the five interrelated dimensions of the Energy Union, taking into account the "energy efficiency first" principle. The second chapter of the document describes the national assumptions and goals of Poland's energy and climate policy, while the third the policies and measures designed to implement them. Because some goals, as well as policies and measures, aim at strengthening more than one dimension, they are assigned to those where they are expected to have the greatest impact. In order to add clarity to the document, the assumptions and goals, as well as policies and measures, are marked with the colours assigned to the individual dimensions of the Energy Union.

The main goals of Poland's energy and climate policy which are identified in this document and constitute the future measure of its implementation are presented in the graph below. It should be noted here that the renewable energy use target is conditional, i.e. attainable at 23% if Poland is granted additional EU funds, including those allocated for just transition. The national targets contribute to the joint fulfilment by the EU of its climate commitments under the Paris Agreement and to the pursuit of climate neutrality.

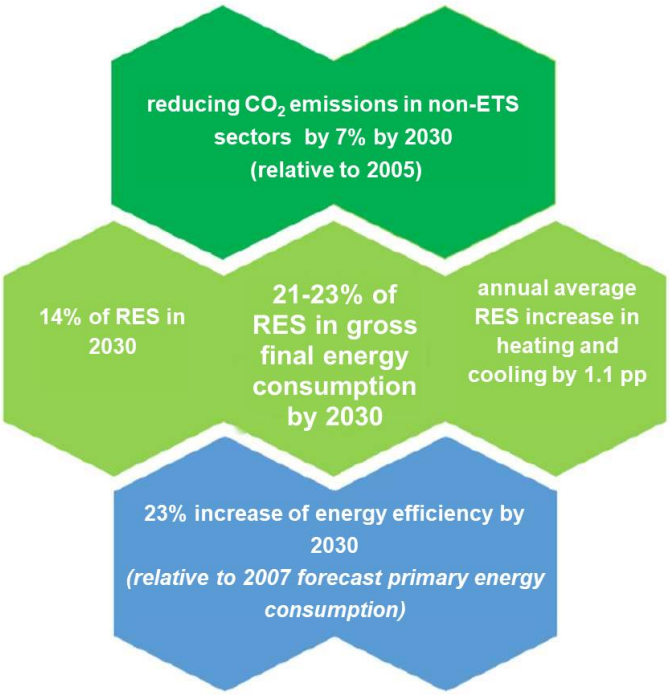


Figure 10. Poland's 2030 climate and energy goals

Decarbonisation

The decarbonisation dimension addresses issues related both to emission and removal of greenhouse gases and air pollution, as well as those regarding the use of renewable energy sources. Given the ever more frequent extreme weather phenomena, the adaptation to climate change is also taken into account.

The reduction target for Poland in terms of greenhouse gas emissions in sectors not covered by the ETS is set at -7% in 2030 compared with 2005; The declared target is to be achieved by reducing emissions in transport, construction and agriculture, taking into account the beneficial effects of the absorption of CO_2 by ecosystems and the flexibility associated with land use, change to land use, and forestry. In this context, crucial importance is also attached to improving the quality of life for people living in Poland, notably the protection of their health and living standard, having regard to environmental protection. In particular, this means solving the problem of 'low-stack' emissions, which are produced by transport and individual heat sources.

As part of meeting the EU-wide 2030 target, Poland declares to achieve a 21%-23%* share of RES in gross final energy consumption (aggregate consumption in the electricity sector, heating and cooling sector, and in transport) by 2030. By 2030, the share of RES in the heating and cooling sector is estimated to grow on average by 1.1 percentage points annually. In transport, a 14% share of renewable energy is expected to be achieved by 2030. In order to attain the above targets, RES is planned to be supported through existing and new support and promotion mechanisms. There are also plans to use advanced biofuels, develop offshore wind energy, and add momentum to the development of RES-based microinstallations.

Energy efficiency

The PRIMES 2007 forecast sets the 2030 national target for improving energy efficiency at 23% for primary energy consumption, which corresponds to primary energy consumption at 91.3 Mtoe in 2030. Actions aimed at reducing energy consumption are given priority since they simultaneously lead to further reduction of emissions and contribute to achieving the energy and climate goals. In this context, developing eco-friendly and effective heating systems, cogeneration, smart grids and mechanisms stimulating energy end-use savings and pro-saving behaviour come to the fore. Both as regards energy efficiency and improvement of the housing conditions for residents, it is considered important to develop a long-term strategy for the renovation of Poland's stock of residential and non-residential buildings, both public and private ones, as provided for by revised Directive 2010/31/EU. Actions are also planned to increase energy efficiency in transport, by promoting more sustainable methods of transporting goods (e.g. intermodal transport, rail transport) and passengers (e.g. public transport). The document provides for increasing energy efficiency through the creation of a coherent, sustainable, innovative and user-friendly transport system at the national, European and global level.

Energy security

Energy security is treated as a priority in Poland. In this dimension, satisfying the growing demand for fuels and energy in connection with the forecast economic growth and ensuring uninterrupted energy supplies are of utmost importance. Maintaining far-reaching energy independence, diversifying the energy mix and directions of imported fuel supplies are a central focus in this context. This pertains to both crude oil and natural gas, which means that there is a need for infrastructure development in these sectors.

In order to satisfy the growing demand for electricity, adding more electricity generation capacity will be needed. The National Plan highlights the deployment of nuclear power in Poland as crucial for ensuring stable supply of electricity and for diversifying energy sources. The first unit (with a capacity of ca. 1-1.5 GW) of the first nuclear power plant is expected to be commissioned in 2033, with another five units to be launched every 2-3 years (with a total capacity of approx. 6-9 GW).

Given the availability of domestic hard coal and lignite deposits, domestic coal production is expected to be maintained at a level capable of satisfying the demand of the energy sector. However, the share of coal in electricity production will gradually decline. In 2030, it is bound to reach 56-60%, with the downward trend maintained until 2040.

Internal energy market

In developing its internal energy market, Poland will strive to enhance the availability and capacity of existing power interconnections and to integrate the national natural gas transmission system with the systems of Central and Eastern European countries and the Baltic region. In this context, further investments in internal gas and electricity networks that will ensure security of energy supply will also be necessary. As regards production of energy from renewable sources, measures will be taken to guarantee an appropriate level of flexibility of the energy system. In order to drive the development of a competitive market, the aim is to increase consumers' knowledge and incentivise them to play a more active role in the energy market, while curbing energy poverty and protecting vulnerable groups.

Research, innovation and competitiveness

* The 23% target is achievable only if Poland is granted additional funds, including those allocated for just transition.

Research, innovations and actions enhancing the competitiveness of the economy will be crucial for delivering the objectives and policies outlined in the NECP since this dimension intertwines with others by providing new technologies and solutions conducive to energy transition. The central aim in this dimension is to bridge the civilization gap between Poland and developed countries, and to improve the living standards for Polish society. Poland also intends to boost the competitiveness of the economy through a more complete use of social and territorial resources and automation, robotisation and digitisation of enterprises. By supporting the development of energy innovations, Poland intends to enhance the competitiveness of the Polish energy sector and thereby maximize the benefits for the Polish economy. Another goal is to accelerate sales of technologies by Polish companies on foreign markets, which is associated with adding international importance and competitiveness to Polish science. The objectives in this respect will be delivered through increased expenditure on R&D in Poland (from 0.75% of the GDP in 2011 to 1.7% in 2020 and 2.5% in 2030) and new rules for using such expenditure, better suited for present conditions. In order to maximise benefits, it is reasonable to further cooperation with the European Commission and EU Member States regarding the Strategic Energy Technology (SET) Plan. One of the main research goals will be to determine the potential for production, use and development of hydrogen technologies in Poland.

2. NATIONAL OBJECTIVES AND TARGETS

The structure of this chapter reflects the systematics and numbering from Annex I to Regulation 2018/1999

2.1. Decarbonisation

The objectives and priority lines related to the decarbonisation dimension are set out by sectoral development strategies, primarily by:

- State Environmental Policy 2030 – strategy for development in the area of environment and water management of 16 July 2019
- Sustainable Transport Development Strategy 2030 of 24 September 2019
- 2030 Strategy for Sustainable Development of Agriculture, Rural Areas and Fisheries of 15 October 2019
- Draft Polish Energy Policy – strategy for the development of the fuel and energy sector (November 2019).

2.1.1. Greenhouse gas emissions and removals

a)	Member State's binding national 2030 target for greenhouse gas emissions in the non-ETS sectors, the annual binding national limits in accordance with Regulation (EU) 2018/842[2] and the commitments under Regulation (EU) 2018/841[3];	**1.** Non-ETS (greenhouse gas emissions from the non-ETS sectors): **On the basis of Regulation (EU) 2018/842, the greenhouse gas emission reduction target in the non-ETS sectors has been set at a level of -7% in 2030 as compared with its level in 2005.** The non-EU ETS sectors (mainly transport, agriculture, municipal and domestic sector, waste management, as well as non-ETS industrial emissions) are a source of ca. 50% of the total greenhouse gas (GHG) emissions in Poland. For 2020, the Climate and Energy Package sets, *inter alia*, the EU-wide 20% GHG emission reduction target (compared with 1990), including the target for the non-ETS sectors of -10% as compared with 2005. The ESD (Effort Sharing Decision, or the non-ETS Decision) has set national targets for Member States for 2020, as their contributions to the EU-wide ambition. In accordance with the above regulation, Poland may increase emissions in non-ETS sectors to +14% until 2020 relative to 2005. By adopting the new EU Climate and Energy Policy framework, the EU set a 2030 reduction target for greenhouse gas emissions of 40% relative to 1990, including a target of 30% for non-ETS sectors compared to 2005. Poland's contribution to the above target in non-ETS sectors is set out in Annex I to the ESR Regulation[4]. **The proposed 2030 reduction target of - 7% should be considered an ambitious commitment.**
		2. Share of the LULUCF sector in meeting the 2030 reduction targets in the EU. The LULUCF Regulation sets out the accounting rules (the rules for generating carbon credits to be possibly used to account for national emissions of greenhouse gases in the non-ETS sector) based on the net balances of emissions and removals of greenhouse gases for utilised forest land, cropland, grassland and afforested and deforested land from 2021 to 2030. In the LULUCF Regulation, the Member States have been proposed the maximum values of the generated credits (accounting allocations) from the managed forest land category. **These allocations have been limited to 3.5% of the national emission of a given Member State in the base year.** As part of the mechanism of credit generation

		the reference levels must be taken into account as the minimum removal value for managed forest land. Reaching these minimum values will be a condition for generating credits, if any. The reference levels will be set in line with the forest stock development scenarios prepared on the basis of the effect of forest practices observed in the period 2000-2009, which are being developed at the national level. The National Forestry Accounting Plan, developed by the Ministry of the Environment in 2018, is the relevant document in this respect. The National Forestry Accounting Plan lists the detailed actions to be taken to implement Article 4 of the LULUCF Regulation. The LULUCF Regulation has also introduced a mechanism for **compensating possible emissions from managed forest land in case the country does not reach a removal value equivalent to the reference level.** Nevertheless, its operation has been based only on a single limited parameter, namely the afforestation rate of the Member State (the average afforestation rate for the reference period 2000-2009). **Poland has been allocated a compensation limit for 10 years (2021-2030) amounting to -22.5 million tonnes of CO_2 equivalent (this is the total maximum limit that can be used over a period of 10 years).** Poland does not rule out the use of the ESR/LULUCF flexibility mechanism. **For cropland and grassland, the proposed base level** for accounting purposes is the average value from the years 2005-2009. On average, it will total **ca. 1500 kt of CO_2 equivalent for the entire accounting period** – this is a preliminary value (consistent with the National Inventory Reports submitted to the UNFCCC Secretariat). Only the accounts of afforesting/deforesting balances and harvested wood products (with the exclusion of paper) will not be limited, either by the allocation or by the reference level.
b)	If applicable, other national objectives and targets consistent with existing long-term low emission strategies. If applicable, other objectives and targets, including sector targets and adaptation goals.	**1.** Efforts to mitigate national greenhouse gas emissions, including CO_2 The effects of climate change observable in the last few decades are deepening, especially as regards the increase in frequency and severity of extreme weather phenomena. Thus, they pose a threat to social and economic development and to natural resources. It is therefore necessary to take further measures to mitigate greenhouse gas emissions and, in parallel, to exercise efforts to adapt to the anticipated impacts of climate change. As regards measures to reduce GHG emissions, the State Environmental Policy 2030 acknowledges the reasonableness of contributing to the objectives of the EU's 2030 climate policy and the Paris Agreement. Among the indicators of the delivery of the State Environmental Policy 2030, the Policy points to reducing the nationwide dynamics of greenhouse gas emissions to 77.1% compared to the reference year 1990. The draft Energy Policy of Poland until 2040 envisages a 30% reduction of domestic CO_2 emissions by 2030 (compared to 1990).
		2. Reduction of the negative impact of transport on the environment, as envisaged by the Sustainable Transport Development Strategy 2030: - **2025 intermediate target – reduction of average CO_2 emissions from new**

		passenger cars and light commercial vehicles by 15% compared to 2021; - **main target – from 2030, reduction of average CO_2 emissions from new passenger cars by 37.5% and light commercial vehicles by 31% compared to 2021;** These targets strengthen pressure to move away from vehicles with conventional combustion engines and to switch to clean vehicles (and to minimise the effects of the development of the transport sector on the environment, including among other things to slow down the increase in greenhouse gas emissions). The task of reducing emissions in the transport sector will be even more challenging given the fact that further significant growth in transport volumes, especially freight transport, is envisaged both in Poland and throughout the EU as an unavoidable effect of continued economic growth. The expected emission reduction will require both the optimisation of transport needs, and the use of the potential of the transport system and an increase in the use of alternative fuels.
		3. Improving the quality of the environment and environmental safety, with account taken of the principles of sustainable development until 2030, by implementing the State Environmental Policy 2030, which will produce, *inter alia*, the following effects: increasing the Environmental Performance Index[8] to > 70 points compared to 64.11 points in 2018, improved status of surface and underground water bodies, the percentage of population using a sewerage system relative to the total population increased to 85% from 70.5% (in 2017). the percentage of population using a sewage treatment plant increased to 86% from 73.6% (in 2017), achieving the limit and target values for substances defined in Directives 2008/50/EC and 2004/107/EC, and maintaining them in the areas in which they have been met, and in the case of PM2.5, also the exposure concentration limit and the National Exposure Reduction Target, achieving, by 2030, the levels of substance concentrations in the air specified by the WHO and meeting new requirements under legal regulations proposed in EU laws. total reduction of the number of zones with exceedances of the limit value for PM10, increasing the number of agglomerations and cities with more than 100,000 residents where the average exposure indicator does not exceed the PM2.5 exposure concentration limit of 20 µg/m^3 to 30 compared to the base level of 11 cities, reducing the share of degraded areas in the total area of the country.
		4. Adaptation to climate change by ensuring sustainable management of

[8] *Environmental Performance Index*, https://epi.envirocenter.yale.edu/. The Environmental Performance Index consists of a series of measures of environmental health (e.g. air quality, water status, environmental impact on human health) and the health and vitality of ecosystems (e.g. wastewater treatment, nitrate pollution, changes to afforestation, fish stocks, species protection, level of GHG emissions).

		environmental resources and the effective functioning of the economy and society in climate change conditions through the implementation of the State Environmental Policy 2030, which will produce, *inter alia*, the following effects: - the percentage of inhabitants of Polish cities covered by urban adaptation plans increased to 60% (compared to the base value of 0% in 2015); - the capacity of small retention reservoirs increased to approx. 844 836 dam^3 (compared to the base level of 826 034.2 dam^3 in 2016), - increasing the afforestation rate in Poland to 31% from the current 29.6%; - progress towards sustainable forest management, by increasing from 95.7% to 99% the share of forest areas subject to approved forest management documentation relative to the total forest area, - covering 100% of Natura 2000 areas with conservation task plans and protection plans, - level of municipal waste prepared for reuse and recycling at 60% by weight.
		5. Reducing emissions of anthropogenic pollutants into the atmosphere: sulphur dioxide (SO_2), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOCs), ammonia (NH_3), and fine particular matter (PM2.5) by 2030. Directive 2016/2284 of 14 December 2016 on the reduction of national emissions of certain atmospheric pollutants, amending Directive 2003/35/EC and repealing Directive 2001/81/EC (NEC Directive) obliges Poland to achieve its pollution reduction targets in two periods, namely 2020-2029 and from 2030 (relative to the reference year 2005). The targets are as follows: - 59% and 70% for SO_2, - 30% and 39% for NOx, - 25% and 26% for NMVOC, - 1% and 17% for NH_3, - 16% and 58% for PM2.5,
		6. Reduction of the share of coal and lignite in electricity production to 56-60% in 2030 and further decreasing trend until 2040 At present, the share of coal and lignite in electricity generation is ca. 77%. The share of coal-fired generation units will gradually decrease as a result of the decommissioning of old end-of-life conventional generation units which do not meet the environmental requirements in terms of pollution emissions (BAT conclusions), and the deployment of high-efficiency conventional technologies. The implementation of technologies that are characterised by high efficiency of energy generation and reduce losses (e.g. in transmission) will add considerably to sustainable use of energy resources and reduction of pollutant emissions. The need to replace production technologies will gradually increase the share of low- and zero-emission technologies, in particular RES and nuclear power. Given the Polish conditions, gas will be a crucial transformational fuel in the transition period, with its importance growing not only in power generation (reserve power units for RES), but also in heating (district and individual heating) and

		transport (as an alternative fuel). As an effect of changes in the electricity generation sector, CO_2 emissions will decrease. In the energy transition process, a key point is to ensure that investments are financed in line with the principle of technological neutrality, without limiting the possibility of obtaining financing for any zero-emission technologies, and in the transitional period, low-emission technologies.
		7. Just energy transition towards decarbonisation In Poland, the medium- and long-term energy transition will proceed in an evolutionary manner, such as to guarantee energy security, and at an acceptable pace from the social, economic and regional perspective. Care will be exercised to carry out this process in the most equitable way and at the lowest possible cost. Poland is in a specific situation compared to other EU countries due to a different starting point, economic, energy and technological conditions, reduction potential and financial capabilities. In the case of Poland, the costs of energy transition will be among the highest of all EU Member States. The decarbonisation strategies in individual sectors will rely on a balanced approach, taking into account the need to protect the competitiveness of the Polish economy and its individual sectors, as well as the social dimension, by reducing disproportionate costs of the transition, especially among low-income earners. The above activities will affect the labour supply in related sectors, the welfare of Polish regions, and the wealth of the whole society. Energy transition is a major challenge in Polish conditions, but also an economic opportunity for investment, economic growth and employment, producing concrete benefits such as diversification of the energy mix, cleaner air, local economic development, and jobs. The success of this process depends on a suitable adaptation policy, supported by domestic and European funds.
2.1.2. Renewable energy (2030 Framework Target)		
a)	Planned share of renewable energy in gross final energy consumption in 2030 as a contribution to the binding EU target being at least 32% in 2030.	As part of meeting the EU-wide 2030 target, Poland declares to achieve a **21%-23% share of RES in gross final energy consumption** (aggregate consumption in the electricity sector, heating and cooling sector, as well as for transport purposes) by 2030, **with a proviso that attaining the 23% will be possible if Poland is granted additional EU funds, *inter alia* for just transition.** The scale of use of RES will largely depend on technological progress – both in the area of existing energy generation methods and entirely new technologies, but also in the area of energy storage technologies. **By 2030, the share of RES in the heating and cooling sector is estimated to grow on average by 1.1 percentage points annually**, i.e. to 28.4%. In **transport**, a **14% share of renewable energy is expected to be achieved by 2030,** while that in the **energy sector** is bound to grow **to around 32%** by the same

		year. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of renewable energy obliges Poland to achieve a minimum 15% share of renewable energy in gross final energy consumption by 2020. In 2018, the share of renewable energy in gross final energy consumption in Poland was 11%. Having regard to the progress in the development of RES to date, the national commitment concerning 2030 should be regarded as ambitious.
b)	Linear trajectory of the share of renewable energy in gross final energy consumption in the period 2021-2030.	Provided that additional financial support from EU funds is available, the trajectory for achieving the 23% renewable energy share in gross final energy consumption may be as follows: ➢ Base year 2015: 15% ➢ 2022 16.4% ➢ 2025: 18.4% ➢ 2027: 20.2%
c)	Trajectories of the sectorial share of renewable energy in final energy consumption in the electricity, heating and cooling and transport sectors in the period 2021-2030.	Given the detailed nature of the data, it is presented in the analytical material: Annex 2 to the NECP – 'Assessment of the impact of planned policies and measures' (Annex 2, Chapter 5.1.2.2. Renewable energy).
d)	Trajectories by renewable energy technology that are projected to be used to achieve the overall and sectorial trajectories for renewable energy from 2021 to 2030, including expected total gross final energy consumption per technology and sector in Mtoe and total planned installed capacity (divided by new capacity and repowering) per technology and sector in MW.	
e)	Trajectories on bioenergy demand, disaggregated between heat, electricity and transport, and on biomass supply, by feedstocks and origin (distinguishing between domestic production and imports). For forest biomass, an assessment of its source and impact on the LULUCF sink	Given the detailed nature of the data, it is presented in the analytical material: Annex 2 to the NECP - 'Assessment of the impact of planned policies and measures' (Annex 2, Chapter 5.1.2.2. Renewable energy).
		1. As regards forest biomass, the main energy sources include round or cleft wood, rootwood and wood residues from forests and tree stands, as well as wood processing industry by-products. In the context of accounting for and reporting greenhouse gas emissions from forest biomass used for energy purposes, it should be noted that it is included when accounting for and reporting the balance of removals and emissions of those gases as part of the forest land category. Emissions relating to forest biomass utilised for energy purposes are reported and accounted for as an effect of woodland biomass loss.
		2. <u>Potential of biomass used for energy purposes</u> Approximately 13% of the[5] domestic biomass potential can be allocated for energy purposes without causing adverse effects in the form of soil degradation and a decrease in the supply of food while complying with the environmental protection requirements under the Common Agricultural Policy. The energy potential of agricultural biomass in Poland, which includes both special purpose crops and

		agricultural and agri-food-processing industry by-products, is ca. 900 PJ annually[6]. The most commonly available raw material to be used for energy purposes is straw. On average, the surplus of straw in Poland amounts to approximately 3.1 million tonnes, ranging from 2 to 4.5 million tonnes, depending on cereal yields in a given year[7]. Biomass stocks from energy crops are estimated to range from 120,000 to 130,000 tonnes of dry matter, and orchard wood stocks are estimated to amount to ca. 88,700 tonnes annually[8]. Along with the development of the agricultural biogas production sector, the importance of the use of agricultural by-products and agri-food industry residual products has been increasing. The energy potential of the agri-food processing industry as regards the production of agricultural biogas is estimated to exceed 7.8 billion m^3 annually.
f)	If applicable, other national trajectories and objectives, including long-term or sectorial ones (e.g. share of advanced biofuels, share of renewable energy in district heating, renewable energy use in buildings, renewable energy produced by cities, energy cooperatives and self-consumers).	**1.** Increase in the use of advanced biofuels to 0.1% by energy content in 2020 According to the RED (Renewable Energy Directive), Member States have been obliged to define the share of advanced biofuels (generated from the raw materials specified in Part A of Annex IX d to the Directive) for 2020. The recommended share of those biocomponents by energy content is to be 0.5%. According to the analyses conducted, this target cannot be met in Poland due to limited access to ligno-cellulosic material and algae processing technologies and the limited supply of waste raw materials. In view of the above, the level of this obligation is set at 0.1% in the Act on biocomponents and liquid biofuels. At the same time, given the need to promote such biocomponents, their share is expected to grow radically in the period 2021-2030, as required by RED II.
		2. Increased dynamics of development of RES-based microinstallations in the period 2020-2030 As at 30 September 2019, over 106,000 RES-based microinstallations with an aggregate installed capacity of over 684 MW were connected to the networks of the 5 largest Distribution System Operators (DSO). Further development of RES-based microinstallations (notably prosumer installations) constitutes a natural direction of development for the electricity sector, which ensues from the changing legislative environment (at the EU level) and decreasing technological costs. The dynamics of the development of RES-based microinstallations are expected to increase throughout the 2020-2030 period.

2.2. Energy efficiency

The objectives and priority lines related to the energy efficiency dimension are set out by sectoral development strategies, primarily by:

- Draft Polish Energy Policy – strategy for the development of the fuel and energy sector (November 2019).
- Sustainable Transport Development Strategy 2030 of 24 September 2019

The above strategies identify the entities responsible for the implementation of individual activities and define the funding framework.

a)	Indicative national energy efficiency contribution to achieving the Union's main energy efficiency target of 32.5% in 2030 as referred to in Article 1(1) and Article 3(4) of Directive 2012/27/EU, as amended by Directive 2018/2002[9], based on either primary or final energy consumption, primary or final energy savings, or energy intensity; expressed in terms of the absolute level of primary energy consumption and final energy consumption in 2020 and 2030, with a linear trajectory for that contribution from 2021 onwards; including the underlying methodology and the conversion factors used	In its energy policy, Poland will continue to pursue directions contributing to an increase in energy efficiency. Improving energy efficiency is horizontal in nature and produces positive effects in all sectors of the economy, helping to enhance their competitiveness. Improving energy efficiency limits the increase in demand for fuels and energy, enhancing energy security through reduced energy demand and dependence on imports, and works to mitigate environmental impacts of the energy sector by supporting rational use of resources, abating pollution and GHG emissions, and reducing waste. Pro-efficiency measures produce real effects by reducing energy costs. They also involve the implementation of new technologies and enhance innovation of the economy, improving its attractiveness and competitiveness. As at 2020, Poland confirms the target for reducing primary energy consumption at 13.6 Mtoe compared to the reference value included in the European Commission's forecast (PRIMES – Baseline 2007). In absolute terms, the target translates into primary consumption at a level of 96.4 Mtoe and final consumption reaching 71.6 Mtoe in 2020. On the basis of an analysis of the effects and impact on the GDP and the potential for savings, Poland declares **a national 2030 energy efficiency improvement target of 23% for primary energy consumption compared to the PRIMES 2007 forecast**. As is projected by this National Energy and Climate Plan, in 2030, primary energy consumption will be around 91.3 Mtoe, which means that, in natural values, the above target will translate into a **reduction of primary energy consumption by approx. 27.3 Mtoe** compared to the PRIMES 2007 forecast (which estimates primary energy consumption at approximately 118.6 Mtoe for the year). The projected final energy consumption until 2030 will be around 67 Mtoe, and therefore the measures provided for in the National Plan will lead to a reduction of final energy consumption by around 18.4 Mtoe compared to the PRIMES 2007 forecasts. In the period 2021-2030, Poland will continue to apply the energy efficiency obligation scheme also known as 'white certificates'. Detailed information on absolute levels of primary and final energy consumption in the

[9] Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency (OJ L328, 21.12.2018).

		years 2020 and 2030, along with the linear trajectory of the associated contribution, is included in the analytical material “Assessment of the impact of planned policies and measures”, which is annexed to this document.
b)	Aggregate value of energy savings to be achieved in the period 2021-2030 in accordance with Article 7 of Directive 2012/27/EU, as amended by Directive 2018/2002, which concerns energy saving commitment.	The **total cumulative final energy savings in the period 2021-2030**, calculated in accordance with the guidelines of the amended EED using forecasts on the annual average final energy consumption from the period 2016-2018, **will amount to ca. 30,635 ktoe**. For information on the methods and measures used by Poland to implement Article 7 of Directive 2012/27/EU on energy efficiency see paragraph 5.1.3.3 of Annex 2.
c)	The indicative milestones of the long-term strategy for the renovation of the national stock of residential and non-residential buildings, both public and private, the roadmap with domestically established measurable progress indicators, an evidence-based estimate of expected energy savings and wider benefits, and the contributions to the Union's energy efficiency targets pursuant to Directive 2012/27/EU in accordance with Article 2a of Directive 2010/31/EU;	Pursuant to Article 5 of Directive 2012/27/EU, 3% of the total heated or cooled area in buildings owned by governmental institutions and occupied by such institutions should undergo renovation on an annual basis in order to meet at least the minimum energy performance requirements determined with the application of Directive 2010/31/EU. The 2018 report, prepared in line with Part 1 of Annex XIV to Directive 2012/27/EU, shows savings of 4945.85 MWh attributable to such measures as improving the thermal transmittance parameters of public building envelopes, replacing window woodwork or lighting sources, or providing employees with internal training on how to save energy. Poland has adopted an alternative solution whereby **the expected 2021-2030 target energy savings achievable as a result of measures improving the energy performance of buildings should amount to 43 440.1 MWh.** **The long-term renovation targets for the national housing stock** are specified in the National Housing Plan: - the share of thermally insulated residential buildings in the total housing stock will amount to 70% in 2030 (as compared with 58.8% in 2015), - the number of people living in sub-standard conditions due to overpopulation, poor technical condition or absence of technical facilities will decrease to 3,300,000 in 2030 (from 5,360,000 in 2011). Poland is preparing a strategy for renovating the national stock of residential and non-residential buildings, both public and private ones, which will be aimed at ensuring improved energy efficiency and low-emissiveness of the building stock, by facilitating a cost-effective transformation of existing buildings into nearly zero-energy ones. The Strategy will be communicated to the EC in line with the requirements of the revised Directive 2010/31/EU as a separate document, other than an annex to the National Energy and Climate Plan.
d)	If applicable, other national targets, including long-term targets or strategies and sectorial targets. National targets in areas such as energy efficiency in the transport sector and with regard to heating and cooling.	**1.** Development of environment-friendly and efficient district heating systems In 2018, only about 20% of the district heating or cooling systems that provide around 85% of the total district heat volume in the country meet the criterion of an energy-efficient system. It is expected that **in 2030 at least 85% of district heating or cooling systems with an ordered capacity of more than 5 MW will meet the criteria of an energy-efficient heating system**.

		The above target will be pursued by the following activities: - development of cogeneration; - converting power plants into heat and power plants; - increasing the use of RES and natural gas in district heating; - increasing the utilisation of waste for energy purposes[9]; - modernisation and expansion of the heating and cooling distribution systems; - promoting heat storage facilities and smart networks; - promotion of smart networks; - ensuring conditions for increasing the use of district heating, especially through: - simplification of procedures for investing in district heating network infrastructure; - changing the heat market model and tariff policy. The demand for heat should primarily be satisfied through the use of district heat, which ensures that fuels are utilised efficiently, improves the quality of life for citizens, and mitigates the problem of 'low-stack' emissions[10]. If connection to the heating network is not possible, efforts should be made to use individual sources with the lowest possible emissivity. In 2015, 61% of households were connected to district heating networks within urban areas – the objective is to increase this rate gradually. The target is to ensure that **70% of households within urban municipalities are connected to district heating networks by 2030**. In accordance with the **2040 target** set, the **heating needs of all households are to be satisfied by district heating or zero- or low-emission heat sources**.
		2. Development of heat production in cogeneration processes Poland has potential for considerably increasing the production of heat in cogeneration processes by replacing heating boilers with cogeneration sources. Exploiting the potential for high-efficiency cogeneration will add efficiency to the use of primary energy carriers, reduce CO_2 emissions, and decrease the resource intensity of the national economy. Support for electricity generated through high-efficiency cogeneration will be maintained. The scheme will be active as long as there is a need for market intervention. In the long run, district heat should be produced mainly through CHP.

[10] See also Direction 8.

2.3. Energy security

The objectives and priority lines related to the energy security dimension are set out by sectoral development strategies, primarily by:
- Draft Polish Energy Policy – strategy for the development of the fuel and energy sector (November 2019).
- sectoral programmes.

The above strategies identify the entities responsible for the implementation of individual activities and define the funding framework.

a) b)	National targets concerning greater diversification of energy sources and supplies from third countries which may contribute to reducing energy import dependency. National objectives with regard to reducing energy import dependency from third countries.	**1.** Deployment of nuclear power in Poland **The first unit** (with a capacity of ca. 1-1.5 GW) **of the first nuclear power plant is expected to be commissioned in 2033**, with another five units to be **launched at 2-3-year intervals (with a total capacity of approx. 6-9 GW)**. The deployment of nuclear power will make it possible for Poland to satisfy the increasing electricity demand, will enhance the diversification of energy sources and will help to reduce national greenhouse gas emissions and dust and gas emissions. Nuclear power plants are a stable and reliable source of energy and will form a foundation of the national power system, which will strengthen electricity security in the long term. Nuclear energy will be deployed along the lines of actions envisaged by the updated "Polish Nuclear Power Programme".
		2. Reduction of **the share of coal in electricity generation to 56-60% in 2030** At present, the share of coal and lignite in electricity generation in Poland is ca. 77%. Owing to the decommissioning of end-of-life generation units, the need to meet strict environmental requirements, and the growingly difficult market situation (mainly the rise in CO_2 emission allowance prices), the share of coal in electricity generation will be decreasing gradually. In view of the fact that stable and reliable energy supplies contributing to energy security need to be guaranteed, and that it is appropriate to maintain a high level of energy independence – coal will remain the basic fuel in the electricity sector until 2030. In this respect, the optimisation of the production and use of this raw material must be ensured.
		3. Expansion of electricity generation capacity to satisfy demand for power At present, the level of conventional generation capacity satisfies peak power demand. Owing to the expected increase in demand for energy and power, in spite of the development of interconnections, generation and transmission infrastructures need to be expanded to safeguard electricity supplies to consumers. With respect to the development of electricity generation infrastructure until 2030, the share of RES is expected to increase from 14% at present to ca. 32%. Gas-based generation capacities will be developed in connection with the need to guarantee backup sources for weather-dependent RES, also on the basis of sources alternative to gas imported from third countries, e.g. methane from mines used for gas mixtures, synthesis gas, biogas, hydrogen. Energy storage technologies, especially those for storing renewable energy will be developed. In order to satisfy the increasing demand, in a situation of substantial decommissioning

		of power generation units, a capacity market has been implemented as an incentive for investments aimed at safeguarding the reliability of supplies. This mechanism will be crucial for expanding current generation capacities, but other market processes will also play a role in shaping the final balance.
		4. Diversification of crude oil supplies and expansion of oil and liquid fuel infrastructure Provision of existing crude oil and liquid fuel storage facilities, along with the accompanying infrastructure, with technical capacities for extruding raw material/fuels within a time limit enabling the raw material to be quickly supplied to the refinery and fuels to be delivered to the market Further diversification of crude oil import requires expanding the internal infrastructure so that the import of the raw material by sea may be increased. In the course of further development of the market, the possibility of increasing the level of storage and separation of various grades of oil imported by sea and efficient and safe transmission within the country must be ensured. The main objective is to ensure uninterrupted crude oil supplies to Polish refineries and to supply liquid fuels to the market at a level ensuring its normal operation in a crisis situation. Adding importance to sea transport is crucial for diversifying the supply of oil to Polish refineries. For these reasons, the construction of the second leg of the Pomorski pipeline by 2023 is legitimate. The need to ensure reliable fuel supplies to the market requires maintaining appropriate crude oil and fuel storage capacities. In this context, appropriate framework must exist, such as to guarantee optimum conditions for investing in storage infrastructure. With respect to the existing infrastructure, it must be guaranteed that all storage facilities operating in Poland have adequate technical capacities for oil to be quickly delivered to refineries and fuels to the market. Such conditions are necessary to ensure that the market functions effectively and that reserves are fully available at times of crisis. The purpose of measures to be undertaken until 2030 is to ensure the continuity of fuel production by domestic refineries and uninterrupted supplies of fuels to the market should a crisis situation occur. In 2018, the physical availability of fuels in storage facilities was 90 days both for aboveground and underground storage, while for crude oil, it was 90 days for aboveground storage and 150 days for underground storage. In 2024, the physical availability of fuel reserves in storage is planned to be 90 days for aboveground and underground storage. That for crude oil will also be 90 days for both aboveground and underground storage.
		5. Diversification of sources and directions of natural gas supply and ensuring more possibilities of sourcing gas from markets alternative to the eastern market; The directions and sources of gas supply will be further diversified through the implementation of key projects, including the construction of the Baltic Pipe, expansion of the capacity to receive liquefied natural gas on the Polish coast, and development of interconnections with neighboring countries.

		6. Maintenance of the natural gas production level in Poland and attempts to increase it with the use of innovative hydrocarbon extraction methods In 2016, natural gas output in Poland was ca. 4.2 billion m^3 (as measured by methane-rich gas equivalent), whereas its output from mine demethylation and from offshore fields was 240 million m^3 (methane-rich gas equivalent). As at the end of 2016, recoverable deposits of developed natural gas fields amounted to 98.9 billion m^3, which accounts for 81% of the total volume of recoverable resources. Industrial natural gas deposits amounted to 52.3 billion m^3 in 2016. The main objective for 2030 in the segment is to maintain stable gas production, to continue exploration for new fields to replace depleted ones, as well as to increase output efficiency. In 2017, the output, as measured by methane-rich gas equivalent, was ca. 4 billion m^3 annually. The output is expected to remain at a similar level in 2030. Imports will continue to be the main method for meeting natural gas demand.
		7. Development of electromobility and alternative fuels in transport Heavy dependency on imported crude oil supplies requires an active policy also in the field of the management of demand for oil-derived fuels. **Achieving the above objectives will be based on the promotion of alternative fuels in transport.** A support instrument in this respect is the Act on electromobility and alternative fuels. The Act is aimed at stimulating **the development and electromobility, and the use of other alternative fuels (natural gas in the form of LNG and CNG, LPG, liquid biofuels, hydrogen, as well as synthetic and paraffinic fuels) in transport.** Dependency on crude oil imports will be reduced by increasing the use of cars powered by alternative fuels, including electric cars, and by expanding infrastructure (including core networks) for charging electric cars and CNG/LNG refuelling in the transport sector. The development of fuel cell electric vehicles contributes significantly to the decarbonisation of transport, which is currently based mainly on diesel and gasoline. Nowadays, e-mobility highly reduces emissions from transport, but when planning to decarbonise this branch completely, efforts should be taken to promote zero-emission vehicles, including hydrogen-powered ones. It is worth emphasising that the potential for using hydrogen should not only be sought in road transport, but also in rail, air and maritime transportation.
		8. Maintenance of autonomy as regards electricity imports from third countries Poland expects to remain independent of electricity imports from third countries until 2030. The National Power System (NPS) is interconnected by the following transboundary lines with third countries: - single-circuit 750 kV Rzeszów-Chmielnicka (Ukraine) line, (inactive since the 1980s); - single-circuit 220 kV Zamość-Dobrotwór (Ukraine) line; - double-circuit 110 kV Wólka Dobryńska-Brześć (Belarus) line (a local line out of operation);

		Since 2011, electricity has been imported to Poland from third countries only through one line, namely the 220 kV Zamość-Dobrotwór one, in volumes not exceeding 0.7% of the country's peak power demand. This interconnection operates on market terms and access to transmission capacity is provided on the basis of monthly tender procedures.
c)	National objectives with regard to readiness to cope with constrained or interrupted supply of an energy source (including gas and electricity) and, where appropriate, a timeframe for when the objectives shall be met[10].	**1.** Diversification of natural gas supply sources and directions and improvement of the possibilities of gas supply from directions alternative to the eastern direction – objectives defined in 2.3.(a) item 5. Pursuant to national legislation adopted, until 2022 the share of natural gas imported by energy companies from a single source in a given calendar year may reach a maximum of 70%. From 2023 onwards, this share may not exceed 33%. The above limits do not apply to intra-Community purchases.
		2. Maintenance of the natural gas production level in the territory of Poland and attempts to increase it with the use of innovative hydrocarbon extraction methods – objectives described in 2.3.(a) item 6.
		3. Maintenance, as far as necessary from the point of view of the energy security of Poland, of non-market-based measures within the meaning of Regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010 In the event of an exceptionally high gas demand, major supply disruptions or other severe deterioration in the gas supply, and in the event that all relevant market measures have been implemented, but the supplies of gas are insufficient to meet the remaining gas demand, non-market-based measures need to be additionally deployed with a view, in particular, to safeguarding supplies of gas to protected customers. Depending on how the situation is assessed and what measures need to be deployed to eliminate the supply disruption, mandatory reserves may be released or restrictions on natural gas consumption imposed.
d)	National objectives with regard to deployment of domestic energy sources (notably renewable energy).	**1.** Enhancement of the possibilities of gas supply from directions alternative to the eastern direction and maintenance of the natural gas output level in the territory of Poland, and attempts to increase it with the use of innovative hydrocarbon extraction methods – objectives defined in 2.3.(a) items 5 and 6.
		2. Development of energy sustainable areas at the local level Safeguarding energy security requires the diversification of sources, raw materials and energy generation and distribution methods. With respect to electricity, this requires developing energy sources balanced with demand by tapping the national potential, with only partial back-up from interconnections. The right choice of renewable and other energy sources for energy clusters, energy cooperatives etc. may ensure local self-sufficiency and thus also energy security. It is expected that 300 energy sustainable areas will be created by 2030 locally (energy

		clusters, energy cooperatives etc.).
		3. <u>Inventory of the national uranium deposits (conventional and non-conventional), including the exploration of deposits and analyses of their recovery possibilities in technical and economic terms (i.e. whether and on what terms it would be viable) until 2030</u> The analyses conducted so far show that Poland does not have industrial quantities of uranium in conventional deposits, but there is unconventional deposit potential (e.g. in ashes, copper mining waste). Their exploitation requires a detailed inventory of conventional and unconventional deposits and technical and economic analyses of the possibilities of using them for national industry purposes, including nuclear energy generation. The appraisal of the size of potential uranium deposits, in particular unconventional ones, is planned to be conducted by 2030, along with the assessment of the possibilities of recovering uranium, including of using it commercially, for the production of nuclear fuel for Polish nuclear power plants.
		4. <u>Maintenance of domestic coal production at a level enabling the satisfaction of the demand of the energy sector</u> Domestic coal is the basic electricity, heat and coke production carrier. The Polish energy sector relies on coal, with the share of electricity produced from coal/lignite amounting to 77% of all electricity produced nationwide in 2018 and that produced from hard coal to about 48%. The share of primary coal-derived energy consumption in primary energy consumption amounts to ca. 39%. For the above reasons coal will continue to determine the nature of the broad energy market in Poland for many years to come. There is a need to guarantee the greatest possible rationality of the recovery and use of coal to ensure reliable supplies of the resource for the purposes of the energy, heat and coke markets. At the same time, the sector should also ensure supplies to the small- and individual-consumer market, *inter alia* through newly created and expanded distribution networks, with the product range and quality offer to be characterised by a growth in the production and supply of higher value-added types of coal, i.e. medium-sized and coarse coal and qualified low-carbon fuels. **Demand for coal will be met by domestic resources whereas imported coal will be treated as supplementary.** The planned measures are oriented to ensuring cost-effectiveness of the coal mining sector, rational management of opened deposits, reasonable distribution of the resource, use or sale of mining by-products (methane, hydrogen, minerals), and innovative extraction and utilisation methods. In the context of the decreasing role of coal, preparing a restructuring plan for Poland's mining regions to ensure their just transformation will be crucial.

2.4. Internal energy market

The objectives and priority lines related to the internal energy market dimension are set out, in the first place, by the draft Energy Policy of Poland – strategy for the development of the fuel and energy sector (November 2019), as well as by national and EU legislation.

2.4.1. Electricity interconnectivity (2030 framework target)

a)	The level of electricity interconnectivity that the Member State aims for in 2030 in relation to the October 2014 European Council objective.	Increasing the availability and capacity of existing interconnections The interconnection capacity among Member States should be increased primarily by the optimum use of the existing interconnectors and eliminating barriers that block grid access for market participants, including bottlenecks in national systems, i.e. by: • developing rules for the allocation of costs of remedial actions taken to manage network flows, • constructing missing lines within national systems, • optimising the methods of providing market participants with access to those capacities (introduction of FBA methodologies), • installing phase shifters or other devices optimising transmission where necessary. In connection with the above, **investments are planned to develop the national transmission network and interconnections by 2030, including**: - investments to improve flow in the synchronous area involving Germany, the Czech Republic, and Slovakia; - construction of a new submarine cable connection between Poland and Lithuania (Harmony Link) and completing the synchronisation of the Baltic countries/continental Europe transmission systems involving the Polish transmission system.

		By 2030, the capacity of Poland's existing interconnections is planned to be enhanced through the projects planned. Pursuant to Regulation (EU) 2019/943 of the European Parliament and of the Council on the internal market for electricity, from 1 January 2020, TSOs should maximise the interconnection capacity offered for transboundary trade. As a consequence, Regulation 2019/943/EU requires that TSOs provide market participants with cross-zonal capacity at a level not lower than 70% of the transmission capacity for a given border or critical network element/contingency (CNEC) pair, subject to operational security limits (hereinafter the 'CEP 70% target'). The power TSO can use the remaining 30% for the purposes of reliability margins, loop flows, and internal flows at each critical network element. Providing the 70% of transmission capacity is a challenge for the TSO, as currently, the Polish market suffers from structural network constraints. As a result, a decision has been made to prepare an **Action Plan** that best responds to the nature of structural network constraints in Poland. **With the application of the Action Plan, the deadline for achieving the CEP 70% target is 31 December 2025**. The Plan will be implemented from 1 January 2020, with the measures scheduled for four years (1 January 2020 to 31 December 2023). Achieving the target will increase the level of diversification of electricity supply, contribute to the equalisation of wholesale electricity prices in the region, and mitigate the impact of external factors (e.g. prices of CO_2 emission allowances – EUA) on the price of electricity in Poland. Additionally, curbing loop flows will improve the availability of existing interconnections for the participants of the National Power System. The subdivision of the bidding zone into two – AT and DE/LU – bidding zones (from October 2018) as a result of the implementation of the ACER Decision of 17 November 2016 establishing the Capacity Calculation Regions (CCR) should produce positive effects. It should be assumed that the above measures will improve the interconnection capacity between Poland and EU Member States.
2.4.2. Energy transmission infrastructure		
a)	Key national objectives for electricity and gas transmission infrastructure that are necessary for the achievement of objectives and targets under any of the dimensions referred to in the Energy Union strategy.	**1.** <u>The key national objectives concerning electricity transmission infrastructure are as follows:</u> - to safeguard the security of electricity supplies – understood as the capacity of the electricity system to ensure the security of operation of the electrical network and to balance supply with demand;

- to ensure long-term capability of the power system to satisfy justified needs as regards domestic and international transmission of electricity, *inter alia* by expanding the transmission network, and, where applicable, developing interconnections with other power systems.

In order to achieve the above objectives, the Transmission System Operator (TSO) is creating a backbone network, which is necessary for the National Power System (NPS) to operate correctly, and at the same time to ensure:

- consumer supply reliability, including in large urban agglomerations, by meeting the n-1 supply reliability criteria and network operation quality parameters;
- power interconnection and evacuation from existing generation sources and sources under construction, including RES;
- fulfilment of the legal requirements concerning the capacity for power exchange with EU's neighbours.

The backbone network enables flexible adaptation to various NPS operation scenarios, even if the role of the transmission network is limited to a reserve function the sole purpose of which is to guarantee system operation security.

Polskie Sieci Elektroenergetyczne S.A. (PSE) is planning to develop its transmission network to meet the increasing demand, energy market requirements and the NPS users' needs.

The development of extra high voltage (EHV) networks will contribute to:

- achieving national strategic objectives defined in the energy policy;
- integrating the market, *inter alia* through the development of cross-border interconnections and the reduction of bottlenecks in energy infrastructure;
- safeguarding the security of supply, *inter alia* through interoperability, appropriate connections and secure and reliable system operation;
- ensuring sufficient transmission capacity on the basis of the power and electricity demand of particular NPS areas forecast until 2025;
- connecting and evacuating power from new generation units based on conventional technologies for which connection conditions have been issued and/or connection agreement have been concluded;
- ensuring transmission capacity for connecting and evacuating power installed in wind farms at a level allowing Poland to meet the required RES share ratios in the national energy balance;
- reducing unscheduled power flows;
- increasing the reliability of supply to major receiving hubs;
- increasing the ability to exchange capacity with other systems operating synchronically;
- strengthening the role of the transmission system in the NPS through the expansion of the 400 kV network and partial and gradual assumption of transmission functions from the 110 kV distribution network;
- increasing voltage control capability;
- creating conditions for safe NPS operation while ensuring compatibility between

		energy sources based on different generation technologies and various performance characteristics; - enhancing the transmission system's operating flexibility so that major network elements can be shut down for maintenance or overhaul, where the shut-down of such elements is difficult given the present form and load of the network; - improving the efficiency of electricity use; - creating a platform for further network expansion (potential development directions).
		2. Construction, extension and modernisation of the domestic gas transmission network; The obligation to develop the transmission system ensues from the need to ensure the long-term capability of the gas system to satisfy reasonable gaseous fuel transmission needs in domestic and cross-border trading by extending this system and, where applicable, by expanding interconnections with other gas systems. The length of the transmission network, which was 11 744 km in 2017, does not enable free gas distribution in all directions, as there are bottlenecks in the network. The expansion of the national transmission network is helpful in constructing an integrated and competitive gas market in Central and Eastern Europe. By making use of the geographical location of Poland, the national transmission system may play a new transit role, constituting a regional gas distribution hub.
		3. Integration of the national natural gas transmission system with the systems of the Central and Eastern Europe states and the Baltic Sea region At present, Poland is not sufficiently integrated with neighbouring states in terms of the gas transmission system. By 2030, the sources and directions of gas supply to Poland are planned to be diversified by the construction of the Baltic Pipe and expansion of liquefied natural gas receiving capacities on the Polish coast (LNG Terminal in Świnoujście, LNG Floating Storage and Regasification Unit in the Bay of Gdańsk), as well as by boosting the import-export potential thanks to the planned construction of interconnections with Ukraine, Slovakia, Lithuania, and the Czech Republic. At the end of 2018, there were no high-capacity interconnections with Lithuania, the Czech Republic or Slovakia.
b)	Where applicable, main infrastructure projects envisaged other than Projects of Common Interest (PCIs)[11];	**1.** Building an interconnector with Ukraine The main purpose of the project is for the Poland-Ukraine interconnection to be able to handle physical gas transmission to Ukraine at 5 billion m^3/year and to Poland also at 5 billion m^3/year (after 2022). The new interconnection will create a transport corridor between Poland and Ukraine and will enhance Poland's exporting capacity, creating conditions for increased utilisation of the transmission potential of the Polish transmission system. Initial value (2017): preparatory work. Target value (2030): operational interconnection.

2.4.3. Market integration		
a)	National objectives related to other aspects of the internal energy market such as market integration and coupling, including a timeframe for when the objectives shall be met	The integration of electricity systems requires transmission capacities to be allocated and made available for trading purposes in a coordinated manner, having regard to technical power transmission capabilities in the interconnected systems, as well as the safety and reliability standards concerning system operation to be satisfied. It is necessary to develop and launch coordinated allocation of transmission capacity comprising the countries of Continental Europe (CCR CORE) in accordance with the FBA methodology (flow-based approach)[12]. Having regard to the above limitations, Poland will pursue its commitments stemming from framework guidelines and codes. Furthermore, Poland will conduct additional actions to roll-out intraday market coupling mechanisms and mechanisms relating to electricity system balancing: - With respect to the prices of electricity of the day-ahead and intraday markets, bid and price limits other than currently applied in the process of uniform, European day-ahead and intraday market coupling have not been applied in Poland since 1 July 2018. The above will not affect the application of the minimum and maximum prices pursuant to Article 41(1) and Article 54(1) of Regulation 2015/1222. - With respect to price limits in the balancing market, from 1 January 2019 onwards, they will be set at a level not lower than that determined for the intraday market. This will not affect the technical price limits in the balancing market, to be applied, if necessary, pursuant to Article 30(2) of the Electricity Balancing Guideline. - Starting from 1 January 2021, prices in the balancing market will be set as the marginal price defined in Article 30(1)(a) of the Electricity Balancing Guideline. This will not affect the possibility of differentiating prices in the Polish bidding zone depending on the location, by applying a solution based on the full transmission network model in the pricing process. If technical price limits are applied in the balancing market, they will take into account the minimum and maximum prices pursuant to Article 30(2) of the Electricity Balancing Guideline.
b)	National objectives with regard to ensuring electricity system adequacy, as well as the flexibility of the energy system with regard to renewable energy production, including a timeframe for when the objectives shall be met;	**1.** Flexibility of the energy system with regard to renewable energy production The low flexibility of the Polish energy market (on the demand and supply sides) is primarily due to the fact that in practice it has no regulating reserve sources (except for pumped-storage power plants) that would be capable of adjusting the production level dynamically depending on demand. Most energy generated in Poland is derived from coal, but at the same time priority in access to the grid is given to renewable energy sources. Given the increase in wind power generation, the full responsibility for balancing variable wind energy generation rests on coal-fired power plants. In such a situation, coal-fired power plants must operate at a load close to technical minimum levels or even shut down units and then immediately switch to operating at full capacity, for which, in fact, they are not

		technically designed. On top of all this, energy demand is becoming more and more variable, reaching record levels especially in largest agglomerations in peak periods. The improvement of flexibility is a priority which must be seen from the perspective of the entire chain, starting from generation sources, through transmission, distribution, energy market, to energy consumers and the entire demand side. Investments in gas production and transmission infrastructure are key to ensuring the system's flexibility in the light of the growing role of RES. The share of active recipients and aggregators capable of responding at times of shortages is bound to grow thanks to the deployment of smart networks. In the long term, the development of demand side response (DSR), energy storage, and energy clusters, which should be capable of self-balancing, may also gain in importance. **The flexibility of system operation is expected to improve by 2030, so that it can respond adequately to changing electricity demand levels and the increased share of uncontrollable energy sources.**
		2. Development and use of offshore wind energy potential in Poland in the 2030 perspective. The potential for the wind offshore sector in Poland in the Baltic Sea offers realistic opportunities for its development after 2025. To make it possible to evacuate full capacity generated by the offshore wind sector, the transmission network needs to be modernised and expanded, which is required in addition to providing electricity network elements necessary for applying voltage and for connection purposes. Such modernisation/expansion of the transmission network has already been envisaged by PSE S.A. in the Transmission Grid Development Plan and scheduled for completion. **Ensuring the adequacy of the power system and the flexibility of the energy system with regard to renewable energy production in the context of market integration is a process which, by definition, engages a larger number of entities. Therefore, seting national objectives in this respect is not reasonable.** The reason for this is that their achievement will depend on other entities engaged in the process. At present, the development of RES, in particular offshore wind farms, is part of the planned deployment of renewable energy sources in Poland. Given the need to ensure adequate offshore energy storage and transmission capacities, the existing offshore wind potential in the Baltic Sea does not make it possible for the technology to be developed and used by 2025. Until then, the expansion of individual local RES sources must be correlated with the retrofitting of traditional generation units and the modernisation of the power infrastructure that can be used for delivering Polish offshore wind energy to end users. The anticipated effect in 2030 will be approx. 3.8 GW of installed offshore capacity, which is expected to grow to approx. 8 GW in 2040.
c)	National objectives to protect energy consumers and improve the	**1.** Raising the awareness of consumers and encouraging them to play a more active

	competitiveness of the retail energy sector.	role in the energy market; Measures to enhance end consumer knowledge are planned to be continued in the period 2021-2030, with a focus on: - consumer rights (relating to the conclusion of contracts, supplier switching, alternative dispute resolution methods), - an active role in the energy market (prosumer, use of aggregation services, smart meters, dynamic price contracts).
		2. Gas market liberalisation – tariff deregulation in the gas trading sector A number of measures have been undertaken in recent years to stimulate the development of competition in the Polish natural gas market. The amendment to the Energy Law of 26 July 2013 introduced a gas exchange obligation to enable the creation of a liquid, wholesale natural gas market in Poland and to make the consumer's right to switch suppliers a reality. The President of the Energy Regulatory Office (URE), by issuing individual decisions, releases entities which have filed appropriate applications from the obligation to submit tariffs for approval with respect to natural gas trading: at a commodity exchange, in a wholesale gas market and in LNG and CNG form, and the sale of natural gas to gas system operators in order for them to carry out their duties. As a result of a further amendment to the Energy Law, gas prices for trading companies were deregulated in December 2016 with respect to the sale: in a wholesale market, at a virtual point (including at a commodity exchange), of compressed natural gas (CNG) and liquefied natural gas (LNG), and by tender procedure, auction or public procurement. On 1 October 2017, prices for all remaining consumers were deregulated, except for household consumers. Natural gas prices for household consumers will continue to be regulated by the President of the Energy Regulatory Office by 31 December 2023 (as per Article 62b of the Energy Law). **The deregulation of natural gas prices for particular consumer groups will enable a far-reaching liberalisation of the gas market and the development of competition in the gas trading sector.**
		3. Development of a competitive gas market in Poland The number of instances of supplier switching is a simple and reliable measure of the development of a competitive gas market. Pursuant to the TPA (Third Party Access) principle, which is regulated by Article 4(2) of the Energy Law, end consumers may use the local provider's network on an individual basis to supply gas or energy purchased from any supplier. Several important factors affect the freedom of choice of the supplier, e.g.: the degree of awareness of customers and their motivation to switch supplier, as well as facility to switch suppliers or the number of competitive offers available on the market. **The number of instances of natural gas supplier switching is expected to rise in connection with the development of the retail gas market.** According to the information provided by the President of the Energy Regulatory Office, the level of the natural gas supplier switching indicator among consumers reached 66

		889 in 2017. The number of instances of natural gas supplier switching is expected to reach 150,000 by 2030.
2.4.4. Energy poverty		
a)	National objectives with regard to energy poverty including a timeframe for when the objectives shall be met.	**1.** Reduction of energy poverty having regard to the protection of vulnerable social groups A comprehensive state policy oriented towards solving the problem of energy poverty is planned to be developed. An effect of the proposed comprehensive public policy will be the reduction of energy poverty and the enhancement of the protection of vulnerable consumers.
		2. Protection of vulnerable consumers of electricity by granting a flat-rate energy allowance In order to protect the poorest people, Amendment to the Energy Law of 26 July 2013 (Journal of Laws 2013, item 984) defines a vulnerable electricity consumer and a vulnerable gaseous fuel consumer. It puts in place a system of support for vulnerable electricity consumers in the form of an energy allowance. The number of vulnerable electricity and gaseous fuel consumers is expected to fall by 2030.

2.5. Research, innovation and competitiveness		
a)	National objectives and funding targets for public and, where available, private research and innovation relating to the Energy Union, including, where appropriate, a timeframe for when the objectives are to be met.	**1.** Reduction of the civilisation gap between Poland and highly developed economies and improvement of the quality of life of Polish people, as well as the fulfilment of the development aspirations of the present and future generations consistently with the sustainable development principle **Increase in expenditure on research and development activities in Poland to 1.7% of the GDP in 2020 and 2.5% of the GDP in 2030** National objectives and budgetary funding targets for research and innovation, including with regard to the Energy Union, are pursued within the framework of the state science, technology and innovation policy. The objectives and targets of this policy have been defined in the strategic direction guidelines for research and development formulated in the National Research Programme (NRP) adopted by the Council of Ministers, which will be updated in 2020. The main criteria applied in the NRP to choose strategic directions for research and development include the long-term needs of the economy, high quality of research in national institutions – global competitiveness, development of innovative business sectors at the micro-, small- and medium-sized scale based on new Polish technologies, or the priority directions in research development defined in European research programmes and strategies (e.g. SET-Plan and Horizon 2020). **Strategic directions for research and development** defined in the NRP are as follows: 1. New energy technologies, 2. Diseases of affluence, new medicines and regenerative medicine, 3. Advanced information, telecommunications and mechatronic technologies, 4. Modern materials technologies, 5. Natural environment, agriculture and forestry, 6. Social and economic development of Poland in the conditions of increasingly global markets, 7. State security and defence. The broad-ranging energy and climate issues addressed by the NRP, including low-carbon technologies, which fall with the scope of the *research, innovation and competitiveness* pillar pursuant to the Regulation on the Governance of the Energy Union, are included in as many as three out of the above seven strategic research and development directions, namely: *(1.) New energy technologies, (4.) Modern materials technologies, (5.) Natural environment, agriculture and forestry.* As noted in the description of Strategic Direction 1 of the NRP. New energy technologies, research conducted in this area should support the implementation of the Polish energy policy and the targets of the energy and climate policy of the European Union. The timeframe for the strategic research and development directions and strategic

		research programmes are defined in a manner ensuring the stability of the research conducted. However, they should be modified in correspondence to the changing conditions, tasks and needs of the economy and society. Strategic directions for research and development are to be implemented over a period of 10-15 years, and strategic research programmes over 3-7 years, taking into account realistic funding levels. The pursuit of the above will be founded equally on increasing research and development funding in Poland and establishing new rules for using such funding in a way reflecting the present-day conditions. This will result, *inter alia*, in raising the level and effectiveness of research in Poland, understood as the delivery of research results and products with a high cognitive quality and social, economic and technological usefulness. The aggregate effect of measures in all the NRP areas **is the enhancement of innovation of the economy and an increase in the significance and competitiveness of Polish science internationally.** The implementation of the NRP helps to enhance the effects of research in new technological solutions, the number of patents and the development of an innovative economy. The achievement of the aforementioned objective requires the concentrated efforts of the scientific community and financial expenditures from the state budget on a limited number of singled out priority areas. The update of the above national strategic research and innovation directions, priorities and objectives regarding energy and climate as part of the new research policy of the state will be aligned to the new Energy Policy of Poland and will contribute to its delivery.
b)	If appropriate, national objectives including long-term targets (2050) for the deployment of low-carbon technologies, including for decarbonising energy- and carbon-intensive industrial sectors and, if applicable, for related carbon transport and storage infrastructure.	**2.** <u>Directions for development of energy innovations:</u> 1) Improvement of competitiveness of the Polish energy sector through: - continuous technological advancement and efficiency of operation; - implementing competitive organisational and business models; - optimising resource use. 2) Maximisation of gains for the Polish economy derived from changes in the energy sector through: - taking advantage of innovation in the energy sector for industrial development, - reducing specific energy consumption and consumption of raw materials, - fostering cooperation between enterprises, public institutions and the research sector. In 2017, the Ministry of Energy developed a document on innovation in the energy sector entitled Directions for Energy Innovation Development. The document covers energy innovations both from the perspective of technologies, processes and funding sources and models, and from the perspective of the implementation of new solutions, and contains a list of indicators relating to innovations and the development of new business models. Cooperation is pursued with energy sector entities with a view to engaging this sector

		in innovation projects, and with organisations supporting the development of research, innovations and implementations. Projects implementing the Directions for Energy Innovation Development concern the following areas: • integrated and interconnected energy system giving a central role to the energy user; • effective and flexible energy generation and use of raw materials that combine environmental impact mitigation with energy security; • diversification of energy generation and use technologies; • green and energy-efficient city. In the context of energy-related R&D&I, a central focus will be on supporting investments in infrastructure (including technologies) for the production, storage and use of hydrogen (e.g. support for research into hydrogen- and coal-based fuels), synthesis gas, and methanol for energy purposes. R&D and commercialisation support in the area of carbon cells and carbon nanostructures in energy storage will be also important.
		3. Acceleration of energy sale in such areas as: air protection, RES, energy saving, water and waste water management, waste management and the protection of biodiversity by Polish companies in international markets An increase in the sale of technologies by Polish companies in international markets will be supported by specialised training for entrepreneurs, foreign missions with the participation of representatives of ministries, the Polish Government or the President of Poland, and the participation of business entities in international events, fairs, and exhibitions. This form of assistance enables Polish companies to increase considerably sales of technologies on international markets at a relatively low cost. At present, the GreenEvo programme is planned to be implemented in the period 2018-2020. Acceleration of the sales of Polish air protection, RES, energy savings, water and sewage management, waste management and biodiversity conservation technologies on foreign markets. The improvement of sales of Polish environmental technologies will be supported through the GreenEvo initiative (Green Evo – Green Technology Accelerator). The Accelerator will organise training for entrepreneurs to prepare them for foreign expansion, and business missions for such events as international fairs or exhibitions, as well as meetings accompanying foreign visits of representatives of the Polish government. This form of support can be used to promote effectively Polish environmental technologies on foreign markets, with relatively low financial outlays. Currently, the 2018-2020 edition of the GreenEvo programme is under way. GreenEvo supports entrepreneurs subject to the de minimis principle applicable to State Aid. Beyond 2020, Poland plans to support foreign transfer of Polish environmental technologies by the successive rounds of the GreenEvo programme and through inter-ministerial cooperation.
		4. Determination of the potential of forest areas for carbon dioxide sinking and the

		launching of research aimed at developing better methods of carbon dioxide balance calculation A research project is envisaged to be funded as part of the Forest Carbon Farms (FCF) pilot project, which explores the mitigation capabilities of forest areas as a result of additional measures in these areas. The above work is expected to align the forest ecosystem carbon balance model to Polish conditions in order to determine accumulated carbon resources in all forest layers. The project is expected to develop carbon dioxide balance calculation methods, *inter alia* for reporting purposes, and to determine the potential for employing additional economic measures to improve the balance of greenhouse gas within forest land. As one of the effects, the research project will create detailed forest development models specific for Poland, such as to enable changes in the carbon balance for forest ecosystems in Poland to be estimated more precisely.
		5. Determining the potential for production, use and development of hydrogen technologies in Poland. The draft Hydrogen Technology Development Programme, which is being prepared now and responds to the growing need to reduce the share of conventional fuels in favour of alternative fuels, envisages setting the main lines for developing the potential of hydrogen technologies. The purpose of the above work is to address aspects related to the production, transport, use, and storage of hydrogen, taking into account the existing support system and the EU and Polish legal context. Owing to its properties, hydrogen can be an important area of development for the Polish economy. In accordance with the Hydrogen Technology Development Programme, there are new potential uses for hydrogen in: • the energy sector; • the transport sector; • the natural gas transmission system. The use of hydrogen is becoming a major direction of research and development, therefore activities are planned to support areas of the hydrogen economy and R&D.
b)	Where applicable, national objectives with regard to competitiveness.	Enhancing the competitiveness of the economy through: - innovation, export and increasing capital mobilised for investment in the enterprise sector (Specific Objective I of the SRD), - fuller exploitation of the social and territorial potential (Specific Objective II of the SRD); and - projects enhancing the efficiency of public institutions that serve enterprises and citizens (Specific Objective III of the SRD), - enhancing sustainable use of renewable resources in industry, - automation, robotisation and digitisation of enterprises. Based on experience, it is envisaged that, in the period 2021-2030, the main competitiveness-oriented activities will focus around investing in areas ensuring an

		increase in the value added of the economy and its competitiveness in foreign markets. A key role will be played by support instruments for businesses willing to engage in and develop (continue) B+R+I activities and thereby improve their competitiveness, especially in areas constituting economic priorities, including: - high-efficiency, low-carbon and integrated energy generation, storage, transmission and distribution systems; - smart and energy-efficient building technologies; - environment-friendly transport solutions; - minimisation of waste generation, including waste unfit for processing, and the use of waste for materials production and energy generation purposes (recycling and other forms of recovery). - optimisation of the management of non-renewable resources with a focus on their quality, value and reusability, - Eco-innovations. There are plans to use instruments for supporting R&D leading to innovations in environmental and low-carbon technologies and in technologies enabling effective (economical) waste management.

3. POLICIES AND MEASURES

The structure of this chapter reflects the systematics and numbering from Annex I to Regulation 2018/1999

3.1. Decarbonisation		
3.1.1. GHG emissions and removals (for the plan covering the period from 2021 to 2030, the 2030 Framework Target).		
a)	Policies and measures to achieve the target set under Regulation [ESR] as referred to in 2.1.1 and policies and measures to comply with Regulation [LULUCF], covering all key emitting sectors and sectors for the enhancement of removals, with an outlook to the long-term vision and goal to become a low-carbon economy with a 50 years perspective and achieving a balance between emissions and removals in accordance with the Paris Agreement; **Responsible/involved parties*:** **Ministry of Climate (MK), Ministry of Infrastructure (MI), Ministry of Agriculture and Rural Development (MRiRW), Ministry of Development (MR), Ministry of State Assets (MAP), Ministry of Development Funds and Regional Policy (MFiPR)** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Meeting the non-ETS (ESR) 2030 reduction target.** Poland has considerably reduced total GHG emissions as compared with 1988. Notably, a profound reduction took place before 2005: from 1988 to 2005, the decrease reached ca. 30%, and from 1990 to 2005 it amounted to ca. 15%. Since 2005, the trend in total GHG emissions of approx. 400 million tonnes of CO_2 equivalent may generally be regarded as stable, with some fluctuations in individual years. Given the above-described trends, the reduction of GHG emissions in the non-ETS sectors covered by the ESR by -7% until 2030 as compared with 2005 will be an ambitious challenge for Poland. An analysis of the current 2030 GHG emission forecast shows that aggregate emissions in those sectors will decrease. The following sectors have the largest shares in the GHG emission structure in Poland in the non-ETS sectors: households, i.e. municipal and domestic sector (ca. 30%), transport sector (ca. 27%), agricultural sector (ca. 15%). From the point of view of meeting the ESR target, the following sectors will be crucial for the level of GHG emissions: transport, agriculture, construction and non-ETS industry (which accounts for ca. 8% of GHG emissions in the non-ETS sectors). The emission trends in these sectors, as well as the actual emission levels in the period 2021-2030, will determine the final total emission level in the non-ETS area. Since 1990 the EU has managed to reduce its total CO_2 emissions by 23%, mainly due to reductions in Central and Eastern Europe countries. Over the same period, CO_2 emissions from car transport have increased by 20%. GHG emissions from the Polish transport sector decreased from ca. 48.8 million tonnes of CO_2 equivalent in 2011 to ca. 44.1 million tonnes of CO_2 equivalent in 2013, to grow again to ca. 63.4 million tonnes of CO_2 equivalent in 2017, and constitute ca. 15.3% of the total domestic emission (in the EU transport emissions as much as 25% of the total emissions on average). Road vehicles, in particular passenger cars and light commercial vehicles, are responsible for the largest share (ca. 98%) of the transport sector emissions in Poland. Actions to reduce greenhouse gas emissions in the transport and agriculture sectors (which fall in the non-ETS category) are specified in the **Sustainable Transport Development Strategy 2030 (TDS)** and the **Strategy for Sustainable Development of Agriculture, Rural Areas and Fisheries 2030 (SSDARAF)**. Actions to reduce emissions across the economy are foreseen by the **State Environmental Policy 2030**, which envisages the **development in 2020 of a policy for reducing greenhouse gas emissions in non-ETS sectors** and support for identified actions to reduce non-ETS emissions by 2030. Generally, the non-ETS reduction target will be pursued based on the existing and new policies

		and measures in the different sectors that fall outside of the scope of the Emissions Trading Scheme, including those discussed in the successive points of Chapter 3.1.1. If necessary, Poland intends to apply flexibility mechanisms provided for in the ESR to account for GHG emissions in the period 2021-2030, namely: **LULUCF flexibility (Article 7)** – the ESR takes into account flexibility between the ESR and the LULUCF area, which enables the use of a certain pool of units deriving from removals in LULUCF to cover ESR emissions. Pursuant to Annex III to the ESR, the maximum volume of this pool for Poland for the entire 2021-2030 period is 21.7 million tonnes of CO_2 equivalent. Units generated by the LULUCF sector will accounted towards the ESR target in the period 2021-2030, having regard to the aforementioned limit and the rules defined in the LULUCF Regulation. - **adjustment – an additional pool of AEA units (Article 10(2)) – Article 10(2)** provides for an adjustment for Poland which will constitute a certain additional pool of units increasing the annual limit on a one-off basis, to be added in the first year of the commitment period. The value for Poland envisaged in Annex IV to the Regulation is 7,456,340 tonnes of CO_2 equivalent; - **banking, borrowing and transferring AEA units (Article 5)** – as in the 2013-2020 commitment period, also in the future period, Member States may bank the unused part of their AEA limits to subsequent years of the commitment period, borrow a part of their AEA limits from the following years or buy AEA units from other Member States. The transfer of units among states may be linked to the implementation of GHG emission reduction projects. If necessary, Poland intends to take advantage of the above possibility of having flexible access to and using its own AEA units, as well as of buying accounting units from other Member States; - **security reserve (Article 11)** – should the remaining flexibilities turn out to be insufficient to cover an AEA shortfall in the period 2026-2030, Poland is planning to use an additional pool of units, taken from the security reserve, at the end of the commitment period (in 2032). The maximum total pool for all Member States that meet specific conditions is 105 million tonnes of CO_2 equivalent. The detailed approach to be followed towards the reduction target in the non-ETS sectors will be outlined in the National Allocation Management Strategy, which will be prepared by 2022 and approved by the Council of Ministers pursuant to Article 21d of the Act on the management of greenhouse gas and other substance emissions. The purpose of the Strategy is to determine the objectives and guidelines for clearing non-ETS emissions, taking into account the actual and forecast GHG emissions and the market situation (the supply of and demand for AEA units). **At present, the reduction effort necessary to meet the 2030 non-ETS reduction target cannot be defined in a precise manner, as the key EU implementing legislation (including input data for calculations) which would precisely define the value of the reference point (the emission level in 2005) or emission allowances (allocations of AEA units) for particulars years in the period 2021-2030, are not available yet. However, it is expected that meeting the 2030 target will require a greater effort than attaining the 2020 target.**

		2. In accordance with the Sustainable Transport Development Strategy 2030, the negative impact of transport on the environment will be mitigated by supporting, *inter alia*: • solutions promoting low-carbon vehicles, including electromobility; • diversity and complementarity of individual forms of transport within the network, as well as by supporting the types of transport with the lowest environmental impact; • managing demand for transport, including promotion of sustainable mobility patterns; • deploying innovative traffic management systems; • modernisation and expansion of transport infrastructure in line with EU and national environmental standards and requirements; • modernisation of the rolling stock and vehicle fleet (vehicles and other necessary devices and accessories, including alternative fuel infrastructure) across the transport modes to align them at least to EU and domestic environmental standards and requirements; • managing demand for freight transportation by combining transport volumes; • public transport and vehicle sharing systems, while limiting the use of individual motor vehicles; • reallocation of tasks between individual types of transport (modal split) and maximising the share of zero- and low-emission vehicles; • striving to reduce pressure on the environment by developing transport infrastructure on the basis of existing spatial structure with priority given to the use of brownfield areas and taking into account landscape impact. • following the road transport-related Recommendations of the Economic Committee of the Council of Ministers knowns as the "Clean Air" Programme, adopted by the Council of Ministers on 25 April 2017, including recommendations on how to reduce exhaust emissions in road traffic, foster the creation of clean transport zones, and improve supervision over the quality of exhaust emissions from vehicles by redesigning the system of oversight over vehicle inspection stations. The TDS provides for a number of activities dedicated to reducing the negative impact of transport on the environment, which address organisational and systemic issues, investments, as well as innovations and technologies.
		3. Implementation of the 2030 Strategy for Sustainable Development of Rural Agriculture and Fisheries (SSDARAF) with a focus on environmental intervention. The Polish agricultural sector accounts for around 12% of GHG emissions (including about half of non-CO_2 emissions, which are associated mainly with animal production and fertiliser management). Even though the potential for reducing emissions in agriculture is limited by biological processes, the agricultural sector has significant potential for CO_2 absorption and storing in biomass and soil. In agriculture, climate policy objectives can be pursued through the promotion of sustainable farm production structure, agrotechnical practices, fertiliser management, precision agriculture techniques, development of a circular bioeconomy, protection of permanent grassland, protection of organic soils and proper water management. It is necessary to stress the risk that excessively restrictive requirements and too ambitious emission abatement targets in European agriculture, including that of Poland, could quickly

		cause it to be transferred to world regions with lower production standards and a high environmental and climate footprint (carbon leakage). **The SSDARAF provides for a number of environmental actions, including:** • adding momentum to projects to eliminate 'low-stack' emissions from heating systems; • actions for high air quality in rural areas in transport and spatial management; • maintaining and, if land for afforestation is available, increasing the total woodland area in the country and the compactness of forest complexes and afforested areas; • supporting the development of green infrastructure in rural areas to adapt to climate change; • promoting eco-farming, dissemination of environmentally-friendly methods of agricultural and fishery production, and management of by-products from agriculture, fisheries and agri-food processing; • water quality protection, *inter alia* by rational management of fertilisers and plant protection products and promoting agrotechnical practices beneficial for water quality, as well as promoting parallel plant and animal production; • protection of soils used for agriculture (against erosion, contamination, acidification, loss of organic matter); • supporting environmentally sound investments in agricultural holdings and fisheries; • dissemination of knowledge on how to protect the environment in agriculture and fisheries, e.g. improving and furthering the system of advice and promoting good agricultural practices; • supporting research on environmental protection in rural areas and in fisheries. The Common Agricultural Policy (CAP) will be an important policy in reducing GHG emissions in agricultural production and adapting agriculture to climate change in the period 2020-2030. The CAP 2020 legislative package presented by the European Commission assumes, *inter alia*, introducing a minimum level of spending on climate-related action of 40% of the CAP budget allocation.
		4. Reducing CO_2 emissions in the construction sector The key measures to reduce GHG emissions in this sector include gradual tightening of energy and thermal insulation standards and fostering the use of renewable energy sources in keeping with new legislation (newly formulated energy requirements, obligation to analyse alternative heating and electricity supply options for buildings) for newly erected and renovated buildings. In parallel, Poland is working on a strategy for renovating the national stock of residential and non-residential buildings, both public and private ones, the implementation of which will contribute to reducing emissions from the construction sector and reducing energy consumption in the area, while adding to the energy efficiency target. In addition, Regulation of the Minister of Infrastructure of 12 April 2002 on the technical conditions to be met by buildings and their siting (Journal of Laws 2019, item 1065) define, *inter alia*, the maximum values of the thermal transmittance coefficient for the building's envelope and energy demand limit values. In addition, the technical and construction provisions that transpose Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings into Polish law are meant to ensure that after 31 December 2020 all new buildings are nearly zero-energy buildings. The above actions will reduce emissions

		from the construction sector.
		5. Reduction of CO_2 emissions in the power and heating sector through actions envisaged by the State Environmental Policy 2030 and strategic documents for the energy sector (draft Energy Policy of Poland until 2040): - retrofitting of power plants, combined heat and power plants, and heating plants – replacing low-efficiency coal-fired power plants by new high-efficiency facilities that meet strict environmental standards on emissions; - increasing the use of renewable energy sources and developing reserve gas sources in connection with it, as well as expansion of transmission/distribution infrastructure; - deployment of nuclear power; - development of energy-efficient heating systems and low-emission individual heating; - development of low-carbon transport, including electromobility; - increasing energy efficiency. The energy sector (referred to in the Inventory as Energy industries) accounted for ca. 50% of CO_2[13] emissions in 2017. Thus, it is a sector with a major share in the greenhouse gas emissions, where even minor percentage changes result in considerable changes in the volume of emissions in CO_2 tonnes and tonnes of CO_2 equivalent. The draft Energy Policy of Poland until 2040 from November 2019 provides for evolutionary transition of the electricity generation sector towards a lower-carbon sector, at a rate guaranteeing energy security and without jeopardising the competitiveness of the economy. The share of RES in electricity generation is expected to rise from the current 14% to ca. 32% in 2030 with further development of the sector expected over the next decade. An increase in the use of RES, the decommissioning of end-of-life, low-efficiency coal-fired units which do not meet the emission requirements (under the BAT Conclusions), as well as the deployment of nuclear power, will reduce the average CO_2 emission level per unit of generated electricity (kg of CO_2/MWh) by ca. 20% by 2030 and by ca. 50% by 2040 as compared with the present level. A major part of the energy sector is covered by the EU ETS, which – by limiting the volume of emissions at the EU level and assessing the EUR value of each tonne of CO_2, indirectly contributes to a systematic change in the fuel mix and the level of technologies used to generate energy in the EU and nationally. It should be stressed, though, that the EU ETS itself by definition does not set national reduction targets in relation to greenhouse gas emissions. It nevertheless does result in the need to undertake additional measures to support emission reduction at the level of individual Member States. The use of mechanisms provided for in the EU ETS Directive to support the transformation of the electricity sector is described below in section 3.1.1.(c)
		6. Launching climate change mitigation and adaptation measures <u>Testing the capacity of forest ecosystem elements to retain more carbon by methodologies involving the expansion of existing technologies and the scope of growing and management work for all forests irrespective of ownership type</u> For this purpose, measures forming part of the Forest Carbon Farm pilot project carried out by

		the ‘State Forests’ National Forest Holding will be undertaken. The Forest Carbon Farm project envisages an attempt to achieve an increased carbon dioxide removal by forest areas through additional forest management activities to be carried out within its impact area. As part of the work already conducted in the initial period the scale and location of activities have been established and first forestry works have been started. Based on inventory data concerning the forest area involved in the FCF project, the expected effect, i.e. the volume of additional carbon dioxide accumulation, has been modelled. The pilot part of the Project will last 10 years (2017-2026), with the effect modelling and effect durability periods expected to span 30 years. As one of its effects, the Forest Carbon Farm project, which is important for enhancing the quality of the carbon balance inventory in forest ecosystems, will improve the system for acquiring forest-related data for emission reporting and removal purposes, as envisaged in the project, by launching measures aimed at building a carbon removal model for forests in Central Europe conditions. The acquired data will also provide a basis for considering additional measures in the forest sector on a broader scale. <u>Adaptation actions</u> Measures will be introduced to adapt to climate change by ensuring the sustainable development and effective operation of the economy and society in climate change conditions, including measures to: - ensure good environmental status, to promote compact, multi-function spatial systems and polycentric urban structures; - include an environment-friendly and low-carbon spatial development approach in spatial planning processes; - develop transport in climate change conditions; - ensure sustainable regional and local development having regard to climate change; - ensure effective adaptation to climate change in rural areas; - stimulate innovations facilitating adaptation to climate change; - form social attitudes helpful in adaptation to climate change. The priority areas specified constitute an answer primarily to the ongoing climate changes and their current and expected consequences for vulnerable sectors. The intensity of adaptation measures will depend, *inter alia*, on the dynamics of climate change until 2030 and in subsequent decades. Furthermore, a low-carbon economy requires a spatial development approach that will ensure efficient use of land and infrastructure and reduce emissions from transport and individual heat sources while following the idea of a compact and cost-efficient city in the spatial planning process. Work is under way to develop an updated strategy for adaptation to climate change, setting out measures and targets beyond 2020 (Strategic Adaptation Plan - SPA2020). The document is planned to be completed by 2020. Currently, in addition to SPA2020, adaptation issues are also addressed by the draft State Environmental Policy 2030, as adopted by Resolution No 67 of the Council of Ministers of 16 July 2019. Owing to the absence of clear national or European indicators concerning adaptation measures, the expected effects of measures undertaken in the period 2021-2030 are of general and qualitative nature.

7. Rationalisation of the use of fertilisers, including nitrogen fertilisers

Issues relating to the storage and use of fertilisers containing nitrogen, including livestock manure, are regulated in the Water Law of 20 July 2017 and Regulation of the Council of Ministers of 5 June 2018 regarding the adoption of the 'Programme of measures aimed at reducing water pollution caused by nitrates from agricultural sources and preventing further pollution', known as the Nitrate Programme, issued on the basis of Article 106 of the Water Law. The Water Law stipulates in particular that a livestock manure dose used in a year for agricultural purposes may not contain more than 170 kg of nitrogen in terms of pure ingredient per hectare of agricultural area used. Additionally, Chapter 1.5 of the aforementioned Regulation of Council of Ministers provides that a nitrogen fertilisation plan is to be prepared by entities:

- having a farm with an area of more than 100 ha of agricultural land used, or
- growing intensive crops on arable land in an area in excess of 50 ha, or
- maintaining stocking density in excess of 60 livestock units (LU) on an annual average basis.

All entities will thus be obliged to apply fertilisers in a rational fashion. The Nitrate Programme will require entities engaged in agricultural production to undertake necessary and long-lasting investment activities. Pursuant to the Nitrate Programme, entities engaged in agricultural production and in the activities referred to in Article 102(1) of the Water Law are obliged to put the area or capacity of sites designated for storing natural fertilisers (livestock manure) in line with the requirements set out in the Programme, by:

(1) 31 December 2021 – in the case of entities breeding animals in numbers exceeding 210 LU, including entities raising or breeding poultry in numbers exceeding 40,000 places or raising or breeding pigs in excess of 2000 sty places for pigs with weight exceeding 30 kg or 750 sty places for sows;

(2) 31 December 2024 – in the case of entities engaged in raising or breeding livestock in numbers not exceeding 210 LU.

To adapt to the new requirements farmers must ensure appropriate funds in their farm budgets. Additionally, funds must also be ensured in the state budget to support investment activities. The Water Law (by amending Article 400a(1)(2a) of the Environmental Protection Law of 27 April 2001) has obliged environmental protection and water management funds to finance projects involving the implementation of a programme of measures aimed at reducing water pollution with nitrates from agricultural sources. Explanatory MemorandumThe explanatory memorandum of the Law notes that projects involving the implementation of the Nitrate Programme will be funded with the use of repayable instruments, subject to State Aid rules. Additionally, some of the measures relating to the implementation of the Nitrate Programme may be supported by EU funds, subject to State Aid rules.

Having regard to the conditions referred to above and the fact that the Nitrate Programme, pursuant to Article 102 of the Water Law, will be applied by all entities engaged in agricultural production, including special branches of agricultural production, and in activities as part of which livestock manure is stored, the following solutions have been applied:

- the requirements applicable to date with respect to manure storage have been transferred from the Fertilisers Act (i.e. 4 months' storage of natural liquid fertilisers) to the Nitrate Programme, and have been set to apply from the effective date of the Programme,

		- the gradual adaptation of farms to the requirements concerning appropriate facilities to store liquid manure (with watertight bottom and sides and covered) and places for storing solid manure (watertight bottom and sides) for livestock manure storage over 6 and 5 months, respectively, has been staggered over time. Measures in this respect will be continuous, spanning the period 2021-2030.
		8. Measures to improve air quality As a result of the air protection policy pursued, emission of pollutants into the air has been reduced considerably over the last thirty years, including that of PM by more than 80%, sulphur dioxide by 70%, and nitrogen oxides by 40%. Nevertheless, in accordance with the report entitled Air Quality Assessment for 2018[14], out of all 46 zones in Poland, exceedances of limit values were found in 39 zones for PM10 and in 14 zones for PM2.5. Analyses show that the responsibility for this state of affairs rests primarily on the household and municipal and domestic sector, transport and, to a minor extent, industry. Improving the quality of the air is one of the priorities of the Government of the Republic of Poland. Detailed activities in this respect are set forth in the **State Environmental Policy 2030**, which provides, *inter alia*, for: • the implementation of the Clean Air strategic project, • support for local governments as regards multi-criteria management of area emissions (heating systems) and line emissions (transport), as well as the siting of investments with point emitters, • supporting the development of low-carbon transport, • abatement of air pollutant emissions through the implementation of the MCP and NEC Directives, support of pro-environmental investments, • developing an odour policy, • adjusting the legal framework to further reduce emissions of air pollutants, including 'low-stack' emissions, • creation of a nationwide system of advisory support in the field of energy efficiency and RES for the public, housing and enterprise sectors, • Development and financial support of the State Environmental Monitoring as regards air quality measurements. The strategic project of the State Environmental Policy 2030 named **Clean Air** involves creating nationwide legal and financial mechanisms for effective delivery of air quality programmes at the provincial and local levels, mainly in respect of the municipal and domestic sector and transport, in particular through: - creating and improving a legal framework stimulating effective measures to improve air quality, - popularisation of financial mechanisms that work towards improving air quality, - involving residents in action to improve air quality by raising public awareness and creating sustainable platforms for dialogue with public organisations, - development and populerisation of technologies conducive to improving air quality, - developing mechanisms to control 'low-stack' emission sources helpful in improving air

		quality. For several years, Poland has been pursuing a number of measures to eliminate what is referred to as 'low-stack' emissions, both at the local and central government level. First, the **National Air Quality Programme**[15] was developed and adopted on 9 September 2015. It is aimed at bringing emissions below the limit values for particulate matter and other hazardous substances in the air, as set out in the applicable laws. Furthermore, it is worth stressing that to enhance the effectiveness of measures envisaged in air quality programmes and short-term action plans local governments have been provided with an additional tool as part of the amendment to the Environmental Protection Law (known as the Anti-Smog Act) of 10 September 2015 (Journal of Laws 2015, item 1593). Pursuant to Article 96 of the Environmental Protection Law of 27 April 2001 (Journal of Laws 2017, item 519, as amended) provincial assemblies may, by resolution, restrict or prohibit the operation of installations in which fuels are combusted, in order to prevent an adverse impact on the environment. At the same time, such resolutions must specify the types or quality of fuels to be admitted for use or prohibited from being used. By 1 November 2019, 11 provinces had adopted what is referred to Anti-Smog Resolutions. Owing to the unsatisfying condition of the air in Poland, on 25 April 2017, the Economic Committee of the Council of Ministers presented **Recommendations for the Council of Ministers – the Clean Air Programme**, which contain a set of actions necessary to improve air quality. The actions are implemented gradually. It should be emphasised that measures aimed at improving the quality of the air are also envisaged in other documents of key importance for the development of Poland, including in the **Strategy for Responsible Development – the 'Clean Air' project, the Electromobility Development Plan 'Energy for the Future', the State Environmental Policy 2030**, as well as in the draft **Energy Policy of Poland until 2040**. At present, Regulation of 1 August 2017 on the requirements for solid fuel boilers (Journal of Laws, item 1690) is in force. The Regulation obliges entities marketing solid fuel boilers with a rated thermal output of not more than 500 kW to comply with boiler design requirements ensuring the achievement of specific limit values of the emissions of carbon oxide, gaseous organic compounds and particulate matter. Additionally, it bans the use of an emergency grate in boiler structures. The adoption of Regulation of the Minister of Energy of 27 September 2018 on the quality requirements for solid fuels is worth highlighting. The improvement of the air quality is also to be achieved through measures relating to the development of district heating systems (in particular heating networks and energy-efficient heating systems based on cogeneration or RES or using waste heat from industrial plants). Additionally, one of the basic measures to improve the quality of the air will be the development of gas distribution to satisfy heating needs. A pilot programme for **thermomodernisation and replacement of individual heating devices for the poorest has been prepared under the name SMOG STOP**. The programme was published on 22 February 2018. It is addressed to 23 towns ranked among the 50 most polluted towns in Europe presented by the World Health Organization. In 2018, Poland launched the **"Clean Air" investment support programme**, financed by the National Fund for Environmental Protection and Water Management. It is a comprehensive government scheme aimed at improving air quality, which provides support for

		thermomodernisation of single-dwelling houses and replacement of old heating sources. The programme is dedicated to improving energy efficiency and reducing air emissions of PM and other pollutants, caused by the use of outmoded heat sources and low-quality fuel to heat single-family houses. The programme is to be delivered until 2029, with a budget of PLN 103 billion. Since the transport sector in large cities is the main cause of nitrogen dioxide limit value exceedances, an expert study entitled*Analysis of the possibilities of creating reduced transport emission zones in Poland* has been prepared, as required by the National Air Quality Programme. The results of the analysis are the basis for **defining eco- and cost-efficient solutions capable of effectively contributing to the reduction of transport emissions in a given area and will constitute justification for taking decisions to create reduced transport emission zones in Poland.** It should also be pointed out that under the Act of 11 January 2018 on electromobility and alternative fuels (Journal of Laws 2018, item 317), in order to prevent the negative impact of emissions from transport on human health and the environment, municipal councils can resolve, under Article 39 of the Act, to establish within high-density housing areas with a concentration of public buildings clean transport zones with restricted access for vehicles other than electric, hydrogen-powered, or gas-fuelled vehicles. The problem of inadequate air quality in cities is also caused by inappropriate spatial planning. In city centres, natural aeration corridors become blocked. Therefore, the issue of **reducing undesirable urban sprawl and green wedge blocking** has been signalled in the reform of the spatial planning system which is currently being prepared by a team of experts. The problem of inadequate spatial planning covers also the issues of the construction of transit routes in densely populated areas. Their location outside urban areas should be considered, along with the construction of by-pass roads taking traffic outside urban areas, the construction of inter-modal nodes and the expansion of environment-friendly transport networks (including a railway system).
		8. Just energy transition The idea of just social and infrastructural transition, associated with the transformation of mining regions, plays a central role in achieving the growingly demanding climate goals. Polish mining regions face major transformational challenges, such as changes in the labour market, and reclamation and regeneration of brownfield land. Minimising the social costs that will accompany economic changes towards low-carbon economies will be crucially important. This means that regions exposed to the negative effects of the transformation should receive support. The pace of energy transition must be adapted to the economic standing and financial capabilities of mining regions. Optimally, the development of solutions in support of just transition should take the form of further dialogue with social partners and local authorities, which is particularly important in restructuring the mining regions that are most vulnerable to climate and energy transition. There is a need to implement development programmes for such regions, e.g. through special support for development projects, creating favourable conditions for conducting and developing business activity, or additional labour market mechanisms, as well as through modernising the sector, and investing in low- and zero-emission generation sources. **Given the challenges facing coal mining regions, a restructuring plan for hard coal and**

		lignite mining areas, to be co-financed by EU funds, will be developed in 2020. The above plan will require preparing an in-depth analysis of the impact of the transformation of mining regions, notably the economic development of the regions, society, employment and skills. Poland strives to provide adequate financial resources to accelerate the transition of the energy sector (including mining) towards decarbonisation as part of modernising the entire economy. In December 2017, the Polish Government launched the Programme for Silesia (Program dla Śląska), a strategic project of the government's Responsible Development Strategy. In addition, Poland has actively joined the Coal Regions in Transition Initiative, which was launched by the European Commission in December 2017. Initially, of the 6 Polish coal regions identified by the European Commission, only Silesia participated, which – being the largest mining region in the EU – was selected as the pilot region. Given the growing interest in the programme by other Polish coal producing areas, now the Dolny Śląska and Wielkopolska regions have joined in. Work is under way to involve a new region, namely Małopolska. There is also potential for attracting other regions. Poland considers the platform an opportunity for stepping up efforts towards social and infrastructural transition through cooperation between regional authorities, social partners, and the government administration. In addition, there are regional strategies for the transformation of coal regions. These include the Sudety Strategy 2030 in Dolny Śląsk and the Clean Air Programme in Małopolska, to name but two. Furthermore, work is underway to prepare a document setting out the transition strategy for the Wielkopolska region. It is necessary to intensify the transfer of EU funds dedicated to coal and lignite production regions in order to support the transformation and minimise the socio-economic effects produced by the EU climate and energy policy in those regions. Therefore the Polish Government will strive to develop, in cooperation with the EU, **financial instruments supporting energy transition, such as the Just Transition Fund**, and to ensure that the funds are used by the Polish coal regions with high levels of employment in mining. As regards employment policy, high-quality job creation and requalification efforts will be crucial to transform the economy into a low-carbon one. Actions will be needed in support of just transition in coal-dependent regions to help employees change jobs and acquire new and specialised skills, support employment initiatives and start-ups, while maintaining dialogue with social partners. Existing "dirty jobs" should not be liquidated, but aligned to the requirements of the green economy. A profound modernisation of workers' skills profile is crucial, especially in regions where hard coal and lignite are extracted. Changes in the economy, including the energy sector and the labour market, should be looked at as development opportunities. The Polish government attaches great importance to the job potential associated with renewable energy sources. The development of renewable energy will translate into new job creation in the wind, solar, bioenergy and other sectors. The development of renewable energy will benefit the national, regional, and local labour markets.
b)	Regional cooperation in this area. **Responsible authority*: MK**	**1. Work concerning the international process of negotiation of the United Nations Framework Convention on Climate Change** Poland is a party to both the UN Convention on Climate Change, and the Kyoto Protocol and the

	* subject to potential changes resulting from amendments to the Act on government administration departments.	Paris Agreement (PA), which are international legal instruments obliging countries to reduce greenhouse gas emissions. Pursuant to the Paris Agreement, all parties are required to prepare, communicate and maintain, on a regular basis, nationally determined contributions to achieving the objectives of the Paris Agreement, as well as to take measures at the national level aimed at reducing emissions for the purpose of attaining these contributions. Both the EU and Member States have fulfilled this obligation by submitting, in 2015, their intended Nationally Determined Contribution (NDC), which envisages, *inter alia*, a EU declaration to carry out its internal commitments to reduce greenhouse gas emissions by at least 40% from 2021 to 2030, as compared with 1990, throughout the EU. The Paris Agreement does not impose specific solutions which might affect the sovereign decisions of the parties to the Agreement, but aims at reducing CO_2 concentration in the atmosphere through both the reduction of emissions and an increase in their removal by forests and soil. Poland's accession to the PA implies its declaration of preparedness to undertake commitments in the form of further NDCs. They will not be legally binding, but in the case of Poland will be submitted as part of the common European Union's NDC, the content of which will be based on the internal decisions of the EU and its Member States with respect to the future EU energy and climate policies (and thus the emission reduction targets binding under the EU internal laws, defined in such policies). The nationally determined contribution is expected to be achieved in accordance with the adopted guidelines. The decisions on climate neutrality until 2050 adopted at the December 2019 European Council are an important issue in the context of the EU NDC contribution to achieving the objectives of the Paris Agreement.
c)	If applicable, without prejudice to the applicability of State aid rules, financing measures, including EU support and the use of EU funds, in this area at national level. **Responsible/involved parties*:** **MK, MR, MAP, MI, MFiPR** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Financing of elimination of 'low-stack' emissions** Poland's decarbonisation efforts include actions undertaken to eliminate what is referred to as "low-stack" emissions by supporting investments that involve: - constructing renewable energy generation installations or high-efficiency cogeneration installations; - promoting energy-efficiency at companies and public and residential buildings; - improving the efficiency of heat supplies to consumers; - developing low-carbon transport. The aforementioned areas are planned to be supported also after 2020. Additionally, Poland plans to deploy instruments supporting the reduction and then elimination of 'low-stack' emissions through the development of energy poverty mitigation policies, connection to district heating networks having regard to the optimisation of expenditures, the development of the natural gas network infrastructure, the introduction of low-carbon zones (at present, clean transport zones are covered by the Act on electromobility and alternative fuels of 11 January 2018).
		2. Mechanisms envisaged in the new EU ETS Directive to be in force in the period 2021-2030 According to the emission allowance allocation for the 4th period of the EU ETS (2021-2030),

		Poland's auction volume is to include around 884,970,000 allowances[11]. On 30 July 2019, by its decision on the division of the 2021-2030 auction pool and on whether or not to take advantage of mechanisms provided for by the Directive, the Council of Ministers waived the derogation for the energy sector and allocated Poland's entire auction volume for auctioning. The proceeds from the sale of 275 million emission allowances will be allotted to the national specific-target fund for the modernisation of the energy sector, which is managed by the minister competent for energy. In addition, decision was taken to auction in 2020-2021 the emission allowances unused in the current accounting period, as per Article 10c. The funds obtained in this way are to constitute state budget revenues, with the proviso that proceeds from the sale of approx. 30 million allowances will be allocated for investments in the energy sector. The Modernisation Fund provided for in the EU ETS Directive is a new instrument of the European Energy Policy, which is to span the years 2021-2030. Its main goal is to promote investments aimed at modernising the energy sector (modernisation of energy systems, improvements in energy efficiency). The Modernisation Fund will be financed through the auction of up to 2% of the total EU ETS allowances (optionally to be increased by another 0.5%). Poland will highly benefit from the Modernisation Fund, consuming a share of 43.41%. A portion of Poland's allocation (approx. 57.5 million allowances) should be dedicated to energy sector companies, while the rest for implementing programmes addressed to wider target groups. In light of the above, given the Polish and EU climate and energy policy lines, the resources of both Funds should be primarily allocated to investments aimed at delivering the National Energy and Climate Plan, in particular: • nuclear energy; • repowering of generating units in the energy sector, • development of transmission and distribution networks, including heating systems, • improving energy efficiency, including in construction, • RES along with accompanying infrastructure, including dams where hydroelectric power stations can be built, • curbing emissions from transport, including electromobility, • energy storage, • promoting the use of hydrogen fuels, • increasing interconnections between EU Member States, • measures to ensure just transition. In 2023, the funding mechanisms and absorption of funds are to be reviewed, in particular to check whether the mechanisms need to be changed or not.
		3. Development of district heating and co-financing of the connection of new consumers Having regard to the need for multifaceted measures to improve air quality, the development of district heating in urbanised areas improves the situation in a unique way and reduces low-stack emissions from inefficient local boilers.

