Energy 77 (2014) 117–124

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

Development of EU (European Union) energy market agenda and security of supply

Marko Sencar [a], Viljem Pozeb [b], Tina Krope [c, *]

[a] Energy Agency of the Republic of Slovenia, Strossmayerjeva 30, 2000 Maribor, Slovenia
[b] Hydro Power Plants – Maribor, Obrežna ulica 170, 2000 Maribor, Slovenia
[c] Ministry of Economic Development and Technology, Trubarjeva 11, 2000 Maribor, Slovenia

ARTICLE INFO

Article history:
Received 12 December 2013
Received in revised form
2 April 2014
Accepted 11 May 2014
Available online 21 June 2014

Keywords:
Energy market
Regulatory authority
Security of energy supply
Vulnerable customer

ABSTRACT

The paper critically discusses the reform of the energy sector in the European Union from the beginnings of the liberalisation processes in 1996 until present. Through EU energy policies and relevant legislation the goals to achieve are sustainable development, security of supply and competitiveness, together with focussing on the needs of customers. The paper analyses all three above-mentioned pillars and customer protection requirements from the viewpoint: customers should have high quality energy delivered at affordable prices. We call for competitiveness to be further underlined by the market. Despite some concerns related to market models, with the latest impetus from the European institutions the market will, and is able to, develop and to integrate also renewable sources. Where the market does not deliver sufficiently, regulators have to ensure customer protection, especially for vulnerable customers in a period of increasing prices.

1. Introduction

The energy sector in the EU (European Union) underwent a reform process after enforcement of the first Electricity Directive in 1996 and the first Gas Directive in 1998. EU MS (Member States) created significantly different conditions for market participants and customers. The period after the second liberalisation package of Directives and Regulations in 2003 and 2005, improving some of the deficiencies, was still characterised by a sluggish development of the market with a broad range of variety. The European Commission found serious internal market malfunctions in its sectoral inquiry report 2006 [1]. Throughout the EU, except for renewable energy, low intensity in new investment characterised the period since the market introduction, which affected also the security and quality of supply.

With market introduction growing concerns were raised to protect the final customer against loss of energy supply. EU Member States maintained or introduced a number of customer protection mechanisms to protect the customers from losing supply, especially those whose life or health would be endangered in case of a supply interruption (i.e. vulnerable customers). Some of those mechanisms have remained in operation to date, e.g. regulated tariffs for customers.

A common EU energy policy was developed by the European Commission [2] and endorsed by the Council [3] in 2007 to set the values and policy objectives on which its three pillars are based: sustainable development, security of supply and competitiveness. Integrated energy markets are the most important part of the third pillar. Although they are a part of all later policy documents, more weight seems to be attributed to the first pillar, particularly by the recent policy document Energy Roadmap 2050 [4].

The next milestone in the development of electricity and gas markets was the enforcement of the third energy liberalisation package. In the EU, a new institution was introduced, Agency for the Cooperation of Energy Regulators. Since 2011 the Agency prepared a series of FG (Framework Guidelines). On their basis a number of NC (Network Codes) were draughted and are currently at different stage of development and adoption. European Council decision (2011) sets the next milestone to be the completion of the internal market by 2014 so as to allow gas and electricity to flow freely [5]. This paper discusses recent developments in different parts of energy supply chain and market segments. Various options are discussed and instruments recommended for future development towards sustainability, security of supply and competitiveness through energy markets. The authors strive to recommend options

* Corresponding author. Tel.: +386 41 346 834.
E-mail addresses: marko.sencar@agen-rs.si (M. Sencar), viljem.pozeb@dem.si (V. Pozeb), tina.krope@gmail.com (T. Krope).

http://dx.doi.org/10.1016/j.energy.2014.05.031
0360-5442/

which will benefit end customers and contribute to their protection.

2. The main development objective

Development of the energy sector in all its components, along with the values defined in the energy policy, can only be successful and sustainable by having customers as its focus. Sufficient volume of energy has to be available to the customer when required, whereby the necessary volume of energy shall already reflect energy efficiency measures as well as other demand side measures. In addition, energy delivered to the customer shall have high quality and affordable price.