[11] According to estimates of the Ministry of State Assets, in cooperation with the Ministry of Climate and KOBiZE

		Making use of financial support dedicated to district heating systems is intended to expand their coverage and connect new consumers. This measure is necessary to improve the quality of the air in Poland by eliminating individual heat sources and replacing them with district heating. Consideration should be given (especially in the context of regional measures) to possible financial support for the modernisation of the internal infrastructure of buildings, necessary to receive heat supplied by district heating systems. A parallel measure necessary to increase the efficiency of the use of primary energy carriers, and thus to reduce CO_2 emissions from the district heating sector, is the reduction of distribution losses of heating networks. Funds assigned to this measure should be expended, *inter alia*, on the retrofitting of district heating substations and replacement of heating pipes by pre-insulated piping. Proposed form of financing: a grant or preferential lending.
		4. Support for the utilisation of coal-bed methane Approximately 80% of coal resources in Poland constitute deposits classified as deposits containing methane, and the greenhouse effect of methane is 21 times greater than that of CO_2. Therefore, if appropriately included in the sector transformation process, methane may become an important raw material in the Polish energy mix, contributing to the energy security of the country and, at the same time, to a considerable reduction in greenhouse gas emissions. The use of methane for energy purposes exemplifies an activity which is not only beneficial for the environment, but also brings economic gains (the calorific value of methane is more than double of the calorific value of coal) and social gains (improvement of the work safety of miners). Coal mine methane has already been used to some extent in the econonomy (mainly for the production of electricity and heat) both by its "producers", i.e. coal mines and external counterparties to which it is sold by mines. Activities are needed to support increased use of CMM, because currently only about 20-25% of methane released in coal mining processes is ultimately utilised. The utilisation of methane is consistent with EU targets concerning the development towards circular economy, since at present a large portion of methane is treated as waste, whereas it can be used as fuel.
3.1.2. Renewable energy (2030 Framework Target)		
a)	Policies and measures to achieve the national contribution to the binding EU-level 2030 target for renewable energy and trajectories as presented in 2.1.2 including sector- and technology-specific measures[16]. **Responsible/involved parties*: MAP, MR, MFiPR, MGMiŻŚ, MRiRW, MK, URE**	**Support for renewable energy** Pursuant to EU regulations concerning State Aid for energy, support for renewable energy should be based on competitive systems, promoting the reduction of costs involved in meeting targets. In Poland, renewable energy sources in the electricity sector are supported with the use, *inter alia*, of an **auction system**, which should be regarded as the most effective solution from the economic point of view. Support granted on the basis of an auction offers permanent and stable conditions for investing in new RES installations. The support system adopted in the form of auctions enables aid to be channeled to selected areas and sectors and thus the energy mix to

	* subject to potential changes resulting from amendments to the Act on government administration departments.	be optimised with regard to electricity. The auction system mechanisms make it possible to stimulate the development of areas with potential for the development of renewable energy sources based on economic, environmental and climate conditions, taking into account and having regard to energy security, technical criteria and the needs of local communities. **The mechanisms for supporting and promoting** energy production from renewable energy and the time horizon of support will be tailored to market needs (although it is expected to be necessary until 2030), and will prioritise the following solutions: - ensuring **maximum availability** (high efficiency and utilisation rate, controllability, **the use of an energy storage facility**), with a relatively lowest energy generation cost; - satisfying **local energy needs** (heat, electricity, transport), but also those relating to waste treatment and disposal (consistent with the waste management hierarchy) and the use of local potential. The support will depend on the type of source and its size, with the following hierarchy: - **priority access to the network** – currently granted all RES installations and the central focus of support. This measure may be modified in the future, but after 1 January 2020, installations with a capacity below 400 kW (and from 1 January 2026 below 200 kW) will continue to have priority access, as required by Regulation 2019/943 of 5 June 2019 on the internal market for electricity. **auctions** – designated for commercial power plants i.e. those ensuring that capacity is available at sufficient levels. The choice of areas to be supported depends on preferences as to the stimulation of the development of RES areas, based on economic, environmental and climatic conditions and having regard to energy security; - **feed-in tariff system** and **feed-in premium system** – they are targeted on sources with a relatively low capacity and applied to utilise energy which is not consumed by small producers; **grants, repayable aid** – a mechanism depending on local needs, mainly distributed in regions; - **guarantees of origin** – documents confirming to the final customer that a certain amount of electricity supplied to the grid has been generated from renewable energy sources – they take the form of certificates and the demand for them is driven by consumers that wish to be perceived as green companies or want to demonstrate high energy efficiency (e.g. building administrators, SMEs or operators of electric car chargers); **aid mechanisms targeted on special technologies** – a solution designated for sources for which there is no competition in the market, since they are a new technology (e.g. offshore wind energy generation), but their implementation is important for the country for various reasons, e.g. high consumption of demand over the year. Progress in the field of renewable energy will be ensured, *inter alia*, by a range of solutions provided for in the amended RES Act, which entered into force on 29 August 2019. The amendment enabled RES electricity auctioning in 2019, with more than 3400 MW allocated for the auctions. It was assumed that the results of the 2019 auctioning would allow annual RES production to be increased by about 9.2 TWh of electricity. In addition, the above amendment introduced solutions stimulating prosumer energy generation and energy cooperatives.

		Furthermore, in order to give a boost to prosumer energy production, additional schemes were put in place, such as 'My Electricity Bill' (Mój Prąd) with a pool of funds of PLN 1 billion. The Scheme, whose goal is to increase energy production from solar sources, foresees the co-financing of new 2-10 kW solar photovoltaic microinstallations. It is estimated that 200,000 beneficiaries will take advantage of the subsidies. In 2019, additional renewable energy schemes were launched with resources available from the National Fund for Environmental Protection and Water Management: • Energy Plus (Energia Plus) – with a pool of funds of PLN 4,000,000,000, intended for projects aimed at reducing the negative impact of enterprises on the environment, including for renewable energy development, • Poviat District Heating (Ciepłownictwo Powiatowe) – a pilot project with a pool of funds of PLN 500,000,000, intended for projects aimed at reducing the adverse effect of heating enterprises on the environment, including for renewable energy development, • Agroenergy (Agroenergia) – with an allocation of PLN 200,000,000, which involves providing comprehensive support for reducing the negative environmental impacts of agricultural activities, including through the development of renewable energy sources, • Polish Geothermal Energy Plus (Polska Geotermia Plus) – with an allocation of PLN 600,000,000 for increasing the use of geothermal resources in Poland. The boosting of the RES support system in 2019 will contribute to achieving the 15% target for the share of energy from renewable sources in 2020. A stable and competitive RES support system will increase the share of renewable energy in the gross final energy consumption, without leading to a considerable increase in prices or serious disturbances in the operation of energy markets. The stabilisation of legal regulations and the consistent implementation of the long-term action plan covering support for individual sectors will contribute to the dynamic growth of new investments. The optimisation of the support system will enable the 2030 target to be achieved through modern, distributed and cost-effective investments, increasing the security and flexibility of the Polish electricity system.
		Role of particular RES technologies in the energy mix broken down to controllable and non-controllable sources The role of non-controllable RES sources is expected to be as follows: - **solar energy (photovoltaics) –** an asset of this technology is a positive interdependence between the intensity of insolation and the daily demand for electricity, and increased generation in summer correlated with cooling demand. They are installations with relatively small capacities, but the total installed capacity is bound to have a growing importance for the National Power System. The use of solar energy is an alternative way for utilising brownfield areas and poor-quality land, as well as building roofs. It is of key importance for the current dynamic development of microinstallations[12], strengthened by dedicated financial

[12] At the end of 2017, approx. 28 800 microinstallations with a total capacity of approx. 183 MW were connected to the six main DSOs. At the end of 2018, these figures almost doubled to 54 200 of microinstallations with a capacity of 343 MW, and after Q3 2019, the number grew to 106,000 with a total capacity

		support schemes. Photovoltaic sources are expected to achieve economic and technical maturity after 2022 in the sense that they will not require operational support past this date. In accordance with the projections to the National Energy and Climate Plan, the capacity achievable in PV installations is expected to increase to approx. 7.3 GW in 2030 and approx. 16 GW in 2040. - **offshore wind energy** – offshore wind blows at relatively high speeds not encountering any obstacles (low terrain roughness), which makes offshore wind farms more productive than those located on land. To start investing in these capacities, work on strengthening the transmission network in the northern part of the country must be completed, so that power can be evacuated inland. It is expected that the first offshore wind farm will be included in the electricity balance after 2025. The Polish coastline offers opportunities for building further off-shore installations, but the possibility of balancing them in the NPS remains a key issue. It is expected that in the 2040 perspective, these sources will be responsible for the largest amount of electricity generated from RES. In accordance with the National Plan, the capacity achievable by offshore wind farms is expected to increase to approx. 3.8 GW in 2030 and approx. 8 GW in 2040. - **onshore wind energy** – it is expected that in the medium term the increase in the share of this technology in the energy balance will be less dynamic than in previous years. An important difficulty in using on-shore wind farms is the absence of correlation between their operation and demand for energy and therefore the rate of their development should depend on costs and balancing possibilities. Another problem is the varied level of acceptance for the construction of wind farms by local communities. To reduce potential conflicts, investors might create systems encouraging resident participation in the implementation of projects; In accordance with the projections of the National Plan, the capacity achievable by onshore wind farms is bound to increase to approx. 9.6 GW in 2030, and the volume will be maintained until 2040. - **hydropower** – owing to the negligible use of available hydropower potential, it is reasonable to enhance the use of run-of-the-river hydropower. In the long-term, the development of hydropower may be stimulated by the development of inland waterways and the regeneration of dams, which are important from the perspective of watercourse regulation and rational water management (flood and drought retention, increased retention). It should be noted that the operation of run-of-the-river plants can be regulated, but to a limited extent. Pumped-storage hydropower plants are not regarded as RES plants, but play a regulating function for the NPS. Bearing in mind the regulating potential of hydropower, it is worth looking for new ways to use it, also on a small scale. With respect to controllable sources, the use of the following technologies is envisaged: **energy from biomass** (and waste-derived heat) – this source will be well suited for households and for cogeneration purposes; it has the largest potential for achieving the RES target in heat generation given the availability of fuel and the technical and economic

of 684.8 MW.

		parameters of installations. Generation units working on biomass should be located close to where it is produced (rural areas, wood processing industry areas, or areas where municipal waste is produced) and where it is possible to maximise the use of primary energy contained in fuel, thus making it possible to minimise the environmental costs of transport. The use of biomass for energy purposes also contributes to better waste management; **energy from biogas** – the use of biogas will be particularly useful in combined electricity and heat generation. One benefit is the possibility of storing energy in biogas, which may be used for regulating purposes. The high investment outlays are the main factor determining the moderate increase in installed capacity of biogas plants. From the point of view of the overall economy, biogas provides extra value added, since it makes utilising particularly noxious waste (e.g. animal waste, landfill gases) possible. Energy products of biogas plants will be increasingly used in the energy sector. Depending on local demand, biogas plants can provide electricity, biomethane, heat or cold using locally available resources for their production. As regards agricultural biogas plants, the raw material potential is rising from year to year as the Polish agricultural sector grows. - **geothermal energy** – although its use is currently at a relatively low level, an upward trend is expected. Major financial expenditures are required to determine geothermal potential, with the degree of certainty being very small, but the use of this type of energy may be instrumental to the development of certain areas; - **heat pumps** – their use in households is becoming more and more common, with the estimated potential similar to that of geothermal energy. Electricity is required for them to be used and therefore linking installations with another RES which generates electricity is a good solution;
b)	Where relevant, specific measures for regional cooperation, as well as, as an option, the estimated excess production of energy from renewable sources which could be transferred to other Member States in order to achieve the national contribution and trajectories referred to in 2.1.2. **Responsible authority*: MAP** * subject to potential changes resulting from amendments to the Act on government administration departments.	**Statistical transfer and the implementation of joint RES projects** Legal possibilities are in place in Poland for a statistical transfer to/from other EU Member States and for the implementation of joint energy projects. It is assumed that until 2030 Poland will rely on its own resources to fulfil the set target, taking into account the required levels of cooperation with other states. At the same time, no excess energy production from renewable sources is envisaged which could be transferred to other Member States in order for them to achieve their national contributions.
c)	Where relevant, specific measures on financial support, including EU support and the use of EU funds, for the promotion of the production and use of energy from renewable sources in the electricity, heating and cooling, and transport sectors.	**1. Support for the production of electricity and heat from renewable energy sources and for the production of biofuels** The funds allocated to support the production of electricity and heat from renewable sources as part of the Operational Programme Infrastructure and Environment 2014-2020 amount to EUR 150 million. The funds allocated as part of Regional Operational Programmes (ROPs) amount to ca. EUR 890 million, which includes ca. EUR 50 million in the form of repayable instruments.

	Responsible/involved parties*: **MAP, MFiPR, MK** * subject to potential changes resulting from amendments to the Act on government administration departments.	Support for the production of biofuels is possible within the framework of seven ROPs, as part of measures dedicated to RES. In accordance with the 'n+3' rule, funds for the above purposes may be expended until 2023. Financial support for the area in question in the financial perspectives 2021-2027 and 2028-2034 is likely, but its amount and scope cannot be defined at the present stage. The scope of support for renewable energy sources is also envisaged by the National Fund for Environmental Protection as part of national funds.
		2. Support for innovative solutions in the production of 2nd generation biocomponents and other renewable fuels An important element of measures relating to the implementation of the new Directive on the promotion of the use of energy from renewable sources (RED II) will be issues concerning the use of biofuels and electricity in the transport sector, whose share in this sector in 2030 should reach 14%. An increase in the commitment concerning the share of energy generated from RES in transport beyond the current commitments (10% in 2020), combined with the restriction on the use of conventional biofuels generated from raw materials for feed production, shows that there is a need for the development and application, to a much greater extent than so far, of new production technologies, which implies the need to construct plants based on new technologies. Otherwise, it will be necessary to purchase considerable quantities of such fuels from abroad. Given the fact that renewable fuels used in transport are more expensive than conventional (mineral) fuels, and the demand for them stems from law (a high regulatory risk), such innovations pose a high risk. Additionally, in the case of innovative technologies high investment costs must be incurred, which considerably reduces the cost-effectiveness of production. This is why supporting this sector is reasonable. Proposed form of support: grants, subsidies, repayable instruments.
		3. Development of distributed energy generation Directive on the promotion of the use of energy from renewable sources (RED II) and the Market Directive introduce new obligations to increase the share of renewable energy: REC (Renewable Energy Communities) and EC (Energy Communities), which additionally emphasises the importance of energy sustainable areas, in particular **energy clusters and energy cooperatives.** Ultimately, the supply/demand balancing certainty in clusters should be high enough for the energy needs of those areas not to be included in the power reserve planned by the transmission system operator. Considering the above, registration of measurement data, balancing energy volumes, and settlements by energy cooperatives and their members, as well as access to measurement data will be governed in detail by legislation. Support for the development of distributed energy generation in energy clusters and energy cooperatives is particularly important from the point of view of the construction of generation sources, networks and control systems. It is estimated that ca. **300 energy sustainable areas will operate at the local level in Poland in 2030.** This task has been included in the Strategy for Responsible Development as one of the priorities in the energy area, and also in the draft Energy Policy of Poland until 2040. Proposed form of financing: grants, repayable aid, guarantee funds.

		What is more, legislation will be amended to improve the development of energy using solar radiation in post-mining areas requiring reclamation, degraded, or mine dumps.
		4. Development of stabilising technologies (production and storage) non-controllable RES Directive on the promotion of the use of energy from renewable sources (RED II) introduces new obligations to increase the renewable energy share. The development of storage technologies is a precondition for growth of RES and changes in the energy market. An excessively high number of intermittent renewable energy sources endangers the security of the NPS and drives prices up. Support for stable RES or other stabilising measures useful in balancing non-controllable RES will be important. Proposed form of financing: grants, repayable aid, guarantee funds.
		5. Development of installations for generating heat from RES The new Directive on the promotion of the use of energy from renewable sources (RED II) introduces new obligations to increase the share of renewable energy in the heat generation sector. Owing to its local nature, heat generation will require funds to be invested at the local government level, which implies the need for the financing of the development of RES mainly by municipal utility companies, whose financial condition does not always guarantee the availability of surplus funds for investment purposes. Proposed form of financing: grants, repayable instruments, guarantee funds.
		6. Development of off-shore energy generation The development of off-shore energy generation is one of the areas of activities that are to guarantee the energy security of the country (satisfaction of the increasing electricity demand) and a contributor to the targeted share of RES in the gross final energy consumption in 2030. Support relating to the development of the off-shore energy generation sector is envisaged. Support in this area will also contribute to building regional cooperation in the Baltic Sea region.
d)	Specific measures to introduce one or more contact points, streamline administrative procedures, provide information and training, and facilitate the uptake of power purchase agreements. **Responsible/involved parties*:** **MAP, URE** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Obtaining the confirmation of qualifications/competences of persons operating in the commercial market** Regarding the issue of granting official authorisations to installers of renewable energy sources (only biomass-fired boilers, photovoltaic systems, solar heating systems, heat pumps, shallow geothermal systems), the minister competent for energy has issued a regulation to enable persons operating on the commercial market to confirm their qualifications/competence. The provisions of the regulation ensure standardised assembly of microinstallations, small installations or renewable energy installations with an aggregate installed thermal capacity not exceeding 600 kW and the impartial and independent conduct of procedure for accrediting entities providing training and certification for installers of a given type of installations. They also ensure that certification procedures are properly documented and registered, and that documentation concerning the certification procedure is kept. The Office of Technical Inspection is the implementing authority responsible for enforcing the regulation.
		2. Enhancing services provided to electricity producers to be covered by the auction-based renewable energy support system

		The solutions adopted by the Energy Regulatory Office guarantee the provision of efficient and modern services to electricity producers to be covered by the auction-based renewable energy support system – from the pre-qualification process and auctioning itself to post-auction support relating to the fulfilment of reporting obligations. Solutions enabling the process to be handled in a swift and intuitive manner with the use of the dedicated IT tools need to be maintained and developed. Streamlining the achievement of the RES target in the electricity generation sector through effective services provided to entities applying for support will speed up investments and construction processes.
(e)	Assessment of the necessity to build new infrastructure for RES-based district heating and cooling. **Responsible/involved parties*:** **MAP, URE** * subject to potential changes resulting from amendments to the Act on government administration departments.	The changing business environment and technological development constitute major challenges for the heating sector. Important issues to be regulated in the near future include: changing the heat market model and tariff policy, developing smart network infrastructure, regulating the rules on the purchase of RES heat, fostering the use of district cooling, etc. The draft Energy Policy of Poland until 2040 envisages the development of district heating as one of the strategic directions. Having regard to the above, measures will be taken to ensure conditions for the development of environment-friendly and efficient heating systems by providing financial, organisational and legal support, including by: - development of cogeneration; - increasing the use of RES and waste in district heating; - conversion of power plants into heat and power plants; - modernising and expanding heating systems and developing technologies for the production of cooling from district heat; - promoting heat storage facilities and smart networks. A measure connected with the measure specified in 3.2.d in this respect.
f)	Where applicable, specific measures on the promotion of the use of energy from biomass, especially for new biomass mobilisation taking into account: - availability of biomass, including sustainable biomass – both domestic potential and imports from third countries; - other biomass uses by other sectors (agriculture and forest-based sectors); as well as measures for the sustainability of biomass production and use. **Responsible/involved parties*:** **MRiRW, MAP** * subject to potential changes resulting from amendments to the Act on government administration departments.	With respect to the promotion of the use of energy from biomass, especially new biomass mobilisation, Polish agriculture has considerable resources of biomass and agriculture and agri-food processing by-products which should be used for energy purposes (biogas production). The development of new technologies should take into account the needs of individual sectors, both as regards the supply of energy and the utilisation of the types of biomass produced as a by-product of the agri-food sector. The method of utilising this type of biomass should contribute to the sustainable development of agriculture (preserving soil fertility – humus level, water resources management etc.). Changes in agricultural production constitute a long-term process and the introduction of new plant species takes time and requires the production profile to be changed. Often, this also involves the need to replaced the entire machinery stock. Therefore, the proposed amendments to legal regulations supporting the use of agricultural biomass for energy purposes will allow for an appropriate adaptation period.

3.1.3. Other elements of the dimension		
a)	Where applicable, national policies and measures affecting the EU ETS sector and assessment of the complementarity and impacts on the EU ETS. **Responsible/involved parties*:** **MK, KOBiZE, MAP, MR** * subject to potential changes resulting from amendments to the Act on government administration departments.	**Participation in the Emissions Trading Scheme – general information.** The Emissions Trading Scheme (EU ETS) is a market-type system, aimed at reducing greenhouse gas emissions. Entities covered by the Scheme account for the quantity of released greenhouse gases by balancing them with emission allowances. Installations eligible for the Scheme are those belonging to specific sectors or meeting the defined threshold conditions set out in Directive 2003/87/EC. The number of installations covered by the Scheme changes from one year to another (ca. 800 installations in Poland). The EU ETS itself by definition does not set national reduction targets, but deploys additional mechanisms that force Member States to reduce emissions at country level. The phasing out of emission allowances (MSR Decision) available at auctions or reduction in the number of free allowances allocated to eligible installations, combined with the rising costs of allowances, forces the units that participate in the Scheme to take measures to reduce emissions. Therefore, it is necessary to undertake modernisation activities in the ETS sectors, especially in the electricity and heating sectors.
		The introduction of the following, from 2021, within the framework of the EU ETS: - **The Modernisation Fund,** - **The Innovation Fund.** At present, work is under way to define, at the national level, in the best possible way, the areas and methods for using innovation support mechanisms provided for in the EU ETS Directive. The framework for the use of revenues derived from the auctioning of CO_2 emission allowances in the pool allocated to Poland is described in section 3.1.1(c). It is worth highlighting that pursuant to the EU ETS Directive measures to decarbonise the economy should be partly financed or co-financed with funds originating from emission allowance auctions (at least 50% of revenues from the sale of allowances by auction should be used for at least one of the environmental objectives specified in the EU ETS Directive).
b)	Policies and measures to achieve other national targets, where applicable. **Responsible/involved parties*:** **MK, MGMiŻŚ, MRiRW, MR, MAP, MI** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Actions to adapt the water management sector to climate change** - Developing and implementing flood risk assessment methods for urban areas, with particular emphasis on flash flooding. - Improving the resistance of the flood risk management system to the effects of climate change, including by ensuring critical infrastructure. - Enhancing retention capacities and restoring aquatic habitats in watercourses (where this is not contrary to other important public objectives). - Restoring and maintaining the good status of water, water ecosystems and water-dependent ecosystems, including actions stemming from river basin management plans and updates thereof.
		2. Measures to adapt the energy sector to climate change - Preparing the energy system for changed conditions, having regard to winter and summer peak energy demand periods.

		- Ensuring reserve energy and transmission sources where the use of primary sources is not possible. - Securing reserve cooling sources in commercial power plants. - Designing transmission and distribution networks, including underground and on-ground ones, having regard to extreme weather circumstances, in order to limit the risk, *inter alia*, of snow and ice accumulation on them, flooding or damage caused by strong wind. - Supporting distributed RES development, with a focus on microinstallations in agriculture.
		3. Measures to protect biodiversity and forest management in the context of climate change - Preparing nature preservation strategies or plans, or plans of nature preservation tasks having regard to changing climate conditions. - Developing programmes aimed at adapting the forest sector to climate change having regard to the conditions and needs of the industry, energy, agriculture and tourism and recreation sectors, regional development and biodiversity. - Increasing woodland area through artificial afforestation and natural succession, and rationalising the use of land and reducing forest complex fragmentation. - Introducing ecosystem-based forestry principles to the economy, ensuring the dynamic protection of existing biodiversity, using both natural genetic processes (adaptation) and human activities aimed at preserving the existing biodiversity, focusing artificial selection also on adaptive traits enabling adaptation to changing climate conditions. - Continuing the implementation of and developing instruments for the protection of agricultural space, forest and high-productivity soil resources. - Diversifying forest stand, in particular during the change of its structure, in terms of: density, species composition (increasing the share of deciduous species), height and age structure and patch/mosaic structure. - Continuing the soil erosion protection programme, continuing and extending the programme for small-scale water retention and soil retention, particularly for forests and grassland. - Monitoring, controlling and counteracting the spread of alien species that endanger native species or natural habitats. - Monitoring forests in terms of tree response to climate change, among others, by phenological observations, changes in species range zones, especially in mountain areas. - Monitoring, in association with the natural dynamics of ecosystems, and conducting periodic assessment of natural areas under protection, and creating a data collection and processing system. - Enhancing forest fire protection by developing systems of monitoring fire risks and fire prevention infrastructure relating to the protection of forests.
		4. Measures to adapt rural areas to climate change - Developing monitoring systems and systems of early warning against possible effects of climate change for plant and livestock production. - Providing investment support for farms along with training and technology advisory services, taking into account issues concerning the adaptation of agricultural production to an

		increased climate risk and climate change prevention. - Improving the system of building up and managing food, seeds, and feed reserves in case of poor harvest. - Promotion of farming systems optimising the demand for water as well as fertilisers and plant protection products, including crops under cover. - Growing plants resistant to water shortages and with a lower demand for nitrogen fertilisers. Rural areas, due to agricultural and forestry activities conducted in them, are particularly vulnerable to climate change. Adaptive measures must be undertaken both in the area of the protection of people in crisis situations along with necessary adaptive measures in agricultural and fishery production and forestry. Local risk monitoring and warning systems are anticipated to be established by 2030 and agricultural and fishing activities are expected to be adapted to climate change in organisational and technical terms within the same timeframe.
		5. Measures to develop transport in the conditions of climate change - Considering changed climate conditions in the process of designing and constructing transport infrastructure. - Establishing a permanent monitoring system or adapting the existing monitoring systems to the need to control construction and transport infrastructure elements vulnerable to climate change and establishing or adapting warning systems used by technical services. - Reviewing or creating measures and plans designed to maintain smooth traffic flow in transit routes or to change routes and apply substitute means of transport. Most elements of the transport system, especially infrastructure, are directly exposed to climate factors and operate in direct contact with atmospheric factors. The vulnerability of transport infrastructure to climate factors needs to be properly assessed in order to undertake effective adaptive and preventive measures, to be developed as a result of an analysis of climate and weather data and the impact of these factors on the condition of infrastructure. Design standards are expected to be developed and a transport route management system is expected to be implemented by 2030 having regard to climate change.
		6. Measures to ensure sustainable regional and local development having regard to climate change - Preparing a risk management strategy at the national, regional and local levels taking into account adaptive measures. - Implementing the local systems of monitoring and warning against, and responding to, extraordinary climate phenomena (e.g. absence of blockages in sewer systems and underground structure drainage systems, situations contributing to an increase in air or water pollution), in cities. - Preventing and reducing the effects of disasters and enhancing the effectiveness of response. - Considering the blue-green infrastructure concept and the system of aeration corridors (wedges) in zoning plans, and specifying permissible heat sources for heating buildings to increase the resilience and improve the operation of ecosystems. Revitalising natural

		environment, including by restoring greenery in degraded areas and original functions to water reservoirs, with emphasis on small-scale retention in cities. Replacing water-tight land surfaces with permeable surfaces. In the light of a number of measures relating directly or indirectly to adaptation, as specified in various strategic documents, appropriate monitoring, warning and response systems are needed in the context of regional and local development. At the same time, the vulnerability of cities to climate change is particularly important, and thus they should be given special significance and priority in the adaptation process. A system for monitoring the state of the environment is planned to be implemented by 2030, along with an early warning and response system for cities and rural areas in the context of climate change. At the same time, work on urban spatial policy will be conduced, having regard to climate change aspects.
		7. Measures to stimulate innovations helpful in adaptation to climate change. Promoting innovative solutions in the area of adaptation to climate change. - Analysing the potential of the Polish economy to generate and implement innovative adaptation technologies. - Consolidating/creating new financing sources for innovative adaptation technologies, including research and implementation projects. - Creating an online platform providing information on Polish adaptation technologies. Work aimed at developing new, innovative organisational and technical solutions that support adaptation needs to be undertaken. The primary objective is to stimulate innovative technologies and to introduce mechanisms enabling cooperation among institutions in situations of complex hazards relating to climate change. The existing sources of funding research on adaptation technologies also need to be adjusted and new ones need to be created, and the results of work must be published.
		8. Measures to encourage social attitudes facilitating adaptation to climate change - Educating people and enhancing their awareness of climate change and methods of minimising its effects, the impact of invasive alien species and the importance of the need to save resources. - Extending programmes for upgrading qualifications for medical professionals by topics relating to climate-dependent and tropical diseases and vector-borne diseases. - Organising training programmes on climate change and methods for preventing and mitigating its impact on people living in areas under threat of floods, landslides and strong winds. - Organising training programmes for farmers concerning climate change and methods for preventing and limiting its impact. - Involving local communities and local government administration authorities in activities preventing the impact of climate change. - Developing comprehensive solutions concerning State Aid granted to cover losses in case of natural disasters and insurance systems covering risks caused by climate change. Effective adaptation to climate change cannot be achieved without raising the awareness of

		hazards and challenges among institutions involved in the adaptation process and people to an appropriate level. In view of the above, educational measures must be implemented, both as part of formal education systems and broadly understood extra-formal education, helping to raise the social awareness of risks related to extreme phenomena and methods for limiting their impact. The primary objectives will also include enhancing the understanding of the impact of climate processes on social and economic life and ensuring appropriate protection to particularly vulnerable groups from the effects of adverse climate phenomena.
		9. Mitigation of climate change, adaptation to it and prevention of natural disaster risks by: - Creating a generally available online Base of knowledge about climate change and adaptation to its effect in the context of improving the resilience of the economy, environment and society to climate change, and preventing and minimising the effects of extraordinary hazards; - Developing adaptation plans in cities with population exceeding 100,000; - Developing and implementing plans for counteracting the effects of draught; - Reviewing and updating flood risk management plans; - Implementation of the Water Shortage Prevention Programme for 2021-2027 with an outlook for 2030, - Review and update of the preliminary flood risk assessment and review and update of flood hazards maps and flood risks maps, - Review and update and implementation of river basin management plans, - Developing flood prevention infrastructure on the basis of high-efficiency and highly viable investments and appropriate spatial planning methods, including by constructing multi-function, functionally coherent small- and, in special cases, large-scale retention reservoirs as part of implementing flood-prevention projects; - Protection against sea erosion and coastal flooding by carrying out protective measures on the sea shore and in the coastal zone (e.g. beach nourishment, storm banks, seawalls and groynes, breakwater structures, underwater barriers), along with monitoring the sea coast, including immediate coastal area; - Managing precipitation water in urbanised areas by using various retention forms and developing greenery infrastructure, - Implementing the strategic project Adaptation to Climate Change. Adaptive measures will consist in developing and implementing strategic/planning documents concerning water resource management, supporting the development and implementation of climate change adaptation plans for urbanised areas, constructing necessary flood prevention infrastructure and small-scale retention structures and implementing projects aimed at protecting the coastline. These measures will also be aimed at managing precipitation water in urbanised areas through various retention forms and the development of greenery infrastructure, the development of blue-green infrastructure in urbanised areas, the limitation of land occupation and soil sealing.
c)	Policies and measures to achieve low-emission	**1. Development of energy efficient low-carbon transport**

	mobility (including transport electrification) **Responsible/involved parties*:** **MAP, MI, MGMiŻŚ, MFiPR, MR, MK** * subject to potential changes resulting from amendments to the Act on government administration departments.	In addition to electromobility and the use of alternative fuels in transport, an improvement in the energy efficiency of transport and emission reduction has been planned. The Sustainable Transport Development Strategy 2030 sets out a number of actions dedicated to reducing the negative impact of transport on the environment, which can be grouped into the following lines of intervention: • <u>organisational and system intervention, *inter alia*</u>: - support for solutions leading to reducing the transport-intensity of the economy; - promoting energy efficiency through the development of inter-modal freight transport, promotion of energy efficient means of transport resulting in, among other things, reducing the dependence of the transport sector on fuels derived from non-renewable energy sources, developing systems supporting logistical optimisation, including fuller use of freight and passenger spaces of means of transport; - support for environment-friendly transport (railway transport, sea transport and inland waterway transport) and efforts to create conditions for a road-to-rail shift and for inland waterway transport, in particular at distances of more than 300 km, promotion of clean means of transport powered by alternative energy sources, resulting, *inter alia*, in reduced emissions; - reducing congestion, in particular in urban areas by: increasing the share of public passenger transport, designating lanes reserved for public transport, integrating public transport in cities and urban agglomeration areas with the construction of P&R and R&D parking systems, optimisation and integration of urban and agglomeration transport and regional passenger transport systems, promoting pedestrian traffic and cycling, organisation and development of delivery systems within settlement units (urban logistics) and elimination of heavy freight traffic and mass transport of hazardous substances across urbanised areas, *inter alia* by using environmentally friendly inland waterway transport, working towards even distribution of urban traffic to reduce rush hours, handling transport by relying on various modes, especially those less harmful to the environment, such as rail and water transportation; - promoting new forms of mobility through: access to travel information, integrated tariffs, delimitation of limited traffic zones in residential areas and city centres, educational and information activities aimed at promoting sustainable and public transport, transport demand management; - Delimitation of low-emission zones (LEZ), with access and parking restrictions for combustion vehicles, especially in city centres; - development of the system of fees and tariffs stimulating desirable transport trends, e.g. with regard to the limitation of pressure on the environment; • <u>investment-related intervention</u>: - modernisation and expansion of linear and nodal transport infrastructure to improve the efficiency of the transport system in line with the EU and national environmental standards and requirements; - modernisation of the rolling stock and vehicle fleet (vehicles and other necessary devices and accessories) across the transport modes to align them, at least, to the EU and domestic environmental standards and requirements, as well as to improve their energy efficiency;

		- implementation of innovative transport management systems for individual modes and interoperative systems contributing to the optimisation of vehicle traffic and thus to a reduction in transport generated emissions; • <u>innovative and technical interventions, including:</u> - application of new technologies, procedures and systems improving the energy efficiency of transport and contributing to a reduction in pollution emissions to the environment – modernisation and provision of the internal interoperability of telematic systems supporting particular transport modes, such as: ITS (road transport), ERTMS, SDIP, CBRK (railway transport), SESAR (air transport), VTMS (maritime transport), RIS (inland waterway); - more common use of environment-friendly means of transport: low-carbon and energy-efficient cars and municipal vehicles (e.g. using fuel cells and hydrogen, or the following drives: electric, gas, hybrid, compressed air) – along with the establishment, especially in agglomerations and densely populated areas and along the TEN-T core network corridors, of a network of battery recharging or replacement points and natural gas or hydrogen refuelling stations, if cost-effective; environment-friendly low-noise and low-carbon rolling stock and airplanes, maritime vessels fuelled by compressed or liquid natural gas, new generation inland waterway vessels (including energy-efficient and low-carbon inland waterway container vessels), use of second and third generation fuels and biofuels based on biocomponents.
		2. Construction and putting in service of inland vessels using alternative fuels A high proportion of inland waterway fleet on Polish rivers is powered by very obsolete engines, which often do not meet the ambitious combustion and emission standards specified for newer types of vessels. New, well defined financial incentives must appear in the Polish market in order to introduce new solutions based on alternative fuels in place of imported old and long-serving vessels. Proposed measures: - developing systemic legislative solutions to streamline the process of building and placing craft in service, including financial incentives, - economic, business and social analyses for water transport, including supply and demand research, - cooperation in the preparation of prototype barges and pusher vessels by research and development units, - institutional support for the preparation of accompanying infrastructure (wharf equipment; recharging and refuelling stations), - cooperation in the preparation of accompanying technologies for the use of barges by research and development units (e.g. methods of disposing of material excavated from places of rockfill accumulation in rivers – in the case of dredgers etc.), - institutional support for vessels manufactured in Poland.
		3. Development of alternative fuel infrastructure, enhancement of operation security, development of electromobility industry and improvement of the quality of the air and comfort of living

			The market of electric vehicles in Poland is at the stage of formation. The regulatory basis for this changes is provided by the Act on electromobility and alternative fuels of 11 January 2018, which provides for the construction of basic infrastructure for alternative fuels in urban agglomerations, in densely populated areas and along roads forming part of trans-European transport corridors. The Act implements the European Directive on the deployment of alternative fuels infrastructure into Polish law. The expansion of the core network will enable the free movement of vehicles using alternative fuels – without the need to be concerned that recharging them will not be possible. The Electromobility Act also provides for the removal of the excise duty on electric and plug-in hybrid vehicles (PHEV), the exemption of such vehicles form parking fees as well as greater possibilities for depreciation charges for companies than in the case of combustion vehicles. In addition to financial benefits, the act envisages a package of solutions useful for drivers in their everyday lives. It is planned that the core network will comprise 6,000 normal recharging points and 400 high power recharging points and 70 CNG refuelling points in 32 urban agglomerations and densely populated areas by 2020. Pilot programmes aimed at intensifying measures in the area of the construction of infrastructure and the development of electromobility industry will be implemented. Conditions and tools will be defined the implementation of which will make it possible to commence the strengthening of the Polish electromobility industry. Regulatory conditions for the development of electromobility were created in the period 2017-2019. It is envisaged that the prototypes of vehicles adapted to the needs of the Polish and European markets will be created and the production of short series of electric vehicles will be launched in the period 2020-2030. In subsequent years, other measures will be proposed, such as further tools aimed at integrating electric vehicles with the network, and instruments for the development of the charging infrastructure will be indicated, which will accelerate the process of constructing it. It is expected that the aforementioned measures will contribute to changes in social awareness, which will lead to electromobility being seen as a necessary response to the challenges of the changing reality. Growing popularity of electric vehicles in households and public transport will drive the demand for green transport. The newly constructed recharging infrastructure will be an additional factor. The network will be fully prepared to provide power to 1 million electric vehicles and will be adapted to the use of vehicles as the electricity system stabilisers. The public administration will use electric vehicles in its fleet. Polish industry will produce subassemblies for electric vehicles, vehicles themselves and instrumentation and infrastructure necessary for the development of electromobility. The task of the Low-Emission Transport Fund is to support the expansion of alternative fuels infrastructure and to build up a market for those fuels. Over the next 10 years, the Fund will have financial means of ca. PLN 6.7 billion. The following areas will be financed from the Fund in the period 2018-2027: (1) supporting investments related to the production of biocomponents, liquid biofuels, and other renewable fuels; (2) supporting the construction or development of infrastructure for the distribution or sale of compressed natural gas (CNG) or liquefied natural gas (LNG), including that derived from biomethane, or for the distribution and sale of hydrogen, or the construction or development

		of infrastructure for recharging electrical vehicles, used in transport; (3) assistance for manufacturers or producers of biocomponents, liquid fuels, liquid biofuels, other renewable fuels, compressed natural gas (CNG), or liquefied natural gas (LNG), including that derived from biomethane, used in transport; (4) supporting: a) producers of vehicles powered by electricity, compressed natural gas (CNG), or liquefied natural gas (LNG), including that derived from biomethane, or by hydrogen, b) Entrepreneurs within the meaning of the Business Enterprise Law of 6 March 2018 (Journal of Laws, item 646) conducting activities in the field of production of subassemblies for the vehicles referred to in (a); (5) supporting public transport based on liquid biofuels, other renewable fuels, compressed natural gas (CNG) or liquefied natural gas (LNG), including from biomethane, hydrogen or electricity, especially in urban agglomerations, health resorts and nature conservation areas delimited pursuant to nature protection laws; (6) subsidising port fees charged for the mooring of vessels propelled by compressed natural gas (CNG), or liquefied natural gas (LNG), including that derived from biomethane, or by hydrogen, or powered by electricity; (7) supporting: a) research aimed at developing new types of biocomponents, liquid biofuels, other renewable fuels, or the use of compressed natural gas (CNG) or liquefied natural gas (LNG), including that derived from biomethane, or hydrogen, or electricity, used in transport, or at developing new design-related solutions in this area, b) operational implementations of the outcomes produced by the research referred to in point (a); (8) supporting educational programmes intended to promote the use of liquid biofuels or other renewable fuels, compressed natural gas (CNG) or liquefied natural gas (LNG), including that derived from biomethane, or hydrogen, or electricity, used in transport; (9) supporting the purchase of new vehicles and vessels powered by liquid biofuels, compressed natural gas (CNG), or liquefied natural gas (LNG), including that derived from biomethane, or by hydrogen, or powered by electricity; (10) supporting analyses and research of the market for biocomponents, liquid fuels, liquid biofuels or other renewable fuels, or the use of compressed natural gas (CNG) or liquefied natural gas (LNG), including that derived from biomethane, or hydrogen, or electricity, used in transport; (11) promoting the production and use of biocomponents and liquid biofuels; (12) and performance of other tasks specified in specific legislation. The development of draft documents involves the need to eliminate legislative barriers, to create a market framework (e.g. to define the vehicle charging service) and to develop alternative fuel infrastructure. In connection with the introduction of new legislation dedicated to electromobility, actions are planned to stimulate the implementation of the following directional goals at the national level: - for 2025:

		• there will be 1 million electric vehicles on roads in the segment of electricity-powered vehicles; • there will be 54,000 vehicles on roads in the segment of vehicles fuelled by CNG, and 32 refuelling points will be available along the core TEN-T corridors; • there will be 3,000 LNG-fuelled vehicles, and 14 LNG refuelling points along the core TEN-T roads; • LNG bunkering installations for vessels will operate in the sea ports of Gdańsk, Gdynia, Szczecin, Świnoujście; - there will be 3,000 electric buses in the public transport segment at the national level in 2030. The above benefits and related instruments aimed at influencing the market will contribute both to the security of operation and to the development of the electromobility industry, as well as to the improvement of the quality of the air and the comfort of life.
		4. Zero-Emission Public Transport Programme Public transport is an important segment of the development of transport using alternative fuels. At present, a growing number of local governments and bus transport companies in Poland add electric buses to their fleets or plan to do so in the near future. Electric buses are still a small part of municipal transport fleet in Poland. Public transport is a transport segment that may be used as a testing ground for a new technology and may be an element contributing to the development of electricity-based transport. Public transport is also an element of the strategy of switching the economy to alternative fuels, with fleet replacement projects constituting a perfect area for the development of new technologies and, consequently, of the entire economy. Local governments, when deciding to purchase electric buses, are guided mainly by the need to improve the quality of the air, the intention to reduce the noise level or the need to systematically raise the standards of passenger transport. The partial replacement of fleet with electric vehicles reflects commitment to modernisation, thus attracting investors and tourists. These objectives are consistent with the government Electromobility Development Plan for Poland, as well as with the EU Clean Mobility Package of 2017. Among the main barriers to transport electrification, the higher costs of purchase of electric vehicles should be mentioned, along with the lack of access to rapid charging infrastructure and the lengthy investment process. None of these barriers may be overcome without the commitment of public funds. Therefore, the Government is planning to provide financial support for investments aimed at expanding electric bus charging infrastructure, to be carried out by entities providing mass transport services. Support for zero- and low-carbon public transport is one of the priorities of the Polish Government listed in the Strategy for Responsible Development. This segment requires support in the form of public funding not only in the area of the construction of infrastructure for public transport, but also in the area of fleet replacement. The reduction of the emissions of pollutants and CO_2 in the public transport sector is linked to its development and, consequently, to at least partial departure from individual motor transport in urbanised areas. It may significantly contribute to the improvement of the air quality in Poland, the reduction of emissions, the achievement of climate targets and the protection of health and the natural

		environment. At the same time, there is a need for financial support for local governments in the field of public transport fleet replacement, which may be carried out only by co-financing the purchase of zero- and low-carbon vehicles, enabling not only the Total Cost of Ownership (TCO) of both means of transport to be brought to the same level, but primarily the difference in the purchase price, which is often decisive in the provision of public transport services, to be compensated for. The financing of the purchase of low-carbon buses and the construction of charging/refuelling infrastructure for these types of vehicles will be provided from, among others, the Low-Emission Transport Fund (LETF). The Act of 11 January 2018 on electromobility and alternative fuels includes a number of obligations and recommendations for local governments, which in many cases may be fulfilled with the use of methane fuel-based transport services. Among more important provisions in this respect is the provision stipulating that local government units in areas with more than 50,000 residents must procure, from 1 January 2025, the performance of public tasks from companies with at least a 30% share of electric vehicles or natural gas-fueled vehicles in the fleet in use. It is estimated that there will be 3,000 electric buses in the public transport segment at the national level in 2030.
		5. Supporting public transport systems in cities with EU Cohesion Policy funds Public transport systems in cities are also supported by EU Cohesion Policy funds under Operational Programmes for 2014-2020 (Operational Programme Infrastructure and Environment, Operational Programme Eastern Poland, Regional Operational Programmes), e.g. the Operational Programme Infrastructure and Environment allocates approx. EUR 2.3 billion worth of subsidies for the construction and modernisation of infrastructure, and the purchase and modernisation of low-emission rolling stock and fleets in the 13 provincial capitals that implement Integrated Territorial Investment Strategies, as well as for competition-based projects related to electric rolling stock, also in medium-sized cities that are losing their socio-economic functions. Financial support for the area in question in the financial perspective 2021-2027 is likely, but its amount and scope cannot be defined at the present stage.
d)	Where applicable, national policies, timelines and measures planned to phase out energy subsidies, in particular for fossil fuels	In the context of the potential phase-out of subsidies in the energy sector, it is crucial that a balanced approach be used, such as to allow maintaining the competitiveness of the national economy and achieving the development goals. The subsidy phase-out process should be supported by flexible transitional measures enabling enterprises to adapt to the new way of production funding, and by preparing mechanisms helping enterprises to modernise production. A list of support measures in the energy sector, including subsidies, is provided in Chapter I.

3.2. Energy efficiency

Planned policies, measures and programmes to achieve the indicative national energy efficiency target for 2030 as well as other objectives presented in 2.2, including planned measures and instruments (also of financial nature) to promote the energy performance of buildings, in particular as regards the following:

a)	Energy efficiency obligation schemes and alternative measures in accordance with Articles 7a and 7b of Directive 2012/27/EU, as amended by Directive 2018/2002 **Responsible/involved parties*:** **MAP, URE** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Energy efficiency obligation scheme referred to in Article 7a of Directive 2012/27/EU:** Article 7a of Directive 2012/27/EU provides that Member States may decide to fulfill their obligations to achieve the amount of energy savings required under Article 7(1) of the Directive by means of an energy efficiency obligation scheme. Under the energy efficiency obligation scheme, Member States are required to ensure that the obligation to achieve end-use energy savings by obliged entities, i.e. energy distributors or retail energy sales companies operating on their territory, is met. The Scheme is expected to remain in effect until 2030, i.e. over the next 10 years, with the annual energy savings it produces averaging 445 ktoe over the timespan. The cumulative final energy savings will be around 55 x 445 = 24 500 ktoe, which represents 80% of the total energy savings required, namely 30 635 ktoe. In Poland, the energy efficiency obligation scheme was created by the statutory imposition of an obligation on obliged entities from 1 January 2013. Currently, the scheme is governed by the Energy Efficiency Act of 20 May 2016. A mechanism stimulating pro-savings behaviour is expected to be in place in the period 2021-2030. Its shape and form will depend on decisions concerning energy efficiency regulations, in particular in the context of the implementation of the new Energy Efficiency Directive adopted in 2018. The Energy Efficiency Act requires that energy efficiency certificates, also known as 'white certificates', be submitted to the President of the Energy Regulatory Office for redemption by the following entities: • energy companies which carry out economic activity in the field of generation or trade in electricity, heat or natural gas, and which sell electricity, heat or natural gas to final consumers connected to the network, • connected end consumers which are members of an exchange within the meaning of the Commodity Exchanges Act of 26 October 2000 or members of a regulated market by virtue of transactions they make on a commodity exchange or a regulated market on their own behalf, • commodity brokerage houses or brokerage houses, for transactions made on a commodity exchange or on a regulated market at the request of final consumers connected to the network. Pursuant to Article 30(1) of the Energy Efficiency Act, energy efficiency certificates incorporate alienable property rights which represent a tradable commodity within the meaning of the Commodity Exchanges Act of 26 October 2000, which means that they can be traded in. Entities which are required by the Act to acquire energy efficiency certificates, but fail to do so and do not redeem or do not complete energy efficiency projects at a final consumer, as documented by an energy audit, must pay a substitition fee as per the Act. Under the energy efficiency obligation scheme, obliged entities are required to obtain and submit for redemption for each subsequent

		year specific amounts of final energy, as defined by the Act. Energy efficiency certificates can only be obtained for the types of projects specified in Article 19(1) of the Act. Pursuant to the Energy Efficiency Act, the President of the Energy Regulatory Office issues certificates at the request from the entity where the energy efficiency project is to be delivered; or from an entity it has authorised. A list of all activities/projects eligible under the energy efficiency obligation scheme notified by Poland has been published by the minister competent for energy by a notice, which is available in the *Monitor Polski* Official Gazette of the Republic of Poland. An energy efficiency certificate issued under the Scheme confirms the declared energy savings derived from the implementation of the respective energy efficiency project. An energy efficiency certificate may be obtained for an action resulting in annual final energy saving of no less than 10 tonnes of oil equivalent (toe) or for a set of actions of the same type whose aggregate effect exceeds 10 toe. The white certificate scheme supports the implementation of investment projects such as: insulation of industrial installations; redevelopment or renovation of a building along with technical systems and equipment; modernisation or replacement of lighting systems, equipment and systems used in industrial processes or in energy, telecommunications or information technology processes, local heating networks and local heat sources. Completing an energy efficiency audit for a given project is a condition for obtaining a certificate. The audit document is submitted to the President of the Energy Regulatory Office by the entity notifying the energy efficiency improvement project. The energy efficiency obligation scheme does not include measures addressed to households affected by energy poverty, nor does it take into account the share of energy savings to be achieved by households pursuant to Article 7(11). It has been decided that the need to mitigate energy poverty should be addressed through alternative policy measures by incorporating social issues in thermomodernisation and renovation support schemes. With regard to the possibility provided for by Article 7a(6)(a), it should be highlighted that obliged entities may count certified energy savings achieved by third parties towards their obligations, but this does not mean that the latter are required to achieve energy savings on behalf of obliged entities. Energy efficiency certificates are issued at the request from the entity where the energy efficiency project is to be delivered or from an entity it has authorised. The entities operate on an arm's length basis and are independent of obliged entities. The scheme does not allow obliged entities to fulfill their commitment through other state-accredited parties. In accordance with the Energy Efficiency Act, the property rights arising under the certificates are alienable and are considered commodities tradable on a commodity exchange or a regulated market. Therefore, obliged entities may buy these property rights on the market and submit them for redemption to the President of the Energy Regulatory Office in order to credit them against their obligations. In accordance with section 4.1 of Commission guidelines, under Article7a(6)(b) of Directive 2012/27/EU, Member States may provide for the possibility of 'banking and borrowing', i.e. allowing obligated parties to count savings obtained in a given year as if they had been obtained in any of the four previous or three following years. It should be noted that this flexibility: • applies only for energy savings stemming from EEOSs implemented since 1 January 2014 and not for alternative policy measures; and • is restricted in time, i.e. Member States may allow obligated parties to "bank and borrow" only

within an obligation period, as referred to in the first subparagraph of Article 7(1)(a).

The energy efficiency obligation scheme operating in Poland meets all the conditions for resorting to this derogation set out in Article 7(8) of Directive 2012/27/EU. Therefore banking and borrowing can be used in Poland, but subject to a time restriction, i.e., for the purposes of the first subparagraph of Article 7(1)(a) of Directive 2012/27/EU – in particular, energy savings obtained after 2010, but before 1 January 2014, will be counted towards the 2014-2020 obligation.

2. Alternative measures referred to in Article 7b and Article 20(6) of Directive 2012/27/EU

Directive 2012/27/EU no longer contains a list of alternative policy measures, but the definition of policy measure in Article 2(18) sets out a non-exhaustive list of the possible types of such measures, i.e. regulatory, financial, fiscal, voluntary or information provision instruments formally established and implemented in a Member State to create a supportive framework, requirement or incentive for market actors to provide and purchase energy services and to undertake other energy efficiency improvement measures.

Following an analysis of the energy efficiency improvement instruments and measures in place in Poland, a selection of priority measures for the second obligation period was made to ensure that the final energy savings required by Article 7(1) of Directive 2012/27/EU are achieved by 2030.

Accordingly, the following alternative policy measures are envisaged for the period 2021-2030:

1) Thermomodernisation and Renovation Fund;
2) Tax relief for expenditure on thermomodernisation of single-dwelling residential buildings;
3) Development of public transport in cities.

THERMOMODERNISATION AND RENOVATION FUND – supports investments for improving energy efficiency of existing residential buildings. The key objective is to provide financial assistance to investors carrying out thermomodernisation or renovation projects of existing single-dwelling residential buildings using loans from commercial banks. Amendments are planned to the Act on supporting thermomodernisation and renovation to enable inclusion of local governments at the municipality level in the implementation of low-emission projects targeted at the energy poor in their territory, financed in part from the Thermomodernisation and Renovation Fund. The introduction of the above changes will make the Thermomodernisation and Renovation Fund a policy measure which takes into account actions targeted at households affected by energy poverty. Beneficiaries of State aid will include, in particular, persons who meet certain income and/or property criteria, i.e. State aid for thermomodernisation and renovation projects will also take into account social aspects, such as energy poverty.

Name of measure	**Thermomodernisation and Renovation Fund**
Purpose	The main objective of the Fund is to provide financial assistance to investors carrying out thermomodernisation and renovation projects.
Final energy savings	Expected energy savings: 70 ktoe/year, a 10-year total of: 10 x 70 = 700 ktoe
Implementation period	2021-2030
Implementing/supervisory authorities and bodies	Bank Gospodarstwa Krajowego/Minister for Development

		Beneficiaries	A thermomodernisation bonus is available to owners and administrators of: ■ residential buildings; ■ collective accommodation buildings; ■ public buildings owned by local governments and occupied by them for public tasks; ■ local district heating networks; ■ local heat sources. The bonus is available to investors regardless of their legal status, i.e. legal persons (e.g. housing cooperatives and commercial companies), local governments, housing associations, and natural persons, including owners of single-dwelling houses. Budgetary entities and budgetary establishments are not eligible for the bonus.
		Description/eligible activities	The specific rules on bonus-based co-funding are laid down by the Act of 21 November 2008 on supporting thermomodernisation and renovation. A thermomodernisation bonus is available for projects aimed at: ■ reducing the consumption of energy for heating and warm service water preparation in residential buildings, collective accommodation buildings, and buildings owned by local governments and occupied by them for the fulfilment of public tasks; ■ reducing the cost of obtaining heat delivered to the above buildings by connecting them to a centralised heat source in connection with the elimination of a local heat source; ■ reducing primary energy losses in local district heating networks and the local heat sources which supply them; ■ partial or full replacement of energy sources with renewable sources or using high-efficiency cogeneration, subject to energy consumption reduction requirements referred to in the Act.
			<u>THE THERMOMODERNISATION BONUS FOR SINGLE-DWELLING RESIDENTIAL BUILDINGS</u> takes the form of a tax relief aimed at creating an incentive for the thermal modernisation of single-dwelling residential buildings through the personal income tax. The current State budget support for thermomodernisation of residential buildings, consisting, amongst others, in granting a thermomodernisation bonus amounting to 20% of the loan taken out for a thermomodernisation project, has been insufficient to achieve the required effects in terms of energy efficiency improvements. For this reasons, State measures have been stepped up in Poland to improve air quality and energy efficiency of single-dwelling residential buildings through their thermomodernisation, i.e. a reduction of demand for thermal energy and the resulting reduction of

pollution emissions from the process of burning fuels for heating.	
Name of measure	**Thermomodernisation bonus**
Purpose	The main purpose is to create an incentive for the thermal modernisation of single-dwelling residential buildings through the personal income tax.
Final energy savings	Expected average energy savings: 200 ktoe/year, a 10-year total of: 10 x 200 = 2,000 ktoe
Implementation period	2021-2030
Implementing/supervisory authorities and bodies	Minister for Finance/Minister for Development
Beneficiaries	The beneficiaries of the thermomodernisation bonus are personal income taxpayers paying the tax according to the tax scale, at a rate of 19% and as a lump-sum on recorded income, who are owners or co-owners of single-dwelling residential buildings, incurring expenses on thermomodernisation projects; however, taxpayers benefiting from other State aid for thermomodernisation projects, e.g. those who received a subsidy from NFOŚiGW/WFOŚiGW funds, cannot deduct the expenditure financed by that subsidy (only the surplus is deducted).
Description/eligible activities	A detailed list of types of building materials, equipment and services related to the supported thermomodernisation projects is set out in the Regulation of the Minister for Investment and Development of 21 December 2018. The thermomodernisation bonus is granted in particular for the following building materials, equipment and services: ■ window and door joinery, including windows, roof windows with assembly systems, balcony doors, garage doors, non-opening transparent surfaces, ■ building materials comprised in heating, domestic hot water and electric heating systems, ■ heat pumps, solar collectors or photovoltaic cells with accessories, ■ installation of the above-listed materials and equipment, ■ start up and control of the heat source, flue gas analysis, hydraulic control and balancing of the system, removal of the solid fuel-fired heat source.
DEVELOPMENT OF PUBLIC TRANSPORT IN CITIES – support for low-emission public transport in cities from the EU Cohesion Fund will be continued under the Operational Programme Infrastructure and Environment 2021-2027.	

		Name of measure	Development of public transport in cities
		Purpose	The main purpose of the Programme will be to develop and enhance the use of low-emission urban transport in serving residents of cities' functional areas.
		Final energy savings	Expected energy savings: 130 ktoe/year, a total of: 10 x 135 = 1,350 ktoe
		Implementation period	2021-2030
		Implementing/supervisory authorities and bodies	Centre for European Union Transport Projects (CUPT) / Minister for Funds and Regional Policy
		Beneficiaries	The participation in the programme is open to: ■ local governments and their unions – province capital cities and their functional areas, as well as organisational entities and special purpose vehicles acting on their behalf; ■ managers of infrastructure used by urban transport; ■ public transport operators.
		Description/eligible activities	The Programme covers infrastructure investments: adaptation, construction, reconstruction, extension of urban transport networks, including: - construction, reconstruction, and development of the track system along routes, and at terminuses, sidings, and depots; - construction of a metro line, - construction, reconstruction, and extension of tramway and trolleybus overhead line networks and traction substations; - reconstruction and development of roads for the purpose of introducing privileged traffic or privileging existing traffic of public transport vehicles, - providing roads, streets, and tracks with engineering structures and necessary road facilities/ purchase of necessary equipment to ensure traffic safety of public transport vehicles; - providing roads and streets with infrastructure serving public transport (e.g. lay-byes, ramps, exit roads) and passengers (e.g. stops, islands); - construction, reconstruction and development of transport interchanges, including "Park & Ride" and "Bike & Ride" systems; - construction of Personal Rapid Transport (PRT) systems. Rolling stock investments: purchase, upgrading of rolling stock (trams, metro) and trolleybus and bus fleets, including infrastructure necessary for their maintenance (e.g. technical facilities for rolling stock and fleet servicing and maintenance, including the necessary

			specialist equipment, and refuelling stations and equipment for alternative fuel).
b)	Long-term renovation strategy to support the renovation of the national stock of residential and commercial buildings (public and private) [17] , including policies, measures and actions to stimulate thorough and cost-effective renovations, as well as policies and actions targeting the national building stock with the poorest energy performance, in accordance with Article 2a of Directive 2010/31/EU; **Responsible/involved parties*:** **MI, MR, MFiPR** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Improvement of housing conditions, technical condition of housing stock and enhancement of energy efficiency** This measure will comprise support for thermal upgrading and renovation investment projects, including broader ones undertaken as part of revitalisation of degraded areas. These instruments envisage in particular financial support for renovation and thermal upgrading investment projects, both using national and European Union funds, the implementation of instruments supporting the processes of revitalisation of degraded areas and a review of regulations concerning technical parameters affecting energy efficiency in residential buildings. The long-term renovation targets for the national stock of residential buildings have been specified by the Government of the Republic of Poland in the National Housing Plan. Activities related to the renovation of the national stock of residential and commercial buildings (public and private), including policies, measures and actions to stimulate thorough and cost-effective renovations, as well as policies and actions targeting the national building stock with the poorest energy performance, will be specified in the building renovation strategy, which is currently being developed and which, in accordance with the amended Directive 2010/31/EU, is to be submitted to the Commission in 2020.
		2. Promoting low-energy buildings, including at the design, construction and redevelopment stages, in a manner ensuring their energy efficiency, and improvement of the availability of renewable energy in new and existing buildings The national plan to increase the number of low-energy buildings defines measures to be undertaken by the government administration authorities to promote low-energy buildings, including at the design, construction and redevelopment stages, in a manner ensuring their energy efficiency, and to improve availability of renewable energy in new and existing buildings, as well as specifies the time schedule for achieving the targets. Pursuant to Article 9(3)b of Directive 2010/31/EU, the National Plan sets out, among others, indirect targets aimed at improving the energy performance of new buildings for 2015, as a way forward towards the achievement of the following assumptions: - all new buildings are to be nearly zero-energy buildings by 31 December 2020, and - new buildings occupied and owned by public authorities are to be nearly zero-energy buildings after 31 December 2018.
c)	Description of policy and measures to promote energy services in the public sector and measures to remove regulatory and non-regulatory barriers that impede the increase in the number of energy efficiency contracts and other energy efficiency service models[18]; **Responsible/involved parties*:**	**1. The Act on energy efficiency of 20 May 2016 (Journal of Laws 2016, item 831, as amended) defines the energy efficiency duties of public sector units.** Public sector units are to carry out their duties by applying at least one of the following measures to improve energy efficiency: - implementing and funding projects aimed at improving energy efficiency; - purchasing devices, installations or vehicles with low energy use or low operating costs; - replacing or upgrading the used devices, installations or vehicles; - implementing thermal upgrading projects within the meaning of the Act on supporting

	MAP, MI, MFiPR, MR * subject to potential changes resulting from amendments to the Act on government administration departments.	thermomodernisation and renovation of 21 November 2008 (Journal of Laws 2014, item 712; 2016, item 615); - implementing the eco-management system referred to in Article 2(13) of the Regulation (EC) No 1221/2009 of the European Parliament and of the Council of 25 November 2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS), repealing Regulation (EC) No 761/2001 and Commission Decisions 2001/681/EC and 2006/193/EC (OJ EU L 342 22.12.2009, p. 1, as amended), confirmed by an entry in the EMAS register referred to in Article 5.1 of the Act on the national eco-management and audit scheme (EMAS) of 15 July 2011 (Journal of Laws, item 1060). Additionally, at the national government level, the minister responsible for energy, the minister responsible for transport and the minister responsible for construction, spatial planning and development and housing are to: 1) organise campaigns promoting the use of measures to improve energy efficiency, including the introduction of innovative technologies; 2) conduct information and educational campaigns to raise awareness of the available energy efficiency improvement measures. Furthermore, Article 7 of the Act on energy efficiency expressly allows energy efficiency contracting by public sector units. The act stipulates that an energy efficiency contract is a contract that specifies, in particular, possible energy savings to be achieved as a result of carrying out a project or projects of the same type aimed at improving energy efficiency with the use of an energy efficiency improvement measure, as well as defines the method of determining the fee, the amount of which is to depend on the energy savings achieved as a result of carrying out those projects.
d)	Other planned policies, measures and programmes to achieve the indicative national energy efficiency contribution targets for 2030, as well as other objectives presented in 2.2 (for example measures to promote the exemplary role of energy-efficient public buildings and public procurement, measures to promote energy audits and energy management systems [19] , consumer information and training measures[20] and other measures to promote energy efficiency[21]); **Responsible/involved parties*:** **MAP, MI, MFiPR, MR, MRiRW** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Introduction of a new support mechanism for high-efficiency cogeneration and systemic changes in the heating sector** The Act of 14 December 2018 on the promotion of electricity from high-efficiency cogeneration (Journal of Laws 2019, items 42 and 412), together with its implementing acts, introduced a new support mechanism for electricity from high-efficiency cogeneration, the aim of which is both to stimulate the construction of new cogeneration units (it is expected that units with a total capacity of 5.1 GWe will receive support by 2028) and to continue the generation of electricity from high-efficiency cogeneration in existing units which would not be able to operate without support due to a financial gap in operating costs. The implementation of the new mechanism is mainly motivated by the necessity to improve air quality in cities, which can be achieved through the development of district heating from the least carbon-intensive sources. In view of the above, support for all electricity generated in high-efficiency cogeneration that has been fed into the grid and sold will concern cogeneration units that supply, at a minimum, 70% of useful heat from cogeneration to the public district heating network. Where less than 70% of generated heat is fed into the grid, support will be granted proportionally to the share of heat fed to the grid in the total amount of heat generated. Moreover, support will only be available to units whose carbon dioxide emission factor (EPS) is not higher than 450 kg/MWh of energy generated (electricity and heat combined). The proposed support system will be largely dedicated to the construction of cogeneration units

		with an installed capacity of up to 50 MWe. However, support for larger units (above 50 MWe) is also envisaged under the mechanism, including due to the need to replace older sources supplying large heating systems (to be decommissioned, e.g. upon cessation of the district heating derogation under the Industrial Emissions Directive (IED)) with newer ones with lower emission levels of CO2, SOx, NOx, dust and other substances.
		2. Promotion of the use of high-efficiency alternative energy and heat supply systems for buildings Pursuant to the Regulation of the Minister for Transport, Construction and Maritime Economy of 25 April 2012 regarding the detailed scope and form of a building permit design (Journal of Laws, item 462, as amended), the technical description of an architectural and construction design should contain an analysis of the possibilities of using high-efficiency alternative energy and heat supply systems. They include renewable energy-based decentralised energy supply systems, cogeneration, local or block heating or cooling, in particular if it is based, whether entirely or partly, on renewable energy sources, and heat pumps. The use of these systems should be considered at the stage of preparing a building permit design. The above-mentioned regulations are aimed at promoting alternative solutions where economically, technically and environmentally justified. The above requirement corresponds to the technical and construction requirements concerning energy efficiency of newly designed buildings, specified in the Regulation of the Minister for Infrastructure of 12 April 2002 regarding the technical conditions to be met by buildings and their location (Journal of Laws 2015, item 1422, as amended). The requirements have been formulated using the indicator specifying the annual calculated demand for non-renewable primary energy in a manner that should stimulate the use of renewable energy sources where technically justified. The aforementioned regulation and related National Plan aimed at increasing the number of low-energy buildings provide for a time schedule for meeting targets concerning the promotion of low-energy buildings, including at the design, construction and redevelopment stages, in a manner ensuring their energy efficiency and the improvement of the availability of renewable energy in new and existing buildings.
		3. Improving energy efficiency in the transport sector – measures in this area are consistent with those related to reducing emissions from the transport sector, as described in chapter 3.1.3.c)
e)	Description of measures to utilise energy efficiency potential of gas and electricity infrastructure[22] **Responsible/involved parties*:** **MAP, electricity distribution system operators, electricity transmission system operator (PSE S.A.), MFiPR, MR, gas distribution system operators and gas transmission system operator (GAZ-SYSTEM S.A.)** * subject to potential changes resulting from	**1. Development of smart electricity grids** With respect to smart metering, a legal framework will be created concerning the technical, legal and economic aspects of bringing smart meters into universal use. It is expected that 80% of consumers will be equipped with smart meters by 2028. Specific measures are described in 3.4.3(e).
		2. Financial support for measures to improve energy efficiency in gas transmission and distribution and in underground gas storage (UGS) facilities The following measures are envisaged: Gas transmission system: - modernisation of old and end-of-life gas transmission pipelines; - minimisation of gas losses;

	amendments to the Act on government administration departments.	- pumping stations – application of energy recovery technologies and effective control of the operation of the transmission system; Gas distribution system: - expansion and modernisation of low- and high-pressure distribution pipelines; - minimisation of gas losses; use of smart metering systems; - use of smart pressure regulators; Underground gas storage facilities: - installation of expanders in process systems; - energy recovery from exhaust gases; Use of underground gas storage (UGS) facilities under the SMART GRID concept: - cooperation of the Storage System Operator (SSO) with the operators of other networks; - use of cavern underground storage facilities to store hydrogen generated from P2G (Power to Gas) processes; Gas infrastructure in mines: - use of expanders in process systems; - use of high-efficiency cogeneration facilities; - use of energy recovery technologies; SMART GRID concept for gas networks: - smart grid metering (SM) – cooperation with end consumers; - interoperability – cooperation with power systems; - use of the network for transmission of unconventional gases; - management of energy efficiency at all stages of the investment process. Given the commitments made with regard to the European Union-wide 2030 targets for energy efficiency and the share of RES in the gross final energy consumption, the support for the above-described area must be maintained in the upcoming financial perspective, i.e. 2021-2027.
f)	Financing measures, including EU support and the use of EU funds, in this area at national level. **Responsible/involved parties*:** **MAP, MFiPR, MR** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Co-financing of energy efficiency measures in gas transmission and distribution and in underground gas storage (UGS) facilities** Approximately EUR 1.4 billion has been allocated to support energy efficiency measures as part of the Operational Programme Infrastructure and Environment 2014-2020 (OPI&E), and ca. EUR 2 billion as part of the Regional Operational Programmes (ROP). Out of the amount mentioned above, approximately EUR 320 million has been allocated through the ROP as repayable assistance. The assistance concerns investments in such areas as energy efficiency of buildings, energy efficiency of enterprises, high-efficiency cogeneration and energy-efficient heating and cooling systems. In accordance with the 'n+3' rule, funds for the above purposes may be expended until 2023. As part of the Smart Growth Operational Programme 2014-2020 (SM OP), ca. 150 smart and energy-efficient construction projects received assistance of approximately PLN 677 million. Given the commitments made with regard to the European Union-wide 2030 targets for energy efficiency and the share of RES in the gross final energy consumption, the support for the above-described area must be maintained in the upcoming financial perspective, i.e. 2021-2027.

		2. Support for companies operating in the energy efficiency and RES sectors, with priority being given to the suppliers of energy services (under the ESCO scheme) The amended directive on energy efficiency stipulates that a Member State is to support the energy services market and the access of small and medium-sized companies to this market, and is also to support the public sector in the acceptance of offers of energy services, in particular with regard to the modernisation of buildings. Despite the fact that the provisions of Directive 2012/27/EU have been incorporated into the Polish legislation, the energy services market is not yet mature and companies operating under the ESCO scheme tend to struggle on the market. Therefore, measures will be undertaken in the period 2021-2030 to extend support onto small and medium-sized companies, including start-ups, especially those serving the public administration sector, i.e. both government or local government administration authorities.
		3. Support for the development of energy management efficiency solutions by linking building energy management systems (BEMS) with the demand side response (DSR) tool The above-mentioned solutions should contribute to the flattening of the energy demand curve and to more effective energy management, which will allow to provide consumers with access to energy without having to excessively expand generation capacity or transmission and distribution networks. The above specified measures will have positive economic and environmental effects – reducing the needs of end consumers will translate into reductions throughout the energy chain, as a result of which emissions from the energy sector and the entire economy will decrease. It should be stressed that the potential for linking BEMS with DSR is particularly high in the case of industrial consumers due to the characteristics of their consumption, high degree of predictability, the economies of scale owing to considerable volumes of consumed energy, as well as its importance for the system.
		4. Development of heat consumption rationalisation technology Heat consumption rationalisation technologies which may potentially be supported from public funds include: - insulation and dewatering of steam systems; - renewable energy sources, including geothermal systems, solar collectors, heat pumps, - thermal upgrading of industrial and office buildings; - recuperation and heat recovery from processes and devices; - modernisation of internal heating networks; - using energy from waste generated in industrial processes; - construction/modernisation of own (internal) energy sources, including high-efficiency cogeneration.

3.3. Energy security[23]		
a)	Policies and measures to achieve the objectives set out in 2.3[24] **Responsible/involved parties*:** **MAP, URE, Government Plenipotentiary for Strategic Energy Infrastructure, companies operating in the energy sector** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Implementation of the Energy Policy of Poland until 2040 (EPP2040)** The objective of the energy policy outlined in the draft EPP2040 is energy security while ensuring the competitiveness of the economy, energy efficiency and reduction of the impact of the energy sector on the environment, as well as the optimum use of own energy resources. Energy security is the priority component of the aforementioned objective. Actions carried out along eight strategic lines described in detail in the draft EPP2040 will lead to guaranteeing Poland's energy security.
		2. Implementation of the Polish Nuclear Power Programme (*Program polskiej energetyki jądrowej* – PPEJ) The draft Energy Policy of Poland until 2040 envisages the implementation of nuclear power programme. The first unit (with a capacity of ca. 1-1.5 GW) of the first nuclear power plant is planned to be commissioned in 2033. Further five units are planned to be commissioned at two or three years' intervals. The installed capacity in nuclear power units is expected to reach ca. 6-9 GW. In the case of Poland, infrastructure necessary for the development and operation of the nuclear power sector (legal, organisational and institutional infrastructure, scientific and research backup facilities, personnel training systems) must be built in order for nuclear power programme to be implemented. An exhaustive diagnosis of individual issues relevant to the development of the nuclear power sector has been presented in the Polish Nuclear Power Programme (PPEJ), which is due to be updated soon. PPEJ is a strategic document which sets out the objectives, stages (milestones) and tools (legal, organisational, financial), as well as entities implementing nuclear power projects in Poland. The milestones in the period 2021-2030 include: - selection of technologies by 2021; - commencement of the construction of the nuclear part (first nuclear concrete placement) by 2024.
		3. Implementation of the Programme for the Coal Mining Sector in Poland 2016-2030 The objective of the Programme for the Coal Mining Sector in Poland is to create conditions conducive to building a profitable, effective and modern coal mining sector based on cooperation, knowledge and innovation, which, while operating in a friendly and predictable policy and legal setting, enables an effective use of resources and the social and economic capital to safeguard Poland's high energy independence and to support the competitiveness of the national economy. The programme's implementation will reflect the rapidly changing settings of the mining sector. A restructuring plan for hard coal and lignite mining areas, with support from EU funds, will be prepared in 2020.
		4. Implementation of the Programme for the Lignite Mining Sector in Poland Lignite resources in the currently exploited deposits enable a stable level of production and the operation of production complexes only until approximately 2030. The programme's implementation will reflect the rapidly changing settings of the mining sector. A restructuring plan for hard coal and lignite mining areas, with support from EU funds, will be prepared in 2020.

		CO2 emission allowance prices and the emergence of new technologies will play a key role in the development of new deposits. Innovations are to contribute to the implementation of low-carbon technologies and an alternative use of lignite. Gasified raw material (synthesis gas) is characterised by lower emissions and its use may be synchronised with demand. Due to its characteristics, lignite lends itself to gasification and, in the long term, also to hydrogenation for the production of liquid fuels. Synthesis gas may be used to generate energy and heat, but also to produce synthetic petrol and many other chemical products.
		5. Monitoring the market in terms of compliance with the Regulation of the Council of Ministers of 24 April 2017 regarding the minimum diversification level of natural gas supplies from abroad. Pursuant to the provisions of the aforementioned regulation, the product to be diversified is imported gas, with diversification to be achieved with the use of the transmission infrastructure on interconnections with other countries. This refers to gas imported to Poland from non-EU and non-EFTA countries, with supplies from non-EU countries by land (with the use of gas pipeline networks) to be treated in aggregate. The application of such a structure is justified by the fact that, at present, all gas supplies through entry points from non-EU countries are carried out from the East, in view of which they should be subject to the diversification obligation in aggregate. Also gas imported in any other form will be subject to diversification. This includes CNG and LNG imports, with the exclusion of gas imported through the LNG terminal in Świnoujście. The percentage thresholds specified in the aforementioned Regulation of the Council of Ministers take into account the long-term contractual commitments of the natural gas sector companies existing at the time of adoption of the Regulation. Setting the threshold at 33% after 2022 is justified by similar regulations in other EU Member States and by the need to diversify sources of natural gas supplies to Poland. The expected outcome is primarily an increase in the level of the security of natural gas supplies and the enhancement of competition on the domestic natural gas market.
		6. Performance of tasks relating to the security of natural gas supplies as specified in the Preventive Action Plan and the Emergency Plan (prepared by the Ministry of Energy in connection with the fulfilment of the obligations set out in EU regulations). The Preventive Action Plan contains proposals for measures which will contribute to the improvement of the energy security of Poland in the natural gas sector. The preventive measures specified in the aforementioned document are consistent with the recommendations of the International Energy Agency. Entities carrying out the measures specified in the Preventive Action Plan are obliged to submit quarterly reports to the Minister for Energy on carrying out measures aimed at improving the security of natural gas supplies. The reports include the schedule of works, the expected date of completing an investment project, the risks for the implementation of the investment project identified by the entity responsible for carrying it out and its impact on the emergency scenarios identified in the Preventive Action Plan. Additionally, by 1 September of each year, the transmission system operator, in consultation with entities transporting natural gas into the territory of Poland, is obliged to prepare a report concerning

		the preparation of the gas system for the winter season, including an analysis of the coverage of the peak natural gas demand in non-fault conditions. The aforementioned measures are aimed at ensuring continuous and uninterrupted natural gas supplies to consumers.
		7. Construction of a direct connection between gas fields in the Norwegian Continental Shelf and expansion (increasing offtake and regasification capacities) of the LNG terminal in Świnoujście Within the framework of measures relating to the diversification of natural gas supply directions and sources, the following projects are carried out: the construction of the Baltic Pipe, the expansion of the LNG terminal in Świnoujście and the construction of the floating regasification terminal in the Gulf of Gdańsk. The following targets are expected to be achieved by 2030: - 2022: an operational two-way connection between Poland, via Denmark, and the fields located in the Norwegian Continental Shelf, which will enable the import of ca. 10 billion m^3 of natural gas; - 2021: an operational expanded LNG terminal in Świnoujście, with a regasification capacity of 7.5 billion m^3 annually (to be possibly further expanded depending on market conditions), along with additional functions enabling vessel bunkering and LNG transshipment to rail, vessels and tank trucks in increased quantities. - 2025: the construction of the FSRU project in the Gulf of Gdańsk – the first phase of construction ensuring the capacity of at least 4.5 billion m^3.
		8. Construction of a transmission system enabling natural gas supplies from the north, west and south, and the construction of system interconnections to meet the requirement to diversify supply sources The current capacities of transmission infrastructure do not allow the full substitutability of natural gas supply sources in the event of supply disruptions. The investment will make it possible to increase natural gas supplies from new directions (LNG, Norwegian Continental Shelf, system interconnections). Expansion of interconnections with neighbouring countries, along with the development of the national transmission network and the expansion of gas storage facilities, is an element of the natural gas supply diversification strategy, which at the same time will create conditions for market development and the growth of the importance of Poland as a regional gas trading hub. Currently, apart from supplies to the LNG terminal, gas supplied to Poland includes mainly Russian gas brought via Belarus and Ukraine, as well as supplies from the territory of Germany and the Czech Republic. To increase import and export capacities, Poland will aim at constructing or expanding interconnections with: - Slovakia – up to an import capacity of 5.7 billion m^3 and an export capacity of 4.7 billion m^3 annually (by 2021); - Lithuania (GIPL) – up to an import capacity of 1.9 billion m^3 and an export capacity of 2.4 billion m^3 annually (by 2021); Czech Republic (Stork II) – up to an import capacity of 6.5 billion m^3 and an export capacity of 5

billion m^3 annually (by 2022);
- Ukraine – up to import and export capacities of 5 billion m^3 annually (by 2022).

9. Expansion of natural gas storage capacities, as well as capacities for natural gas offtake and injection to underground storage (UGS) facilities in Poland

In Poland, the overall capacity of underground storage facilities exceeds 3 billion m^3 with an offtake capacity below 50 million m^3/day. The total available working gas volume of underground high-methane gas storage facilities in the 2017/2018 season is 2,985.4 million m^3. In addition to the aforementioned high-methane gas storage facilities, two high-nitrogen gas storage facilities managed by PGNiG S.A. are in operation, namely:
- UGS Daszewo with a capacity of 40 million m^3;
- UGS Bonikowo with a capacity of 200 million m^3.

The high-nitrogen gas system is a closed system and the aforementioned high-nitrogen storage facilities are used to stabilise production.

It is advisable to continue the development of storage facilities as part of the UGS Working Volume Development Scheme that consists in the construction of the Kosakowo Covern Underground Storage Facility (CUGS) with the aim of stabilising the supply of gaseous fuels to the Tricity-Koszalin areas. Once the expansion process is completed, the working gas volume of CUGS Kosakowo will be a minimum of 250 million m^3. The completion of the investment project is planned in 2021. At present, CUGS Kosakowo has a working gas volume of 145.5 million m^3.

Additionally, Operator Gazociągów Przesyłowych Gaz-System S.A. (OGP Gaz-system S.A.) is analysing the possibility of expanding its operations to include underground gas storage in accordance with its 2016-2025 strategy. The baseline scenario is the construction of a storage facility in Damasławek near the locality of Świątkowo (Janowiec Wielkopolski municipality) and Ustaszewo (Żnin municipality) in the Kujawsko-Pomorskie Province, with Białogard in the Pomorskie Province being an alternative location.

Other gas storage expansion projects are also under consideration, such as UGS Wierzchowice or CUGS Mogilno.

The expected effects of the measures by 2030 include, if sufficient internal and external funding is obtained, an increase in the capacity of underground gas storage facilities to a minimum of 4 billion m^3 by the 2030/2031 winter season and an increase in maximum offtake capacity from the current 48.7 million m^3 per day to a minimum of 60 million m^3 per day.

The implementation of the construction projects concerning new underground gas storage facilities and the expansion of existing ones will considerably contribute to the improvement of the country's energy security through an increase in storage capacities which may be used to maintain commercial stocks for balancing and emergency purposes.

10. Implementation of investment plans and strategies of companies with State Treasury shareholding in accordance with the Policy of the Government of the Republic of Poland for Logistic Infrastructure in the Oil Sector

The construction of the second leg of the Pomorski pipeline (Płock-Gdańsk) is an undertaking of vital importance to safeguarding the energy security of the Republic of Poland. The current transmission infrastructure of the Pomeranian section, in spite of comprising a reversible-flow pipeline, constitutes

	a single artery only and is the weakest link of the crude oil pipeline transport system due to the fact that it is not substitutable by other logistic infrastructure. This is why it is appropriate and necessary to aim at creating redundancy infrastructure, which will constitute an additional security measure for crude oil transport in the Pomeranian section. A single pipeline makes it impossible to meet the demand from PKN ORLEN refineries in Płock and, at the same time, from LOTOS GROUP refineries in Gdańsk. Furthermore, if an emergency occurs or security incidents pile up in this section of the pipeline, there is a risk of prolonged stoppage in crude oil injection and, consequently, of destabilisation of the chain logistics of supplies to the most important Polish refinery. Baseline value (2017): Three-element infrastructure for crude oil transmission, comprising the Friendship Pipeline (Eastern Section – 240 km, Western Section – 416 km) and the Pomeranian Pipeline (235 km) Expected effects (2030): Expansion of crude oil transmission infrastructure – construction of the second leg of the Pomeranian pipeline (Płock-Gdańsk)
	11. Development of regulations concerning crude oil and petroleum product stocks To ensure an efficient emergency stock system in Poland, legal regulations must be amended to increase the role of the Agency of Stocks Reserves in building up, maintaining and financing (through the stock fee system) emergency stocks. Producers and traders build up and maintain mandatory stocks of crude oil or fuel, with the exclusion of liquefied petroleum gas (LPG), in quantities corresponding to the product of 53 days and the average daily output of fuels or the imports of crude oil or fuels by the producer or trader in the preceding calendar year. The optimisation of crude oil and fuel emergency stock system management should be achieved by lessening the administrative burden resting on producers and traders obliged to build up and maintain obligatory crude oil and fuel stocks.
	12. Development of the rules for electricity market operation Lessons learned from the operation of a single-commodity market and theoretical studies concerning electricity markets show that the achievement of an 'ideal' single-commodity electricity market where there is no missing money problem resulting subsequently in the missing capacity problem, is a difficult task. This concerns both the substantive solutions and the acceptance of periodically high electricity prices, or even restrictions on electricity supplies. The problem is made worse by support systems used in Europe on a large scale in relation to some generation technologies, which currently, due to the lack of developed energy storage technologies, cannot safeguard the security of supplies. In connection with the results of analyses concerning the assessment of capacity adequacy, which clearly show that there is a threat to the security of electricity supplies in Poland over the next years, a decision has been taken to implement a capacity market in order to have an effective tool in place for safeguarding the security of supplies. The efficiency of operation of the electricity market depends largely on solutions adopted on the balancing market and the system services market. The balancing market ensures that the energy demand and generation are balanced on an on-going basis, while at the same time the energy supply security criteria are met. The energy prices on this market are reference prices for forward markets (bilateral and exchange prices) and for spot markets (day-ahead and intraday), since they reflect the

	value of energy at the time of its supply. The system services market makes it possible to ensure short-term excess capacity in the system with specific technical parameters, maintained for the purpose of balancing the electricity system. Prices of balancing energy from reserve capacity show, in the first place, balancing tensions (reserve shortfall leads to an increase in prices), which generates investment signals by influencing prices. The prices of individual system services create incentives for the development of sources with specific technical abilities, which support the safe operation of the electricity system, such as the ability to quickly increase or reduce the quantity of generated electricity, in accordance with the current demand, or the ability to operate with a broad range of loads. For the above reasons, correct pricing processes in the balancing market and in the system services market are an important factor affecting the quality of operation of market mechanisms in the electricity sector. The following measures are underway in Poland to improve the efficiency of operation of the electricity market: - **ancillary frequency control services** – changes are aimed at applying market mechanisms for obtaining reserve capacity (system services) which generate pricing signals for the development of sources necessary to balance the system in an effective manner and at the same time assume an increase in prices of reserve capacity when it is in deficit; **balancing energy pricing mechanism** – changes are aimed at applying a pricing mechanism based on offers actually used to generate electricity, which at the same time reflects various energy values in particular system locations due to restrictions on available network resources. By applying this approach, appropriate pricing incentives will be created for market participants to counteract short-term balancing difficulties in the system; - **development of consumer participation in the balancing market** – changes are aimed at expanding consumer participation by enabling consumers to offer both energy supplies and system services (reserve capacity). When offering their services, consumers should be able to define the specific reduction parameters, such as the time of activating a reduction, the maximum and minimum reduction period and level, intervals between subsequent reductions etc. Such a solution will ensure conditions for maximizing the available volume of consumer load reduction and its effective use by the system operator for system balancing purposes. The above-mentioned measures are carried out as part of a broader project aimed at implementing advanced tools for managing the operation of the national electricity system in market conditions (Market Management System – MMS), enabling its operation to be optimised with the use of precise technical and cost models and techniques of allowing for uncertainties caused by unstable sources.
	13. Introduction of a capacity market as a solution ensuring the sufficiency of generation in a medium- and long-term perspective The main goal of the capacity market is to safeguard the security of electricity supplies to end consumers in a long-term perspective. The capacity market is a market mechanism whose objective is to safeguard the required level of security of energy supplies while minimizing costs for the economy. The capacity market is neutral in technological terms, as a result of which it creates a level playing field for all electricity generation technologies, energy storage facilities and DSR (Demand Side

Response) [25], taking into account the degree in which particular technologies contribute to safeguarding the security of supplies and provided that the requirements set out in the Act on the capacity market of 8 December 2017 are met. The capacity market rewards capacity market units which supply capacity in risk periods, that is in periods in which the risk of losing the continuity of supplies in the National Power System (NPS) has been identified.
The capacity market operates in parallel to the electricity market and does not introduce restrictions on pricing processes in the electricity market – prices are formed on the basis of the relationship between electricity demand and supply.
The capacity market is a commodity derivatives market, where physical delivery of capacity is carried out after the main trading processes are completed. The primary market has the form of auctions with the transmission system operator (TSO) as the only buyer. The primary market consist of the main auction that will take place in the fifth year before the delivery period and additional auctions that will take place in the year preceding the year to which the delivery periods relate. There is the secondary market to complement the primary market by enabling the reduction of risks borne by the capacity market participants, at which capacity obligations of certified capacity market units are traded in.
The capacity market is an additional market mechanism complementary in relation to the energy market:

- it creates conditions for the stable operation of existing generation sources and their repowering, as long as these sources are necessary to safeguard the security of supplies;
- it ensures clear pricing signals aimed at coordinating decisions to construct new generation capacities, as well as to decommission specific generation resources;
- it limits the investment cycle phenomenon that can be observed in energy prices for end consumers on a single-commodity electricity market, since decisions to invest in or to decommission resources are coordinated by the capacity market;
- it creates conditions for developing DSR services, both through the participation of the DSR in capacity market processes and through the provision of DSR services at the facilities of industrial consumers in order to reduce their peak power demand and thus to reduce the operation costs of the capacity market.

In 2018 and 2019, the first four main auctions were conducted on the capacity market for delivery years: 2021, 2022, 2023, 2024.
The capacity market mechanism will be modified in view of the provisions of Article 22 of Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity, which prevent units emitting more than 550 g/kWh of carbon dioxide from receiving payments and commitments under the capacity market from 1 July 2025. Work will be carried out to amend the Capacity Market Act in order to bring it into line with EU regulations, while continuing to ensure security of electricity supply to end consumers.

14. **Measures to ensure flexibility of the power system in line with the anticipated changes in the NPS.**
Due to an increased use of weather-dependent renewable energy sources and the need to ensure availability of back-up sources for electricity generation, it is necessary to introduce measures for the

		flexibility of the power system. Some of these measures have already been implemented by means of programmes for Demand Side Reduction (DSR) units, which are being developed by the transmission system operator (TSO) and through the capacity market. Special attention should be paid to the capacity market, which allows DSR units and energy storage facilities to participate in auctions. Nearly 3,200 MW of DSR units and energy storage facilities obtained capacity contracts through auctions in 2018 and 2019. Nevertheless, an analysis would be warranted to address potential barriers to emergency gas sources. Moreover, the new regulations will introduce a legal framework for the operation of the smart metering system, which will have an impact on the flexibility of the power system. As regards the smart metering system, remote reading meters for at least 80% of end consumers connected to the distribution network with the rated voltage of no more than 1 kV are planned to be installed by the end of 2028.
		15. **Identification of barriers and support for the development of energy sustainable areas at the local level.** Barriers to the implementation of local investments, in particular those resulting from the lack of social acceptance for the development of dispersed power generation, will be identified together with their causes. The analysis will concern the lack of acceptance for the development of, for example, wind power plants, agricultural biogas plants, biomass-fired thermal power plants, etc. Steps will be taken to address concerns and possibly carry out measurements of noise, odours or other nuisance factors associated with power facilities with the aim of encouraging local communities to change their negative attitude towards investment projects. The results of measurements will be communicated to local communities as they are released.
b)	Regional cooperation in this area. **Responsible/involved parties*:** **MAP, MSZ** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Co-operation within the framework of the Visegrad Group (V4)** Co-operation on the following issues is planned in the period 2021-2030 among the Visegrad Group states: - joint position within the European Union on the directions of development for the energy sector, - scientific research and development cooperation, - experience sharing in the area of development of the energy sector, including cooperation with the particular technology suppliers, in particular nuclear power suppliers.
		2. Market integration Poland is a member of the following groups: Penta Plus 'Electricity Neighbours' HLG and Penta Initiative Technical Group on Flexibility (SG III). Poland declares its further participation in the work of the aforementioned groups and its involvement in creating an appropriate framework for further market integration. Poland expects that the continuation of the above-described measures will result in the achievement of market integration targets through an agreement among EU Member States on matters concerning the elimination of all barriers restricting flexibility in the areas of generation, demand side involvement and development of spot and balancing markets at the level of Member States and at the regional and European Union-wide levels.
		3. Co-operation with EU States and experience sharing relating to the implementation of

		nuclear power programmes Poland is engaged in an active dialogue with EU States having advanced nuclear power programmes, taking advantage of their experience both in the field of development of nuclear power projects, including those aimed at increasing the share of domestic industry, as well as in the field of radioactive waste and spent fuel management. Talks are also underway concerning the development of new nuclear power technologies. Further cooperation agreements may be concluded with other countries in the field of nuclear power at the level of Ministers responsible for nuclear power.
		4. Cooperation with pro-nuclear like-minded states In November 2017, the United Kingdom proposed an initiative to re-activate the pro-nuclear like-minded group. The re-activated group is composed of representatives of Bulgaria, the Czech Republic, France, Finland, Hungary, Poland, Romania, Slovakia, Slovenia and the United Kingdom. To date, the Group has developed several joint positions on nuclear power matters, addressed to European Union institutions. Expected effects of the Group's operation: - working party meetings of the Group (two meetings/semester at the level of ambassadors at the EU, working party coordination before meetings of the Working Party on Atomic Questions (WPAQ), appointment of the State to coordinate the work of the Group); - joint positions within the EU on the optimisation of conditions for the development of nuclear power; - coordination of positions on important issues within the Working Party on Atomic Questions (WPAQ); - establishment of a coalition for the purpose of voting on an amendment to the regulation implementing Article 41 of the Euratom Treaty; - establishment of a coalition for the purpose of possible voting on amendments to the Euratom Treaty – the sharing of information relevant to nuclear power in the EU.
c)	If applicable, financing measures in this area at national level, including EU support and the use of EU funds. **Responsible/involved parties*:** **MAP, MFiPR, MR** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. The financing measures for, among other things, energy security in the electricity and gas sectors** are described in 3.4.2.
		2. Development of the use of LNG infrastructure in Poland This area covers the following projects: - **Construction of liquefying (LNG) installations with the use of technologies based on the transmission network capacity.** The rapid development of the LNG market in Poland requires that all available options be used to supply both enterprises and vehicle fleets with gas. By exploiting the capacity of high-pressure gas pipelines, energy-efficient gas liquefying installations make it possible to increase the energy efficiency of the transmission system and the scope of services provided. - **Construction and operation of LNG bunkering infrastructure in the Baltic Sea-LNG Bunkering Vessel.** The objective of the project is to expand infrastructure for bunkering vessels in the Baltic Sea with low-sulphur LNG fuel. The planned development and modernisation of supply systems for vessels, relating to the legal regulations in force and the development of the LNG market, will require the expansion of LNG fuel bunkering infrastructure. Due to an expected increase in demand for LNG bunkering services, it is necessary to enable a quick and reliable

		bunkering of vessels in the Baltic Sea. - **CHP (Combined Heat and Power) – increasing the regasification capacity of the LNG terminal in Świnoujście.** Project objective: Enhancing the energy efficiency of the terminal will allow to reduce its operating costs. - **Inter-modal LNG logistic base.** Project objective: Increasing the reach of the logistic services of the LNG terminal in Świnoujście. Possibility of implementing a virtual pipeline service. Possibility of transporting high volumes of LNG at long distances. Enhancing the effectiveness of services provided by the LNG terminal in Świnoujście and thus increasing its role in the CEE & Baltic region. Supplying the necessary volumes of LNG to peak shaving stations supporting the National Transmission System (NTS) and satellite regasification. Transmitting raw material for the purpose of providing other LNG services, e.g. supplying vehicle refueling stations, vessel bunkering stations etc. - **ISO containers.** Project objective: Use of intermodal gas carriers. - **Peak shaving regasification station.** Project objective: Using LNG to supply the areas of GAZ-SYSTEM infrastructure characterised by insufficient transmission capacity. Ensuring the possibility of providing areas and customers not connected to the NTS with gas infrastructure on a temporary or permanent basis. Creating infrastructural foundations (transshipment depots for ISO containers) for further distribution of natural gas in liquefied form. - **LNG transshipment skid.** Project objective: Ensuring a possibility of quick and reliable LNG transshipment and bunkering. - **Expansion of LNG regasification capacity on the Polish Baltic Sea coast.** Project objective: The developing LNG market makes it necessary to prepare gas infrastructure for an increased natural gas off-take in case of market interest. The implementation of projects in the area concerned will contribute to improving energy security (not only in terms of imports, but also in terms of ensuring gas supplies, taking into account infrastructure constraints in Poland) and to a reduction in the emission of air pollutants and greenhouse gases. *Proposed form of financing:* CEF grant, non-repayable grant.
		4. Underground gas storage: From the point of view of increasing domestic gas consumption, subsidies for investments relating to the construction and expansion of underground gas storage facilities should be sought. Expected increase in domestic gas consumption is due to: - investments in gas blocks (including cogeneration blocks); - provision of gas infrastructure to new areas and replacement of existing heat sources with gas; - increase in the importance of gas in road and maritime transport; - increase in the role of gas as an energy source providing back-up for the operation of the sector of unstable renewable energy sources. Additionally, as a location in which a gas transmission and trading hub is planned to be created, Poland should have storage capacities to meet the requirements of the proper operation of the transmission system and the needs of entities from other countries of the region. Support should be provided to investments relating to the construction or expansion of cavern underground gas storage facilities, which are of key importance to safeguarding the security of

		supplies in winter and in a situation where supplies from prevailing import directions are discontinued. The construction and expansion of cavern underground gas storage facilities are characterised by high capital intensity and time consumption. In a majority of cases, the aforementioned factors and the low profitability of investments make it impossible to rely on market mechanisms when carrying out construction projects. Nevertheless, such projects are necessary in order to ensure the correct operation of the gas system.
		5. Support for the development of large-scale energy storage facilities to balance energy demand and generation (power balance) Having regard to current trends in the development of the energy sector and an unavoidable increase in the use of renewable energy sources, there is a need for developing an energy storage technology which will facilitate the integration and development of distributed RES. Support from European funds should cover both the application and purchase of storage technologies, as well as research, development and implementation. At the current level of technological progress and given the current economic situation, there are no incentives to vigorously pursue energy storage projects.
		6. Improvement of Poland's energy security with regard to the diversification of crude oil supplies and expansion of liquid fuel storage facilities This area covers the following projects (carried out by PERN S.A.): - second stage of development of the Oil Terminal in Gdańsk; - construction of two tanks for crude oil at the Storage Depot in Gdańsk/Górki; - construction of tanks for liquid fuels; - construction of the second leg of the Pomeranian Section; - construction of the Boronów-Trzebinia fuel pipeline. These projects contribute to the implementation of the Policy of the Government of the Republic of Poland for Logistic Infrastructure in the Oil Sector. The projects are aimed at supporting the diversification of crude oil supplies through the expansion of the infrastructure system for the supply of crude oil from sources alternative in relation to pipeline supplies from the Russian Federation. The projects will enable an increase in emergency stock storage capacities that will enhance regional energy security.

3.4 Internal energy market[26]		
3.4.1. Electricity infrastructure		
a)	Policies and measures to achieve the targeted level of interconnectivity presented in 2.4. **Responsible/involved parties*:** **MAP, power transmission system operator (PSE S.A.), Government Plenipotentiary for Strategic Energy Infrastructure, URE** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. The availability of the current cross-border interconnections will be increased by optimising the allocation of available capacity based on the flow-based approach[27]** It is expected that by better addressing network conditions (including congestion), the FBA, which is planned to be implemented by 2025, will enable a more accurate calculation of electricity flows. In connection with this optimisation measure, an increase is expected in the transmission capacities made available by Poland for cross-border trade. The determination of interconnection capacity planned in 2030 depends on the implementation of the investment schedule and progress in the implementation of the coordinated methodology for capacity determination. In view of the above, Poland is unable to set a numerical target at the present stage. It should be stressed that phenomena such as unscheduled compensatory power flows (loop flows) have to be taken into account when determining the interconnectivity factor. In accordance with Regulation (EU) 2019/943 of the European Parliament and of the Council on the internal market for electricity, an Action Plan that addresses the nature of structural network congestion in Poland has been prepared with a view to making available 70% of transmission capacity. When the Action Plan is applied, the final deadline for achieving the CEP 70% target is 31 December 2025. The Action Plan will be carried out from 1 January 2020. The measures adopted under the Action Plan are scheduled over four years (1 January 2020 to 31 December 2023).
		2. With respect to the development of the transmission network by 2030, the following three projects concerning the development of the national transmission network and cross-border interconnections have been included in the TYNDP2018: **1. GerPol Improvements** **2. GerPol Power Bridge I** **3. LitPol Link Stage II** Poland is aware of the need to ensure efficient and well developed network infrastructure, which is why the investment area related to transmission infrastructure is regarded as extremely important. The cross-border interconnection capacity between Member States should be increased primarily by the optimum use of existing interconnections and the elimination of barriers preventing market participants from getting access to the grid, including the elimination of bottlenecks in national systems. The purpose of GerPol Improvements is to increase cross-border transmission capacities within the synchronous area (covering interconnections at the border with Germany, the Czech Republic and Slovakia) by switching the 220 kV Krajnik-Vierraden line to 400 kV and installing phase-shifters on the existing Poland-Germany interconnections. The implementation of the project will enable

		increasing the NPS's import capacities by 500 MW and its export capacities by 1,500 MW. The purpose of GerPol Power Bridge I is to increase cross-border transmission capacities within the Polish synchronous area. Looking forward to 2030, the expansion of the internal transmission network is planned in the western part of the country, which will enable increasing import capabilities of the National Power System by 1,500 MW and its export capacities by 500 MW. GerPol Power Bridge I is included in the fourth PCI list, published in 2019, and covers the following investment projects: - the internal 400 kV Krajnik-Baczyna line, - the internal 400 kV Mikułowa-Świebodzice line, - the internal 400 kV Baczyna-Plewiska line. LitPol Link Stage II was a follow-up to the construction of an interconnection between Poland and Lithuania to achieve the planned transmission capacity of 1,000 MW in both directions. The construction of additional transmission network facilities in Poland and Lithuania (including the second back-to back converter at the Alytus station) was planned under the project. However, in 2016, the Lithuanian Government decided not to proceed with the construction of the second converter in view of ongoing discussions within the framework of BEMIP HLG on another option of interconnection with the European transmission system, which was to include elements of LitPol Link Stage II. The third PCI list included a project covering the construction of the 400 kV Stanisławów-Ostrołęka line. The investment project will be completed by 2023 and will result in the creation of conditions for electricity exchange with the Lithuanian electricity system while ensuring safe operation of this interconnection. In connection with the political agreement of 28 June 2018 between the Baltic states and Poland concerning the synchronisation of the Baltic states, Poland regards this project as necessary for the synchronic integration of the Baltic States with the Continental Europe system and will proceed with the construction of the Stanisławów-Ostrołęka line despite Lithuania's withdrawal from the Alytus second direct current converter project.
b)	Regional cooperation in this area[28] **Responsible/involved parties*:** **MAP, power transmission system operator (PSE S.A.), Government Plenipotentiary for Strategic Energy Infrastructure** * subject to potential changes resulting from amendments to the Act on government administration departments.	**Support, as part of regional fora (Penta Plus 'Electricity Neighbours' HLG, Penta on Flexibility (SG III)), for the implementation of the FBA for calculating and allocating transmission capacities throughout the region and the adoption of fair rules for settling the costs of remedying measures conducted in the region.** To increase the transmission capacities of cross-border interconnections Poland intends to develop cooperation with neighbouring countries, primarily with the Republic of Lithuania and the Federal Republic of Germany. Among the positive results of cooperation to date is the construction of a 'power bridge' between Poland and Lithuania completed in 2015. The project included the construction of an interconnection between the Ełk Bis station with the Alytus station in Lithuania and, at the same time, on the Polish side, the construction and modernisation of power lines and stations in three provinces. Eleven major network infrastructure investment project were carried out as part of the project, four 400 kV power lines were constructed with an aggregate length of ca. 400 km, five power stations were constructed and two power stations already in operation were modernised.
c)	If applicable, financing measures in this area at	**1. Monitoring the operator's use of proceeds from interconnection capacity allocation**

	national level, including EU support and the use of EU funds. **Responsible/involved parties*:** **MAP, URE, MFiPR, MR** * subject to potential changes resulting from amendments to the Act on government administration departments.	The transmission system operator will use any revenues resulting from the allocation of interconnection in accordance with the provisions of Regulation 714/2009 and its amending Regulation COM (2016)861. The President of the Energy Regulatory Office (URE) will monitor the implementation of this measure. By 31 July of each year, the President of URE publishes a report specifying: - the amount of revenue collected for the 12-month period up to 30 June of the year concerned, - the use made of the revenues in question, together with verification that use complies with the amended Regulation 714/2009, its amending Regulation COM (2016)861 and the Guidelines; and - information on whether the total amount of congestion income is devoted to one or more of the three prescribed purposes. The assignment of income from the allocation of interconnection capacity will contribute to ensuring the desirable level of the available cross-border transmission capacity and to developing transmission infrastructure.
		2. Inclusion of projects which can contribute to the integration of regional markets in the list of Projects of Common Interest (PCI) and their effective implementation Poland actively participates in the preparation of lists of Projects of Common Interest (PCI). The lists created so far include projects promoted by Polskie Sieci Elektroenergetyczne S.A.(PSE S.A.). In the period 2021-2030, Poland will seek to include new PCIs in future PCI lists, which will contribute to the further integration of regional markets.
		3. Investment support under the Connecting Europe Facility (CEF) Poland intends to take advantage of funding for infrastructure projects under the Connecting Europe Facility as part of the future financial perspective. The CEF instrument is dedicated to PCIs and Poland will seek the PCI status to be granted to new infrastructure projects.
		4. Development of the gas transmission network Support in the form of EU funds should be allocated to, among other things, the development of a transmission network in Poland. Following the implementation of transmission investments, it will be possible to increase the volumes of natural gas transmitted to consumers connected both to the transmission and distribution networks, including in the areas not yet connected to gas infrastructure. GAZ-SYSTEM is going to carry out most of the planned intersystem projects by the end of 2022, i.e. under the current financial perspective, which includes the expansion of the LNG terminal in Świnoujście and of interconnectors with neighbouring EU Member States. Pursuant to the new Ten-Year National Plan (TYNP) 2018-2027, a far-reaching investment plan is to be carried out in the first five-year period, i.e. from 2018 to 2022. In 2023-2028, that is in the actual period of implementation of the future EU financial perspective, GAZ-SYSTEM's investment plans focus on the expansion of the transmission network in the eastern part of Poland and in other regions of the country.

3.4.2. Energy transmission infrastructure		
a)	Policies and measures related to the elements set out under 2.4.2, including, where applicable, specific measures to enable the delivery of Projects of Common Interest (PCIs) and other key infrastructure projects. **Responsible/involved parties*:** **MAP, power transmission system operator (PSE S.A.), gas transmission system operator (GAZ-SYSTEM S.A.), Government Plenipotentiary for Strategic Energy Infrastructure, electricity and gas distribution system operators, URE** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Inclusion of projects which can contribute to the integration of regional markets in the list of Projects of Common Interest (PCI) and their effective implementation** Poland is actively participating in the preparation of lists of Projects of Common Interest (PCI) in relation to electricity and natural gas investments. The lists to date include projects promoted by the Polish electricity transmission network operator Polskie Sieci Elektroenergetyczne S.A.(PSE S.A.) and the Polish natural gas transmission network operator OGP GAZ-SYSTEM S.A. In the period 2021-2030, Poland will seek to include new PCIs in future PCI lists that will contribute to the further integration of regional markets, their competitiveness, the safety of energy supply and sustainable development. **2. Investment support under the Connecting Europe Facility (CEF)** It is reasonable to keep the possibility of funding infrastructure projects under the Connecting Europe Facility as part of the future financial perspective. The CEF instrument is dedicated to PCIs and Poland will seek the PCI status to be granted to new infrastructure projects. **3. Poland's electricity projects regarded as Projects of Common Interest (PCI)** Poland's electricity projects are classified as Projects of Common Interest in the first, second and third lists of Projects of Common Interest (PCI). The projects located in the Poland-Lithuania and Poland-Germany corridors (phase shifter at the Mikułowa station) have already been completed. The PCI list published in 2017 includes three Polish projects forming part of the NSI East Group: - 3.14.2 Krajnik-Baczyna internal line (expected to be completed by the end of 2023); - 3.14.3 Mikułowa-Świebodzice internal line (expected to be completed by the end of 2023); - 3.14.4 Baczyna-Plewiska internal line (expected to be completed by the end of 2023); and one project forming part of the BEMIP Group: - 4.5.2 Stanisławów-Ostrołęka internal line (expected to be completed by the end of 2023). The aforementioned projects are expected to be carried out as part of investment activities aimed at developing the transmission network and cross-border interconnections by 2030.
		4. Poland's gas projects regarded as Projects of Common Interest (PCI) The PCI list published in 2019 includes four Polish projects forming part of the NSI East Gas Group: - 6.2.1 Poland-Slovakia Interconnector - 6.2.2 North-South gas corridor in Eastern Poland - 6.2.10. Poland-Czech Republic Interconnector ['Stork II'] - 6.2.11 North-South gas corridor in Western Poland and three projects forming part of BEMIP Gas: - 8.3.2 Poland-Denmark Interconnector ['Baltic Pipe'] - 8.5 Poland-Lithuania Interconnector ['GIPL'] - 8.7 – Expansion of the LNG Terminal in Świnoujście Implementation of investment tasks consisting in the construction of infrastructure enabling gas supplies to Poland from new sources (Norway and LNG), the development of the national transmission network, the increase of storage, offtake and injection capacity of underground gas

		storage facilities, and the construction of a system of interconnections integrating the national transmission system with the neighbouring markets. Expected effects for 2030: Operational cross-border interconnections with the neighbouring EU countries and Ukraine and an expanded and modernised transmission network enabling gas to be supplied to customers in Poland and abroad.
		5. Monitoring of the implementation, by the operators, of investment projects included in the development plans for meeting current and future electricity demand An energy company transmitting or distributing gaseous fuels or energy is required to prepare a development plan for its area of operation, concerning the satisfaction of current and future demand for gaseous fuels or energy, for a period of at least three years. Pursuant to Article 16(2) of the Energy Law (Journal of Laws 2017, item 220), a gas transmission system operator and an electricity transmission system operator are required to prepare a development plan concerning the satisfaction of current and future demand for gaseous fuels or electricity for a period of 10 years. The aforementioned plan is subject to updating every two years as regards demand for gaseous fuels, and every three years as regards electricity demand. Pursuant to Article 16(4) of the Energy Law, a gas distribution system operator and an electricity distribution system operator are to prepare a development plan concerning the satisfaction of current and future demand for gaseous fuels or electricity for a period of at least five years. The President of the Energy Regulatory Office (URE) is obliged, under Article 23(2a)(2) of the Energy Law, to prepare a report presenting and assessing, among other things, the implementation of the plans referred to in Article 16(2) and 16(4) (i.e. development plans concerning the satisfaction of current and future demand for gaseous fuels or electricity of the operators of the transmission and distribution systems). The report is to be prepared in accordance with Article 23(2c) of the Energy Law every two years. It was prepared in the years 2013, 2015 and 2017. In addition to the above, the achievement of the planned volumes is analysed on an annual basis and the results of the analysis are used in the process of agreeing subsequent editions of development plans or their updates. Such analyses are conducted on the basis of annual reports on the implementation of the development plan, which energy companies are obliged to submit on the basis of Article 16(18) of the Energy Law. In the period 2021-2030, the President of URE will monitor the implementation of development plans on an annual basis and will prepare, on a biannual basis, a report presenting and assessing the conditions for undertaking and conducting business activities in the field of electricity generation, transmission or distribution and the implementation of development plans of transmission and distribution system operators with respect to the satisfaction of current and future demand for gaseous fuels or energy.
b)	Regional cooperation in this area[29] **Responsible/involved parties*:** **MAP, power transmission system operator**	**1. Integration of the electricity transmission networks of the Baltic States** The third list of Projects of Common Interest (PCI) was published in 2017, including projects relating to the integration of the networks of the Baltic states and the North-South (N-S) Corridor projects. The PCI list includes the Stanisławów-Ostrołęka line project, identified with number 4.5.2., as an element of the Baltic Energy Market Interconnection Plan (BEMIP Electricity) corridor. The investment project will be carried out before 2030, and its effects will include the creation of

	(PSE S.A.), gas transmission system operator (GAZ-SYSTEM S.A.), Government Plenipotentiary for Strategic Energy Infrastructure * subject to potential changes resulting from amendments to the Act on government administration departments.	conditions for the exchange of electricity with the Lithuanian electricity system, while ensuring the secure operation of this interconnection. On 28 June 2018, on the sidelines of the European Council, an agreement on the synchronisation of the Baltic states (BS) with the electricity system of the Continental Europe was signed by the Prime Ministers of Poland and the Baltic states and the President of the European Commission in the form of a Political Road Map. The synchronisation process will be carried out using the existing double-circuit alternating current (AC) line between Poland and Lithuania (LitPol Link) and constructing an offshore direct current (HVDC) connection between Poland and Lithuania.
		2. Construction of a gas interconnection between the transmission systems of Poland and Ukraine The launching of the Hermanowice-Bilche Volytsia two-way high-pressure gas interconnection with an annual capacity of up to 5 billion m^3. The effect of the interconnection will be to increase the export capacity of the Polish gas market and provide conditions to increase the degree of utilisation of the transmission capacity of the Polish transmission system, as well as to enable Polish entities to use underground gas storage facilities located in the territory of Ukraine.
c)	If applicable, financing measures in this area at national level, including EU support and the use of EU funds. **Responsible/involved parties*:** **MFiPR, MR, MAP** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Financial support for the construction of electricity transmission and distribution and gas transmission and distribution infrastructure** Given the electricity system interconnections target set at 15%, support must be provided for this area within the next financial perspective. The acceleration of the transition of the EU power system towards a low-carbon system and the increasing share of renewable energy sources in energy mix results in the need to ensure appropriate funds to invest in flexible generation sources and the expansion of gas and electricity infrastructures in relation to distribution and transmission networks. Financial support for the area in question in the financial perspectives 2021-2027 and 2028-2034 is desirable. The amount and scope of support for distribution projects should take into account the need to reduce low-carbon emission and to improve the quality of the air. Support for cross-border electricity and gas interconnections is possible as part of the Connecting Europe Facility (CEF) or other EU financial instruments to be in operation after 2020. Strong competition from Member States in the process of seeking funds for the expansion of transmission infrastructure results in a situation where financial support, if any, as part of this source will only be granted to few investment projects. If necessary, funds will be applied for under the Connecting Europe Facility financial instrument or other EU financial instruments in operation after 2020.
		2. Development of an electricity transmission network This category covers the following project areas, in which Polskie Sieci Elektroenergetyczne S.A. operates. The listed projects improve Poland's energy security. The implementation of the specified projects enhances the energy efficiency of the electricity transmission network in Poland. - Expansion of the transmission network to improve the reliability of power evacuation from conventional energy sources – location of the project (province): Dolnośląskie, Mazowieckie, Śląskie; - Expansion of the transmission network to improve the reliability of power evacuation from

		renewable energy sources – location of the project (province): Zachodniopomorskie, Wielkopolskie; - Development of the transmission network to enhance transmission capacities of the NPS – location of the project (province): Dolnośląskie, Lubuskie, Łódzkie, Świętokrzyskie; - Enhancement of the security of electricity supplies and the improvement of the conditions of supply from the transmission network – location of the project (province): Łódzkie, Małopolskie, Mazowieckie, Śląskie, Zachodniopomorskie; - Interconnection of and power evacuation from the first nuclear power plant in Poland – the construction of a nuclear power plant will imply the need to adapt the transmission network to safe power evacuation from the facility. The determination of the investment needs will be possible once the location has been selected and the basic parameters of the facility have been specified; - Interconnection of and power evacuation from off-shore wind farms (including the construction of off-shore transmission capacities). The scope of the necessary investments in transmission networks will depend on the installed capacity of off-shore wind farms and the model of their connection to the NPS.
		3. Improving the reliability of electricity supply to consumers, including conversion of MV overhead lines to underground lines in forested areas. Over 41,000 km of overhead MV lines are located in forest and woodland areas, where the overhead-to-underground conversion is particularly important for the reduction of the causes and effects of failures. To achieve a more reliable operation of the network, medium voltage networks must be successively converted from overhead to underground lines. For this purpose, a national plan of overhead-to-underground conversion until 2040 will be developed in 2020. Additionally, equipping medium voltage line connectors with remote control systems is also regarded as a priority. Appropriate funding for the aforementioned investments needs to be guaranteed.
		4. Provision of gas supply infrastructure in Poland through the development of the distribution network and local LNG supply stations If financing is obtained from EU funds as part of Multiannual Financial Frameworks for the period 2021-2027 for projects in the gas sector, a portion of funds should go to the gas distribution sector understood as a distribution network and local networks equipped with local LNG regasification stations, with an emphasis on the following issues: - civilisational advancement of rural areas and Eastern Poland not connected to gas infrastructure; - reduction of low-carbon emissions – PM2.5 and PM10 (smog); - gas as low-carbon fuel in the context of CO_2 emissions. Despite the fact that in a vast majority of cases investments in distribution networks are regarded as commercial investments, it is appropriate to accelerate investments enabling an increment in areas covered by gas supply infrastructure. The measures taken are expected to result in bringing gas infrastructure to ca. 77% of Polish municipalities (compared to the current figure of 65%). As part of the assessment of projects for which financial support is sought, the impact of the project

		on the air pollution with particulate matter should be treated as an equally important criterion as maturity (understood as a possibility of carrying out the investment project within the financial perspective). Plans for the provision of gas supply infrastructure for areas currently regarded as most polluted on the basis of the official data of the Chief Inspectorate for Environmental Protection (*Główny Inspektorat Ochrony Środowiska* - GIOŚ) should be treated on a priority basis.
		5. Expansion of gas transmission infrastructure In the case of granting financing from EU funds for investments in the gas sector, the area covers the following projects, planned to be implemented by the company Operator Gazociągów Przesyłowych GAZ-SYSTEM S.A.: - Rembelszczyzna-Wronów DN 1000 gas pipeline, - Rozwadów-Końskowola-Wronów gas pipeline with a diameter of at least DN 700, - Jarosław-Rozwadów gas pipeline with a diameter of at least DN 700, - Hermanowice-Jarosław gas pipeline with a diameter of at least DN 700, - Gustorzyn-Wronów DN 1000 gas pipeline, - Reszki-Gustorzyn DN 1000 gas pipeline, - Tworzeń-Oświęcim gas pipeline with a diameter of at least DN 500, - Damasławek-Mogilno-Odolanów DN 1000 gas pipeline, - Racibórz-Oświęcim gas pipeline with a diameter of at least DN 700/ - STORK II gas pipeline (Kędzierzyn-Hat) The projects enhance the energy efficiency of the natural gas transmission system in Poland. Investments are a form of implementing the policy of levelling differences between regions in the area of energy network infrastructure. The projects are aimed at supporting the diversification of natural gas supplies through the expansion of transmission system infrastructure, which will allow to improve the energy security of Poland.

3.4.3. Market integration		
a)	Policies and measures related to the elements set out in 2.4.3. **Responsible/involved parties*:** **MAP, URE, power transmission system operator (PSE S.A.) and gas transmission system operator (GAZ-SYSTEM S.A.), MK** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Integration and improvement of market operation** In the past four years, the Government of the Republic of Poland has taken a number of measures aimed at integrating and improving the operation of the electricity market. The examples of such measures include: • increasing the exchange obligation from 15% to 30% (January 2018), • increasing the exchange obligation to 100% (January 2019), • changing price caps on the Day-Ahead Market, the Intraday Market and the Balancing Market, • significantly reducing technical barriers to cross-border trade within the synchronous area, • acting as a leader in the process of synchronising the power systems of the Baltic States with the continental Europe system. Poland is currently carrying out or planning to carry out shortly the following actions: • carrying out investments in electricity networks to significantly increase, by 2025, interconnection capacities made available for trade and in times of emergency (in connection with the implementation of the Action Plan), • accession of the Polish Power Exchange (Towarowa Giełda Energii S.A.) and the TSO to the European XBID trading system on the intraday energy market (IDM), • a programme to improve liquidity on the energy exchange through designation of market makers, • using marginal pricing as a basis for balancing market prices, • enabling balancing service providers to update their integrated scheduling bids as close as possible to real time (intraday market gate closure), • implementing the scarcity pricing mechanism, • phasing out system services in relation to the provision of the necessary capacity in the NPS: Cold Contingency Reserve (*Interwencyjna Rezerwa Zimna*), Interventional Operation (*Praca Interwencyjna*), Guaranteed DSR Emergency Programme (*Gwarantowany Interwencyjny Program DSR*), Operational Capacity Reserve (*Operacyjna Rezerwa Mocy*).
		2. Implementation of the provisions of network codes and the European Commission guidelines concerning mechanisms for allocating transmission capacities and coupling markets in various time horizons Participation in the implementation of network codes and the European Commission guidelines prepared in the form of EU regulations. The aforementioned tasks will be implemented in accordance with the time schedules specified in these regulations. Commission Regulation (EU) 2017/459 of 16 March 2017 establishing a Network Code on Capacity Allocation Mechanisms in Gas Transmission Systems and repealing Regulation (EU) No 984/2013 took effect on 6 April 2017. The most important change to the amended network code consists in supplementing the regulation by new provisions setting out the Europe-wide rules for identifying market demand for the expansion of existing system interconnections or the construction of new interconnections and the rules for

		allocating additional capacity or new capacity referred to as incremental capacity (the so-called incremental procedure). The Regulation has also been supplemented by new dates of interconnection capacity auctions for annual and quarterly products. In the case of quarterly product auctions, the frequency with which they are organised has also been increased. Also the rules for offering firm and interruptive capacity for long-term products have been defined more precisely. Regulation (EU) 2019/943 widened the scope of the provisions of the existing network codes and Commission guidelines by introducing, amongst others, a target relating to the provision of cross-zonal capacity for the purposes of cross-border trade. This target has been imposed on TSOs as an obligation to provide market participants, as of 1 January 2020, with cross-zonal capacity at a level not lower than 70% of the transmission capacity for a given border or critical network element/contingency (CNEC) pair, subject to operational security limits. If network constraints exist in a bidding zone, a Member State may decide to meet the target at a later date on the assumption that the provided transmission capacity will increase annually. Poland has decided to prepare an Action Plan under which the 70% target will be reached by 31 December 2025 through the adoption of a variety of measures. On 17 March 2017, Commission Regulation (EU) 2017/460 of 16 March 2017 establishing a network code on harmonised transmission tariff structures for gas was published. It entered into force on 6 April 2017 and was to be implemented by 31 May 2019. The purpose of the new regulation is to enhance the transparency of the process of determining gas transmission tariffs, as well as to make their structures in the European Union area uniform. The Regulation also sets out consultation and publication obligations concerning the calculation methodology and the technical parameters to be adopted to calculate transmission tariffs, which is to ensure the users of EU systems a greater predictability of the level of fees and their comparability. Solutions enabling the application of a discount at the entry to the transmission system from an LNG terminal have also been adopted. The adoption of the uniform standards of capacity allocation in transmission systems throughout the EU will contribute to the smooth operation of the gas market and to increasing energy security. The implementation of the Code concerning the harmonisation of gas transmission tariff structures should contribute to a better integration of the European gas market, enhancement of the security of supplies and the development of system interconnections, which in turn may improve the competitiveness of EU companies and will contribute to reducing gas bills issued to households.
		3. Monitoring the security of electricity and natural gas supplies in various time horizons The President of the Energy Regulatory Office (URE) is obliged, under Article 23(2)(20) of the Energy Law, to monitor, among other things, the operation of the electricity system as regards the security of electricity supply, under Article 23(2a) of the Energy Law, to prepare a report presenting and assessing the conditions for undertaking and conducting business activities in the field of generation, transmission and distribution of electricity and the fulfilment of the plans referred to in Article 16(2) and (4) (i.e. development plans concerning the satisfaction of current and future demand for gaseous fuels or electricity of the Operators of transmission and distribution systems). The existing powers are expected to be maintained in 2021-2030, i.e. the President of URE will

		monitor the operation of the electricity system in terms of the security of electricity supply and will prepare a biannual report presenting and assessing the conditions for undertaking and conducting business activities in the field of electricity generation, transmission and distribution and the fulfilment of the plans referred to in Article 16(2) and (4). With respect to the gas sector, the minister responsible for energy will assess, on an annual basis, the security of natural gas supplies. With regard to the natural gas sector, the minister responsible for energy, pursuant to Article 15b of the Energy Law, is obliged to assess annually the security of gaseous fuel supplies, in particular by monitoring a sustainable and continuous supply of natural gas to the country. The results of the assessment are presented in the *Report on the results of monitoring the security of gaseous fuel supplies*, which is published in the ministry's public information bulletin (BIP) and communicated to the European Commission. Moreover, the minister responsible for energy, as a competent authority within the meaning of Regulation (EU) 2017/1938 concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010, prepares *Assessment of risk relating to the security of natural gas supply to Poland* (updated every 4 years), as well as *preventive action plans and emergency plans* (updated every 2 years).
		4. Actions to guarantee an appropriate level of flexibility of the electricity system through: - **expansion of transmission and distribution networks;** - **construction of modern generation units with an extensive range of control options;** - **modernisation of small and medium-sized units (redevelopment of thermal units enabling operation with a minimum technical load of up to 20-30%);** - **expansion of smart energy networks along with smart metering systems enabling electricity demand to be shifted;** - **shifting electricity demand from daily peaks to periods of low demand at night (night valleys);** - **use of system ancillary frequency control services.** The changing characteristics of operation of the National Power System (NPS), including in particular the growing share of uncontrollable renewable sources, increasing participation of prosumers and also – in the future – of electric vehicles, accompanied by changes in the development of power demand during the 24 hour cycle, result in the need to implement measures aimed at increasing power system flexibility. Additionally, there are practically no regulating reserve sources in the Polish NPS (except for pumped-storage plants) that would be capable of adjusting the level of production to changes in electricity demand. The implemented measures will contribute to a greater flexibility of the NPS and will enable the transmission system operator and distribution system operators to operate the power system in a secure and effective manner.
		5. Strengthening mechanisms for the protection of electricity consumers' rights in the retail market The task will be carried out by making the existing consumer protection mechanisms more efficient, partly also by implementing Directive of the European Parliament and of the Council on common rules for the internal market in electricity COM(2016)864 into the Polish legal regime. In this respect,

		new mechanisms will be expanded to protect household consumers. The platform for comparing vendors' offers will be expanded. Additionally, information will be presented in bills in an expanded form, so that end consumers know the components of the electricity fees they pay. At the same time, bills and additional information will be presented more clearly to make them more comprehensible to end consumers. Moreover, the existing alternative dispute resolution methods will be further developed and improved so that end consumers have access to information on available alternative solutions (e.g. spreading payments into installments, advice on debt management) reasonably in advance before the suspension of supplies of electricity or gaseous fuels.
		6. Strengthening regulations to increase the activity of household consumers and proposing new legal solutions The task will be carried out by streamlining the existing incentive mechanisms aimed at encouraging consumers to be more active in the electricity market. The task will be partly carried out by implementing Directive of the European Parliament and of the Council on common rules for the internal market in electricity into the Polish legal regime. It is expected that new mechanisms will be introduced and the existing ones will be expanded in the period 2021-2030 as part of work on strengthening the legal environment encouraging household consumers to take a more active role in the electricity market. The first solution to be applied will be the introduction of regulations encouraging suppliers to offer dynamic price contracts. The availability of these services will be linked to the popularisation of smart meters. Additionally, regulations encouraging consumers to engage in prosumer activities will be drafted, so that consumers can generate energy as well as store and sell it. In view of the fact that consumers will adopt more active roles, the legal settings will have to be prepared for the development of demand aggregation services, not only at the level of entities with a greater demand for electricity, but also at the level of household consumers. What is more, households may become active in the electricity market not only on an individual basis (as prosumers), but also on a collective basis, for example by becoming involved in setting up local energy communities. Strengthening of the legal environment, which is an additional incentive for the implementation of prosumer investments, will also consist in detailed regulation of technical requirements, grid connection conditions and cooperation of RES micro-installations with the power system. This will be done taking into account the need to increase the share of electricity from microinstallations in the State's energy balance, while ensuring the safety and reliability of the operation of the power system. Moreover, issues such as the registration of metering data, energy balancing, billing of renewables self-consumers and provision of measurement data will be regulated. It should be noted that the detailed regulation of phase-to-phase balancing will bring measurable benefits for the billing of micro-installations and the final balance of energy generated from these installations and that taken from the grid.
b)	Measures to increase the flexibility of the power system with regard to renewable energy production	**Implementation of intraday market coupling mechanisms relating to electricity system balancing**

	such as smart grids, aggregation, DSR, storage, distributed generation, mechanisms for grid traffic dispatching, re-dispatching and curtailment, real-time price signals, including the roll-out of intraday market coupling and cross-border balancing markets. **Responsible/involved parties*:** **MAP, URE, power transmission system operator (PSE S.A.)** * subject to potential changes resulting from amendments to the Act on government administration departments.	The task will be implemented in accordance with the time schedules specified in the following regulations: - Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management, - Commission Regulation (EU) 2016/1719 of 26 September 2016 establishing a guideline on forward capacity allocation, - Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing. The implementation of measures will allow to ensure the security of the national power system while enabling integration in the field of cross-border exchange. An important integration element to be considered when implementing balancing guidelines is the specific nature of the Polish centrally dispatched balancing system. The rules and time schedule for carrying out the task may be changed if an amendment to the EU legislative acts referred to under 1-3 is adopted, which is planned to take effect in 2020.
c)	If applicable, measures to ensure a non-discriminatory share of renewable energy, DSR and storage, in all energy markets. **Responsible/involved parties*:** **MAP, URE** * subject to potential changes resulting from amendments to the Act on government administration departments.	**Ensuring priority access and transmission of renewable energy or energy from high-efficiency cogeneration on the basis of the Energy Law and the Act on renewable energy sources** To meet the target, the Polish legal order contains the rule of priority for connecting installations using renewable energy to the electricity grid (Article 7(1) of the Energy Law), as well as the rule of priority for transmitting and distributing electricity from renewable sources and for cogeneration (Article 9c(6) of the Energy Law). Regulation (EU) 2019/943 of 5 June 2019 on the internal market for electricity has introduced, as of 1 January 2020, capacity limits to which mandatorily applies the principle of priority access to the network.
d)	Policies and measures to protect consumers, especially vulnerable and, if applicable, energy poor consumers, and to improve the competitiveness and contestability of the retail energy market. **Responsible/involved parties*:** **MAP, URE** * subject to potential changes resulting from amendments to the Act on government administration departments.	**Awareness actions targeted at electricity and gas consumers** On-going information actions addressed to electricity and gas consumers, to the extent these tasks are currently carried out by: - operating an Information Centre for electricity and gas consumers, - operating an online energy price calculator, - preparing a Set of Consumer Rights. The President of the Energy Regulatory Office (URE) is engaged in the work aimed at developing standard agreements between suppliers and operators of electricity systems (the so-called general distribution agreements), as well as monitors the retail energy market on an on-going basis. With respect to the improvement of protection of household consumers, mechanisms are currently in place aimed at protecting these consumers, among other things, by URE enabling them to have access to the offer calculator or to alternative dispute resolution methods. Once the calculator has been expanded and billing information has been simplified, household consumers will have an easier and broader access to information about offers and, consequently, more possibilities of deciding whether to switch suppliers. Additionally, due to active forms of participation in the

		electricity market, e.g. through the use of aggregation services, the undertaking of the prosumer role or the use of dynamic price contracts, becoming more common, they will be able to influence the market to increase competition in it. The aforementioned measures are intended to enhance the position of vulnerable consumers and encourage them to take on a more active role in the electricity market. Expected effects for 2030: - raising awareness among consumers with respect to the rules of operation of the energy and gaseous fuel markets, - activating consumers in the area of electricity supplier switching, among other things by enabling offers to be compared with the use of the online calculator, - strengthening of the position of consumers in the energy and gas markets by raising consumer knowledge on and awareness of rights in their relations with energy companies, - conducting information campaigns to make consumers aware of their rights in their relations with energy companies, - in connection with the timeframe for deregulating gaseous fuel prices in the household sector set out in statutory regulations, an online tool for comparing supplier offers in this segment is planned to provided.
e)	Description of measures to enable and develop demand response including those addressing tariffs to support dynamic pricing[30]. **Responsible/involved parties*:** **MAP, URE** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Amendment to transmission network codes which set out the detailed rules for participating in system services on the demand side** The development of these rules will be supported by the President of the Energy Regulatory Office (URE) to the extent they meet the proportionality and effectiveness conditions, including cost-proportionality and effectiveness, and to the extent they are based on the implementation of network codes and guidelines developed in the form of EU regulations. Expected effects (2030): - increasing the share of system services of the demand side in the operation of the energy market, - reducing energy shortfalls during peak demand.
		2. Development of smart electricity grids The minister responsible for energy prepared a draft amendment to the Energy Law that introduces a smart metering system in Poland. The draft amendment provides for, among other things: - installing, by 2028, remote reading meters for at least 80% of end consumers connected to a distribution network with the rated voltage of no more than 1 kV, in accordance with a specified time schedule; - designating a metering information operator (MIO); - settling the costs of electricity or distribution services on the basis of metering data received from the MIO; - managing the operation of household equipment forming part of the Home Network Infrastructure (the Internet of things) and metering electricity fed into the grid by prosumers; - ensuring the standards of metering data protection against unauthorised access. Benefits deriving from the implementation of the system will include mainly: - a possibility of managing electricity consumption by controlling the system – connecting and

		disconnecting equipment depending on the time of day and year and the electricity price; - a possibility of using dynamic tariffs offered to consumers; - a possibility of settling consumer costs on the basis of actual consumption data within a time limit and for a settlement period convenient for the parties; - the improvement of the quality parameters of electricity supplied by the provider to the benefit of the consumer and a possibility of applying a discount on account of a failure to meet quality parameters and interruptions in electricity supply; - the simplification and shortening of the procedure of switching electricity suppliers; - an increase in the share of informed electricity consumers which will decrease the system balancing costs and contribute to the final cost of electricity supply; - a decrease in consumer service costs; - the enhancement of competitiveness in the electricity market; - the enabling of the development of distributed electricity sources; - the reduction of peak power demand due to demand side response possibilities; - the reduction of imbalance by decreasing the level of commercial losses (theft); - the reduction of the costs of analyses relating to the determination of the conditions for connection to the grid; - the improvement of the effectiveness of maintenance, renovation and modernisation works. Moreover, the construction of a smart grid is inextricably linked to: advanced power system monitoring technologies, automation, remote control and redevelopment of communication systems in the power industry. The implementation of the Programme is linked directly to measures undertaken as part of the Strategy for Responsible Development.
3.4.4. Energy poverty		
a)	Policies and measures to achieve the objectives set out in 2.4.4. **Responsible/involved parties*:** **MR, Plenipotentiary of the Prime Minister for the Clean Air Programme, MAP, MRPiPS, MK, URE** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. The definition of energy poverty and the development of methodology adapted to Polish conditions** The problem of protection of vulnerable consumers against energy poverty has been addressed in the Recommendations of the Council of Ministers Economic Committee (CEC) under the Clean Air Programme. Pursuant to the Programme guidelines, work on the following issues was carried out in 2018: - creating a definition of energy poverty adapted to Polish conditions, - developing a coherent methodology for diagnosing energy poverty and - creating a statistical model necessary to monitor the scale of the phenomenon in Poland. Based on the results of the work, the number of households affected by energy poverty will be determined. Where this figure represents a significant share in terms of the number of households, the most effective tools to reduce energy poverty will be identified. The issue of protection of vulnerable consumers is related to the problem of energy poverty. A vulnerable electricity consumer is defined in the Energy Law (Article 3(13c)) and is entitled to receive a flat-rate energy allowance. The amount of the energy allowance is specified each year by

		the minister responsible for energy and depends on the product of electricity consumption limit and the average electricity price for household consumers.
		2. Monitoring the number of households affected by energy poverty Currently (Q4 2019), a report has been accepted that includes recommendations for the definition of energy poverty and a model for measuring and monitoring such poverty. This will enable quantifying the phenomenon of energy poverty. The methodology is based on data from statistical surveys that are updated annually. Depending on the adopted definition of energy poverty (and its related components, e.g. the threshold of energy costs in household disposable income), the target groups eligible for support will be specified. The monitoring of the number of households affected by energy poverty will enable a reliable evaluation of the effects of the proposed solutions. It will make it possible to assess whether the proposed solutions are effective and which of them need to be changed (e.g. the tool's ineffectiveness due to an incorrect assessment of the needs of the poor).
		3. Continuation of publicly (including EU) funded programmes and their possible adaptation to the needs of energy poor consumers, in particular loan programmes intended to finance modernisation measures aimed at improving energy efficiency <u>Multi-dwelling residential buildings</u> The national instrument for supporting the improvement of energy efficiency of buildings is governed by the provisions of the Act of 21 November 2008 on supporting thermomodernisation and renovation. Support from the Thermomodernisation and Renovation Fund in the form of a thermomodernisation bonus and a renovation bonus (non-refundable support) is intended for creditworthy entities and is mainly used by housing cooperatives and communities. Over 31,000 bonuses were granted from the Thermomodernisation and Renovation Fund in 2009-2019. The total amount of support granted exceeded PLN 1.7 billion and covered 460,800 dwellings. The value of investments supported under the fund amounted to over PLN 11.1 billion. Work is underway to amend the Act on supporting thermomodernisation and renovation. Such amendments will, amongst others, enable municipalities to apply for support for renovation of municipal buildings (renovations would have to be combined with, for example, the requirement to adapt the building to the current technical conditions concerning thermal insulation and energy efficiency). This is a solution aimed at reducing energy poverty, as municipal buildings often have poor energy standard that translates into high living costs and, at the same time, are inhabited by people with the lowest income. Increased intensity of works in this type of development may, therefore, not only to contribute to the improvement of energy efficiency, but also reduce pollution (through replacement of heat sources) and mitigate the problem of energy poverty (through reduction of heating costs). <u>Single-dwelling buildings</u> According to preliminary research, ca. 60% of energy poor people use single-family dwellings. What is more, a considerable proportion of energy poor people have no creditworthiness. As a result, a considerable proportion of such people are excluded from support programmes. Due to subsidy programmes, energy poor people will be able to carry out the most expensive investment projects (e.g. thermal upgrading), which will contribute to a considerable increase in the

		efficiency of energy consumption and to a reduction in the share of energy costs in household budgets. In addition to thermomodernisation support programmes, support systems are currently in place for the replacement of heating sources in newly built and existing single-dwelling houses. The 'Clean Air' and 'Stop Smog' programmes enable the use of subsidies and preferential loans to support the poorest households. Award and payment of support are carried out by local government organisations and coordinated at the level of the national government plenipotentiary. In addition, a thermomodernisation bonus has been in place as of 1 January 2019, offering the possibility of deducing costs of construction materials, equipment and services incurred in connection with a thermomodernisation project in a single-dwelling building from the taxable base. In February 2019, the governmental programme 'Stop Smog' was launched upon entry into force of the Act amending the Act on supporting thermomodernisation and renovation (Journal of Laws 2019, item 51). The programme is targeted at the energy poor living in single-dwelling buildings. The programme is addressed to all municipalities that are able to demonstrate poor air quality in their territory, i.e. concentrations of air pollutants exceeding EU standards. The programme covers the following projects carried out in the above-mentioned households: • replacement of heating devices or systems with those compliant with low-emission standards, • removal of heating devices or systems and connection to the district heating, electricity or gas network, • comprehensive building thermomodernisation. Projects are carried out by the municipality for the benefit of the final beneficiary and financed from public funds up to 100% of their value. The municipality provides an own contribution of 30% (or higher if it has more than 100,000 inhabitants). The remaining part of the Programme (70%) is financed from the State budget via the Thermomodernisation and Renovation Fund. The programme is currently planned to run in 2019-2024 and its total budget (comprising the State's and local governments' contributions) amounts to PLN 1.2 billion.
		4. Construction, expansion and upgrading of district heating networks The expansion and upgrading of existing district heating networks towards efficient district heating and cooling systems will have a direct impact on the reduction of areas at risk of energy poverty and will enable an effective fight against low-stack emissions and smog.
		5. Monitoring the protection of vulnerable consumers of electricity and gaseous fuels To protect the poorest, the group of vulnerable consumers of electricity and gaseous fuels is defined and the system of support for this group is regulated in an amendment to the Energy Law of 26 July 2013 (Journal of Laws 2013, item 984). A vulnerable consumer of electricity is a person who is granted a housing allowance within the meaning of Article 2(1) of the Act on housing allowances of 21 June 2001 (Journal of Laws of 2017, item 180) and who is eligible for a lump-sum energy allowance. A vulnerable customer of gaseous fuels is defined similarly. The following elements of the support system (as laid down in the Act of 10 April 1997 – Energy Law, Journal of Laws 2019, item 1556) have also been introduced: • installation of a prepayment metering and billing system (Article 6f),

		• protection against suspension of supplies (Article 6c, 6c(3), 6d), • option to terminate contracts without extra charge (Article 4j(3) and (3a)), • option to change the vendor of electricity or gaseous fuels (Article 4(2)), • access to the collection of consumer rights prepared by the President of URE together with the President of the Office for Competition and Consumer Protection (Article 5(6e)).
		6. Anti-smog tariff The aim of the new tariff is to encourage household owners to replace outdated furnaces and heat their homes at night with electricity. The above tariff is set out in the Regulation of the Minister for Energy of 29 December 2017 on detailed rules for the determination and calculation of tariffs and billing in electricity trade that entered into force on 30 December 2017. Following the introduction of the anti-smog tariff and its adjustment by energy companies, the tariff rates for night-time distribution of electricity have been reduced, on average, by 10 times compared to fixed tariff rates (G11). Electricity rates have been reduced, too, as a result of the introduction of the anti-smog tariff. They are 35÷50% lower than the rates in the G11 tariff most commonly used in Poland. The new tariff provides for lower distribution rates for electricity additionally consumed between 10 p.m. to 6 a.m. Lower rates apply to electricity in excess of that consumed in the corresponding period of the previous year. During the remaining hours of the day, the consumer will pay for energy as much as in the G11 tariff, i.e. the most popular tariff among households (with fixed rates throughout the day). Taking into account the above, in all the cases under consideration, the cost of electricity in a household using heat sources powered by electricity is much lower than the cost of heating according to the existing tariffs (G11, G12, G13). • 487 contracts were concluded by the end of May 2018.

3.5.	**Research, innovation and competitiveness**	
a)	Policies and measures including those to achieve the objectives set out in 2.5 **Responsible/involved parties*:** **MNiSW, MAP, MR, MFiPR** * subject to potential changes resulting from amendments to the Act on government administration departments.	**1. Implementation of the State science, technology and innovation policy** The targets and objectives of the national science, technology and innovation policy are set out within the seven strategic directions for research and development formulated in the National Research Programme (NRP) adopted by the Council of Ministers in 2011. These directions form the basis for the Council of the National Centre for and Development (Rada Narodowego Centrum Badań i Rozwoju – NCBiR) to develop strategic research and development programmes as part of which R+D projects are subsidised. Strategic programmes have been carried out since 2011, depending on the availability of budgetary funds, consecutively for all seven NRP areas. On 1 October 2018, an act reforming the science and higher education system in Poland took effect, i.e. the Higher Education and Science Law of 20 July 2018 (Journal of Laws, item 1668). Pursuant to the new regulations, the NRP will apply until the Council of Ministers adopts (no later than by 31 March 2020) a new state science policy as part of which the priorities and strategic research programmes will be updated. The updated strategic research directions in the field of energy and climate should be consistent wit the Strategy for Responsible Development (SRD) and, in the field of low-carbon technologies, additionally with the new Energy Policy of Poland until 2040. The expenditures on research and development activities in Poland are planned to be increased to 1.7% of the GDP in 2020 and to 2.5% of the GDP in 2030, and new rules for using these expenditures as part of the science and higher education reform carried out since 2016, better adapted to prevailing social and economic conditions, are planned to be implemented. This will lead, among other things, to an increase in the level and effectiveness of science in Poland, understood as providing results and products of scientific research of high cognitive quality and high social, economic and technological utility. As a joint effect of these actions, the innovativeness of the economy will be enhanced and the international importance and competitiveness of Polish science will increase.
		2. Implementation of the Directions for Energy Innovation Development Programme In 2017, the Ministry of Energy developed the Directions for Energy Innovation Development (DEID). It is a document defining the broad innovation activity framework for the sector and institutions supporting it. The directions are to correlate strategic documents at the level of government administration and state agencies in the field of development and innovation policy for the energy sector. From the point of view of the implementation of the DEID, it is important to target public expenditures at the most attractive and at the same time the most urgent challenges, as well as to activate leading business entities operating in the Polish energy sector and to increase their involvement in, including financial commitment to, research, development and implementation activities. Pursuant to the objectives of the aforementioned document, projects in the following areas will be carried out: - an integrated and interconnected power system giving the central role to the energy user; - effective and flexible energy generation and the use of raw materials combining the reduction

		of the impact on the environment with energy security; - diversification of energy generation and use technologies; - a green and energy-efficient city. The key factor for the development and implementation of innovation is the understanding of particular types of innovation and the development stages of a given technology. Innovation does not concern new technologies only, but also processes and organisational structures. Therefore, much attention has been devoted in the DEID to, among other things, new business models which are based on the application of technologies in a different manner or in another market segment. Moreover, to understand the fundamental problems of the phenomenon known as the valley of death, faced by companies not only in Poland but also worldwide, innovations have been divided according to their type and duration: - current projects – short-term incremental innovations (up to two years), - development projects – medium-term incremental projects (two to four years), - projects for the future – long-term breakthrough innovations (more than four or five years). In view of the above, in the period 2021-2030, efforts should be focused mainly on three levels: - **support for new ideas and incubation**, where a condition for success is the generation of as many low-funding and high-risk projects as possible, with short processing and decision making time, and the creation of a start-up community and an innovation ecosystem; - **support for dissemination and commercialisation**, where a condition for success is the commitment of venture capital and the involvement of large entities as customers and product consumers; - **support for expansion and international development**, where a condition for success is cooperation of large and medium-sized companies and support for international expansion through economic diplomacy. A weakness of the Polish system is undoubtedly the technology development and implementation stages which involves the need for technologies to be piloted and scaled. This is why, in the operation of existing institutions dealing with energy sector innovations or institutions established for this purpose, special emphasis is placed on precisely the aforementioned issues. To streamline efforts in the area of energy sector innovations, work carried out as part of research and analytical back-up facilities must be coordinated. The objective remains to be the optimisation of the use of funds allocated to research, development and innovation through streamlining the operation of various institutions. Cooperation between universities and companies should lead to an increase in the number of patents, and also in the exchange of personnel between academia and industry. An important issue is the enhancement of the exchange of knowledge with foreign centres and the implementation of placement programmes for researchers in energy sector entities. One of the tools may be course programmes sponsored by and created jointly with market entities, conducted by lecturers working on a permanent basis for the most renowned foreign centres and the cooperation of the Polish energy business entities with renowned foreign research centres. Moreover, in addition to researchers, sector company employees should be more involved in international cooperation, through study visits or educational programmes in Poland or work for foreign subsidiary entities. This is particularly important for creating and developing an innovation ecosystem which should

		also cover cooperation with the following related sectors: chemical, information technology and telecommunications, motor industry or defence sectors. It is important to ensure that, within the framework of the regulations in force both concerning the energy sector (tariff system) and intersectoral ones (Public Procurement Law), entities investing in Poland in research, development and innovations be rewarded, e.g. by taking into account expenses on R+D+I and on cooperation with local research centres. It is also important that space be created for the implementation of new solutions. Investments in the energy sector, in particular in innovations, may leverage the development of the entire economy and should be analysed from the point of view of the maximisation of benefits for the Polish economy – not only in terms of standard economic parameters, but also in terms of their potential for the development of science and industry. Natural synergies exist between the energy sector and related sectors, e.g. the chemical, information technology and telecommunications, transport or construction sector. The use of these synergies is beneficial for companies operating in these sectors and offers new possibilities to consumers. Therefore, the criterion for the assessment whether to invest in the energy sector should be the maximisation of national value added, in particular the possibility of obtaining technologically advanced products and services. The achievement of the objectives set out in the strategic document Directions for Energy Innovation Development by 2030 will result in the strengthening of the synergy effect in the area of innovations between companies, public institutions and the science sector, leading to such effects as e.g.: - increase in expenditure on R+D+I in energy sector entities by 200% as compared with 2018; - revenues in energy sector entities from segments which were not included in the existing offer or were marginal in 2018 reaching 25%; - increase in employee innovation in energy sector entities; - utilisation of 30% of waste generated in the energy sector; - utilisation of at least 0.5 billion m^3 of coal-bed methane (CBM) annually; - increase in the utilisation of coal-mine methane (CMM), ventilation-air methane (VAM) and abandoned-mine methane (AMM) by 100% as compared with 2018; - reduction of energy-consumption of buildings by 20% as compared with 2018; - 10% of industrial buildings being equipped with BEMS (Building Energy Management Systems); - increase in the number of patent applications in energy sector entities and research institutes; - reduction of unit energy consumption in industry by 20% as compared with 2018; - increase in the number of agreements and understandings between the energy sector, industry and research units; - enhancement of the technological advancement and competitiveness of the Polish energy sector and reduction of the adverse impact on the environment.
		3. Implementation of the strategic project 'Environmental Technology Verification (ETV) System/Implementation of the Environmental Technology Verification (ETV) Programme in Poland' Environmental Technology Verification (ETV) is a system supporting the commercialisation and

		dissemination of innovative environmental technologies that consists in an impartial and reliable confirmation that performance and benefit claims put forward by a technology manufacturer are credible, complete, and based on reliable research results. The system is implemented in Poland through a strategic project that forms part of the Strategy for Responsible Development. ETV verifies the innovation of the solution in the context of the environmental effect of the technology from a life-cycle perspective. The pilot project is addressed to operators offering technologies in the following areas: water treatment and monitoring, materials, waste and resources, energy technologies. The ultimate ETV programme will depend on decisions taken at EU level and on the results of the evaluation of the EU ETV Pilot Programme. In addition to the above technical areas, the programme is also planned to cover: technologies for soil and groundwater monitoring and soil treatment, technologies and processes for cleaner production, technologies for limiting air pollution and monitoring and reducing emissions from stationary sources, environmental technologies for agriculture.
		4. Implementation of and support for national smart specialisations (NSS) National smart specialisations are economic priorities determined by EU Member States and their regions in the area of research, development and innovation (R&D&I) under a given financial perspective. Smart specialisations are designed to contribute to the transformation of the national economy through modernisation, diversification of products and services, structural transformation and creation of innovative social and economic solutions. Analyses of endogenous economic advantages and cooperation with social and economic partners led to the establishment of a list of 15 national smart specialisations (effective from 1 January 2019), three of which are directly related to sustainable energy: • NSS 1. A healthy society • NSS 2. Innovative technologies, processes and products of the agri-food and forest wood sectors • NSS 3. Biotechnological and chemical processes, bio-products, specialty chemicals and environmental engineering products • **NSS 4. High-efficiency, low-carbon and integrated energy generation, storage, transmission and distribution systems** • **NSS 5. Smart and energy-efficient building construction** • **NSS 6. Environment-friendly transport solutions** • NSS 7. Circular economy – water, fossil fuels, waste • NSS 8. Multifunctional materials and composites with advanced properties, including nanoprocesses and nanoproducts • NSS 9. Sensors (including biosensors) and smart sensor networks • NSS 10. Smart ICT and geoinformation networks and technologies • NSS 11. Printed, organic and flexible electronics • NSS 12. Automation and robotics of technological processes • NSS 13. Photonics • NSS 14. Smart creative technologies • NSS 15. Innovative maritime technologies for specialised vessels, marine and coastal

		structures and logistics based on maritime and inland waterway transport The result of the determination of NSSs is a system underlying the bottom-up creation of priority developmental areas of Poland's scientific and innovation policies. The formulation of a vision for the development of the Polish economy is instrumental to the targeting of financial support to specialisations that are the most promising in developmental terms, thereby contributing to the improvement of innovation and competitiveness of the Polish economy and to the emergence of a knowledge-based economy.
		5. Preparation and implementation of Technology Foresight of the Polish economy by 2040 The aim of Technology Foresight is to analyse the state of technological development of the Polish economy by 2040, identify technological trends and foresight technologies, and establish scenarios for the development of the Polish economy. Prior to foresight analysis, an analysis will be carried out of resources, activities and achievements of scientific units and enterprises in the field of technology development, as well as of technology trends. Technology Foresight of the Polish economy will contribute to the selection of the most competitive technological areas that will have a long-term impact on accelerating social and economic development and will be the areas of specialisation of the Polish economy towards 2040. The results of the analysis will form the basis for verifying and updating the list and descriptions of national smart specialisations. Thanks to this analysis, measures under National Smart Specialisation and the Responsible Development Strategy will be complemented with specific recommendations and actions aimed at implementing the vision of the future in the area of technology.
b)	Cooperation with other Member States in this area, including information on how the SET Plan objectives and policies are being translated to a national context. **Responsible/involved parties*:** **MNiSW, MAP, MR, MFiPR** * subject to potential changes resulting from amendments to the Act on government administration departments.	**Cooperation with the European Commission and Member States as part of the SET-Plan Steering Group** Due to the range of topics: science-energy-industry, Members States are represented in the Steering Group both by representatives of the ministries responsible for energy policy, and those responsible for research (Poland is represented by the representative of the Ministry of Energy and the Ministry of Science and Higher Education). At present, cooperation concerns primarily the participation in TWGs (temporary working groups), which are successively converted to IWGs (implementation working groups), the main task of which is to develop and then carry out implementation plans for the 10 key actions listed in the Commission Communication of 19 September 2015 on accelerating the European energy system transformation – an integrated SET Plan (C(2015) 6317). A total of 15 TWGs have been set up in line with the ten key areas specified in the aforementioned Communication (two different groups have been set up for the selected priorities in view of their complexity). Poland has joined two TWGs: TWG Action 6 'Energy efficiency in industry' and TWG Action 10 'Nuclear'.
c)	If applicable, financing measures in this area at national level, including EU support and the use of EU funds. **Responsible/involved parties*: MNiSW, MAP, MR, MI, MK, MFiPR**	**1. Obtaining of European funds by domestic research units and companies for research and innovation projects** An analysis of the experience based on measures undertaken to day within the framework of the innovation policy conducted by Poland and the lessons learned from the implementation of the previous and current financial perspectives have highlighted the need to target support at areas that offer the greatest competition and innovation potential for the national economy. The current share

	* subject to potential changes resulting from amendments to the Act on government administration departments.	of Polish entities in the Horizon 2020 framework research and innovation programme barely reaches 1%. Among the reasons for Poland's insufficient participation in framework programmes, one should point out, among others, the low capacity of Polish entities to generate projects that can successfully compete for European funding. The low level of this share is correlated with low national expenditures on research, development and innovation. On the basis of this experience, investments should be focused on areas ensuring an increase in the value added of the economy and its competitiveness in foreign markets. The basic instrument is support addressed to companies to enable them to undertake and develop (continue) R+D+I activities, owing to which companies will raise their competitiveness, relating to, among others, the following areas: - high-efficiency, low-carbon, flexible and integrated energy generation, storage, transmission and distribution systems; - smart and energy-efficient building technologies; - environment-friendly transport solutions; - minimisation of waste generation, including waste unfit for processing, and the use of waste for materials production and energy generation purposes (recycling and other forms of recovery). - research on clean coal technologies. At present, funding is provided to research and development projects that lead to innovations in the area of environmental and low-carbon technologies and technologies enabling an effective (economical) resource management. Innovative solutions to problems in the area of sustainable development, including low-carbon transport and renewable energy generation, identified by the public sector (e.g. through the pre-commercial public procurement mechanism) can also be developed. Moreover, the executive agency overseen by the Ministry of Science and Higher Education – the National Centre for Research and Development will subsidise the participation of Polish companies in R+D projects from the European Structural Funds, which should lead to carrying out between ten and twenty sector projects and research and innovation joint venture projects, including in the area of low-carbon emission technologies.
		2. Energy storage facilities, including cells and batteries for electric vehicles The development of electromobility is consistent with the EU strategic direction presented in e.g. the Clean Mobility Package (an initiative related to batteries) and the European Commission Communication concerning innovations in the energy sector COM (2016) 763. This area must be covered by a support instrument as a market that is only at the stage of development. The solutions that are currently in operation are expensive and do not meet consumers' expectations. Projects carried out in this area are characterised by a long payback period and a high-risk rate of return and therefore the private sector is not interested in investing on the required scale. New technologies in this area may have many applications, e.g. in the energy sector and in transport.
		3. Support for the expansion of infrastructure for the distribution and sale of alternative fuels used in transport Alternative fuels are at an early stage of development or at the pilot or even experimental stage and therefore this area needs special financial support. Due to the low level of development of the

		market, as well as the fact that it is a key element for bringing electric vehicles into universal use, vehicle charging and refueling infrastructure should be supported primarily from public funds. In all market analyses, the absence of infrastructure is indicated as the main barrier, and because of major differences in the profitability of projects carried out in various locations support should be provided in as flexible forms as possible. Poland intends to be an active partner in creating the European network of alternative fuel charging and refueling stations in accordance with the guidelines set out in Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure and the Clean Mobility Package published by the EC in November 2017. The Act on electromobility and alternative fuels implements Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure into Polish law. The act is to regulate the newly emerging market for the distribution and sale of alternative fuels used in transport and to enable the fulfilment of the obligation towards the EU. Due to the fact that air pollution and CO_2 emission in Polish cities exceed pollution and emissions in most EU states, support should be sufficiently intense and instruments sufficiently flexible to ensure reasonably quick development of zero- and low-carbon transport. Due to increasing global competition in the market of alternative fuel vehicles and infrastructure and software for them, Poland finds it necessary to support domestic industry with public funds at this early stage of its development. This is consistent with the incentivising models for the so-called infant industries adopted in the world, as well as is underpinned in, among other things, the directions set in the EC Communication on accelerating clean energy innovation COM (2016) 763.
		4. Implementation of the Power-to-Gas group technologies The implementation and development of Power-to-Gas technologies will make it possible to: - prevent electricity network congestion caused by over-generation of energy from the unstable operation of renewable sources; - optimise the use of the gas network (after power-to-gas transformation); - integrate the electricity and gas systems. The Power-to-Gas technology is currently used at an early stage of development. It should be assumed that the implementation of the technology on a scale having a real impact on the energy sector in Poland cannot be financed with the use of market mechanisms.
		5. Construction of small-scale regasification plants with a cooling energy recovery module The purpose of the project is to construct a small-scale regasification plant with a cooling energy recovery module which might also operate as a plant supplying natural gas to make up for shortfalls in the transmission/distribution system. The implementation of the project would contribute to enhancing the flexibility of the operation of the transmission network and to improving the energy efficiency of the natural gas transmission system in Poland. The project enhances the use of LNG importing infrastructure and promotes the development of low-carbon energy sources.
		6. Support for research and implementation projects relating to putting autonomous or partly autonomous alternative fuel vehicles into service The Act on electromobility and alternative fuels of 11 January 2018 introduces the possibility of using roads for testing autonomous vehicles, thus contributing to the development of this technology.

		The issue of introducing autonomous vehicles into transport services has also raised interest in the European Commission, which in its report Autonomous cars: a big opportunity for European industry (published in January 2017 in Digital Transformation Monitor) indicated the main areas of benefits – not only for the European economy, but primarily for EU citizens. First of all, the improvement of safety should be mentioned (ADAS – Advanced Driving Assistance System) and the fact that smart and interconnected transport systems (ITS – Intelligent Transport Systems) will be brought into universal use, an expected effect of which is, among other things, the shortening of the time of transport of goods in the EU. The need to drive the vehicle being eliminated, semi-autonomous cars will save approximately one hour of spare time for the driver each day. In view of the above it is expected that part of work-related activities could be carried out already in the vehicle. In the opinion of some analysts, this may contribute to the improvement of employee productivity by as much as 10% to 15%.
		7. Support for recycling batteries from electricity-fuelled vehicles This area needs to be covered by a support instrument as a market at the development stage. Electric vehicles have appeared on roads relatively recently and, consistently with European plans and the economic trend, their number will be growing. Taking into account the rare-earth materials from which batteries are made, the current and planned price and also the fact that they continue to preserve ca. 80% of their initial performance capacity, battery recycling is an area to develop. Moreover, recycling issues are also consistent with the sustainable growth and circular economy policies promoted in the European Union.
		8. Use of mining waste and combustion by-products The minimisation of the impact on the environment, implying, among other things, the reduction of waste generation at source, must refer to the conditions and specific nature of particular industries. The mining industry has its characteristics and circular economy (circular economy, CE) targets should be adapted to them. The mining sector, by using natural resources as the main raw material, has limited possibilities of becoming a typical area of circular activities. In spite of this, mining companies, when conducting their medium- and long-term operations, should take into account those changes in the political, legislative and market environment which will affect their competitiveness, flexibility, efficiency and innovativeness in the future. In the mining sector, waste generation at source is reduced already at the stage of designing mineral exploitation as well as through the optimisation of the applied deposit mining technologies. Waste in the form of fly ash, slag, ash-and-slag mixture and reaction waste from exhaust gas treatment plants constitutes anthropogenic minerals (AM), whose pozzolanic and hydraulic properties have been known for years. They may and should be fully used by construction industry. Due to their specific properties, combustion by-products (CBP) and mining by-products may replace natural raw materials and thus reduce the need to mine them and emissions relating to this process. There is a great potential in Poland for using anthropogenic minerals in the process of mining site recultivation. This area will develop in Poland due to a considerable scale of mining (both deep and open-cast mining) in the recent decades and growing pressure to restore environmental conditions in mining areas and thus to increase their potential to be used for other purposes.

		9. Creation of investment areas at former mining sites Development of former mining sites to assign them new economic functions along with a possibility of promoting them. Former mining sites are attractive in economic terms due to their location (agglomeration centres, vicinity of motorways) and the fact that they have utilities infrastructure, railway sidings, are zoned industrial in local zoning plans and occupy large areas. Possible measures in this respect will consist in the comprehensive preparation of sites for economic activity. The purpose will be to prepare investment sites, including economic activity zones, to be used for the needs of potential investors. Projects may be carried out that consist of the comprehensive preparation of an investment site, that is projects improving the site's attractiveness for investors, e.g. recultivating or securing former mining sites (e.g.: landslides), site levelling, providing or supplementing infrastructure (i.e. sewage and rainwater systems, water supply networks and power, heat supply, telecommunications or gas supply networks etc.). Expenditures on internal transport infrastructure (internal roads) should be treated as a complementary element of the project and thus may only account for a smaller portion of the project budget. Investments in the information technology infrastructure (ITI) are permissible if they are necessary to provide comprehensive infrastructure for the investment site. They may consist in providing a telecommunications and data transmission network while excluding the site on which the investment project is being carried out.
		10. Support for the producers of means of transport using alternative fuels Due to increasing global competition in the market of alternative fuel vehicles, Poland finds it necessary to support domestic industry with public funds at the early stage of its development. The main instruments stimulating the development of vehicle production should be repayable mechanisms, such as loans, capital entries and the acquisition of bonds. Non-repayable instruments should be applied only in exceptional and justified cases, particularly in relation to minor investment projects where the grant component is the final element completing the financial setup.
		10. Supporting national research on clean coal technologies (CCT) EU climate and energy policy will affect the competitiveness of coal-fired power generation. One of the promising solutions is the alternative use of coal, i.e. a shift from normal combustion in power boilers to coal gasification and the use of the resultant synthesis gas to obtain methanol or hydrogen. The resulting products can be used to generate electricity using innovative IGCC systems, and in further stages also to power fuel cells or hydrogen cells. The use of clean coal technologies brings multiple benefits, such as: - ensuring greater energy security of the State, - diversification of raw materials for the domestic chemical industry, - technological development that will have an impact on economic development and improvement of Poland's competitiveness.
		12. <u>New directions of hydrogen use</u> According to the assumptions of the draft Programme of Hydrogen Technology Development in Poland, the use of hydrogen serves three main purposes: • increasing the competitiveness of energy companies;

		• increasing energy security; • maximising gains for the Polish economy in connection with changes in the energy sector. The above mentioned Programme outlines the directions and potential opportunities for the use of hydrogen in, amongst others, the power industry and transport. One of the uses of hydrogen is to obtain a chemical element from a power-to-gas (P2G) installation, where redundant electricity can be used to produce hydrogen (typically produced from water in the electrolysis process). Currently, the hydrogen obtained in this way has three uses: • it is used in natural gas networks as a process input or, in pure form, in fuel cells; • for the conversion of carbon dioxide into methane; the resulting gas can either be fed directly into the grid or used to produce electricity (through a cogeneration module); • for the improvement of biogas quality, which is a promising way of increasing the use of biomethane and reducing dependence on fossil fuels. Another way is to produce hydrogen-based liquid fuels (P2L), which can be CO2-neutral and contribute to a significant reduction in greenhouse gas emissions while staying liquid. Liquid form makes energy transport and storage a much easier task. An option to use fuel cells and hydrogen for prosumer power generation, as elements of small hybrid systems connected to the power grid or operating in island mode is an interesting alternative avenue of development.

I. Energy support measures, including grants – national and non-national measures

Name / Type	Funding area	Amount of funds	Horizon	Additional information
RES support systems: a) 'green certificates' – number of aid measure: SA.37345 (2015/NN), b) RES auctions – number of aid measure: SA.43697 (2015/N), c) FIT and FIP tariffs – number of aid measure: SA.51852 (2018/X).	development of renewable energy sources	a) PLN 450 million (annually)* b) PLN 40,000 million c) PLN 622.2 million	2040**	* The amount of funds for 'green certificates' is indicative (it is not a maximum amount either) given the fact that the price of certificates of origin is market driven. ** Support schemes are in place for the following periods: a) by 30 June 2016, b) by 30 June 2021 (option to organise auctions), c) by 30 June 2021.
Support scheme – capacity market (CM) – number of aid measure: SA.46100 (2017/N)	providing an investment incentive for a stable and secure energy supply	ca. PLN 4,000 million (annually)	2020-2042*	The costs of the scheme will be included in the electricity bills. The support scheme has been in place since the third quarter of 2020 (the cost will be lower this year). The scheme has been approved by the European Commission for a period of 10 years from the date of the first auction, but the aid granted under the scheme will continue to be paid after this period. The capacity market has been developed to safeguard the security of electricity supplies to end consumers in a long-term perspective. The Polish CM is to ensure sufficiency of generation in the national system from 2021. The CM creates the conditions for the stable operation of existing generation sources and for their modernisation, but above all it provides clear pricing signals aimed at coordinating decisions to construct new generation capacities. The amount of remuneration received under the scheme is determined through auctions. Capacity auctions are open to existing and new generation units, irrespective of the type of fuel used and the technology applied, and to energy storage facilities and demand-side entities. The ability to deliver capacity is the determining factor for admission to an auction.
Support scheme for high-efficiency cogeneration – number of aid measure SA.51192 (2019/N)	development of high-efficiency cogeneration	PLN 36,300 million	2019-2048*	The costs of the scheme will be included in the electricity bills. * The scheme has been approved by the European Commission for a period of 10 years, but the aid

Name / Type	Funding area	Amount of funds	Horizon	Additional information
				granted under the scheme will continue to be paid after this period. The implementation of this scheme is mainly motivated by the necessity to improve air quality in cities, which can be achieved through the development of district heating from the least carbon-intensive sources. Support for all electricity generated in high-efficiency cogeneration that has been fed into the grid and sold will concern cogeneration units that supply, at a minimum, 70% of useful heat from cogeneration to the public district heating network. Where less than 70% of generated heat is fed into the grid, support will be granted proportionally to the share of heat fed to the grid in the total amount of heat generated. Support will only be available to units whose carbon dioxide emission factor (EPS) is not higher than 450 kg/MWh of energy generated (electricity and heat combined).
Aid scheme SA.52832 (2019/N) – Poland – Modification of State aid to the Polish coal sector in 2015-2023	Aid for: a) covering exceptional costs and b) shutting down of production units*.	PLN 12,991.97 million, including: PLN 320.33 million for the shutting down of production units	2015-2023**	* The aid for the shutting down of coal production units was discontinued in 2016. ** The aid was granted for the first time in 2014 due to the fact that it was allocated by production year and not by calendar year. State aid to the hard coal mining sector to cover exceptional costs is granted in the form of: subsidies, exemptions from mandatory fees and penalties, exemptions from payments to PFRON and from fees and penalties to NFOŚiGW and PGWWP, relief on the tax on civil law transactions (PCC), relief on the corporate income tax (CIT), exemptions from payments from profit, exemptions from the obligation to obtain a licence for methane mining. Aid is granted by: - Minister for Energy - National Fund for Environmental Protection and Water Management (NFOŚiGW) - State Fund for the Rehabilitation of Persons with Disabilities (PFRON) - Państwowe Gospodarstwo Wodne Wody Polskie - The First Silesian Tax Office in Sosnowiec - Minister for the Environment

Name / Type	Funding area	Amount of funds	Horizon	Additional information
NFOŚiGW funds, including: *a) Energy Plus* *b) Poviat District Heating – pilot* *c) Agro-energy* *d) Polish Geothermal Energy Plus* *e) My Electricity** *f) Co-financing of projects financed under Axis I of OPI&E 2014-2020* *g) 'Clean Air' Programme***	Measures improving energy efficiency, low-carbon energy sources, including renewable energy sources and high-efficiency cogeneration, district heating, environmental education, other green investments, improving air quality, low-carbon transport	*a) PLN 4,000 million* *b) PLN 500 million* *c) PLN 200 million* *d) PLN 600 million* *e) PLN 1,000 million* *f) PLN 2,000 million* *g) PLN 103,000 million*	2019-2025	Details of the NFOŚiGW power sources are available at: https://nfosigw.gov.pl/o-nfosigw/o-nas/ http://nfosigw.gov.pl/oferta-finansowania/ * The My Electricty programme is financed from the climate account. The funds come from the ETS and the National Fund for Environmental Protection and Water Management (NFOŚiGW) acts as the National Green Investment System Operator. ** Funds to be disbursed until 2029.
Low-Emission Transport Fund (Fundusz Niskoemisyjnego Transportu)	Development of electromobility and transport based on alternative fuels, including CNG, LNG, biocomponents (e.g. for fleet purchases, charging infrastructure, public transport, promotional and educational activities)	PLN 6,700 million	2021-2025	LETF revenues are: - targeted State budget subsidies, - funds provided by the TSO, - proceeds from the substitution fee, - proceeds from the emission fee. The Fund is administered by the minister responsible for energy and managed by the National Fund for Environmental Protection and Water Management. https://www.gov.pl/web/energia/fundusz-niskoemisyjnego-transportu
European Funds – Operational programmes under the financial perspective 2014-2020	a) RES b) Energy efficiency in buildings c) Energy efficiency in enterprises d) district heating networks e) high-efficiency cogeneration f) electricity infrastructure g) gas infrastructure	a) EUR 150.00 million b) EUR 486.54 million c) EUR 78.11 million d) EUR 559.20 million e) EUR 200.88 million f) EUR 573.67 million g) EUR 750.00 million	2014-2020	Funds at the disbursement phase http://www.funduszeeuropejskie.gov.pl/ https://www.gov.pl/web/energia/co-robimy-fundusze-europejskie
European Funds – Operational programmes under the financial perspective 2021-2027	a) RES b) Energy efficiency in buildings c) Energy efficiency in enterprises d) district heating networks e) high-efficiency cogeneration	Estimated above EUR 6,000 million (probably ca. EUR 3,000-4,000 million under national programmes and a similar allocation under Regional Operational Programmes)	2021-2027	Funds at the financial setup phase – neither the overall fund framework nor the breakdown by programme is known.

Name / Type	Funding area	Amount of funds	Horizon	Additional information
	f) electricity infrastructure g) gas infrastructure			
European funds – Connecting Europe Facility (CEF)	construction and modernisation of energy infrastructure, smart grids, CCSs (including projects of common interest)	EUR 4,700 million* PLN 40.00 million	2014-2020 2021-2025	*The amount until 2020 is the total budget of the facility for non-reimbursable grants. The amount since 2021 is included in the national budget http://www.funduszeeuropejskie.gov.pl/strony/o-funduszach/zasady-dzialania-funduszy/program-laczac-europe/informacje-o-cef/.
European Funds - the Just Transition Fund under the European New Deal	transition of mining regions	No data available	2021-2027	Funds at the financial setup phase
Modernisation Fund	modernisation of the energy sector	ca. EUR 2,000-4,800 million	2021-2030	The Fund will be financed through the auctioning of 2% of all emission allowances under the EU ETS. The amount of the funds will depend on the prices of the allowances. The Fund will be available to EU countries whose GDP per capita is below 60% of the EU average, including Poland. Power generation from solid fuels will be excluded, with the exception of district heating in Bulgaria and Romania.
InvestEU	Low-carbon infrastructure, R&D, SMEs, competence building	Estimated over EUR 6,000-7,000 million (the allocation for the energy sector is difficult to estimate)	2021-2027	Under the existing Investment Plan for Europe (Juncker Plan), over EUR 3.7 billion has been allocated for investments in Poland worth nearly EUR 18.6 billion.
Horizon Europe	Research and development	–	2021-27	The successor of Horizon 2020
LIFE Programme	Protection of the environment and climate	ca. EUR 5,000 million	2021-27	Follow-up to the programme launched in 1992
Norwegian Financial Mechanism, EEA Financial Mechanism	High-efficiency cogeneration, modernisation of networks and sources in district heating systems, improvement of energy efficiency in schools, geothermal power, small hydropower, pellet	PLN 862.35 million	2021-2025	The amount in the State budget may be increased as part of co-financing from NFOŚiGW funds. The mechanism goes beyond the area of energy

Name / Type	Funding area	Amount of funds	Horizon	Additional information
	production projects			
Loans from international financial institutions (e.g. World Bank, European Investment Bank, Council of Europe Development Bank)	Particularly anti-smog measures related to transition and modernisation of the energy sector, improvement of energy efficiency	No data available	No data available	Programmes and mechanisms are developed on an ongoing basis as needs arise.
'White certificates' support scheme	Improving energy efficiency of enterprises	No data available	2030	The horizon can possibly be extended
Thermomodernisation and Renovation Fund	Thermomodernisation projects	No data available	since 1999	The Fund is financed from the State budget. In 1999 and 2018, PLN 2,575 million was transferred to the Fund, with further amounts being arranged https://www.bgk.pl/samorzady/fundusze-i-programy/fundusz-termomodernizacji-i-remontow/

II. Response to the European Commission's Recommendation C(2019)4421 of 18 June 2019 on the draft integrated National Energy and Climate Plan of Poland covering the period 2021-2030

In accordance with Regulation 2018/1999, each Member State should take due account of any recommendations from the Commission in its integrated national energy and climate plan, and if the Member State concerned does not address a recommendation or a substantial part thereof, that Member State must provide and make public its reasons. **This means that pursuant to Regulation 2018/1999, the Commission's recommendations are not binding.** It is, therefore, within the discretion of the Member State concerned whether and to what extent to address the Commission's recommendations in the final national energy and climate plan.

Recommendation 1 *Provide more information on planned policies and measures to address the projected substantial gap to Poland's greenhouse gas target for sectors not covered by the EU emissions trading system for 2030 of -7% compared to 2005. This includes more clarity on transport measures and more details on additional measures, notably in the building, agriculture and land use, land use change and forestry sectors and the application of accounting rules as set out in the Regulation (EU) 2018/841 of the European Parliament and of the Council.*

As recommended by the Commission, corrections have been made to the analytical part of the NECP concerning the base year for GHG emission forecasts and the emission projections themselves. The information on policies and measures to reduce emissions from sectors not covered by the EU's emissions trading system has been clarified and supplemented in Chapters 2.1.1 and 3.1.1.

Recommendation 2 *Increase the level of ambition for 2030 to a renewable energy share of at least 25% as Poland's contribution to the Union's 2030 target, as indicated by the formula in Annex II under Regulation (EU) 2018/1999. Include an indicative trajectory in the final integrated national energy and climate plan that reaches all the reference points pursuant to Article 4(a)(2) of Regulation (EU) 2018/1999 in accordance with that share, in view of the need to increase the level of efforts for reaching this target collectively. Put forward detailed and quantified policies and measures that are in line with the obligations laid down in Directive (EU) 2018/2001 of the European Parliament and Council to enable a timely and cost-effective achievement of this contribution. Ensure that the renewable energy target for 2020 set out in Annex I of Directive 2009/28/EC of the European Parliament and of the Council10 is fully met and maintained as a baseline from 2021 onwards, and explain how such a baseline share will be met and maintained. Increase the level of ambition in the heating and cooling sector to meet the indicative target included in Article 23 of Directive (EU) 2018/2001 and put in place detailed measures to meet the transport target set in the draft integrated national energy and climate plan, in line with Article 25 of Directive (EU) 2018/2001. Provide additional details and measures on simplification of administrative procedures, on the enabling frameworks for renewable selfconsumption and renewable energy communities, in line with Articles 21 and 22 of Directive (EU) 2018/2001.*

The increase in RES share of gross final consumption of energy up to 25% in 2030, as recommended by the Commission, is too ambitious given the domestic conditions, forecasts for the development of the economy and the particular sectors, the development potential of individual technologies, as well as the evolutionary process of a just energy transition and its social and economic considerations. Nevertheless, the NECP sets a target share of RES at 21-23% in 2030, although the 23% target is achievable only if Poland is granted additional funds, including those for just transition.

Otherwise, the Commission's recommendations have been addressed in the NECP by:

- demonstrating an indicative trajectory that reaches all the reference points for the achievement of the 2030 RES target – in point. 2.1.2(b) of this document and in the analytical annex,
- keeping the RES target as the base year for forecasting analytics,
- setting the average annual target for an increase of RES share in heating at 1.1 p.p. and taking that target into account in forecasting analytics,
- identifying the additional measures implemented in 2019 to achieve the 2020 RES target and complementing the policies and measures to meet the 2030 RES target, including those to support selfconsumption and energy communities – Chapters 2.1.2 and 3.1.2.

Recommendation 3 *Review its contributions and identify additional policies and measures that could deliver further energy savings in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target. The proposed level of ambition towards reducing the final contribution should be better justified*

and backed by adequate and quantified savings from polices and measures. Support policies and measures with an impact assessment and deliver more detailed information on the scale and timeframe of implementation. Further explore policies and measures in transport considering the expected increase in the sector's energy demand in the future.

Chapters 2.2 and 3.2 and forecasting analyses of the NECP have been supplemented in accordance with the above recommendation from the Commission.

Recommendation 4 *Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility of the energy system to accommodate the foreseen changes towards 2030 and beyond.*

Chapters 2.3 and 3.3 of the NECP have been supplemented in accordance with the above recommendation from the Commission.

Recommendation 5 *Define forward-looking objectives and targets concerning market integration, in particular measures to assess the impact of public service obligations, in particular gas storage and price regulation on market functioning and clarify how negative consequences will be mitigated. Outline a strategy and timeline for progressing towards fully market based prices.*

Chapter 3.4.3 has been supplemented in accordance with the above recommendation.

Recommendation 6 *Clarify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate plan. Underpin such objectives with specific and adequate policies and measures, including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan.*

The Commission's recommendations have been reflected in NECP by means of supplementing Chapters 2.5 and 3.5 thereof.

Recommendation 7 *Continue and broaden the consultation of neighbouring Member States and regional cooperation in the context of the Visegrad Group (Czechia, Hungary, Poland and Slovakia) and in the respective high-level groups. The focus of the regional exchanges could be on further integration in the internal energy market, assessing system adequacy in light of the planned continuation of a capacity market, just transition issues, decarbonisation and renewables deployment and the impact on the energy system and cross-border electricity trade.*

The Commission's recommendation has been followed by including information on regional consultations in Chapter 1.1.

Recommendation 8 *List all energy subsidies, including in particular for fossil fuels, and actions undertaken as well as plans to phase them out.*

The recommendation has been followed by supplementing Chapter 3.1.3 of the NECP and adding a list of energy support measures in Chapter I.

Recommendation 9 *Complement the analysis of the interactions with air quality and air emissions policy, including from a quantitative perspective, and presenting the impacts on air pollution for the various scenarios.*

The forecasting part of the NECP has been extended to include results of analyses of the impacts of implementation of air quality improvement policies and measures on the reduction of pollutant emissions.

Recommendation 10 *Integrate just and fair transition aspects better, notably by providing more details on social, employment and skills impacts of planned objectives, and policies and measures. The final integrated national energy and climate plan should particularly address the impact of the transition on the populations living in coal regions, reinforcing the link to the ongoing coal regions in transition initiative and the corresponding national and regional transition plans, as well as those affected by adjustments in other energy-intensive sectors. Further develop the approach to addressing energy poverty issues, including by specifying objectives and*

intended impacts of planned policies and measures as required by the Regulation (EU) 2018/1999.

The Commission's just transition recommendation has been addressed by supplementing Chapters 2.1 and 3.1. However, a comprehensive analysis of the impact of the energy transition on mining areas (including society, employment and skills) was not possible within the timeframe required to submit the NECP. This analysis will be carried out as part of the restructuring plan for coal and lignite mining areas to be drawn up in 2020. Energy poverty issues are addressed in Chapters 2.4.4 and 3.4.4.

List of abbreviations

BAT	- best available techniques
CNG	- compressed natural gas
DSR	- demand side response
NP	- nuclear power plant, nuclear power generation
ENTSO-E	- European Network of Transmission System Operators for Electricity
ENTSO-G	- European Network of Transmission System Operators for Gas
EU ETS	- European Union Emissions Trading System
FBA	- flow-based allocation
FSRU	- floating storage regasification unit
FTN	- Low-Emission Transport Fund
GDA	- general distribution agreements
GUS	- Central Statistical Office (*Główny Urząd Statystyczny*)
HTR	- high temperature reactor
ICT	- information and communication technology
IOŚ	- Institute of Environmental Protection (*Instytut Ochrony Środowiska*)
CDGU	- centrally dispatched generating units (managed by the TSO)
NPS	- national power system
LNG	- liquified natural gas
MAP	- Minister for State Assets (in charge of the energy and mineral deposits management departments of government administration as of December 2019)
MF	- minister responsible for public finance
MFiPR	- minister responsible for regional development
MGMiŻŚ	- minister responsible for maritime economy and inland navigation
MI	- minister responsible for transport
MNiSW	- minister responsible for science and higher education
MK/MŚ	- minister responsible for the environment (Minister for Climate as of December 2019)
MR	- minister responsible for development, economy, construction, land use planning, spatial development and housing
MRPiPS	- minister responsible for family, labour and social security
MRiRW	- minister responsible for agriculture and rural development
MSWiA	- minister responsible for internal affairs and public administration
MSZ	- minister responsible for foreign affairs
NIT	- National Indicative Target (relating to the share of RES in transport)
LV	– low voltage power lines
EMIO	- energy market information operator
EDSO	- electricity distribution system operators
GDSO	- gas distribution system operators
ETSO	- electricity transmission system operator – Polskie Sieci Elektroenergetyczne S.A. (PSE S.A.)
GTSO	- gas transmission system operator – Operator Gazociągów Przesyłowych GAZ-SYSTEM S.A.
RES	– renewable energy sources
UGS	– underground gas storage facilities
PNPP	- Polish Nuclear Power Programme
PRMCzP	- Plenipotentiary of the Prime Minister for the Clean Air Programme
PRSIE	- Government Plenipotentiary for Strategic Energy Infrastructure
SAIDI	- System Average Interruption Duration Index
SAIFI	- System Average Interruption Frequency Index

MV - medium voltage power lines
SRD – Strategy for Responsible Development
EU - European Union
URE – Energy Regulatory Office (*Urząd Regulacji Energetyki*)

[1] Regulation of the Council of Ministers of 24 April 2017 regarding the minimum diversification level of natural gas supplies from abroad.

[2] Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013 (hereinafter: The Effort Sharing Regulation, ESR).

[3] Regulation of the European Parliament and of the Council on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry in the 2030 climate and energy framework, and amending Regulation (EU) No 525/2013 and Decision 529/2013/EU (hereinafter: the LULUCF Regulation).

[4] Regulation of the European Parliament and of the Council on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 for a resilient Energy Union and to meet commitments under the Paris Agreement and amending Regulation No 525/2013 of the European Parliament and of the Council on a mechanism for monitoring and reporting greenhouse gas emissions and other information relevant to climate change.

[5] As assessed by the Institute of Agricultural and Food Economics (Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej – IERiGŻ) of the National Research Institute (Państwowy Instytut Badawczy – PIB) in a study prepared at the request of the Ministry of Agriculture and Rural Development.

[6] Estimates of the Institute of Agricultural and Food Economics (IERiGŻ).

[7] Institute of Soil Science and Plant Cultivation – National Research Institute (Instytut Uprawy Nawożenia i Gleboznawstwa – Państwowy Instytut Badawczy) in Puławy, study entitled: “Sprzedaż słomy przez rolników na cele energetyczne i jej wpływ na żyzność i urodzajność gleb” (“Sales of straw by farmers for energy purposes and the associated impact on soil fertility and yield.”

[8] The presented solid agricultural biomass estimates are based on crops harvested every year, having regard to the demand for it in agriculture.

[9] In accordance with the waste hierarchy and waste management plans, for municipal waste, this activity only applies to waste other than collected selectively to the extent it cannot be recycled

[10] Consistency will be ensured by the preventive action and emergency plans under Regulation [as proposed by COM(2016) 52] concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010, and the risk preparedness plans under Regulation [as proposed by COM(2016) 862] on risk-preparedness in the electricity sector and repealing Directive 2005/89/EC.

[11] Regulation (EU) No 347/2013 of the European Parliament and of the Council of 17 April 2013 on guidelines for trans-European energy infrastructure and repealing Decision No 1364/2006/EC and amending Regulations (EC) No 713/2009, (EC) No 714/2009 and (EC) No 715/2009 (OJ L 115, 25.4.2013, p. 39)

[12] The ‘flow-based approach’ means a capacity calculation method in which energy exchanges between bidding zones are limited by power transfer distribution factors and available margins on critical network elements. The FBA enables available transmission capacity to be used in a better way, which is more effective in economic terms.

[13] Source: National Inventory Report 2019, KOBiZE

[14] Available at: http://powietrze.gios.gov.pl/pjp/content/show/1001777,

[15] The Programme is available at: https://www.mos.gov.pl/srodowisko/ochrona-powietrza/krajowy-program-ochrony- powietrza/, situation as at 10 April 2018.

[16] When planning these measures, Member States are to take into account the end of life of existing installations and the potential for repowering.

[17] In accordance with Article 2a of Directive 2010/31/EU, version as amended in accordance with proposal [COM(2016) 765].