Sufficient energy supply with a "business as usual" approach may only be ensured in short-term. In this case levels of environmental protection, investments into infrastructure, production and knowledge remain similar to those over the past decade. In long-term, sufficient energy volumes may only be retained through substantial amendments of the present paradigm. Additional elements of environmental protection in the whole energy supply chain shall encompass gradual modification of fuel mix, better use of the existing infrastructure, coordinated operation, planning and investments into new infrastructure incorporating an increasing level of knowledge, especially research. Certainly, these measures require resources. To counterbalance their inflatory push on prices, a functioning and integrated energy market is necessary to maintain energy prices for customer transparent and affordable.

The future market development will require some corrective elements. Two of them are further discussed: generation adequacy and protection of vulnerable customers.

The main objective above relates to all customers regardless of their size, social position or other specificities. As the market itself does not provide sufficient protection to vulnerable customers their protection together with a broader question of affordability has to be addressed by additional measures. To that end, national regulatory authorities, organised in the CEER (Council of European Energy Regulators) developed a vision in 2011 which is shared with the EU consumer organisation, BEUC (Bureau Européen des Unions de Consommateurs). That vision changes the past paradigm and puts smaller customers first. It also declares four governing principles for relationship with customers: reliability, affordability, simplicity as well as protection and empowerment. Regulatory authorities are committed to engage and act in ways that promote this vision [6].

3. Sustainable development

Elements of the main objective are reflected in Energy Policy for Europe [2], which defines the three pillars of a common energy policy: sustainable development, security of supply and competitiveness, and sets policy objectives. They could easily lead to divergent and contradictory strategies, therefore a governance framework and later rules have to provide balance.

Overall decarbonisation path of the EU economy will have to be followed by the energy sector and will strongly impact market development. A corresponding Energy Roadmap 2050 [4] was presented by the European Commission in December 2011. It encompasses five decarbonisation scenarios and two current trend scenarios, a reference scenario and current policy initiatives scenario. The latter assumes measures from Energy Efficiency Directive [7] and RES (renewable energy sources) Directive [8] are implemented. It lists ten structural changes necessary for energy system transformation. Among them, electricity will have to play a greater role and increase its share in final energy demand. The portion of household expenditure for energy, including transport, will increase, and energy savings will become more important. The document also clearly shows the inevitable energy price increase for at least a decade.

The susceptibility of the electricity sector to climate change adds to the complexity. It varies significantly among countries as reported by Klein et al. [9]. This paper analyses for 21 European countries specific influencing factors and introduces an index to measure quantitative relative indication of susceptibility among the countries included. According to their findings, countries show significant difference in susceptibility to climate change, and some which show low susceptibility will become more susceptible in the future. The analysis also identifies those aspects of electricity systems that are vulnerable. Effects of climate change on the renewable power generation, namely wind and solar, in Northwest Metropolitan Region, Germany, are analysed by Wachsmuth et al. [10]. The paper identifies a need for an extension of networks and for the storage of electricity over months. Their model shows impacts of climate change in reducing the need for network extension and storage, but expects their increased volatility.

Further research on developments in sustainable energy and environmental protection, mainly related to the enhanced use of renewable sources, is summarized by Olabi [11] and [12]. Electricity from RES is more competitive on the market in combination with storage facilities. In this field, Carton and Olabi [13] present a study on the potential use of different storage technologies, their contribution and development potentials in Ireland, Denmark and Norway. They propose distributed wind/hydrogen hybrid systems to enhance the efficiency of wind farms with the primary aim to reduce the need for their curtailment and save wasted energy. This will contribute to the security of supply, reduction of backup power, and transmission losses, among others. Projects of that kind were limited to residential and related small energy consumption. For energy intensive industries competitive solutions will have to be elaborated in the EU. Furthermore, Connolly et al. [14] present a study on future energy costs and maximum wind penetration feasible in Ireland. They modelled the Irish energy system and projected the fuel prices up to 2020. They found the Irish energy system being very vulnerable to future fuel and CO_2 prices.