[18] Pursuant to Article 18 of Directive 2012/27/EU.

[19] Pursuant to Article 8 of Directive 2012/27/EU

[20] Pursuant to Articles 12 and 17 of Directive 2012/27/EU.

[21] Pursuant to Article 19 of Directive 2012/27/EU

[22] Pursuant to Article 15(2) of Directive 2012/27/EU.

[23] Policies and measures must reflect the energy efficiency principle above all else.

[24] Consistency will be ensured by the preventive action and emergency plans under Regulation [as proposed by COM(2016) 52] concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010, and the risk preparedness plans under Regulation [as proposed by COM(2016) 862] on risk-preparedness in the electricity sector and repealing Directive 2005/89/EC.

[25] The Demand Side Response (DSR) service consists in reducing power demand with the use of tools to manage energy demand.

[26] Policies and measures must reflect the energy efficiency principle above all else.

[27] The 'flow-based approach' means a capacity calculation method in which energy exchanges between bidding zones are limited by power transfer distribution factors and available margins on critical network elements. The FBA enables available transmission capacity to be used in a better way, which is more effective in economic terms.

[28] Other than the PCI Regional Groups established under Regulation (EU) No 347/2013.

[29] Other than the PCI Regional Groups established under Regulation (EU) No 347/2013.

[30] In accordance with Article 15(8) of Directive 2012/27/EU.

ENERGY AND CLIMATE POLICY (ECP) SCENARIO

Impact assessment of policies and measures

Annex 2 to the ***National Energy and Climate Plan for 2021-2030***

Rev. 5.2 of 18/12/2019

Table of contents

Introduction

This document is the second analytical annex to the National Energy and Climate Plan for 2021-2030 (NECP).

It presents an **Energy and Climate Policy (ECP) Scenario** containing an analysis (assessment) of the impacts of policies and measures, demonstrating how and with what effect the objectives will be achieved in the five dimensions of the Energy Union, including the 'climate and energy targets'.

The document contains comparisons to the Reference Scenario (REF), i.e. an analysis of the impacts of the PaMs (policies and measures) that existed until the end of 2017 (business as usual) – Annex 1 to the NECP. Both documents present a multi-faceted analysis of the impacts of implementation by 2030, with an outlook for 2040.

The document also implements the conclusions drawn from comments submitted during the public consultation process between 15 January and 18 February 2019, as well as the conclusions of the European Commission recommendations of 18 June 2019 to the NECP, which had been received by all EU Member States.

The structure of the document reflects the five dimensions of the Energy Union – energy security, the internal energy market, energy efficiency, decarbonisation, and research, innovation and competitiveness.

The content and the scope of information presented correspond to the guidelines set out in Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council.

In line with the guidelines, statistical data is presented for the years 2005, 2010 and 2015, while the forecasts span five-year periods to 2030, with an outlook for 2040. In accordance with the Commission Recommendation, the document presents the trajectory of the share of renewable energy in gross inland final energy consumption and for the power, heating and cooling and transport sectors by year for the 2021-2030 timespan. Some trajectories for the decarbonisation and energy efficiency are also broken down by year.

Statistical data from the EUROSTAT database for historical periods has been modified in line with the update made by the EUROSTAT on 24 April 2019. Therefore, the statistical data provided for 2005, 2010 and 2015 differ from the data presented in the REF scenario.

5. IMPACT ASSESSMENT OF POLICIES AND MEASURES

5.1. Impacts of planned policies and measures on the energy system and GHG emissions and removals

This document presents the results of analyses and forecasts aimed at determining the future situation of the fuel and energy sector for conditions determined by economic and environmental requirements and resource constraints, taking into account the planned PaMs described in the previous section. The analysis covers all sectors of the national economy, as well as the currently used and prospective energy carriers across the supply chain. The results of forecasts are compared for the two scenarios: the Energy and Climate Policy (ECP) and REF. The purpose of the comparisons is to assess the impact of the parameters that underlie the differences between these scenarios and to identify the interactions between existing and planned policies and measures within the five dimensions of the Energy Union.

The calculation methods used are based on methodologies commonly used worldwide for preparing sectoral analyses and forecasts that take into account economic developments and that can be used for drafting and analysing scenarios and variants for the development of the energy sector to the extent that allows analysing:

- the impacts of changes in the energy sector on the country's economy,
- changes in the electricity production mix as a result of changes in external factors and regulations (global energy trends, international fuel prices, prices of ETS emission allowances, changes in technology costs, macroeconomic indicators, cost of raising capital for investments), as well as changes in internal factors and legislation,
- the share of energy produced from renewable energy sources in gross final consumption and by sector (heating and cooling, electricity, transport), broken down into individual RES technologies, taking into account the technical and economic potential, availability of resources, capital expenditure and operating costs, existing and planned support schemes, and solutions designed to improve the flexibility of the system,
- changes in the volume of carbon dioxide emissions across the economy and in individual sectors (taking into account the potential for recovery), the situation in the heating and cooling sector, in particular as regards the development of cogeneration and renewable sources,
- movement in electricity prices on the wholesale and retail markets as a result of developments in the electricity sector and external factors,
- changes in final energy demand under the influence of independent variables (including GDP growth and value added in sectors, changes in the manufacture of energy-intensive products),
- potential primary and final energy savings by sector of the economy, as well as developments on the natural gas market,
- changes in the use of fuel, including for electricity and heating generation purposes,
- developments on the liquid fuels market, taking into account trends in the transport sector, including the growing importance of electromobility.

The following basic models are used for analysing the fuel and energy economy:

1. The STEAM_PL (Set of Tools for Energy Demand Analysis and Modelling) simulation model for forecasting final energy demand
2. The MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impacts) electricity and heating sector optimisation model
3. The computable general equilibrium (CGE) model for analysing the impacts on the economy and employment
4. Models for analysing pollution volumes and assessing health impacts.

5.1.1. General parameters and variables

5.1.1.1. Population

Estimates regarding the size of Poland's resident population are made on the basis of the 2011 census, while the calculations for the following years are based on official records of births, deaths and long-term internal and international migration (the migration estimates do not include undocumented and illegal migrations)[1].

[1] Residents (resident population), Central Statistical Office, access: http://stat.gov.pl/obszary-tematyczne/ludnosc/ludnosc/rezydenci-ludnosc-rezydujaca,19,1.html

Table 1. Resident population [million]

	2005	2010	2015	2020	2025	2030	2035	2040
Total	38.1	38.1	38.0	38.1	37.9	37.5	37.1	36.5
Urban	23.4	23.1	22.9	22.6	22.3	21.8	21.2	20.7
Rural	14.7	14.9	15.1	15.4	15.6	15.7	15.8	15.8

Source: Prognoza ludności rezydującej Polski na lata 2015-2050 (Projected Polish resident population in 2015-2050). Central Statistical Office, Warsaw, January 2016.

As is shown by the demographic projection presented, the resident population is expected to fall over the timespan from the current 38.0 million to 36.5 million. This decline has mostly effect on the urban population, with a simultaneous, gradual increase in the number of rural residents, which is mainly associated with the growing urban-rural migration, mostly to suburban municipalities centred around large cities, a trend that has been observed since 2000.

5.1.1.2. GDP

The macroeconomic scenario that underlies the projection of energy demand in Poland until 2040 is based on GDP growth forecasts published by the Ministry of Finance (MF)[2] in May 2017[3]. The projected GDP growth for Poland in absolute terms used in the model calculations is presented in Table 2, while the projections of average annual increases is shown in Table 3.

Table 2. Gross domestic product [EUR'2016 million]

	2005	2010	2015	2020	2025	2030	2035	2040
GDP	317 010	400 114	462 370	551 249	649 661	748 029	843 849	938 089

Source: Eurostat, MF

Table 3. 2016-2040 GDP forecast (average annual growth)

	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040	2016-2040
GDP	103.6	103.3	102.9	102.4	102.1	102.9

Source: MF, ARE S.A.

As the projections demonstrate, the average annual 2016-2040 GDP growth rate in Poland is 2.9%. The rate is higher than assumed in the PRIMES [4] baseline scenario by approx. 0.7 percentage points. The reindustrialisation of the economy announced in the government's 'Strategy for Responsible Development' and the projected increase in the affluence of society are expected to be the main drivers of future economic growth[5].

5.1.1.3. Sectoral gross value added

[2] Guidelines on the use of uniform macroeconomic indicators for assessing the financial impacts of draft legislation. May 2017 Update (*Wytyczne dotyczące stosowania jednolitych wskaźników makroekonomicznych będących podstawą oszacowania skutków finansowych projektowanych ustaw*. Aktualizacja - maj 2017 r.), Ministry of Finance, Warsaw 2017, https://www.gov.pl/web/finanse/wytyczne-sytuacja-makroekonomiczna

[3] More recent MF projections are currently available, including those from May 2019, but the projections used in the forecast and the latest MF estimates on Poland's macroeconomic development only differ for the first five-year period. In order to ensure comparability with the REF scenario, the calculations are based on an unchanged path of economic growth. Furthermore, the energy demand projections are adjusted against the latest statistical data regarding the fuel and energy economy. In most cases, the adjustments produce an increase in energy demand, which is closely associated with the growth of GDP in the first five-year forecast period as anticipated by the latest MF projections.

[4] *Poland: Reference Scenario. Detailed Analytical Results*. Primes Ver. 4 Energy Model. E3MLab, National Technical University of Athens.

[5] Strategy for Responsible development (with an outlook for 2030), as adopted by Resolution of the Council of Ministers of 14 February 2017, Warsaw 2017.

The structure of gross value added is estimated on the basis of the anticipated GDP growth path and macroeconomic assumptions derived from the PRIMES model (Reference Scenario)[10].

Table 4. Sectoral gross value added [EUR'2016 million]

	2005	2010	2015	2020	2025	2030	2035	2040
Gross value added	**278 683**	**351 994**	**402 825**	**475 640**	**555 687**	**636 721**	**714 785**	**790 674**
Industry	61 282	86 857	103 904	119 117	137 327	156 588	171 983	185 218
Agriculture	10 298	10 267	9 537	9 735	9 937	10 143	10 351	10 564
Transport	18 277	18 613	25 905	31 207	33 929	36 469	38 943	41 184
Construction	22 971	29 885	35 389	35 166	38 852	42 636	44 560	46 727
Services	165 855	206 373	228 090	280 416	335 641	390 886	448 947	506 982

Source: Eurostat, Ministry of Finance, PRIMES Ref2016, ARE S.A.

In accordance with the projection of gross value added growth, services will be the fastest growing sector of the economy, with its value added bound to double in 2015-2040. Added value also increases considerably in industry, although its share in the breakdown will gradually decline (Figure 1).

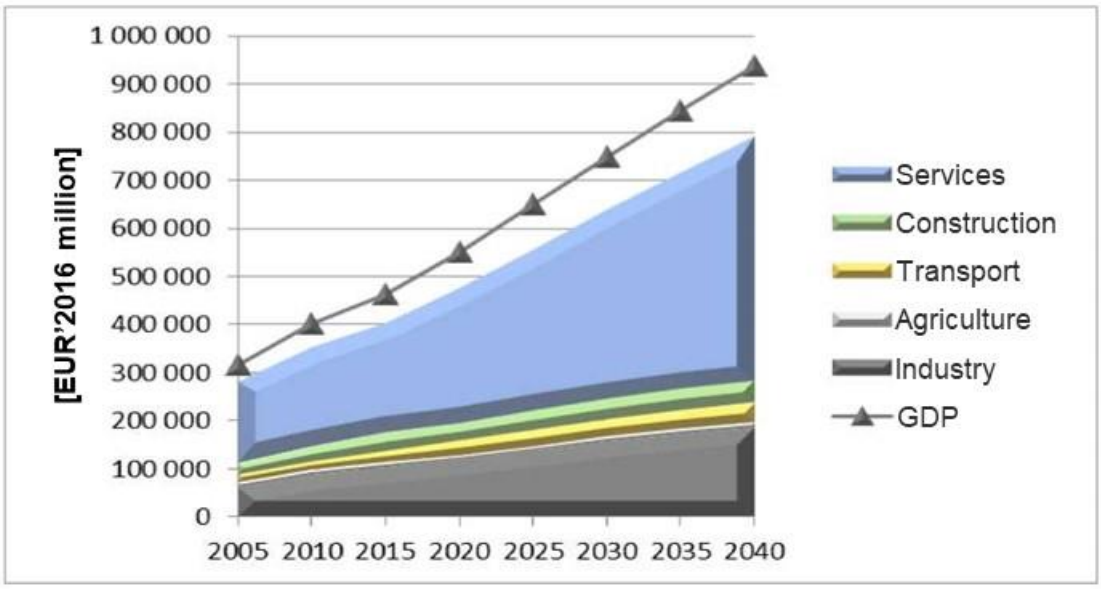


Figure 1 GDP and breakdown of gross added value in Poland

5.1.1.4. Number and size of households

The projections of the number of households and the average number of people per household used in the model calculations (tables 5 and 6, respectively) stem from Poland's projected size of population. The individual estimates are based on an analysis of the historical trend and comparisons with corresponding projections of the Central Statistical Office (GUS). The analyses foresee a gradual improvement of the housing conditions in Poland, as manifested by a decrease in the number of persons per household. In 2015, the average household consisted of 2.7 persons, with this figure set to improve to approx. 2.3 in 2030 and 2.2 in 2040.

Table 5. Number of households

	2005	2010	2015	2020	2025	2030	2035	2040
Total	**12 776**	**13 471**	**13 962**	**14 742**	**15 443**	**16 044**	**16 530**	**16 922**
Urban	8 580	9 088	9 398	9 875	10 301	10 646	10 905	11 102
Rural	4 196	4 383	4 564	4 867	5 142	5 398	5 625	5 820

Source: GUS, ARE S.A.

Table 6. Number of members per household

	2005	2010	2015	2020	2025	2030	2035	2040
Total	**3.0**	**2.8**	**2.7**	**2.6**	**2.5**	**2.3**	**2.2**	**2.2**
Urban	2.7	2.5	2.4	2.3	2.2	2.0	1.9	1.9
Rural	3.5	3.4	3.3	3.2	3.0	2.9	2.8	2.7

Source: GUS, ARE S.A.

5.1.1.5. Disposable income of households

In accordance with the Eurostat methodology, which has been implemented into Polish statistics, household's available income is the sum of annual gross cash incomes of all household members minus tax on income, property taxes, social and health insurance contributions, inter-household cash transfers paid, and settlements with the Tax Office (cash that households can allocate for consumption, investments or savings). This indicator can be used for assessing the real purchasing power of households. For the purposes of this document, use is made of statistical data on the level of average monthly disposable income per capita presented in a GUS publication[6]. The forecast for this indicator (table below) is based on the projected growth of GDP in Poland and the average size of household.

Table 7. Projected disposable household income [EUR'2016]

	2005	2010	2015	2020	2025	2030	2035	2040
Country total	8 640	11 111	10 731	12 700	14 383	16 019	17 607	19 493

Source: GUS, ARE S.A.

According to the presented projection, disposable income of households almost doubles in the period 2016-2040, which reflects the improvement in the financial situation of society.

5.1.1.6. Passenger transport performance

The demand for transport performance is the primary driver of the demand for fuels and energy, as well as of emissions in the transport sector.

In accordance with the methodology adopted in this document, the forecast demand for passenger transport presented in this section are not assumptions, but stem from calculations made using the energy model (STEAM_PL). The demand in this model is calculated as follows:

Transport performance for the mode of transport concerned [tkm]
= weight of transported loads [tonne] average transport distance of 1 tonne of load [km]*

Subsequently, the total demand for transport is calculated as the sum of transport activity performed by all types of passenger transport.

The model forecasts such categories as the number of vehicles of a given type, the average annual mileage, and the average number of passengers using a given type of vehicles.

The resultant values of total demand for transport are confronted with the results of an econometric model relying on identified relationships between the level of economic activity measured by GDP per capita and the level of transport activity (top-down approach).

The transport performance values for different modes of transport for the ECP scenario differ from those obtained in respect of the REF scenario since they include the additional measures aimed at reducing energy consumption and emissions from the transport sector envisaged by the National Plan. In summative terms, they are similar (the slight differences stem from the assumption that some actions to be taken in the ECP scenario will reduce mobility, e.g. introduction of clean transport zones), but the way of satisfying the demand for

[6] 2016 Household Budgets, GUS, Warsaw 2017.

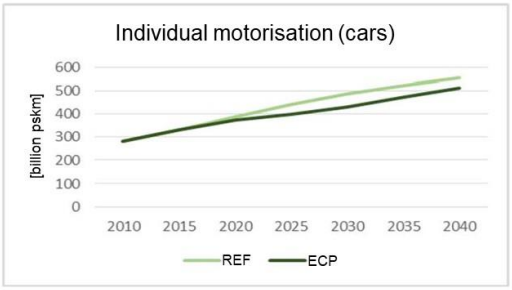
passenger transport activity is completely different, oriented more to the low-carbon modes, e.g. most of the burden of transport performance is transferred to public transport, which is characterised by lower specific emission factors.

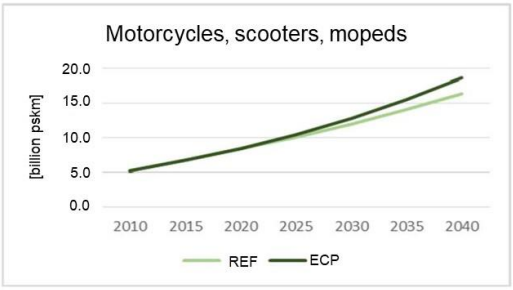
In synthetic terms, the demand for passenger transport performance in the ECP scenario increases in 2015-2040 from 408 billion pskm to 664 billion pskm, i.e. by about 63%. By mode of transport, the greatest share in the demand is represented by individual road transport, which increases from 332 billion pskm in 2015 to 515 billion pskm in 2040. However, the ECP scenario demonstrates a clear slowdown in the growth of demand for transport handled by individual motor vehicles (passenger cars). A comparison of the two scenarios points to a shift from individual motorised transport to public transport (passenger rail, bus, tram, and metro transport) and to low-emission individual means of transport (motorcycles, mopeds, scooters and bicycles).

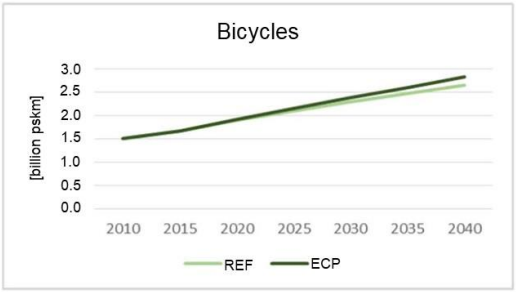
Table 8. Passenger transport performance [billion pskm] – ECP scenario

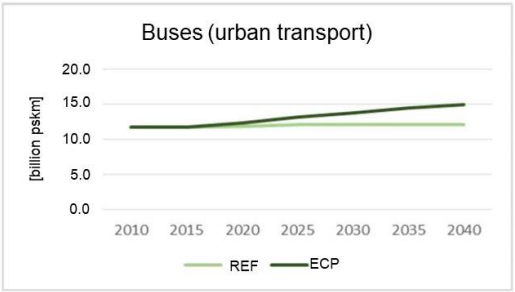
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Passenger cars (individual)	No data	281.0	332.5	375	400	432	473	515
Motorcycles (individual)	No data	5.1	6.7	8	10	13	15	19
Scooters, mopeds, bicycles	No data	1.5	1.7	2	2	2	3	23
Buses (urban transport)	No data	11.7	11.7	12	13	14	14	15
Buses (extra-urban)	21.6	21.5	21.5	22	23	24	26	27
Railways (public)	18.2	17.9	17.4	19	26	40	43	45
Aeroplanes	8.5	8.3	13.5	17	21	24	28	31
Inland waterway vessels	No data	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Rail vehicles (trams, trolleybuses, metro)	No data	3.2	3.5	4	5	7	8	10
Total	**No data**	**350**	**408**	**460**	**501**	**556**	**610**	**664**

Source: Primes Ver. 4 Energy Model. National Technical University of Athens, 2013-01-07, "Transport - wyniki działalności" – GUS. Warsaw, 2011, 2012, 2013, 2014, 2015, "Sustainable Transport Development Strategy 2030". Warsaw, 2019 and ARE S.A. estimates.









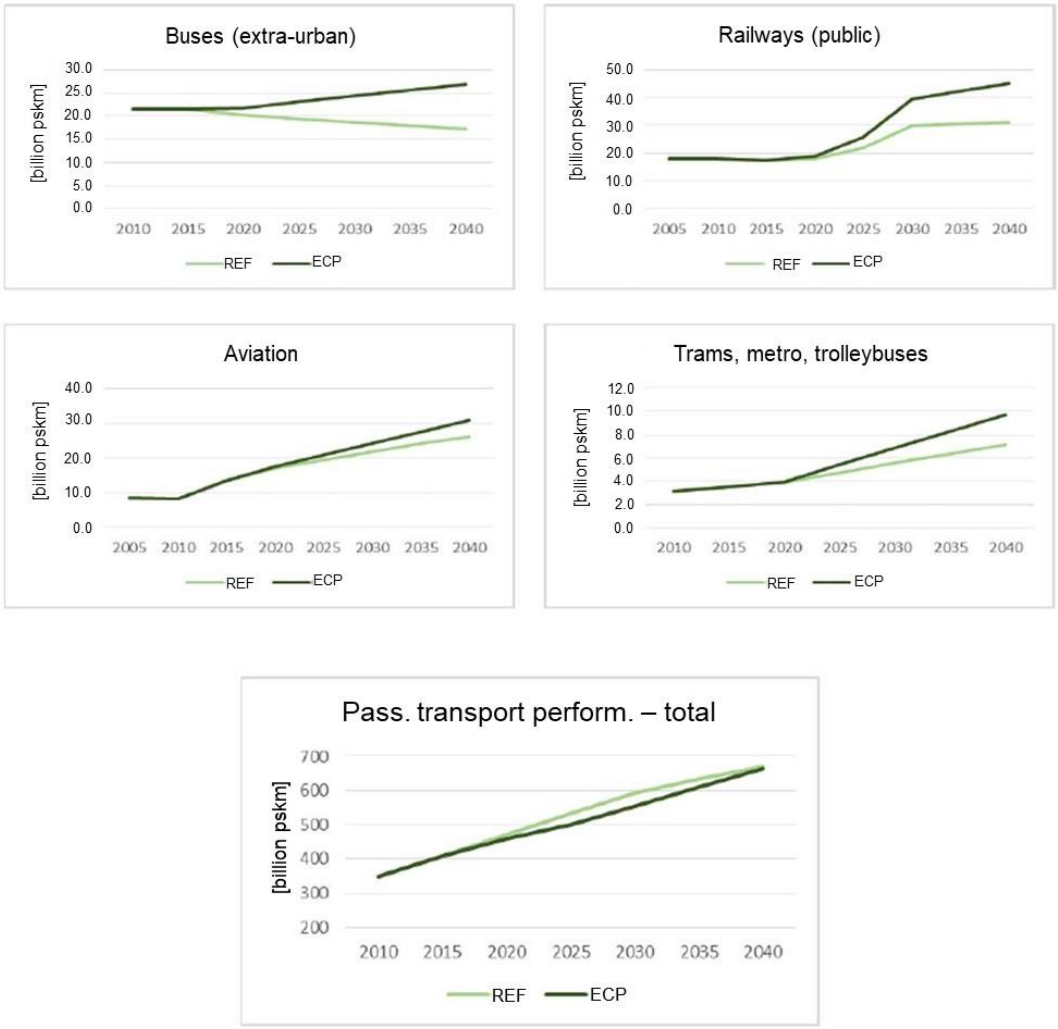


Figure 2. Comparison of projected demand for passenger transport – ECP vs REF

5.1.1.7. Freight transport performance

In addition to economic growth as measured by a number of macroeconomic indicators, the demand for freight transport is driven by such factors as changes in the transport intensity of business operations (which tend to decrease with the increase in the share of highly processed goods and services), the volume of Polish foreign trade, the modal shift, and the developments on international transport markets. The projections of the demand for freight transport used in the energy forecasts result from a model based on the following algorithm:

Transport performance for the mode of transport concerned [tkm]
= weight of transported loads [tonne] average transport distance of 1 tonne of load [km]*

The forecast assumes an increase in demand for freight transported by Polish carriers from 1 824 million t in 2015 to 2 398 million t in 2030, and then to 2 437 million t in 2040 (based on the result obtained in an econometric model where the nationwide GDP growth rate is adopted as the explanatory variable). The forecasts of the average distance over which loads will be transported by individual means of transport are based on a historical trend analysis. The tables below summarise the projections of freight transport performance generated by the bottom-up model used for the purposes of this document, for the REF and ECP scenarios, respectively.

As is shown by the results presented, the demand for freight transport increases from 506 billion tkm in 2015 to 682 billion tkm in 2030 and to 732 billion tkm in 2040. By modes, the largest portion of the demand is that of road transport, the share of which reaches approx. 54% in 2015 to drop gradually to 43% in 2040. The greatest differences between the scenarios occur in rail and road transport. The graphs below illustrate the differences in the projected demand for freight transport.

Table 9. Freight transport performance [billion tkm] – ECP scenario

	2005	2010	2015	2020	2025	2030	2035	2040
Rail transport	50.0	48.9	50.7	72	90	109	126	141
Road transport	119.7	214.2	273.1	296	311	322	321	315
Pipeline transport	25.4	24.2	21.8	24	27	28	29	29
Inland waterway transport	1.3	1.0	0.8	1.4	1.6	1.9	2.2	2.4
Shipping	No data	112	158	180	200	220	235	245
Air transport	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
Total	**No data**	**400**	**506**	**573**	**629**	**682**	**713**	**732**

Source: ARE S.A., Primes Ver. 4 Energy Model. National Technical University of Athens, 2013-01-07, "Transport - wyniki działalności" – GUS. Warsaw, 2011, 2012, 2013, 2014, 2015, "Sustainable Transport Development Strategy 2030". Warsaw, 2019 and ARE S.A. estimates.

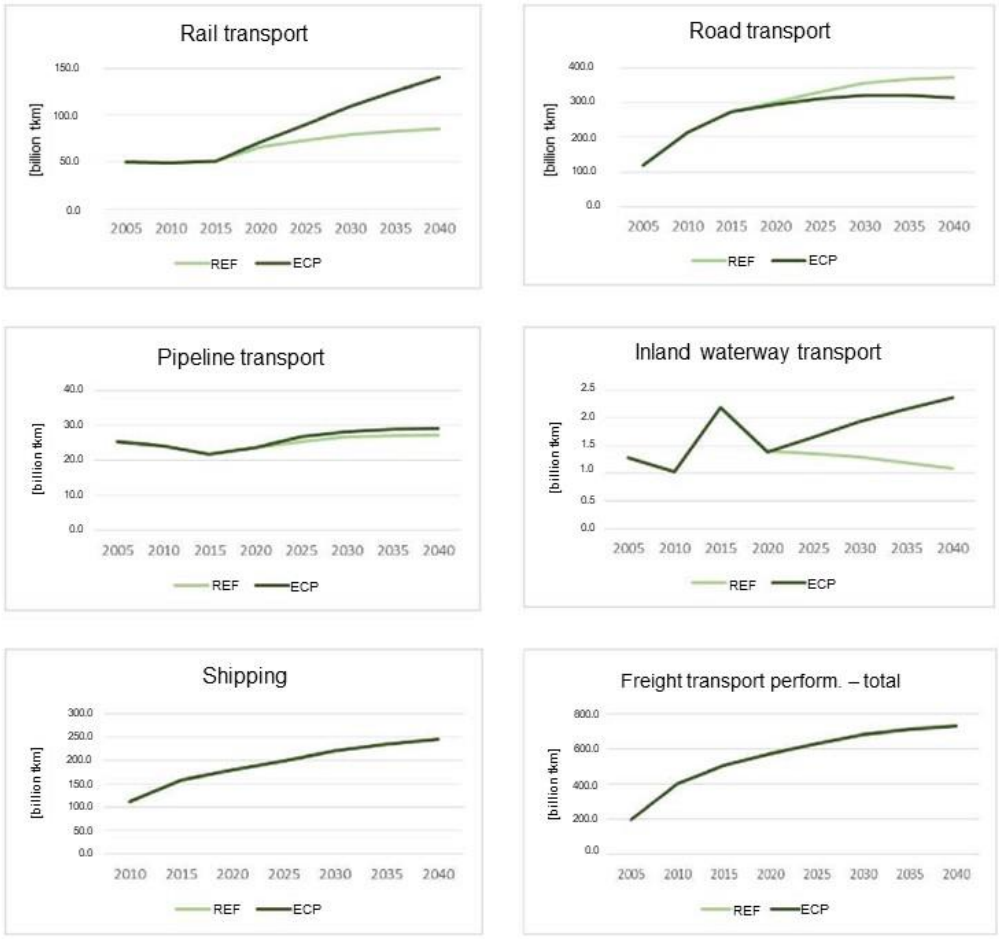


Figure 3. Comparison of projected demand for freight transport – ECP vs REF

5.1.1.8. International fuel import prices

The projections of the prices of fuels imported into the European Union used in the model calculations (see the

table and figure below) come from the projection of the International Energy Agency (IEA)[7] – World Energy Outlook 2017, New Policies Scenario. These projections are used as the basis for determining trends in fuel price projections on the domestic market.

The hard coal and natural gas price projections for the Polish energy sector are based on the assumption that fuel prices in Poland are correlated with those on global markets.

The cost of coal for individual baseload power plants used in the model is differentiated on the basis of statistical data, taking into account, *inter alia*, differences in the cost of transport.

Table 10. Prices of fuels imported into the EU [EUR'2016/GJ (NCV)]

	2005	2010	2015	2020	2025	2030	2035	2040
Crude oil	7.73	9.94	6.83	8.0	10.7	12.1	13.3	14.3
Natural gas	5.17	6.28	6.64	5.5	6.9	7.6	8.0	8.4
Coal	2.18	2.66	1.97	2.2	2.6	2.7	2.7	2.7

Source: ARE S.A. on the basis of the World Bank, IMF, European Commission, and IEA's New Policies Scenario 2017

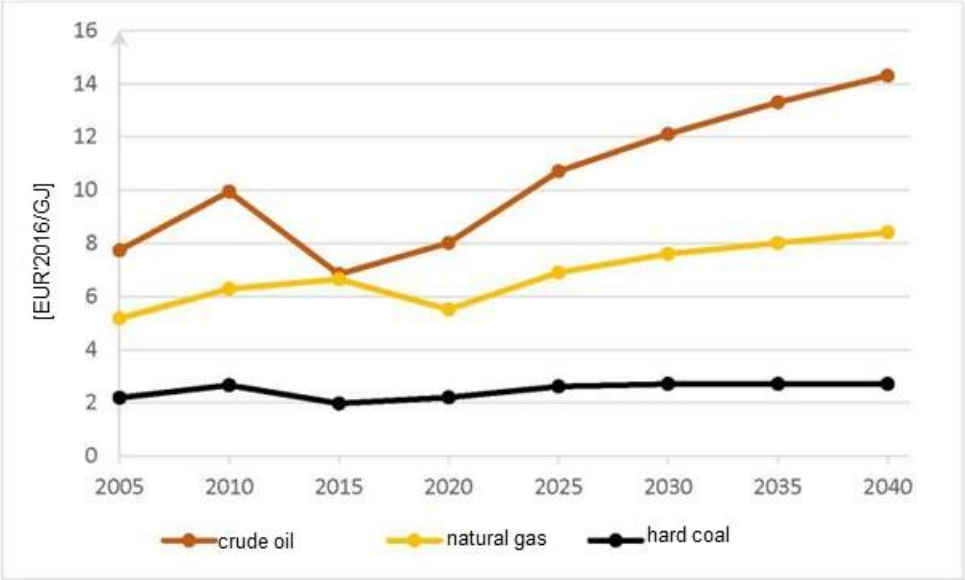


Figure 4. Prices of fuels imported into the EU

5.1.1.9. Prices of EU ETS CO_2 emission allowances

In order to maintain consistency, the projected prices of EU ETS CO_2 allowances (EUA) are also based on the IEA's World Energy Outlook 2017 (New Policies Scenario)[15]. The Outlook foresees a substantial increase in EUA prices over the time horizon under study. The prices of CO_2 emission allowances applied in the analysis are presented in Table 11. Over the timespan, a linear increase in the cost of CO_2 emission allowances is assumed.

Table 11. EUA prices [EUR'2016/tCO_2]

	2005	2010	2015	2020	2025	2030	2035	2040
Price of 1 allowance	0	12	8	17	21	30	35	40

Source: ARE S.A. on the basis of IEA, EC, Thomson Reuters, KfW Bankengruppe

[7] World Energy Outlook 2017, International Energy Agency, Paris 2017.

It is assumed that the price of CO_2 emission allowances will gradually increase to EUR'2016 40/t CO_2 in 2040, working towards the EU's goal of cutting GHG emissions by 40% in 2030 and the ambitious long-term goal of reducing GHG emissions by 80-95% in 2050 compared to the 1990 level[8]. The price of CO_2 emission allowances will be driven, *inter alia*, by the Market Stability Reserve (MSR). Until 2030, the assumed prices of allowances align with the recommendations of the European Commission on the use of indicators for the purposes of preparing national plans[9]. In 2030-2040, the increase in the prices of CO_2 emission allowances assumed by the IEA is slightly slower than in the EC's Reference Scenario.

It should be noted that the projections presented have a long-term nature and do not take into account the fluctuations that will certainly occur in the future, but only set a certain trend. There will be periods when market prices will be both above and below the trajectory, but prices averaged over longer periods should align with it.

The European Commission has not questioned the CO_2 emission allowance price increase path assumed in the forecasts for the REF and ECP scenarios. In addition, despite the substantial increase in prices of CO_2 emission allowances in 2018, the EC has not presented updated, i.e. higher, EUA price forecasts to be used in analytical work for national plans. Therefore, the price projections adopted are considered to be suitable for analytical needs.

5.1.1.10. Exchange rates

The exchange rates are adopted in correspondence to the recommendations of the European Commission regarding the preparation of the NECP. They assume stabilisation of the USD/EUR exchange rate at 1.2 and that for PLN/EUR at 4.25. The 2005-2015 historical figures come from the NBP data.

Table 12. Exchange rates

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
USD/EUR	1.245	1.328	1.120	1.16	1.20	1.20	1.20	1.20
PLN/EUR	4.023	3.995	4.184	4.25	4.25	4.25	4.25	4.25

Source: NBP, European Commission recommendations. Number of heating and cooling degree-days

Assumptions underlying the number of heating and cooling degree-days

The assumptions regarding the number of degree-days over the forecast period are adopted on the basis of the Commission's recommendations regarding the preparation of the NECP. The 2005-2015 historical data originate from Eurostat statistical databases. The projections assume a gradual rise in average annual temperatures in Poland's climate zone, which has a significant impact on the forecast demand for heat in the heating period and for cold in the summer.

Table 13. Number of heating degree-days (HDD)

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
HDD	3 547	3 881	3 113	3 442	3 430	3 418	3 408	3 399

Source: Eurostat, European Commission recommendations

Table 14. Number of cooling degree-days (CDD)

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
CDD	216	197	220	223	226	229	231	233

Source: Eurostat, European Commission recommendations

[15] Ibidem.

[8] European Commission, Energy Roadmap 2050 (COM(2011) 885 final of 15 December 2011.

[9] European Commission: EU Reference Scenario 2016. Energy, transport and GHG emissions trends to 2050, July 2016.

5.1.1.11. Assumptions regarding the technical and economic parameters of energy technologies

The parameters of new generating units presented in Table 15 are based on the latest publications of reputable research centres available at the time when this document was being prepared. The analyses in the model assume that the electricity and heat generation technologies that are currently available in commercial offers will exclusively be available. Carbon capture and storage (CCS) technologies are also included in the list. As regards renewable energy technologies, use is also made of the costs estimated in the Regulatory Impact Assessment for Regulation of the Minister of Energy on the reference price of renewable electricity[10] and the results of previous auctions. Some values are updated in correspondence to the assumptions indicated in section 4.1.12 in Annex 1, i.e. in the REF scenario.

Explanatory note to the table below:

CHP – cogeneration, combined heat and power generation;
PC – condensing power plants with pulverised coal boilers
PL – condensing power plants with pulverised lignite boilers
CCS – sequestration (carbon capture and storage)
GTCC – gas turbine combined cycle power plants
IGCC – integrated gasification combined cycle power plants
FBC – fluidised bed combustion power plants
PWR – pressurised water reactor
MV – medium voltage
EHV – extra highest voltage
HV – high voltage

Source of data presented below: *ARE S.A. based on:*
World Energy Outlook, International Energy Agency, Paris 2016;
WEIO 2014-Power Generation Investment Assumptions, International Energy Agency, Paris 2014;
The Power to Change: Solar and Wind Cost Reduction Potential to 2025", International Renewable Energy Agency, Bonn 2016; Energy and Environmental Economics – "Recommendations for WECC's 10- and 20-Year Studies", San Francisco 2014;
World Energy Perspective Cost of Energy Technologies, World Energy Council, Project Partner: Bloomberg New Energy Finance, 2013;
Lazard's Levelized Cost of Energy Analysis - Version 9.0, Lazard, New York 2015;
Scenarios for the Dutch electricity supply system, Frontier Economics, London 2015;
Energy Technology Reference Indicator projections for 2010-2050, European Commission JRC Institute for Energy and Transport, Brussels 2014;
Projected Cost of Generating Electricity 2015 Edition, International Energy Agency, Nuclear Energy Agency, Organization for Economic Co-operation and Deployment, Paris, 2015;
Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2016, U.S. Energy Information Administration, Washington 2016.

Table 15. Technical and economic parameters of production and transmission technologies (EUR'2016 constant prices)

fuel/ technology	**commissioning time**	**capital expenditures**	**costs**		**Net electrical/total efficiency**	**Full load hours equivalent**	**Technical life time**
			fixed	**variable**			
		EUR thousand/ MW_{net}	**EUR thousand/MW_{net}**	**EUR/MWh_{net}**	**%**	**h/annum**	**years**
CHP							
1.1 Lignite – PL	2016-2040	1800	48	3.4	44	7000	40
1.2 Lignite – PL+CCS	2030-2040	3250	72	8.6*	38	7000	40

[10] Regulatory Impact Assessment for Regulation of the Minister of Energy on the reference price of electricity produced from renewable energy sources in 2017 and the time periods applicable to producers that won auctions in 2017. Warsaw, 24 March 2017.

1.3 Lignite – FBC	2020-2040	2050	50	3.4	40	7000	40
2.1 Coal – PC	2016-2040	1650	44	3.2	46	7000	40
2.2 Coal – IGCC	2025-2040	2250	58	5.0	48	7000	40
2.3 Coal – IGCC+CCS	2030-2040	3250	78	7.2*	40	7000	40
2.4 Coal – CHP	2016-2040	2250	48	3.2	30/80	7000	40
2.5 Coal – CHP+CCS	2030-2040	3500	76	10*	22/75	7000	40
3.1 Natural gas – GTCC	2016-2040	750	18	1.8	58↑62	7000	30
3.2 Natural gas – GTCC+CCS	2030-2040	1350	38	4.0*	50↑52	7000	30
3.3 Natural gas – GTCC+CHP	2016-2040	1050	32	1.8	50↑75	6000	30
3.4 Natural gas – TG	2025-2040	500	16	1.4	40	1500	30
3.5 Gas Micro CHP	2016-2040	2350	97	-	20/90	3500	25
4.1 Generation III nuclear power plant – PWR	2030-2040	4500	85	0.8	36	7500	60
Renewable energy sources							
5.1 Onshore wind	2016-2020	1350	50	-	-	2300↑2400	25
5.1 Onshore wind	2021-2040	1350↓1250	50	-	-	2400↑2600	25
5.2 Offshore wind	2020-2030	2450↓2250	90	-	-	3500↑3750	25
5.2 Offshore wind	2031-2040	2250↓2100	90	-	-	3750	25
5.3 Large hydropower	2020-2040	2500	35	-	-	2000	60
5.4 Large hydropower	2016-2040	3000	75	-	-	3500	60
5.5 Geothermal	2020-2040	7000↓5500	160	-	0.12	7500	30
5.6 Photovoltaics	2016-2020	1100↓800	16	-	-	750↑850	25
5.6 Photovoltaics	2021-2040	800↓600	16	-	-	850↑1000	25
5.70 Roof photovoltaics	2016-2020	1250↓1100	20	-	-	750↑850	25
5.7 Roof photovoltaics	2021-2040	1100↓700	20	-	-	850 ↑950	25
5.8 Agricultural biogas	2016-2040	3250↓2750	220	-	40/80	5250	25
5.9 Wastewater treatment plant biogas	2016-2040	3500	135	-	40/65	4400	25
5.10 Landfill biogas	2016-2040	1800	80	-	40/45	4000	25
5.11 Solid biomass	2016-2040	2500	100	-	35	6000	30
5.12 Solid biomass – CHP	20161-2040	2950↓2750	120	-	25/80	5500	30
5.13 Municipal waste incineration plant – CHP	2021-2040	10000	150	-	16/60	6000	25
Heat plants							
6.1 Coal-fired heat boiler	2016-2040	350	1	1.4	0.9	2500	30
6.2 Natural gas-fired heat boiler	2016-2040	150	1	0.4	0.96	2500	30
6.3 Heating oil-fired boiler	2016-2040	200	1	0.5	0.95	2500	30
6.4 Biomass-fired heat boiler	2016-2040	500	1	1.4	0.9	2500	30
Connection to/strengthening power grid							
7.1 Baseload power plants	2016-2040	250					
7.2 Onshore wind	2016-2040	350					
7.3 Offshore wind	2016-2040	850					

7.4 Other power plants and CHP plants	2016-2040	50 - 250	

** Including carbon transportation and storage*

Table 16 presents the technical and economic parameters of central heating (CH) and warm service water (WSW) technologies used by households and small service enterprises adopted for the calculations in the model. The data comes from a range of different sources, including official websites of manufacturers and distributors of the individual devices in Poland.

Table 16. Technical and economic parameters of CO and WSW technologies

	purchase cost [EUR'2016/kW]	**cost of additional installations to be purchased [EUR'2016/kW]**	**description of additional installations**	**efficiency [%]**
electric boilers or heaters – installed permanently	24	none	N/A	100
electric boilers or heaters – movable	12	none	N/A	100
electric underfloor heating	143	48	control devices and automatic controls	100
electric water heater (boiler, flow-through heater)	17	none	N/A	100
central heating natural gas-fired boiler	48	179	water heaters + connection	90-97
natural gas water heater (boiler, flow-through water heater)	18	60	connection	90
natural gas-fired combi boiler (CH+WSW)	72	179	water heaters + connection	90-97
LPG central heating boiler	48	239	water heaters + tank	90-97
LPG water heater	18	2	cylinder	90
LPG combi boiler (CH+WSW)	72	239	water heaters + tank	90-97
CH fuel oil-fired boiler	48	131	water heaters + tank	90-95
fuel oil-fired combi boiler (CH+WSW)	72	131	water heaters + tank	90-95
CH solid fuel-fired boiler	48	119	water heaters	60-80
solid fuel-fired water heater	18	48	solid fuel-fired boiler	60-80
solid fuel-fired combi boiler (CO+WSW)	66	119	water heaters	60-80
solid fuel space heaters	24	none	N/A	40-80
open solid fuel fireplace	24	72	mantel	40-80
solid fuel fireplace with a closed insert	24	72	mantel	50-80
solid fuel fireplace with a water jacket	96	191	mantel + radiators	60-80
solid fuel cooker	24	none	N/A	30-80
dual-purpose district heating substation	70	none	substation+connection	70
heat pump	717	119	water heaters	3.5-5.4*

** For heat pumps, the coefficient of performance (COP) is given instead of the efficiency*

Source: ARE S.A. based on data collected from producers and distributors of devices

Owing to the complexity of production processes in industry and the high diversity of industrial technologies and solutions, the industry sector is treated in a simplified manner in the energy model. The model defines five main purposes of energy use: boiler heat, process steam, electric drives, space heating and lighting. The results are given in the table.

Table 17. Technical and economic parameters of industrial technologies

technology	fuel	purpose	purchase cost [EUR'2016/kW]	O&M costs [EUR'2016/GJ]	technical life time	CO_2 emission factor [kg/GJ]
industrial furnaces/boilers for process heat production	blast furnace gas	furnace heat	1200-3030	0.30	25	260
industrial furnaces/boilers for process heat production	coke oven gas	furnace heat	1611-4066	0.40	25	44
industrial furnaces/boilers for process heat production	coke	furnace heat	500-1262	0.12	25	107
industrial furnaces/boilers for process heat production	electricity	furnace heat	1200-3029	0.30	25	0
industrial furnaces/boilers for process heat production	coal	furnace heat	1611-4066	0.40	25	94
industrial furnaces/boilers for process heat production	heavy fuel oil	furnace heat	1611-4066	0.40	25	77
industrial furnaces/boilers for process heat production	light fuel oil	furnace heat	1611-4066	0.40	25	77
industrial furnaces/boilers for process heat production	LPG	furnace heat	1200-3030	0.30	25	63
industrial furnaces/boilers for process heat production	natural gas	furnace heat	1200-3030	0.30	25	56
electric motors	electricity	electrical propulsion	400-1100	0.18	10	0

Source: ARE S.A. on the basis of on input data for the MARKAL[11] model and European Commission guidelines on the preparation of the NECP

Table 18 presents the technical and economic parameters of road transport vehicles.

Table 18. Technical and economic parameters of technologies used in transport and agriculture

	New vehicle purchase cost [EUR'2016/vehicle]	Specific fuel/energy consumption [l/100km] 2015→2040
Cars (petrol<1399 cm^3)	8 200	5.4 → 3.6

[11] *UK MARKAL Model Documentation*, Kannan R., Strachan N., Pye S., Anandarajah G., Balta-Ozkan N. 2007, access: www.ucl.ac.uk/energy-models/models/uk-markal.

Cars (petrol 1400-1900 cm^3)	10 600	6.6 → 4.3
Cars (petrol >1900 cm^3)	12 900	8.5 → 5.5
Cars (Diesel <1399 cm^3)	11 800	4.6 → 3.0
Cars (Diesel 1400-1900 cm^3)	15 300	5.9 → 3.8
Cars (Diesel >1900 cm^3)	17 600	6.9 → 4.5
Cars (LPG <1399 cm^3)	8 900	6.4 → 4.3
Cars (LPG 1400-1900 cm^3)	11 300	8.1 → 7.0
Cars (LPG >1900 cm^3)	13 600	10.7 → 7.1
Cars (hybrid)	17 400 → 12 000	3.8 → 2.8
	[EUR'2016/vehicle]	**[m3/100km]**
Cars (CNG)	16 500	7.1 → 6.5
HGVs up to 3.5t (CNG)	31 000	11.9 → 10.5
	[EUR'2016/vehicle]	**[kWh/100km]**
Cars (electric)	20 000 → 14 000	23.0 → 21.0
HGVs up to 3.5 t (electric)	70 000 → 50 000	33.0 → 28.0
	[EUR'2016/vehicle]	**l/100km**
HGVs up to 3.5t (petrol)	24 000	12.0 → 8.5
HGVs up to 3.5t (Diesel)	31 000	9.6 → 7.0
HGVs up to 3.5t (LPG)	29 000	12.1 → 10.6
HGVs up to 3.5t (CNG)	31 000	11.9 → 8.7
HGVs above 3.5t (Diesel)	94 000	45.0 → 34.0
	[EUR'2016/vehicle]	**[toe/annum]**
Agricultural tractors	40 000	1.15 → 1.02
Forage harvesters	135 000	4.5 → 3.96
Combine harvester-threshers	63 500	1.42 → 1.25

Source: ARE S.A. on the basis of EC recommendations, data obtained from producers and industry organisations (e.g. ITS, SAMAR). In agriculture: Pawlak Jan, Instytut Budownictwa Mechanizacji i Elektryfikacji Rolnictwa – „Nakłady inwestycyjne i koszty energii w rolnictwie polskim". Warsaw, 2007.

5.1.2. 'Decarbonisation' dimension

5.1.2.1. Greenhouse gas emissions and removals

The 2040 projections of GHG emissions and recovery for the Energy and Climate Policy (ECP) scenario are based on the following data sources:

1. Activity forecasts for the ECP scenario (consumption of fuels), which are presented further below;

2. Draft Fourth Biannual Report for UNFCCC (BR4) (Projekt Czwartego raportu dwuletniego dla UNFCCC), Instytut Ochrony Środowiska - Państwowy Instytut Badawczy, KOBiZE, 2019;

3. National Inventory Report 2019. Greenhouse Gas Inventory for 1988-2017 (Krajowy raport inwentaryzacyjny 2019. Inwentaryzacja gazów cieplarnianych dla lat 1988-2017), prepared by the National Centre for Emissions Management (KOBiZE), Institute of Environmental Protection – National Research Institute, for the purposes of the United Nations Framework Convention on Climate Change and the Kyoto Protocol;

4. CRF tables with data on greenhouse gas emissions (2019), prepared by the National Centre for Emissions Management (KOBiZE), Institute of Environmental Protection – National Research Institute, in connection with the above reporting obligation.

5.1.2.1.1. Forecasts of greenhouse gas emissions and removals with projected changes in sectors

Below are the synthetic results of the 2020-2040 greenhouse gas emissions forecast in Poland, as part of the planned policies and measures, by the sectors included in the methodology (classification) of the Intergovernmental Panel on Climate Change (IPCC), in relation to 2005-2015 emissions (Table 19 and Figure 5).

Table 19. GHG emission projections for the ECP scenario by sectors

Source category	**GHG emissions [$ktCO_{2eq}$]**							
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Total excluding LULUCF	**403 424.42**	**411 668.71**	**390 444.60**	**384 247.14**	**363 471.01**	**336 252.75**	**295 011.52**	**271 109.81**
Total including LULUCF	**356 817.09**	**381 648.18**	**359 888.13**	**352 469.47**	**336 133.38**	**314 559.82**	**277 268.88**	**257 088.53**
1. Energy	331 239.12	340 898.85	318 446.48	314 996.08	294 590.13	267 891.48	227 183.91	203 763.73
2. Industrial processes and product use	25 467.77	25 000.46	28 508.35	24 419.97	24 039.81	23 605.13	23 106.20	22 792.66
3. Agriculture	29 656.05	29 727.52	29 612.74	31 751.72	32 452.22	32 880.91	33 169.74	33 249.44
4. Land Use, Land-Use Change and Forestry (LULUCF)	-46 607.33	-30 020.54	-30 556.47	-31 777.68	-27 337.63	-21 692.93	-17 742.64	-14 021.28
5. Waste	17 061.48	16 041.89	13 877.03	13 079.37	12 388.85	11 875.23	11 551.66	11 303.98

Source: ATMOTERM S.A. own data on the basis of KOBIZE data for 2005-2015 and for 2020-2040 regarding greenhouse gas emissions for the following sectors: 2. Industrial processes and product use, 3. Agriculture, 4. Land Use, Land-Use Change and Forestry (LULUCF) and 5. Waste

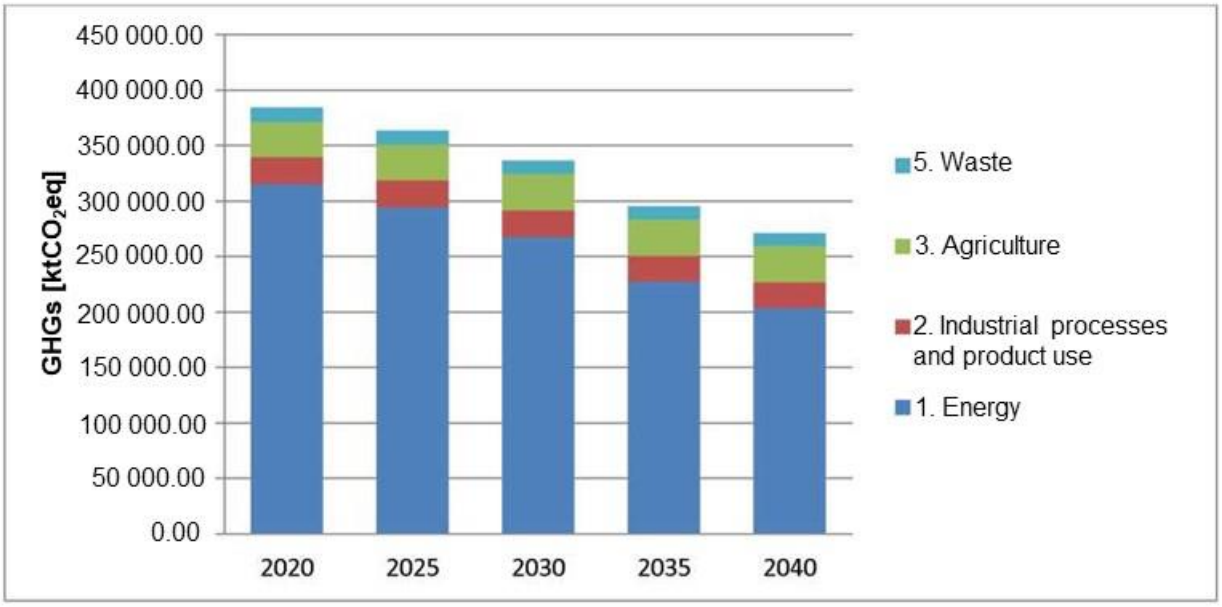


Figure 5. GHG emission projections for the ECP scenario by sectors, excluding LULUCF

As is shown by the data presented above, a steady decline in greenhouse gas emissions is expected over the forecast period, particularly noticeable in 2035 and 2040. Consequently, **in 2040 emissions reach the level of approx. 271 million tonnes of CO_2eq (including LULUCF), which means a downward movement of approx. 33% in the period 2005-2040. The reduction of CO_2eq emissions in the entire economy relative to 1990 is 29% for 2030 and 43% for 2040, respectively.**

In 2040, the largest emission volumes will continue to come from the energy sector, notably the combustion of fuels, but emissions in this sector will gradually decrease (Table 19).

The anticipated emission evolution of emissions as broken down by the ETS and non-ETS (ESD) sectors are shown in Table 20 and Figure 6.

Table 20. GHG emission projections by ETS and non-ETS for the ECP scenario

Emission	**Greenhouse gas emissions [kt CO_2eq.]**							
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Total excluding LULUCF	**403 424.4**	**411 668.7**	**390 444.6**	**384 247.1**	**363 471.0**	**336 252.8**	**295 011.5**	**271 109.8**
EU ETS	223 440.9	199 726.9	198 696.5	188 921.1	181 772.1	169 525.1	137 797.5	121 846.5
Non-ETS (ESD)	179 983.5	211 941.8	191 748.1	195 326.1	181 698.9	166 727.7	157 214.0	149 263.3

Source: ATMOTERM's own data

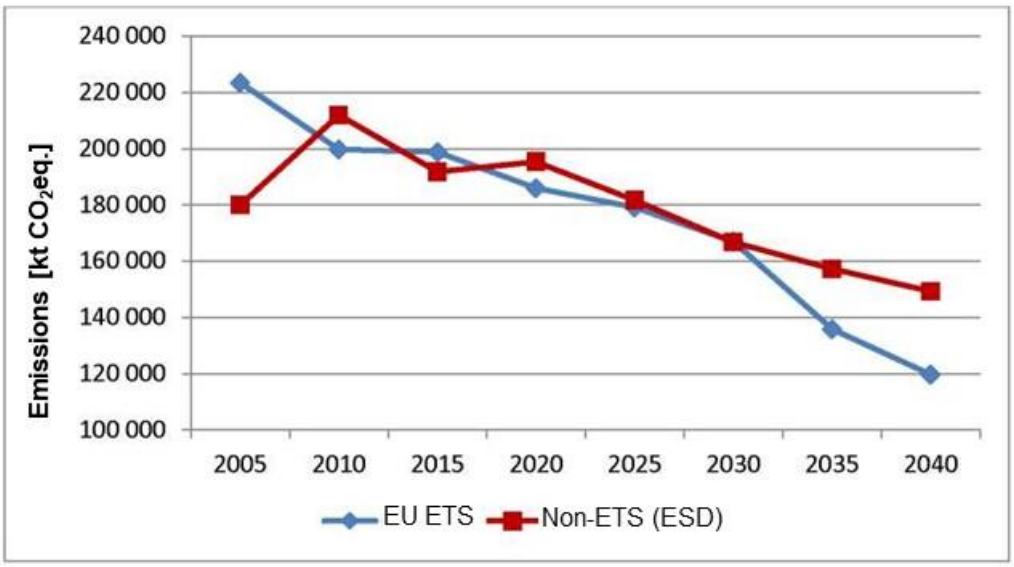


Figure 6. GHG emission projections by ETS and non-ETS sectors for the ECP scenario

Greenhouse gas emissions are expected to fall in both ETS and non-ETS. An increase is only anticipated for non-ETS emissions over the years 2015-2020 as a result of growing activity in transport. **The ETS is expected to see a 25% HGH emission reduction in 2005-2030.**

Given the 2030 non-ETS reduction target for Poland set at -7% compared to the level calculated for 2005 (using a KOBIZE methodology consistent with methods defined by the European Commission):

- on the basis of information on total greenhouse gas emissions (excluding LULUCF) in 2005 (in accordance with the 2019 inventory);
- with account taken of adjustments stemming from the second and third ETS phases;

it can be concluded that the results of the forecasts indicate attainment of the reduction target with the PaMs foreseen in the ECP scenario. **It is estimated that with the actions foreseen in the ECP scenario, a reduction of at least 7% is feasible in non-ETS sectors.**

The forecast shares of individual greenhouse gas emissions for the ECP scenario is presented in Tables 21-23 and Figure 7 below.

The largest CO_2 emissions will be produced by the energy sector, with a projected steady decline towards 2040. Emissions from industrial processes and product use rank second and are bound to increase slightly. In accordance with the methodology used (IPCC), the energy sector includes emissions generated by the combustion of fuels in all sectors and fugitive emissions from fuels.

Table 21. Projected CO_2 emissions by sector for the ECP scenario

Source category	**CO_2 emissions [kt]**							
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Total excluding LULUCF	**322 545.79**	**333 457.41**	**312 320.56**	**311 227.40**	**292 568.10**	**268 601.18**	**230 561.04**	**208 893.98**
Total including LULUCF	**271 331.36**	**298 727.57**	**280 636.39**	**277 532.70**	**263 260.92**	**244 996.85**	**210 897.79**	**193 078.08**
1. Energy	**304 748.07**	**315 601.31**	**292 619.07**	**290 147.24**	**271 155.63**	**246 879.43**	**208 592.08**	**186 661.77**
A. Fuel combustion	301 576.50	312 796.48	288 368.88	285 598.27	266 993.84	242 923.81	204 975.28	183 415.11
1. Energy industries	177 290.03	172 262.80	162 622.03	146 578.98	142 112.87	132 233.28	101 830.10	87 259.45

2. Manufacturing industries and construction	33 790.32	29 455.75	27 738.32	25 437.57	22 234.82	19 355.89	17 432.54	15 639.33
3. Transport	35 613.78	48 659.65	47 367.83	62 849.34	60 362.78	56 327.76	54 598.87	52 365.71
4. Other sectors	54 882.37	62 418.29	50 640.71	50 732.37	42 283.37	35 006.87	31 113.77	28 150.62
B. Fugitive emissions from fuels	3 171.57	2 804.83	4 250.19	4 548.97	4 161.80	3 955.62	3 616.79	3 246.65
1. Solid fuels	2 019.08	1 747.97	2 221.01	2 521.42	2 133.60	1 926.90	1 587.64	1 217.12
2. Crude oil and natural gas	1 152.49	1 056.85	2 029.18	2 027.55	2 028.20	2 028.72	2 029.16	2 029.53
2. Industrial processes and product use	**16 091.78**	**16 642.81**	**18 484.19**	**19 327.17**	**19 622.99**	**19 909.94**	**20 129.36**	**20 344.52**
A. Mineral products	8 355.79	9 849.54	10 088.59	10 873.13	11 124.74	11 349.32	11 531.04	11 700.97
B. Chemical industry	4 886.78	4 335.42	5 141.13	5 303.40	5 375.28	5 446.71	5 503.64	5 560.75
C Metal production	2 216.99	1 784.33	2 576.81	2 442.32	2 414.66	2 405.60	2 386.37	2 374.48
D. Non-energy products from fuels and solvent use	632.22	673.53	677.66	708.31	708.31	708.31	708.31	708.31
3. Agriculture	**1 291.94**	**790.01**	**736.36**	**1 013.16**	**1 041.93**	**1 064.27**	**1 092.06**	**1 140.15**
G. Liming	944.90	391.55	373.84	448.91	489.45	527.19	569.70	631.60
H. Urea application	347.04	398.46	362.52	564.25	552.48	537.08	522.36	508.55
4. Land Use, Land-Use Change and Forestry (LULUCF)	**-51 214.43**	**-34 729.84**	**-31 684.16**	**-33 694.70**	**-29 307.18**	**-23 604.33**	**-19 663.26**	**-15 815.90**
5. Waste	**414.00**	**423.27**	**480.95**	**739.83**	**747.54**	**747.54**	**747.54**	**747.54**
C. Ashing and open burning of waste	414.00	423.27	480.95	739.83	747.54	747.54	747.54	747.54
CO_2 emissions from biomass	**19803.98**	**30442.05**	**34962.70**	**41 228.70**	**42 222.21**	**45 167.75**	**47 522.40**	**50 028.71**

Source: ATMOTERM's own data

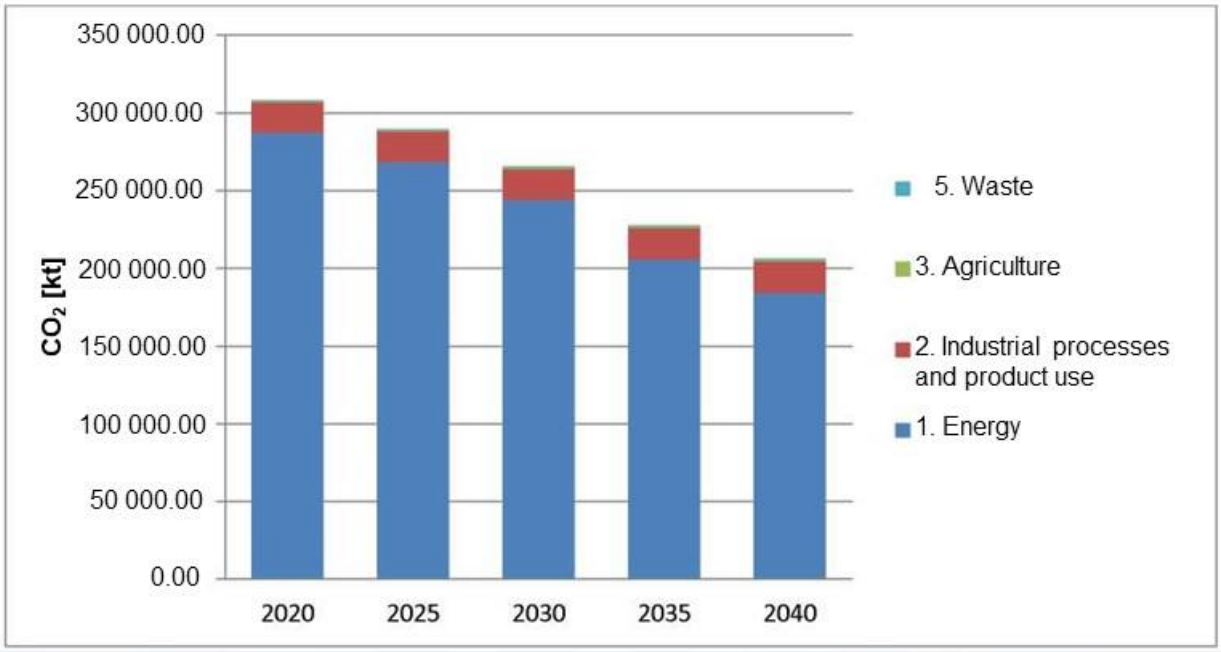


Figure 7. CO_2 emissions by sectors for the ECP scenario, excluding LULUCF

The projected N_2O emissions are presented in the table below. The largest emissions of nitrous oxide are produced by agriculture, followed by the energy and waste sectors, on a much smaller scale though. In the agricultural sector, a steady increase in emissions is expected until 2040.

Table 22. Projected N_2O emissions by sectors for the ECP scenario

Source category	**N_2O emissions [kt]**							
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Total excluding LULUCF	**75.90**	**66.35**	**63.86**	**67.70**	**68.54**	**69.31**	**69.71**	**69.30**
Total including LULUCF	**91.25**	**82.05**	**67.53**	**74.04**	**75.05**	**75.62**	**76.05**	**75.22**
1. Energy	**8.80**	**8.46**	**8.05**	**6.34**	**6.21**	**6.00**	**5.41**	**5.07**
A. Fuel combustion	8.80	8.46	8.05	6.34	6.21	5.99	5.41	5.07
1. Energy industries	2.61	2.68	2.60	2.45	2.47	2.47	2.00	1.75
2. Manufacturing industries and construction	0.48	0.50	0.60	0.60	0.63	0.66	0.65	0.66
3. Transport	1.57	1.97	1.83	2.17	2.08	1.91	1.83	1.74
4. Other sectors	4.13	3.31	3.02	1.11	1.03	0.95	0.93	0.92
B. Fugitive emissions from fuels	0.0016	0.0015	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018
2. Crude oil and natural gas	0.0016	0.0015	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018
2. Industrial processes and product use	**15.29**	**4.15**	**2.96**	**3.04**	**3.05**	**3.07**	**3.08**	**3.09**
B. Chemical industry	14.87	3.71	2.51	2.60	2.61	2.62	2.64	2.65
G. Production and use of other products	0.43	0.44	0.44	0.44	0.44	0.44	0.44	0.44
3. Agriculture	**49.18**	**50.92**	**49.68**	**55.07**	**56.02**	**57.02**	**58.03**	**58.00**
B. Livestock manure	7.57	7.26	6.97	7.74	7.98	8.26	8.54	8.69
D. Agricultural soils	41.58	43.63	42.67	47.29	47.99	48.72	49.45	49.27

Source category	**N_2O emissions [kt]**

	2005	2010	2015	2020	2025	2030	2035	2040
F. Incineration of plant waste	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04
4. Land Use, Land-Use Change and Forestry (LULUCF)	**15.35**	**15.70**	**3.67**	**6.34**	**6.51**	**6.31**	**6.35**	**5.92**
5. Waste	**2.63**	**2.82**	**3.17**	**3.25**	**3.26**	**3.23**	**3.18**	**3.13**
B. Biological neutralisation of solid waste	0.13	0.19	0.44	0.46	0.50	0.50	0.50	0.50
C. Ashing and open burning of waste	0.06	0.09	0.18	0.25	0.25	0.25	0.25	0.25
D. Sewage management	2.43	2.54	2.55	2.53	2.51	2.47	2.43	2.37

Source: ATMOTERM's own data

The projected CH_4 emission trends are presented in the table below. The highest CH_4 emissions come from the energy and agriculture sectors, and smaller from waste. Emissions are expected to decline in the energy and waste sectors, while agriculture is bound to see a steady slight growth.

Table 23. Projected CH_4 emissions by sectors for the ECP scenario

Source category	**CH_4 emissions [kt]**							
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Total excluding LULUCF	**2 139.59**	**2 055.20**	**2 000.64**	**1 949.35**	**1 881.88**	**1 771.79**	**1 667.90**	**1 604.75**
Total including LULUCF	**2 140.93**	**2 056.47**	**2 002.00**	**1 950.48**	**1 883.07**	**1 772.97**	**1 669.08**	**1 605.93**
1. Energy	**954.77**	**911.02**	**937.14**	**918.39**	**863.37**	**769.00**	**679.15**	**623.63**
A. Fuel combustion	141.08	172.69	145.89	144.40	124.22	108.60	100.99	96.30
1. Energy industries	2.51	3.92	4.70	5.25	6.01	7.23	7.09	6.90
2. Manufacturing industries and construction	3.37	3.52	4.27	4.44	4.68	4.89	4.88	4.95
3. Transport	6.87	6.24	4.58	5.13	5.18	5.21	5.56	5.71
4. Other sectors	128.33	159.01	132.34	129.58	108.36	91.27	83.46	78.73
B. Fugitive emissions from fuels	813.69	738.33	791.25	773.99	739.15	660.40	578.16	527.33
1. Solid fuels	719.82	651.44	690.01	663.39	626.98	546.63	461.25	408.41
2. Crude oil and natural gas	93.87	86.89	101.24	110.59	112.17	113.77	116.91	118.92
2. Industrial processes and product use	**1.89**	**2.50**	**2.62**	**2.97**	**3.04**	**3.10**	**3.15**	**3.20**
B. Chemical industry	1.39	2.03	2.02	2.40	2.47	2.53	2.58	2.63
C Metal production	0.50	0.46	0.60	0.57	0.57	0.57	0.57	0.57
3. Agriculture	**548.33**	**550.50**	**562.87**	**573.15**	**588.70**	**593.03**	**591.34**	**592.96**
A. Enteric fermentation	471.12	479.57	496.78	499.76	496.21	491.88	488.27	489.71
B. Livestock manure	76.43	70.08	65.14	72.41	91.47	100.11	101.99	102.13
F. Incineration of plant waste	0.77	0.85	0.95	0.99	1.01	1.04	1.07	1.11
4. Land Use, Land-Use Change and Forestry (LULUCF)	1.34	1.27	1.36	1.13	1.18	1.18	1.18	1.18
5. Waste	**634.60**	**591.18**	**498.00**	**454.84**	**426.77**	**406.65**	**394.25**	**384.96**
A. Landfill of solid waste	474.16	444.05	387.76	354.89	328.87	310.84	298.13	288.85
B. Biological neutralisation of solid waste	2.15	3.13	7.34	7.73	8.34	8.34	8.34	8.34
C. Ashing and open	0.00000	0.00000	0.00000	0.00009	0.00009	0.00009	0.00009	0.00009

burning of waste	5	2	6					
D. Sewage management	158.30	143.99	102.90	92.21	89.56	87.47	87.78	87.77

Source: ATMOTERM's own data

5.1.2.1.2. Comparison of projected GHG emissions and removals until 2040 with the PaMs planned under the ECP to projections with existing PaMs – ECP vs. REF.

The results of the comparison of projections of GHG emissions and removals until 2040 for the ECP scenario to projections for the REF scenario are presented in Table 24.

Table 24. Comparison of projections of GHG emissions and removals for the ECP scenario to projections for the REF scenario by main source categories

Source category	**GHG emissions [$ktCO_{2eq}$]**									
	REF scenario					**ECP scenario**				
	2020	**2025**	**2030**	**2035**	**2040**	**2020**	**2025**	**2030**	**2035**	**2040**
Total excluding LULUCF	**397 810.5**	**403 635.2**	**404 739.6**	**370 476.2**	**333 869.8**	**384 247.1**	**363 471.0**	**336 252.8**	**295 011.5**	**271 109.8**
Total including LULUCF	**366 032.8**	**376 297.6**	**383 046.7**	**352 733.6**	**319 848.5**	**352 469.5**	**336 133.4**	**314 559.8**	**277 268.9**	**257 088.5**
1. Energy	328 559.4	334 754.3	336 041.7	301 769.4	265 070.7	314 996.1	294 590.1	267 891.5	227 183.9	203 763.7
2. Industrial processes and product use	24 420.0	24 039.8	23 941.8	23 985.4	24 245.6	24 420.0	24 039.8	23 605.1	23 106.2	22 792.7
3. Agriculture	31 751.7	32 452.2	32 880.9	33 169.7	33 249.4	31 751.7	32 452.2	32 880.9	33 169.7	33 249.4
4. Land Use, Land-Use Change and Forestry (LULUCF)	-31 777.7	-27 337.6	-21 692.9	-17 742.6	-14 021.3	-31 777.7	-27 337.6	-21 692.9	-17 742.6	-14 021.3
5. Waste	13 079.4	12 388.9	11 875.2	11 551.7	11 304.0	13 079.4	12 388.9	11 875.2	11 551.7	11 304.0

Source: ATMOTERM's own data

The total greenhouse gas emissions for all forecast years for the REF scenario are clearly higher than those calculated for the ECP scenario. Difference in emissions between the scenarios. The measures to be delivered under the ECP scenario produce a reduction in emissions (with LULUCF) relative to the REF scenario of about 18% in 2030 to about 20% in 2040.

The largest reduction of CO_2 emissions between the ECP and REF scenarios will take place in the fuel combustion sector, in particular in the energy industries. Considerable differences can also be observed for other sectors, including housing and services, as well as transport. It is worth noting that the ECP scenario involves an increase in CO_2 emissions from biomass.

A comparison of projected emissions by the ETS and non-ETS (ESD) sectors for the ECP and REF scenarios is presented in Table 25 and in Figure 8.

Table 25. GHG emission projections for the ECP and REF scenarios by ETS and non-ETS

Source category	**GHG emissions [$ktCO_{2eq}$]**									
	REF scenario					**ECP scenario**				
	2020	**2025**	**2030**	**2035**	**2040**	**2020**	**2025**	**2030**	**2035**	**2040**
Total excluding LULUCF	**397 810.50**	**403 635.22**	**404 739.60**	**370 476.24**	**333 869.76**	**384 247.14**	**363 471.01**	**336 252.75**	**295 011.52**	**271 109.81**
Total including	199	203	204	176	144	188	181	169	137	121

LULUCF	685.72	891.44	972.43	238.34	822.99	921.07	772.09	525.07	797.50	846.55
EU ETS	198 124.79	199 743.78	199 767.17	194 237.89	189 046.77	195 326.07	181 698.92	166 727.68	157 214.02	149 263.27
Non-ETS (ESD)	**397 810.50**	**403 635.22**	**404 739.60**	**370 476.24**	**333 869.76**	**384 247.14**	**363 471.01**	**336 252.75**	**295 011.52**	**271 109.81**

Source: ATMOTERM's own data

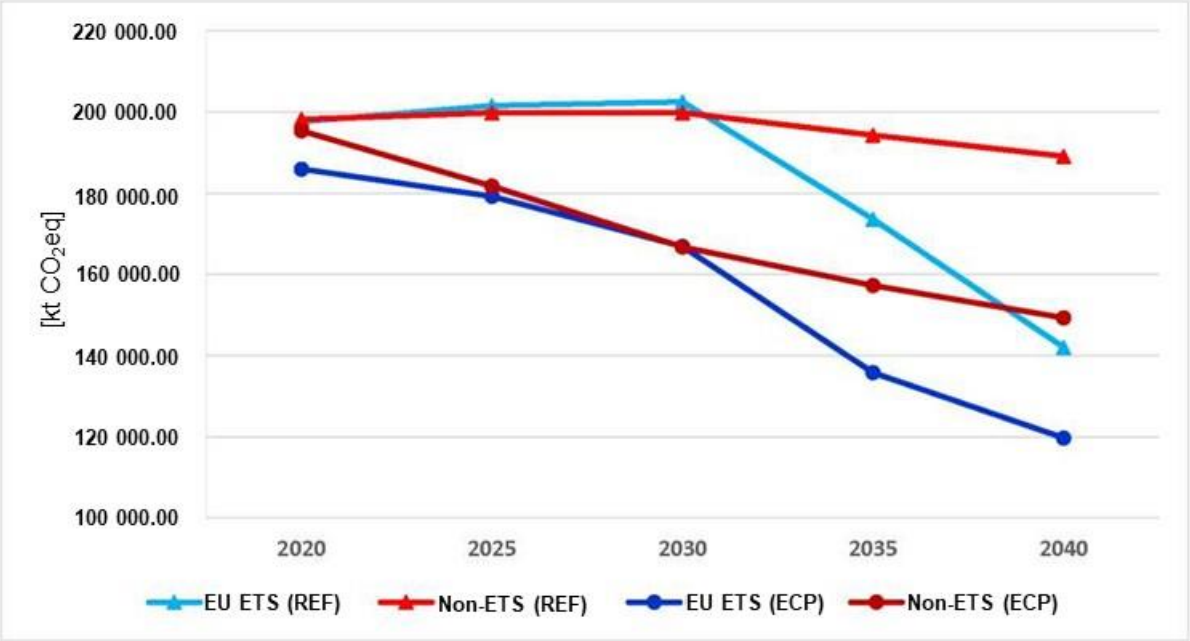


Figure 8. GHG emissions by sectors for the ECP and REF scenarios, excluding LULUCF

Until 2030, a slight initial increase in ETS greenhouse gas emissions is forecast for the REF scenario to be followed by a sharp decline. For non-ETS, the decline in emissions after 2030 is mild. In the ECP scenario, both ETS and non-ETS show a gradual downward trend, which is particularly noticeable for the ETS.

However, **given the 2030 GHG emission reduction target for Poland (in the non-ETS sector) of -7% relative to 2005**, it can be seen that it cannot be met **in the REF scenario** (the projected 2030 emissions will be higher by approx. 11% compared to the 2005 baseline), **while for the ECP scenario the target will be achieved** (the projected 2030 emissions will be lower by approx. 7.4% compared to 2005).

The differences in greenhouse gas emission projections for the ECP and REF scenarios (tables above) reveal the greatest changes for the following sectors:

- energy industries (notably electricity and heat production);
- manufacturing industries and construction;
- other sectors (housing, institutions/trade, services, agriculture – stationary sources);
- transport (in particular road transport).

For the above sectors, projections of 2020-2040 pollutant emissions are prepared for both scenarios (REF and ECP), following which the absolute difference in emissions between the scenarios is determined. The following pollutants are included: NOx, NMVOC (non-methane volatile organic compounds), SOx, NH3, PM2.5 and PM10. The forecast of air pollutant emissions in 2020-2040 for the REF and ECP scenarios is based on the relationship between the GHG and air pollutant emissions inventoried in the base year (2015) and in the preceding years (in accordance with KOBIZE reports to the European Commission).

The two tables below summarise pollutant emissions for the projection years and both scenarios, and the differences between the results. Depending on the type of pollution, the greatest reductions in emissions between the REF and ECP scenarios are expected for:

- NO_x – in road transport;
- NMVOC – in other sectors (in particular housing and services);
- SO_x – in other sectors, manufacturing industries and construction, as well as in electricity and heat production;
- NH_3 – in road transport;
- $PM_{2,5}$ and PM_{10} – in manufacturing industries and construction.

Table 26. Projected pollutant emissions from selected sectors

Year	REF scenario – emission [kt]						ECP scenario – emission [kt]					
	NO_x (as NO_2)	NMVOC	SO_x (as SO_2)	NH3	PM2.5	PM10	NO_x (as NO_2)	NMVOC	SO_x (as SO_2)	NH3	PM2.5	PM10
	1A1a. Electricity and heat production											
2020	153.83	3.95	164.18	0.00	10.18	17.19	151.72	3.77	158.71	0.00	9.98	16.85
2025	134.60	4.08	136.82	0.00	8.91	15.05	126.33	3.65	132.17	0.00	8.31	14.04
2030	135.81	4.11	138.05	0.00	8.99	15.18	116.83	3.37	122.22	0.00	7.69	12.98
2035	110.14	3.34	111.95	0.00	7.29	12.31	87.88	2.54	91.93	0.00	5.78	9.76
2040	81.84	2.48	83.19	0.00	5.42	9.15	73.94	2.13	77.36	0.00	4.87	8.21
	1A2. Manufacturing industries and construction											
2020	55.64	37.39	110.26	0.00	27.58	27.58	49.11	33.00	97.32	0.00	24.34	24.34
2025	54.03	36.31	107.08	0.00	26.79	26.79	43.02	28.91	85.26	0.00	21.33	21.33
2030	52.32	35.16	103.69	0.00	25.94	25.94	37.55	25.24	74.42	0.00	18.62	18.62
2035	50.60	34.01	100.27	0.00	25.08	25.08	33.88	22.77	67.14	0.00	16.79	16.79
2040	48.91	32.87	96.93	0.00	24.25	24.25	30.46	20.47	60.37	0.00	15.10	15.10
	1A4. Other sectors (housing, institutions/trade, services, agriculture – stationary sources)											
2020	92.09	112.17	168.04	0.48	67.25	112.70	89.49	109.00	163.29	0.47	65.35	109.52
2025	90.69	110.46	165.47	0.48	66.22	110.98	74.65	90.93	136.21	0.39	54.51	91.36
2030	88.80	108.16	162.02	0.47	64.84	108.67	61.92	75.42	112.98	0.33	45.21	75.78
2035	86.50	105.36	157.83	0.46	63.16	105.86	55.17	67.20	100.66	0.29	40.28	67.51
2040	83.91	102.20	153.10	0.44	61.27	102.69	50.09	61.01	91.39	0.26	36.58	61.30
	1A3b. Road transport											
2020	289.62	84.41	0.00	5.77	13.29	15.98	257.86	75.15	0.00	5.13	11.83	14.23
2025	305.70	89.10	0.00	6.09	14.03	16.87	249.89	72.83	0.00	4.97	11.47	13.79
2030	314.65	91.71	0.00	6.26	14.44	17.36	237.06	69.09	0.00	4.72	10.88	13.08
2035	311.85	90.89	0.00	6.21	14.31	17.21	227.41	66.28	0.00	4.53	10.44	12.55
2040	307.49	89.62	0.00	6.12	14.11	16.97	216.37	63.06	0.00	4.31	9.93	11.94

Source: ATMOTERM's own data

Table 27. Differences in projected emissions from selected sectors for the ECP and REF scenarios

Year	REF-ECP – changes in emissions [kt]					
	NO_x (as NO_2)	**NMVOC**	**SO_x (as SO_2)**	**NH3**	**PM2.5**	**PM10**
	1A1a. Electricity and heat production					
2020	2.12	0.18	5.47	0.00	0.20	0.34
2025	8.27	0.43	4.65	0.00	0.60	1.01
2030	18.98	0.74	15.83	0.00	1.30	2.20
2035	22.26	0.80	20.02	0.00	1.51	2.55
2040	7.89	0.34	5.83	0.00	0.55	0.93
	1A2. Manufacturing industries and construction					
2020	6.53	4.39	12.94	0.00	3.24	3.24
2025	11.01	7.40	21.82	0.00	5.46	5.46
2030	14.77	9.93	29.27	0.00	7.32	7.32
2035	16.72	11.24	33.13	0.00	8.29	8.29
2040	18.45	12.40	36.56	0.00	9.15	9.15
	1A4. Other sectors (housing, institutions/trade, services, agriculture – stationary sources)					
2020	2.60	3.17	4.75	0.01	1.90	3.18
2025	16.04	19.53	29.26	0.08	11.71	19.63
2030	26.88	32.74	49.04	0.14	19.63	32.89
2035	31.33	38.16	57.17	0.16	22.88	38.34
2040	33.82	41.19	61.71	0.18	24.70	41.39
	1A3b. Road transport					
2020	31.76	9.26	0.00	0.63	1.46	1.75
2025	55.80	16.26	0.00	1.11	2.56	3.08
2030	77.60	22.62	0.00	1.54	3.56	4.28
2035	84.43	24.61	0.00	1.68	3.88	4.66
2040	91.12	26.56	0.00	1.81	4.18	5.03

Source: ATMOTERM's own data

5.1.2.2. Renewable energy

5.1.2.2.1. Projected consumption of renewable energy

Tables 28-32 present national and sectoral forecasts for RES share, for the scenario with PaMs (ECP). The shares are compared with those obtained for the REF scenario.

As is shown by the projection results, the **2030 share of renewable energy in the final gross demand will amount to 23%**. Attaining that share will require the commitment of considerable funds and undertaking a series of robust actions across the relevant sectors, namely the electricity, heating and transport industries. As can be seen in the calculation results, by 2020, the share of RES in gross final energy consumption may reach a level consistent with the 15% target for Poland foreseen by the RES Directive[12]. Achieving this will be supported by obtaining large volumes of renewable energy through auctions, as well as by stimulating the potential for co-firing biomass and coal in existing installations and enhancing the use of biofuels in transport. However, it is expected that the technological development and economic maturity of individual sources will boost the share of RES after 2020.

In the years 2021-2030, activities for the development of the domestic renewable energy potential will gain momentum. Importantly, additional volumes of renewable electricity will be provided by offshore wind farms, and large photovoltaic, biomass, and biogas installations. The gradual increase in renewable heat production and the growing amounts of biocomponents and use of electricity in transport will play a particular role, too. The model calculations take into account the growing importance of biomass in CHP and heating plants expected as a result of making district heating systems more efficient. Biomass-fired boilers are expected to be a technology that will easily replace the capacity of coal-fired boilers in existing heating plants. On the one hand, the much wider use of biomass in heat production than to date (also e.g. in the municipal and domestic sector) is necessary to attain the required increase in the share of RES in heating by at least 1.1 pp on average per annum by 2030, and on the other, to secure a specific contribution towards the targeted 23% share of renewable energy in gross final energy consumption. By 2030, the consumption of biomass for heat production in heating plants must grow almost 10 times, to 346 ktoe (in 2015, 36 ktoe of chemical energy contained in solid biomass was consumed at all Polish heating plants, while in 2016 and 2017 this was 58 and 66 ktoe respectively). Considering the limited biomass resources, this is likely to require deploying mechanisms incentivising plants with the highest production efficiency, mainly cogeneration units and heating boiler plants, to use this raw material.

The results obtained imply the need to ensure a substantial increase in the **share of renewable energy in electricity generation**. **In 2015-2030, the share of renewable energy in the power sector is set to grow from 13.4% in 2015 to 31.8% in 2030**. The sector is the one where renewable energy development can be controlled by the volumes of energy made available for auction by the Ministry of Energy. **Achieving the above RES results in the energy sector will not be possible without ensuring a substantial share of offshore wind energy. By 2030, offshore power plants with a capacity of nearly 4 GW should have been built.**

By far the highest volumes of RES are consumed by heating, which is shown both by historic data and by forecasts. As is demonstrated by the projections for the ECP scenario, **the share of renewable energy in the heating and cooling sector increases from 14.5% in 2015 to 28.4% in 2030**, which means an increase of 13.9 pp in 2015-2030 and by 11 pp in 2020-2030 (the average annual increase is therefore 1.1 pp, which is consistent with the one recommended in the RED II Directive). The completed analysis, which takes into account the optimisation of the entire national fuel and energy system and resource-related conditions (availability of primary energy carriers), shows that the pace of renewable energy development in Polish heating proposed by the RED II Directive is only achievable if sufficient financial resources are available for thorough modernisation of existing units of heating plants, 97% of which are currently based on coal. Biomass will become the main renewable energy carrier used in Polish district heating. The domestic resources of biomass and its cost, as well as the introduction of criteria for sustainable biomass production with a view to enhancing the economic and environmental effects of its use are the factors that constrain its utilisation. In the municipal and domestic sector, given the planned anti-smog measures, the increase in the use of biomass for heating purposes is not significant though noticeable. However, a much more widespread use of biomass in combined heat and power

[12] Eurostat renewable energy statistics on the progress made by other Member States towards their RES share targets in 2016 are available under the following link, access: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Renewable energy statistics/pl

plants is anticipated.

The production of electricity and heat by distributed sources will also add significantly to the increase in the share of RES in Polish energy consumption. The projections for RES development in buildings are presented in the next subsection.

In the transport sector, the RES share is expected to have reached 14% in 2030. This target is primarily pursued through the use of biocomponents in liquid fuels and increased use of electricity (especially in road transport), as well as through the development of biofuels from waste (mainly second- generation biofuels), the amount of which depends on the limit on the content of first-generation biofuels of up to 7%. The above forecasts indicate that a 10% share of renewable energy in transport will be achieved in 2020, but this requires a substantially increased share of biofuels used in transport in 2020, including high amounts of imported second-generation biofuels. Attaining the 2020 target in the transport sector will be very challenging since 2016 and 2017 saw a high increase in the official consumption of diesel and petrol following a decline in illegal trade in these fuels, which drives up the amount of biofuels required to reach the same percentage share. As regards the prospects for the development of renewable energy in transport in 2040, the results of the analysis demonstrate that a 22% share of RES is feasible, although this will require far-reaching growth of the market for alternative fuels, including electromobility. Electricity consumed in road transport greatly increases the share of renewable energy because of the associated use of a multiplier, which means that the energy consumed in this way is counted against the share at a level that is several times higher. Second-generation biofuels in road transport will also contribute to the target to a greater extent[13].

The figure below presents the use of renewable energy by energy subsectors and the share of renewable energy in final energy consumption. The following tables show detailed forecasts for the use of RES by source.

[13] The calculations for the period until 2020 use the multipliers set out in Directive 2009/28/EU, as amended by Directive 2015/1513, i.e.

- second-generation biofuels – conversion factor of 2;
- RES electricity in road transport – conversion factor of 5;
- RES electricity in rail transport – conversion factor of 2.5;

On the other hand, the multipliers used in calculations as from 2021 are consistent with Directive 2018/2001 of 11 December 2018 on the promotion of the use of energy from renewable sources:

- second-generation biofuels – conversion factor of 2;
- RES electricity in road transport – conversion factor of 4;
- RES electricity in rail transport – conversion factor of 1.5.

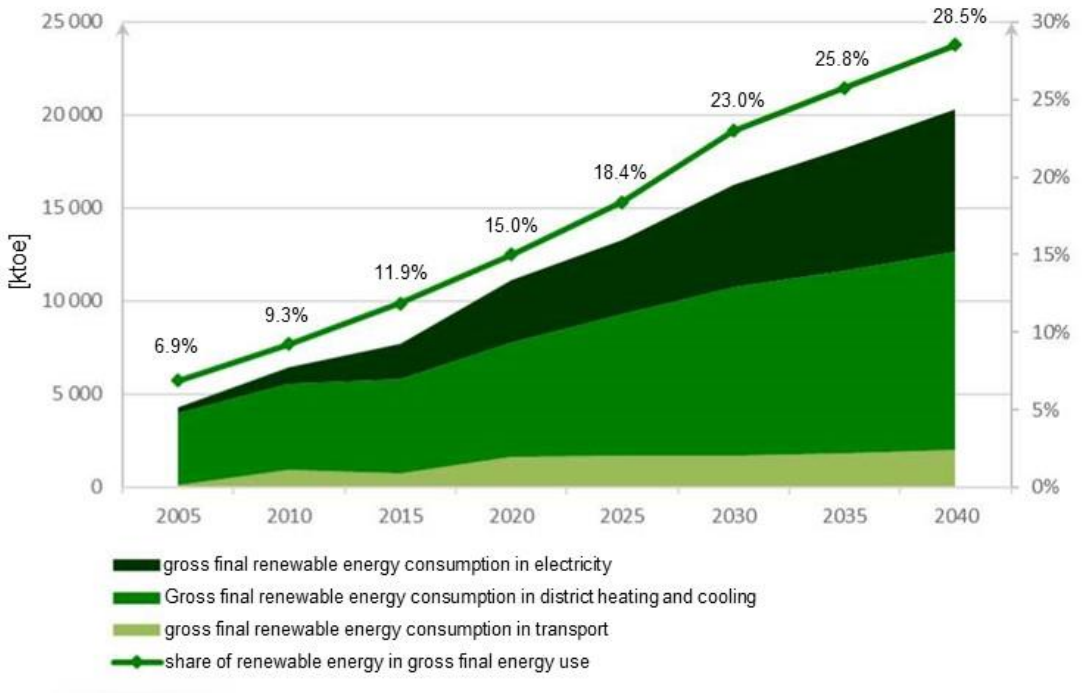


Figure 9. Gross final renewable energy consumption in the three subsectors [ktoe] and the share of RES in gross final energy consumption [%]

Table 28. Projected total and sectoral gross final renewable energy consumption [ktoe] and the share of RES consumption – total and by sector [%] – ECP scenario

[ktoe]	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
gross final energy consumption (RES-OS denominator)	**61573.8**	**69156.4**	**64596.0**	**73512**	**71508**	**69345**	**68906**	**68836**
gross final renewable energy consumption	4245.4	6399.3	7664.4	11 027	13 143	15 937	17 761	19 637
consumption of RES in electricity	331.7	890.3	1894.3	3369	4004	5493	6581	7715
consumption of RES in district heating and cooling	3867.6	4641.6	5116.7	6163	7604	9027	9812	10601
consumption of RES in transport	95.2	916.2	721.2	1613	1677	1708	1856	2024
[%]	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
share of RES in gross final energy consumption	**6.9%**	**9.3%**	**11.9%**	**15.0%**	**18.4%**	**23.0%**	**25.8%**	**28.5%**
share of RES in the electricity sector	3.1%	7.0%	13.4%	22.1%	24.8%	31.8%	36.0%	39.7%
share of RES in district heating and cooling	10.2%	11.7%	14.5%	17.4%	22.7%	28.4%	31.5%	34.4%
share of renewable energy in transport (with multipliers)	1.6%	6.6%	6.4%	10.0%	11.2%	14.0%	17.7%	22.0%

Source: Own study by ARE S.A., Eurostat

The table below also shows the expected increases in renewable energy use between 2020 and 2030, with the checkpoints marked.