Denmark is among the frontrunners in the use of renewable energy. Lund [15] presented some lessons learnt in Denmark where the planning process and energy policy was a result of a process of conflicts which led to significant technological changes and transformed the national energy policy. Lund's and Mathiesen's analysis [16] shows that Denmark can switch to complete renewable energy systems and the first steps to do this are feasible, however these have to be accompanied by a number of measures. Further scenario analysis for Denmark to be fossil fuel free by 2050 is presented by Kwon and Østergaard [17]. Pillai et al. [18] develop a tool for modelling energy scenarios for Denmark. The model includes hourly and dynamic balancing energy and encompasses electric vehicles as an electricity storage. In some computed cases the operational frequency deviates unacceptably from the nominal value of 50 Hz [18]. However, the system frequency deviation is a component of voltage quality (see Section 4.2) and should remain within the ranges prescribed by quality standards.

4. Security of supply

Three events significantly contributed to raise the importance of security of supply: the decrease of gas supplies by around one third in January 2006, complete interruption of gas supplies in January 2009, and a large electricity system disturbance on the 4th of November, 2006. On that day at around 22:00 h the whole UCTE (Union for the Coordination of Transmission of Electricity), today ENTSO (European Network of Transmission System Operators)

system disaggregated following a routine disconnection of a line without sufficient coordination between the neighbouring TSOs (transmission system operators). The disconnection caused the interconnection to fall into three parts with different frequency, and led to blackouts in around half EU Member States. The sequence of events is explained more in detail in Ref. [19], the circumstances evaluated from the regulator's view in Ref. [20].

Diversification of sources and transport paths added importance to new projects intended to bring gas from new sources to the EU and to transport gas, particularly north-south, within the EU.

Regulation [21] from 2010 requires EU Member States to prepare preventive and mitigating measures. It also lays down rules for the design of national and joint preventive action plans based upon risk assessment and emergency plans. By imposing bidirectional flow and N-1 rule it will also influence infrastructure investment planning.

Both in electricity and gas, investments into transmission networks were very limited both in electricity and gas, since liberalisation started. For security of supply and market functioning, higher level of coordination of investments was needed. The first tool is EU wide TYNDP (ten year network development plan) for electricity and gas, prepared under the 3rd package. The second tool are Lists of PCI (Projects of Common Interest) in electricity and gas, developed under a new regulation on trans-European energy networks [63]. This regulation also provides for new financing mechanisms for PCIs and requires EU Member States to ensure a shorter, time limited site licensing process. However, a residual risk remains in the jurisprudence as in disputed cases final decisions on siting permits will be taken by courts.

4.1. Security of supply concept

Winzer [22] introduces a conceptual view on energy security. His concept separates dimensions of supply security by sources of risk from the scope of their impacts which are further grouped according to their severity. Also, main interdependencies among these dimensions are listed, and a strong dependence of the resulting level of security on the concept is shown. Therefore, a clear separation of conceptual boundaries is recommended [22]. His main recommendation is to use energy supply continuity as the resulting concept. In this paper we use the term security of supply interchangeably with energy security as proposed by Winzer. Johansson [23] examines security threats to the energy system separately from threats generated in the energy systems. In this paper security of supply is determined by the sum of both. Johansson [24] also reveals uneven security risks related to different RES as well as a broad range of their impacts which exceed only energy systems. The authors propose further research to analyse risks and related risk factors together with their contributions to overall security of supply, throughout the energy supply chain.

4.2. Quality of supply in electricity

In electricity, continuity of supply is also one of three components of quality of supply. The other two components are voltage quality and commercial quality. Continuity of supply was the first component followed and benchmarked by energy regulatory authorities. Most frequently used indicators are SAIDI (system average interruption duration index), and SAIFI (system average frequency index). Benchmarking reports by the Council of European Energy Regulators from 2001, 2003, 2005, 2008 and 2011 [25] analyses supply continuity and presents indices for EU Member States. In the last report an annex is added to incorporate data for Energy Community Contracting Parties with electrically interconnected systems.