Table 29. Projected gross final renewable energy consumption [ktoe] and share of renewable energy consumption [%] (trajectory) in 2020-2030, with checkpoints marked – ECP scenario

[ktoe]	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
gross final energy consumption (RES-	**73512**	**73260**	**72890**	**72464**	**71993**	**71508**	**71051**	**70561**	**70151**	**69704**	**69345**

OS denominator)											
gross final renewable energy consumption	11027	11423	11939	12241	12497	13143	13758	14232	14742	15350	15937
consumption of RES in electricity	3369	3397	3506	3553	3659	4004	4281	4571	4892	5229	5493
consumption of RES in district heating and cooling	6163	6516	6909	7147	7278	7604	7966	8175	8387	8682	9027
consumption of RES in transport	1613	1583	1620	1649	1685	1677	1673	1682	1688	1696	1708
share of RES in gross final energy consumption [%]	15.0%	15.6%	16.4%	16.9%	17.4%	18.4%	19.4%	20.2%	21.0%	22.0%	23.0%
share of RES in the electricity sector	22.1%	22.1%	22.6%	22.6%	23.0%	24.8%	26.1%	27.5%	29.0%	30.6%	31.8%
share of RES in district heating and cooling	17.4%	18.6%	19.9%	20.8%	21.5%	22.7%	24.1%	25.0%	25.9%	27.1%	28.4%
share of RES in transport (with multipliers)	10.0%	9.3%	9.8%	10.2%	10.8%	11.2%	11.6%	12.2%	12.7%	13.3%	14.0%

*Table 30. Projected gross final renewable energy production in the **electricity sector** by technology [ktoe] and the shares of RES from individual technologies [%] – ECP scenario*

renewable energy production by technology [ktoe]	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
gross final electricity consumption (RES-E denominator)	12 396 .7	13 390 .8	14 102 .1	15 258	16 156	17 297	18 289	19 412
hydropower*	184.3	202.0	202.4	206	246	254	262	270
wind farms*	17.5	146.2	833.0	2020	2278	3290	3940	4746
photovoltaics	0.0	0.0	4.9	173	390	584	929	1274
biomass	120.4	507.8	776.2	822	835	1001	984	887
biogas	9.6	34.3	77.9	132	230	334	431	498
renewable municipal waste	0.0	0.0	0.0	17	25	30	35	40
share of technology in renewable energy consumption in the electricity sector [%]	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
hydropower	55.6%	22.7%	10.7%	6.1%	6.1%	4.6%	4.0%	3.5%
wind farms	5.3%	16.4%	44.0%	59.9%	56.9%	59.9%	59.9%	61.5%
photovoltaics	0.0%	0.0%	0.3%	5.1%	9.7%	10.6%	14.1%	16.5%
biomass	36.3%	57.0%	41.0%	24.4%	20.8%	18.2%	15.0%	11.5%
biogas	2.9%	3.9%	4.1%	3.9%	5.7%	6.1%	6.5%	6.5%
renewable municipal waste	0.0%	0.0%	0.0%	0.5%	0.6%	0.5%	0.5%	0.5%

Source: Own study by ARE S.A., Eurostat

*Table 31. Projected gross final renewable energy consumption in **district heating and cooling** by sources [ktoe] and share of individual types of sources in renewable energy consumption in heating and cooling [%] – ECP scenario*

Gross final renewable energy consumption in district heating and cooling by sources [ktoe]	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
gross final energy consumption in district heating and cooling (RES-	38064. 0	39558. 3	35202. 3	35489	33472	31794	31141	30822

H&C denominator)								
geothermal	11.4	13.4	21.7	31	45	59	75	109
solar	0.1	10.0	45.0	108	271	455	570	591
solid biomass	3814.5	4554.6	4896.0	5597	6473	7288	7555	7950
biogas	40.9	50.8	88.4	135	243	341	436	508
heat pumps	0.0	9.9	25.6	177	431	728	1001	1247
renewable municipal waste	0.7	2.9	39.9	115	140	157	176	197
share of technology in renewable energy consumption in district heating and cooling [%]	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
geothermal	0.3%	0.3%	0.4%	0.5%	0.6%	0.7%	0.8%	1.0%
solar	0.0%	0.2%	0.9%	1.7%	3.6%	5.0%	5.8%	5.6%
solid biomass	98.6%	98.1%	95.7%	90.8%	85.1%	80.7%	77.0%	75.0%
biogas	1.1%	1.1%	1.7%	2.2%	3.2%	3.8%	4.4%	4.8%
heat pumps	0.0%	0.2%	0.5%	2.9%	5.7%	8.1%	10.2%	11.8%
renewable municipal waste	0.0%	0.1%	0.8%	1.9%	1.8%	1.7%	1.8%	1.9%

Source: Own study by ARE S.A., Eurostat

Table 32. Projected gross final renewable energy consumption in the transport sector by technology [ktoe] and the share of the technology in renewable energy consumption in transport [%] – ECP scenario

Gross final renewable energy consumption in the transport sector by technologies [ktoe]	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
gross final energy consumption in transport (RES-T denominator)	**10178.7**	**14951.0**	**14488.0**	**20295**	**19804**	**18884**	**18673**	**18356**
electricity	49.1	48.8	67.8	118	142	291	488	703
first-generation biofuels/first-generation HVO/CHVO	46.1	867.4	653.4	1274	1198	999	889	832
second-generation biofuels or second-generation HVO/COHVO	0.0	0.0	0.0	221	338	418	479	489
consumption of electricity for road transport purposes classified as renewable energy	0.3	0.34	0.48	13	53	150	295	473
consumption of electricity for rail transport purposes classified as RES	43.7	43.30	61.06	96	82	132	182	218
consumption of electricity in pipeline transport classified as RES	5.2	5.13	6.26	9	7	9	11	12
total consumption of electricity in transport	343.0	287.0	267.2	355	627	1004	1356	1769
including: for road transport purposes	1.8	2.0	1.9	39	234	517	819	1190
for rail transport purposes	305.2	254.9	240.6	290	363	457	507	550
in pipeline transport	36.0	30.2	24.7	26	29	31	31	30
[%]	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
share of electricity in renewable energy consumption in transport	51.6%	5.3%	9.4%	7.3%	8.4%	17.0%	26.3%	34.7%
share of biofuels in renewable energy consumption in transport	48.4%	94.7%	90.6%	92.7%	91.6%	83.0%	73.7%	65.3%
share of electricity used for road transport purposes	0.5%	0.7%	0.7%	11.0%	37.3%	51.4%	60.4%	67.3%
share of electricity used for rail transport purposes	89.0%	88.8%	90.1%	81.6%	58.0%	45.5%	37.4%	31.1%
share of electricity used in other types of	10.5%	10.5%	9.2%	7.4%	4.7%	3.1%	2.3%	1.7%

transport								

Source: Own study by ARE S.A., Eurostat

5.1.2.2.2. Projected generation of electricity and heat in buildings

The projections on the production of electricity in buildings stem from the cost optimisation carried out with the use of the MESSAGE model, which takes into account existing legislation on the development of distributed RES-based energy and the anticipated potential decrease in the cost of associated technologies. In the model, distributed sources compete with the retail price of electricity and the cost of heat generation from various types of sources. As the technologies develop and the costs of energy generation by such installations decline, they should gradually gain in importance.

The results of analysis regarding the possible production potential of RES-based small installations and microinstallations, as presented below, are based on the assumption of a gradual decrease in technology costs, growing retail prices of electricity (mainly as a result of the rising costs of the purchase of CO_2 emission allowances for units fired with fossil fuels), as well as the functioning of specific support schemes, in particular the co-funding of investment costs (subsidies), availability of preferential loans, and availability of surpluses injected into the network by prosumers subject to the system of discounts provided for by the RES Act. The growth rate has been verified through comparisons with other European countries (based on progress recorded in statistics in the last decade and predictions by reputable research institutions for the timespan under study). The results of the analysis indicate that photovoltaics will be the fastest growing technology in the category of small installations and microinstallations in buildings (with the highest rate of cost decrease).

Tables 33 and 34 present projections of electricity and heat generation from renewable energy sources by small installations and microinstallations in buildings, including data on self-consumed electricity and electricity injected into the grid. The share of energy injected into the grid in individual periods has been determined on the basis of an analysis of historical data provided by the Energy Regulatory Office (URE)[14]. The projections on the production of heat by microinstallations are based on the STEAM-PL simulation model, which relies on such elements as the level of demand for usable energy, existing potential, technology costs, level of subsidies, user preferences, pace of development to date, forecasts of industry organisations and reputable Polish and foreign research institutions.

Table 33. Generation of electricity through renewable energy sources in buildings [GWh]

Total gross production [GWh]				
year	Biogas plants	Photovoltaics	Wind farms	Small hydropower
2015	0	9	0	0
2020	68	710	22	22
2025	331	1586	47	57
2030	594	2550	68	93
2035	857	4959	84	129
2040	1120	7323	99	165
Self-consumption [GWh]				
	Biogas plants	Photovoltaics	Wind farms	MEW
2015	0	5	0	0
2020	55	416	6	2
2025	265	928	13	6
2030	476	1492	18	9
2035	686	2901	22	13
2040	897	4284	27	16
Energy injected into the grid [GWh]				
	Biogas plants	Photovoltaics	Wind farms	Small hydropower

[14] Zbiorcze informacje dotyczące wytwarzania energii elektrycznej z odnawialnych źródeł energii w mikroinstalacji lub małej instalacji za 2016 r. (art. 17 ustawy OZE) (Summary information on renewable electricity generation by microinstallations and small installations in 2016 (Article 17 of the RES Act)) – URE Report. Warsaw, April 2017.

2015	0	4	0	0
2020	14	295	16	19
2025	66	658	35	52
2030	118	1058	50	84
2035	170	2058	61	117
2040	223	3039	73	149

Source: ARE S.A. own study (STEAM-PL, MESSAGE-PL)

Table 34. Generation of heat through renewable energy sources in buildings [ktoe]

Total gross production [ktoe]					
	Biogas plants	Solar collectors	Biomass-fired boiler heaters	Heat pumps	Geothermal
2015	0	45	1054	26	0
2020	46	108	1253	177	0
2025	133	271	1592	431	0
2030	221	455	1991	728	0
2035	277	570	2117	1001	0
2040	294	591	2300	1247	0
Self-consumption [ktoe]					
	Biogas plants	Solar collectors	Biomass-fired boiler heaters	Heat pumps	Geothermal
2015	0	45	1054	26	0
2020	46	108	1253	177	0
2025	133	271	1592	431	0
2030	221	455	1991	728	0
2035	277	570	2117	1001	0
2040	294	591	2300	1247	0
Energy injected into the grid [ktoe]					
	Biogas plants	Solar collectors	Biomass-fired boiler heaters	Heat pumps	Geothermal
2015	0	0	0	0	0
2020	0	0	0	0	0
2025	0	0	0	0	0
2030	0	0	0	0	0
2035	0	0	0	0	0
2040	0	0	0	0	0

Source: ARE S.A. own study (STEAM-PL, MESSAGE-PL)

5.1.2.2.3. Comparison of projected renewable energy consumption – ECP vs REF

Table 35 and Figure 9 summarise the results of comparisons for the two scenarios, namely ECP and REF, in terms of the nationwide and sectoral RES shares to be attained by 2030 (with an outlook for 2040). The figures reveal differences following from the assumption of a steep increase in the share of RES by 2030 in the ECP scenario. The results obtained for 2040 assume maintaining the pace of renewable technology development within the various sectors and technologies used after 2030, but they should be looked at with some caution, both due to the rather distant perspective and due to limited possibilities of verifying the possible technical potential. **All subsectors demonstrate considerable differences between the scenarios; in each of them, the 2030 ECP scenario shows percentages higher by 4-12.4 pp for the RES share, and by 7.8 pp for total gross energy consumption.**

Table 35. Comparison of nationwide and sectoral RES shares – ECP vs REF

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Nationwide RES share (ECP)	**6.9%**	**9.3%**	**11.9%**	15.0%	18.4%	23.0%	25.8%	28.5%
Nationwide RES share (REF)	**6.9%**	**9.3%**	**11.9%**	13.2%	13.9%	15.2%	16.9%	18.0%
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**

Share of RES in electricity (ECP)	2.7%	6.6%	**13.0%**	22.1%	24.8%	31.8%	36.0%	39.7%
Share of RES in electricity (REF)	2.7%	6.6%	**13.0%**	15.0%	16.5%	19.4%	23.9%	25.9%
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Share of RES in district heating and cooling (ECP)	10.2%	11.7%	**14.5%**	17.4%	22.7%	28.4%	31.5%	34.4%
Share of RES in district heating and cooling (REF)	10.2%	11.7%	**14.5%**	15.6%	16.5%	17.7%	18.8%	19.7%
	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Share of RES in transport (ECP)	1.6%	6.6%	**6.4%**	10.0%	11.2%	14.0%	17.7%	22.0%
Share of RES in transport (REF)	1.6%	6.6%	**6.4%**	10.0%	10.4%	11.2%	12.1%	13.0%

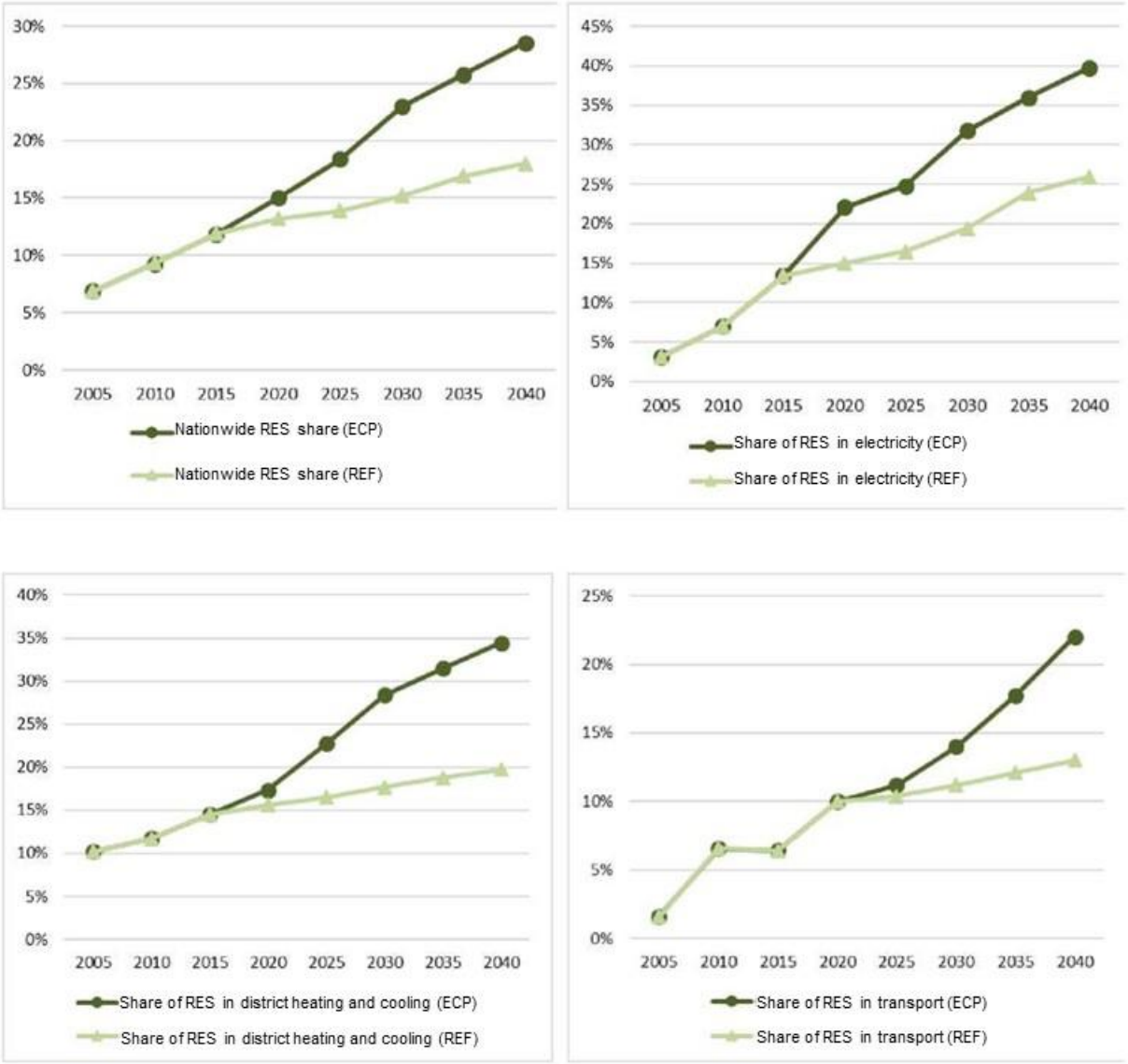


Figure 10. Comparison of nationwide and sectoral RES shares – ECP vs REF

5.1.3. 'Energy Efficiency' dimension

Poland intends to continue its policies that improve the energy efficiency of the economy, not only because they are consistent with the corresponding EU efforts, but also – most importantly – because they produce measurable economic and environmental benefits. It is also one of the main pillars of sustainable development. Despite the progress made in this area, the energy intensity of the Polish economy continues to deviate from the EU average. The primary energy intensity of Poland's GDP, climate corrected, as expressed in constant 2010 prices and taking into account purchasing power parity in 2016, amounted to 0.138 kgoe/euro10ppp and was 15% higher than the European average (0.120). The discrepancy fell by 26 percentage points compared to 2000. In 2000-2016, Poland was improving its energy intensity almost twice as fast (2.9%/year) as the EU average (1.7%/year).

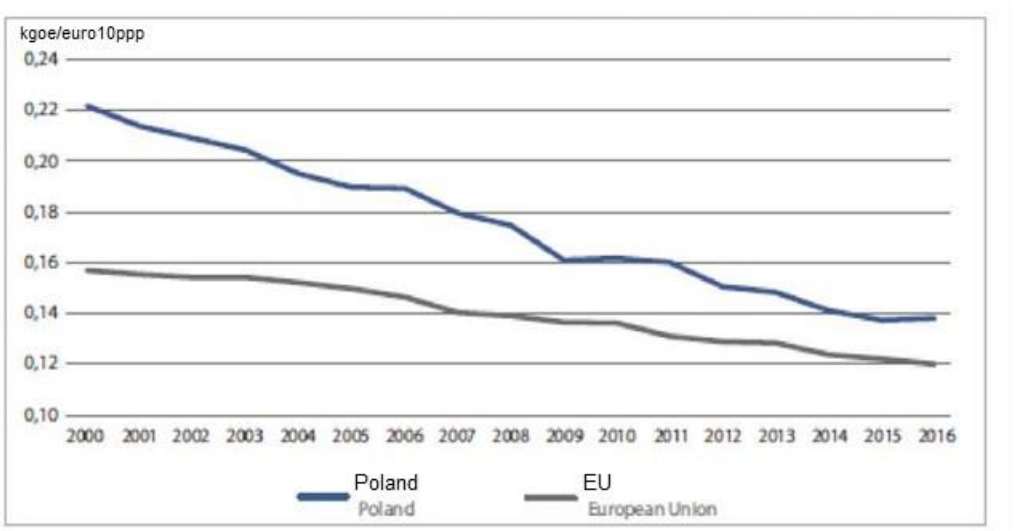


Figure 11. Primary energy intensity of GDP, climate corrected[15]

Reducing energy consumption is a priority in the EU. Actions to improve energy efficiency are recognised not only as a means of ensuring sustainable energy supplies, mitigating greenhouse gas emissions, improving security of supply and reducing spending on energy imports, but also as a tool for promoting EU competitiveness. In 2007, EU leaders set a 20% EU-wide consumption reduction target for 2020, and in 2018, they defined a 32.5% target for 2030. Member States

5.1.3.1. Primary and final energy consumption

The table and figure below summarise the historical and projected primary and final energy consumption in Poland. The projections presented for the ECP scenario show a decrease in demand for both primary and final energy. The results of projections stem from a number of assumptions, in particular those on the possibilities of improving energy efficiency (as described further below) in the individual sectors of the national economy and the pace of RES growth.

Table 36. Total primary and final energy consumption [ktoe]

	2005	2010	2015	2020	2025	2030	2035	2040
Primary energy consumption including non-energy use	92 560	101 558	95 739	101 890	99 893	96 848	94 556	93 391
Primary energy consumption	87 952	96 589	90 104	96 400	94 396	91 317	88 963	87 736
Final energy consumption including non-energy use	62 080	70 199	66 409	75 211	73 180	71 040	70 821	70 767

[15] "Efektywność wykorzystania energii" (Efficiency of energy use) – GUS. Warsaw 2016, 2017, 2018, 2019.

Final energy consumption	57 472	65 230	60 775	69 720	67 682	65 509	65 229	65 112

**including non-energy use*
Source: ARE S.A. own study (STEAM-PL, MESSAGE-PL), EUROSTAT

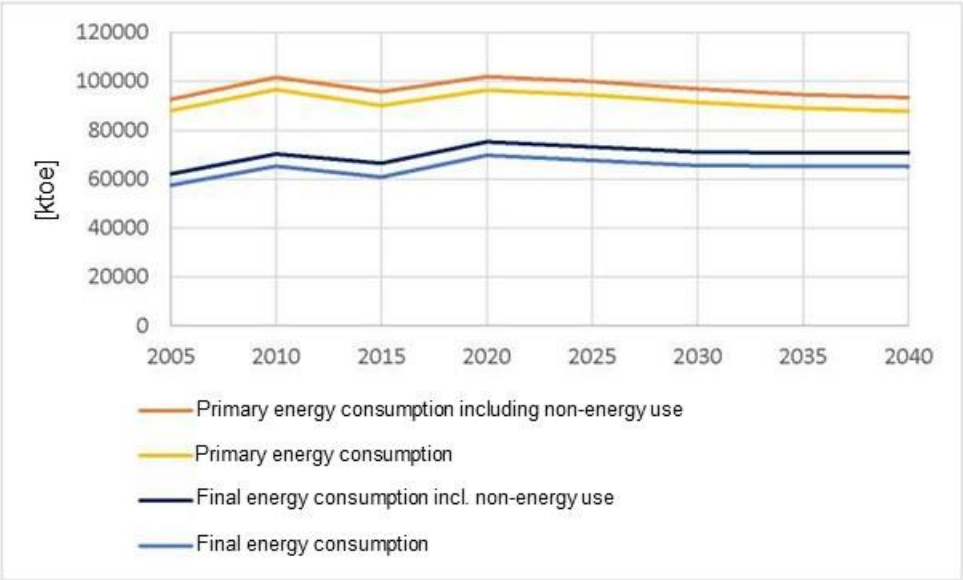


Figure 12. Total primary and final energy consumption – ECP scenario

The table below presents projections by years for 2021-2030.

Table 37. Total primary and final energy consumption in 2021-2030 [ktoe]

	2021	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Primary energy consumption including non-energy use	102 175	101 965	101 187	101 018	99 893	99 317	98 503	98 053	97 441	96 848
Primary energy consumption	96 706	96 486	95 704	95 528	94 396	93 813	92 993	92 533	91 916	91 317
Final energy consumption including non-energy use	74 905	74 557	74 140	73 674	73 179	72 753	72 278	71 839	71 388	71 040
Final energy consumption	69 436	69 077	68 657	68 184	67 682	67 249	66 768	66 319	65 863	65 509
Final energy consumption (Europe 2020-2030)	71 276	70 895	70 447	69 944	69 408	68 939	68 420	67 934	67 443	67 053

Source: ARE S.A. own study (STEAM-PL, MESSAGE-PL), EUROSTAT

The projections taking into account measures to improve energy efficiency in individual sectors of the national economy are based on the following assumptions:

- the policy oriented to increasing energy efficiency of the economy will be continued with a view to reducing its energy intensity;
- the national potential for improving energy efficiency will be exploited;
- the planned measures will be market-based to the maximum extent;
- the targets will be achieved following the minimum cost principle, that is by maximising the use of existing

mechanisms and organisational infrastructure[16];
- use will be made of any available energy efficiency improvement measures (horizontal measures, actions to improve energy efficiency in buildings and public institutions, industry, and small and medium-sized enterprises (SMEs), transport, and the electricity and heating sectors).

In order to determine the targets for improving energy efficiency in the EU, primary energy (without non-energy use) and final energy projections prepared for the European Commission in 2007 (PRIMES scenario – Baseline 2007) are used as the REF. In accordance with these projections, in 2030, the primary and final energy consumption in Poland will be 118.6 and 85.5 Mtoe respectively (109.8 and 77.4 Mtoe for 2020). The figure below presents the results of the projection of primary and final energy consumption in Poland against the background of the 2007 PRIMES scenario, which are the basis for determining the proposed percentage reduction.

The national 2030 target for improving energy efficiency is 23% and is calculated in relation to primary energy consumption in the PRIMES 2007 forecast. In absolute terms, it amounts to - 91.3 Mtoe in 2030. The results of calculations of final energy savings demonstrate that savings in final energy consumption of 21.5% relative to the PRIMES 2007 scenario are achievable. In absolute terms, the 2030 target is 67.0 Mtoe.

In 2030, **the amount of primary energy saved in absolute terms is 27.3 Mtoe, which translates into a 23% reduction in relation to the consumption of energy at 118.6 Mtoe projected by the PRIMES 2007 reference scenario**.

As can be seen in the projections, the 2020 energy efficiency improvement target set pursuant to Article 3(1) of Directive 2012/27/EU will be achieved. In absolute terms, meeting the commitment means primary energy consumption of up to 96.4 Mtoe (12.4% primary energy savings). However, attention must be drawn to the possible difficulties caused by adjustments to statistical data as a result of the curbing of illegal trade in liquid fuels. **The 2020 final energy savings target of up to 71.6 Mtoe[17] will be achieved.**

The projections reveal a slight increase followed by a decrease in the demand for primary energy (including non-energy use) in Poland from 95.7 Mtoe in 2015 to 96.8 Mtoe in 2030 and 93.4 Mtoe in 2040. Final energy consumption first increases from 66.4 Mtoe in 2015 to 71.0 Mtoe in 2030 to stabilise at a similar level until 2040. The results of the projections are associated with a number of assumptions, in particular those related to the possibility of improving energy efficiency in the various sectors of the national economy and the pace of RES growth. The Polish economy is undergoing dynamic development, which entails increasing consumption. It is worth noting that currently the consumption of primary and final energy per capita is one of the lowest in Europe. Depending on their intensity, efforts to improve energy efficiency may hinder further growth or, at best, contribute to a partial reduction in current levels of energy demand.

The figure below compares projected primary and final energy consumption against the background of 2007 projections, which serve as the baseline for measuring energy savings.

[16] "The National Energy Efficiency Action Plan for Poland", Ministry of Energy, Warsaw 2017.
[17] "The National Energy Efficiency Action Plan for Poland", Ministry of Energy, Warsaw 2017.

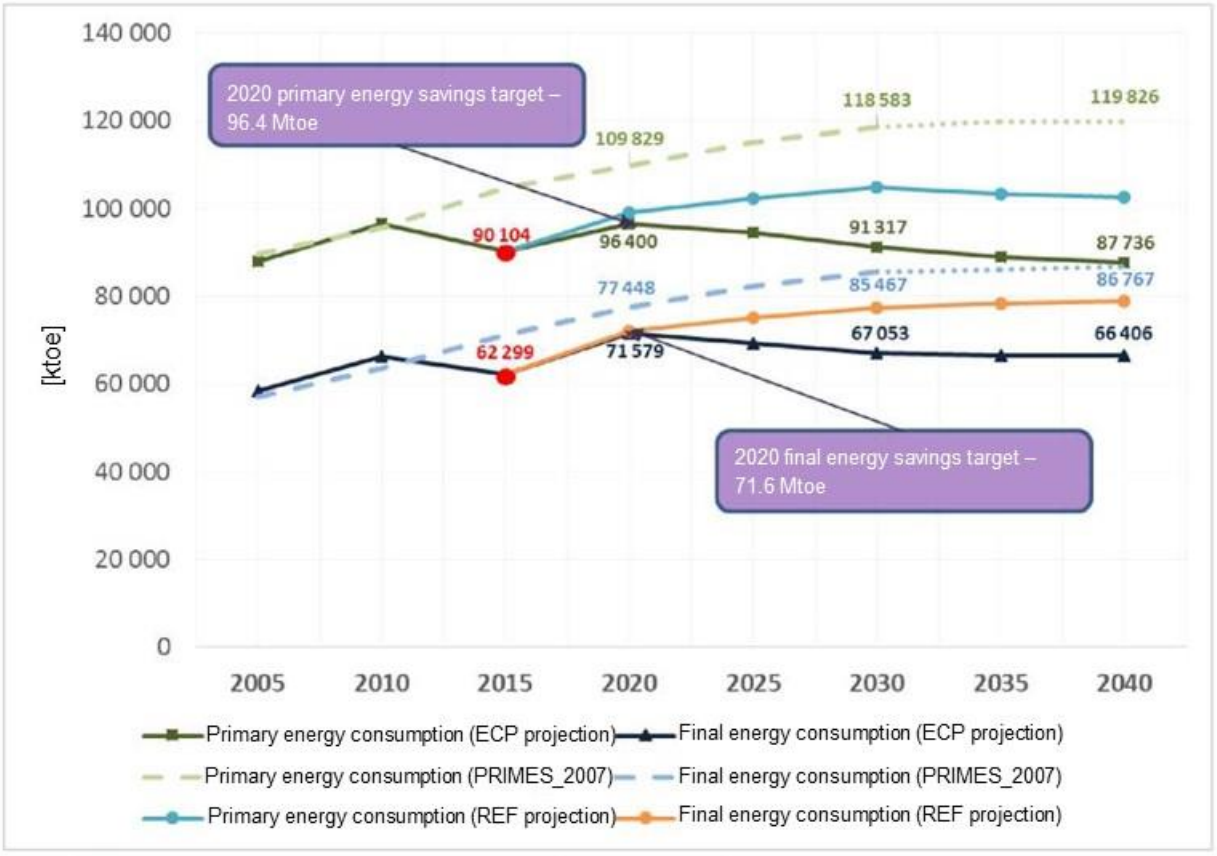


Figure 13. Projected primary and final energy consumption against the background of the 2007 PRIMES scenario projections.

The forecast for the 2007 PRIMES scenario only spans the period until 2030, therefore the trajectories of domestic primary and final energy consumption for 2040, as shown in the figure above, are the result of extrapolation of the 2005-2030 figures. The extrapolation results obtained have been used as the REF for determining the percentage reductions in 2040, which amount to 27.3% and 23.5% for primary and final energy consumption, respectively.

The graph below depicts the year-by-year trajectory of primary and final energy consumption in 2021-2030.

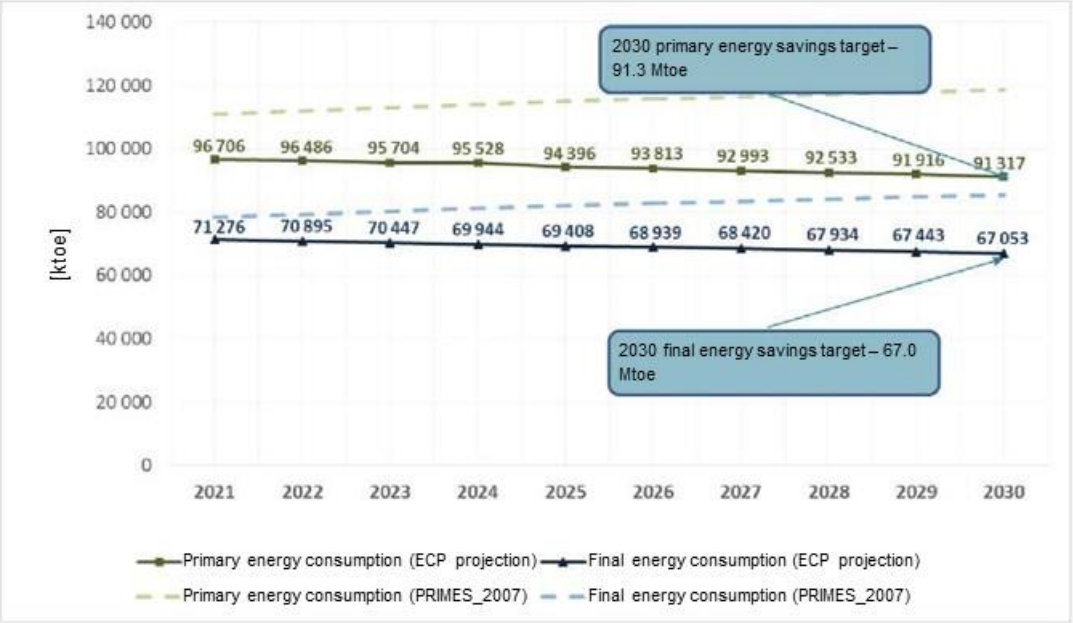


Figure 14. Projected primary and final energy consumption in 2021-2030 and energy efficiency improvement targets for 2030.

5.1.3.2. Comparison of projected primary and final energy consumption – ECP vs REF

The tables and figures below summarise the results of projections of primary and final energy demand in Poland for the ECP and REF scenarios. The differences in energy consumption between the ECP and REF scenarios represent the projected amount of energy reduction to be obtained as a result of the planned energy efficiency policies and measures over the timespans considered. Energy savings within individual energy efficiency improvement measures accumulate over time, which means that savings in a given year consist of savings from the previous year plus savings achieved through new actions implemented in a given year.

Table 38. Total primary and final energy consumption – ECP vs REF [ktoe]

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Primary energy consumption (ECP)	87 952	96 589	90 104	96 400	94 396	91 317	88 963	87 736
Primary energy consumption (REF)	87 952	96 589	90 104	98 943	102 217	104 778	103 199	102 680
Primary energy savings	-	-	-	2 543	7 821	13 462	14 235	14 944
Final energy consumption (ECP)	57 472	65 230	60 775	69 720	67 682	65 509	65 229	65 112
Final energy consumption (REF)	57 472	65 230	60 775	72 117	75 078	77 327	78 300	78 784
Final energy savings	-	-	-	2 397	7 396	11 818	13 071	13 672

5.1.3.3. Final energy savings

Below is detailed information on the methods and measures employed by Poland to implement Article 7 of

Directive 2012/27/EU on energy efficiency (EED)[18].

5.1.3.3.1. Calculation of the level of the energy savings requirement to be achieved over the whole period from 1 January 2021 to 31 December 2030

Commission Recommendation on transposing the energy savings obligations under the Energy Efficiency Directive[19] provides guidance on how to calculate the total amount of new final energy savings to be achieved under the obligation spanning the period 2021-2030 and specifies which statistical datasets can be used.

In accordance with the Commission Recommendation, the total amount of energy savings is to be calculated and reported under the 'final energy' category, which is why the analysis in this paragraph is conducted in this category.

The value of averaged annual final energy consumption and the baseline on which the energy savings will be calculated are presented in the table below, according to Eurostat data. The values of final energy consumption will be used to determine energy savings.

Table 39. Final energy consumption according to Eurostat data in 2016-2018 [ktoe]

item	category (NRG_BAL_C)	item	2016	2017	2018 (estimates)	average
FEC2020-2030	Final energy consumption [ktoe]	1	66 601	70 923	(71 700)	**69 741**
FC_TRA_E	Final energy consumption – transport [ktoe]	2	18 557	21 431	(22 444)	**20 811**
Final energy consumption (excluding energy consumed by transport) [ktoe]		3=1-2	48 044	49 492	(49 256)	**48 930**

Source: own study based on Eurostat data

5.1.3.3.2. Total cumulative amount of final energy savings to be achieved in accordance with point (b) of Article 7(1) of Directive 2012/27/EU

In accordance with the first subparagraph of Article 7(1)(b) of Directive 2012/27/EU, the total energy end-use savings to be attained under the energy efficiency obligation scheme or through alternative policy measures must be equivalent to at least new savings in each year from 1 January 2021 to 31 December 2030 **at 0.8% of annual final energy consumption, averaged over the last three years preceding 1 January 2019** (69 741 ktoe on average).

In addition, according to the concept of the obligation period set out in paragraph (2)(i) of Annex V of Directive 2012/27/EU, it is considered that any individual action aimed at achieving energy savings contributes to attaining savings not only in the year when it is implemented, but also in the following years, until 2030. Therefore, the required amount of savings can "accumulate" from year to year.

[18] Article 7(6) of Directive 2012/27/EU on energy efficiency (Directive of the European Parliament and of the Council (EU) 2018/2002 of 11 December 2018 amending Directive 2012/27/EU on energy efficiency) provides that Member States are required to describe in their integrated national energy and climate plans in accordance with Annex III to Regulation (EU) 2018/1999[18], the calculation of the amount of energy savings to be achieved over the period from 1 January 2021 to 31 December 2030 referred to in the first subparagraph of Article 7(1)(b) of Directive 2012/27/EU and are required, if relevant, to explain how the annual savings rate and the calculation baseline were established, and how and to what extent the options referred to in Article 7(4) were applied.

Furthermore, pursuant to paragraph 5 of Annex V to Directive 2012/27/EU, Member States are required to notify to the Commission their proposed detailed methodology for the operation of the energy efficiency obligation schemes and alternative policy measures referred to in Articles 7a and 7b, and Article 20(6) of Directive 2012/27/EU.

[19] Commission Recommendation of 25 September 2019 on transposing of energy savings obligations under the Energy Efficiency Directive, C(2019) 6621 FINAL.

The level of energy savings to be achieved under the obligation covering 2021-2030 was calculated in accordance with section 2.1 of the above-mentioned Recommendation.

The amount of final energy savings to be achieved in 2021 by implementing Article 7 is (69 741 x 0.8% x 1 year) = 558 ktoe. In 2022, the cumulative amount of energy savings is (69 741 x 0.8% x 2 years) = 1 116 ktoe (including 558 ktoe from the previous year). The calculation has been made for each successive year until 2030, when the total required final energy savings is (69 741 x 0.8% x 10 years) = 5 580 ktoe. **The total amount of final energy savings, understood as the amount of final energy savings cumulated from year to year, to be achieved overall in 2021-2030 is 30 690 ktoe.** The mechanism is presented in the table below.

Table 40. Final energy savings to be achieved in 2021-2030 – annual and cumulative (based on the provisions of EED) [ktoe]

year	required percentage of savings	annual energy savings [ktoe]										TOTAL
2021	0.8%	558										**558**
2022	0.8%	558	558									**1 116**
2023	0.8%	558	558	558								**1 674**
2024	0.8%	558	558	558	558							**2 232**
2025	0.8%	558	558	558	558	558						**2 790**
2026	0.8%	558	558	558	558	558	558					**3 348**
2027	0.8%	558	558	558	558	558	558	558				**3 906**
2028	0.8%	558	558	558	558	558	558	558	558			**4 464**
2029	0.8%	558	558	558	558	558	558	558	558	558		**5 022**
2030	0.8%	558	558	558	558	558	558	558	558	558	558	**5 558**
Cumulative savings in 2021-2030												**30 690**

Data used in the calculation of final energy consumption and sources of such data

The final energy consumption on the basis of which the energy savings are calculated are taken from the above-mentioned category (FEC2020-2030) in the Eurostat dataset. With respect to the statistical data used in calculating the required amount of final energy savings, section 2.2.1 of Commission Recommendation provides that all the elements that are required under the first subparagraph of Article 7(1)(b) of Directive 2012/27/EU are included in the relevant Eurostat category, i.e. in the category "final energy consumption – Europe 2020-2030"[20] (codeFEC2020-2030). This particular category in the Eurostat statistical dataset has been defined in relation to the contribution of Member States to energy efficiency and the energy savings obligation. Eurostat has revised the energy balance based on international recommendations on energy statistics published by the Statistical Commission.

5.1.3.3.3. Amounts of energy savings required using the options provided for in Article 7 item 2 of Directive 2012/27/EU

In accordance with Article 7(2) of Directive 2012/27/EU, Member States may make use of the option to count the amount of energy savings required in one or more of the following ways:

(a) applying an annual savings rate on energy sales to final customers or on final energy consumption, averaged over the most recent three-year period prior to 1 January 2019;
(b) **excluding, in whole or in part, energy used in transport from the calculation baseline**;
(c) making use of any of the options set out in Article 7(4) of Directive 2012/27/EU.

At the same time (in accordance with Article 7(3) of Directive 2012/27/EU), where Member States make use of the above possibilities, they are required to establish:

(a) their own annual savings rate; and
(b) their own calculation baseline and energy used in transport, in whole or in part, excluded from the calculation [in ktoe];

[20] https://ec.europa.eu/eurostat/documents/10186/6246844/Eurobase-changes-energy.pdf (p. 25)

Poland will make use of the option provided for in Article 7(2)(b) of the Directive by excluding, in whole or in part, energy used in transport from the calculation baseline, as per the first subparagraph of Article 7(1) of Directive 2012/27/EU.

Consequently, the average annual final energy consumption in transport has been calculated on the basis of the Eurostat statistical dataset. The calculation has been made on the basis of statistical data from the three years (2016, 2017 and 2018) predating 1 January 2019 [in ktoe], which are given in Table 39 at the beginning of this subsection.

Table 41. Energy savings excluding energy consumed by transport

category (NRG_BAL_C)	2016	2017	2018 (estimates)	average	annual energy savings	rate
Final energy consumption [ktoe]	66 601	70 923	(71 700)	**69 741**	**558**	**0.8%**
Final energy consumption – transport [ktoe]	18 557	21 431	(22 444)	**20 811**	**N/A**	**N/A**
Final energy consumption (excluding energy consumed by transport) [ktoe]	**48 044**	**49 492**	**(49 256)**	**48 930**	**563**	**1.15%**

Table 42. Savings and rate for determining final energy savings

Final energy savings after exclusions	21 530 ktoe	These are the total final energy savings calculated using the 0.8% ratio excluding energy consumed by transport (48 930 ktoe x 0.8%)
Additional savings to be attained	9160 ktoe	These are the energy savings that are missing for the required minimum level of total energy savings to be achieved (30 690 ktoe - 21 530 ktoe)
Own savings rate required with transport excluded	1.15%	Own savings rate to be applied if energy consumed by transport is excluded from the calculation baseline (48 930 x 1.15% = 563)

The annual savings determined with the use of own savings rate are 563 ktoe, which exceeds the minimum required level, i.e. 558 ktoe (see Table 41).

In the second obligation period provided for by Article 7(1)(b) of Directive 2012/27/EU, the options referred to in Article 7(4)(b)(g) of Directive 2012/27/EU are not planned to be availed of. Consequently paragraph 2(d) and (e) of Annex III to Directive 2012/27/EU does not apply.

5.1.3.4. Final energy consumption by sectors

It follows from the projections that final energy demand is bound to stabilise in the long term, which is determined by two mutually balancing factors, namely economic growth, as measured by macroeconomic indicators, i.e. GDP and gross value added, which will generate increased demand for usable energy, and the planned energy efficiency improvement measures described in the previous subsections. As is shown by the analysis completed, reducing energy consumption beyond what is estimated by the above energy consumption reduction analysis in the situation of the anticipated economic growth in Poland may be very difficult, or at best very expensive.

By sectors (table and figure below), an increase in final energy demand is only anticipated for the transport and services sector.

The transport sector is an area where reducing or at least slowing down the growth rate will be an extremely difficult challenge. The level of motorisation in Poland is higher than in other European countries, even those with higher GDP rates. The demand for passenger and freight transport is growing and the trend is bound to

continue as a result of the improving economic situation of Poland and its efforts to catch up with the EU average level of economic development. The age and technical condition of vehicles used on Polish roads is also a serious problem. Imports of used cars with relatively high specific fuel consumption and high emissions are still on the rise, and from today's perspective, curbing it seems requisite in the context of reducing inland consumption of petroleum fuels and combating emissions.

A key focus of the plan in this respect will be on promoting electromobility, which, given the cost of technology and the need to build charging infrastructure from scratch, can in fact proceed at a significantly slower pace than assumed by the government. Therefore, it is recommended that additional measures be implemented to foster the use of CNG and hydrogen in passenger cars and commercial vehicles, which may compensate for the slower popularisation of electric vehicles. Creating conditions conducive to a road-to-rail shift is another crucial activity both with respect to passenger and freight transport.

Based on the assumptions made as regards measures to be taken to improve energy efficiency in the transport sector, the potential savings in this sector are estimated at 4.47 Mtoe in 2030 and around 4.9 Mtoe in 2040.

As mentioned above, an increase in final energy demand will also be observable in the service sector. Services are the most dynamically developing sector of the national economy (with the macroeconomic development path assumed, the added value in the sector is expected to double in 2015-2040). The increase in final energy consumption in services will primarily stem from the growing consumption of electricity. Energy savings have been estimated for all areas of energy use, i.e. space heating, WSW preparation, preparation of meals, use of electrical appliances, and room and street lighting. **Total energy reduction in services is 1.2 Mtoe in 2030 and 1.4 Mtoe in 2040.**

Energy demand is expected to decline in the other sectors. The fall is relatively small, but given the current situation and forecasts, achieving it will involve enormous effort. In households, this will depend on the success of the Clean Air programme, which entails large-scale thermomodernisation of single-dwelling buildings and complete replacement of low-efficiency solid fuel boilers until 2030. In addition, the model calculations take into account intensified actions to improve energy efficiency of electrical devices. The anticipated pace of replacement of energy-consuming devices is presented in the graphics below (figure below). The quantities on the y-axis mean the share of households that use devices from a given energy class in the total number of devices.

The final demand for energy in households in the time horizon considered drops slightly. On the one hand, the number of households is growing and housing conditions are improving, with a corresponding increase in the number of home appliances and electronic devices (a phenomenon inherent in the growth of household wealth), which drives energy consumption. On the other hand, energy efficiency of new devices is improving, which means that the potential for increased demand is also being limited. The Energy and Climate Policy scenario assumes that the pace of energy efficiency improvement will prevail over the factors that drive energy demand, which can reasonably be expected, in particular, given the high prices of energy carriers, which are a consequence of the energy and climate policy. **The projected household savings are 4.1 Mtoe in 2030 and 4.8 Mtoe in 2040**, with the highest energy efficiency improvement rate expected in 2019-2030.

In the manufacturing sector, energy demand drops very slightly. In principle, consumption stabilises if 2015 is taken as REF (increase by 3.6% y/y). **The estimated size of energy savings in the manufacturing sector is 1.7 Mtoe in 2030 and 2.2 Mtoe in 2040.**

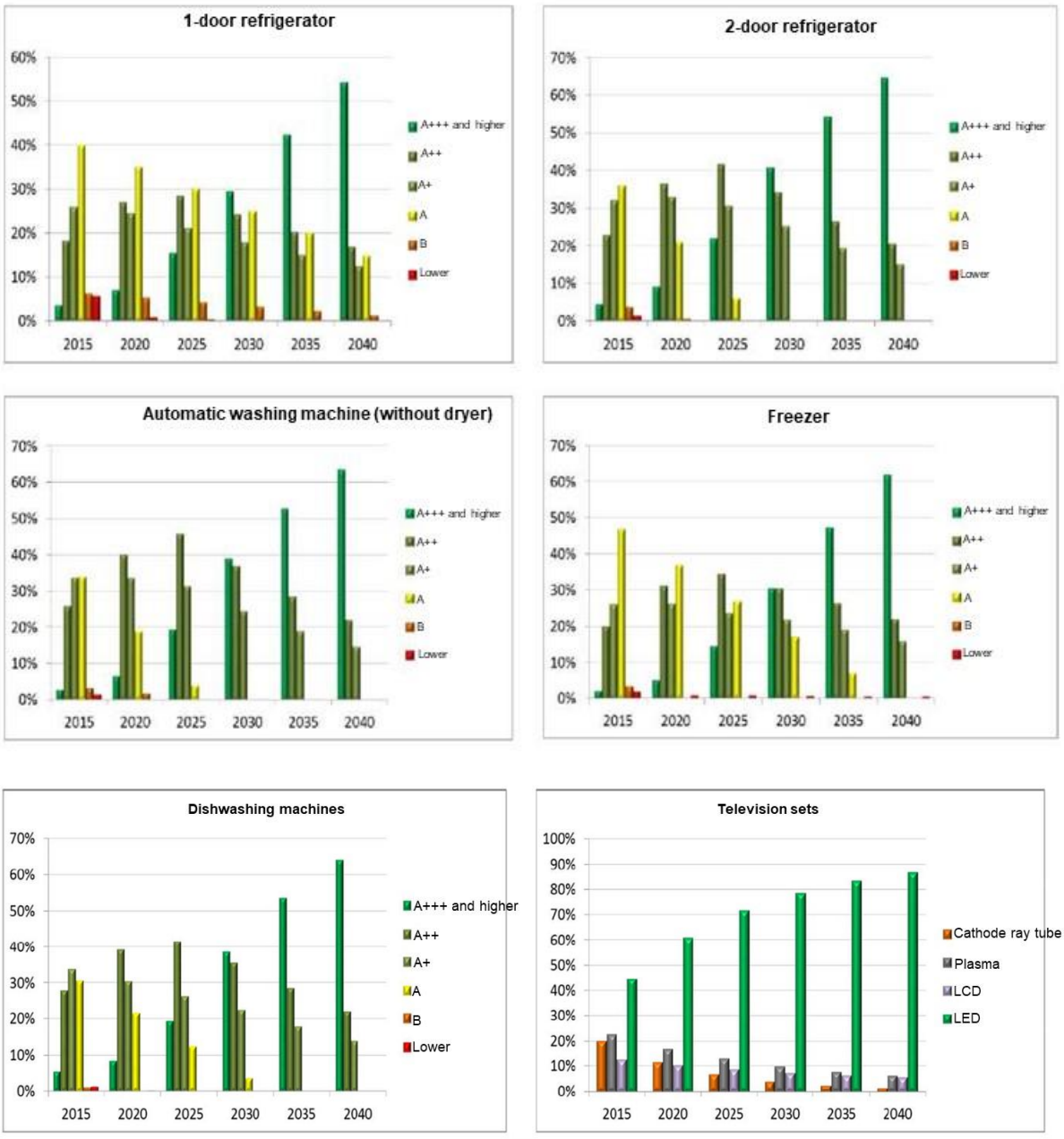


Figure 15. Household electrical device replacement rate

Table 43. Final energy consumption by sectors (excluding non-energy use) [ktoe]

	2005	2010	2015	2020	2025	2030	2035	2040
Industry	14 616	13 498	14 096	15 316	14 902	14 763	14 664	14 596
Transport	12 221	17 187	16 559	22 546	22 075	21 049	20 827	20 492
passenger	No data	No data	8 985	10 118	9 434	8 598	8 745	8 957
freight	No data	No data	7 494	12 346	12 557	12 364	11 995	11 449
Special purpose vehicles	No data	No data	79	82	84	86	87	87
Households	19 467	21 981	18 948	19 772	18 506	17 513	17 505	17 657
Services	6 730	8 833	7 842	8 343	8 586	8 700	8 853	9 079
Agriculture	4 438	3 730	3 330	3 743	3 613	3 485	3 379	3 287
TOTAL	**57 472**	**65 230**	**60 775**	**69 720**	**67 682**	**65 509**	**65 229**	**65 112**

Source: ARE S.A. own study (STEAM-PL), EUROSTAT

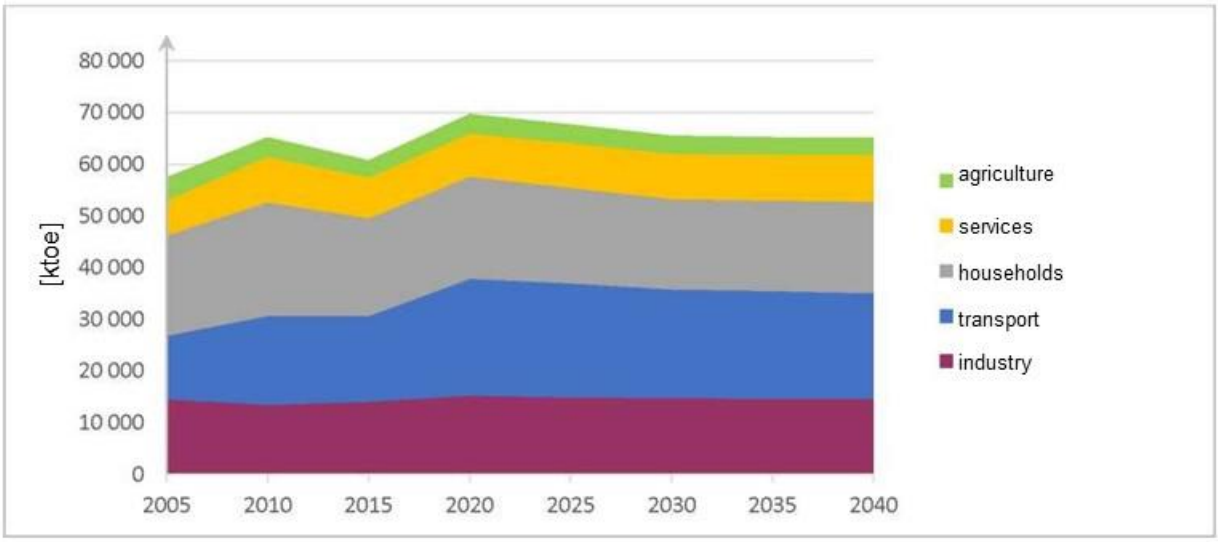


Figure 16. Final energy consumption by sectors (excluding non-energy use)

The table below presents the anticipated reduction of energy consumption in individual sectors. The negative energy savings values in the agriculture sector follow from the 2019 statistical corrections, which considerably increase the consumption of diesel in this sector.

Table 44. Reduction of final energy consumption by sectors [ktoe]

	2020	**2025**	**2030**	**2035**	**2040**
Households	496	2 483	4 102	4 566	4 758
Services	467	844	1 237	1 432	1 440
Transport	948	2 822	4 742	4 917	4 942
Industry	772	1 369	1 699	1 981	2 234
Agriculture	-287	-122	38	176	298
Final energy reduction	**2 397**	**7 396**	**11 818**	**13 071**	**13 672**
Energy sector	124	1 311	2 278	1 514	1 361
Primary energy reduction	**2 520**	**8 707**	**14 096**	**14 586**	**15 033**

Source: ARE S.A. own study

The tables and figures below summarise the results of projections of final energy demand in Poland for the ECP and REF scenarios in the individual sectors of the national economy. The differences reflect the amounts of energy savings to be obtained as a result of the planned energy efficiency improvement actions and measures.

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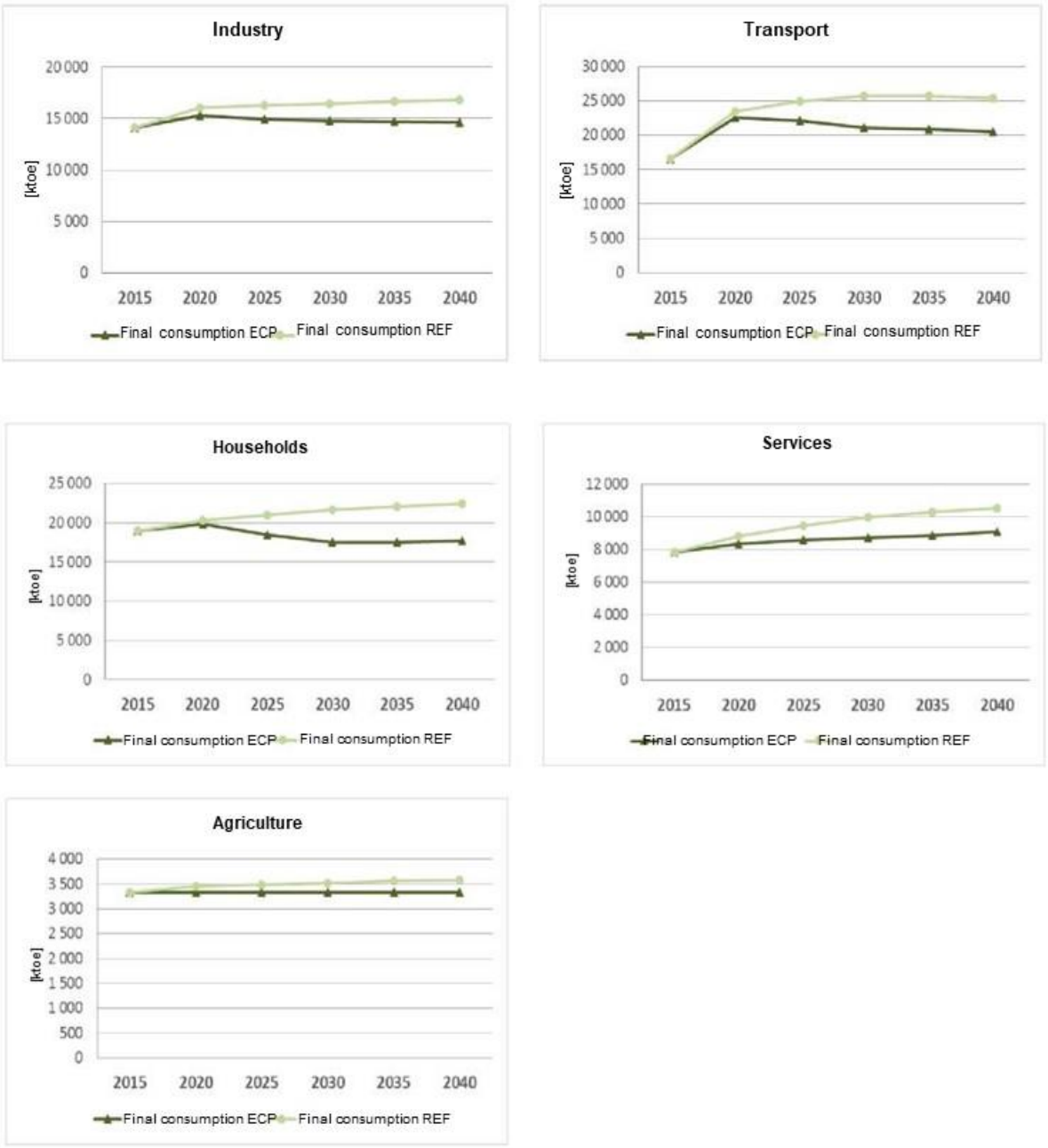

Figure 17. Final energy consumption by sectors – ECP vs REF

5.1.3.5. Final energy consumption by fuels and carriers

In final energy consumption, major changes in the fuel mix are observable. First of all, there is a significant reduction in coal consumption in the domestic economy (with the share for this carrier dropping from 18.5% in 2015 to less than 7.5% in 2030 and about 4.4% in 2040). By contrast, the consumption of electricity, natural gas and energy from renewable energy sources is gradually increasing, which is a natural consequence of the policy aimed at reducing emissions. Based on the assumptions made, a relatively small decrease in demand for district heat is expected as a result of the anticipated pace and scope of thermomodernisation of buildings and Commission's recommendations regarding the projected number of heating degree-days which reflects global warming. In turn, the limited pace of reduction follows from the assumption that efforts to connect new customers to district heating networks will be intensified in an effort to fight smog. The decrease in hard coal consumption is mainly associated with the slow but steady retrofitting of production plants (in the industry sector), which is partly required in connection with the ETS, which forces a switch to gas or electricity. The decrease in coal consumption will also be driven by the replacement of old, inefficient manually fed boilers in households,

supported by subsidies from the Clean Air programme and other dedicated schemes. Also the provisions of Regulation of the Minister of Economic Development and Finance on the requirements for solid fuel boilers[21] which impose restrictions on boilers manufactured and installed in Poland with a capacity below 500 kW will add considerably to the reduction in the consumption of coal by households. Since its entry into force, solid fuel boilers must meet the requirements of emissivity class 5 according to PN-EN 303-5:2012. The projection assumes that all new boilers meet the criteria set forth by the Regulation.

Table 45. Final energy consumption by fuels and carriers [ktoe]

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Electricity	9 028	10 206	10 990	12 152	13 041	14 202	15 349	16 520
District heat	6 634	6 547	5 462	5 748	5 436	5 090	5 080	5 132
Coal	12 340	13 733	11 218	9 917	7 117	4 899	3 735	2 842
Petroleum products	17 563	20 213	18 646	23 822	22 602	20 911	20 063	19 124
Natural gas	7 917	8 884	8 487	10 144	10 353	10 327	10 277	10 108
Biogas	40	48	78	97	131	165	201	237
Solid biomass	3 755	4 306	4 639	5 295	5 916	6 439	6 681	7 036
Biofuels	46	867	653	1490	1531	1413	1364	1317
Municipal and industrial waste	136	378	486	785	871	891	905	919
Solar collectors, heat pumps, geothermal	12	48	116	270	685	1 172	1 574	1 876
TOTAL	**57 472**	**65 230**	**60 775**	**69 720**	**67 682**	**65 509**	**65 229**	**65 112**

Source: ARE S.A. own study (STEAM-PL), EUROSTAT

5.1.3.6. Non-energy use

Non-energy use is the amount of energy carriers used for process needs in manufacturing certain products (e.g. consumption of gas for the production of mineral fertilisers or hard coal for the production of electrodes). The forecast assumes a moderate increase in the consumption of all energy carriers used previously for non-energy purposes in line with the historical trend observed (table below). This increase is highly correlated with economic growth. Differences in non-energy use compared to the REF scenario are negligible, and therefore are not included here.

Table 46. Non-energy use by fuels [ktoe]

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Coal	52	54	102	118	119	119	120	121
Coke	39	1	0	0	0	0	0	0
Peat	90	30	0	0	0	0	0	0
Kerosene	672	986	1 048	984	925	884	872	856
LPG	73	81	144	91	78	70	68	66
Other petroleum products	1 664	2 156	2 222	2 146	2 201	2 256	2 309	2 365
Natural gas	2 017	1 661	2 120	2 151	2 176	2 202	2 223	2 245
TOTAL	**4 564**	**4 953**	**5 428**	**5 486**	**5 514**	**5 550**	**5 601**	**5 664**

Source: ARE S.A. own study (STEAM-PL), EUROSTAT

5.1.3.7. Primary energy intensity

The table below presents the ratio of primary energy intensity to GDP for the ECP scenario. The indicator is gradually decreasing throughout the timespan considered in correspondence to the improvement in energy efficiency in the economy. As is shown by the comparisons, energy intensity per unit of GDP has been decreasing in Poland over the last several years more than twice faster than on average in the EU (it dropped

[21] Regulation of the Minister of Economic Development and Finance of 1 August 2017 on the requirements for solid fuel boilers.

by approx. 30% relative to 2005). The primary energy intensity of GDP calculated for 2015, which amounts to 207 toe/EUR'2016 million, was almost twice higher than the EU average (approx. 89% according to EUROSAT data). The comparisons made indicate that there is significant potential for further efficiency improvement, but it is certainly not overly large and not easily obtainable. Another point is that the energy intensity index calculated by reference to the purchasing power parity (PPP), which was only 17% higher than the EU average in 2014, would be a much better indicator. The high values of the indicator lie not so much in low energy efficiency, but rather in the low values of GDP. The figure below compares the primary energy intensity/GDP ratio for the ECP and REF scenarios, while the next one compares the primary energy intensity relative to GDP for 2015 and its projected value for Poland against the background of EU countries.

Table 47. Primary energy intensity in relation to GDP [toe/EUR'2016 million]

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Country total – ECP scenario	292	254	207	181	152	128	111	99

Source: ARE S.A. own study

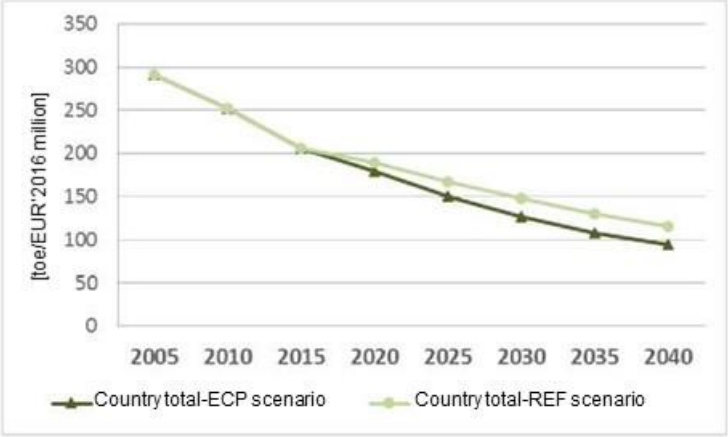

Figure 18. Ratio between primary energy intensity and GDP – ECP vs REF, Source: ARE S.A. own study

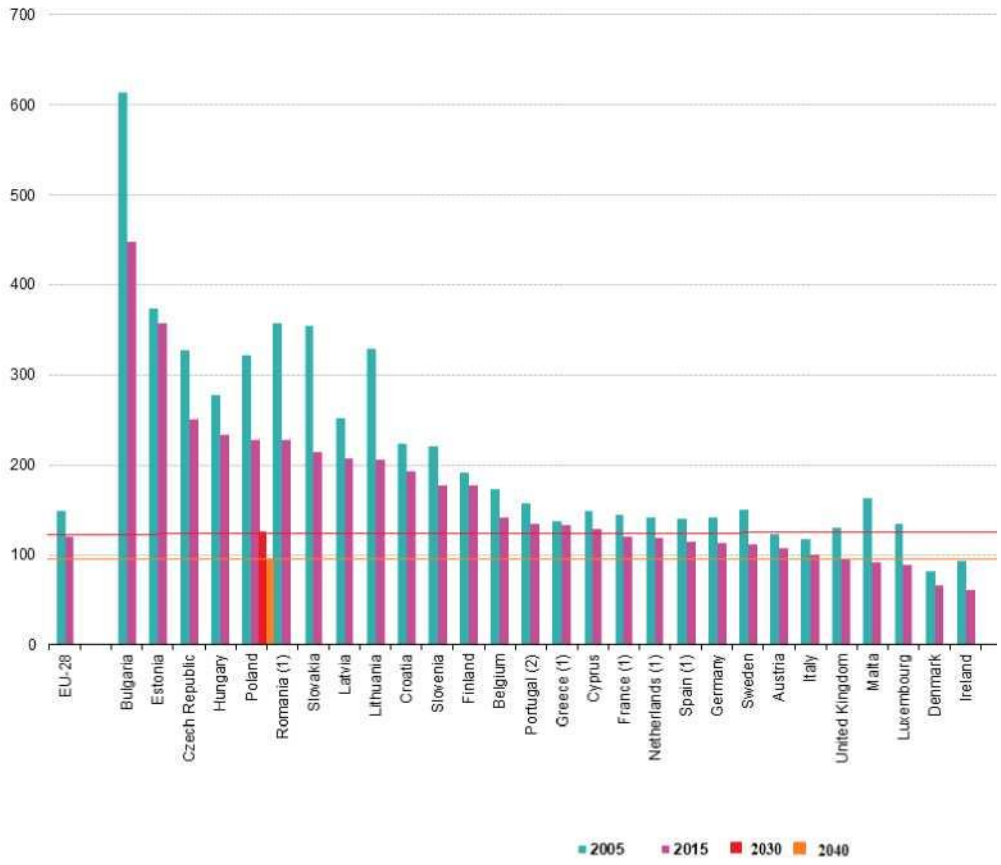

Figure 19. Primary energy intensity in Poland against the background of EU countries, Source: Eurostat, ARE S.A. (projections for Poland)

5.1.3.8. Final energy intensity by sector

The table below presents the ratios of final energy intensity by sectors. As is shown by the data, the indicators improve gradually over the period under analysis across the sectors of the national economy. The total final energy intensity for the country improves almost twice in 2015-2040. It decreases by 35% until 2030.

Table 48. Final energy intensity by sectors [toe/EUR'2016 million]

	2005	2010	2015	2020	2025	2030	2035	2040
Country total	**196**	**175**	**144**	**134**	**111**	**94**	**83**	**75**
Industry	225	156	139	132	114	100	92	85
Transport	677	930	644	727	654	581	538	501
including: passenger	no data	no data	347	324	278	236	225	217
freight	no data	no data	289	396	370	339	308	278
Services	41	43	34	30	26	22	20	18
Agriculture	431	363	349	385	364	344	326	311
Households [toe/household]	1524	1632	1357	1341	1198	1092	1059	1043

Source: ARE S.A. own study

5.1.3.9. Fuel input in electricity and heat generation

The table below presents projections of the consumption of fuels for the purposes of electricity and heat generation. The 2015-2040 consumption figures are a derivative of the optimal structure of electricity and heat production and capacity in the country determined by the dedicated model (MESSAGE-PL) and is described in detail further on.

The key conclusion that can be drawn from the results obtained is the anticipated phasing-out of coal and lignite use in the power and heating sectors, mainly due to the rising cost of CO_2 emission allowances, the need to put out of service units that are not able to meet environmental requirements, and the adverse regulatory and market environment for high-carbon plants. This is done with parallel increase in the share of fuels and technologies that are less burdensome for the natural environment (RES, gas, nuclear energy). Thanks to the introduction of a capacity market and the operation of mechanisms mitigating the effects of the sector's transformation (which is taken into account in the model), a major decrease in the consumption of coal by the power sector is noticeable only after 2030. The prices of CO_2 emission allowances assumed in the forecasting model in accordance with the Commission's recommendations rise in this period to 3040 EUR/tCO_2, pushing coal-fired plants out of the merit order curve. However, the prices of CO_2 emission allowances are a key element of uncertainty in the results obtained. During the period under consideration, the consumption of coal in the production of electricity and district heat falls from 35.3 Mtoe in 2015 to 26.6 Mtoe in 2030 and 14.9 Mtoe in 2040, which means a decrease of 25% by 2030 and 58% by 2040.[22]

Table 49. Fuel input for electricity and heat generation [ktoe]

	2005	2010	2015	2020	2025	2030	2035	2040
Power plants								
Coal	2 265	1 118	507	4 722	5 925	5 990	6 047	4 796
Petroleum products	10	4	1	6	5	5	6	3
Gas	1	0	0	0	188	571	1 587	2 019
RES, waste	6	61	441	450	447	416	416	0
Combined heat and power plants								
Coal	34 392	33 935	32 375	24 369	22 282	19 746	12 223	9 681
Petroleum products	555	558	403	337	334	324	301	289
Gas	1 182	1 093	1 347	2 259	2 562	3 018	3 582	4 277
RES, waste	435	1 547	2 021	2 696	3 473	4 592	4 909	5 414
Nuclear fuel	0	0	0	0	0	0	4 624	6 936
Heat plants								
Coal	3 063	3 360	2 403	1 864	1 278	856	565	394
Petroleum products	52	36	16	23	21	20	21	24
Gas	295	277	209	154	127	111	105	109
RES, waste	40	47	42	82	193	404	423	448

Source: ARE S.A. own study (MESSAGE-PL)

5.1.3.10. Fuel input in other conversion processes

The transformation sector comprises the industrial plants that use technological processes where one form of energy (usually primary energy carriers, e.g. coal) is converted into another, derivative form of energy (e.g. electricity, heat, coke, gas from technological processes, etc.). In addition to power plants, combined heat and power plants and heating plants, which are discussed in the previous section, the transformation sector also includes refineries, petrochemical plants, gas works, coking plants, patent fuel plants and blast furnaces. Table 50 illustrates the total fuel consumption in these units. The presented data shows a slight increase in consumption associated with the growing needs of the developing economy. The consumption of all the fuel/energy carrier categories defined in the table consumed as fuel input in conversion processes is expected to increase. After 2030, the amount of processed oil decreases on account of the changes anticipated in transport (replacing petroleum fuels with other, more environmentally friendly types).

Table 50. Fuel input in other conversion processes [ktoe]

	2005	2010	2015	2020	2025	2030	2035	2040
Crude oil	18432	23188	26537	27247	27227	26784	26861	26754
Coal	9519	10559	11063	11197	10713	10601	10562	10606

[22] In accordance with the EUROSTAT methodology (based on which all statistical data presented in this document is prepared), combined heat and power plants include units that generate even minimal amounts of heat (also in separate production processes, e.g. heating boiler units of utility power plants). There are few such units so the figures are small.

Petroleum products	1085	1703	1906	1864	1916	1942	1982	2009
Gas	204	308	638	649	630	596	571	545
RES, waste	0	0	0	0	0	0	0	0

Source: ARE S.A. own study (STEAM-PL)

5.1.3.11. Production of electricity through high-efficiency cogeneration

An indisputable advantage of cogeneration systems is their high energy efficiency, which significantly reduces the consumption of primary fuels, which in turn reduces emissions of CO_2 and other pollutants. In cogeneration plants, most energy savings are produced by more complete use of energy supplied in the fuel thanks to the utilisation of residual heat that accompanies separate production of useful heat and electricity. It follows from analyses, *inter alia* those carried out by ARE S.A., that Poland has the potential to install another 7.5 to 10 GW of cogeneration capacity[23][24]. The new support scheme introduced by the Act of 14 December 2018 on the promotion of electricity from high-efficiency cogeneration should boost the growth of cogeneration and district heating and investment in new CHP sources, and the retrofitting of existing ones.

In the simulations under the model, the rate of cogeneration development in Poland is determined on the basis of projected useful heat demand, taking into account economic factors, and assuming continued support for high-efficiency cogeneration. The results of the calculations (table below) are indicative of an increase in the volume of electricity produced through high-efficiency cogeneration from approx. 26.2 TWh in 2017 to over 36.5 in 2030, which means a 30% growth. Further increase in production can also be expected until around 2035, after which electricity production will stabilise at 39 TWh (table below). The fastest-growing technologies include gas-fired CHP plants (the choice of the solution is particularly warranted by the availability of fuel and competitiveness in the face of the rising prices of CO_2 emission allowances), and renewable energy technologies supported by auctions (biomass and biogas).

Table 51. Electricity production through high-efficiency cogeneration [GWh]

	2015	**2020**	**2025**	**2030**	**2035**	**2040**
Total production	**26 290**	**31 619**	**33 886**	**36 596**	**38 598**	**38 979**

Source: ARE S.A. own study (MESSAGE-PL)

Despite the expected increase in electricity production through high-efficiency cogeneration, its percentage share in the total electricity generation nationwide will rise very moderately, from 16.0% in 2015 to 18.3% in 2030, to remain stable until 2035 and decrease gradually in the following years (table below). The differences between the ECP and REF scenarios result from the projected lower demand for useful heat and the steep increase in generation by electricity-only units (wind, photovoltaic and gas and nuclear after 2030).

Table 52. Percentage share of high-efficiency cogeneration in electricity production – ECP vs REF

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
ECP	12.9%	17.6%	15.9%	19.3%	20.8%	18.5%	17.8%	19.1%
REF				19.3%	21.0%	21.4%	23.9%	24.4%

Source: ARE S.A. own study (MESSAGE-PL)

5.1.3.12. Production of heat in power plants, combined heat and power plants and heating plants

Currently, approx. 66%[25] of useful heat comes from cogeneration, while the remaining portion is produced in water boilers (heating plants and heating boiler units of utility power plants). Consequently, Poland has considerable potential that can be tapped primarily through the conversion of water boilers that do not meet the environmental requirements into cogeneration units. In addition, there are technical possibilities of utilising

[23] "Raport o stanie kogeneracji w Polsce w latach 2007-2014" (Report on the state of cogeneration in Poland in 2007-2014), ARE S.A.. Warsaw, 2015.
[24]"Kogeneracja - wczoraj, dziś, jutro" (Cogeneration – yesterday, today, tomorrow), ARE S.A.. Warsaw 2016.
[25] Gospodarka paliwowo-energetyczna (Fuel and Energy Economy), GUS, Warsaw 2016

waste heat generated by industrial installations or other installations that produce waste heat. Micro-cogeneration and prosumer energy offer further opportunities.

The results indicate that heat production in combined heat and power plants will increase from approx. 185 PJ in 2015 to 213 PJ in 2025 to decrease gradually to approx. 206 PJ in 2030. **The decrease results from the lower overall demand for district heat over the period as a result of the efficiency measures taken, notably support provided for thermomodernisation and renovation investment projects**. In the last decade, there is a noticeable increase in production to around 213 PJ in 2035 and maintenance of the production level in the years that follow, mainly as a result of further replacement of coal-fired boiler plants by cogeneration units. As a consequence, heat production in heating plants will decline considerably – a fall of over 50% by 2040. There is a pronounceable decrease in heat production from coal, which stems from a shift towards natural gas and renewable energy in CHP plants, and from replacement of old coal-fired boilers into biomass-fired units in heating plants.

Table 53. Production of heat in power plants, combined heat and power plants and heating plants [TJ]

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Total production	**336 391**	**335 831**	**280 106**	**290 684**	**275 843**	**259 615**	**256 690**	**258 732**
Power plants	0	0	0	0	0	0	0	0
Combined heat and power plants	219 883	205 851	185 339	207 729	213 015	205 980	213 620	212 328
Heat plants	116 508	129 980	94 767	82 955	62 828	53 635	43 070	46 404

Source: ARE S.A. own study (MESSAGE-PL)

The table below compares the results for the ECP and REF scenarios. The differences in heat production volumes are attributable to the lower heat demand in the ECP scenario. There is also a decrease in the use of coal in the ECP scenario. The next table compares heat production in power plants and combined heat and power plants between the ECP and REF scenarios.

Table 54. Percentage share of cogeneration in district heat production – ECP vs REF

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
ECP	65.4%	61.2%	66.2%	71.5%	77.2%	79.3%	83.2%	82.1%
REF				68.1%	71.4%	73.3%	76.0%	75.1%

Source: ARE S.A. own study (MESSAGE-PL)

Table 55. Production of heat in combined heat and power plants and heating plants by type of generation unit [TJ] – ECP vs REF

	2020	**2025**	**2030**	**2035**	**2040**
Combined heat and power plants (ECP)	207 729	213 015	205 980	213 620	212 328
Combined heat and power plants (REF)	200 060	218 230	230 000	244 539	247 396
% difference (ECP-REF)	3.7%	-2.4%	-11.7%	-14.5%	-16.5%
Heating plants (ECP)	82 955	62 828	53 635	43 070	46 404
Heating plants (REF)	93 662	87 302	83 902	77 096	82 182
% difference (ECP-REF)	-11.4%	-28.0%	-36.1%	-44.1%	-43.5%

The figure below presents heat production and the share of electricity and heat generated through cogeneration in relation to total electricity and heat production, based on the results presented in the tables above.

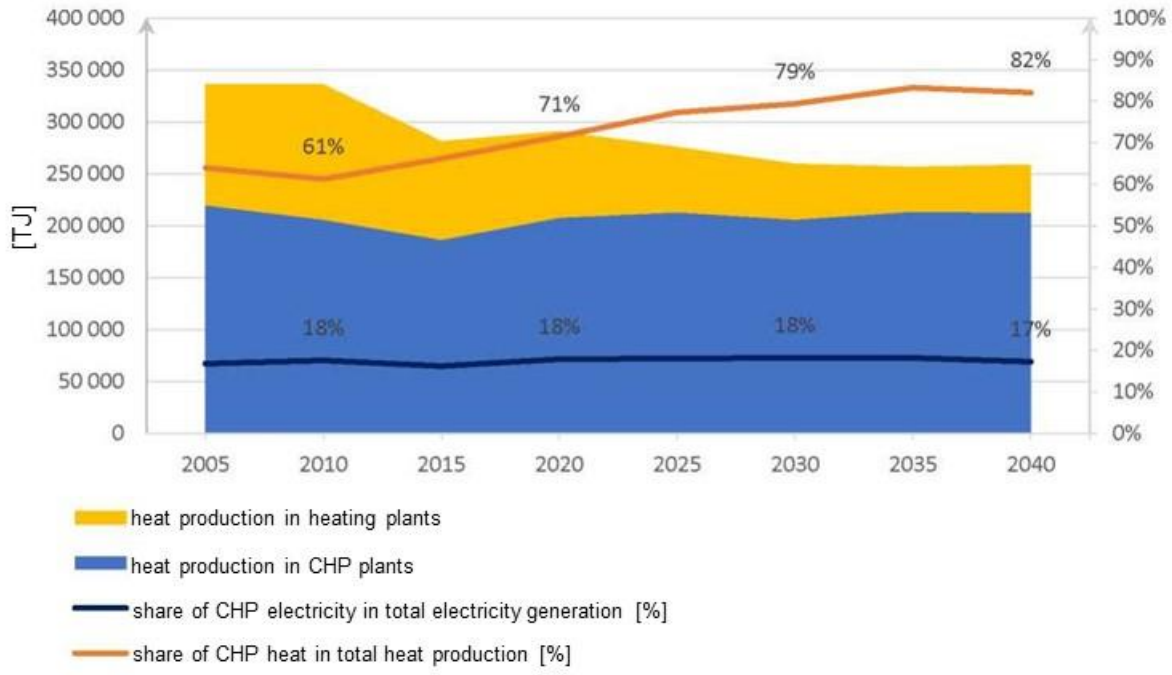

Figure 20. Heat production [TJ] and the share of electricity and heat generated through cogeneration in relation to total electricity and heat production [%]

5.1.4. 'Energy Security' dimension

5.1.4.1. Domestic production by fuel type

Table 56 illustrates the volume of domestic supply of individual fuels and energy carriers until 2040. The following conclusions can be drawn from the results obtained:

- Production of **hard coal** declines throughout the period – from 32.1 Mtoe in 2015 to 22.6 Mtoe in 2030 and 16.2 in 2040 (in natural units, this is 59.6 million t, approx. 36 million t and approx. 30 million t, respectively). The downward trend is associated with the decreased demand across the sectors of the domestic economy – for households to a much greater extent than in the REF scenario. The decrease in demand for coal in industry will be mainly attributed to the upgrade of production processes. In households and services, as part of anti-smog efforts, inefficient manually fed boilers will gradually be replaced by boilers meeting higher environmental standards (high energy conversion efficiency) and coal-based technologies will be replaced by more environmentally friendly ones (RES, gas, district heating). In the ECP scenario, the Clean Air programme and far-reaching thermomodernisation efforts will add considerably to the decrease in coal demand. Furthermore, it is worth stressing that to enhance the effectiveness of measures envisaged in air quality programmes and short-term action plans local governments have been provided with an additional tool as part of the amendment to the Environmental Protection Law (also known as the Anti-Smog Act) of 10 September 2015 (Journal of Laws of 2015, item 1593). Pursuant to Article 96 of the Environmental Protection Law of 27 April 2001 (Journal of Laws of 2017, item 519, as amended) provincial assemblies may, by resolution, restrict or prohibit the operation of installations in which fuels are combusted, in order to prevent an adverse impact on the environment. At the same time, such resolutions specify the types or quality of fuels that can be used or prohibited from being used.

  The decommissioning of end-of-life generation units is bound to accelerate after 2030. The construction of new coal-fired units (except those for which the investment decision has already been made) will be more hindered in economic terms by the increasing prices of CO_2 emission allowances, ever tighter environmental requirements and the EU's energy and climate policy. The Ostrołęka power unit is likely to be the last conventional coal-fired power plant built in Poland. Work on clean coal technology (CCT) may slow down the downward coal consumption trend, but foreign experience has not proven conclusively that CCT technology can be competitive. Installations fitted with CCS can only be competitive with high prices of CO_2 emission allowances, i.e. in excess of EUR 50/t.

- Extraction of **coking coal** (closely related to coke production) will fall slightly in the long term, from 9.2 Mtoe to 8.6 Mtoe in 2040. Domestic and foreign demand for coke depends on the rate of global economic growth, which means that it is subject to high, unforeseeable fluctuations. Consequently, the actual level of production may deviate considerably from the forecasts.

- The supply of **lignite** drops significantly after 2030. It is assumed that no new units will be built other than the one under construction in Turów (455 MW). The Złoczew and Ościsłowo opencast mines, which are to be launched, will supply lignite for existing generation units.

- The level of **crude oil** production will remain stable (relatively low – at around 1 Mtoe), as will domestic **natural gas** production (approx. 3.6-4 Mtoe per year).

- Fostering domestic production of first generation biofuels and launching domestic production of second and third generation biofuels are expected in response to the growing demand in the transport sector. With the use of first generation biofuels, the maximum allowable 7% share in diesel and petrol consumption can be achieved. The remaining amount of biofuels necessary to achieve the assumed RES share ceilings in the sector will be produced or imported in the form of first and second generation HCO/COHVO.

- In 2015-2030, **solid biomass** production will increase by around 56% in 2015-2030, and by 63% by 2040. The demand for biomass is bound to grow in all sectors. Along with the increase in prices of CO_2 emission allowances, the profitability of biomass utilisation in dedicated boilers, hybrid systems and installations co-firing coal should increase in the electricity and heating sector. In the household and service sector, intensified use of biomass will be associated with the replacement of outmoded coal boilers with modern pellet-fired ones. Importantly, this will be supported by the introduction as from 2021 of biomass certification to confirm compliance with EU-wide sustainability criteria. In addition, when calculating the reduction of greenhouse gas emissions from biomass, account will be taken of the release of carbon into the atmosphere, which will also affect the attractiveness of using biomass as fuel.

- Uranium ore mining and processing into nuclear fuel within Poland is not planned, but production of uranium by unconventional methods is not ruled out in the long run.

Table 56. Domestic production by fuel type [ktoe]

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Coal	45 736	35 302	32 136	29 367	27 433	22 615	18 831	16 210
Coking coal	9 948	8 216	9 155	9 339	8 809	8 668	8 588	8 564
Coke	5 721	6 701	6 666	6 653	6 397	6 401	6 456	6 560
Lignite	12 736	11 559	12 299	10 637	11 110	11 095	5 971	3 761
Crude oil	840	681	914	1 000	1 000	1 000	1 000	1 000
Natural gas	3 884	3 693	3 683	3 595	3 627	3 653	3 675	3 694
Nuclear fuel	0	0	0	0	0	0	0	0
Biofuels	117	446	936	1 100	1 133	1 042	1 006	972
Solid biomass	4 166	5 866	6 268	7 356	8 385	9 753	9 986	10 193

Source: ARE S.A. own study (STEAM-PL)

5.1.4.2. Net imports by fuel type

The import-export balance plays an important role in determining the ways of meeting demand and deciding on the electricity production mix, and influences the price of this carrier on the wholesale market.

Since 2014, a clear upward trend in the share of electricity imports has been observable in the National Power System (NPS) as a result of the growing import and export capacities and intensive subsidisation of RES, which are unstable energy sources, by neighbouring countries.

By around 2023, Poland is expected to become a net importer of electricity, unless extraordinary circumstances lead to a change in the current price relationships at interconnectors.

The planned completion of the decommissioning of German nuclear power plants in 2023 and the general

reduction in overcapacity in Central and Western Europe as a result of the shutdown and replacement of conventional energy sources may drive up prices on European energy markets. In addition, the country's energy security will be strengthened by the launch of a capacity market and commissioning of new investments (including Opole, Jaworzno, Turów, and Ostrołęka). **The strategic analyses for the NECP (i.e. of strategic nature) do not assume that the country's energy security will be based on imports.** Neither the Polish Government nor the transmission system operator are in the position to ensure availability of excess power from other EU Member States. Therefore, in the remainder of the forecast, the electricity import and export balance is expected to remain at a near-zero level, in keeping with the assumption of maintaining maximum energy self-sufficiency.

However, it must be emphasised that the precise determination of future volumes of exchange at existing and planned interconnections is characterised by high uncertainty, especially as regards the anticipated electricity prices on wholesale markets in neighbouring countries, which determine the direction and volume of transboundary trade, given that they are largely dependent on weather conditions, the legislative and regulatory environment, and many other fortuitous factors, including emergency shutdowns of power units.

Table 57. Net electricity import-export balance [ktoe]

	2005	2010	2015	2020	2025	2030	2035	2040
Electricity	-962	-116	-29	65	0	0	0	0

"-" before the value stands for exports
"+" before the value stands for imports
Source: ARE S.A. own study (MESSAGE-PL), Eurostat

The table below summarises the current situation and forecasts for net imports of other energy carriers. The data presented in the table shows the need for a slight increase in crude oil imports. Efforts to improve energy efficiency can slow down the very dynamic rate of growth in the consumption of petroleum products in transport. The negative consequences of implementing the PaMs include an increase in natural gas imports and considerable deterioration of the country's energy self-sufficiency. Steady hard coal exports is assumed in connection with the efforts to ensure liquidity, viability, and economic and financial efficiency of the hard coal mining sector.

Table 58. Net import-export balance [ktoe]

	2005	2010	2015	2020	2025	2030	2035	2040
Coal	-8 161	489	-1 588	-660	-3 148	-3 179	-3 101	-3 028
Coking coal	-1 801	944	275	57	148	223	286	342
Coke	-3 068	-4 227	-4 333	-4 090	-3 983	-4 101	-4 221	-4 341
Lignite	-2	-19	16	14	15	15	8	5
Crude oil	17 741	22 484	26 311	26 533	26 515	26 074	26 153	26 048
Natural gas	8 531	8 874	9 947	12 952	13 663	14 468	16 002	16 968
Nuclear fuel	0	0	0	0	0	0	4 624	6 936
Biofuels	-65	427	-144	397	409	376	363	350
Solid biomass	0	0	506	540	638	769	792	811

Source: ARE S.A. own study (STEAM-PL, MESSAGE-PL), Eurostat

Import dependency from third countries is defined as the total volume of energy imports from non-EU countries to gross inland energy consumption.

Table 59. Import dependency from third countries

	2005	2010	2015	2020	2025	2030	2035	2040
Electricity	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Coal	4.2%	13.1%	8.6%	9.3%	0.9%	0.5%	0.5%	0.5%
Coking coal	0.3%	18.3%	17.0%	15.3%	17.3%	18.4%	19.3%	20.0%
Coke	0.5%	1.2%	2.1%	3.4%	3.9%	4.4%	4.7%	4.9%
Lignite	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Crude oil	95.7%	95.9%	99.0%	97.2%	97.2%	97.2%	97.2%	97.2%

Natural gas	67.7%	61.8%	52.6%	59.0%	63.0%	65.4%	68.2%	69.8%
Nuclear fuel	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%
Biofuels	0.0%	0.0%	6.5%	4.9%	4.9%	4.9%	4.9%	4.9%
Solid biomass	0.0%	0.0%	8.5%	7.8%	7.8%	7.8%	7.8%	7.8%
Total import dependency	**12.9%**	**28.2%**	**29.7%**	**33.2%**	**32.5%**	**33.9%**	**38.6%**	**41.2%**

Source: ARE S.A. own study

In 2015, Poland's import dependency was at a level of 29.7%. In light of the results of projections, it is bound to increase in the coming years, mainly due to imports of fossil fuels.

5.1.4.3. Main sources of imports (countries)

With respect to the main sources of imports, use is made of an expert approach that is based on an analysis of current directions of supply and prospects for the emergence of new sources. Therefore, for the majority of fuels and energy carriers analysed, no significant changes in the key sources of imports are expected (imports directions are largely determined by global developments, which are difficult to predict), with the exception of natural gas, which has been previously dominated by one supplier. The government's strategy provides for the diversification of gas supplies by the completion of an investment for transporting gas from Norway and by the intensification of purchase of liquefied gas from the United States.

Table 60. Main sources of imports (countries)

	2005	2010	2015	2020	2025	2030	2035	2040
Electricity	Germany	Germany	Sweden	Sweden	Sweden	Sweden	Sweden	Sweden
	Ukraine	Sweden	Germany	Germany	Germany	Germany	Germany	Germany
	Belarus	Czech Republic	Czech Republic	Lithuania	Lithuania	Lithuania	Lithuania	Lithuania
Coal	Russia	Russia	Russia	Russia	Russia	Russia	Russia	Russia
	Ukraine	Czech Republic	Czech Republic					
		Ukraine	Colombia					
		Kazakhstan						
Coking coal	Czech Republic	USA	Australia	Australia	Australia	Australia	Australia	Australia
	Australia	Czech Republic	Czech Republic	USA	USA	USA	USA	USA
	Germany	Australia	USA	Russia	Russia	Russia	Russia	Russia
Coke	Czech Republic	Czech Republic	Russia	Russia	Russia	Russia	Russia	Russia
		Russia						
Lignite	-	Germany	Czech Republic	Germany	Germany	Germany	Germany	Germany
			Germany					
Crude oil	Russia	Russia	Russia	Russia	Russia	Russia	Russia	Russia
		Norway	Iraq					
Natural gas	Russia	Russia	Russia	Russia	Norway	Norway	Norway	Norway
	Uzbekistan	Germany	Germany	Germany	USA	USA	USA	USA
	Kazakhstan			USA	Germany	Germany	Germany	Germany
Nuclear fuel	-	-	-	-	-	-	No data	No data
Biofuels	-	No data	Germany	Germany	Germany	Germany	Germany	Germany
	-	-	Netherlands					
	-	-	Switzerland					
Solid biomass	-	No data	No data	No data	No data	No data	No data	No data

Source: ARE S.A. own study

5.1.4.4. Gross inland fuel and energy consumption

The gross inland consumption of individual fuels and energy carriers are presented in the table below[26]. The following conclusions can be drawn from the presented data:

- An increase of inland **electricity** consumption in 2015-2030 – in absolute values, total electricity consumption increases from 14.2 Mtoe (164.6 TWh) in 2015 to 17.3 Mtoe (201.2 TWh) in 2030 to grow to 19.4 Mtoe (225.8 TWh) in 2040. The average annual growth rate in this category is 1.2% in 2016-2040. This pace is only achievable on conditions that decisive measures are taken to improve the efficiency in the use of electrical devices across the sectors of the national economy.
- The increase in the consumption of electricity by households is a consequence of the growing wealth of Poles (as measured by disposable income), the rising number of dwellings equipped with more and more appliances and their intensifying use, even though the declining consumption of electricity by these devices will slow down the pace.
- The increase in electricity consumption in industry will be mainly driven by the growing manufacture of industrial products, and by the modernisation and mechanisation of manufacturing plants.
- More electricity is also expected to be utilised in transport. In rail transport, this will be mainly driven by the improvement of the quality of rail passenger transport services and its growing popularity, while in road transport by the development of e-mobility.
- Unlike the REF scenario, a decrease in **district heat** consumption is expected as a result of the thermomodernisation of buildings (including single-dwelling ones). The projection assumes that measures to mitigate 'low-stack' emissions will provide incentives for investments in district heating development, which will slow down the downward trend, notably by increasing the number of users connected to district heating networks, even though the demand per consumer will be lower.
- The consumption of **coal and lignite** is expected to decrease as a result of the implementation of the energy and climate policy, including the reduction of emissions, high prices of CO_2 emission allowances, and limited consumption of coal by households, but also as a result of improved efficiency of generating units. The decline in coal consumption in the electricity and heating sectors accelerates considerably in 2030-2040.
- Inland consumption of crude oil and petroleum products is expected to stabilise as a result of actions taken to reduce consumption and emissions of pollutants in transport, which includes promoting alternative fuels and electromobility.
- The forecast anticipates further gradual increase in the demand for renewable energy carriers, such as biomass, biogas, biofuels and renewable municipal and industrial waste, which is a natural consequence of the process of replacing fossil fuels in the energy mix.

Table 61. Gross inland fuel and energy consumption [ktoe]

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Electricity	12 532	13 440	14 154	15 258	16 156	17 297	18 289	19 412
District heat	8 032	8 021	6 721	6 721	6 626	6 204	6 153	6 204
Coal	37 651	39 774	31 248	28 707	24 284	19 436	15 731	13 181
Coking coal	7 891	8 700	9 489	9 396	8 957	8 891	8 874	8 906
Coke	2 318	2 074	2 228	2 563	2 415	2 299	2 235	2 219
Lignite	12 726	11 576	12 283	10 651	11 124	11 110	5 979	3 766
Crude oil	18 459	23 184	26 506	27 247	27 227	26 784	26 861	26 754
Petroleum products	21 987	25 956	24 074	31 280	31 225	31 060	30 817	30 510
Natural gas	12 235	12 805	13 776	16 547	17 290	18 121	19 677	20 662
Coke oven gas	1 447	1 707	1 704	1 535	1 449	1 409	1 416	1 419
Blast furnace gas	560	526	632	576	532	489	454	428
Other gaseous fuels	161	149	163	88	76	76	75	75
Solid biomass	4 166	5 866	6 884	7 896	9 023	10 522	10 778	11 004
Biogas	54	115	229	284	318	352	388	425
Biofuels	54	868	664	1 497	1 542	1 418	1 369	1 322

[26] Gross inland fuel and energy consumption is calculated according to the following algorithm: (+) Final consumption
(+) Consumption in the electricity sector
(+) Consumption in the energy transformation sector
(-) Transmission and distribution losses
(+/-) Statistical differences
(=) Gross inland energy consumption

Nuclear fuel	0	0	0	0	0	0	4 624	6 936
Municipal and industrial waste	157	400	564	1 047	1 251	1 329	1 417	1 499

Source: ARE S.A. own study (STEAM-PL, MESSAGE-PL), Eurostat

5.1.4.5. Electricity and heat production

The table and graph below present data on the gross electricity and district heat production in Poland in the ECP scenario. As is shown by the projections, domestic electricity production is expected to grow from 164.9 TWh in 2015 to 201.2 TWh in 2030 and to 225.8 TWh in 2040. The percentage increase is 22% in 2015-2030 and 37% in 2015-2040. As regards domestic production of district heat, the projections anticipate a gradual decrease from 281 PJ in 2015 to 260 PJ in 2030 (over 7%) and stabilisation at a slightly lower level after 2030. The results of projections are based on the assumption that activities to improve the energy efficiency of buildings will be intensified through accelerated and more thorough renovation, and that the behaviour of heat energy consumers will change. Importantly, the volume of district heat production will be influenced by the projected number of heating degree-days, as recommended by the Commission, reflecting the global warming in our climate zone.

Table 62. Gross electricity and district heat production

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Electricity [GWh]	156 935	157 658	164 944	176 700	187 895	201 167	212 699	225 760
District heat [TJ]	336 292	335 831	281 393	290 684	275 842	259 615	256 690	258 732

Source: ARE S.A. own study (STEAM-PL, MESSAGE-PL), Eurostat

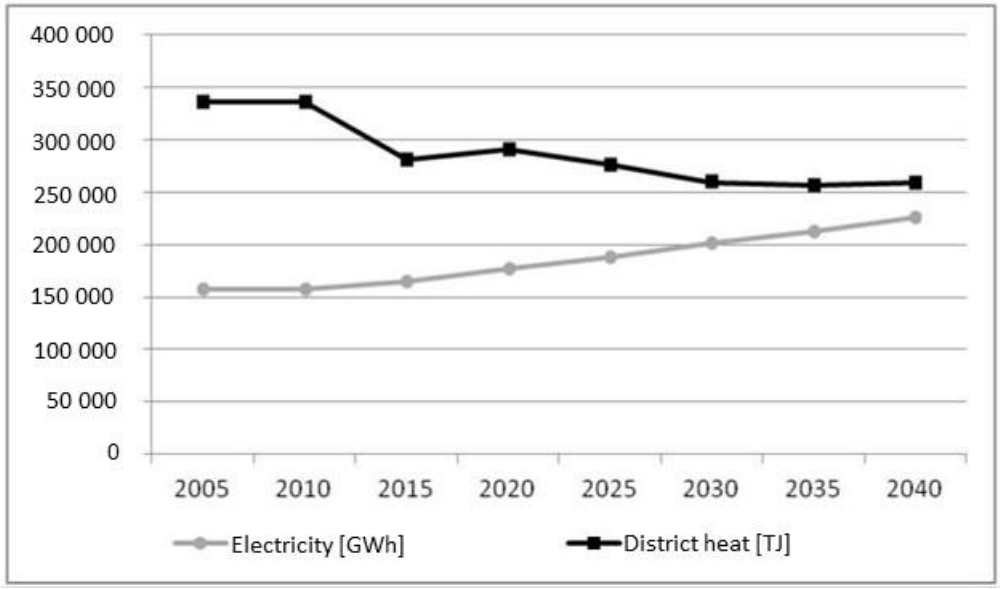

Figure 21. Gross electricity and district heat production

The table below compares the results of projections regarding electricity and district heat demand in Poland obtained for the ECP and REF scenarios. The slight discrepancies in electricity production are due to the forecast economic growth.

The results for heat vary greatly, which is attributed to the improvement of the efficiency of buildings and the 'Clean Air' programme. The decline occurs despite the stricter regulations regarding the obligation to connect customers to the network, as well as the wider use of district heating.

Table 63. Gross electricity and district heat production – ECP vs REF

		2015	2020	2025	2030	2035	2040
Electricity (ECP)	GWh	164 944	176 700	187 895	201 167	212 699	225 760
Electricity (REF)	GWh		178 374	192 875	204 915	212 924	220 887
Difference (ECP-REF)	%	-	-0.9%	-2.6%	-1.8%	-0.1%	2.2%
District heat (ECP)	TJ	281 393	290 684	275 842	259 615	256 690	258 732
District heat (REF)	TJ		293 722	305 532	313 902	321 635	329 578
Difference (ECP-REF)	%	-	-1.0%	-9.7%	-17.3%	-20.2%	-21.5%

5.1.4.6. Gross electricity generation by fuel

Electricity generation by fuel is presented in the table and figure below. An analysis of the lines of development of the national power sector indicate gradual shifts in the energy mix as a result of legislative and market developments. The development of renewable energy sources and requiring operators of coal-fired plants to purchase CO_2 emission allowances under the ETS will steadily decrease the share of coal-fired plants in the energy mix.

- The share of **coal-based units** in the generation structure is expected to decrease from approx. 80% in 2015 to approx. 56% in 2030 (113 TWh). The reduction in the share of coal will be mainly driven by the decommissioning of coal-fired units and the declining operating time of old coal-fired units, *inter alia* as a result of the expected enhanced use of low-carbon sources over the period (notably nuclear reactor units, high-efficiency steam-gas units and further upward trend in electricity generation from renewable energy sources, especially offshore wind farms and solar farms). Nevertheless, despite the high decline in the share, coal-fired power plants will still remain a crucial producer of electricity in the country, which is important for ensuring continued energy supplies to consumers. To a large extent, the power unit in Kozienice, the units in Opole and Jaworzno, and the unit in Ostrołęka contribute to this.

- The role of **gas-fired units** (the new ones mainly include high-efficiency gas-steam cogeneration units, and after 2024 also condensing units) grows from 4% in 2015 two and a half times until 2030 to grow at a similar pace to around 17% in 2040. The country's climate and energy policy will force the implementation of new low-carbon sources, a large proportion of which will be non-controllable intermittent renewable sources (wind farms and solar farms). Ensuring the anticipated number of such generation sources will require investing in flexible sources, demand side response (DSR), and energy storage, etc., which are necessary for the sources to be integrated with the power system. Therefore the presence of gas-fired units is crucially important for the operational security of the National Power System – gas-fired power plants are flexible enough to satisfy the increased requirements for the balancing of RES.

- The **share of renewable energy** in electricity production in 2015 (13%, 23 TWh) will more than double by 2030 (31.8%, approx. 64 TWh). By 2040, it will have reached approx. 40% (approx. 90 TWh), of which over three quarters will be produced from wind (approx. 55 TWh, 25% share in total production) and photovoltaics (ca. 15 TWh or 7%). The net volume of electricity generated from RES in 2040 may be up to four times higher than in 2015.

- The development of **nuclear energy** in Poland plays a central role in the decarbonisation policy. The first nuclear power plant unit is expected to be made operational by 2033, another two in 2035 and 2037, and three more at 2-3 year intervals. In 2040, the estimated production from nuclear power plants will be about 30.6 TWh, which translates into a 14% share in total electricity production.

Table 64. Gross electricity production [TWh]

	2005	2010	2015	2020	2025	2030	2035	2040
lignite	54.8	48.7	52.8	47.0	50.4	49.9	27.5	17.3
hard coal*	88.2	89.2	79.4	75.4	72.3	63.1	53.2	45.7
gaseous fuels**	5.2	4.8	6.4	12.0	15.3	20.7	31.3	38.4
fuel oil	2.6	2.5	2.0	1.9	1.9	1.9	1.8	1.7
nuclear energy	0.0	0.0	0.0	0.0	0.0	0.0	20.4	30.6
pumped-storage hydropower	1.6	0.6	0.6	0.6	0.8	0.9	1.2	1.5
hydropower	2.2	2.9	1.8	2.4	2.9	3.0	3.0	3.1

biomass	1.4	5.9	9.0	9.6	9.7	11.6	11.4	10.3
biogas	0.1	0.4	0.9	1.5	2.7	3.9	5.0	5.8
onshore wind	0.1	1.7	10.9	23.5	23.7	23.8	24.2	24.6
offshore wind	0.0	0.0	0.0	0.0	2.7	14.5	21.7	30.6
solar energy	0.0	0.0	0.1	2.0	4.5	6.8	10.8	14.8
other***	0.7	1.1	1.0	0.7	0.9	1.1	1.2	1.3
total	**156.9**	**157.7**	**164.9**	**176.7**	**187.9**	**201.2**	**212.7**	**225.8**

** Including coke oven gas and blast furnace gas*

*** Methane-rich and nitrogen-rich natural gas, mine demethylation gas, oil field gas *** Inorganic industrial and municipal waste*

Source: ARE S.A. own study (MESSAGE-PL), Eurostat

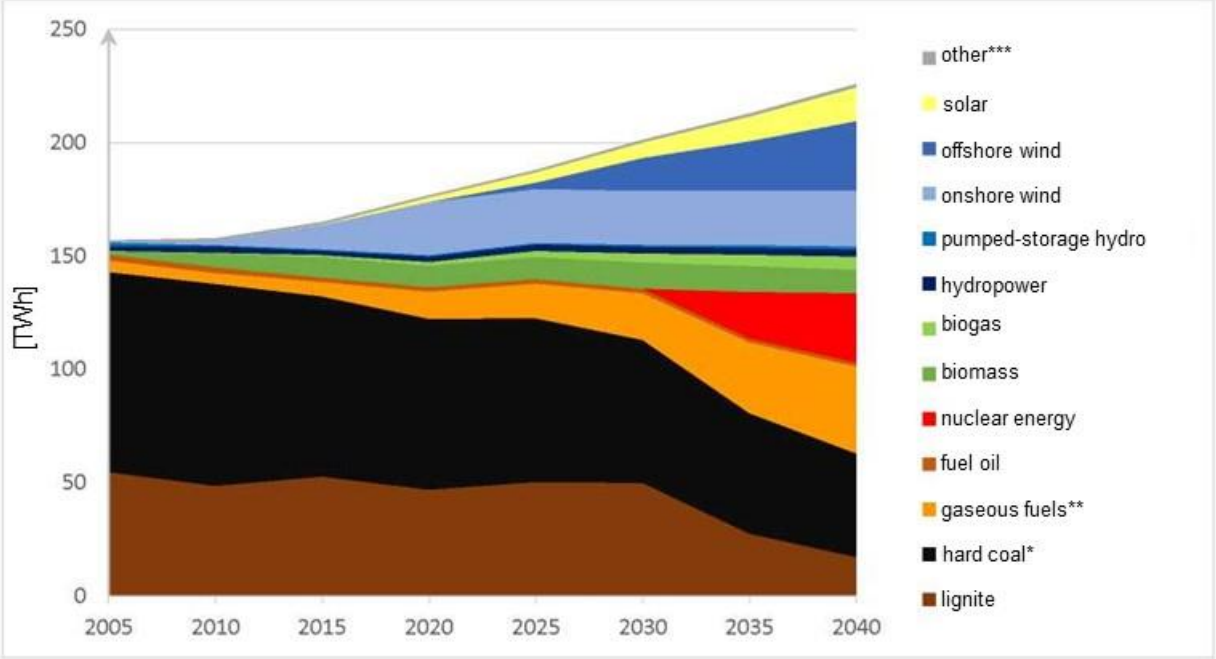

Figure 22. Gross electricity production in Poland by fuel [TWh]

The next figure presents the above-mentioned data at 5-year intervals and shows the share of coal fuels and renewable energy sources in electricity generation in 2020, 2030 and 2040. This illustrates the shift to take place in the energy mix in the next twenty years.

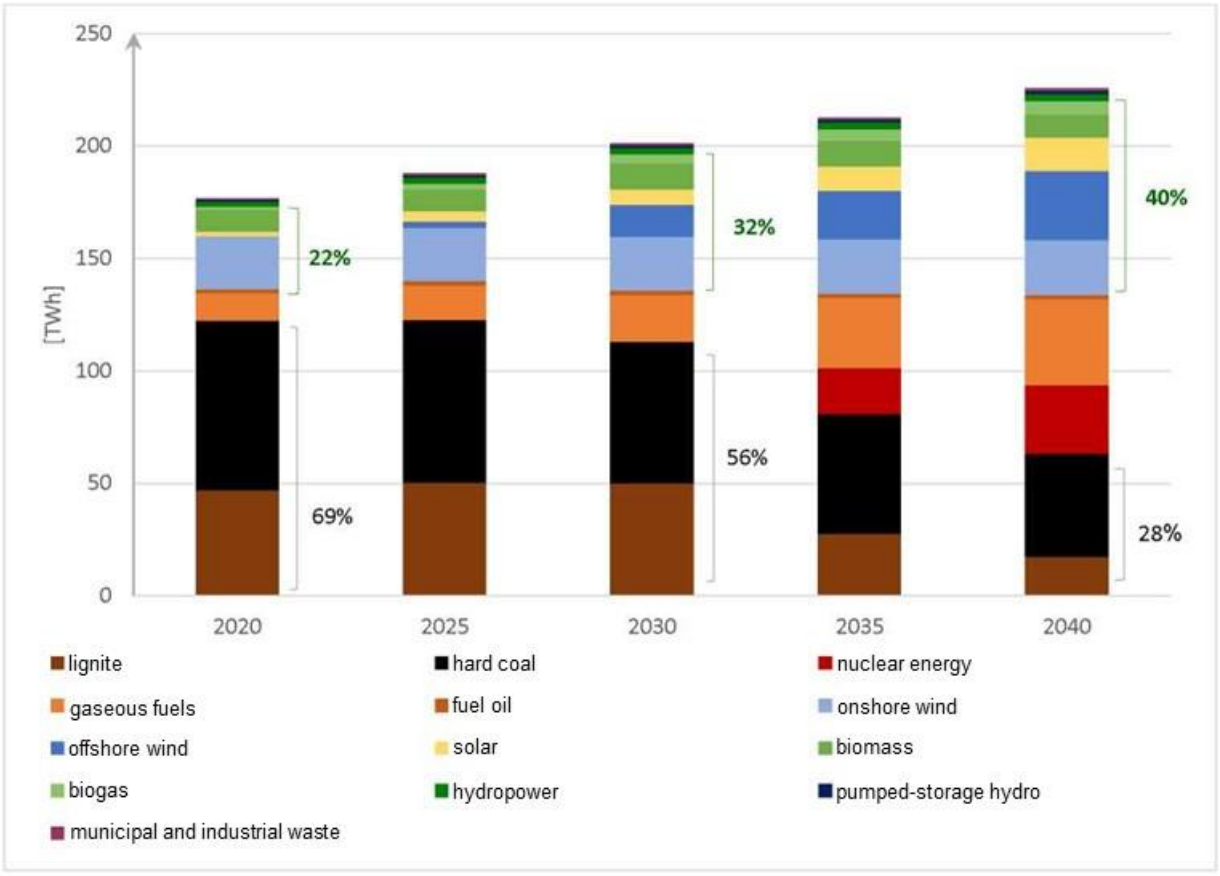

Figure 23. Gross electricity production in Poland by fuel [TWh] and shares of coal fuels and renewable fuels in the energy mix for 2020, 2030 and 2040

5.1.4.7. Electricity generation capacity by source

The results of analyses reveal a relatively large shift in the Polish electricity production mix until 2040, with the capacity of generation sources bound to increase from approx. 46 GW in 2018 (37.3 GW in 2015) to approx. 59 GW in 2030 (growth by ca. 58%) and to 72 GW in 2040, which means that it will almost double over the period (93%).

The share of **renewable energy sources** in the power balance increases gradually, from 18% in 2015 to about 40% in 2030 and 50% in 2040, mainly thanks to increased use of photovoltaic and wind power. There is an increase in the share of gas capacities, which are important for balancing the power system on account of the high operating flexibility they offer. Between 2030 and 2035, the **first nuclear unit** with a capacity of 1-1.5 GW appears in the electricity production mix (the projection assumes that a single unit will have a capacity of 1.3 GW, which does not imply what technology will be chosen). At intervals of 2-3 years, more units with a total installed capacity of approx. 6-9 GW will be made operational. The installed capacity of **energy storage** facilities and the level of DSR reserve capacities are bound to grow, too, as a result of the deployment of smart grids, increased awareness of energy consumers, and the expected popularisation of aggregators.

The projection envisages a reduction in the installed capacity of **coal-fired** utility power plants, especially past 2030. This applies in particular to near-end-of-life hard coal-fired units that will not meet the emissions requirements. Given their improved efficiency, the new coal-fired units that are currently under construction can generate more electricity with the same installed capacity (efficiency of approx. 38% vs ca. 45%). The share of installed capacity of coal- and lignite-fired units will fall from approx. 70% in 2015 to 40% in 2030 and to 19% in 2040.

The change in the fuel mix of installed capacity is **particularly noticeable after 2030**, which is connected with the decommissioning of end-of-life coal-fired units, which will be replaced by new, high-efficiency coal units (4.4 GW by 2025), development of renewable energy, construction of nuclear power units (3 units with a total

capacity of 4.5 GW), as well as with a major increase in the capacity of gas units (nearly 2 GW of new capacity may be created in gas-steam power plants by 2040). The capacity of lignite power plants is declining as a result of the decommissioning of existing units. A unit in Turów with a net capacity of approx. 450 MW is the only new lignite investment. The role of coal-fired CHP plants in the system will also be much less pronounced since most of the new cogeneration units will probably combust gas. By 2030, approx. 2.5 GW of this type of new units may be commissioned, with another 3.5 GW added in the following years until 2040. They will replace old coal-based power plants and combined heat and power plants, and after 2030, also some of the currently operating gas-fired CHP plants. Together with the new gas-steam power plants, they will improve the reliability of the power system operation, which is necessary with the large share of non-controllable renewable sources (wind and solar). Wind energy will continue to be the prevalent RES (66% of installed renewable energy capacity in 2040). The shares of the other sources in RES-E in 2040 are as follows: solar – 14.5%, biomass – 9.5% hydro – 6% and biogas – 3.5%.

Table 65. Net generating power of electricity sources by technology [MW]

	2005	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
lignite-fired pp – old	8 197	8 145	8 643	7 481	6 992	6 992	4 098	2 939
lignite-fired pp – new	0	0	0	451	451	451	451	451
coal-fired pp – old	14 613	14 655	13 617	12 126	10 867	7 983	3 539	3 184
coal-fired pp – new	0	0	0	3 520	4 450	4 450	4 450	4 450
coal-fired cp	6140	6126	4 046	4 713	4 383	3 544	3 123	2 714
industrial cp			1 925	1 973	1 740	1 710	1 898	1 826
gas-fired pp	0	0	0	0	1 900	1 900	3 039	3 260
gas-fired cp	760	807	928	2 688	3 807	4 371	4 100	5 261
nuclear pp	0	0	0	0	0	0	2 600	3 900
pumped-storage hydropower	1 256	1 405	1 405	1 415	1 415	1 415	1 415	1 415
hydroelectric power stations	1 064	935	964	995	1 110	1 150	1 190	1 230
biomass pp and cp	102	140	553	658	1 143	1 531	1 536	1 272
biogas cp			216	305	517	741	945	1 094
onshore wind	121	1 108	4 886	9 497	9 574	9 601	9 679	9 761
offshore wind	0	0	0	0	725	3 815	5 650	7 985
photovoltaics	0	0	108	2 285	4 935	7 270	11 670	16 062
gas turbines	0	0	0	0	0	0	350	350
DSR/energy storage/interconnectors	0	0	0	550	1 160	2 150	3 660	4 950
total	**32 253**	**33 320**	**37 290**	**48 656**	**55 167**	**59 073**	**63 391**	**72 103**

pp – power plants, cp – cogeneration plants
Source: ARE S.A. own study

The figures below show the evolution in generating power of sources for the timespan under study (area chart) and at 5-year intervals (bar chart). The graph below also illustrates the share of coal-based sources and renewable energy sources in the energy balance in 2020, 2030 and 2040. In the 2040 perspective, these values nearly reverse, although it must be remembered that capacity installed in renewable energy sources, which are more weather-dependent, has a lower share in production. At the same time, the greatest the capacity of intermittent sources, the more reserve capacity should be available in the power system. This drives the costs of energy production due to the need to incur the capital expenditures on the dual capacities and fixed costs of 'backup' power plants. Therefore, the installed capacity is higher in the ECP scenario than in REF, too.

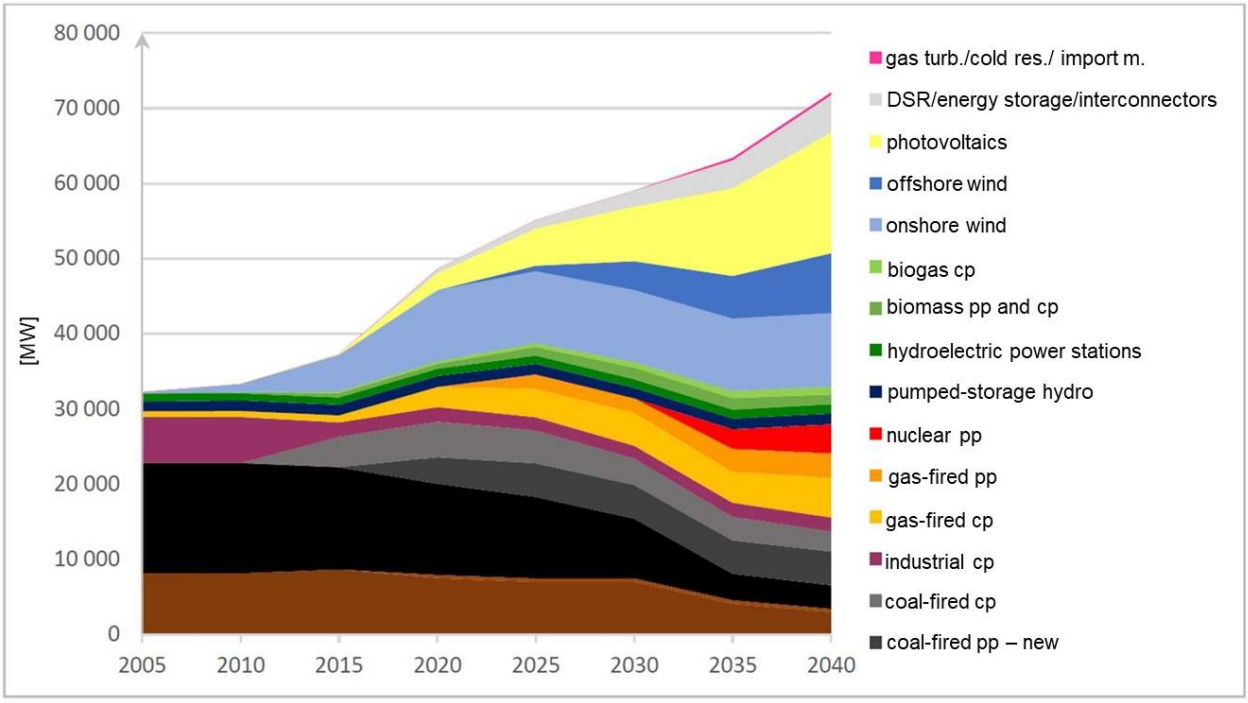

Figure 24. Generating power of electricity sources by technology [MW]

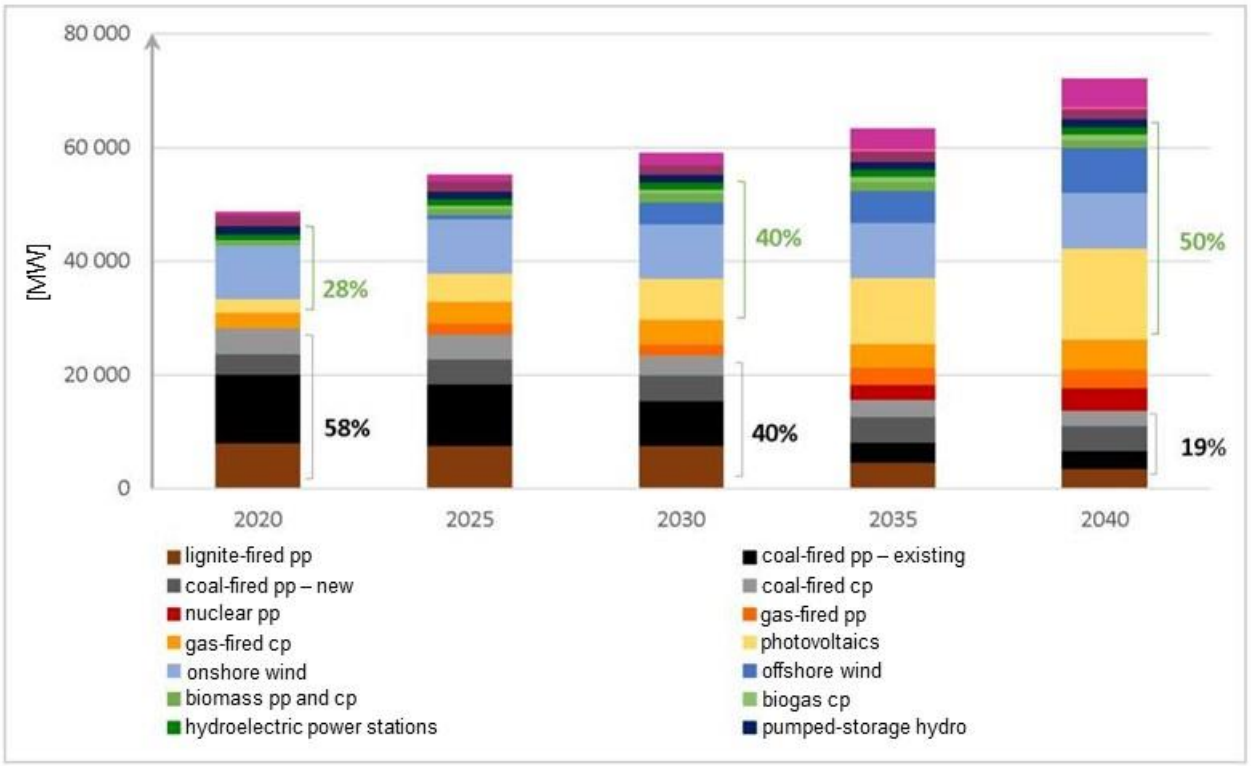

Figure 25. Generating power of electricity sources by technology [MW] and the share of coal and renewable fuels in 2020, 2030 and 2040 in the power balance

5.1.4.8. Projected decommissioning of power generation units

The timetable of the decommissioning of existing power units and retrofit plans will play an important role in building Poland's energy mix. The table below presents figures on decommissioned capacity, as broken down

into centrally dispatched generating units (CDGU) and non-centrally dispatched generating units (non-CDGU), i.e. those whose operation cannot be regulated by the transmission system operator. According to 2016-2040 estimates, approx. 26.5 GW of generation capacity will be permanently decommissioned, including approx. 15.8 GW of CDGU in thermal power plants and 3.2 GW in commercial combined heat and power plants from the non-CDGU group. The figure below illustrates the determined and planned permanent shutdowns of generating units in commercial and industrial power plants by technology.

The results are based on surveys conducted among power undertakings and information from annual reports of power undertakings. Since it was necessary to close the input of data into the analysis presented in this document, the figures given in the table may differ to some extent from the information presented in the latest documents of the transmission system operator, which always has the most recent and most detailed information in this regard. In addition, the shutdown timeline used in the projection optimisation model is based on expert assessment of the technical condition of the principal devices (boilers, turbines), the number of service hours, as well as derogations granted and the reasonableness of incurring capital expenditures in order to meet the EU requirements of emission standards following from the BAT conclusions, which can also produce discrepancies.

According to the analyses, the largest amount of generation capacity will be decommissioned after 2030, with the main sources being coal and lignite power plants. At the time, a large number of wind farms will also be shut down as a result of the end of life of the oldest turbines.

Table 66. Cumulative decommissioning in 2016-2040 [MWnet]

	2016-2020	**2021-2025**	**2026-2030**	**2031-2035**	**2036-2040**	**2016-2040**
Cumulative decommissioning, including:	3004	2626	4050	9806	7042	26 528
Thermal CDGU	2041	1756	2884	7398	1804	15 883
Non-CDGU commercial CHP plants	0	371	1016	1147	697	3 231

Source: own study by ARE S.A.

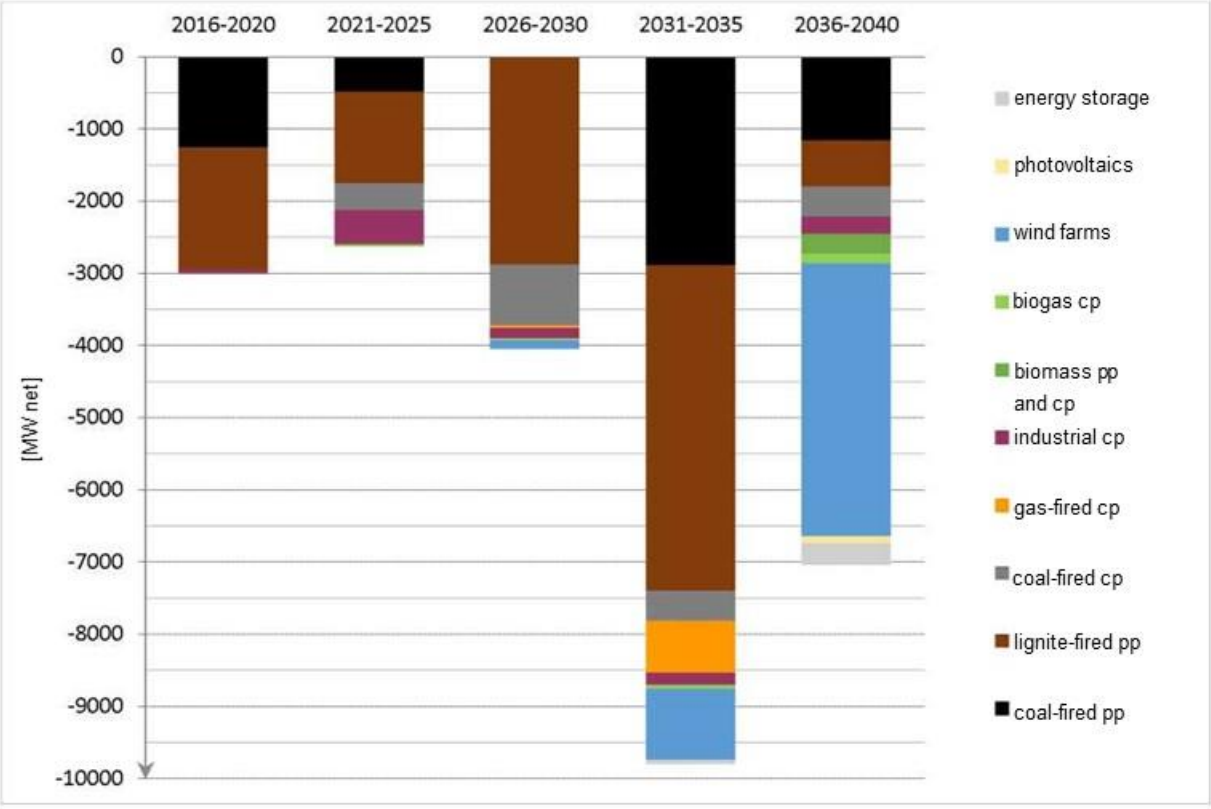

Figure 26. Projected decommissioning in 2016-2040

5.1.4.9. Electricity generation costs

The figure below shows the average annual costs of electricity generation assuming the production and capacity mix in the NPS established in the ECP scenario, as broken down into the following components: average annual capex, fixed costs, variable operations and maintenance (O&M) costs, fuel costs, and costs of CO_2 emission allowances.

The average cost of electricity production in the system in 2015 (approx. EUR'2016 9 billion) will increase by 40% by 2020 (approx. EUR'2016 13 billion), by 75% by 2030 (around EUR'2016 16 billion), and will more than double by 2040 (around EUR'2016 19.5 billion) compared to 2015. The average cost of production per unit of energy in 2015 (around EUR'2016 60/MWh) will increase by approx. 30% by 2020 (approx. EUR'2016 80/MWh), by 40% by 2030 (approx. EUR'2016 86/MWh) and by 50% by 2040 (approx. EUR'2016 90/MWh) relative to 2015.

On the one hand, the increase in the share of renewable energy reduces the costs of fuel and of the purchase of CO_2 emission allowances, but on the other, the need to build and maintain reserve capacity to stabilise the system drives fixed and capital costs up, which are several times higher in 2040 than in 2015. It must be emphasised that the costs presented here only contain the generation component, and do not include network costs, which are a condition for handling such a significant increase of power in the system (in addition to current investments to upgrade existing lines).

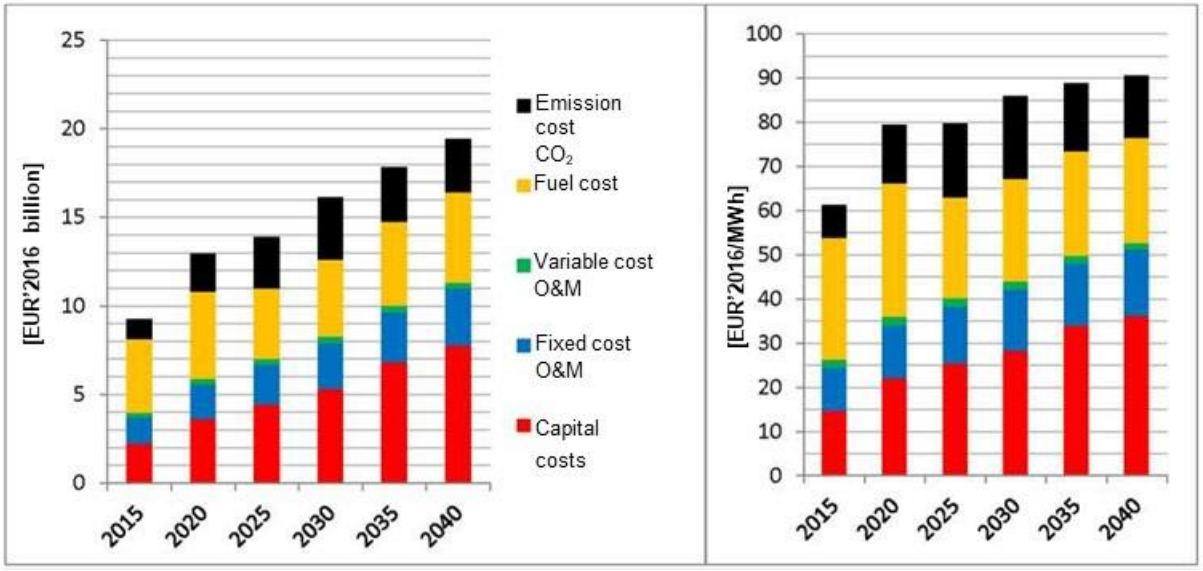

Figure 27. Average annual electricity production costs in Poland

The decarbonisation of the Polish energy sector will be a long-lasting and very costly process, which must be spread over time in such a way as to mitigate the resulting economic and social impacts. Estimates of anticipated capital expenditures for the ECP scenario are presented in section 5.3.

5.1.5. 'Internal Energy Market' dimension

5.1.5.1. Electricity transmission infrastructure

The main aim regarding the electricity transmission infrastructure in Poland is to balance the supplies of electricity with the demand for it and to ensure that the power system is capable of satisfying justified needs for domestic and transboundary transmission of electricity in the long run. Polskie Sieci Elektroenergetyczne S.A. (PSE S.A.), a state sole proprietorship, is the Polish electricity transmission system operator (eTSO) responsible for ensuring secure operation of the NPS and reliability of electricity supply.

The high and extra highest voltage transmission network consists of over 250 lines with a length exceeding 14 000 km and over 100 extra highest voltage transformer stations. Currently, Poland has active connections with Germany, the Czech Republic, Slovakia, Lithuania and Sweden (undersea cable), as well as two connections with a third country (Ukraine), one of which is out of service (Chmielnicka-Rzeszów). The internal energy market is being built by maximising cross-border exchange between interconnected power systems (while ensuring secure operation of these systems), which shapes, and consequently, aligns wholesale electricity prices across the EU. It must also be emphasised that Poland is of the opinion that security of electricity supply should be based on well-developed domestic generation, transmission and distribution infrastructures.

In order to achieve the above objectives, the eTSO will pursue activities consisting of the construction, extension and modernisation of substations, switchgear, lines and other devices, including those used for reactive power compensation within the high and extra highest voltage range (110-220-400 kV) over the whole timespan under analysis. As a result of the implementation of investment programmes until 2025, the following should be primarily ensured:

- possibility of evacuating power from the following power plants: Kozienice, Turów, Bełchatów and efficient transmission of power from the Dolna Odra Power Plant;

- extension of the network in the north, north-west (where a large proportion of windfarms are located on account of good wind conditions), north-east parts of Poland, as well as above and below the imaginary Warsaw-Poznań line;

- better use of the Krajnik-Vierraden interconnection (improved interconnections within the Poland-Germany-Czech Republic-Slovakia synchronous area);

- the exploitability of the Poland-Lithuania undersea connection (Harmony Link).

The distribution network is formed by over 700 000 km of high voltage, medium voltage and low voltage lines and almost 260 thousand substations, i.e. part of the 110 kV lines and all below. Distribution is a regulated activity, and electricity distribution system operators (eDSOs) are responsible for the operation and maintenance, and if necessary also the development of the distribution system and interconnections, as well as for ensuring that the system is capable of satisfying reasonable demand for power distribution in the long run.

In order to ensure the highest quality of electricity supply and development of electromobility (sufficient network capacity and possibility of connecting recharging points), DSOs pursue the objectives and tasks resulting from the quality regulation defined by the President of the Energy Regulatory Office (URE). Since 2018, the methodology for determining the supply quality indicators has taken into account both weather anomalies and the diversity of areas (large cities, cities with district rights, towns and villages), as well as the current level of development in the area of a given eDSO. Activities of eDSOs primarily comprise the restoration of infrastructure, building new lines, but also actions to increase the overhead-to-underground conversion ratio for the medium-voltage network.

5.1.5.2. Electricity transmission capacity

As regards enhancing the possibility of cross-border exchange for Poland, the key objective is to ensure secure operation of the NPS within the interconnected system. In the first place, this should be ensured through the optimal use of existing interconnections and the construction of the power lines missing within the national systems, changing the rules for sharing transboundary transmission capacities, optimising the methods of sharing these capacities with market participants (introduction of a flow-based approach – FBA), and installing

phase shifters if this is necessary to reduce unplanned flows of electricity across the NPS.

In connection with the above, by 2030, **there are plans to complete investments to develop the national transmission network and interconnections with a view to pursuing the above objectives**.

The table below summarises historical data and forecasts regarding the capacity of cross-border electricity interconnectors. In 2015, the total installed capacity at all interconnectors was approx. 10 GW.

Table 67. Projected capacity of existing and planned interconnections [MW]

	interconnection	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Germany	Krajnik-Vierraden	592	592	592	2078	2078	2078	2078	2078
Germany	Mikułowa-Hagenverder	2730	2730	2730	2640	2640	2640	2640	2640
Czech Republic	Wielopole/ Dobrzeń - Nosovice/ Albrechtice	2772/ 2480	2772/ 2480	2772/ 2480	2772/ 2480	2772/ 2480	2772/ 2480	2772/ 2480	2772/ 2480
Czech Republic	Kopanina/Bujaków - Liskovec	800/794	800/794	800/794	800/794	800/794	800/794	800/794	800/794
Slovakia	Krosno Iskrzynia - Lemesany	2078	2078	2078	2078	2078	2078	2078	2078
Sweden	Słupsk - Starno	600	600	600	600	600	600	600	600
Belarus	Białystok - Roś*	0	0	0	0	0	0	0	0
Ukraine	Rzeszów - Chmielnicka**	0	0	0	0	0	0	0	0
Ukraine	Zamość - Dobrotwór	381/310	381/310	381/310	381/310	381/310	381/310	381/310	381/310
Lithuania	Ełk - Alytus***	0	0	488	488	488	0	0	0
Lithuania	Żarnowiec-Darbenai	0	0	0	0	0	700	700	700
TOTAL		**9953/ 9584**	**9953/ 9584**	**10 441/ 10 072**	**11 837/ 11 468**	**11 837/ 11 468**	**12 049/ 11 680**	**12 049/ 11 680**	**12 049/ 11 680**

with different availability in winter and summer marked: 'winter/summer'

*under liquidation, **out of service (determining the capacity of the interconnection will be possible after appropriate analyses and technical studies are completed), ***after the power systems of the Baltic states are synchronised with the system of Continental Europe, the total capacity of the interconnector will be dedicated to technical exchange; no trade exchange at this interconnector; the possibility of trade at this interconnection after 2025 will depend on the degree to which the Baltic states' systems are adapted to synchronous operation with the Continental Europe system.

Source: PSE SA, own study by ARE S.A.

The way interconnected power systems operate indicates that the level of interconnected transmission capacity made available by the TSO does not correspond to the thermal capacity of existing cross-zonal interconnections. Restrictions on power transmission stem, *inter alia*, from maintenance works and the activities of the eTSO carried out to ensure secure operation of the power system.

Pursuant to Regulation (EU) 2019/943 of the European Parliament and of the Council on the internal market for electricity, from 1 January 2020, TSOs should maximise the interconnection capacity offered for transboundary trade. As a consequence, Regulation 2019/943/EU requires that eTSOs provide market participants with cross-zonal capacity at a level not lower than 70% of the transmission capacity for a given border or critical network element/contingency (CNEC) pair, subject to operational security limits (hereinafter 'CEP 70% target'). The eTSO can use the remaining 30% for the purposes of reliability margins, loop flows, and internal flows at each critical network element.

Providing the 70% of transmission capacity is a challenge for the eTSO, as currently, the Polish bidding zone

suffers from structural network constraints. As a result, a decision has been made to prepare an Action Plan that best responds to the nature of structural network constraints in Poland. When the Action Plan is applied, the final deadline for achieving the CEP 70% target is 31 December 2025. The Action Plan will be carried out from 1 January 2020. The measures adopted under the Action Plan are scheduled for four years (1 January 2020 to 31 December 2023). The table below presents historical and forecast trading capacities with other countries. The table that follows presents the interconnectivity ratio as the quotient of net transmission capacity available for imports and total installed capacity in the NPS according to the currently projected trading capacity.

Table 68. Net transmission capacity of existing and planned interconnections [MW]

	2010	**2015**	**2020**	**2025**	**2030**	**2040**
PL→DE/CZ/SK	900	1000	1605/1587	3629/3525	3629/3 525	3629/3525
DE/CZ/SK→PL	0	0	605/587			
PL→SE	100	100	600	600	600	600
SE→PL	600	600	600	600	600	600
PL→UA	0	0	0	0	0	0
UA→PL	220	220	220	220	220	220
PL→LT	0	500	500	500	700	700
LT→PL	0	500	500	500	700	700
PL export	**1 000**	**1600**	**2705/2687**	**4729/4625**	**4929/4 825**	**4929/4825**
PL import	**820**	**1 320**	**1925/1907**	**4949/4845**	**5149/5045**	**5149/5045**

Source: ARE and PSE SA forecasts (with different capacities in winter and summer marked: 'winter/summer')

Table 69. Interconnectivity

	2010	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
NTC import [MW]	820	1 320	1 925	4 949	5 149	5 149	5 149
Installed capacity [MW]	33 320	37 290	48 656	55 167	59 073	63 391	72 103
Interconnections [%]	**2.5**	**3.5**	**4.0**	**9.0**	**8.7**	**8.1**	**7.1**

Source: ARE S.A. and PSE S.A. projections

5.1.5.3. Natural gas transmission infrastructure

In 2015, the maximum capacity of the national transmission system (NTS) to receive natural gas was over 25.8 billion m^3 per year. In 2016, the LNG regasification terminal in Świnoujście was commissioned with an annual capacity of approx. 5 billion m^3. Poland remains heavily dependent on natural gas supplies from abroad, mainly from the East, but also from Germany and the Czech Republic (in 2018, 79% of consumed natural gas came from imports and intra-Community purchases, with 61% originating from the East). In the coming years, the share of LNG in natural gas consumption may reach even 30%. The Polish terminal is a key item of infrastructure from the point of view of security of gas supply not only for Poland, but also for neighbouring countries. It is the only facility of this size in Central Europe, and the importance of LNG trade on the global natural gas market is growing, *inter alia* thanks to the increasing price competitiveness compared to gas supplied by gas pipelines. However, it is important to ensure access to gas to end users, which requires developing the national transmission, distribution and storage infrastructures.

The so-called Yamal contract[27], which currently ensures the majority of supplies to Poland, will expire at the end of 2022, therefore actions working towards real diversification of the sources of supply must be completed before the gas year 2022/2023 starts. This will break the monopoly-based price trends. In addition to infrastructure activities, it is vital that energy companies continue their efforts towards diversifying natural gas supplies on a contractual basis.

The key investment projects ensuring the country's energy security through diversification of sources and directions of natural gas supply include:

- construction of the Baltic Pipe – capacity of about 10 billion m^3 towards Poland and 3 billion m^3 towards

[27] Contract for the supply of natural gas to Poland signed between PGNiG and Gazprom in 1996.

Denmark and Sweden;

- expansion of the LNG terminal in Świnoujście - regasification capacity of approx. 7.5 billion m^3;

- floating storage regasification unit in the Gulf of Gdańsk with a capacity of at least 4.5 billion m^3;

- construction/development of interconnectors: with Slovakia – capacity of 5.7 billion m^3 towards Poland and 4.7 billion m^3 towards Slovakia; with Lithuania – 1.9 billion m^3 towards Poland and 2.4 billion m^3 towards Lithuania; with the Czech Republic – 6.5 billion m^3 towards Poland and 5 billion m^3 towards the Czech Republic; with Ukraine – 5 billion m^3 in both directions.

The **national transmission network** must enable the imports infrastructure to be used to the full (the length of the natural gas transmission network is nearly 12 000 km), which requires developing the national gas pipeline system. The plan until 2022 (with an outlook for 2029) focuses on the development of the network:

- in western, southern and south-eastern Poland (from Świnoujście to the interconnections with the Czech Republic, Slovakia, and Ukraine) – this will allow gas to be transmitted from the LNG terminal and imported via the Baltic Pipe to domestic consumers, and to be exported to neighbouring countries and imported from new suppliers in the south;

- in north-eastern Poland (to the interconnector with Lithuania) – this will stimulate gasification in this part of Poland and will strengthen the energy integration of the Baltic states with Continental Europe.

The expansion and modernisation of the **distribution** infrastructure is another crucial element of the development of the national network. Currently, around 65% of Polish municipalities have access to natural gas, with the gasification level bound to increase to around 77% in 2022, and with further growth expected in subsequent years in response to market needs. A heavy emphasis has been placed on removing what is referred to as 'white spots' – places lacking access to gas. Where the construction of a gas pipeline is not viable, use will be made of LNG regasification stations (also known as virtual LNG pipelines). Alternatively, such areas can be supplied with biomethane (biogas purified and processed to natural gas quality) from local biogas plants, if there is potential for biogas production in the region. Local access to gas means that it can be used in heating, transport and as a reserve for renewable energy sources, which depend on weather conditions. At the same time, the use of gas and/or renewable energy sources – as low-emission heat sources – is an alternative to individual boilers fired by low-quality solid fuels in areas where access to district heating is not available.

5.1.5.4. Gas transmission capacity

The above investments will create conditions for Poland to become a gas transmission and trade hub for the countries of Central and Eastern Europe and the Baltic states, and will allow Polish infrastructures to be adapted so as to satisfy the dynamically growing demand for natural gas. The favourable geographical location of Poland makes it reasonable for it to strive to become a transit country for gas transmission along the east-west and north-south axes (gas transmission and trade hub). These projects constitute the Polish contribution to the Three Seas initiative, which aims to deepen the integration of the Baltic, Adriatic and Black Sea and EU's priority countries – the north-south gas corridor[28] for the CEE countries (an alternative to the east-west corridor and reduction of dependency on one gas supplier), and will add to the planned energy integration of Baltic states.

The table below presents the anticipated parameters of technical natural gas transmission capacity per year.

Table 70. Parameters of cross-border entry and exit points for the gas transmission system – annual technical transmission capacity [million m^3 at 0°C]

interconnection	border point	entry/exit	2020	2025	2030	2035	2040
LNG terminal	LNG terminal	entry	4 993.2	7500	7500	7500	7500
Germany	GCP entry point (Lasów, Gubin)	entry	1 594.3	1 594.3	1 594.3	1 594.3	1 594.3

[28] The north-south gas corridor will connect the LNG terminal in Świnoujście and the Baltic Pipe, running across southern Poland, the Czech Republic, Slovakia and Hungary, with the markets of Southern Europe, in keeping with the Three Seas concept.

Germany	GCP exit point (Lasów Rewers, Kamminke)	exit	440.8	440.8	440.8	440.8	440.8
Czech Republic	Branice	entry	1.4	1.4	1.4	1.4	1.4
Czech Republic	Cieszyn*	entry	587.2	587.2	587.2	587.2	587.2
Ukraine	Drozdowicze	entry	4 380.0	4 380.0	4 380.0	4 380.0	4 380.0
Ukraine	Hermanowice towards Ukraine**	exit	02	02	02	02	02
Belarus	Tietierowka k/Białegostoku	entry	236.5	236.5	236.5	236.5	236.5
Belarus	Wysokoje k/Janowa Podlaskiego	entry	5 475.0	5 475.0	5 475.0	5 475.0	5 475.0
Belarus	Kondratki k/Białegostoku EUROPOL	entry	33 741.2	33 741.2	33 741.2	33 741.2	33 741.2
Germany	Mallnow k/Słubic EUROPOL	exit	30 602.4	30 602.4	30 602.4	30 602.4	30 602.4
Germany	Mallnow k/Słubic EUROPOL reverse flow	entry	6 132.0	6 132.0	6 132.0	6 132.0	6 132.0
Yamal	point of interconnection	entry	9 076.1	9 076.1	9 076.1	9 076.1	9 076.1
Denmark	Baltic Pipe	entry	0	10000	10000	10000	10000
Denmark	Baltic Pipe	exit	0	3000	3000	3000	3000
Slovakia	gas interconnection Poland-Slovakia (GIPS)	entry	0	5700	5700	5700	5700
Slovakia	gas interconnection Poland-Slovakia (GIPS)	exit	0	4700	4700	4700	4700
Lithuania	gas interconnection Poland-Lithuania (GIPL)	entry	0	1900	1900	1900	1900
Lithuania	gas interconnection Poland-Lithuania (GIPL)	exit	0	2400	2400	2400	2400
floating storage regasification unit (FSRU)	floating storage regasification unit (FSRU)	entry	0	4500	4500	4500	4500

** calculation takes into account seasonal variation; ** Intermittent capacity, continuous capacity available conditionally: 1463-2190 million m^3/year, values above 1 463 million m^3/year depending on the arrangements between GAZ-SYSTEM and Ukrtransgaz.*

Source: own study by ARE S.A.

5.1.5.5. Electricity and gas markets, energy prices

One of the fundamental changes recorded last year on the electricity market was the entry into force of the Capacity Market Act of 8 December 2017, i.e. transition from a single-product market (only energy) to a two-product market (energy and capacity). The purpose of the capacity market is to ensure medium and long-term security of electricity supply to final consumers in a cost-effective, non-discriminatory, and sustainable manner. The Capacity Market Act provides for the payment for readiness to provide capacity and for providing power at times of hazard. The capacity market is to incentivise energy companies to invest in and retrofit their plants, as well as to prevent them from decommissioning existing generation sources prematurely. It operates in parallel to the electricity market, does not affect the prices on the wholesale electricity market, and is technologically neutral, which creates a level playing field for all electricity production technologies and DSR services. The first three main auctions with 2021, 2022 and 2023 supply dates took place in 2018, and the main auction for the 2024 deliveries was held in 2019.

The establishment of the capacity market will deactivate existing balancing mechanisms, i.e.: Cold Contingency Reserve (*Interwencyjna Rezerwa Zimna*), Interventional Operation (*Praca Interwencyjna*), Operational Capacity Reserve (*Operacyjna Rezerwa Mocy*), and Guaranteed DSR Emergency Programme (*Gwarantowany Interwencyjny Program DSR,* i.e. reduction in demand at TSO's request). Consequently, from 1 January 2021 onwards, the operating costs of these mechanisms will no longer be incurred. The costs of the capacity market will be transferred to final consumers of electricity through the so-called 'capacity fee' included in electricity bills. The fee will be charged as from 1 October 2020.

The new requirements for capacity mechanisms are set out by Regulation 2019/943 on the internal electricity market. With effect from 4 July 2019, the Regulation excludes from the participation in the capacity market new generating units (not engaged in commercial production before that date) that emit more than 550 g CO_2/kWh, and it does so for existing units (engaged in commercial activity before 4 July 2019) that emit more than 550 g CO_2/kWh and over 350 kg CO_2/kW (on average per year) with effect from 1 July 2025. Capacity contracts made before 31 December 2019 are exempted from the regulatory restrictions throughout their term.

5.1.5.5.1. Electricity prices by sector

The table below presents projections of electricity prices for three defined groups of end users. The presented figures are average prices offered under comprehensive and separate contracts, include taxes (the calculations assume an excise duty of PLN 0.5 /MWh at current prices and 23% VAT throughout the forecast horizon). As is shown by the results obtained, a gradual increase in electricity prices is expected for all the three groups of end users considered. The increase in prices is evenly distributed across the sectors, which is a consequence of the assumption of proportional distribution of the costs of all support schemes, with the exception of support for renewable energy (currently industry is partially exempted from the RES charge). The main factors behind the projected increase include the costs of CO_2 emission allowances, which increase over time, and the costs of generation unit and transmission infrastructure building and modernisation, as applicable.

VAT for industrial consumers is reimbursed by the State Treasury, therefore electricity prices including this tax for industrial consumers are presented for reference only.

Table 71. Electricity prices by sector [EUR'2016/kWh]

	2005	2010	2015	2020	2025	2030	2035	2040
Households	0.114	0.145	0.150	0.159	0.186	0.188	0.192	0.192
Services	No data	No data	0.135	0.140	0.167	0.170	0.173	0.173
Industry	0.066	0.100	0.082	0.110	0.123	0.124	0.127	0.123

Source: ARE S.A. forecasts

The figure below compares electricity price projections for the individual groups of consumers for the ECP and REF scenarios. The increase in prices compared to the REF scenario stems from the higher costs of the construction and improvement of energy infrastructure, including the development of offshore energy, distributed energy, electromobility, and the deployment of smart grids, as well as from market and regulatory developments that have taken place after 2017, which are not covered by the reference scenario.

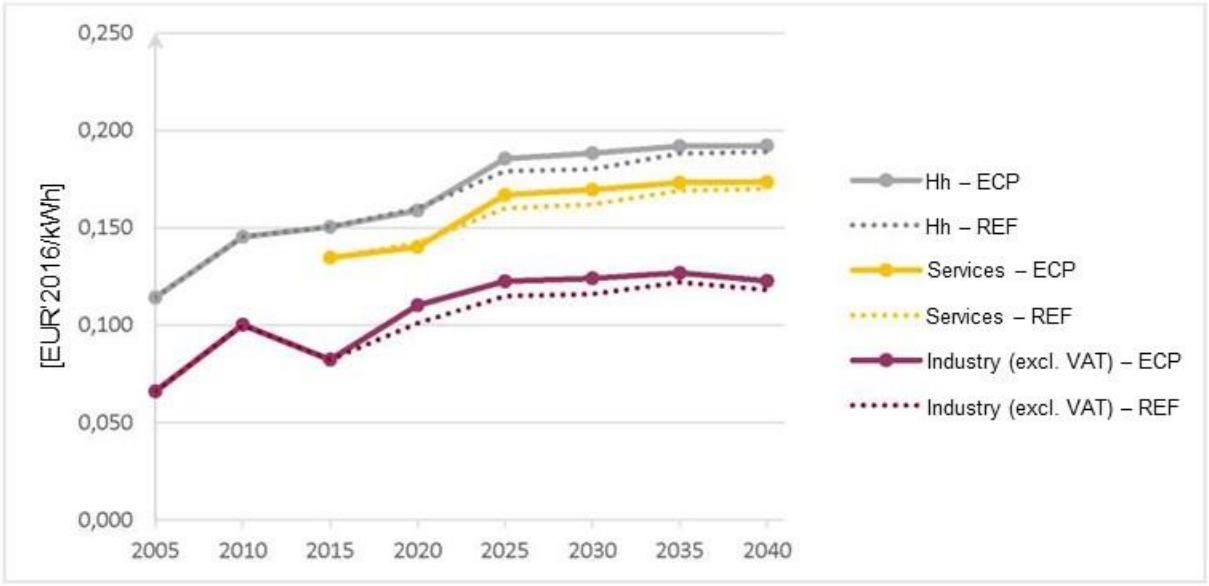

Figure 28. Comparison of electricity prices for final consumers – ECP vs REF

5.1.5.6. National retail prices of fuels

The model simulations distinguish between ex-mine/ex-yard coal prices by groups of consumers – energy sector, industry and small-scale consumers based on the domestic structure of prices taken from 2005-2015 statistics. Also for natural gas, the simulations take into account the costs and share of gas produced in Poland, the average costs of transport in the network, and costs associated with infrastructure investments. The projected prices of natural gas, coal and petroleum products are based on trends in global prices of these energy carriers. It is assumed that the prices of solid, liquid and gaseous fuels in the ECP scenario will not differ from those in the REF scenario. This is a simplifying assumption, but it is necessary in the light of the uncertainty inherent in the prices of energy carriers. However, implementation of some of the policies and measures defined in the ECP scenario may increase natural gas prices and reduce coal fuel prices to some extent. However, the extent of these fluctuations is difficult to estimate.

The results are presented in the table below.

5.1.6. ‘Research, Innovation and Competitiveness’ dimension

This dimension is described in detail in Parts 1 (National assumptions and objectives) and 2 (Policies and measures) of the NECP in the subsections relevant for this dimension.

Also Annex 1 to the NECP “Current situation and projections with existing policies and measures – state at the end of 2017 (REF scenario)” includes a description of the individual technologies.

Table 72. National retail prices of fuels [EUR'2016/ktoe]

	Natural gas								Steam coal					Coking coal
	industry (total)	industry (excise tax)	industry (VAT)	el. prod. (av. price)	el. prod. (nitrogen gas)	households (total)	households (excise)	households (VAT)	industry (total)	el. prod. (total)	households (total)	households (excise)	households (VAT)	industry (total)
2005	212 271	0	0	175 216	-	418 771	0	75 428	96 360	87 981	222 767	0	40 154	154 630
2010	379 524	0	0	243 484	-	645 043	0	116 229	147 186	129 740	299 987	0	54 089	224 466
2015	339 968	2 832	0	238 394	332 803	636 686	567	119 527	117 657	106 019	318 345	0	59 532	138 406
2020	291 002	2 666	0	215 286	304 723	621916	0	116 293	106 616	97 046	318 830	0	59 619	142 442
2025	327 425	2 666	0	242 481	343 215	700 476	0	130 983	118 462	107 829	354 256	0	66 243	158 269
2030	350 711	2 666	0	259 868	367 815	750 703	0	140 375	125 231	113 990	374 499	0	70 028	167 313
2035	373 211	2 666	0	276 667	391 598	799 232	0	149 450	127 770	116 301	382 090	0	71 448	170 704
2040	382 210	2 666	0	283 386	401 114	818 643	0	153 080	130 308	118 611	389 681	0	72 867	174 096

	Light fuel oil					Diesel					Petrol			LPG			
	industry (total)	industry (excise tax)	households (total)	households (excise)	households (VAT)	comm. consump. (total)	comm. consump. (excise)	non-comm. consump. (together)	non-comm. (excise)	non-comm. (VAT)	non-comm. consump. (together)	non-comm. (excise)	non-comm. (VAT)	comm. consump. (total)	non-comm. consump. (together)	non-comm. (excise)	non-comm. (VAT)
2005	613 425	79 188	796 974	79 188	143 761	1 031865	406 181	1 258 889	406 181	227 024	1 457 052	573 547	262 861	704 947	860 478	206 607	155 070
2010	730 719	74 717	929 669	74 717	167 791	1 130 529	415 357	1 379 244	415 357	248 825	1 573 408	573 598	283 685	792 309	966 616	199 271	174 417
2015	671381	65 730	860 111	65 730	160 925	1 037 404	415 847	1 276 007	415 847	238 563	1 408 693	507 954	269 651	612 179	752 980	178 755	140 779
2020	745 110	61 857	739 697	61 857	138 278	1 120 631	391 342	1 378 376	391 342	257 745	1 479 352	478 021	276 627	716 135	834 678	168 221	156 078

2025	832 689	61 857	783 969	61 857	146 554	1 194 244	391 342	1 468 920	391 342	274 676	1 557 631	478 021	291 264	779 024	889 807	168 221	166 387
2030	907 442	61 857	831 194	61 857	155 382	1 257 075	391 342	1 546 203	391 342	289 127	1 624 446	478 021	303 758	832 702	936 862	168 221	175 186
2035	942 429	61 857	881 569	61 857	164 799	1 286 483	391 342	1 582 374	391 342	295 891	1 655 717	478 021	309 606	857 826	958 885	168 221	179 304
2040	992 172	61 857	935 305	61 857	174 845	1 328 292	391 342	1 633 800	391 342	305 507	1 700 177	478 021	317 919	893 545	990 196	168 221	185 159

Source: own study by ARE S.A., EUROSTAT - "Energy prices and taxes"

5.1.7. Assessment of mutual interactions between existing and planned PaMs in the various dimensions and between current and planned PaMs related to other dimensions

Identification and understanding of mutual interactions between existing and planned policies within the five dimensions of the Energy Union analysed can be used for determining the positive or negative impacts on the effectiveness of the implemented solutions. In many areas, the impacts of the implemented PaMs overlap, which fosters the effectiveness of actions, leads to the mutual neutralisation of effects, or produces negative impacts, as the case may be. Suitable balancing of the type and scope of implemented solutions allows the energy and climate policy objectives to be attained with gradually declining use of resources and funds. The most frequently identified cases of overlapping PaMs occur in the 'decarbonisation' and 'energy efficiency' dimensions, with them predominantly strengthening the effect of action.

The following table summarises the interactions identified between existing and planned PaMs within the individual dimensions and those with PaMs pursued in other dimensions. In the table, '1' stands for a positive impact of a given measure in a given dimension on another dimension, '0' means no impact or inestimable impact, while '-1' indicates a negative impact.

The table below presents the conclusions of an analysis of the interactions between existing and planned PaMs within the five dimensions of the Energy Union.

Table 73. Interactions between PaMs identified within dimensions

Dimension/measure	Dimension 'Decarbonisation'	Dimension 'Energy Efficiency'	Dimension 'Energy Security'	Dimension 'Internal Energy Market'	Dimension 'Research, Innovation and Competitiveness'
Dimension 'Decarbonisation'					
Measures to improve air quality					
Air Quality Programmes (elimination of 'low-stack' emissions and anti-smog efforts)		1	1	0	1
Fuel quality monitoring and control		0	0	0	0
Supporting use of alternative fuels in transport		1	1	0	1
Supporting the development of district heating and cooling		1	1	0	1
Actions to reduce greenhouse gas emissions					
Implementation of low-emission technologies and solutions		1	1/-1	0	1/-1
Supporting utilisation of coal-bed methane		1	1	0	1
Supporting RES (including distributed electricity production)		1	1/-1	1	1
Supporting low-carbon transport		1	1	0	1
Dimension 'Energy Efficiency'					
Stimulating energy efficiency measures (legal and financial incentives)	1		1	0	1
Thermomodernisation of buildings	1		1	0	1
Promoting the use of efficient alternative energy and heat supply systems for buildings	1		1	0	1
Promoting low-energy buildings	1		1	0	1
Supporting high-efficiency cogeneration	1		1	0	1
Supporting the development of smart networks	1		1	1	1
Dimension 'Energy Security'					
Deployment of nuclear power	1	-1		0	1
Implementation of a capacity market	1/-1	1/-1		0	0
Supporting the development and modernisation of transmission infrastructures	1	1		1	1
Supporting the development	1	1		0	1

of energy storage technologies					
Dimension 'Internal Energy Market'					
Empowering consumers on the energy market	1	1	1		0
Developing interconnections	1	0	1		1
Dimension 'Research, Innovation and Competitiveness'					
Fostering the competitiveness of the Polish economy by pursuing continuous technological advancement	1	1	1	1	
Supporting the development of innovative products and services	1	1	1	1	

1 - positive impact, -1 - negative impact, 0 - no impact

'Decarbonisation' dimension

Measures to improve air quality

- The main measures in this area are as follows:
- comprehensive thermomodernisation of buildings,
- replacement of old manually fed boilers with new low-emission or zero-emission ones,
- expansion of district heating networks.

All of these activities will have a positive effect on energy efficiency (reduction of primary energy consumption in connection with limited thermal needs and improved energy transformation efficiency of boilers), energy security (limited fuel imports) and competitiveness (lower specific fuel consumption and purchase costs, exploitation of the potential for implementing and using innovative thermomodernisation and heating technological solutions).

Promoting the development of alternative fuels in the transport sector, which is largely co-responsible for smog in cities, is another activity. Importantly, the planned activities will involve wide support for the use of electricity and CNG in road transport, which will gradually decrease Poland's oil imports dependency thereby improving the country's energy security. Reduced need to use biofuels to achieve the assumed RES target in road transport will be another positive effect of using electricity in road transport.

As regards the impact on Poland's competitiveness, the ICT industry has a chance to increase its potential based on the increase in production and sale of electric and autonomous vehicles. The development of electromobility will contribute to the modernisation of the Polish energy sector, lower transport costs and increase the share of own fuels and energy sources in the country's energy mix.

Creating conditions for the development of district heating is one of the priority tasks as regards improving air quality in Poland. Not only will fostering the use of district heating reduce emissions, but will also bring Poland closer to its energy efficiency targets.

Actions to reduce greenhouse gas emissions

The key actions aimed at reducing greenhouse gas emissions include the deployment of zero-emission renewable energy technologies. The process in this area takes place in virtually all sectors of the economy, and is mainly stimulated by various types of subsidies. Not only does the development of renewable energy sources (both on a large scale and distributed ones) contribute to reducing emissions of pollutants into the air, but it also works towards reducing primary energy consumption, especially in the electricity and heating sectors. The use of renewable energy is therefore important for energy efficiency, as it reduces the consumption of primary energy.

The effect of renewable energy development on energy security is twofold. On the one hand, it helps to reduce the consumption of fossil fuels, but on the other, it can have a destabilising effect on the operation of the power system due to intermittent operation. Generation sources such as wind and solar farms reduce security of supply and require reserves in the form conventional sources (which also generates additional costs). However, the expected development of storage technologies may eliminate these drawbacks in the future.

The impact of this factor on the competitiveness of the economy is ambiguous. The development of renewable energy in Poland can boost innovation provided that the opportunities that arise are properly utilised. One drawback is the increased cost of energy supply, which does not only include the costs associated with the production of electricity by more expensive sources and the costs of reserve generation units (including capex on both), but also the transmission, distribution and balancing costs. Competitiveness lies primarily in the ability of companies to compete on the global market, which is considerably hindered by high generation costs.

Promoting low-carbon transport is another important measure to reduce emissions. This priority is to be pursued through a wide range of activities that will contribute to improving the efficiency of energy use in this sector (including promotion of public transport and the use of alternative fuels). In turn, the greater the final energy savings produced in the sector, the lower the RES energy volumes required to attain the renewable fuel use targets.

'Energy Efficiency' dimension

The planned measures in this dimension are as follows:

- stimulating energy efficiency measures (legal and financial incentives)
- thermomodernisation of buildings
- promoting the use of efficient alternative energy and heat supply systems for buildings
- promoting low-energy buildings
- supporting high-efficiency cogeneration
- supporting the development of smart networks

All these activities will have a positive effect on emissions of greenhouse gases and pollutants, which will also improve energy efficiency. Improved energy efficiency will be also helpful in reducing the required volumes of energy from renewable energy sources counted against the national target (at the same time, increased use of RES will reduce primary energy consumption). Thus, improving energy efficiency is a measure that works towards the RES target. The implementation of solutions improving energy efficiency is also much more beneficial for the economy since most renewable energy technologies come from imports, while energy efficiency improvement measures can be largely sourced from inside the country.

'Energy Security' dimension

The deployment of nuclear energy in 2033 is a key element of this dimension, which corresponds to the other dimensions. The main purpose is to ensure stable electricity supply from a source that does not contribute to greenhouse gas emissions. Nuclear energy will provide large volumes of near-zero emission energy, reducing the pressure on the development of renewable energy, although it increases primary energy consumption.

The so-called 'capacity market', which is under implementation now, is the second element. Its main goal is to ensure the security of electricity supply in a situation of growing share of non-controllable RES generating units. On the one hand, it will enable further development of renewable energy sources in Poland. The mechanism will delay the decommissioning of coal-fired units, but with no renewable energy subsidies, their operation would be more beneficial in economic terms. The lack of the capacity market would mean the risk of no supplies of electricity.

The expansion and modernisation of generation infrastructure and development of energy storage technologies will also improve the share of renewable energy. In fact, they are a condition for the development of RES in the system.

'Internal Energy Market' dimension

Enhancing the role of consumers and activating them within the energy market is one of the actions envisaged in this area. The goal is, *inter alia*, to increase the number of prosumers, which will directly lead to the

development of distributed energy from renewable sources and, as a result, reduce emissivity and fuel consumption within a given area. In addition, it is assumed that increased consumer awareness will be an incentive to rationalise self-consumption and pro-efficiency activities.

The development of cross-border networks, as another action within a given area, may improve the security of energy supply. Interconnections with neighbours can be helpful during periods of power shortage in the national power system. The development of interconnections and transboundary trade in electricity may have a positive effect on the wholesale electricity market, depending on how price relations evolve on individual markets.

'Research, Innovation and Competitiveness' dimension

The activities specified in this dimension are intended to develop new technologies focused on decarbonisation and high energy efficiency. Examples include the development of new energy generation technologies, integrated high-efficiency and low-carbon energy storage, transmission and distribution systems, and electromobility.

5.2. Macroeconomic, health and environmental impacts on employment and education, as well as impacts on skills in this area and social impacts

5.2.1. Analysis of macroeconomic and social impacts in both scenarios – REF and ECP

The study uses a methodical approach based on the theory of macroeconomic development under conditions of gradual progress towards a general equilibrium (CGE-PL) in the modelled sectors of the national economy as a result of forcing impulses, i.e. the energy and climate policy intervention measures pursued in the national economy. The impulses disturb the balance in the base year (2015) and work towards a new equilibrium in the successive 5-year subperiods until 2040. The **macroeconomic analysis and adaptation assessment is presented for two scenarios – REF and ECP**.

The calculations are based on information exchange between macroeconomic models and energy models. The assessment entails a number of variables, ranging between the volume and dynamics of GDP, the volumes of value added sectors of the economy and their profitability, and the level and structure of employment. A central role is played by the CGE-PL macroeconomic model, which is crucial for the systemic approach to development-focused research that combine the assumptions and effects of the climate and energy policy on both the energy sectors and the remaining sectors of the national economy (manufacturing and consumption). It also takes into account the key relationships with the external environment, i.e. the balance of exports and imports of goods and services, and the relations with the natural environment – calculation of CO_2 emissions vs. the overall balance of the potential costs and benefits of the ETS EUA system in Poland. The Mezzo-Impact sectoral model is the component used for assessing the economic and social impacts.

5.2.1.1. Analysis of macroeconomic and social impacts in the REF scenario

5.2.1.1.1. Economic growth in 2015-2030 and the 2040 perspective – REF

This section presents the most relevant results of calculations for the REF scenario, with Tables 74-75 showing the calculated results (in the CGE-PL model) for GDP and added value in the aggregate sectors of the national economy (NE). They are almost identical to the assumptions on growth in the REF scenario. In the period 2015-2030, GDP grows by over 60%. In the decade of 2030-2040, GDP growth gradually slows down, but it doubles in the entire 2015-2040 period at an average annual rate of around 2.9%. In addition, the table below summarises the foreign trade balance calculated on the basis of CGE-PL, the estimated macroeconomic CO_2 emissions, and changes in employment and unemployment rates. The calculated GDP growth path and breakdown in the REF scenario are illustrated in the figure below.

Table 74. GDP level and trends of selected macroeconomic variables in the REF scenario – results of the CGE-PL model

Item/category	**Unit**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
GDP level	EUR'2016 billion	462.4	550.8	649.2	747.1	843.7	937.1
GDP dynamics	2015=100	100	119.1	140.4	161.6	182.5	202.7
Foreign trade balance	EUR'2016 billion	14.3	5.4	5.8	14.7	8.8	19.5
Employment	thousand people	15 977	15 865	16 011	16 163	16 175	16 033
Unemployment rate	%	6.9%	5.0%	5.0%	4.0%	4.0%	4.0%
Model calculation subperiods	*years*	-	***2016-2020***	***2021-2025***	***2026-2030***	***2031-2035***	***2036-2040***
Annual average GDP growth rate over the five-year period	*%*	-	*3.6%*	*3.3%*	*2..9%*	*2.5%*	*2.1%*

Source: EnergSys's own study, CGE-PL model

Table 75. Changes in value added in the economy by economic sectors and industries in the REF scenario [EUR'2016 billion]

Item/category	2015	2020	2025	2030	2035	2040	2040/2015 ratio
Agriculture, forestry and	10.43	12	13	15	16	17.7	1.70

fishing							
Extraction of mineral resources	1.46	2	2	2	2	2.6	1.78
Manufacturing	85.5	98	113	130	146	158.0	1.85
Construction	34.6	39	44	55	61	65.4	1.89
Transport	27.40	32	37	44	49	56.0	2.04
Services	233.00	281	337	386	439	489.0	2.10
Fuel and energy sector	17.80	21	22	21	20	24.0	1.35
Total	410.19	486	568	654	734	812.7	1.98
GDP	462.4	550.8	649.2	747.1	843.7	937.1	2.027

Source: EnergSys's own study, CGE-PL model

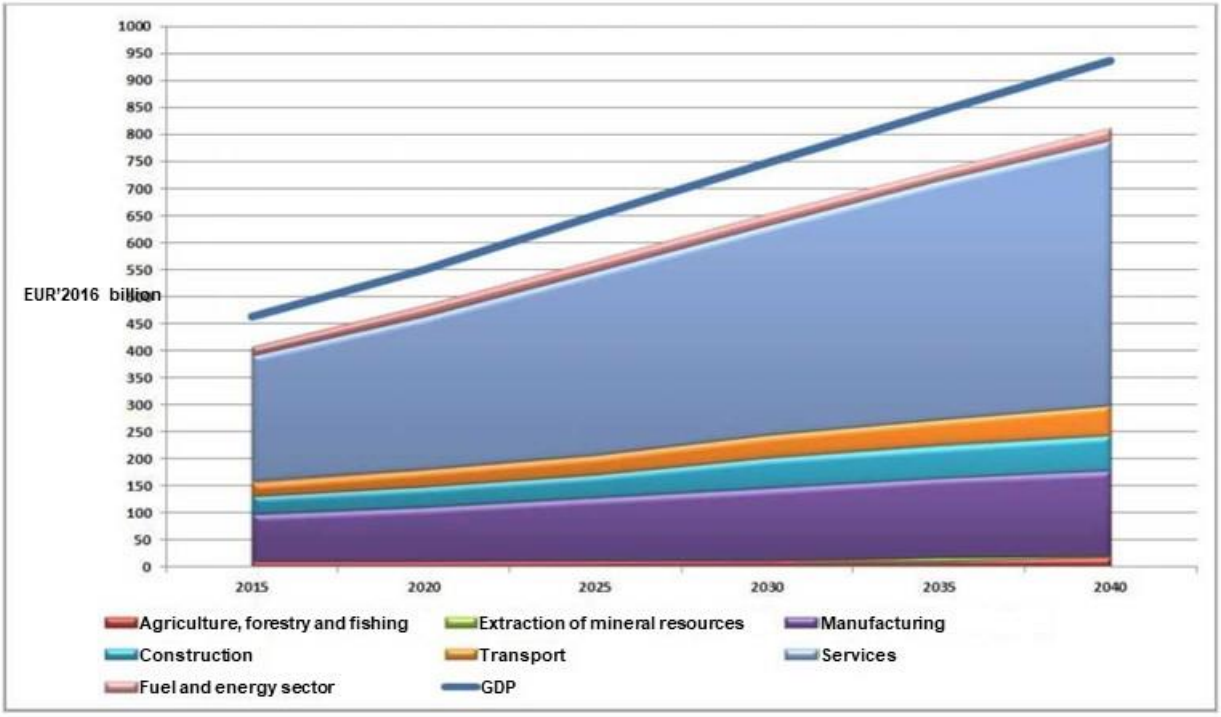

Figure 29. GDP level and value added in aggregate NE sectors – REF

In the REF scenario, the results of the calibration process in the CGE-PL model also include factors of production (engaged capital and labour) and changes in their sectoral productivity throughout the period concerned (2015-2040). The workforce in the REF scenario is estimated on the basis of employment data by the adoption of the following minimum unemployment rates in the successive years:

- 2015 – 6.9%;
- 2020 – 5.0%;
- 2025 – 5.0%;
- 2030-2040 – 4.0%.

The assumptions on the rate of growth of capital resources and capital expenditures in 2015-2040 are based on the likely range of their formation/accumulation in the Polish economy over the period analysed. The calculations allow a variability in the accumulation rate of 19-21 pp (in relation to GDP), in line with the actual values from the last five-year period (2011-2015). Sectoral productivities of the factors of productions, adjusted in an iterative cycle, were the parameters used for obtaining the required GDP volume in the CGE-PL model calibration process. The goodness of fit criterion was considered to be met if the difference was not greater than 0.1% of the assumed GDP (in REF) minus GDP calculated iteratively in the model calibration process.

The estimated values of production factor productivity paths for labour and capital are presented in the table below. Energy is another important factor of production, which is applied in the macroeconomic models (CGE-PL and Mezzo-Impact), using the results of calculations of energy models on the basis of the outcomes of projected fuel consumption.

Table 76. Resources of factors of production and their productivity in the REF scenario

	Unit	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Workforce	thou. of employed	17 161	16 700	16 854	16 836	16 849	16 701
Gross capital formation (capital resource)	EUR'2016 billion	95	103	120	135	149	160
Capital formation dynamics	[-/-]	100	108	126	142	157	169
Changes in factors of production relative to GDP							
Labour productivity dynamics	[-/-]	100	120	140	160	180	202
Capital productivity dynamics			110	111	114	116	120
Dynamics of fuel and energy productivity in manufacturing (excluding households)			99.8	113	126	141	156
Dynamics of fuel and energy productivity in the country (including households)			102	116	130	144	159

Source: EnergSys's own study, CGE-PL model

The workforce constrains assumed make the desired path of GDP growth achievable only with a very fast increase in labour productivity, especially in labour-intensive sectors, i.e. agriculture and services. With the assumed major changes in labour productivity, accurate calibration of the model results did not require substantial changes in the numerical values of capital productivity parameters. This reflects the general trend of technical progress in the economy, with labour savings generated by provision of better technical equipment for workplaces. Notably, even in the REF scenario, limiting final energy consumption to the level Poland committed to (until 2015) will require far-reaching improvement in productivity – by over 25% in 2030 and around 45% in 2040. This means the productivity of energy use in the generation of the Polish GDP, net of fuel and energy consumption in the Hh sector (energy consumption). On the other hand, with account taken of the total energy demand (manufacturing plus households), final energy productivity increases by approx. 17% in 2030, following which it stabilises until 2040.

5.2.1.1.2. Analysis of the profitability, employment structure, and production prices of the manufacturing industry in the REF scenario

The study analyses the impact of the conditions of the REF scenario on the profitability of gross revenues in manufacturing industries. The results obtained are presented in the table and figure below.

Table 77. Changes in gross profitability of selected manufacturing industries in the REF scenario (current prices)

	2015	**2016**	**2017**	**2018**	**2020**	**2025**	**2030**	**2035**	**2040**
Food industry	4.7%	5.1%	4.5%	4.7%	4.6%	4.4%	4.3%	3.3%	2.7%
Light industry	6.8%	6.9%	6.1%	6.1%	7.3%	6.8%	6.9%	5.6%	3.3%
Paper industry	8.4%	8.3%	8.5%	9.5%	8.1%	7.4%	7.3%	6.2%	5.1%
Chemical industry	7.9%	8.2%	7.0%	6.7%	7.9%	7.2%	7.1%	5.8%	4.6%
Mineral industry	9.0%	8.6%	9.2%	8.6%	9.7%	8.9%	8.9%	8.1%	6.8%
Metallurgy	5.7%	6.4%	5.6%	5.7%	5.9%	5.2%	4.9%	4.0%	2.7%
Machinery industry	4.5%	4.4%	4.1%	3.8%	4.5%	4.9%	5.2%	5.0%	4.5%
Other industries	6.9%	7.0%	6.4%	5.5%	6.0%	5.1%	4.4%	3.2%	2.4%

Source: EnergSys's own study, Mezzo-Impact model

Compared to the 2015-2018 profitability ratios, it can be seen that after 2020 virtually all manufacturing

industries may experience increased operating costs in the REF scenario, with the exception of the light, mineral and machinery industries, which demonstrate an increase in profitability in 2020-2030. As is shown by the results of the CGE-PL model, the rate of cost growth outweighs the dynamics of revenue growth. The changes can be attributed to the change in the structure and volume of demand for industrial products as a result of differences in the increase in the prices of production of the individual industries and sectors of the national economy. This causes the gross profitability ratios of individual industries to decline overall, especially in 2030-2040.

The post-2030 changes in the operating conditions in the REF scenario prove to be relatively least severe for enterprises of the mineral industry, where production is highly energy-intensive and generates substantial carbon dioxide emissions (mainly process-generated ones). The prices of products of this sector rise the most in the manufacturing industry, which, however, does not significantly affect the volume of demand. The increased price of production generates revenues that compensate for the increase in production costs. The mineral industry owes its success to the large scale of construction projects in the economy, notably in the housing and energy sectors.

A more detailed analysis reveals that the scale of threat to the profitability of several industries can be largely attributed to the share of revenues of exports in total turnover. In the food, metallurgy and other industries, as from 2035 profitability ratios dive as a result of decreasing price competitiveness of products on international markets. In the CGE model, this is caused by a high price elasticity of demand for exports sales (relatively high price sensitivity/competitiveness of products on international markets).

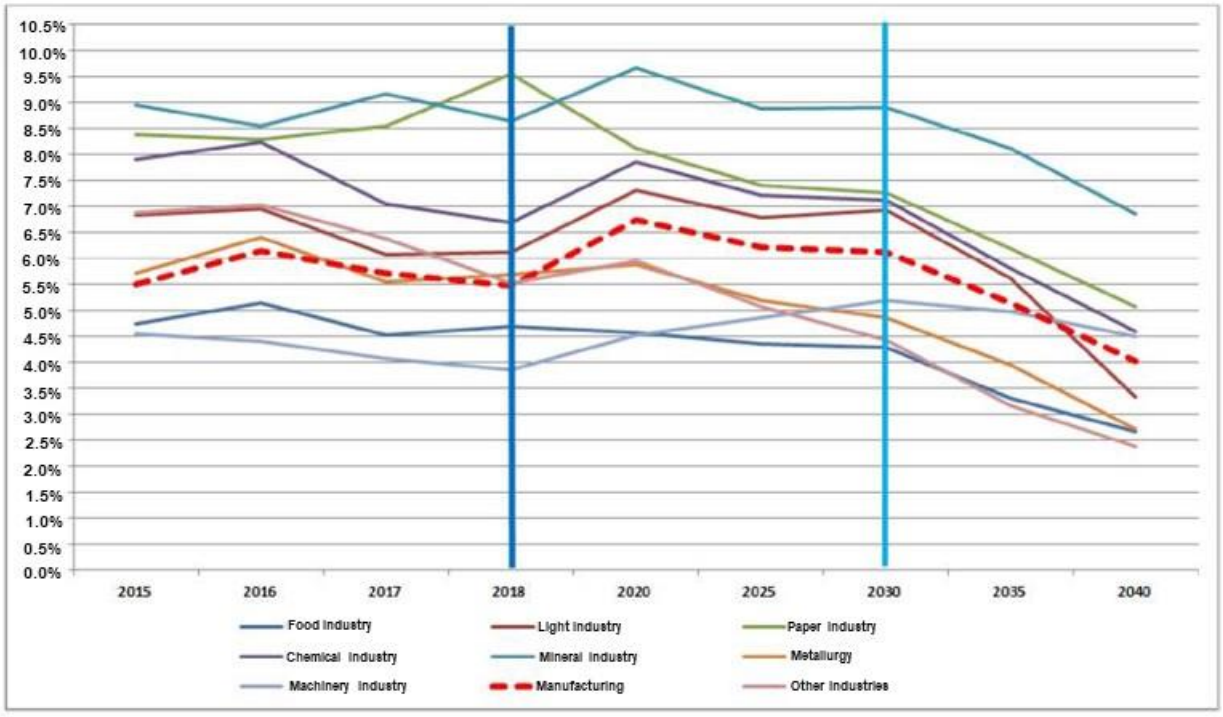

Figure 30. Changes in gross profitability of selected manufacturing industries in the REF scenario (current prices)

Changes in employment in the sectors of the NE used in the CGE-PL model are presented in the table below, while changes in the sectoral structure calculated for the period 2015-2040 in the graph that follows. According to the preliminary assumptions, the level of employment in the NE will fluctuate slightly, with shifts in the employment structure attributable mainly to a decline in the workforce in agriculture. In the period 2020-2030, the number of employees in the manufacturing, construction and service sectors rises steeply, and decreases in agriculture and the fuel and energy sector. In the decade that follows (2030-2040), employment in agriculture shrinks on a much smaller scale, while that in the sector of services, including public services, drops considerably. On the other hand, employment continues to rise in the manufacturing, construction and transport sectors.

Table 78. Employment in the economy by sectors and industries in the REF scenario [thousand employees]

Item/category	2015	2020	2025	2030	2035	2040
Agriculture, forestry and fishing	1 841	1 689	1 507	1 390	1 309	1 307
Extraction of non-energy raw materials	46	46	48	48	50	54
Manufacturing	3 250	3 191	3 240	3 609	3 548	4 054
Construction	1 157	1 127	1 134	1 290	1 336	1 410
Transport	652	614	571	592	604	652
Services	8 652	8 815	9 150	8 902	9 032	8 241
Fuel and energy sector	378	382	362	331	296	314
Total	15 977	15 865	16 011	16 163	16 175	16 033
Workforce	17 161	16 700	16 854	16 836	16 849	16 701

Source: own study, CGE-PL model

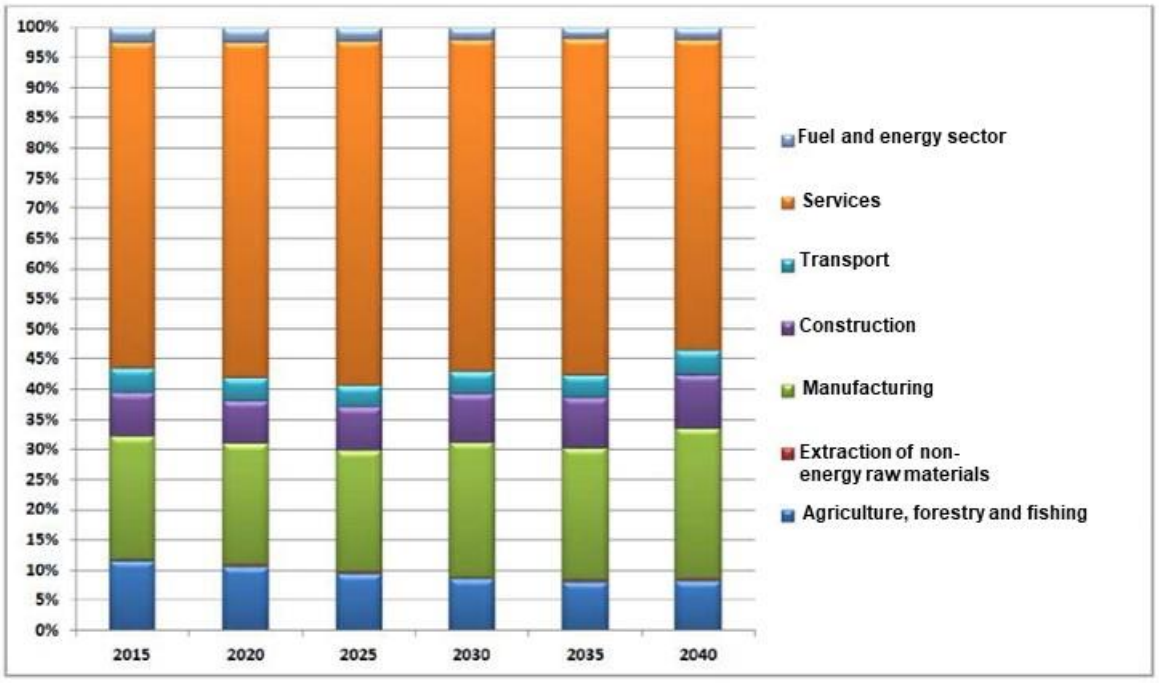

Figure 31. Employment structure in sectors of the NE in the REF scenario in 2015-2040

Thanks to the assumed major improvement in the efficiency of production factors, the projected economic growth is obtained with moderate inflation, despite strong inflation impulses related to the increase in CO_2 emission allowance and fuel prices on international markets. The results obtained are presented in the table and figure below. The inflation slows down as a result of the very moderate dynamics of service prices. The price dynamics in all sectors (excluding fuels and energy) grows fairly moderately in the period 2021-2030 to accelerate after 2030 in line with the rising trend in global prices, mainly of natural gas and CO_2 emission allowances, which highly adds to the increase of prices in the manufacturing industry, consuming high and growing amounts of electricity over time. As a consequence, increases in the prices of fuels and energy, and construction materials (cement, steel, chemicals), as well as a significant share of value added (salaries), together with a high rise in productivity, contribute jointly to a noticeable increase in prices of services in the construction sector. Relatively smaller price increases can be expected in the services and transport sectors, which function on competitive markets, often with relatively small barriers to entry.

Table 79. Evolution of inflation rate and nominal production price dynamics in sectors of the national economy in the REF scenario

Item/category	2015	2020	2025	2030	2035	2040
Inflation rate	100	107	116	119	126	132

Product and service price dynamics in sectors of the economy						
Agricultural, forestry and fisheries products	100	107	114	119	125	133
Non-energy source materials		108	118	123	127	137
Industrial products		109	118	124	128	142
Construction services		108	116	122	131	143
Transport services		104	110	112	119	127
Other services (commercial and public)		104	111	110	116	118
Fuels and energy		112	140	157	172	190

Source: EnergSys, CGE-PL model

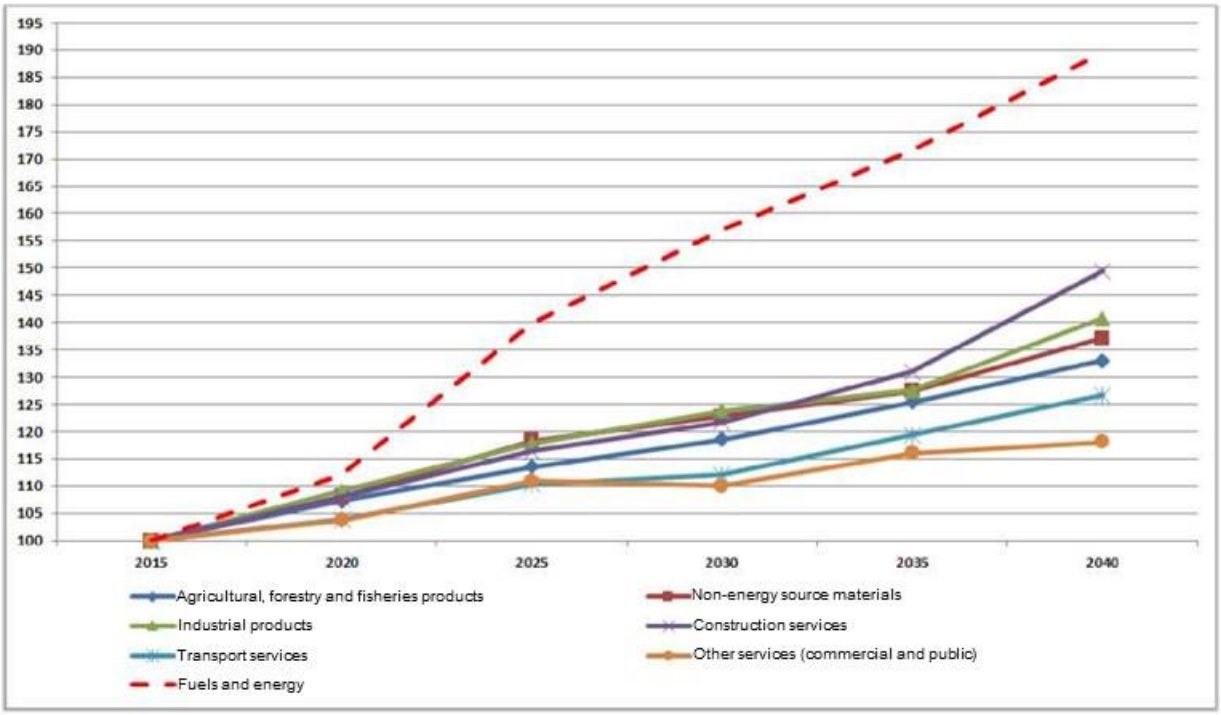

Figure 32. National nominal service and product price dynamics by sectors in the REF scenario [2015=100]

The figure above shows that, with the assumed global trends, rising prices of hydrocarbon fuels and ETS CO_2 emission allowances, a rapid increase in domestic fuel and energy prices can be expected. Over the whole period, these prices increase almost twice. However, a high increase in labour productivity along with the planned increase in salaries will have the strongest impact on the growth of prices in construction and manufacturing, which requires major investments in the latest Industry 4.0 technologies (automation and robotisation, digitisation and smart systems).

5.2.1.1.3. Analysis of social impacts in the REF scenario

This section analyses the social impacts that comprise the following macroeconomic categories over the 2030-2040 timespan:

- real wage dynamics,
- dynamics of disposable income of households (Hh),
- growth of households' expenditures on fuels and energy and their share in income, by five income groups (five quintiles: Nos 1 and 2 comprise the poorest households – 40% of all Hh, quintile No 3 comprises middle-income earners – 20% of Hh, while No 4 and 5 include the wealthiest 40% of Hh, according to the GUS criteria adopted for 2015).

The model analysis of social impacts is carried out using the Mezzo-Impact model – the Hh module, in which the results of calculations are influenced by a range of macroeconomic variables as determined in the CGE-PL

model. They constitute the so-called 'driving force' (impulse) in the calculations of the assessment of the social impacts inherent in the implementation of the public policy instruments investigated by the Mezzo-Impact model. The trends in macroeconomic indicators calculated in the CGE-PL model in 2015-2040 are summarised in the table below.

Table 80. Disposable income of households, real wage dynamics, and nominal domestic fuel and energy price dynamics in the REF scenario

Item/category	**Unit**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Disposable income of Hh	**EUR'2016 billion**	**270**	**320**	**376**	**421**	**473**	**521**
Dynamics of real disposable income of Hh	[-/-]	100	119	139	156	175	193
Real wage dynamics			114	135	143	158	173
Inflation rate			107	116	119	126	133
Nominal value dynamics							
Nominal disposable income dynamics	100		127	162	185	221	256
Solid fuels (coals and biomass)			110	122	131	138	155
Liquid fuels (fuel oil and LPG in cylinder)			112	143	162	176	191
Gaseous fuels			112	163	191	209	237
Electricity and district heating			115	132	145	163	176

Source: EnergSys's own study, CGE-PL model

Since the calculations in the CGE-PL model are made at current prices, use is made of the inflation rate. The evolution in disposable income of Hh reflects the gross revenues of Hh, as calculated in the CGE-PL model. Gross revenues of Hh include all value streams received by Hh, i.e. revenues (before tax) from all monetary and non-monetary sources (labour and capital). The growth of fuel and energy prices consumed by Hh is given in current prices.

Given the nature of the study, which consists in assessing the impact of changes in the share of the value of fuel and energy costs in the Hh spending basket, it is necessary to know the projected fuel and energy consumption in the period 2015-2040, taking into account shifts in the fuel mix and evolution in the volume of future consumption in the subperiods analysed. The data is based on energy consumption projections presented in the table below, which constitute one of the components discussed in the subsections dedicated to the forecast of final inland energy consumption.

Table 81. Direct consumption of fuels and energy in households in the REF scenario [PJ]

Item/category	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Final consumption of fuels and energy in Hh, of which:	792	866	898	926	947	962
Solid fuels (coals and derivatives)	261	260	242	224	208	194
Renewable energy (biomass and others)	111	125	137	152	165	174
Liquid fuels (fuel oil and LPG)	24	25	25	25	25	25
Gaseous fuels	132	175	197	214	225	234
District heat	163	169	176	181	185	187
Electricity	102	112	121	130	138	148

Source: own study by ARE S.A.

The projected changes in consumption of energy carriers in the successive subperiods of the analysis influence future shifts in the consumption of fuels and energy by Hh. In the REF scenario, with the use of incentives already available on the market and availability of measures anticipated by the current energy policy, pro-efficiency changes in the use of fuels and energy are similar to the historically observed 2010-2016 trends.

Cumulatively, the figures in the table above and below are used to determine the social impacts of changes in the share of expenditure on fuels and energy in disposable income of Hh, which means the need to pay bills for consumed fuels and energy to their suppliers (sellers).