Voltage quality has been analysed in recent reports. Much less data are available, e.g. monitored data are available and reported in 13 CEER (Council of European Energy Regulators)countries at different voltage levels. Also differences exist between countries in the choice of monitored voltage quality parameters [25]. Where available, voltage dip data are reported and analysed in this report. In 2012, the Council of European Energy Regulators together with the Energy Community Regulatory Board published guidelines of good practices on the implementation and Use of Voltage Quality Monitoring Systems for Regulatory Purposes [26]. These guidelines recommend principles and parameters to be monitored within Voltage Quality Monitoring programs. They further recommend, inter alia, to follow standards whenever possible, and to follow all disturbances as listed in EN 50160 standard. Where standardized measurement methods do not exist, e.g. voltage transients and transient overvoltages, benchmarking is impossible, but it may still be helpful in following the performance of the network. Commonly agreed indices for benchmarking as well as standard methods should be used, but should also not exclude the use of additional characteristics and indices.

Commercial quality is a very complex issue, indicators relating to it have been classified into four main groups [25]: Connection (Group I), Customer Care (Group II), Technical Service (Group III), Metering and Billing (Group IV).

Unlike voltage quality where the quality standards are based upon EN 50160 (and for voltage dips, draft EN 61000-4-30) standard, commercial quality standards are set by other national authorities, frequently regulators. They separate guaranteed standards, overall standards and other available requirements. A special characteristic of these standards is that they imply obligations for the utility to financially compensate the customer in case of not-compliance.

4.3. Quality of supply in gas

Quality of supply in gas has been limited to the commodity. It is characterised by the Wobbe number and it is in the process of being standardised. Quality of gas and voltage quality of electricity have a similar meaning: to ensure appliances to be supplied with electricity or gas within quality ranges for which they were constructed. The remaining two components, described in the section above for electricity, are not used nor standardised in the field of gas. Commercial quality relates to the service of the supplier or utility company and could be used in the same way also in gas. The authors recommend to apply the same approach with further examination of fine-tuning it to gas utilities.

Continuity of supply has not been measured in the same way as in electricity. The authors propose to develop a composite index for this component.

4.4. Some security of supply indicators

ECN (Energy research Centre of the Netherlands) and CIEP (Clingendael International Energy Programme) developed a methodology and supply and Demand index to evaluate security of supply in medium and long-term, as well as crisis capability index for short-term. In an S/D index demand side is weighted with 30% and supply with 70%. Inside supply, 30% belongs to conversion and transport and 70% to primary energy supply. This methodology is proposed to be used as standard to assess security of supply throughout EU [27].

Zlatar et al. assess impacts of economic downturn on security of electricity supply for the Slovenian power system over a period

between 2004 and 2008. They developed an advanced method for quantification of risks and created a composite index to evaluate national security of electricity supply (SoES index) [29]. This index is constituted from 3 dimensions: (i) security of primary energy supply, (ii) environmental performance, and (iii) power system stability. These dimensions are further divided into sub-dimensions and evaluated by separate indices. Sub-dimension indices are in the next step aggregated into distinct dimensions indices. Data which are used at the level of dimension are already specific to the evaluated electric power system. Dimension indices represent contributions to the overall composite index which are aggregated to a single composite SoES index. However, this index does not enable direct comparisons nor benchmarking among different power systems.

The method presented above is proposed to authorities in order to evaluate, at state level, different development and investment strategies as well as policy measures and their contributions or impacts on overall security of electricity supply. As the SoES index is very neutral and to a great extent independent on personal judgement, the authors propose to further analyse its potential use for evaluating security of gas supply.

5. Energy market developments

The third pillar of energy policy, competitiveness, depends on the cost efficiency of the energy sector and is encompassing the whole energy supply chain. To expose all of its parts to face market pressure, two conditions have to be met. The first is a functioning and integrated internal market with sufficient energy available, and the second is a stable regulation of natural monopoly activities. Market governance, developments in the EU and wider are discussed here. Special features of energy markets, balancing, generation adequacy and consumer protection are also discussed.

5.1. The market: past development and legal framework

The sectoral enquiry report [1] revealed serious malfunctions in the EU energy wholesale market which was insufficiently integrated, even foreclosed in some Member States. A number of barriers for market functioning and market entry were highlighted and addressed by (i) regional initiatives and (ii) new legislation.

Regional Initiatives in electricity and gas facilitate market development especially through coordination of cross-border capacities in seven electricity regions and three gas regions. Progress at regional level was gradually achieved, however market integration among the regions is still coordinated at EU. Regional specificities will continue to exist but may not cause divergent tendency.

New market legislation encompasses third legislative package (2009) and REMIT (Regulation on energy market transparency and integrity), (2011).

Directives for electricity ([30]) and gas ([31]) provide new rules for electricity and gas market functioning. They substantially upgrade requirements for unbundling of network related activities from market based activities and introduce strict rules for different models of transmission system operators. They also increase the role and responsibilities of national regulatory authorities by requiring a very high level of their independence from industry and also other authorities' influence, and entrusts them with substantial executive powers in order to enhance their market monitoring and competition protection role.

Regulations on cross-border exchanges in electricity [32] and gas [33] upgrade rules for cross-border trade to enhance traded volumes and increase transparency. The rules require more coordinated and user-friendly operation and more efficient market models. In electricity this means a shift towards implicit capacity allocation, and in gas capacity auctions and bundled capacity products at both sides of borders. These regulations establish the ENTSO (European Networks of Transmission System Operators) for electricity and for gas. Their role is mainly to coordinate TSOs and to prepare and propose new acts at EU level, such as TYNDPs and Network Codes. Regional cooperation gets institutionalised and coordinated at EU level.

Regulators will play a key role in shaping future energy markets and in future probably also at the generation or production side. Apart from that, decisions on infrastructure and market monitoring will remain their key roles. A regulation [34] establishes a new Agency for the Cooperation of Energy Regulators and defines its role: '*The purpose of the Agency shall be to assist the NRAs in exercising, at Union level, the regulatory tasks performed in the Member States and, where necessary, to coordinate their action*'. However, investigating and enforcing powers remain with the national authorities. This regulation defines the areas in which the Agency may give opinions or recommendations to EU institutions, TSOs and national regulatory authorities. It further provides for implementation and market monitoring as well as reporting by the Agency.

The Agency for the Cooperation of Energy Regulators contributes to the new energy market through Framework Guidelines, the basis for Network Codes, and in development and coordination of regional markets to gradually converge to EU internal market.

Agency will complement NRA activities in monitoring. It started market monitoring at EU level and published reports on the year 2011 [35] and on 2012 [36]. It also reported its activities under REMIT in 2012 [37]. By further developing its activities under REMIT [38], the Agency will decisively contribute to detect and deter market abuse at the wholesale level. Agency will also monitor and report on the implementation of Network Codes, implementation of the ITC mechanism (for 2012 [39]) and other issues, e.g. congestions and infrastructure projects.

5.2. Global energy markets

The World Energy Council [28] analyses the energy systems and publishes Energy Sustainability Index for 129 countries worldwide for the year 2013. This index includes the dimensions: (i) energy security, (ii) energy equity and (iii) environmental sustainability. A market analysis is being done against those 'Trilemma objectives' which provides countries' profiles. These profiles and the sustainability index indicate countries' abilities to provide stable, affordable, and environmentally-sensitive energy systems. A balance score is attributed to each country to show how well it manages the trade-off between the three energy sustainability dimensions. Eight among ten countries with the highest balance score belong to Northern and Western Europe. The index is also aimed at supporting policymakers in preparing national energy policies. WEC calls for balanced and sustainable energy systems to prevail in long-term.

5.3. European energy markets

The ACER (Agency for the Cooperation of Energy Regulators) annual report on electricity and gas market monitoring for 2012 [36] reveals retail pricing are still increasing despite the economic downturn. Annual end-user post-tax prices rise in 2012 vs. 2011 rise amounted to 3% for electricity (EU 27 average), 10% for gas (EU 25 average). The same price increases in 2011 vs. 2010 were 9% for electricity and 10% for gas. Cross-border infrastructure in electricity and gas could be used more efficiently at several interconnectors. Barriers to entry persist, among them end-user price regulation: around 49% of EU households are supplied under regulated

electricity prices and 46% under regulated gas prices. Supplier switching process is not so active, but there is also a good example. In Slovenia a new supplier entered the market which caused an average reduction of around 20% of gas price.