The results obtained for the REF scenario indicate that, despite the growing incomes of Hh and the anticipated bridging of the income gaps in society, the poorest households will continue to experience energy poverty until the end of the analysed period. What is more, sixty percent of the population can experience energy poverty until 2030, with only the relatively richest group of Hh in quintile 5 not likely to feel this kind of discomfort in their spending.

The table below presents evolution in the share of fuel and energy expenditure in disposable incomes of Hh as estimated in the Mezzo-Impact model by the quintile groups analysed.

Table 82. Evolution in the share of expenditure on fuels and energy in Hh budgets in the REF scenario, by income quintile groups, in per mille [‰]

Item/category	Unit	2015	2020	2025	2030	2035	2040
First quintile							
Solid fuels	‰	37	27	22	19	15	14
Natural gas		28	26	33	36	35	35
Liquid fuels (fuel oil and LPG in cylinders)		1	1	1	1	1	1
Electricity, heat and renewable energy		85	67	63	64	63	60
Total expenditure on fuels and energy		**151**	**121**	**119**	**120**	**113**	**109**
Second quintile							
Solid fuels	‰	31	25	20	17	14	13
Natural gas		20	21	27	29	28	28
Liquid fuels (fuel oil and LPG in cylinders)		1	1	1	1	1	1
Electricity, heat and renewable energy		61	54	52	53	52	50
Total expenditure on fuels and energy		**113**	**101**	**100**	**100**	95	92
Third quintile							
Solid fuels	‰	28	24	19	17	14	12
Natural gas		19	22	28	31	30	31
Liquid fuels (fuel oil and LPG in cylinders)		1	1	1	1	1	1
Electricity, heat and renewable energy		55	53	51	52	51	50
Total expenditure on fuels and energy		**104**	**99**	**99**	**101**	**96**	93
Fourth quintile							
Solid fuels	‰	23	20	16	14	11	10
Natural gas		19	23	30	34	33	33
Liquid fuels (fuel oil and LPG in cylinders)		1	1	1	1	1	1
Electricity, heat and renewable energy		52	53	51	53	53	51
Total expenditure on fuels and energy		95	97	**99**	**101**	**98**	96
Fifth quintile							
Solid fuels	‰	11	10	8	7	6	5
Natural gas		15	19	24	27	26	27
Liquid fuels (fuel oil and LPG in cylinders)		1	1	1	1	1	1
Electricity, heat and renewable energy		39	41	40	41	41	40
Total expenditure on fuels and energy		66	71	73	76	74	72

Source: EnergSys Mezzo-Impact model, Hh module

The results of calculations in the table below are also illustrated in the charts that follow for the base year and 2020, 2030 and 2040. Each graph illustrates the share of expenditure on energy for all income quintiles, with an estimated breakdown by fuel and energy type, in the successive years of the modelled period (2015-2040). In addition, the red line in the figures marks the energy poverty line as 'defined' for Polish Hh (10% of the Hh budget). If the bars cross the "red line", this indicates exposure to energy poverty in the income group (quintile) concerned.

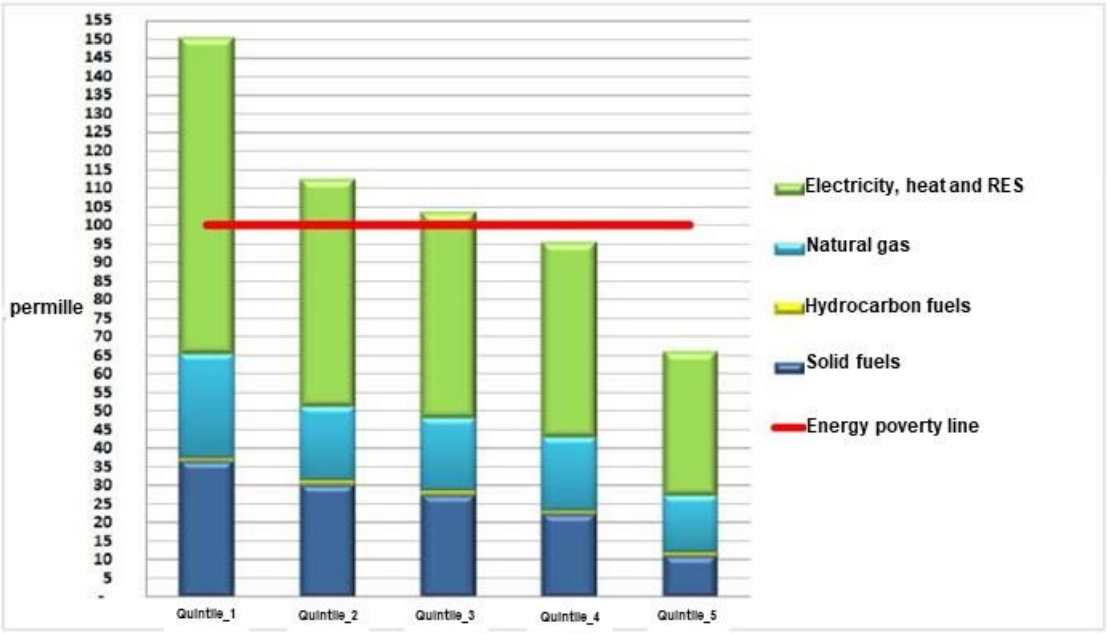

Figure 33. Structure and differences in the share of expenditure on fuels and energy by Hh income quintiles in 2015 (base year for the calculations) – REF scenario

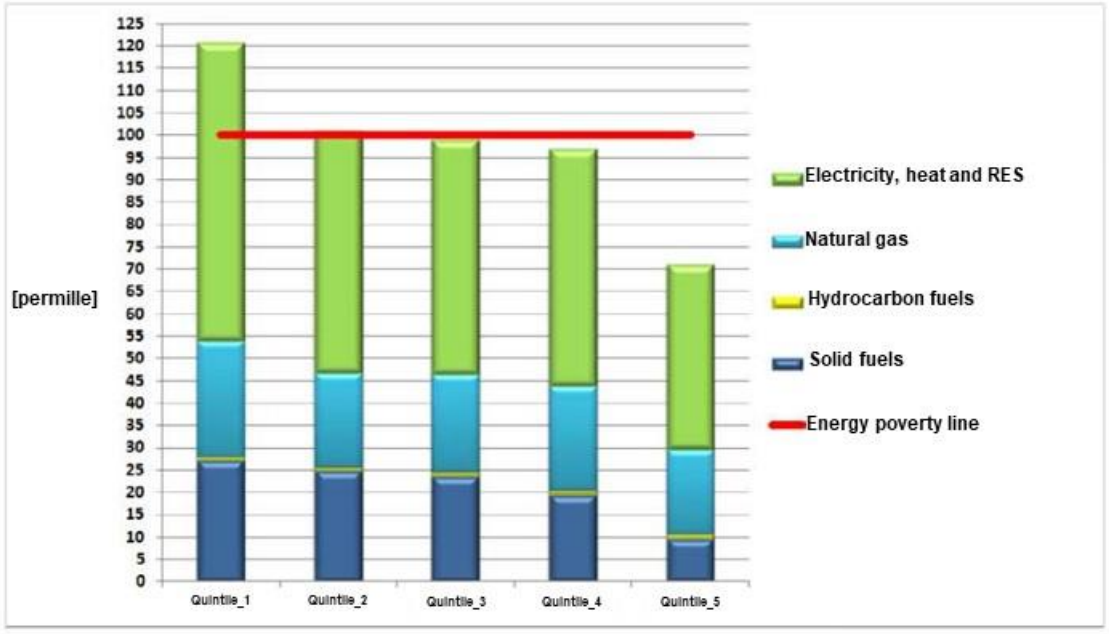

Figure 34. Structure and differences in the share of expenditure on fuels and energy by Hh income quintiles in 2020 – REF scenario

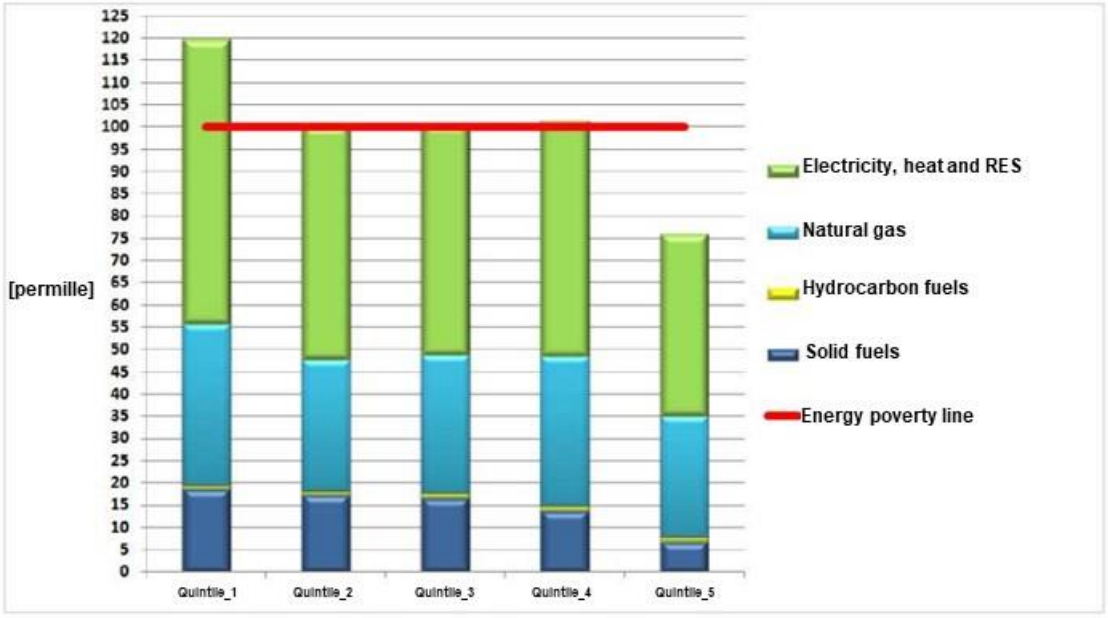

Figure 35. Structure and differences in the share of expenditure on fuels and energy by Hh income quintiles in 2030 – REF scenario

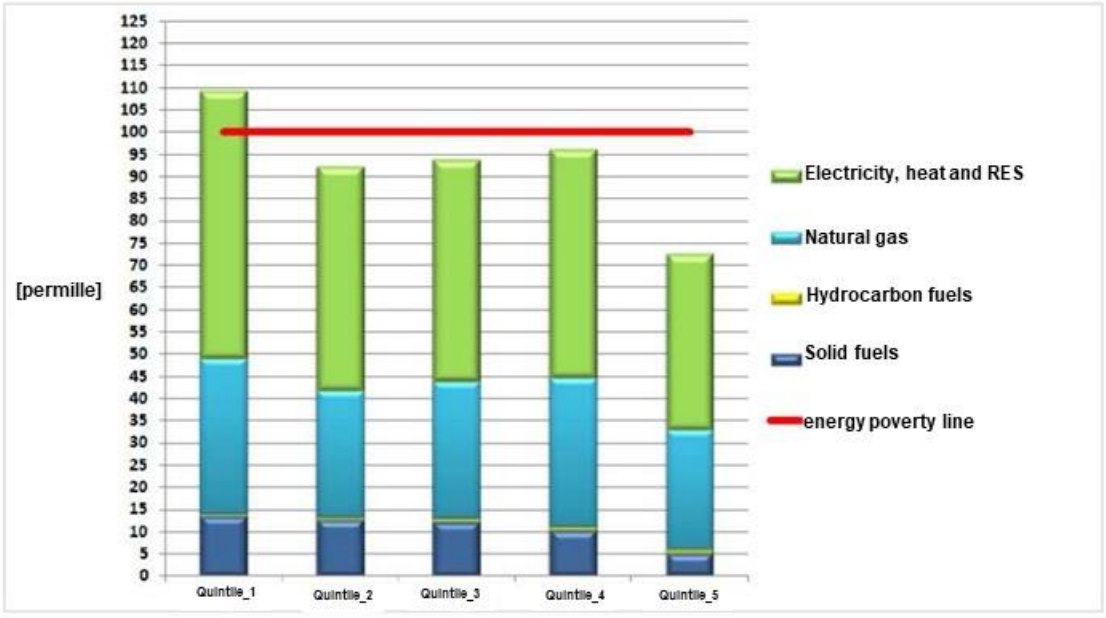

Figure 36. Structure and differences in the share of expenditure on fuels and energy by Hh income quintiles in 2040 – REF scenario

The main observation revealed by the analysis of social impacts in the REF scenario is that of a noticeable reduction in the share of expenditure on fuels and energy in Hh as a result of the expected increase in disposable incomes of Hh – both from paid work and from various forms of public support. Cumulatively these revenues contribute to a partial reduction, or actually to a weakening, of energy poverty by 2030 in the poorer income quintiles (2-4). At the same time, the calculations show that without major support for energy-savings programmes targeted at the poorest Hh – especially those from the 1-st quintile, energy poverty cannot be fully overcome even by 2040.

5.2.1.2. Analysis of macroeconomic and social impacts in the ECP scenario

5.2.1.2.1. Economic growth in 2015-2030 and the 2040 perspective

The calculations for the ECP scenario use the same – as in the REF scenario – assumptions regarding the prices of CO_2 emission allowances and fuel prices on global markets, and the assumptions regarding the development potential of the economy, i.e. evolution in the factors of production (capital, labour) and their sectoral productivity obtained in the CGE-PL model calibration process.

In relation to REF, the assumptions made for the calculations in the ECP scenario differ in terms of:

- the volume and carrier and sectoral structure of the energy demand and supply balance in manufacturing (production) of the national economy,
- the volume and carrier structure of energy demand in households,
- the capital expenditures needed to realise the ECP assumptions,
- the assumption that in both scenarios (REF and ECP) funds obtained from the sale of ETS emission allowances will be divided in the following proportions: 25% as s shield for households, 25% for the state budget, and 50% for modernisation investments.

The calculations of the ECP scenario take into account the increases (differences) in the volume and structure of capital expenditures compared to the REF scenario. Account is taken of both capital expenditures on obtaining, processing, and supplying fuels and energy as well as those related to use – aimed at saving and/or improving the efficiency of fuel and energy consumption for all consumers.

The table below presents the assumptions regarding the factors of production used in the calculations for the ECP scenario. The grey shading in the table stands for the elements that remain unchanged (by assumption) in both scenarios. The scale of the needed increase in energy productivity of manufacturing needs to be emphasised. The required growth rate for energy productivity is summarised in the last two lines of the table.

Table 83. Resources of factors of production and their productivity in the ECP scenario

	Unit	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Workforce	thou. of employed	17 161	16 700	16 854	16 836	16 849	16 724
Gross capital formation (capital resource)	EUR'2016 billion	95	103	120	135	149	160
Capital formation dynamics	[-/-]	100	108	126	142	157	169
Changes in factors of production relative to GDP							
Labour productivity dynamics	[-/-]	100	120	140	160	181	202
Capital productivity dynamics			110	111	114	117	120
Dynamics of fuel and energy productivity in manufacturing (excluding households)			102	123	144	165	184
Dynamics of fuel and energy productivity in the country (including households)			120	140	160	181	202

Source: EnergSys's own study, CGE-PL model

The energy productivity growth rates demonstrate a much higher rate of growth in the anticipated energy productivity in the Hh sector, where excessive fuel and energy volumes are currently consumed. The planned measures and schemes in support of urgent thermomodernisation, combined with the replacement of heating devices and other appliances used in Hh are and will be a very important contributor to the fulfilment of the goals and assumptions of the NECP.

The following two tables present the results of calculations of the CGE-PL model regarding the volume of GDP and value added in sectors of the national economy (NE). In addition, evolution in the country's foreign trade balance, as well as the expected employment (workforce engagement) and unemployment rates calculated in CGE-PL are presented.

The results in the ECP scenario do not display large numerical differences from those obtained in the REF

scenario, which is connected with the productivity of labour and capital, which remains unchanged by assumption and is essential for the GDP growth rate. Therefore, the dynamics of GDP and shifts in its breakdown (the added value in the sectors of the national economy analysed) are highly similar. In 2015-2030, GDP potentially increases by around 60%. In the longer time horizon, economic growth gradually slows down, even though the GDP doubles over the entire 2015-2040 period. The results obtained are also shown in the figure below.

Table 84. GDP level and trends in selected macroeconomic variables in the ECP scenario

Item/category	**Unit**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
GDP level	EUR'2016 billion	462.4	551	649	747	850	941
GDP dynamics	2015=100	100	119	140	162	184	203
Foreign trade balance	EUR'2016 billion	14.3	-0.8	7.0	-1.2	9.8	28.2
Employment	thousand people	15 977	15 855	16 004	16 175	16 193	16 020
Unemployment rate	%	6.9%	5.1%	5.0%	3.9%	3.9%	4.1%
Model calculation subperiods	*years*	**-**	***2020-2020***	***2022-2020***	***2020-2020***	***2022-2020***	***2020-2020***
Annual average GDP growth rate over the five-year period	*%*	-	***3.6%***	***3.3%***	***2.8%***	***2.6%***	***2.0%***

Source: EnergSys's own study, CGE-PL model

Table 85. Changes in value added in the economy by economic sectors and industries in the ECP scenario [EUR'2016 billion]

Item/category	2015	2020	2025	2030	2035	2040	2040/2015 ratio
Agriculture, forestry and fishing	10.43	12	13	15	16	17.7	1.70
Extraction of mineral resources	1.46	2	2	2	2	2.7	1.79
Manufacturing	85.5	97	109	127	143	153.0	1.79
Construction	34.6	39	44	56	61	65.4	1.89
Transport	27.40	33	37	44	49	55.4	2.02
Services	233.00	282	340	389	443	492.0	2.11
Fuel and energy sector	17.80	22	23	21	24	29.4	1.65
Total	410.19	486	569	654	739	816.0	1.99
GDP	462.4	551	649	747	850	941	2.03

Source: EnergSys's own study, CGE-PL model

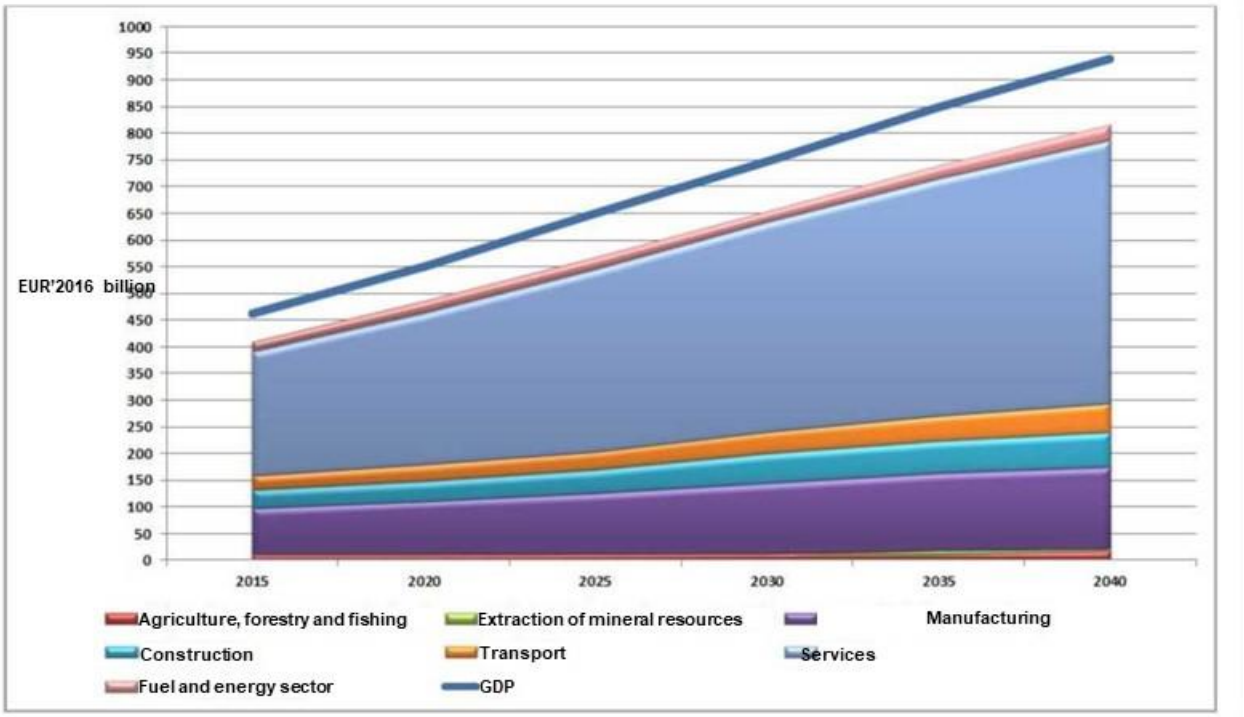

Figure 37. GDP and value added in aggregate sectors of the NE – ECP

In terms of shifts in the GDP generation structure, the results of the model are also close to the original assumptions of the REF scenario, although there are some differences. The table and figure below show a gradual increase in the share of the service sector, by nearly 1 pp in 2040 compared to 2015, and a radical increase in the share of the fuel and energy sector after 2030, which reaches several percentage points. **This is connected with the very large increase in capital expenditures on additional RES, which is much higher than in the REF scenario**. By contrast, the shares in manufacturing and transport decrease.

5.2.1.2.2. Analysis of the profitability, employment structure, and production prices of the manufacturing industry in the ECP scenario

The study analyses the impact of the conditions of the ECP scenario on the profitability of gross revenues in manufacturing industries. The results obtained are presented in the table and figure below.

Table 86. Changes in gross profitability of selected manufacturing industries in the ECP scenario (current prices)

	2015	2016	2017	2018	2020	2025	2030	2035	2040
Food industry	4.7%	5.1%	4.5%	4.7%	4.6%	4.4%	4.4%	3.4%	2.7%
Light industry	6.8%	6.9%	6.1%	6.1%	7.3%	6.8%	6.4%	5.5%	3.0%
Paper industry	8.4%	8.3%	8.5%	9.5%	8.0%	7.2%	7.1%	6.1%	5.0%
Chemical industry	7.9%	8.2%	7.0%	6.7%	7.9%	7.3%	7.2%	6.0%	4.9%
Mineral industry	9.0%	8.6%	9.2%	8.6%	9.3%	8.3%	8.3%	7.6%	6.5%
Metallurgy	5.7%	6.4%	5.6%	5.7%	5.7%	5.0%	4.8%	3.8%	2.7%
Machinery industry	4.5%	4.4%	4.1%	3.8%	4.3%	4.4%	4.8%	5.0%	4.5%
Other industries	6.9%	7.0%	6.4%	5.5%	5.9%	4.9%	4.3%	3.2%	2.6%

Source: EnergSys's own study, Mezzo-Impact model

As for the GDP creation volume and structure, the differences between the scenarios in terms of changes in the profitability of industries are not large, and their evolution trend is similar to that calculated in REF. This similarity of development on a national economy scale is attributable to the unchanged values of labour and capital productivity, similar way of redistribution of revenues from the sale of CO_2 emission allowances, and other development-related features of the national economy, determined, *inter alia*, by demographics and the mobility

and qualifications of the workforce.

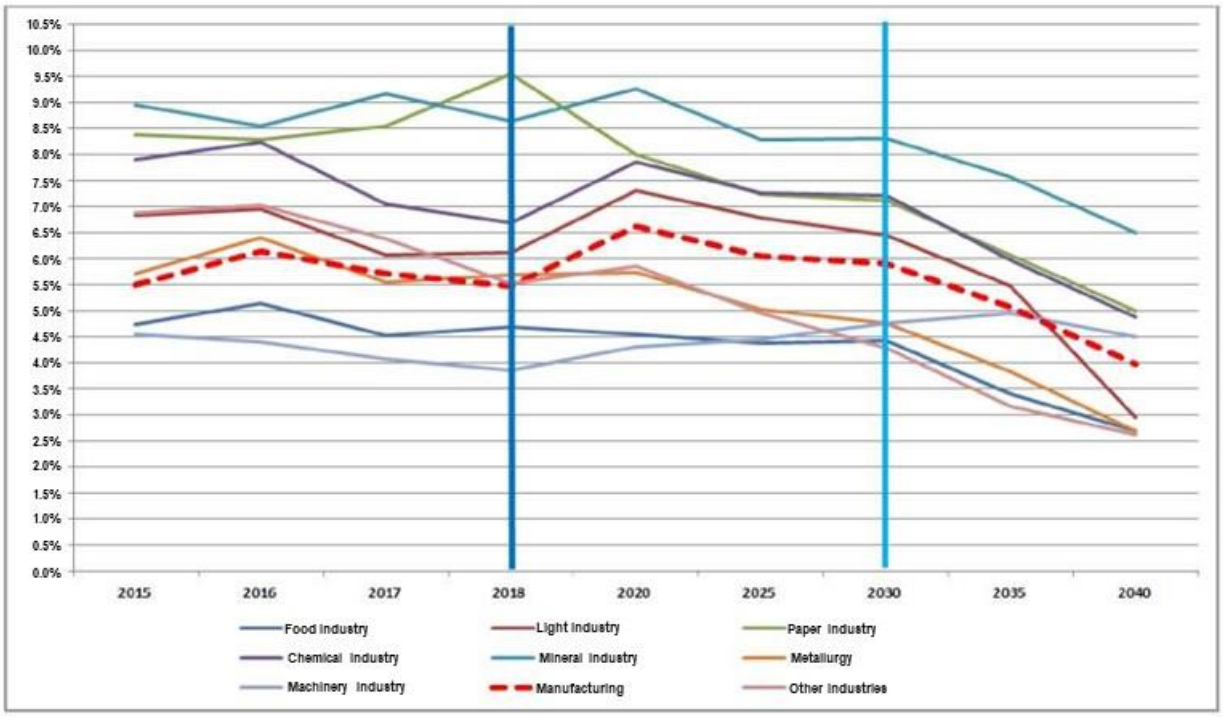

Figure 38. Changes in gross profitability of selected manufacturing industries in the ECP scenario (current prices)

The changes of employment in the sectors of the NE used in the CGE-PL model are presented in the table below, while the shifts in employment structure in 2015-2040 by sectors are shown in the graph that follows. Also for this element, the results of simulations in the model are very similar in both scenarios. The number of people employed in agriculture, and after 2035 also in services, goes down. In the period 2015-2040, the number of employees in the manufacturing and construction industries rises steeply, which stems from the adverse demographic processes in Poland.

Table 87. Employment in the economy by sectors and industries in the ECP scenario [thousand employees]

Item/category	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Agriculture, forestry and fishing	1 842	1 701	1 524	1 441	1 438	1 388
Extraction of non-energy raw materials	46	45	46	50	52	55
Manufacturing	3 250	3 198	3 260	3 492	3 610	3 796
Construction	1 157	1 131	1 163	1 358	1 382	1 472
Transport	652	621	589	626	631	697
Services	8 652	8 877	9 284	9 163	9 051	8 547
Fuel and energy sector	378	372	367	330	312	299
Total	15 977	15 944	16 233	16 459	16 476	16 254
Workforce	17 273	16 695	17 087	17 145	17 162	16 931

Source: EnergSys's own study, CGE-PL model

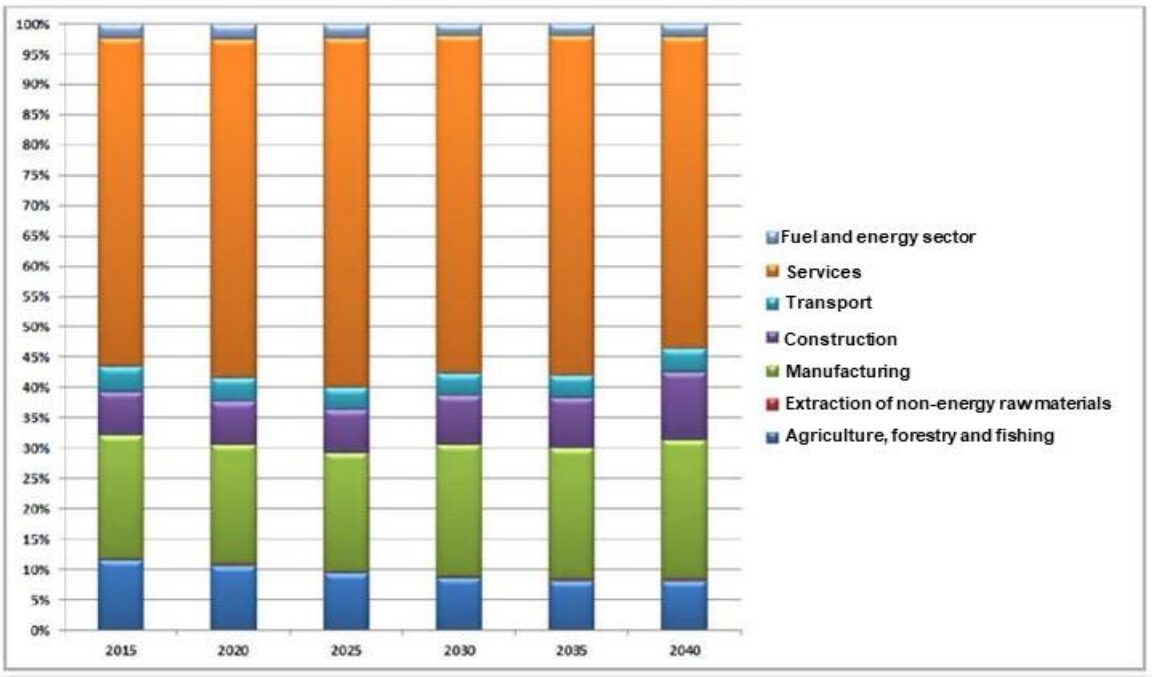

Figure 39. Employment structure in sectors of the NE in the ECP scenario in the period 2015-2040

Another major group of results is formed by the **price trends**, which are determined in the ECP scenario by dynamics indicators. They are slightly higher than those obtained for REF (*inter alia*, as a result of the reduction in the excise duty and the interim fee). For the ECP scenario, the price dynamics obtained in the calculations are presented in the table and figure below.

All prices rise quite strongly in 2021-2025 to slow down in 2026-2030, except for fuel and energy prices. Stronger price increases may occur especially in the 2035-2040 subperiod, which will potentially correlate with the anticipated cycles of the domestic and world economy. The differences in the pace and scale of price increases between the scenarios (ECP vs. REF) are mainly noticeable for fuel and energy prices, which do not grow so fast in the ECP scenario over the 2020-2035 period. This is attributable to the significantly higher energy efficiency improvement rate, including much higher fuel and energy savings in the Hh sector. The anticipated energy savings, combined with the development of distributed renewable electricity, will reduce the demand for final energy thereby relieving the tensions in the energy production and supply mix. The process, supported by stable public policies, will constitute one of the fundamental qualitative changes of development in the ECP scenario. These changes are based on sustainable energy transition, initiated and maintained by changes in the preferences and behaviour of consumers, followed by adaptation measures of producers and sellers of fuels and energy.

Table 88. Evolution of inflation rate and nominal production price dynamics in sectors of the national economy in the REF scenario

Item/category	2015	2020	2025	2030	2035	2040
Inflation rate	100	107	116	119	126	133
Product and service price dynamics in sectors of the economy						
Agricultural, forestry and fisheries products	100	107	114	119	125	133
Non-energy source materials		108	118	123	127	137
Industrial products		110	119	125	128	147
Construction services		108	117	122	131	143
Transport services		104	110	112	119	127
Other services (commercial and public)		104	111	110	117	119
Fuels and energy		113	139	154	166	187

Source: EnergSys's own study, CGE-PL model

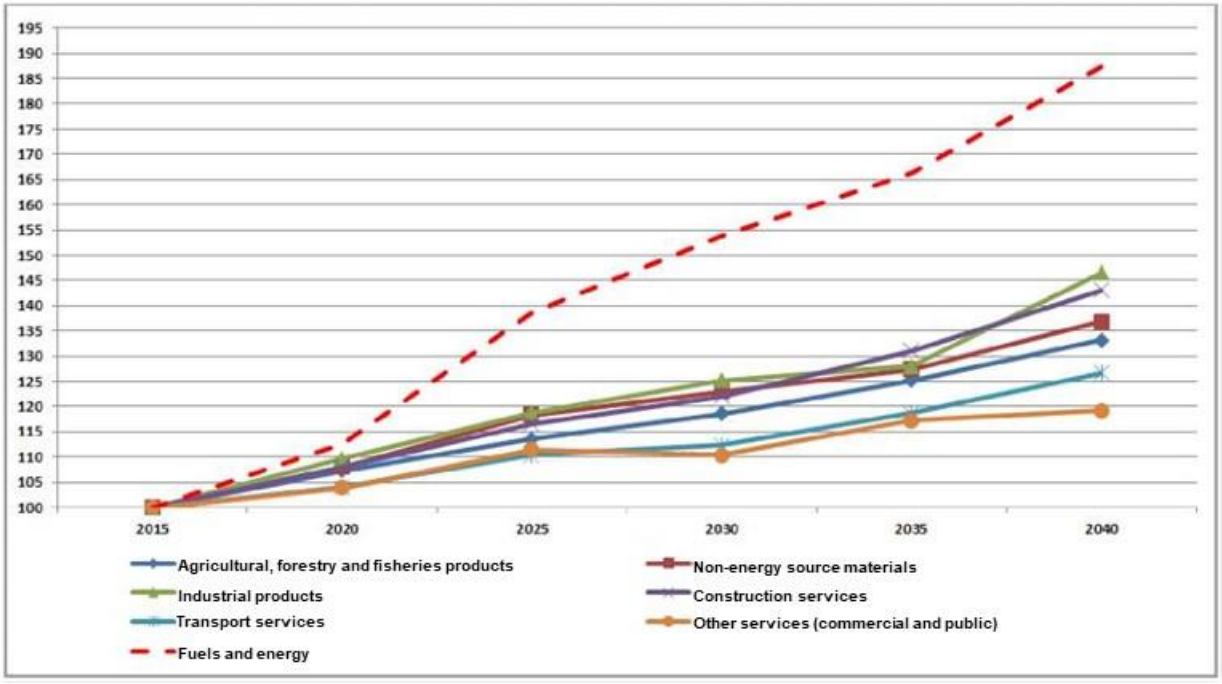

Figure 40. National nominal service and product price dynamics by sectors in the ECP scenario

5.2.1.2.3. Analysis of social impacts in the ECP scenario

This section analyses the social impacts comprising the following macroeconomic categories in the perspective of the country's economic development until 2040:

- real wage dynamics,
- dynamics of disposable income of households,
- growth of households' expenditures on fuels and energy and their share in income, with account taken of the income gap (five quintiles: Nos 1 and 2 comprise the 40% poorest Hh, quintile No 3 comprises middle-income earners – 20% of Hh, while No 4 and 5 include the wealthiest 40% of Hh, according to the GUS criteria adopted for 2015).

The model analysis of social impacts is carried out using the Mezzo-Impact model – the Hh module, in which the results of calculations are influenced by a range of macroeconomic variables as determined in the CGE-PL model. They constitute the so-called 'driving force' (impulse) in the calculations of the assessment of the social impacts inherent in the implementation of the public policy instruments investigated by the Mezzo-Impact model.

The macroeconomic categories calculated in the model for the period 2015-2040 are summarised in the table below. Importantly, in the CGE-PL model, calculations are made in current prices, while the macro categories in real prices are determined with account taken of the inflation rate, as calculated in the model.

Table 89. Disposable income of households, real wage dynamics, and nominal domestic fuel and energy price dynamics in the ECP scenario

Item/category	**Unit**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Disposable income of Hh	**EUR'2016 billion**	**270**	**318**	**373**	**416**	**482**	**522**
Dynamics of real disposable income of Hh	[-/-]	100	118	138	154	178	193
Real wage dynamics			114	134	142	160	172
Inflation rate			107	116	119	126	132
Nominal value dynamics							

Nominal disposable income dynamics	100	126	161	183	224	255
Solid fuels (coals and biomass)		112	121	122	134	151
Liquid fuels (fuel oil and LPG in cylinder)		112	140	162	170	206
Gaseous fuels		111	162	190	207	233
Electricity and district heating		116	131	141	155	168

Source: EnergSys's own study, CGE-PL model

The table below presents a forecast of demand for fuels and energy in the household sector resulting from projections prepared for the ECP scenario.

Table 90. Direct consumption of fuels and energy in households in the ECP scenario [PJ]

Item/category	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Final consumption of fuels and energy in Hh,	**792**	**845**	**793**	**751**	**751**	**757**
of which:						
Solid fuels (coals and derivatives)	261	243	169	109	80	57
Renewable energy (biomass and others)	111	122	143	166	186	206
Liquid fuels (fuel oil and LPG)	24	26	25	23	23	22
Gaseous fuels	132	177	183	182	181	182
District heat	163	169	157	147	148	149
Electricity	102	108	116	124	133	143

Source: own study by ARE S.A.

Even though the dynamics of fuel and energy prices determined in the ECP scenario is similar to the prices in REF, the level of fuel and energy consumption in households in ECP is much lower – by approx. 20-22% in 2030-2040. By contrast, the dynamics of disposable income of households, real wages and inflation rates are very similar in both scenarios. The results of calculations summarised in the table at the beginning of this subsection and the real wage dynamics indicate that in the successive 5-year subperiods the share of expenditure on fuels and energy, even among the poorest Hh (quintiles 1 and 2), may decrease considerably in the period analysed. In the table below expenses in excess of this level are marked in red. Under the ECP scenario, if energy-savings projects in households are implemented quickly, until 2020, energy poverty will affect up to 40% of households, and in the REF scenario, as many as 60%. This is a major and beneficial change, but one dependent on enormous scale of support for energy-savings measures.

Table 91 below presents the evolution in the share of fuel and energy expenditure in disposable incomes of Hh (until 2040) as estimated in the Mezzo-Impact model by the quintile groups. They are determined using the macroeconomic categories compiled in the table at the beginning of this subsection and projected energy consumption shown in the table above, as well as the assumed shifts in the quintiles.

Table 91. Evolution in the share of expenditure on fuels and energy in Hh budgets in the ECP scenario, by income quintile groups, in per mille [‰]

Item/category	**Unit**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
First quintile							
Solid fuels		37	26	15	9	6	4
Natural gas		28	26	31	31	27	27
Hydrocarbon fuels		1	1	1	1	1	1
Electricity, heat and renewable energy		85	66	61	60	56	56
Expenditure on energy		**151**	**120**	**108**	**100**	**90**	**87**
Second quintile							
Solid fuels		30.5	24.1	14.1	8.0	5.2	3.6
Natural gas		19.9	21.1	25.0	25.4	22.2	21.9
Hydrocarbon fuels		1.0	0.9	0.8	0.8	0.6	0.6

Electricity, heat and renewable energy		61.2	54.2	49.8	49.2	46.5	46.8
Expenditure on energy		**113**	**100**	**90**	**83**	**75**	**73**
Third quintile							
Solid fuels		27.8	22.8	13.4	7.7	5.0	3.6
Natural gas		19.5	22.1	26.3	26.9	23.7	23.5
Hydrocarbon fuels		1.0	0.9	0.9	0.8	0.7	0.7
Electricity, heat and renewable energy		55.4	52.4	48.5	48.2	45.9	46.6
Expenditure on energy		**104**	**98**	**89**	**84**	**75**	**74**
Fourth quintile							
Solid fuels		22.6	18.8	11.1	6.4	4.2	3.0
Natural gas		19.5	23.6	28.2	29.0	25.6	25.6
Hydrocarbon fuels		1.0	1.0	0.9	0.9	0.7	0.8
Electricity, heat and renewable energy		52.4	52.9	49.2	49.1	47.0	47.9
Expenditure on energy		**95**	**96**	**89**	**85**	**78**	**77**
Fifth quintile							
Solid fuels		11.3	9.4	5.6	3.2	2.1	1.5
Natural gas		15.0	19.2	22.9	23.5	20.7	20.6
Hydrocarbon fuels		1.0	1.0	0.9	0.9	0.8	0.8
Electricity, heat and renewable energy		38.8	41.3	38.3	38.2	36.5	37.1
Expenditure on energy		**66**	**71**	**68**	**66**	**60**	**60**

Source: Mezzo-Impact module

The results of calculations in the table below are also illustrated in the four successive graphs that follow for the years 2015, 2020, 2030, and 2040. Each graph illustrates the share of expenditure on energy for all income quintiles, with an estimated breakdown by fuel and energy type, in the successive years of the modelled period (2015-2040). In addition, the red line in the graphs marks the energy poverty line as 'defined' for Polish Hh. Such a situation occurs when the energy spending bars cross the 'red line' of energy poverty for the respective Hh income quintile.

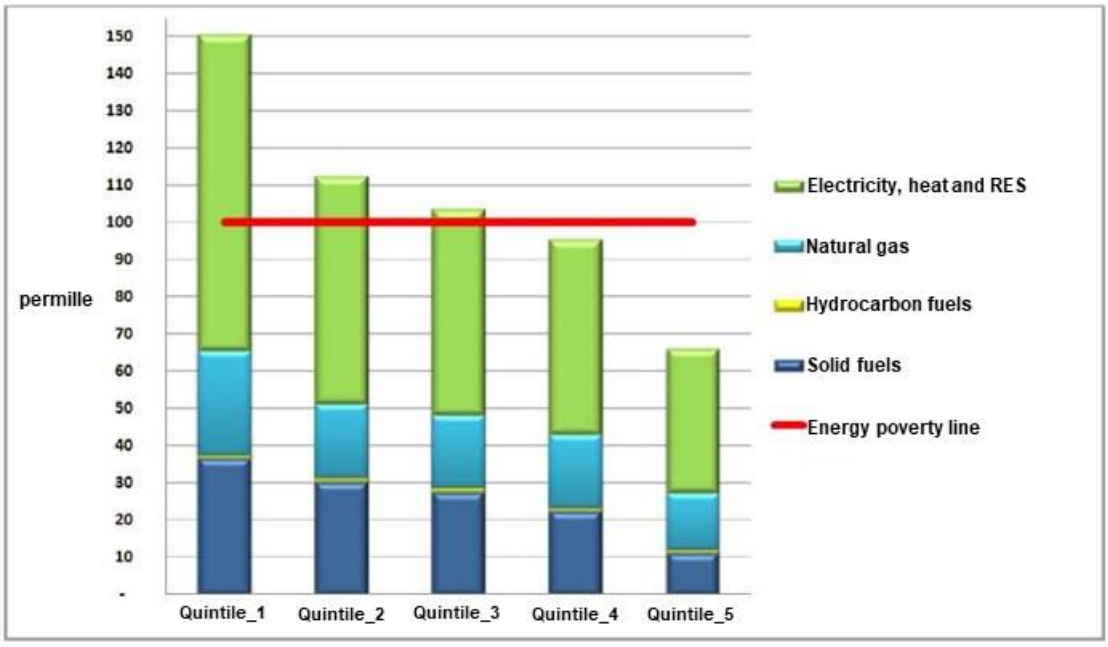

Figure 41. Structure and differences in the share of expenditure on fuels and energy by Hh income quintiles in 2015 – ECP scenario

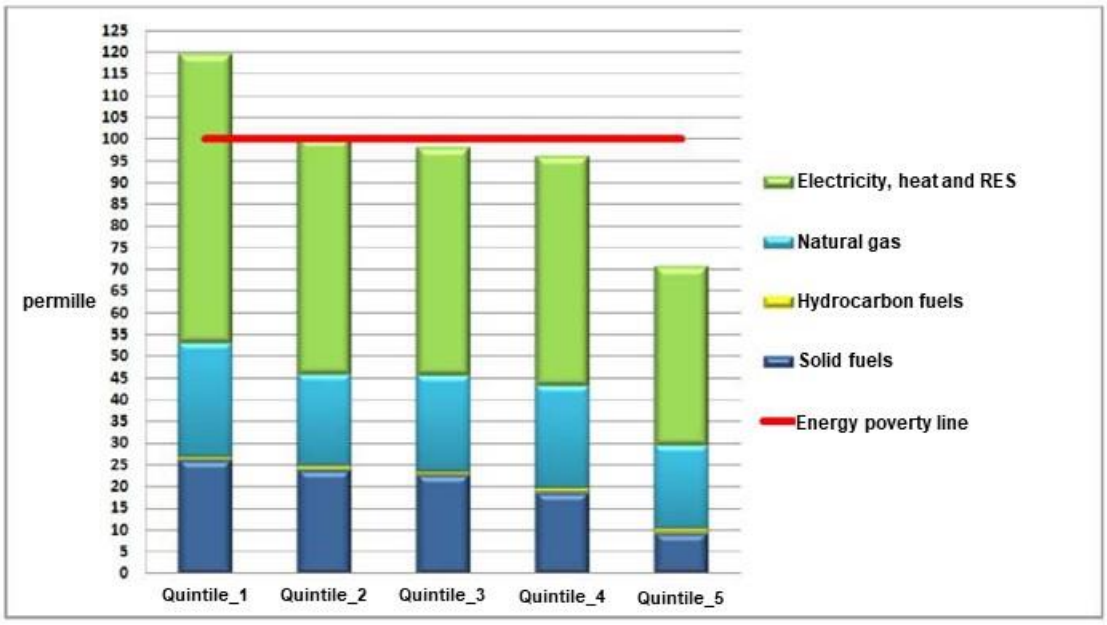

Figure 42. Structure and differences in the share of expenditure on fuels and energy by Hh income quintiles in 2020 – ECP scenario

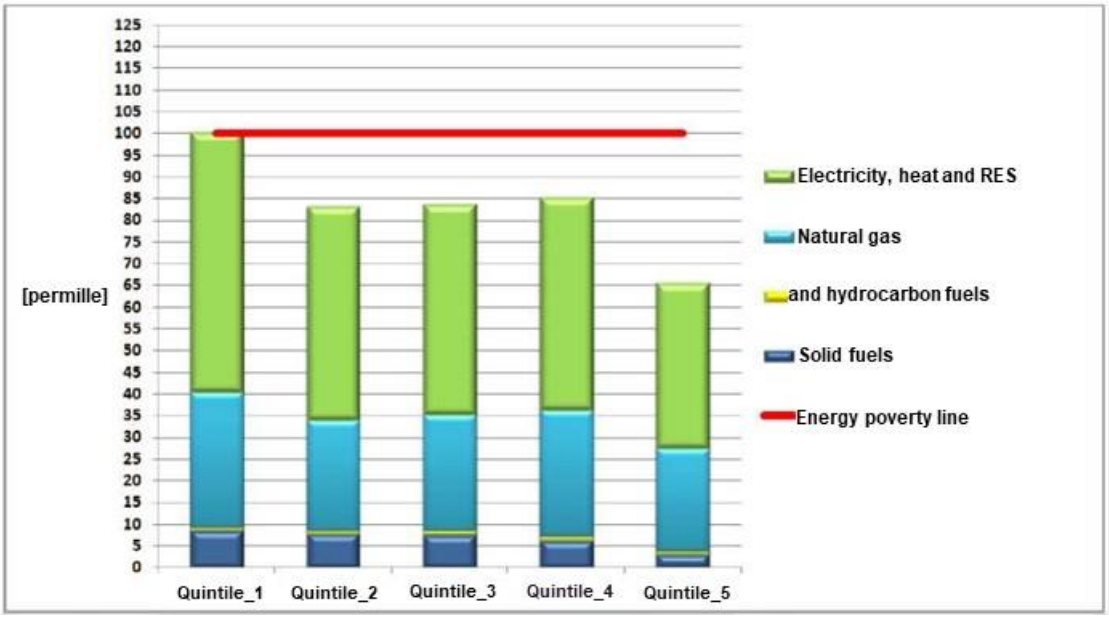

Figure 43. Structure and differences in the share of expenditure on fuels and energy by Hh income quintiles in 2030 – ECP scenario

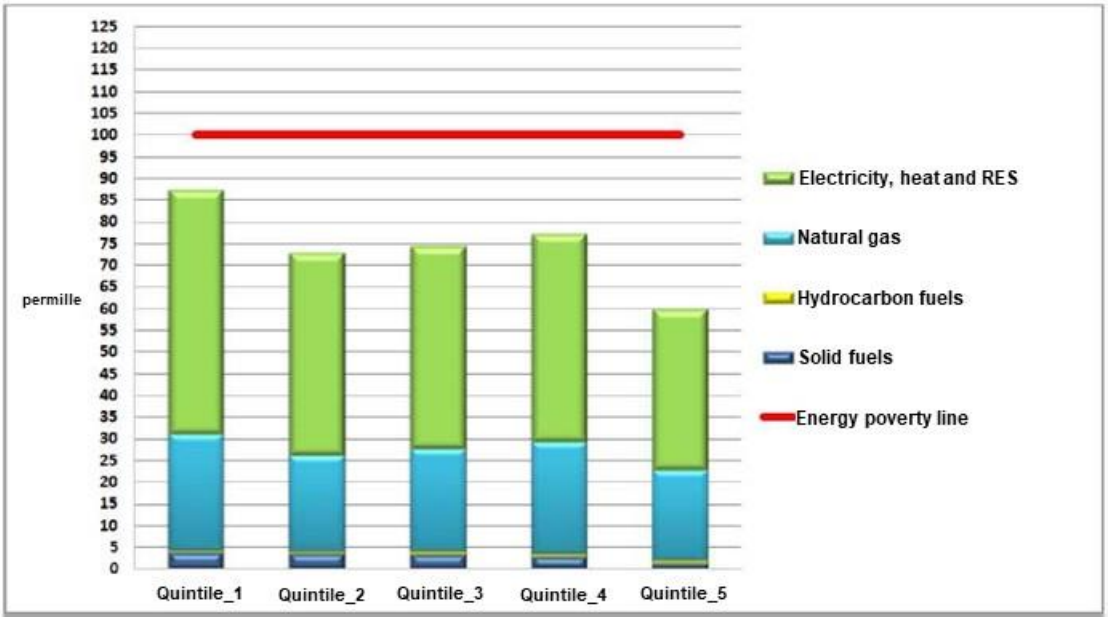

Figure 44. Structure and differences in the share of expenditure on fuels and energy by Hh income quintiles in 2040 – ECP scenario

The key conclusion that can be drawn from the analysis of social impacts in the ECP scenario is one on a fairly radical reduction in expenditure on fuels and energy in Hh, which directly reduces the scale of energy poverty, especially in the poorer quintiles, namely 1-3, of the population of households.

5.2.2. Macroeconomic and social impact assessment for both scenarios – REF and ECP

The macroeconomic and social impacts for both scenarios are assessed by comparing the REF and ECP variants. The assessment is completed through an analysis and comparison of the obtained results of model calculations, taking into account changes in the energy mix and capital expenditures. The changes occur in:

- the volume and breakdown of domestic demand for fuels and energy in the period 2015-2040,
- the volume and structure of demand for fuels and energy in Hh throughout the period,
- the volume of capex in the fuel and energy sector and the volume of expenditure on improving fuel and energy management among final consumer sectors (households, transport, industry, services, agriculture).

The other values of macroeconomic variables, i.e. capital, workforce and their productivity in industries and economic sectors, do not change by assumption. Also the paths of global fuel prices and ETS CO_2 emission allowance prices remain unchanged in both scenarios (REF vs ECP).

Based on the above assumptions, a comparative assessment of the impacts of changes in the economy and Hh expenditure on fuels and energy in the investigated scenarios is possible. The impacts result from changes in the volume and demand-supply fuel and energy mix to be attained as result of the ECP scenario. In the CGE model, the adaptation changes in the industry and sector structure of value add and GDP creation **are also driven by changes in the volume of capex**. With the limited resources in the national economy, mainly of capital and workforce, (with their ceilings set in the REF scenario), **using them on a much greater scale for remodelling the energy sector causes** (in accordance with the general equilibrium concept) **them to be less available for other sectors and/or industries of the national economy**.

It should be emphasised that a large proportion of the planned capital expenditures is to be allotted for either efficiency and health projects (large-scale thermomodernisation investments and elimination of 'low-stack' emissions in the housing and service sectors) **or projects focused on supporting development activities, such as promoting electromobility, mainly in cities. This will produce synergy effects throughout the economy, as a result of which the spending should generate much higher multiplier effects.** This is confirmed by the results of macroeconomic modelling presented below.

5.2.2.1. Macroeconomic impact assessment

The table below summarises the key macroeconomic indicators that underlie the results and assumptions in both scenarios.

The differences between the results for GDP and employment are not particularly pronounceable (greater variations in employment occur between economic sectors, as is described in the subsection dedicated to the impact assessment for selected manufacturing industries). Both GDP volume and employment in the economy are slightly higher in the ECP scenario from 2030. The value added in the services sector is also higher, while that in manufacturing is slightly lower compared to REF.

More pronounced differences between the scenarios can be seen for the foreign trade balance and the productivity of fuels and energy consumed for manufacturing (excluding Hh) and **in the country** (including Hh).

The trends in the aggregate fuel and energy prices in the scenarios are also slightly different. Although in both scenarios the increase in this price in 2015-2040 is almost twofold, in the ECP scenario the price of fuels and energy rises much slower in 2025-2035. A key role is played by changes in the volume and mix of fuels towards an increased share of low-emission fuels (RES), which produce a lower price impulse than imported fuels and rising prices of CO_2 emission allowances.

The **much higher productivity of final energy in manufacturing in the ECP scenario as compared to the productivity in REF** is noteworthy. This mainly stems from the assumed larger-scale energy-savings measures across the sectors of the economy, which will allow Poland to maintain competitive advantage on the EU and global markets.

Table 92. Summary of selected macroeconomic categories in the REF and ECP scenarios

Model category	Unit	Scenario	2015	2020	2025	2030	2035	2040
GDP level	EUR'2016 billion	REF	462	551	649	747	844	937
		ECP	462	551	649	747	850	940
Employment	'000	REF	15 977	15 865	16 011	16 163	16 175	16 055
		ECP	15 977	15 855	16 004	16 175	16 193	16 060
Inflation rate	%	REF	100.0	107.1	116.2	118.5	126.4	132.6
		ECP	100.0	107.4	116.4	118.6	125.7	132.1
Foreign trade balance	EUR'2016 billion	REF	14.3	1.6	13.0	8.4	2.2	21.7
		ECP	14.3	-0.8	7.0	-1.2	9.8	28.2
Share of service sector in value added	%	REF	57.3	57.9	59.4	59.1	59.8	59.9
		ECP	57.3	58.1	59.8	59.6	59.9	60.0
Share of manufacturing in value added	%	REF	19.9	20.3	19.9	20.0	19.9	19.5
		ECP	19.9	19.9	19.2	19.4	19.4	18.9
Labour productivity dynamics	2015 = 100	REF	100	120	140	160	180	202
		ECP	100	120	140	160	181	202
Capital productivity dynamics	2015 =100	REF	100	110	111	114	116	120
		ECP	100	110	111	114	117	120
Fuel and energy productivity dynamics in manufacturing	2015 =100	REF	100	100	113	126	141	156
		ECP	100	110	130	148	156	169
Fuel and energy price dynamics	2015 =100	REF	100	112	140	157	172	190
		ECP	100	113	139	154	166	189

Source: EnergSys, CGE-PL model

The chart below presents the differences in GDP creation between the two scenarios. The results of second loop calculations indicate that, as in the first stage of the study, the differences in the dynamics of GDP growth in the ECP and REF scenarios are insignificant. However, a comparison of the version of the climate and energy policy planned with the conditions of the REF scenario indicates that there is no clear impulse for the economy as a whole until 2030, mainly as a result of the medium- and long-term nature of investments in retrofits and in other sectors of the economy. In addition, it is necessary to emphasise the far higher unit consumption of capital by RES installations (photovoltaics, wind farms) in combination with their much lower production efficiency

(lower usable capacity per year), connected with Poland's geographical conditions. Consequently, the considerably higher capital invested in lower-efficiency RES installations will start to bear fruit after a longer period than it would if invested in alternative projects. Also the effects of energy-savings measures, in particular the housing stock thermomodernisation plan, are likely to produce economic effects after about 20-25 years, which is confirmed by the assessment of cost-effectiveness implied by a number of energy audits.

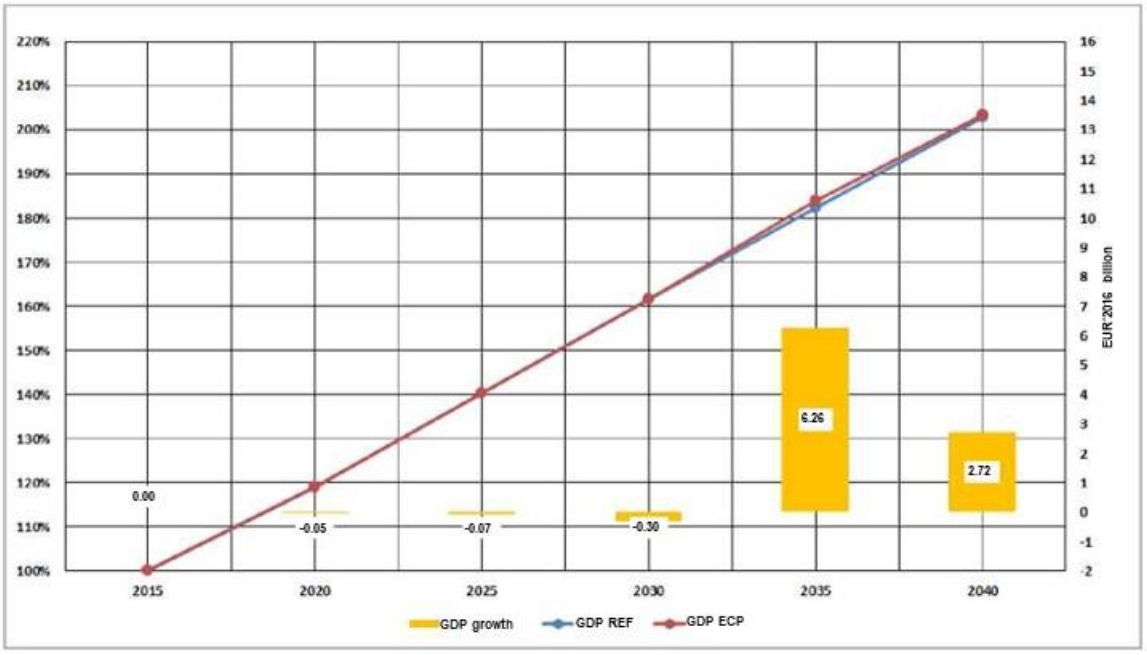

Figure 45. Comparison of GDP dynamics in the ECP and REF scenarios

The differences (see the figure above) in **GDP** are in the order of tens of millions of EUR, although they are in favour of the REF scenario in the early years (until around 2030). Economic acceleration as a result of the completion of the ECP scenario can only be expected after 2030. In 2035, the 'gain', as measured in GDP growth, reaches EUR 6 billion, and in 2040 nearly EUR 3 billion. Additionally, calculations of the sensitivity of GDP to the use of decarbonisation instruments, including those to improve energy efficiency, only in the ECP scenario, highly improve the economic efficiency of the ECP scenario over REF, as illustrated in the figure below.

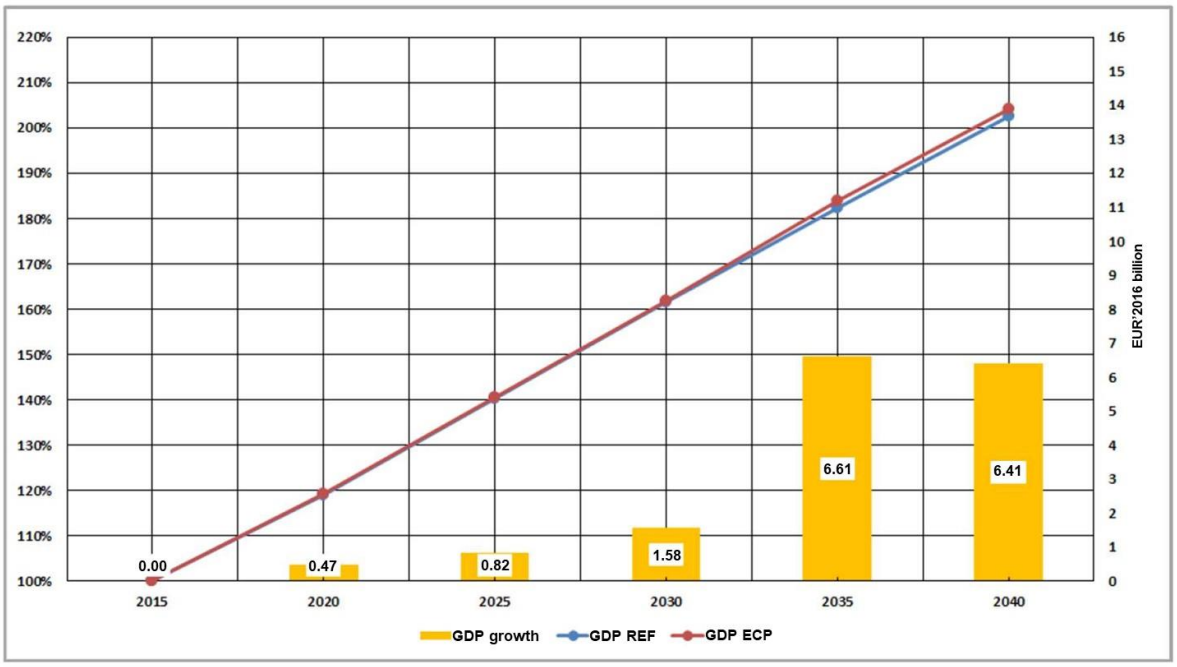

Figure 46. Comparison of GDP dynamics in the ECP and REF scenarios (distribution of revenues from the sale of allowances only in the ECP scenario)

In both scenarios, the **foreign trade balance** (FTB), i.e. exports minus imports, follows a similar path, which is illustrated in the figure below.

In 2020, the reduced FTB in both scenarios is caused by the need to increase imports of natural gas by about 20%. In later years, the volatility of the FTB depends on the difference between the growth in the needs for imports (including for fuels) and the possibilities of increasing exports, which determine the relationship between domestic and global prices of products across the economic sectors. In the ECP scenario, the needs for natural gas imports are so high that in 2020 and 2030 the FTB turns out to be negative. In 2030, with the assumptions regarding world inflation adopted (identical for both scenarios), the relations between domestic and import prices slow the growth of exports down to a rate lower than the increase in import needs, which depends, *inter alia*, on the economic growth rate. Despite a similar course of changes, it can be observed that in the 2030 horizon, the ECP scenario is characterised by worse foreign trade performance. After 2030, this tendency clearly changes in favour of the ECP scenario, which is associated with the need for technological adjustments in many manufacturing industries and clearly reduced demand for fuels and energy in the household sector as a result of efficiency schemes.

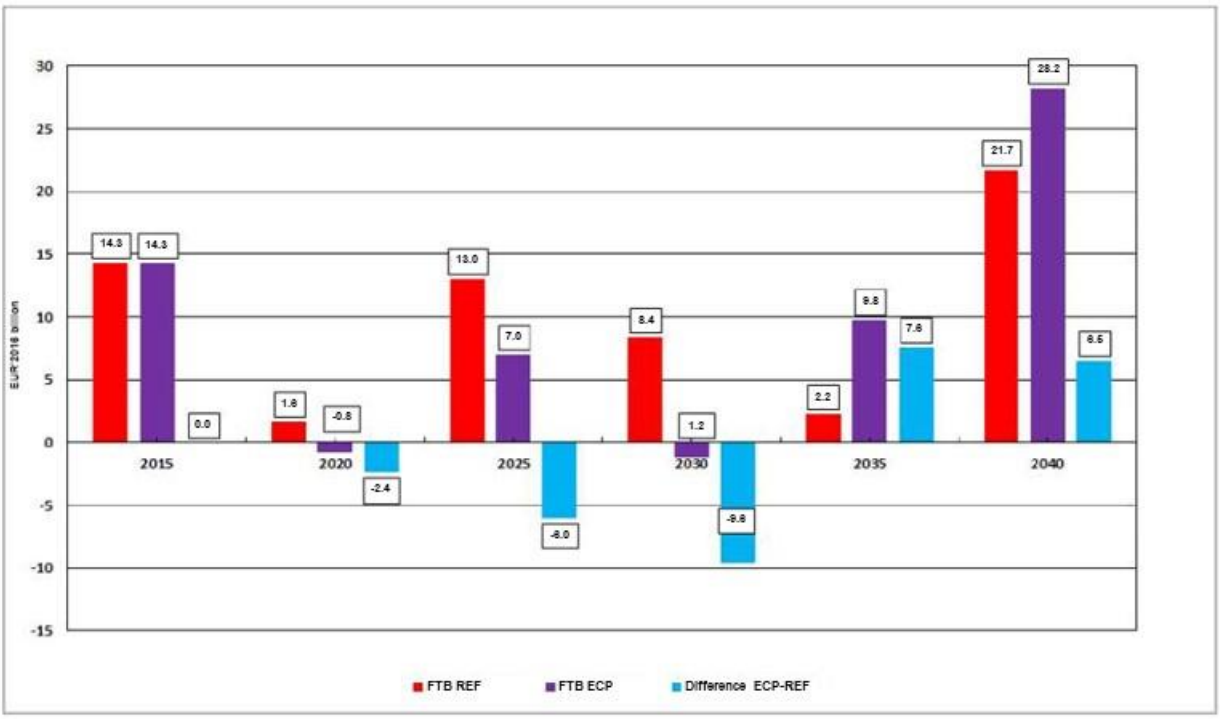

Figure 47. Comparison of foreign trade balances between the ECP and REF scenarios

Unlike the above-discussed differences in GDP in both scenarios, the results for evolution in energy productivity clearly indicate a strong advantage of productivity in ECP over REF, which is illustrated by the chart below.

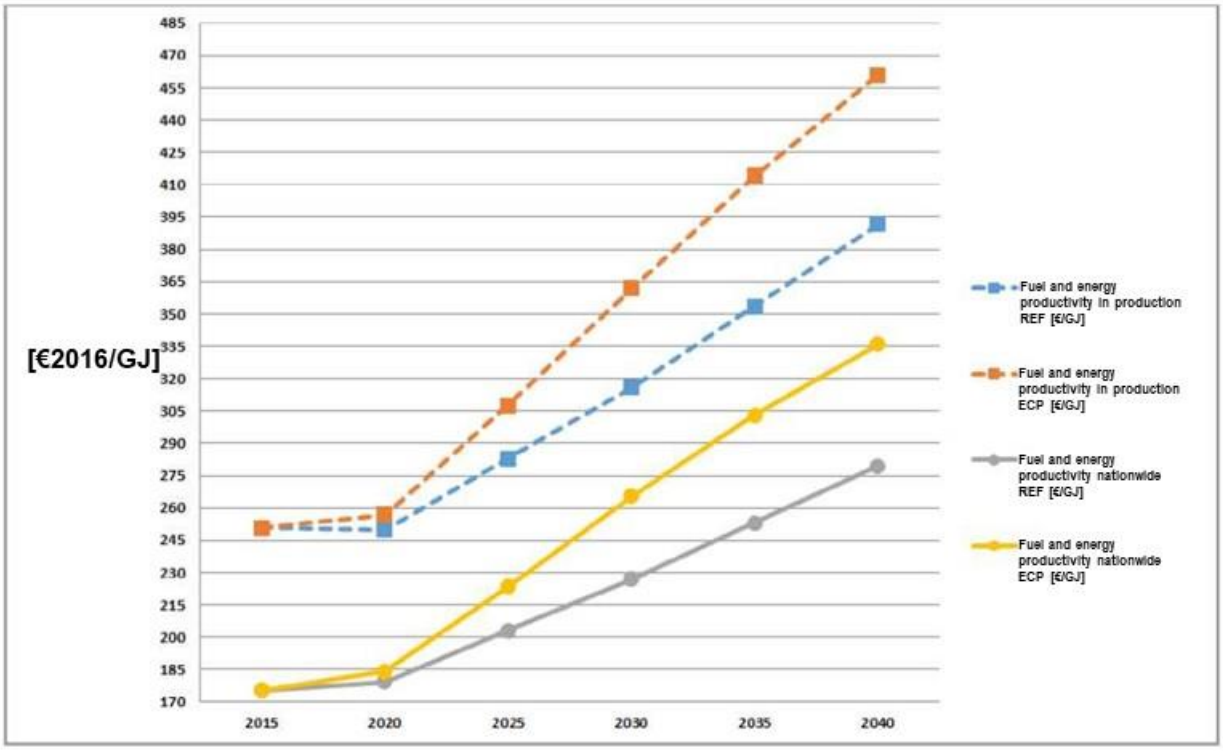

Figure 48. Comparison of changes in energy productivity for final energy and overall in the REF and ECP scenarios

The study compares the change trends in the two categories of productivity of final energy in the production sphere, which is formed by all economic sectors that generate added value and, as a result, GDP. In the

analysis, use is made of a simplified approach in which energy consumption in the housing sector (Hh) is subtracted from inland energy consumption. Thereby the production consumption is better linked to the production activity of the production and service sectors. In the figure, this productivity is illustrated by dashed lines.

The effects described above stem both from energy-savings measures in the sectors of the national economy and from the improvement of energy productivity through a number of modernisation and retrofitting activities, in combination with the substitution of fuel and energy carriers, notably the much higher use of electricity in the increasingly modern production processes (products and services).

The figure shows that in ECP, energy productivity increases very quickly – by 2030, it grows by 50% (the base effect and result of intervention measures with a high energy-savings potential) to slow down slightly in the following years and reach close to 85% in 2040 relative to 2015. The assumptions in the REF scenario are more conservative – in 2040, productivity is approx. 55-60% higher than in 2015. In relative terms, final energy productivity in the ECP scenario is approx. 20-30 pp above the REF value in 2040.

It is worth emphasising that the changes will highly contribute to nearly all climate and energy policy objectives, i.e. strengthen the security of fuel and energy supply, reduce environmental pressure, and improve the competitiveness of the production of goods and services. The last of the benefits is particularly important because it will considerably improve stability by highly reducing exposure to external risks, including, for example, fluctuations in fuel and energy prices on international markets. **A comparison of the results for the ECP and REF scenarios demonstrates that a much higher qualitative leap and stablisation can be achieved through consistent pursuit of the assumptions adopted in the ECP scenario**.

5.2.2.2. Sectoral assessment of macroeconomic impacts – manufacturing industries

The table below and the two graphs that follow summarise the trends in **gross profitability indicators of sold production** in both scenarios – REF and ECP.

Similarly, to employment and GDP levels, the differences in the profitability of manufacturing industries between the two scenarios are inconsiderable and reveal a slight advantage of REF over the ECP scenario. The deterioration of profitability in the ECP variant is not strong enough to deepen considerably the general downward profitability trend across the manufacturing industry as a result of the strong impulse from the increase in energy and fuel prices and the only slightly less intense impulse from the increase in real wages. These two factors, together with the required strong increase in capital expenditures, decrease sales profitability ratios, which means that a number of other innovative actions need to be taken, including organisational ones, so as to give domestic manufacturers a better competitive position on international markets. Undoubtedly, the policy measures assumed in the ECP scenario improve and stabilise the competitive position of domestic manufacturers.

It is worth mentioning that the high convergence between the scenarios is attributable to the assumed capital and labour productivity trends, which are the same in the analysed scenarios. This is a fairly common practice in economic modelling, which allows assessing the impact of a single key factor (here: energy) on the economy with the assumption of no change (conservative approach) in other factors (here: capital and labour). With this in mind, it can be concluded that, if well-designed and effectively implemented, the public policies envisaged can contribute to the creation of more favourable economic conditions such as to strengthen the path of sustainable development according the ECP scenario.

Table 93. Summary of changes in gross profitability in the manufacturing industry in the REF and ECP scenarios [%]

Model category	scenario	2015	2020	2025	2030	2035	2040
Gross profitability in the food industry	REF	4.7	4.6	4.4	4.3	3.3	2.7
	ECP	4.7	4.6	4.4	4.4	3.4	2.7
Gross profitability in the light industry	REF	6.8	7.3	6.8	6.9	5.6	3.3
	ECP	6.8	7.3	6.8	6.4	5.5	3.0
Gross profitability in the paper industry	REF	8.4	8.1	7.4	7.3	6.2	5.1
	ECP	8.4	8.0	7.2	7.1	6.1	5.0
Gross profitability in the chemical industry	REF	7.9	7.9	7.2	7.1	5.8	4.6
	ECP	7.9	7.9	7.3	7.2	6.0	4.9

Gross profitability in the mineral industry	REF	9.0	9.7	8.9	8.9	8.1	6.8
	ECP	9.0	9.3	8.3	8.3	7.6	6.5
Gross profitability in metallurgy	REF	5.7	5.9	5.2	4.9	4.0	2.7
	ECP	5.7	5.7	5.0	4.8	3.8	2.7
Gross profitability in the machinery industry	REF	4.5	4.5	4.9	5.2	5.0	4.5
	ECP	4.5	4.3	4.4	4.8	5.0	4.5
Gross profitability in other industries	REF	6.9	6.0	5.1	4.4	3.2	2.4
	ECP	6.9	5.9	4.9	4.3	3.2	2.6

Source: EnergSys's own study, CGE-PL model, and Mezzo-Impact module

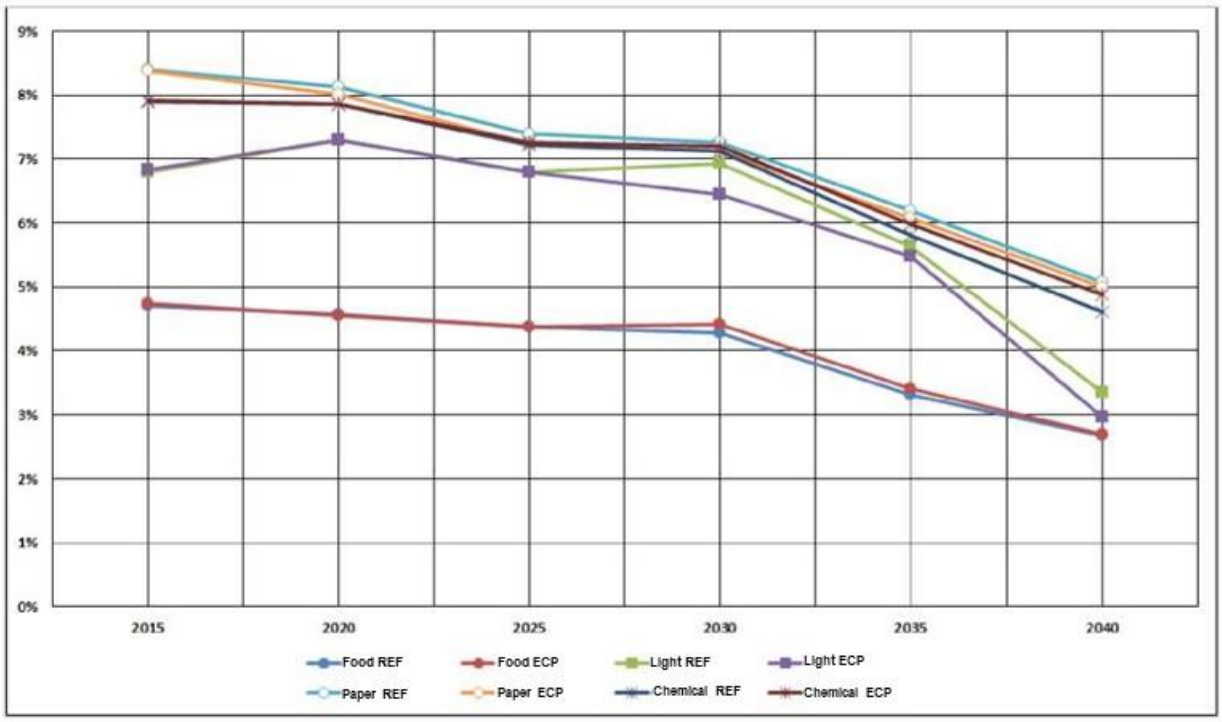

Figure 49. Changes in gross production profitability in the food, light, paper and chemical industries in the REF and ECP scenarios

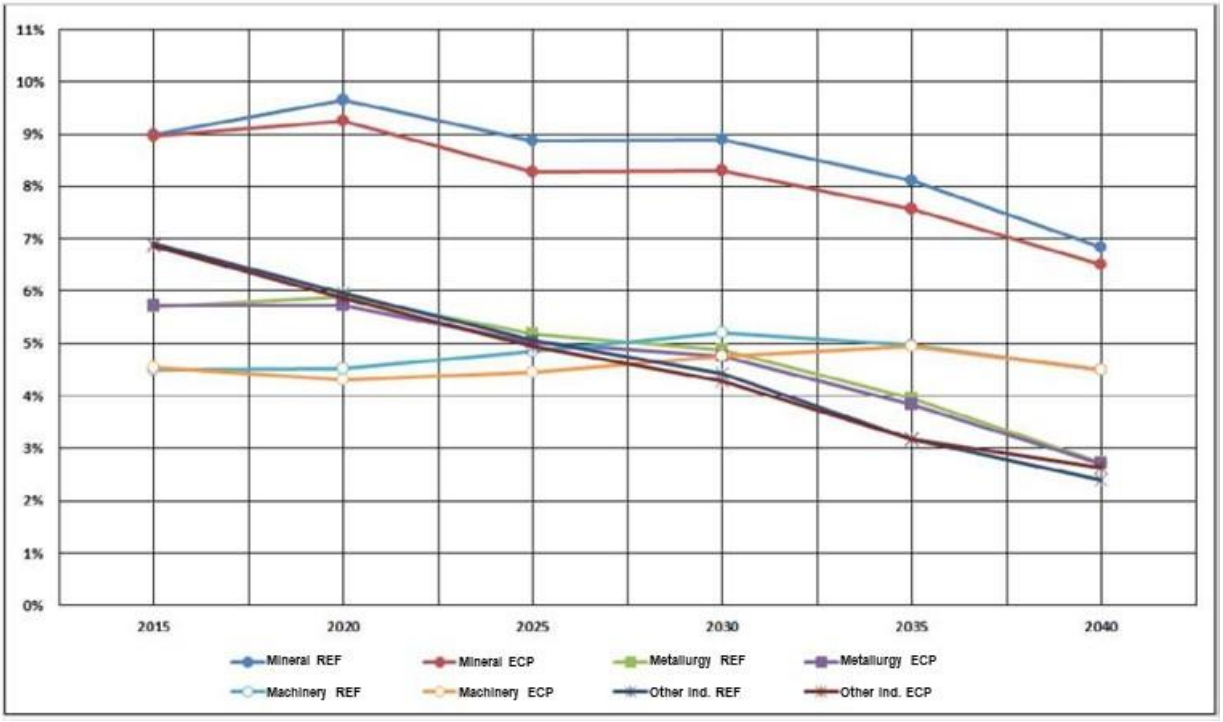

Figure 50. Changes in gross production profitability in the mineral, metallurgical, machine and other industries in the REF and ECP scenarios

5.2.2.3. Social impact assessment

The implementation of the ECP scenario requires a number of changes in the fuel and energy economy both in the electricity sectors (full supply chain) and in energy-using sectors. This involves thorough remodelling of the approach to development investments in the energy sector, and far-reaching modifications at final consumers, including the housing sector, where the use of fuels and energy in households inhabiting multi-dwelling buildings and single-family houses comes to the fore.

The analysis of the social impacts of the ECP scenario on selected parameters (indicators) of social and/or energy well-being presented in previous sections indicate that **the approach to the delivery of the climate and energy policies set out in the ECP scenario should not worsen the situation of households compared to the REF scenario in the medium and long term, and may even improve it. Unfortunately, in the short term, in which high expenditure on efficiency and health-oriented measures will be necessary, households – as fuel and electricity consumers – may experience some disturbances, partly mitigated by an increase in real wages, and partly by public policies, which are to be addressed to the poorer part of society, though.** As is shown by the calculations, reasonable public support should be channelled to the lower three Hh income quintiles (1-3), which correspond to 60% of the Hh that are currently in need of public support in Poland.

The macroeconomic categories presented in the table below are used in the comparative assessment of social impacts. The analysis includes both the Hh income side, which looks fairly optimistic, and the expenditure side, i.e. the share of Hh expenditure on fuels and energy of the 20% poorest Hh (quintile 1) and the 20% most affluent Hh. Meanwhile, all the Hh income groups are presented in the two graphs that follow.

Changes in relationships between macroeconomic categories are noteworthy. For example, the dynamics of nominal disposable income of Hh in both scenarios increases 2.5 times, and by slightly more in ECP. Meanwhile, the growth of nominal wages (the product of real wages and the annual inflation rate) increases slightly less, by about 2.2 times. The difference between these categories is attributable to the fact that a portion of growth in Hh incomes comes also from capital incomes (investments in funds, bank deposits, or stocks and shares, and the surplus of income from self-employment).

Table 94. Key macroeconomic categories relevant for social impact assessment – REF and ECP

Model category	Unit	Scenario	2015	2020	2025	2030	2035	2040
Direct consumption of fuels and energy in households	PJ	REF	792	866	898	926	947	962
		ECP	792	845	793	751	751	757
Real disposable Hh income dynamics	2015 = 100	REF	100	119	139	156	175	193
		ECP	100	118	138	154	178	193
Real wage dynamics		REF	100	114	135	143	158	173
		ECP	100	114	134	142	160	172
Nominal wage dynamics		REF	100	122	156	169	199	229
		ECP	100	122	156	169	201	228
Share of **first-quintile** Hh expenditure on fuels and energy	‰	REF	151	121	119	120	113	110
		ECP	151	120	108	100	90	87
Share of **fifth-quintile** Hh expenditure on fuels and energy		REF	66	71	73	76	74	73
		ECP	66	71	68	66	60	60

Source: EnergSys own study, CGE-PL and Mezzo-Impact models, Hh module

However, **the declining trend in the share of expenditure on fuels and energy in households is the key indicator for assessing social impact in 2015-2040** in both scenarios, with the trend being highly positive as from 2030 in the ECP scenario, which is demonstrated by the growing disparities in the Hh expenditure dynamics between the ECP and REF scenarios. However, it must be emphasised that in quintile 1 (20% group of the poorest Hh), the expenditure may exceed the 'defined' energy poverty threshold (10% share of expenditure on fuels and energy in income) by around 2030 in ECP and by 2040 in REF. This is indicative of the importance of an effective housing stock thermomodernisation policy combined with other measures for the development and implementation of low-emission sources.

The results reflect the complexity of the current economic situation of the poorer Hh, as well as the need for public support targeted at the poorest Hh in order to reduce expenditure below the 'defined' energy poverty line.

The two charts below present the evolution in Hh expenditure on various groups of fuels and energy for all income quintiles in both scenarios. The red line marks the Hh energy poverty line 'defined'.

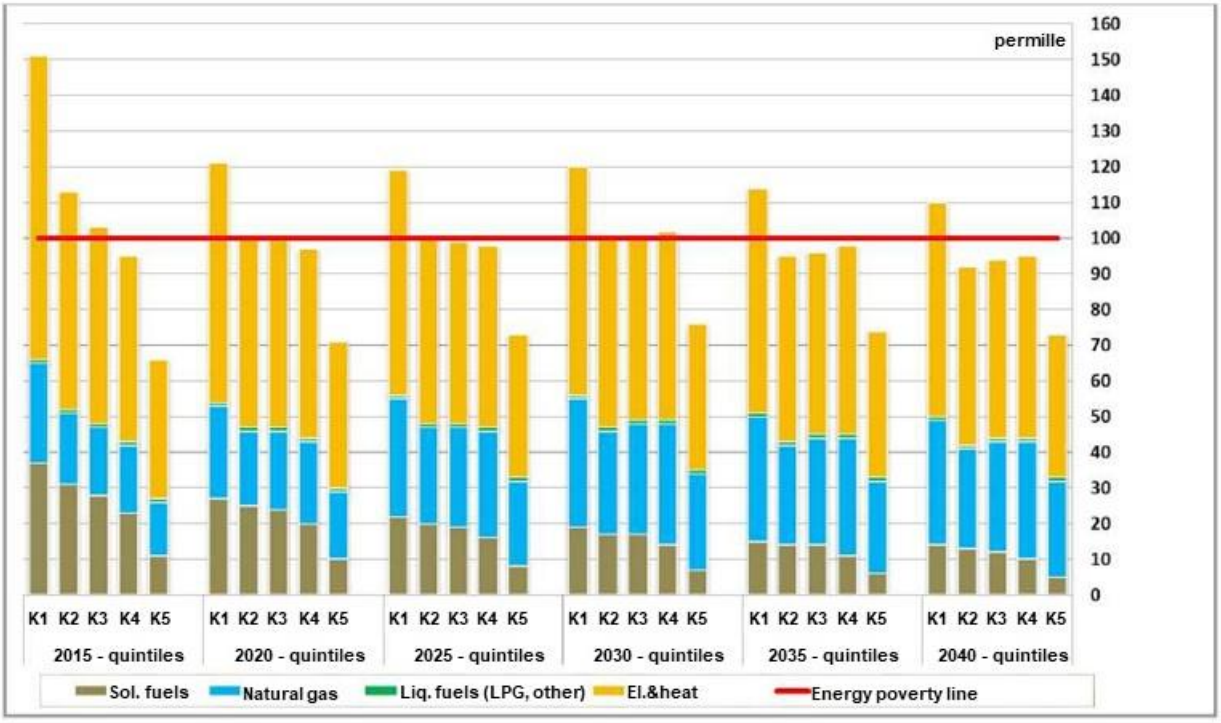

Figure 51. Changes in the share of expenditure on fuels and energy in household budgets by quintiles – REF

A comparison of these two graphs clearly shows that the implementation of the climate and energy policy assumptions of the ECP scenario should highly contribute to reducing the share of energy costs in the income across the Hh quintiles, thereby mitigating the energy poverty 'defined'.

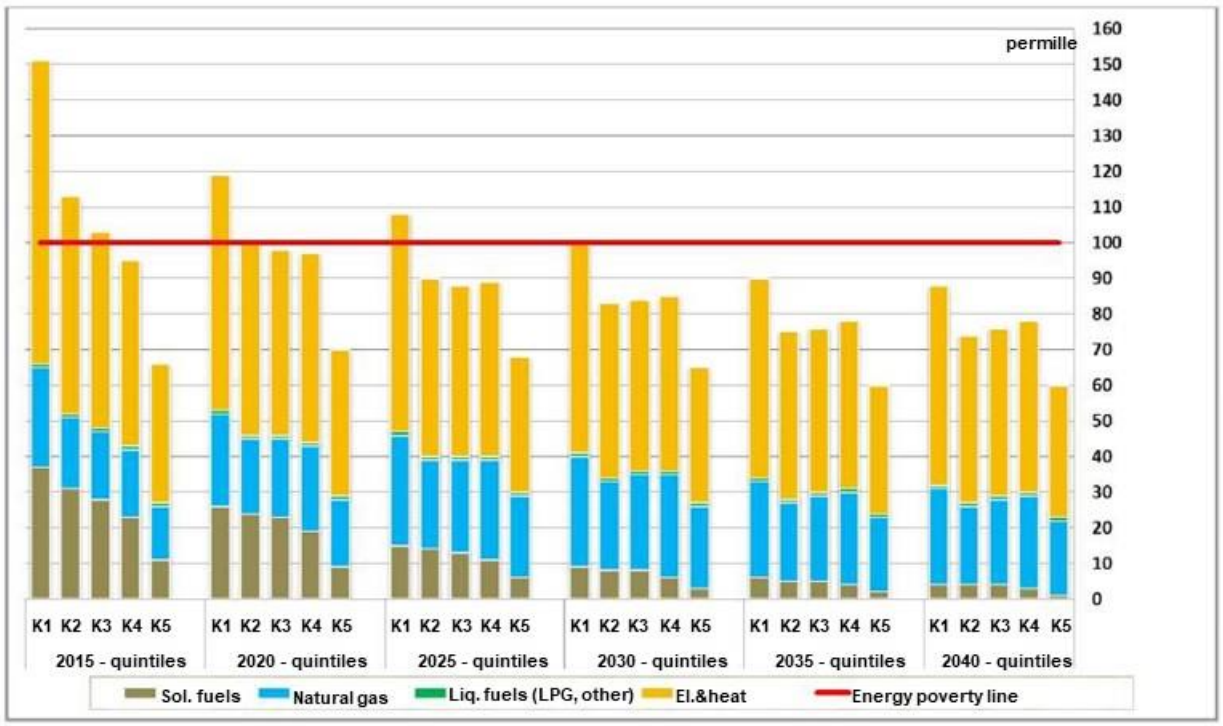

Figure 52. Changes in the share of expenditure on fuels and energy in household budgets by quintiles – ECP

It is also worth remembering that a significant reduction in the share of energy expenditure in the Hh spending basket may produce a rebound effect, i.e. re-increase in Hh expenditure on energy, mainly as a result of faster saturation of households with equipment that consumes energy, mainly electricity (e.g. household appliances, electronics, etc.). In some situations, it may also take the form of no reduction or even increased consumption of fuels for heating when a Hh chooses to increase the thermal comfort in the house/dwelling or to use more rooms in a previously underheated building. This must be borne in mind when designing the intervention policy instruments in each of the scenarios.

5.2.2.4. Summary and conclusions on macroeconomic and social impacts

The report presents all the essential elements of macroeconomic and sectoral analysis necessary to assess the macroeconomic and social impacts and the cost-effectiveness of the planned policies and measures (interventions) foreseen in two, qualitatively different, visions of the country's development over the period 2015-2030, with an outlook for 2040. To this end, use is made of an approach based on two development scenarios:

- Reference Scenario (REF) – which assumes completing the development policies and programmes that stem from Polish and EU legislation effective at the end of 2017.

- the Energy and Climate Policy scenario (ECP) – the effect of the policies and measures that indicate how the objectives in the five dimensions of the Energy Union will be achieved takes into account the provisions of the Clean Energy for All Europeans package.

Importantly, the assumptions of the scenarios in the analysis are prepared in such a way that the elements that differentiate them concern areas that may be affected by changes in the energy and climate policy. The calculations assume that the country's development potential associated with the availability of workforce and capital and their increasing productivity will be identical in both scenarios. The values of these development determinants (resource and productivity) are determined through the calibration of CGE-PL macroeconomic model based on the REF scenario assumptions.

The REF and ECP scenarios analysed differ in several important respects:

- different volume and structure of the demand and supply balance of fuels and energy in the country,

- different volume and structure of the demand for fuels and energy in households,

- different fuel and energy productivities in the production sphere (value of sales per unit of energy consumed),

- different volumes and distribution of overall capital expenditures in the national economy, including expenditure in the fuel and energy supply sector and energy end-use sectors,

- different allocation of revenues from the sale of CO_2 emission allowances; in the REF scenario, they are fully allotted to the state budget, while in ECP, the proceeds are distributed between the budget, sectors of the economy, and support for Hh (in the first calculation loop),
  However, both scenarios assume the same rules for the allocation of revenues from the sale of CO_2 emission allowances, namely distribution of revenues between the budget, economic sectors and support for Hh (in the second calculation loop).

The results of model calculations for both scenarios are compared in the following three main areas of impact:

(a) in the national economy – changes in the rate of GDP growth are compared,

(b) in industry – changes in the profitability of the manufacturing industries are compared,

(c) in the social area – the dynamics of disposable income of households and changes in the share of expenditure on energy in household budgets are compared, with 5 income groups distinguished (five quintiles – Nos 1 and 2 comprise the 40% poorest Hh, quintile No 3 comprises middle-income earners – 20% of Hh, while No 4 and 5 include the wealthiest 40% of Hh, according to the GUS criteria adopted for 2015).

The results obtained in all the examined areas reveals a greater number of macroeconomic and social benefits in the ECP scenario, which envisages the adoption of new requirements, including mechanisms for the implementation of the climate and energy policy, in comparison to the REF scenario (delivery of currently applicable policy instruments, including national and EU legislation).

The main benefits of the ECP scenario include, *inter alia*: slightly higher GDP volume and higher employment, including in manufacturing industries, a slower decline in gross profitability ratios in industries, much higher energy productivity in sectors of the national economy, mainly industry and services, and a much faster rate and a larger percentage of households that make it out of the 'defined' energy poverty.

Selected conclusions regarding the country's macroeconomic development

- An assessment of the ECP scenario indicates that a climate and energy policy leading to a major reduction in domestic CO^2 emissions without adverse effects on the economic growth rate is possible, provided that the efficiency of fuel and energy use in the economy is improved quickly and effectively (better energy productivity means increased cost-efficiency and highly mitigated exposure to the risk posed by fuel and energy price fluctuations on international markets). In addition, the effects of fuel and energy savings in manufacturing and consumption may vitally contribute to reducing production costs, fostering the competitiveness of Polish products and producers in international trade.

- Disturbances to the long-term development of the country (maintaining the conditions of general equilibrium as the main characteristic of the CGE-PL model) caused by the excessively rapid remodelling of the production potential of the fuel and energy sectors can only be avoided by **allocating substantial resources for supporting energy savings and energy efficiency improvement processes in all energy use areas, i.e. manufacturing, services and households**.

- The macroeconomic (and social) impact assessment carried out in the report proves that **developing an effective set of instruments for supporting energy efficiency measures targeted at final consumers** will be a key success factor for energy transition. To this end, use should be made of financial instruments

and funds, e.g. from the sale of CO_2 emission allowances, support funds, including energy efficiency, thermomodernisation funds, etc. The instruments should be systemic in nature, with built-in self-correction mechanisms that respond, within specific bounds, to developments in energy markets, including the dynamically growing markets for energy and multi-energy services.

Conclusions for manufacturing

- The rapid increase in fuel and energy prices, which is inevitable in the situation of accelerated modernisation or even technological remodelling of part of the domestic energy sector, reduces the profitability of the Polish manufacturing industry. Despite this, given the relatively high profitability of the manufacturing industries, including the energy-intensive ones that benefit from geographical premium and strong internal demand (investments), the decrease in profitability by 2030 will not lead to a clear deterioration of their operating conditions. The model results reveal that after 2030 downward trends in profitability of the industries that export a large proportion of their production may prove dangerous for their sustainability. However, this is a fairly distant perspective (> 12 years), over which many of the conditions taken into account in the model may change, which means that a series of subsequent calculations will be needed to correct the current assumptions.

- The conditions set out in the ECP scenario only slightly mitigate the downward trend in the loss of gross profitability of industries resulting from the strong increase in the prices of fuels and energy available on the Polish market – from domestic resources. The strong price increase is a consequence of the growth in fuel prices on international markets, but also the increase in domestic production costs. In addition, the rise in prices of fossil fuels, mainly coal, is amplified by the steep upward CO_2 emission allowance trend. Given the next steps in the area of climate protection and the increasing integration of energy and climate issues, it seems that choosing a development path consistent with the ECP scenario will highly mitigate the economic risk, and at the same time reduce the social nuisance of choosing the scenario and strategy for the development of the Polish energy sector.

Conclusions concerning the social area

- The elimination of energy poverty (according to Eurostat data, in 2015, about 80% of households were affected) is possible, *inter alia*, by reducing the income gap between the Hh quintiles and urgent but prudent investments in energy efficiency, including rational thermomodernisation of residential and commercial buildings, as well as the upgrading of supply sources and networks.

- The results of the analysis and assessment show that a considerable portion of public support for improving energy efficiency should be allocated for the poorest groups of Hh (quintiles 1-2 and 3). This will speed up eliminating energy poverty and will considerably curb ‘low-stack’ emissions in Poland. The results of the model analysis confirm the reasonableness of the adopted framework criteria for providing public support through the Clean Air programme.

General conclusion

After analysing and assessing the results of calculations for both macroeconomic development scenarios, i.e. REF and ECP, it can be concluded that the choice of the ECP scenario is a better option for the Polish economy as a whole, including households and other target groups, although in many cases the numerical differences are relatively small. The rationale for choosing ECP is well documented by the results of both scenarios and – just as importantly – it is consistent with global energy developments.

5.2.3. Environmental and health impact assessment

The assessment of the environmental and health impacts resulting from the implementation of the ECP scenario is based on the following assumptions:

- **the environmental and health impacts** are determined as environmental and health losses related to air pollutant and greenhouse gas emissions, respectively, as expressed in monetary terms;

- **the environmental and health losses** are calculated for those sectors of the economy for which the implementation of the ECP scenario causes a significant reduction in emissions (fuel combustion – electricity and heat production, fuel combustion – manufacturing and construction, fuel combustion – road

transport, fuel combustion – other sectors)

- **the impact of greenhouse gas and air pollutant emissions on human health and the environment** is determined on the basis of available models and external unit cost indicators.

The environmental and health benefits resulting from the implementation of the ECP scenario relative to the REF scenario are expressed as avoided environmental and health losses from emissions of air pollutants and greenhouse gases (expressed in monetary values), respectively. They are captured as the absolute difference in environmental and health losses determined for the REF and ECP scenarios for the key sectors of the economy mentioned above.

It should be noted that a number of conclusions in this context are provided by section 5.1.2 'Decarbonisation'. The methodology for calculating environmental and health impacts is described below.

The following types of air pollution are included in the analysis of the **environmental and health impacts of air pollution emissions**:

- nitrogen oxides (as NO_2);
- non-methane volatile organic compounds (NMVOC);
- sulphur oxides (as SO_2);
- ammonia (NH_3);
- $PM_{2.5}$;
- the portion of PM_{10} with the grain diameter between 2.5 and 10 µm ($PM_{CO} = PM_{10}-PM_{2.5}$).

The environmental and health impacts of the ECP and REF scenarios and the environmental and health benefits resulting from the implementation of the REF scenario are assessed on the basis of data on the projected pollutant emissions presented in Tables 26 and 27 respectively (subsection 5.1.2.1.2). **For the energy production sector** (electricity and heat production) and the industry sector (manufacturing and construction), the unit indicators of external costs of air pollution are adopted on the basis of the NEEDS research report[29].

For the transport sector (road transport), the unit indicators of external costs adopted are based on a EC handbook[30].

For the fuel combustion sector (other sectors), the unit external cost indicators consist of the average values determined for the other sectors.

The analysis of the **environmental and health impacts of greenhouse gas emissions** for human health and the state of ecosystems takes into account such climate change phenomena as:
- heat waves and their implications for health (e.g. heart disease) and the environment (droughts),
- the direct and indirect consequence of extreme weather events (hurricanes, floods),
- increased risk of cancer due to increased exposure to UV radiation,
- increased concentration of allergic pollen in the air due to longer growing season.

This impact is usually expressed by the **integrated indicator of unit damage costs** per tonne of carbon dioxide equivalent (CO_2eq). Given the global nature of the impact of greenhouse gases, the indicator involves much greater uncertainty than analogous indicators for air pollution, and takes different values in various specialist studies, depending on the assumptions regarding, *inter alia*, the extent of impact and macroeconomic parameters. For the purpose of the forecast of the environmental benefits resulting from the implementation of the ECP scenario, use is made of a **variable unit damage cost indicator** based on a World Bank study[31] in two variants – high and low (in 2017, it amounts to 37 and 75 USD/tCO_2eq, respectively).

The tables below present the environmental and health impacts of pollutant and greenhouse gas emissions for

[29] NEEDS. New Energy Externalities Developments for Sustainability. Deliverable 6.1-RS1a; FP6. 2009.
[30] Handbook on the external costs of transport, EC, 2019
https://ec.europa.eu/transport/themes/sustainable/studies/sustainable_en
[31] "Guidance note on shadow price of carbon in economic analysis", World Bank, 2017,
http://documents.worldbank.org/curated/en/621721519940107694/pdf/2017-Shadow-Price-of-Carbon-Guidance-Note.pdf

the ECP and REF scenarios, as well as the environmental and health benefits resulting from the implementation of the ECP scenario in relation to the REF scenario, expressed in monetary terms, as calculated using the above methodologies.

Table 95. Environmental and health impacts of air pollutant and greenhouse gas emissions from the key sectors for the ECP and REF scenarios – low and high unit damage cost values

	AIR POLLUTANT EMISSION IMPACTS – low variant				GREENHOUSE GAS EMISSION IMPACTS	
	HEALTH IMPACTS [EUR million]		ENVIRONMENTAL IMPACTS [EUR million]		TOTAL [EUR million]	
YEAR	REF	ECP	REF	ECP	REF	ECP
2020	13 444	12 234	1 355	1 239	10 897	10 304
2025	13 194	10 768	1 329	1 093	13 056	11 266
2030	13 177	9 589	1 332	980	15 038	11 710
2035	12 562	8 528	1 263	868	15 171	11 043
2040	11 869	7 773	1 186	790	14 624	10 867

	AIR POLLUTANT EMISSION IMPACTS – high variant				GREENHOUSE GAS EMISSION IMPACTS	
	HEALTH IMPACTS [EUR million]		ENVIRONMENTAL IMPACTS [EUR million]		TOTAL [EUR million]	
YEAR	REF	ECP	REF	ECP	REF	ECP
2020	13 444	12 234	1 355	1 239	22 089	20 886
2025	13 194	10 768	1 329	1 093	26 464	22 836
2030	13 177	9 589	1 332	980	30 483	23 737
2035	12 562	8 528	1 263	868	30 752	22 385
2040	11 869	7 773	1 186	790	29 643	22 028

Source: ATMOTERM S.A. own study

Table 96. Environmental and health benefits resulting from the implementation of the ECP scenario in relation to the REF scenario – low and high unit damage cost values

	BENEFITS OF REDUCED EMMISSIONS OF – low variant			
	AIR POLLUTIONS [EUR million]		GREENHOUSE GASES [EUR million]	TOTAL [million EUR]
YEAR	HEALTH	ENVIRONMENT		
2020	1 209	116	594	**1 918**
2025	2 426	236	1 790	**4 452**
2030	3 588	352	3 328	**7 268**
2035	4 034	396	4 128	**8 557**
2040	4 097	395	3 757	**8 248**

	BENEFITS OF REDUCED EMMISSIONS OF – high variant			
	AIR POLLUTIONS [EUR million]		GREENHOUSE GASES [EUR million]	TOTAL [million EUR]
YEAR	HEALTH	ENVIRONMENT		
2020	1 209	116	1 203	**2 528**
2025	2 426	236	3 628	**6 291**
2030	3 588	352	6 746	**10 686**
2035	4 034	396	8 367	**12 796**
2040	4 097	395	7 615	**12 107**

Source: ATMOTERM S.A. own study

It follows from the above that the **environmental and health benefits** resulting from the implementation of the ECP scenario in relation to the REF scenario for the forecast years amount to EUR 1.918 billion in 2020 to EUR 8.248 billion in 2040 – for the low variant, and from EUR 2.528 billion in 2020 to EUR 12.107 billion in 2040 –

for the high variant.

Notably, the projections reveal differences between the scenarios, which are bound to deepen in favour of the ECP scenario with each five-year period – in both dimensions, both as regards the impacts of air pollutant emissions and greenhouse gas emissions.

The spreads between the above figures prove that estimating these costs is difficult. Nevertheless, the summary of their scale and air pollutant and GHG emission reductions achieved, as presented in section 5.1.2, imply a highly positive impact of the PaMs set out in the NECP. One particularly noteworthy development is the improvement of air quality resulting from the ECP, which, in addition to having a real effect on reducing the impacts on human health (e.g. chronic or fatal diseases), will improve people's quality of life by reducing nuisance associated with temporary breathing problems, headaches, or depressed mood.

5.3. Overview of investment needs

5.3.1. Existing investment flows and forward investment assumptions with regard to the planned policies and measures

This subsection presents estimates of expected capex on the delivery of the ECP scenario with relevant comparisons with the REF scenario. The table below summarises energy-related capex in the national economy, by capex in the fuel and energy sector and energy-related capex in non-energy sectors as from 2016. These two categories of capex are disaggregated in the subsections below. As is shown by the estimates, nearly half of the expenditure covers non-energy sectors, which shows how deep and widespread the impact of the NECP will be.

Table 97. Projected energy-related capital expenditure in the entire economy in 2016-2040 [EUR'2016 million]

	2016-2020	2021-2025	2025-2030	2031-2035	2036-2040	2016-2040
energy-related capex in the national economy	94 973	100 251	95 528	86 561	74 369	**451 682**
capital expenditures in the entire fuel and energy sector	53 618	45 178	45 810	52 712	48 174	**245 492**
energy-related capex in non-energy sectors (industry, Hh, services, transport and agriculture)	41 355	55 073	49 718	33 850	26 195	**206 190**

Source: own study by ARE S.A.

5.3.1.1. Capex in the fuel and energy sector

Capex on the development of the fuel and energy sector include investments in the electricity, heating, gas, mining and liquid fuels sectors. In the case of the **electricity sector**, both spending on construction and modernisation of the generation sector (power plants and cogeneration plants), and on transmission and distribution network development, including connection of new generation capacities and promotion of electromobility are taken into account. Costs of the installation of meters in 80% of households until 2026 are included, too. Estimates for transmission and distribution networks are based on operators' plans. In the **district heating sector**, in addition to new production capacities, the modernisation and expansion of heating networks is taken into account. In the **gas sector**, the projections include outlays on the development of the distribution network as a result of the gasification of successive Polish regions, as well as the planned investments in the area of transmission network development based on expansion plans for gas companies. Outlays in the **liquid fuels** sector are determined, *inter alia*, by shifts in Poland's energy mix as a result of the development of alternative fuels and increased use of electricity and biocomponents (including advanced biofuels) in transport. The development of storage infrastructure and actions to increase the capacity at existing refineries are also included. Outlays in **mining** are based on Poland's coal[29] and lignite[30] programmes and own estimates for the periods that go beyond the timeframes of the programmes. The table below presents estimated energy-related capex in the fuel and energy sector in 2016-2040.

[29] Program dla rozwoju sektora górnictwa węgla kamiennego w Polsce na lata 2016-2030 (Programme for the development of the coal mining sector in Poland in 2016-2020), adopted by Resolution of the Council of Ministers of 23 January 2018.

[30] Program dla sektora górnictwa węgla brunatnego w Polsce (Programme for the Polish lignite mining sector for 2016-2020), adopted by the Council of Ministers of 30 May 2018.

Table 98. Projected capex in the fuel and energy sector for the two scenarios [EUR'2016 billion]
Table 98

	2016-2020	2021-2025	2025-2030	2031-2035	2036-2040	2016-2040
ECP	53.6	45.2	45.8	52.7	48.2	**245.5**
REF	46.2	38.4	37.6	46.3	51.1	**219.5**

Source: own study by ARE S.A.

The total planned capital expenditures in the domestic fuel and energy sector in the 2040 perspective amount to approx. EUR'2016 246 billion. It is estimated that nearly 60% of these outlays will be incurred in 2016-2030 (EUR'2016 144.6 billion). Post 2030, the increase in capex is associated with planned investments in nuclear energy – in the long run, this would be less noticeable since the investment is expected to provide energy production for 60-80 years. These expenditures are lower than in the REF scenario since the construction of one nuclear unit is put forward beyond 2040 in the ECP scenario.

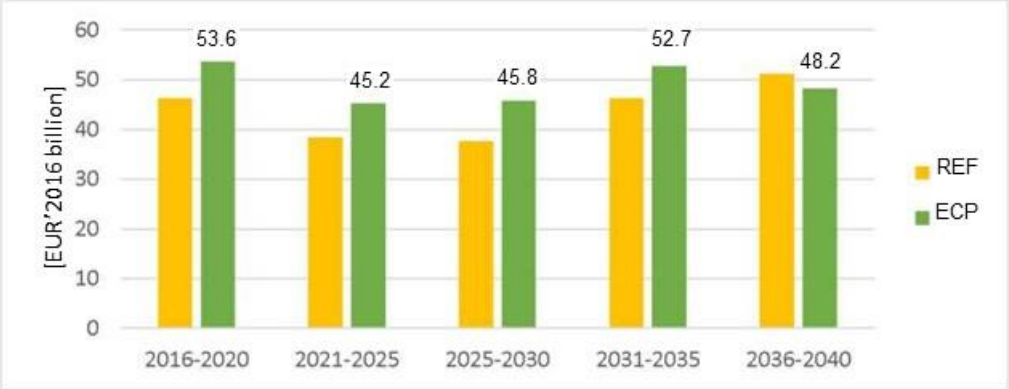

Figure 53. Comparison of capital expenditures in the ECP and REF scenarios in the fuel and energy sector in 2016-2040

The table below presents capex trends in the individual fuel and energy subsectors in the two scenarios along with differences between these sums. In most cases, expenditures in the ECP scenario are higher, with a declining trend in mining.

Table 99. Forecast capex in the energy sector by subsectors [EUR'2016 million]

Sectors:				**Comments:**
Electricity generation				Capex on the modernisation and expansion of the electricity generation sector (power plants and cogeneration plants, energy storage, DSR, costs of adaptation to IED/BREF).
	REF	**ECP**	**difference**	
2016-2020	15 169	20 407	5 238	
2021-2025	7 026	11 706	4 680	
2026-2030	6 348	12 229	5 881	
2031-2035	17 929	23 879	5 949	
2036-2040	24 580	22 880	-1 700	
2016-2020			**20 049**	

Transmission and distribution of electricity				Capex on the expansion and modernisation of the transmission and distribution network, including the strengthening of the distribution network to serve electromobility needs and the installation of smart meters at 80% of households by 2026. Prepared on the basis of transmission and distribution network development plans provided by operators.
	REF	**ECP**	**difference**	
2016-2020	8 395	8 501	**105**	
2021-2025	8 841	10 020	**1 180**	
2026-2030	9 109	10 535	**1 425**	
2031-2035	9 392	9 772	**381**	
2036-2040	9 149	9 487	**337**	
2016-2040	**44 886**	**47 140**	**3 429**	

District heating				Capex on the retrofitting and construction of new district heating plants (excluding industrial plants that produce heat for the needs of their parent plants).
	REF	**ECP**	**difference**	
2016-2020	2 476	2 202	-274	
2021-2025	2 455	2 758	303	
2026-2030	2 563	3 192	629	
2031-2035	1 978	2 267	289	
2036-2040	582	1 238	656	
2016-2020	**10 054**	**10 110**	**1 603**	

Distribution of district heat				Capex on the development and modernisation of district heating networks.
	REF	**ECP**	**difference**	
2016-2020	1 204	1 265	61	
2021-2025	1 363	1 486	123	
2026-2030	1 060	1 158	99	
2031-2035	847	960	113	
2036-2040	685	804	119	
2016-2020	**5 159**	**5 680**	**515**	

Gas industry				Capex on investments in the sector as planned by gas companies.
	REF	**ECP**	**difference**	
2016-2020	7 121	9 529	2 408	
2021-2025	6 053	6 291	238	
2026-2030	6 053	6 291	238	
2031-2035	5 146	4 154	-992	
2036-2040	5 146	4 154	-992	
2016-2020	**29 519**	**30 418**	**899**	

Liquid fuels				Capex on the expansion of the Oil Terminal in Gdańsk, building of the second leg of the Pomeranian Pipeline, construction of approx. 350 thousand m^3 of new fuel storage capacities and 200 thousand m^3 of oil storage capacities, and extension of the fuel pipeline from Boronów to Trzebinia. The costs of the Brody-Adamów oil pipeline are included. The capex associated with the maintenance, modernisation and development of infrastructure in the liquid fuels sector are assumed on the basis of data reported by fuel and logistics companies operating on the Polish market.
	REF	**ECP**	**difference**	
2016-2020	9 832	9 739	-93	
2021-2025	9 926	10 623	697	
2026-2030	9 998	11 010	1 011	
2031-2035	10 057	9 830	-227	
2036-2040	10 106	9 472	-634	
2016-2020	**49 919**	**50 673**	**754**	

Mining of coal and lignite				Capex related to the implementation of the January 2018 Programme for the hard coal mining sector in Poland and the May 2018 Programme for the lignite mining sector in Poland.
	REF	**ECP**	**difference**	
2016-2020	1 976	1 976	0	
2021-2025	2 758	2 293	-465	
2026-2030	2 438	1 395	-1 043	
2031-2035	912	1 850	938	
2036-2040	806	140	-666	
2016-2020	**8 890**	**7 655**	**-1 236**	

Source: own study by ARE S.A.

The costs in the electricity and heating sectors are disaggregated.

In the **electricity sector** (generation, transmission and distribution), capex in the 2016-2030 period is EUR'2016 73.4 billion for the ECP scenario and **EUR'2016 139.4 billion for the period 2016-2040**. The steep increase in 2031-2040 is explained by the assumed construction of three nuclear units with a total capacity of 3 900 MW. Notably, in the approach adopted, the expenditure is 'made' in the year when the unit is commissioned. This is a simplification, but adds transparency to the data analysis and eliminates the problem of a depreciation-based approach, which goes beyond the scope of the analysis, i.e. 2040. Outlays on RES are also noteworthy. The detailed scope of capex planned in the generation, transmission and distribution sector is presented in the two tables below, as well as in the graph – for generation.

Table 100. Projected capex in the electricity transmission and distribution sector [EUR'2016 million]

	2016-2020	**2021-2025**	**2025-2030**	**2031-2035**	**2036-2040**	**2016-2040**
transmission network	1 393	1 740	2 897	2 375	2 402	10 807

distribution network	7 108	8 280	7 638	7 397	7 085	35 597
total	**8 501**	**10 020**	**10 535**	**9 772**	**9 487**	**46 404**

Source: own study by ARE S.A.

Table 101. Projected capex in the electricity generation sector [EUR'2016 million]

	2016-2020	**2021-2025**	**2025-2030**	**2031-2035**	**2036-2040**	**2016-2040**
by type						
power plants	14 858	8 008	9 246	21 459	19 445	**73 016**
combined heat and power plants	3 824	3 234	2 784	1 981	2 874	**14 697**
DSR/energy storage	25	64	199	439	561	**1 288**
adaptation to IED/BREF	1 700	400	0	0	0	**2 100**
by fuel						
coal	9 222	2 237	0	287	446	**12 192**
gas	1 709	2 511	591	1 802	1 298	**7 911**
nuclear	0	0	0	11 700	5 850	**17 550**
other	694	539	446	689	1 061	**3 430**
renewable	**8 782**	**6 419**	**11 192**	**9 401**	**14 225**	**50 019**
hydro	110	317	120	120	120	**787**
wind	5 966	1 842	7 467	5 504	10 025	**30 804**
solar	2 004	2 156	1 659	2 819	2 838	**11 475**
biomass	407	1 318	1 109	93	278	**3 206**
biogas	294	786	837	865	964	**3 747**
total expenditures on electricity generation capacities	**20 407**	**11 706**	**12 229**	**23 879**	**22 880**	**91 101**

Source: own study by ARE S.A.

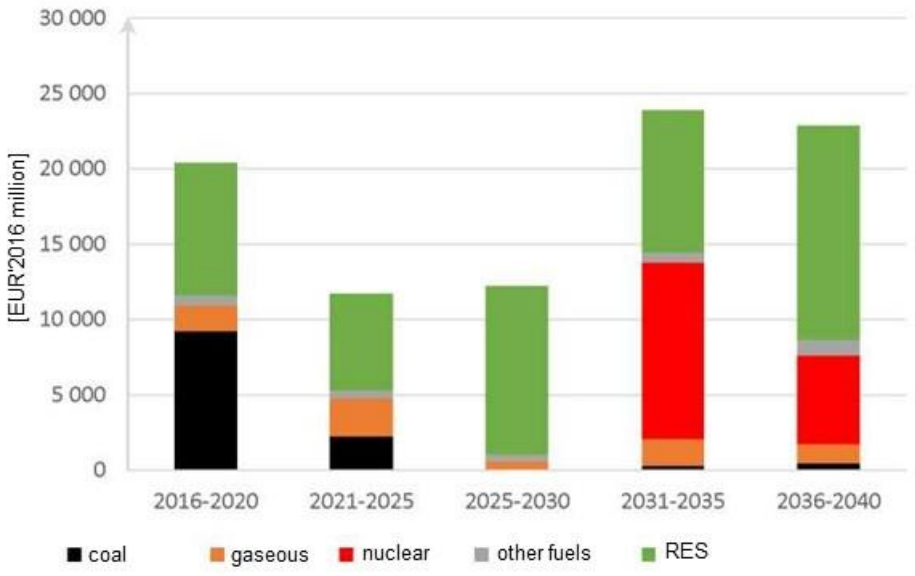

Figure 54. Projected capex in manufacturing in 2016-2040 [EUR'2016 million]

In the **district heating sector** (generation and distribution), for the ECP scenario, capex in the 2016-2030 period is EUR'2016 12.0 billion and **EUR'2016 17.3 billion in 2016-2040**. In the sector, the replacement of old coal-fired boilers for biomass- and natural gas-fired boilers will require high sums, as will the retrofitting of boilers and the process of adaptation to environmental requirements. The modernisation and development of district heating systems is another crucial cost factor, which – as the presented assumptions show – is expected to consume around EUR'2016 4 billion in 2016-2030 and nearly EUR'2016 6 billion in 2016-2040. The table below

presents estimated capital expenditures on the completion of the ECP scenario in district heating.

Table 102. Projected capex in the district heat generation and distribution sector (excluding industrial heating plants) [EUR'2016 million]

	2016-2020	2021-2025	2025-2030	2031-2035	2036-2040	2016-2040
district heating boilers	292	1 254	2 349	241	733	**4 868**
energy storage	13	28	0	7	0	**47**
upgrading	1 898	1 476	843	2 020	505	**6 742**
total generation	**2 202**	**2 758**	**3 192**	**2 267**	**1 238**	**11 657**
total district heat distribution	**1 265**	**1 486**	**1 158**	**960**	**804**	**5 680**

Source: own study by ARE S.A.

5.3.1.2. Energy-related capex in other sectors

The table below summarises the estimated energy-related capex in other sectors of the national economy, i.e. industry, services, transport, households and agriculture. The expenditures are shown in the table below, and their detailed breakdown by sectors is presented in the following table. Notably, in each case capex in the ECP scenario is higher than in REF.

Table 103. Projected energy-related capex in other sectors for both scenarios [EUR'2016 billion]

	2016-2020	2021-2025	2025-2030	2031-2035	2036-2040	2016-2040
ECP	41.4	55.1	49.7	33.8	26.2	**206.2**
REF	36.7	39.3	35.7	27.6	22.9	**162.3**

Source: own study by ARE S.A.

Table 104. Projected energy-related capex in other sectors [EUR'2016 billion]

Sectors:				**Comments:**
Industry				Replacement of technologies that supply process heat (process furnaces and ovens and industrial heating plants). Replacement and upgrading of electric drives and light sources, energy efficiency improvement measures.
	REF	**ECP**	**difference**	
2016-2020	3 215	3 990	774	
2021-2025	3 681	5 636	1 955	
2026-2030	3 047	4 575	1 528	
2031-2035	2 523	3 722	1 199	
2036-2040	2 070	3 040	970	
2016-2020	**14 536**	**20 092**	**6 427**	
Transport				Capex on rail infrastructure (tracks, stations, rolling stock), development of intermodal transport, development of recharging/refuelling infrastructure for vehicles powered by electricity/CNG respectively, expansion of airports and seaports, river regulation, replacement of public transport fleet/rolling stock.
	REF	**ECP**	**difference**	
2016-2020	17 165	17 738	574	
2021-2025	19 857	25 470	5 612	
2026-2030	17 551	22 894	5 343	
2031-2035	11 418	14 370	2 952	
2036-2040	9 721	11 553	1 832	
2016-2020	**75 713**	**92 025**	**16 312**	
Households				Capex on thermomodernisation, retrofitting and replacement of heat sources (CH, WSW), replacement of light sources with energy-efficient ones, replacement of electric devices for low-energy ones, purchase of new energy-efficient appliances.
	REF	**ECP**	**difference**	
2016-2020	9 970	12 071	2 102	
2021-2025	9 734	15 867	6 133	
2026-2030	9 696	14 543	4 847	
2031-2035	8 714	9 478	764	
2036-2040	6 697	6 772	75	
2016-2020	**44 811**	**58 732**	**13 921**	

Services				
	REF	**ECP**	**difference**	Capex on thermomodernisation, retrofitting and replacement of heat sources (CH, WSW), replacement of light sources with energy-efficient ones in commercial premises, upgrade of street lamps, replacement of electric devices for low-energy ones, purchase of new energy-efficient appliances.
2016-2020	1 304	2 446	1 142	
2021-2025	1 329	3 251	1 921	
2026-2030	1 181	3 145	1 965	
2031-2035	1 042	2 057	1 015	
2036-2040	925	966	41	
2016-2020	**5 781**	**11 865**	**6 084**	

Agriculture				
	REF	**ECP**	**difference**	Capex on thermomodernisation, retrofitting and replacement of heat sources (CH, WSW), replacement of light sources with energy-efficient ones, replacement and purchase of agricultural tractors and machines for less energy-intensive ones.
2016-2020	5 076	5 110	34	
2021-2025	4 680	4 849	169	
2026-2030	4 254	4 560	306	
2031-2035	3 872	4 223	350	
2036-2040	3 532	3 863	332	
2016-2020	**24 414**	**22 606**	**1 192**	

The table below presents the estimates on capex required to complete the thermomodernisation of buildings assumed in the ECP scenario, which are based on the assumption that by 2030, 70% of residential buildings will have been fully or partially insulated. In the service sector, it is assumed that by 2030, approx. 78% of the total useful floor area of public healthcare, administration and education buildings, and 70-75% of the area of hotels, offices, workshops, and warehouses that provide non-commercial services will have been insulated.

Table 105. Projected capex on thermomodernisation of buildings [EUR'2016 billion]

	2016-2020	**2021-2025**	**2025-2030**	**2031-2035**	**2036-2040**	**2016-2040**
ECP	3 111	7 372	7 532	4 619	1 518	24 151
REF	1 689	1 839	1 865	1 889	1 905	9 186

Source: own study by ARE S.A.

5.3.2. Sector or market risk factors or barriers in the national and regional context

5.3.2.1. Electricity sector – sectoral risks

The electricity sector is exposed to risks and threats arising from the specificities of its operations and functioning in a certain market and regulatory environment.

In the power sector, both investment processes and payback periods are long. Therefore, the strategic documents, legislation, and state ownership policies formulated by international organisations, in particular the European Union, and by the Polish state are very important and have a crucial impact on both the investment decisions of energy companies and their implications.

Regulatory risk

The factors that have an impact on the development and performance of the Polish energy sector include the EU's Climate and Energy Package, which sets the 2030 GHG emission reduction target, and the clean energy for all Europeans package, which works towards the realisation of the Energy Union in legal terms. A number of risks arise from the tightening of emission standards and the rules for the functioning of the CO_2 emission allowance-trading scheme (EU ETS). The main problem related to carbon prices lies in the uncertainty inherent in their trends, which means that power undertakings do not know what technology to invest in so they prefer to put investment decisions off.

A threat to the development of the energy sector is also posed by other EU regulations adopted within the framework of the environmental policy and related to the reduction of pollutant emissions. They include the IED and best available techniques (BAT) conclusions for large combustion plants provided for by Directive 2010/75/EU (BAT conclusions for LCP). Given the uncertainty as to their final wording (this applies, in particular, to the BAT/BREF revision), they are a potentially significant risk factor likely to translate into a change in the

level of expenditures in the sector, their directions, or even the profitability of construction projects, which may prove non-conducive to energy transition after several years from their commencement.

A similar threat is posed by Regulation on the internal electricity market (EMR) and Directive on common rules for the internal market in electricity (EMD), which aim to create a new framework for the single energy market, *inter alia*, by introducing many pro-consumer solutions and making the market more flexible, as well as by interfering in the structure of mechanisms.

With a sufficiently high capacity of interconnections, a substantial portion of domestic demand for electricity can be satisfied by foreign producers. An investor examining the feasibility of an investment project must, in fact, take into account the potential risk, as well as strategies and prices of electricity offered by producers located outside of Poland. A major barrier is also created by unregulated legal status of property, which gives rise to difficulties in acquiring or accessing land as part of new investments (especially in the distribution segment).

Market risk

A serious market risk is posed by uncertainty regarding future prices of electricity and related products, e.g. property ownership or CO_2 emission allowances, as well as that concerning the volume of electricity sold (resulting from the uncertainty of electricity and heat demand determinants). The actual occurrence of market risk factors may have an adverse effect on the entity's financial result, *inter alia*, by reducing its revenues, driving up its costs, or undermining the margin.

The large share of near-end-of-life, high-emission coal- and lignite-fired power plants, which will be gradually decommissioned in the next several years, *inter alia* due to non-compliance with emission standards, plays a role, too. This hinders new investments, especially with the insufficient funds available in the economy. There is also pressure on the operating results of Polish energy companies, caused by competition from the free EU energy market, which will limit their investing potential.

The risk resulting from banks' reluctance to finance investments in conventional energy or in other non-renewable sources should be highlighted, too. This may cause power shortages in the system, causing interruptions to continuous energy supplies for the economy.

Risk arising from sustainable finance

In accordance with the sustainable finance concept proposed by the High-Level Expert Group (HLEG), economic activities are to be classified in environmental terms. The criteria for determining whether a given activity is sustainable include the phasing out of anthropogenic greenhouse gas emissions, including those from sources based on fossil fuels. It can be assumed that in the case of activities that will be classified as unsustainable, incentives will be created to divert capital available on financial markets towards other activities, e.g. through greater prudential requirements for securing loans for such investments, or a lower rating. This means that obtaining private capital for investments in activities considered unsustainable will be more difficult than at present.

Therefore, institutions dealing with asset and investment management are to be put under an obligation to integrate sustainable finance factors (Economic, Social & Governance – "ESG") into their core activity, which means adaptation of their processes, internal procedures, risk management rules and sale policy to European Commission proposals. If a project is not aligned with the climate objectives and the 2030 Agenda, getting a loan or insurance may be difficult. Currently, a large proportion of financial market actors (including investment funds, insurance companies, and banks) have already been put under an obligation to inform customers of the availability of an ESG-based solution.

Technology risk

In addition to the huge benefits, the decarbonisation of the energy sector also produces risks. A large proportion of investments in generation capacity is channelled to renewable but unstable energy sources, with insufficient focus on technologies serving better integration of renewable energy sources with the power system, in particular dispatchable sources producing energy at competitive prices, and above all the development of energy storage technologies, including use of hydrogen.

Notably, in Poland, there are few actors that can compete with international suppliers of energy technologies,

both due to less extensive experience and the prevailing economic conditions. Therefore, the Polish energy sector may be in a disadvantaged position in terms of investments and their subsequent servicing.

Poland undertakes R&D challenges in the energy sector, but struggles, in particular, with much more difficult access to capital than in richer economies. This may hinder acquisition of new technologies, but efforts are being made towards international cooperation or raising foreign capital.

Transmission and distribution risks

Transmission and distribution system operators seem to be in a slightly more advantaged position. Although new legislation places a number of tasks on them, the investment risk incurred by transmission and distribution system operators is much lower, mainly on account of the stable regulations to which these subsectors are subject, i.e. specific return on investment which is ensured by the regulator in the form of transmission and distribution tariffs. Despite this, the transmission subsector is facing the problem of long-term project planning. Plans to build new capacities evolve and change over the years, e.g. in terms of parameters or the choice of technology. The network is built in a multi-year process, so it is difficult to keep up with market developments that take place in the meantime. The construction of the transmission network is strongly linked to the pace and extent of the construction of new generation units, which follows from the fact that the TSO is required to provide capacity and integrate these units into the common network.

In addition, the lack of understanding from the public of the need to build new networks is a major obstacle to forecasting the development of both transmission and distribution networks.

5.3.2.2. Heating sector – sector risks

In the years to come, the heating sector faces many challenges related to new regulations. The key legislative acts affecting the functioning of the heating sector on the local market include the Renewable Energy Directive, the Energy Efficiency Directive, and Directive on energy performance of buildings. In Poland, district heating is strongly affected by the implementation of a capacity market and a new cogeneration support scheme.

Currently, the heating sector is characterised by a very high dependence on coal for heat generation and high level of wear of the legacy heat generation units and transmission networks.

There is also the ‘cost trap’ of heat generation technology modernisation projects resulting from the fact that, on the one hand, technology upgrades typically require the replacement of coal by other conventional fuels, which are much more expensive, and on the other hand, from the capital weakness of most heating companies, which forces them to entrust retrofitting projects to ‘third funding parties’, i.e. specialised ESCOs, which seek to achieve a high margin and return on investment in the short run;

There is also the ‘price trap’ of environmental investing which stems from the existence of mechanisms encouraging heating enterprises to pursue projects that reduce pollution and simultaneous difficulties with access to cheap funding instruments for these projects, which in turn contributes to direct and high rises in heat prices as a result of the completion of environmental projects.

Ownership risk

In Poland, most district heating systems are owned by municipalities, which means that they do not have high financial resources readily available for investments. As regards large corporate groups, the cash flows they generate are high enough to finance individual investments. Smaller district heating companies do not have such an easy access to the financial market as large players present on a larger, more reliable market. The sole option that remains, namely commercial loans, are not always easily available since funding institutions are reluctant to extend loans to entities that are facing stricter standards, rising environmental costs, and restrictive tariffs. Schemes of financial support from energy efficiency or renewable energy development funds are an opportunity.

Regulatory risk

The sector will be affected by the BAT standards for large combustion plants (LCP), which were adopted in April 2017 and which introduce strict requirements, in particular as regards pollutant emission limit values. They will apply from 2021, imposing strict criteria for the emission of nitrogen and sulphur compounds and PM for all large

combustion units with a capacity of more than 50 MW. Small and medium-sized units from 1 to 50 MW are required to comply with equally stringent requirements, imposed by Directive on the limitation of emissions of certain pollutants into the air from medium combustion plants (MCP Directive).

Another major risk to investments in district heating development is posed by EU and domestic regulations preventing inefficient heating systems [32] from obtaining public financial support. This causes network investments to be unprofitable as business ventures since the payback period is usually several-decade long. However, such investments are pursued to increase the security of heat supply and connect new consumers. Currently, practically only 20 per cent of district heating networks within the Polish heating system are efficient, i.e. such that are environmentally friendly and can have a real contribution to the fight against smog and cause local fuels to be used in a better way.

In the coming decade, deep modernisation of heating systems should be carried out, which, in many cities, especially smaller ones, will minimise the risk of losing existing sources of heat supply and air quality deterioration and will prevent the liquidation of some companies due to the lack of sufficient own funds for investments. A certain threat and risk to investments in district heating is also posed by the current regulation model, which should be more flexible and give heat companies the opportunity to obtain a fair return on capital so that they are able to raise funds for investments necessary to meet applicable emission requirements. Currently, heating companies have limited opportunities of raising capital for retrofitting their generation assets (not to mention complete replacement of the generation technology) and development of the network. It is necessary to revise the current tariff policy, so that it better contributes to the development of the sector and ensures that more funds are allocated to system development in order to provide better quality services.

The inability to expand the network due to the lack of spatial planning legislation is another important risk factor that affects district heating development. District heating, like many other network businesses, faces serious difficulties caused by spatial planning issues and the resultant problems with access to land. The delineation and construction of new heating networks and obtaining the formal consents from plot owners is very time consuming and expensive. This forms an additional barrier to the development of district heating, which runs the risk of being constrained to the urban areas where district heating is already available.

In many cases, district heat will not be an attractive option for developers. This results from Directive 2010/31/EU of 19 May 2010 on the energy performance of buildings, which requires investors using coal-based district heat to raise the building's energy standard (i.e. reduce the building's energy intensity or add a renewable energy source). This means that investors may find installing individual gas- or pellet-fired boilers cheaper than connecting buildings to district heating systems.

Market risk

Some heating companies are wound up because they do not have enough own funds for investments. They are not in the position to raise capital on market terms and cannot apply for public aid because they are 'inefficient systems' and are unable to make their way into the category of 'energy-efficient systems'.

Another problem for the sector is posed by the decrease in heat demand as a result of the thermomodernisation of buildings already connected to the network. New buildings are often out of the network because it is more profitable for investors to supply them with heat from individual sources. There is also an increased risk of other enterprises going bankrupt due to falling demand and emission abatement costs. The risk stems from the fact that new environmental investments mean rising unit prices of heat sold, which in turn reduces the demand for heating services and drives the spiral of prices.

The cogeneration support scheme introduced in 2019 can create stable conditions for investing in cogeneration and can be a strong impulse for building new CHP units, especially at the sites of existing heating plants. However, the current poor condition of the heating sector limits the possibility of converting some heat-only boilers into cogeneration units. Still, the potential is considerable.

From the perspective of cogeneration support, a serious risk to investors will be posed by optimal selection of

[32] Directive 2012/27/EU on energy efficiency defines 'efficient heating (cooling) systems' – efficient district heating and cooling means a district heating or cooling system using at least 50% renewable energy, 50% waste heat, 75% cogenerated heat or 50% of a combination of such energy and heat.

fuel, which is made on the basis of projected price trends for individual fuels and CO_2 emission allowances, which are burdened with a high margin of error. This follows from the fact that these parameters are crucially important for the entire economics of implemented projects.

5.3.2.3. Gas sector – sector risks

The development of gas infrastructure in Poland is primarily determined by the need to ensure diversified sources of gas supply and by the development of interconnections to ensure integration with European markets. Ensuring gas supplies alternative to current sourcing directions is of utmost importance. Historically, the NTS was being developed so as to handle exclusively the transport of Russian gas from east to west, which caused Poland to be fully dependent on one direction. In recent years, in order to eliminate barriers to access to neighbouring foreign gas markets, the transmission system operator has completed a number of activities aimed at diversifying the directions and sources of natural gas supplies, striving to minimise the risk of dependency on the historically dominant supplier (Russia).

The activities integrating Poland with regional gas markets continued by the TSO (GAZ-SYSTEM S.A.) include the building of interconnections and continued expansion of the national transmission system so as to handle gas supplies from any direction and clear existing bottlenecks within the transmission system. This has removed the successive barriers, which improves the diversification of gas supply sources and boosts the technical potential for accessing alternative, competitive Western markets.

Regulatory risk

From the investor's point of view, the key barriers and risks to investment projects include the long process of incorporating pipeline investments into local plans, difficulties with acquisition of legal titles to land, no immediate enforceability of administrative decisions, and long timeframes for filing objections, appeals and complaints, which results in increased project costs. The protracted permit issuing process, the lengthy appeal procedure, and the repealability of issued administrative decisions considerably extend investment delivery times, and may result in the abandonment or postponement of key investment decisions. Issues related to obtaining consents from property owners, which extend the investment process, also remain a major problem. This renders projects that teeter on the edge of profitability unprofitable.

Market risk

In the gas sector, the operator of transmission pipelines responds to increased demand for natural gas signalled by the market and conducts a number of infrastructural investments. The difficulties encountered by the TSO are specific to the entire construction sector and relate to limited availability of contractors and designers. There is an observable increase in prices of contractor services as a result of limited resources on the market. In addition, in some tendering procedures, the prices bid exceed the estimated value of the awarding entity's budget. Large tenders for the construction of gas pipelines may entail inflated bids and increase the risk of the contractor failing to meet the completion deadline.

One key challenge for the contractor is to accumulate the necessary resources and materials in the initial period of the contract, and another is the high diversity of preparatory work in terms of the disciplines involved, including several areas that go beyond gas work as such. Often, contractors has such work completed by third-parties, which complicates the entire process because of the need to obtain specialised equipment and qualified staff or engage subcontractors. The problems that the construction industry struggles with mainly relate to limited contracting and design potential.

5.3.2.4. Liquid fuels sector – sector risks

Given the limited access to domestic crude oil resources, it is essential that Poland aims towards diversifying supplies and ensuring security of crude oil and liquid fuels supply. Further diversification of crude oil imports requires, above all, well-developed and reliable inland infrastructure to reduce supply barriers and ensure the possibility of increasing imports by sea. In order to provide technical possibilities to diversify sources of oil supplies to domestic refineries, investments are also necessary to increase aboveground storage infrastructures.

Market risk

The Polish fuel market is supplied from two sources: domestic producers (PKN Orlen S.A. and Grupa LOTOS S.A.) and importers. The main market risks to which the liquid fuels sector is exposed in its operations include the commodity risk, which is associated with changes in refinery and petrochemical margins achievable on product sales, the Brent/Ural price differential, crude oil and petroleum product prices, and prices of CO_2 emission allowances.

The overall economic situation is crucial for fuel consumption, determining the level of sales, prices of products in the liquid fuels sector and its financial standing, and consequently the potential for further development. The fuel market is also exposed to the risk resulting from what is referred to as the 'grey market', which mainly involves illegal trade in fuels with no taxes paid. Companies from the liquid fuels sector are exposed to oil processing disturbances caused by the unavailability of pipeline logistics services and instability in oil-producing countries. Change to the parameters of supplied oil and the resultant lower yields of 'white products', as well as maintenance shutdowns of production installations, have a major impact, too. For example, the expansion of existing and construction of new refineries in Russia may decrease the volumes of Russian crude oil allocated for export, and consequently, decrease the availability of crude oil for European buyers, including Polish companies.

The predominant activity in the liquid fuels sector is represented by the downstream segment, i.e. the processing of crude oil into petroleum products, including fuels, and the sale of these products to customers. The upstream segment is the production sector, which includes prospecting for potential underground or underwater oil and gas fields, drilling exploratory wells, and operation of the wells that recover and bring crude oil or raw natural gas to the surface. Extraction projects are exposed to a number of geological and operational risks that may make achieving the expected profits difficult. The implementation of such projects may be delayed or may fail, chiefly due to the associated high exploration risk, cost overruns, lower oil and gas prices than assumed, higher tax burdens than anticipated, unfavourable legislative developments in the sector, equipment and qualified staff shortages, difficult weather conditions, or difficulties in finding partners to share project risks and costs. Often, such projects may also require using new, state-of-the-art technologies that are expensive to develop, acquire and implement, and may not function as expected.

Notably, the sector is exposed to the risk associated with the need to pursue the goal of increasing the share of renewable energy in transport. Entities encounter technological difficulties in blending methyl esters and bioethanol and in meeting the requirements for the types of biocomponents to reach the target. The costs incurred may also affect the competitiveness of these entities.

5.3.3. Analysis of additional public financial support to avoid identified risks

A large proportion of the risks cannot be avoided since they result from market developments which have occurred or will occur as a result of the implementation of EU legislation. A number of risks will be eliminated as a result of the implementation of the PaMs envisaged by the NECP, and whose financing is described in Part 2 (Policies and measures) of this document.

Technological development, which can be of key importance for each of the sectors, will certainly play a role.

5.4. Impacts of planned PaMs on regional cooperation and other Member States

5.4.1. Impacts on the energy system in neighbouring and other Member States in the region

5.4.1.1. Power systems

The efficient use of interconnections in Europe is crucial for future energy security. To this end, Poland intends to continue active cooperation with neighbouring countries.

The construction of the 'power bridge' between Poland and Lithuania is one of the most vital investments completed in recent years by PSE S.A. The main element of the project was the construction of a connection between the Ełk Bis station and the Alytus station in Lithuania, which can handle cross-border exchange of up to 500 MW.

Currently, the 'LitPol Link' is the only interconnector between the Baltic states and the system of Continental Europe, which has made it possible for Lithuania, Latvia and Estonia to trade with Continental Europe. The interconnector is the first step towards the desynchronisation of the Baltic states' system from the IPS/UPS. The

next stage will involve the construction of the Harmony Link, a high-voltage direct current cable connection. The deadline for completing the synchronisation of the Baltic States with Continental Europe is scheduled for 2025.

By 2030, PSE S.A. plans to expand its domestic network in the west of the country. The investments are known as the "GerPol Improvements" and "GerPol Power Bridge I" projects. Analyses carried out by the operator indicate that the expansion of the transmission network in the area of the Krajnik and Mikułowa stations will generate comparable effects in terms of the possibility of increasing power imports as would the construction of a new interconnector with Germany, but it requires lower capital expenditures. The expansion of the domestic network also improves the certainty of the evacuation of power from domestic power sources. The expansion of the domestic transmission network will produce 2 000 MW of import capacity with no need to build a third interconnection with Germany.

- Joint determination of transmission capacity

The division of Europe into CCRs (Capacity Calculation Regions), which has been decided on by ACER, aims to ensure stability of interconnections between the region of western and eastern Europe in the coming years. In the individual CCRs, transmission network operators will jointly determine transmission capacities at the borders between the regions. The borders of the Polish bidding zone are assigned to three independent CCRs (Hansa, CORE, Baltic).

The goal of TSO's cooperation under the CORE CCR is to combine Eastern (CEE) and Western (CWE) energy markets into a single system (CORE). Within its framework, Poland is interconnected with Germany, the Czech Republic, and Slovakia.

Until 2025, the FBA (flow-based allocation) methodology is to be employed in CORE as the mandatory method of determining transmission capacity. The FBA approach relies on physical flows in determining the transmission capacity, with the calculation of available capacity based on power transfer distribution factors, subject to safety margins.

The currently used capacity factor is calculated as the ratio of the transmission capacity made available to the installed capacity of power units in the respective Member State. It does not take into account the structural conditions in power systems, which may lead to erroneous conclusions as regards the need to build new interconnections. Poland will increase its cross-border transmission capacities by 2030, *inter alia* through projects of common interest to PCI (which are listed in the second part of the document – Policies and measures). Based on the results of the Expert Group's work, the European Commission has proposed a set of new thresholds to launch urgent measures to provide the necessary infrastructure to help achieve the "interconnectivity" goal for 2030. These new thresholds to help achieve the "interconnectivity" goal are provided for by Regulation on the Governance of the Energy Union (Regulation 2018/1999/EU (*inter alia* Annex I, Part 1, Section A, paragraph 2.4.1).

Detailed information on the development of interconnections is provided by subsections 5.1.5.1. and 5.1.5.2.

5.4.1.2. Gas systems

Poland has planned a series of activities to achieve real diversification of energy supplies. This will be accomplished by investing in the Baltic Pipe, increasing the capacity of the LNG terminal in Świnoujście, building a Floating Storage Regasification Unit in the Gulf of Gdańsk, and creation/expansion of the interconnections with Slovakia and Lithuania. Investments in cooperation with the Czech Republic and Ukraine are also possible. These projects constitute the Polish contribution to the Three Seas initiative, which aims to deepen the integration of the Baltic, Adriatic and Black Seas and EU's priority countries – the north-south gas corridor for the CEE countries, and add to the planned energy integration of Baltic States.

In addition, expanding gas interconnectors will allow countries in the region to foster commercial use of natural gas storage. Ukraine has the largest natural gas storage capacity in Europe (over 30 billion m^3), Slovakia has a storage capacity of almost 4 billion m^3, the Czech Republic over 3 billion m^3, and Lithuania 3.2 billion m^3. The increased cross-border gas transmission capacity will therefore create the possibility of making storage capacities available on a commercial basis.

It is in the common interest of all countries in the region interconnectivity so as to enhance the diversification of natural gas supplies for the needs of the national economies in the region of Central and South-East Europe.

Such activities will increase energy security in the region and will stabilise energy carrier prices.

Detailed information is provided in subsections 5.1.5.3. and 5.1.5.4.

5.4.1.3. Nuclear power

Given the need to replace ageing generation capacities in the national power system from 2030 and increasing demand for electricity, it is necessary to invest in new sources. The construction of nuclear power plant units in Poland will mainly produce benefits in terms of energy security, diversification, and mitigation of impacts of the power sector on the environment. In addition, it will drive the development of the energy market, both for Poland and neighbouring countries. The investment is expected to slow down the growth of energy prices and, in the long run, to stabilise them. Nuclear power plants ensure predictability and stability of operation. Enhancing the country's production potential will improve the possibilities of exporting electricity to the neighbouring countries that are interconnected with Poland, and will add to the creation of an internal regional energy market. Given the lower unit cost of production compared to other power generation technologies, which is attributable to the small share of fuel costs in the total costs of electricity production, nuclear power plants will contribute to the stabilisation of wholesale electricity prices.

5.4.1.4. Capacity market

A capacity market has been launched in Poland pursuant to the Capacity Market Act of 8 December 2017. In addition to domestic entities, capacity market auctions are open to foreign physical generation units and demand reduction units located in the EU Member States whose power systems are interconnected with the Polish system, i.e. the Czech Republic, Germany, Lithuania, Slovakia, and Sweden. Foreign units must take part in a preliminary auction, which will be held for the first time in 2019, and therefore, for the first time, the units will participate in the main auction for 2024. For the periods 2021-2023, foreign units may participate only in additional auctions. The Act delimits three geographical zones for which the maximum volumes of capacity obligations that can be offered by the units of these zones will be determined each time. The preliminarily assumed level is around 1 GW.

The capacity market is to provide an investment impulse to ensure stability of electricity supply. Given the substantial decommissioning of existing units within the system, enhancing production capacities is crucially important for ensuring reliability of supply and satisfying the increased demand. Disruptions to the operation of the Polish power system could also have implications on the neighbouring countries interconnected with the National Power System. The capacity market mechanism is designed to prevent such disruptions. Supporting transboundary capacities is one of the foundations of the integration of EU energy markets.

Ensuring security of supply is based on maintaining a balanced system, continuity and reliability of supplies, as well as on transparency and competitiveness of the wholesale market. The creation of new and modernisation of existing units will undoubtedly improve the technical infrastructure and will help maintain the required power levels. Additionally, it will stabilise energy prices on the wholesale market. As a result of the introduction of the capacity market, reserve capacities will increase, which will reduce capacity shortage times during the year, thereby mitigating the risk of shortage of electricity supply. Maintaining a secure and required level of capacity in the system will contribute to building a stable European energy market.

By definition, the supply of electricity within the interconnected European energy markets supports the building of an energy union. Exploiting the production potential of generation units made available by neighbouring countries and transboundary trade may produce benefits for all the countries involved, such as improved technological competitiveness and the resultant reduction of production costs. Efficient use of production capacities is only possible with no disruptions to cross-border trade, expanded transmission networks, and upgraded distribution systems. In order to coordinate physical flows in a better way and enhance the potential for trade between the interconnected systems, cooperation with operators of neighbouring countries is necessary. It is necessary to eliminate the risk of failure to deliver the contracted capacity in situations where the neighbouring country is also struggling with difficulties in balancing its power system. Allowing foreign units to participate in the capacity market contributes to the creation of an internal European market.

Poland has opened the mechanism up to all kinds of capacity providers, including foreign ones, and has ensured the regularity and competitiveness of the auctions. In addition, during the notification process, Poland undertook to reform the electricity market. The capacity market mechanism has been approved by the European Commission, which clearly demonstrates that it does not threaten the integration of the Polish energy market

with neighbours' markets. It contributes to the security of energy supply, while safeguarding competition in the single market, and does not impede cross-border flows of electricity in the EU.

5.4.2. Impacts on energy prices, utilities and energy market integration

5.4.2.1. Impacts on energy prices

Actions taken in the area of gas systems will largely affect the structure of the gas market. Increased diversity of supply directions in the region will improve the competitiveness and stability of gas prices. The investment burden that must be borne by gas transmission companies in Poland and neighbouring countries will be partly relieved by support from EU funds, in particular for PCIs. The support will allow partial cost mitigation in order to rationalise the increase in gas prices for final consumers.

Currently, natural gas prices for non-industrial customers in the region vary widely. According to the Eurostat, in the last three years average natural gas prices (excluding taxes) have varied twice in extreme cases. With the exception of the Czech Republic (where the price of gas for the largest non-industrial customers is around EUR 12/GJ), gas prices in the region are lower than the European average. The lowest gas prices (around EUR 5/GJ) were recorded in Ukraine. For several years, gas prices in Lithuania have been falling (to EUR 6/GJ in the first half of 2018), similarly to Slovakia (to EUR 9.6/GJ). As regards industrial customers, natural gas prices are much more similar and, unlike previously, higher than the EU average. Prices in the region range from EUR 6.3/GJ in Ukraine to EUR 7.3/GJ in Lithuania. Deliveries of gas from the Norwegian continental shelf will allow the wholesale gas prices in the region to be equalised.

Regarding electricity, attention should be drawn, in the first place, to positive effects for neighbouring countries, which will be able to import some energy, especially during spells of adverse weather conditions (weak wind, low sunlight). The effects will be produced by the construction of nuclear power units and partly by the capacity market, which will stimulate the construction of stable sources able to offer extra export capacity in addition to the fulfilment of the capacity obligation.

- Energy market integration

Regulation 2017/2195 (guidelines on balancing) contains a number of recommendations regarding the balancing of electricity within the interconnected European system created. Cooperation in this dimension will reduce the balancing costs and increase the security of the NPS. At present, TSO-TSO balancing service exchange platforms are being created. In this solution, the service provider is required to provide services to its TSO (transmission system operator) for it to be able to provide the same to another requesting TSO. Currently, the following projects are being implemented under the Regulation:

- PICASSO (Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation) platform for the exchange of balancing energy from frequency restoration reserves with automatic (secondary automatic) activation – aFRR. The project is carried out by the TSOs that have joined the initiative. PICASSO is designed and delivered as a joint European platform for activating automatic secondary regulation taking into account economic aspects leading to service cost optimisation.

- MARI (Manual Activated Reserve Initiative) is a platform for the exchange of balancing energy from frequency restoration reserves with non-automatic (secondary manual) activation – mFRR. The project is carried out by the TSOs which have joined the initiative. MARI is designed and implemented as an initiative of a joint European platform for the exchange of balancing energy between control areas. Electricity comes from units contracted to provide the manually activated secondary reserve service.

- TERRE (Trans European Replacement Reserves Exchange), i.e. a platform for the exchange of balancing energy from replacement reserves. The project includes the individual TSOs that have joined the initiative. TERRE is designed and implemented as an initiative of a joint European platform for the exchange of balancing energy between control areas. Electricity comes from units contracted to provide the manually activated tertiary reserve service.

- IGCC (International Grid Control Cooperation) is a project implementing an imbalance netting process between TSOs of two or more LFC Areas (Load-Frequency Control Areas). Activities are carried out within one or several synchronous areas to prevent the activation of balancing energy from the secondary frequency recovery reserve in opposite directions and to correct controllers within the LFC Areas of specific

TSOs.

5.4.3. Impacts on regional cooperation

Paris Agreement

Developed countries have committed themselves to providing USD 100 billion a year until 2020 to developing countries for investments in energy efficiency and combatting harmful emissions. Poland is among the group of developed countries and has declared a contribution of USD 8 million at the conference. Countries have undertaken to verify the targets in 5-year cycles. Poland actively cooperates with all the countries that have ratified the Agreement, pursuing actions to reduce greenhouse gas emissions, while taking into account the socio-economic specificities of the country. It also actively organises and hosts climate summits (Poznań, Warsaw, Katowice), which aim to achieve progress in creating the principles and obligations of implementing the Agreement.

Statistical transfer

As part of international cooperation between Poland and EU countries (as well as Switzerland and EFTA members), a certain amount of electricity generated in RES installations can be transferred in a given year. The arrangement takes the form of what is referred to as 'statistical transfer', which is effected on the basis of international agreements or civil law agreements. Countries can benefit from a transfer if their national target for the share of energy from renewable sources in gross final consumption is not met. It is assumed that until 2030 Poland will rely on its own resources to fulfil the target set, taking into account the required levels of cooperation with other countries. At the same time, Poland does not envisage surplus production of energy from renewable sources which could be transferred to other Member States in order for them to achieve their national contributions.

SET PLAN

Poland is currently an active member of two teams of Temporary Working Groups of the Strategic Energy Technology (SET) Plan. They are TWG Action 6 'Energy efficiency in industry' and TWG Action 10 'Nuclear'. Active participation in the work of other TWGs depends on the definition of Poland's energy priorities in line with the priorities of the SET Plan. This means that Poland's priority areas in the SET-Plan will be selected on the basis of its energy policy and will be implemented at a later date. After the areas are determined, national representatives will be designated to selected TWGs (the Ministry of Science and Higher Education will be able to invite the National Centre for Research and Development to join in and appoint experts to TWGs).

Baltic Energy Market Interconnection Plan

The activities carried out continuously over the entire period covered by the Plan should include the above-mentioned monitoring activities as regards diversification of gas supply sources. In addition, Poland envisages further cooperation at European level under the Baltic Energy Market Interconnection Plan (BEMIP). The investment projects listed above will allow the strategic assumptions of the Plan to be put into practice. To this end, continuous communication will be maintained between participants in this initiative. The expected effects will include closer regional cooperation in the field of energy and free trade in energy carriers and electricity.

Nuclear energy

The National Atomic Energy Agency (*Państwowa Agencja Atomistyki*) is the state authority appointed to ensure nuclear safety and radiation protection in Poland. This body participates in the creation of international standards and legislative acts by exchanging information on nuclear safety with neighbouring countries. Given the operation of nuclear power plants in close proximity to Poland's borders, as well as the planned investment in Poland, there is a need for cooperation with nuclear regulatory bodies of neighbouring countries, which should be pursued on the basis of intergovernmental agreements on early notification of nuclear accidents and cooperation in the field of nuclear safety and radiation protection. The National Atomic Energy Agency has concluded agreements with all countries bordering Poland, as well as with Austria, Denmark and Norway.

In addition, the National Atomic Energy Agency is engaged in international cooperation to enhance competence and implement good practices by exchanging knowledge and experience with foreign partners while participating in the work of international organisations and associations. Poland is an active member of

communities, groups and associations, such as the European Atomic Energy Community (Euratom), the International Atomic Energy Agency (IAEA), the Nuclear Energy Agency of the Organization for Economic Cooperation and Development (NEA OECD), the Heads of the European Radiological Regulatory Authorities (HERCA), the Western European Association Nuclear Regulators' Association (WENRA), the Council of the Baltic Sea States (CBSS), the European Nuclear Security Regulators Association (ENSRA), and the European Safeguards Research And Development Association (ESARDA). Poland declares its continued willingness to participate and act in the above-mentioned groups within the framework of international and regional joint efforts.

Open international cooperation in improving the safety of nuclear power plants because of the potential global impacts of nuclear accidents is a useful means of gaining knowledge and experience from other countries and disseminating good practices. Poland believes that international cooperation and the learning process provide an opportunity for quick and effective implementation of the best solutions in nuclear power plants. Poland plans to further develop cooperation with partners that have extensive experience in overseeing large nuclear installations and to continuously develop the R&D potential for nuclear power.

Within the European Union, Poland participates in the work of the Joint Working Party on Research/Atomic Questions, which discusses legislative and non-legislative documents for the EWEA. Poland participates in the coalition of pro-nuclear countries and submits positions in support of the development of nuclear energy in the EU, improvement of investment conditions in the sector, and an increase in funds for nuclear R&D. It also monitors and if necessary makes intervention during work of other working groups of the EU Council on matters relevant to the development of nuclear energy, e.g. environmental issues. Poland is also a member of working parties dedicated to Task 10 of the SET Plan, which is the technological pillar of the European Climate and Energy Policy, ensuring the visibility of, and access to, funding for Polish high-technology research projects, nuclear safety, and radioactive waste management.

The Visegrad Group (V4)

In the area of energy, Poland also cooperates within the Visegrad Group. Joint initiatives are being undertaken to create a regional gas market. In order to ensure diversification of gas supplies for the region, the members of the Group are cooperating with the aim of sourcing liquefied gas from the US. In addition, the North-South Gas Corridor project will include the construction of the following gas interconnectors: Poland-Slovakia, Poland-Czech Republic, and Slovakia-Hungary. All V4 countries have a unified position on the use of nuclear energy and cooperate in the field of electricity. These activities are conducive to developing the energy security and independence of the V4 countries. Setting objectives in a consistent way and implementing them in a unified manner contributes to the integration of the European Union and the harmonisation of its development level.

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EXECUTIVE SUMMARY OF POLAND'S NATIONAL ENERGY AND CLIMATE PLAN FOR THE YEARS 2021-2030 (NECP PL)

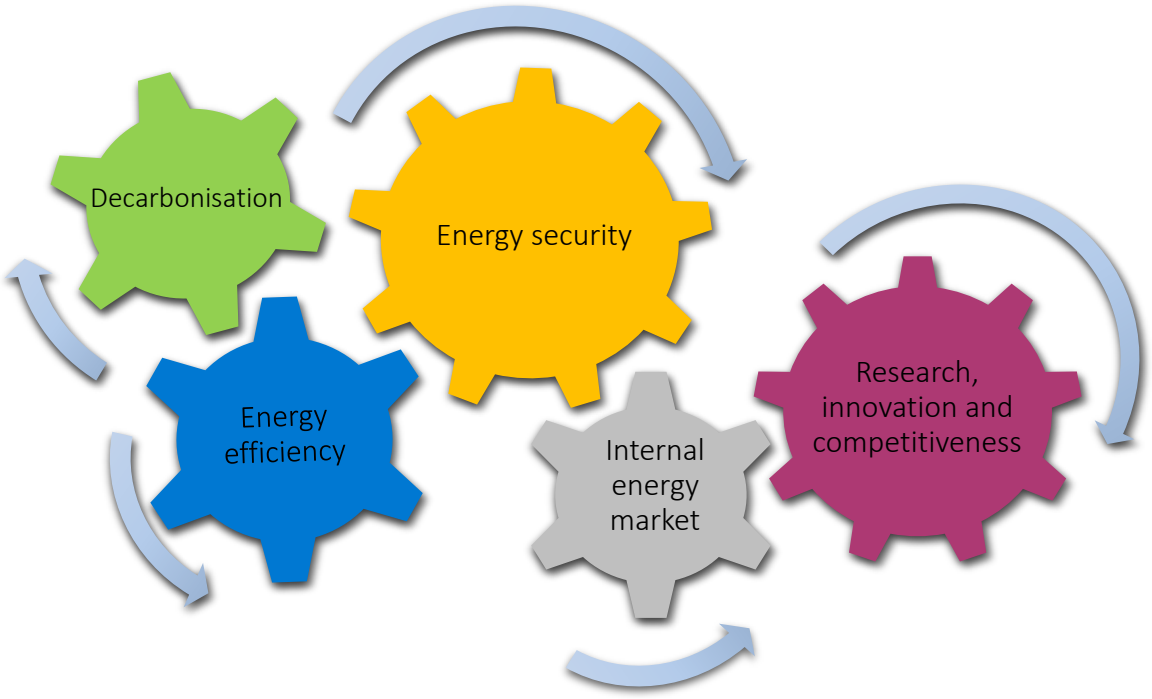
1. OVERVIEW AND THE PROCESS OF DEVELOPING THE NATIONAL ENERGY AND CLIMATE PLAN 2021-2030

Poland's National Energy and Climate Plan for years 2021-2030 (NECP PL) along with attachments has been developed in fulfilment of the obligation set out in *Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action.*

NECP PL was submitted to the European Commission in connection with Article 3 of the aforementioned Regulation.

The final version of the National Plan was prepared taking into account the conclusions derived from inter-ministerial and public consultations, the updates of the national sector development strategies outlined in the Strategy for Responsible Development 2020 (with an outlook to 2030), as well as regional consultations and recommendations of the European Commission C(2019) 4421.

The document presents an integrated approach to the implementation of the five dimensions of the Energy Union. The numbering of the chapters (in Polish version NECP) corresponds to scheme from Annex I of the Regulation (EU) 2018/1999.

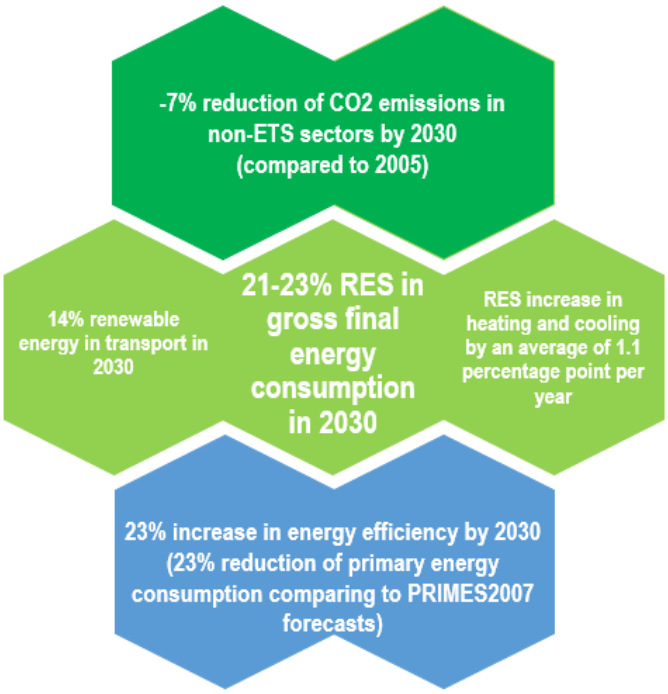


2. OVERVIEW WITH KEY OBJECTIVES, POLICIES AND MEASURES OF THE NECP PL

Poland's National Energy and Climate Plan was prepared with a view of establishing a stable framework for a sustainable, economically effective and just transformation in energy sector and the whole economy. This document is intended to enable synergies with the realization of activities in the interconnected five dimensions of the energy union, taking into account the principle of "energy efficiency first". The document

describes the national objectives and targets of the Polish energy and climate policy, as well as describes the policies and measures to achieve them. Due to the fact that some goals, as well as policies and measures, strengthen more than one dimension, they have been assigned to those in which their greatest impact is estimated. For greater readability of the document objectives and targets as well as policies and measures are marked with colours assigned to the respective dimensions of the energy union.

The main targets of Poland's energy and climate policy contained in the document and constituting a future measure of its implementation are presented in the graph below. It should be noted here that the RES target is conditional, i.e. that its implementation at the level of 23% will be possible if additional EU funds are granted, including those addressed to a just transition. National PL targets are the contribution to collective achievement of EU climate-energy goals.



Picture 1. Poland's climate and energy targets until 2030

Dimension Decarbonisation

In the dimension of decarbonisation, there are issues related to both the emission and absorption of greenhouse gases and air pollution, as well as concerning the use of renewable energy sources. The issue of adaptation to climate change has also been taken into account.

The reduction target for Poland in terms of greenhouse gas emissions in sectors not covered by the ETS system was set at -7% in 2030 compared to the level in 2005. The stated target is to be achieved by reducing emissions in transport, construction and agriculture, taking into account the beneficial effects of CO2 absorption by ecosystems and the flexibility associated with land use, land use change and forestry (LULUCF). In this aspect, it is also important to improve the quality of life of the inhabitants of Poland, especially to protect their health and living conditions, including environmental protection. This applies in particular to solve the problem of air quality associated with emissions of pollutants in transport and by individual heat sources.

As part of the EU-wide 2030 target, Poland declares to achieve 21-23% of RES share in gross final energy consumption by 2030 (total consumption in electricity, heating and cooling as well as for transport purposes). It is estimated that in the perspective of 2030 the share of renewable energy sources in heating and cooling will increase by an average of 1.1 percentage point per year. In transport, a 14% share of renewable energy is expected to be achieved by 2030. The RES share in electricity production will increase to approx. 32% in 2030. To enable the achievement of the above-mentioned targets, it is planned to support renewable energy sources in the form of continuation of existing and creation of new support and promotion mechanisms. It is also planned to increase the use of advanced biofuels, introduce offshore wind energy and increase the dynamics of development of renewable energy micro installations.

Dimension Energy efficiency

The national target for improving energy efficiency by 2030 was set at the level of 23% reduction of primary energy consumption comparing to the PRIMES 2007 forecast. Actions aimed at reducing energy consumption are treated in a special way, as they simultaneously lead to strengthening energy safety, sustainable usage of energy resources and further reduction of emissions, affecting the achievement of energy and climate goals. In this context, the development of ecological and effective heating systems, the production of heat in cogeneration, intelligent networks and the functioning of mechanisms that stimulate the saving of energy end-use and pro-saving behaviour are particularly important. Both in terms of energy efficiency and the improvement of housing conditions, it is important to develop a long-term strategy for the renovation of domestic stocks of residential and non-residential buildings, public and private, in accordance with the amended Directive 2010/31/EU. Actions are also planned to increase energy efficiency in transport by promoting more sustainable methods of transporting goods (e.g. intermodal transport, rail transport) and societies (e.g. public transport). The document provides for increasing energy efficiency through a creation of a coherent, sustainable, innovative and user-friendly transport system at national, European and global level.

Dimension Energy security

Energy security is treated as a priority in Poland. From the Polish point of view, the most important in this dimension is to cover the growing demand for fuels and energy in connection with the forecasted economic growth, while ensuring uninterrupted energy supplies. It is important to maintain a high index of energy independence, increase diversification of the energy mix and diversification of directions of supplies of imported fuels. It applies to both crude oil and natural gas, which is also associated with the necessity of infrastructure development in these sectors.

To cover the growing demand for electricity, it will be necessary to increase electricity generation capacity, especially based on RES. Taking into account the availability of domestic hard coal and lignite deposits, it is expected that coal generation will be important to guarantee stable and reliable electricity supply. However, the share of coal in electricity generation will be systematically reduced. In 2030 it will reach the level of 56-60% and in 2040 the downward trend will be maintained.

The implementation of nuclear energy in Poland is indicated in the national plan as important from the point of view of ensuring stable and zero-emission electricity supply, as well as diversifying energy sources. The commissioning of the first nuclear power unit (with a capacity of about 1-1.5 GW) of the first nuclear power plant is planned for 2033. In the next years, it is planned to launch another five such units every 2-3 years (with a total capacity of approx. 6-9 GW).

Dimension Internal energy market

As part of the development of the internal energy market, Poland will strive to increase the availability and capacity of current cross-border interconnections and to integrate the national natural gas transmission system with the systems of Central and Eastern Europe and the countries of the Baltic Sea region. In this context,

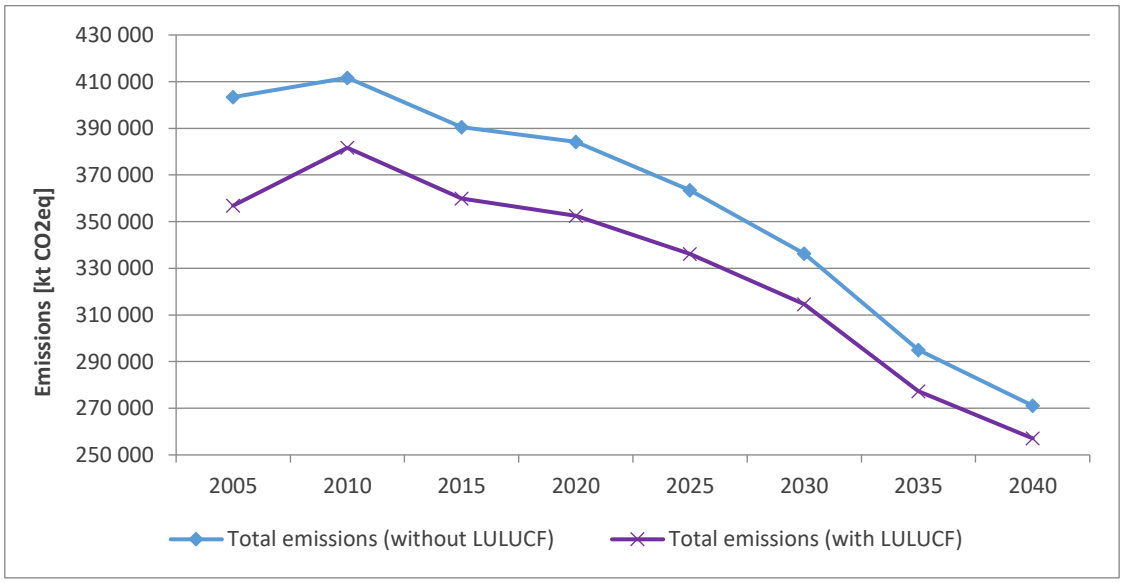
further investments in internal gas and electricity networks that will ensure security of energy supply will also be necessary. With regard to the production of energy from renewable sources, measures will be taken to guarantee an appropriate level of flexibility of the energy system.

To enable the development of a competitive market, the objective is to increase consumers' knowledge and to encourage them to play a more active role in the energy market, while limiting the energy poverty, taking into account the protection of vulnerable social groups.

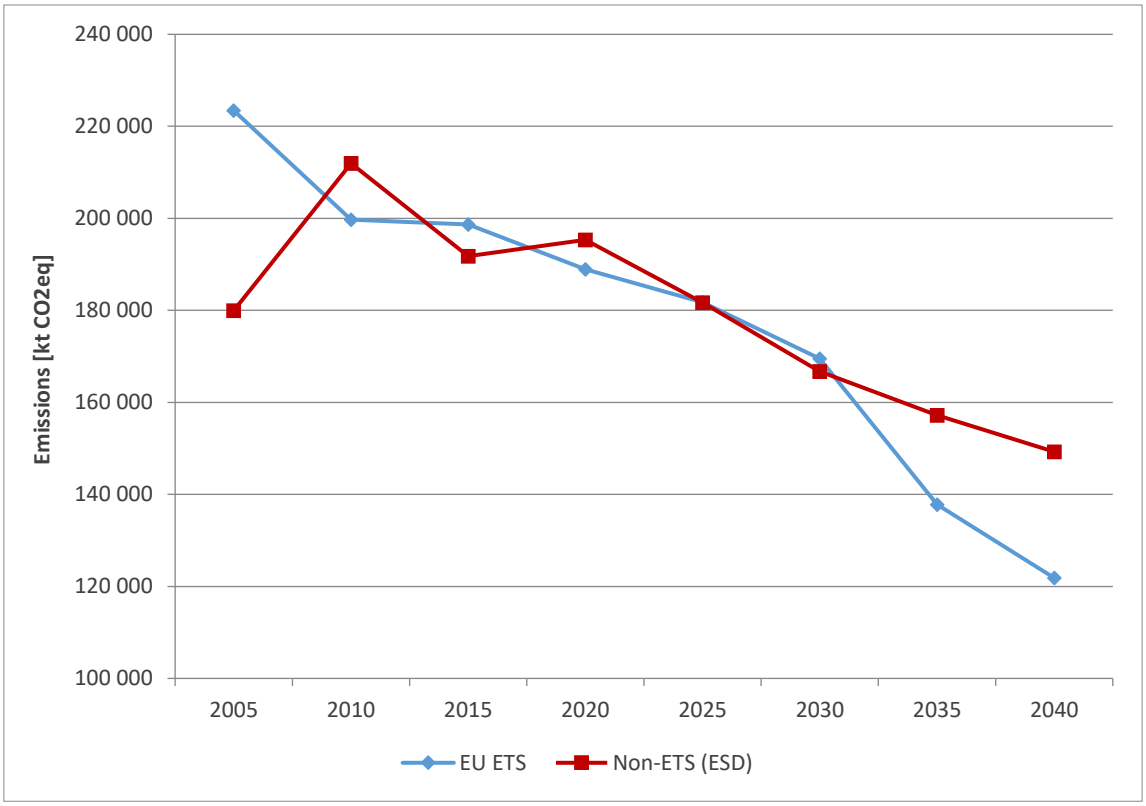
Dimension Research, innovation and competitiveness

Research, implementation of innovations and activities related to the development of competitiveness of the economy will be of significant importance for realization of the objectives and policies mapped in the NECP PL. This dimension is particularly interwoven with other pillars of energy union, providing new technologies and solutions supporting energy transformation. The main objective of this dimension is to reduce the civilization gap between Poland and economically highly developed countries, and to improve the quality of life of Polish society. Poland also plans to increase the competitiveness of the economy through a more complete use of social and territorial resources as well as automation, robotization and digitization of enterprises. By supporting the development of energy innovations, it is planned to increase the competitiveness of the Polish energy sector, and thus maximize the benefits for the Polish economy. Another goal is the acceleration of technology sales by Polish companies on foreign markets, combined with the growing importance and competitiveness of Polish science on the international stage. The foundation for the realization of the objectives in this area are: an increase in expenditure on research and development in Poland (from 0.75% of GDP in 2011 to 2.5% of GDP in 2030) and the establishment of new, better suited to today's conditions, rules for using this inputs.

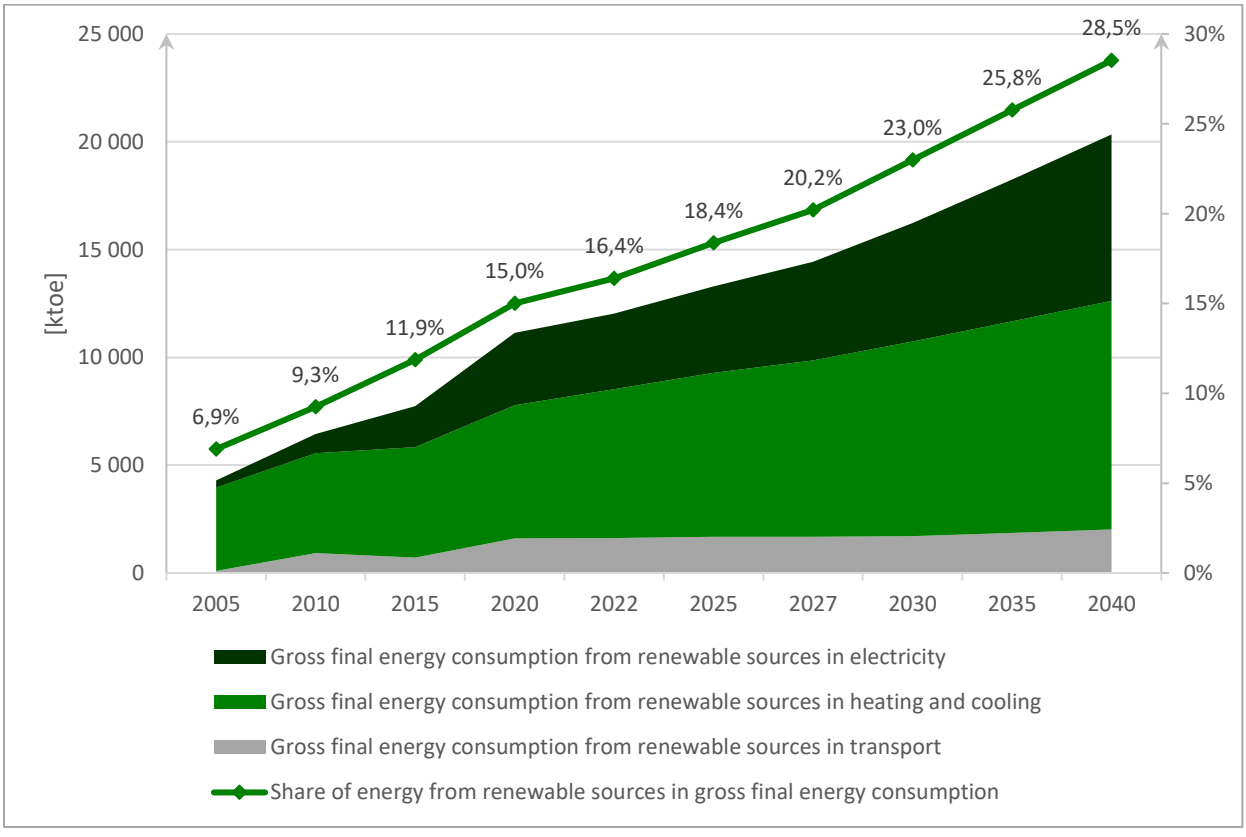
3. EXTRACT OF PROJECTIONS



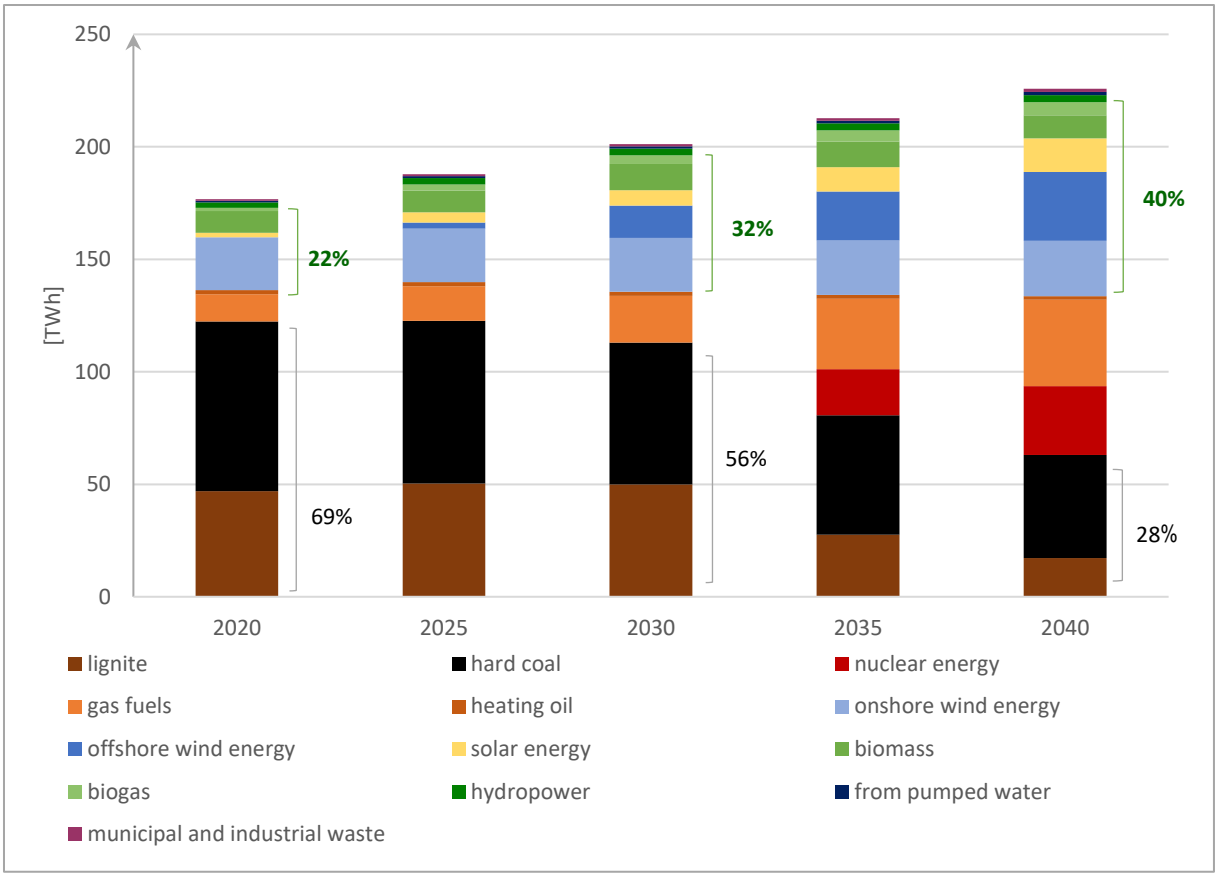
Picture 2. GHG emissions reduction



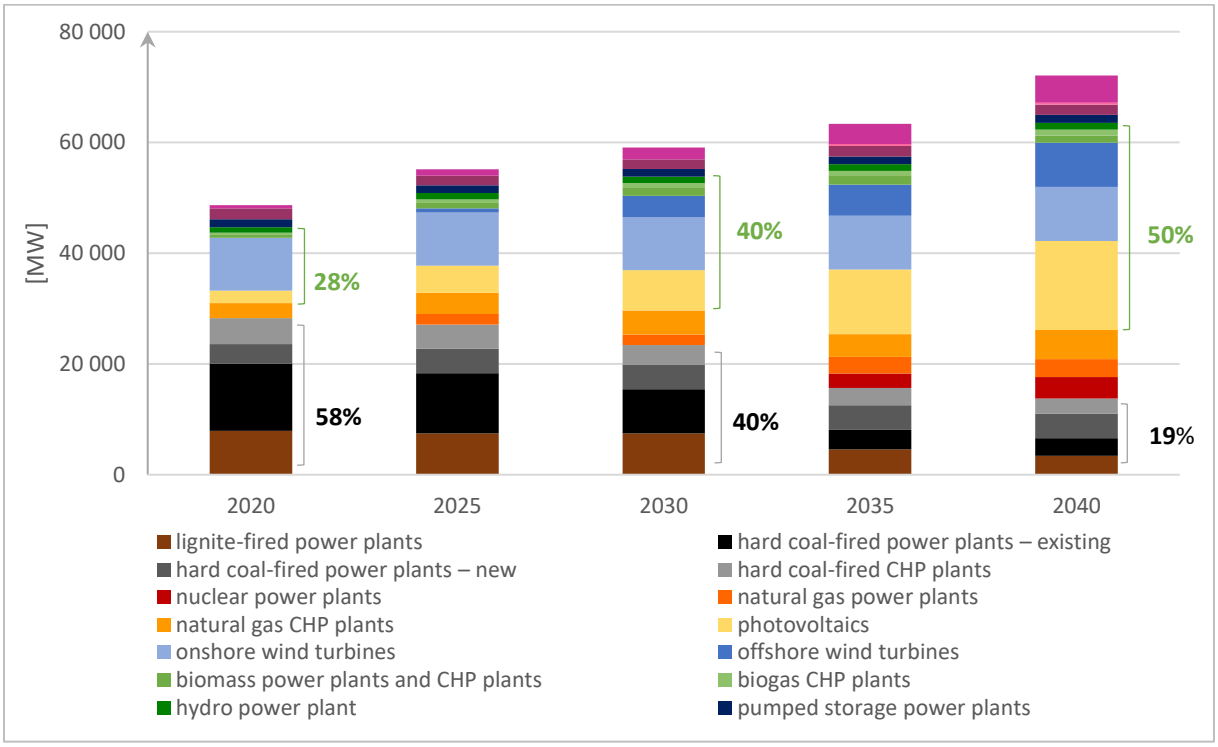
Picture 3. GHG emissions reduction in ETS and non-ETS



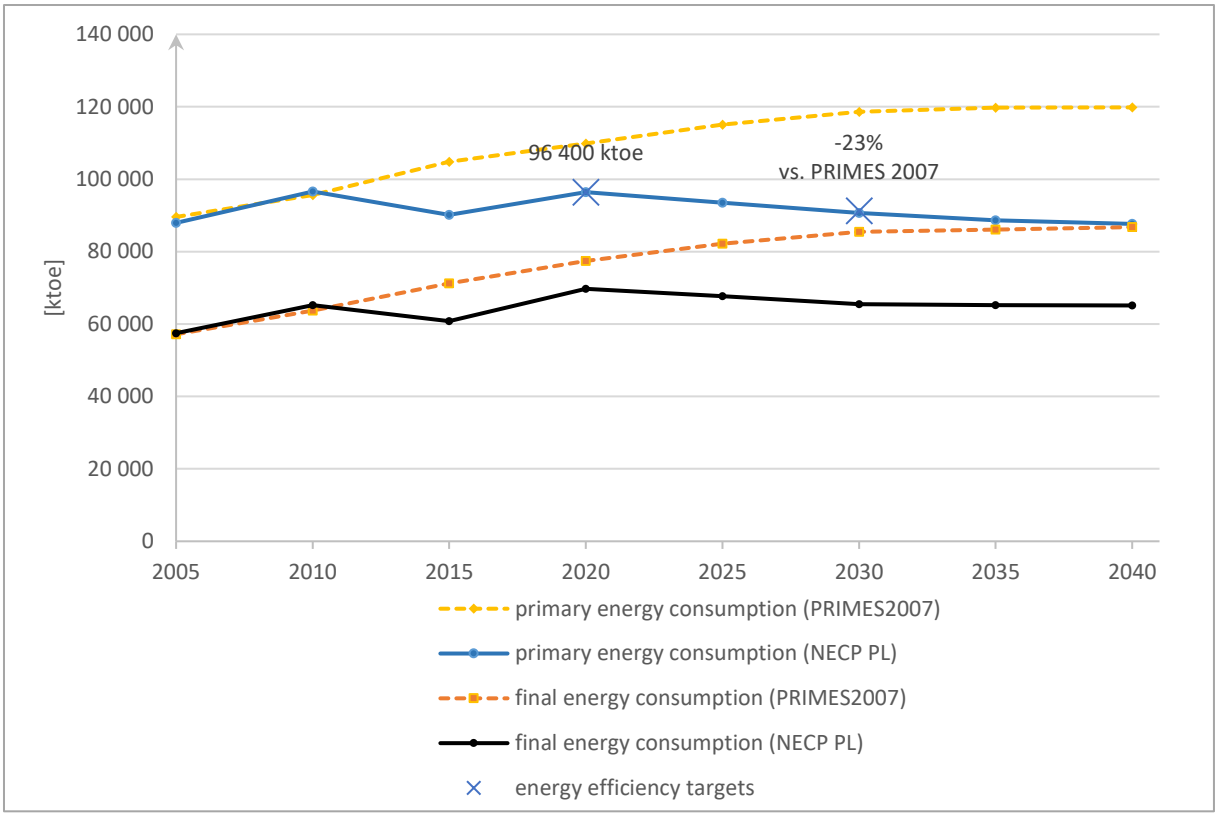
Picture 4. RES development



Picture 5. Structure of electricity production



Picture 6. Structure of electricity capacities



Picture 7. Energy efficiency targets

4. IMPLEMENTATION OF COMMISSION RECOMMENDATION OF 18.6.2019 ON THE DRAFT INTEGRATED NATIONAL ENERGY AND CLIMATE PLAN OF POLAND COVERING THE PERIOD 2021-2030 C(2019)4421

1. *Provide more information on planned policies and measures to address the projected substantial gap to Poland's greenhouse gas target for sectors not covered by the EU emissions trading system for 2030 of -7 % compared to 2005. This includes more clarity on transport measures and more details on additional measures, notably in the building, agriculture and land use, land use change and forestry sectors and the application of accounting rules as set out in the Regulation (EU) 2018/841 of the European Parliament and of the Council.*

   The implementation of the abovementioned EC recommendation was made by adjustments in the analytical part regarding GHG emission forecasts. Information on policies and measures addressed to reduce emissions from sectors not covered by the EU Emissions Trading System are supplemented in chapters 2.1.1 and 3.1.1 (in Polish version of NECP).

2. *Increase the level of ambition for 2030 to a renewable energy share of at least 25% as Poland's contribution to the Union's 2030 target, as indicated by the formula in Annex II under Regulation (EU) 2018/1999.Include an indicative trajectory in the final integrated national energy and climate plan that reaches all the reference points pursuant to Article 4(a)(2) of Regulation (EU) 2018/1999 in accordance with that share, in view of the need to increase the level of efforts for reaching this target collectively. Put forward detailed and quantified policies and measures that are in line with the obligations laid down in Directive (EU) 2018/2001 of the European Parliament and Council, to enable a timely and cost-effective achievement of this contribution. Ensure that the renewable energy target for 2020 set out in Annex I of Directive 2009/28/EC of the European*

Parliament and of the Council10 is fully met and maintained as a baseline from 2021 onwards, and explain how such a baseline share will be met and maintained. Increase the level of ambition in the heating and cooling sector to meet the indicative target included in Article 23 of Directive (EU) 2018/2001 and put in place detailed measures to meet the transport target set in the draft integrated national energy and climate plan, in line with Article 25 of Directive (EU) 2018/2001. Provide additional details and measures on simplification of administrative procedures, on the enabling frameworks for renewable self-consumption and renewable energy communities, in line with Articles 21 and 22 of Directive (EU) 2018/2001.

The increase in the share of renewable energy in final gross energy consumption to 25% in 2030, recommended by the European Commission, was assessed as too ambitious taking into account national circumstances, forecasts for the economy development and energy sector as well as the evolutionary process of fair energy transformation and its social aspects. Nevertheless, the NECP PL has set a target of 21-23% RES share in 2030, while reaching 23% will be possible if Poland is granted additional EU funds, including those addressed to a just transformation.

In implementing the remaining part of the EC recommendation, the content of the NECP was supplemented by:

- indication of the approximate trajectory for achieving all reference points for the RES target in 2030 – in section 2.1.2 b) of NECP PL and in the analytical annex,
- maintaining the renewable energy 2020 target as the base year for the forecast,
- setting a target for RES increase in heating and cooling sector at the level of 1.1 percentage point. annually (average),
- indication of additional measures implemented in 2019 for the RES 2020 target and complementing the policies and measures leading to the achievement of the RES target for 2030, including measures to support prosumption and energy communities - in sections 2.1.2 and 3.1. 2.

3. *Review its contributions and identify additional policies and measures that could deliver further energy savings in view of the need to increase the level of efforts to reach the Union's 2030 energy efficiency target. The proposed level of ambition towards reducing the final contribution should be better justified and backed by adequate and quantified savings from polices and measures. Support policies and measures with an impact assessment and deliver more detailed information on the scale and timeframe of implementation. Further explore policies and measures in transport considering the expected increase in the sector's energy demand in the future.*

   The NECP PL was supplemented with the content of chapters 2.2 and 3.2. and prognostic analyses.

4. *Specify the measures supporting the energy security objectives on diversification and reduction of energy dependency, including measures ensuring flexibility of the energy system to accommodate the foreseen changes towards 2030 and beyond.*

   The NECP PL was supplemented with the content of chapters 2.3 and 3.3.

5. *Define forward-looking objectives and targets concerning market integration, in particular measures to assess the impact of public service obligations, in particular gas storage and price regulation on market functioning and clarify how negative consequences will be mitigated. Outline a strategy and timeline for progressing towards fully market based prices.*

   The NECP PL was supplemented with the content of section 3.4.3.

6. *Clarify the national objectives and funding targets in research, innovation and competitiveness, specifically related to the Energy Union, to be achieved between now and 2030, so that they are readily measurable and fit for purpose to support the implementation of targets in the other dimensions of the integrated national energy and climate plan . Underpin such objectives with specific and adequate policies and*

measures, including those to be developed in cooperation with other Member States, such as the Strategic Energy Technology Plan.

The NECP PL was supplemented with the content of chapters 2.5 and 3.5.

7. *Continue and broaden the consultation of neighbouring Member States and regional cooperation in the context of the Visegrad Group (Czechia, Hungary, Poland and Slovakia) and in the respective high-level groups. The focus of the regional exchanges could be on further integration in the internal energy market, assessing system adequacy in light of the planned continuation of a capacity market, just transition issues, decarbonisation and renewables deployment and the impact on the energy system and cross-border electricity trade.*

   Information on regional consultations is provided in chapter 1.1.

8. *List all energy subsidies, including in particular for fossil fuels, and actions undertaken as well as plans to phase them out.*

   The recommendation was implemented by supplementing the content of NECP in chapter 3.1.3. and by listing energy support measures in Chapter I.

9. *Complement the analysis of the interactions with air quality and air emissions policy, including from a quantitative perspective, and presenting the impacts on air pollution for the various scenarios.*

   The NECP PL in the forecast part has been supplemented with the results of analyses of the impact of the implementation of policies and measures in the field of improving air quality.

10. *Integrate just and fair transition aspects better, notably by providing more details on social, employment and skills impacts of planned objectives, and policies and measures. The final integrated national energy and climate plan should particularly address the impact of the transition on the populations living in coal regions, reinforcing the link to the ongoing coal regions in transition initiative and the corresponding national and regional transition plans, as well as those affected by adjustments in other energy-intensive sectors. Further develop the approach to addressing energy poverty issues, including by specifying objectives and intended impacts of planned policies and measures as required by the Regulation (EU) 2018/1999.*

    The EC recommendation on fair transformation was taken into account by expanding the content of chapters 2.1 and 3.1. The comprehensive analysis of the impact of energy transformation on mining areas (including on society, employment and skills) was not possible within the time required for submission of the NECP. Such analysis will be carried out as part of the restructuring plan for hard coal and lignite mining regions envisaged in 2020.

    Energy poverty issues are described in sections 2.4.4 and 3.4.4.