National reports on the state of energy markets have been regularly published by national regulatory authorities since 2004. Summaries are published by European Commission, e.g. 2012 [41].

5.4. Making the EU market work…

European Commission in its communication [42] underlines some achievements so far, especially larger customer choice, more competitive prices and secure supplies. It calls for further development and getting most out of the market. It calls for enforcement of legislation in force and underlines customer orientation, including protection of vulnerable customers. It also proposes an action plan to enable the market to deliver.

European Parliament issued a report [43] which supports the Commission proposal. It calls for a consumer oriented market, for actions to further integrate the market, include innovation, develop infrastructure, and for customer protection, including those most vulnerable. It also supports demand response measures and market-oriented support to RES generation.

5.5. Other observations on liberalisation policies and instruments

Pollitt [44] notes that liberalisation has led to positive and globally widespread but modest efficiency gains and significantly improved the governance of monopoly utilities. The benefits to households in many countries were not so clearly visible. Transition to low carbon energy systems will depend on the willingness of societies to bear the cost which will be significant no matter what the extent of liberalisation. He also indicates that states will have to balance costs for environmental measures and competitiveness.

6. Expectations for future market development

Energy, i.e. commodity market integration brings benefits but has to be accompanied by functioning balancing markets and, in electricity, non-distortive capacity remuneration mechanisms, if applied.

6.1. Expected benefits

A comprehensive study by Booz&Co., et al. [45] assesses benefits of integrated markets in electricity and gas which are analysed for different development scenarios, separately for electricity and gas. The study also takes due consideration of previous research from different organisations. In gas, this study examines benefits in terms of price and security of supply. Price levels, price flexibility and the ability to sell gas purchased under long-term 'Take-or-pay' contracts were examined. Price benefits are estimated for three scenarios: €27 bn in scenario 1, €8 bn in scenario 2 and €29-31 bn in scenario 3. The latter is characterised by the highest level of market integration and also investment into infrastructure. Benefits of gas market integration for security of supply at EU level are summarized for two scenarios. They are shown as an overall reduction in daily GDP (gross domestic product) at risk which lies within a range between €0.1 and 19 million for one scenario and between €0.04 and 24 million for the other [45].

In electricity, the same study [45] analyses two timeframes. The first one is 2004 until 2014, the 'market coupling era', in which gains from increasing cross-border trade from 10% of consumption to 15% of consumption are estimated. Under some assumptions these would lead to an estimated gain of 1.5–2.5% of wholesale electricity value which is an annual saving between €2.5 bn and €4 bn. Approximately 58%–66% of the economic value of market coupling has already been achieved.

The second timeframe, 2015–2030, considers more scenarios. Savings in different scenarios compared to baseline scenario are listed. Integrating the market delivers the largest benefits, in the range of €12.5 bn to €40 bn per year by 2030. Up to 90% of the net benefits can be achieved even if only half of the optimal new transmission capacity is built. If security of supply is achieved by generation adequacy at national level, the benefits are reduced for €3 bn to €7,5 bn per year by 2030. Additional benefit of €0,3 bn to €0,5 bn per year by 2030 is possible by sharing balancing reserves. Using smart grids to facilitate demand side response could contribute up to €4 bn of additional benefit. Large gains of €16 bn–€30 bn a year are available if there is a true common market for renewable energy as envisaged by the Renewables Directive and locational signals. The conditions for these benefits are strong commitments from EU Member States in order to ensure that energy markets, renewables markets and capacity markets are truly international. The necessary investment rate into RES generation also needs to be maintained until 2030 [45].

6.2. Balancing markets

Balancing markets in both electricity and gas are diverse among the Member States and have high priority in designing Network Codes.

Draft Network Code on Electricity Balancing is in an advanced stage at ENTSO-E (closed public consultation in August 2013). An impact assessment study on European electricity balancing market [46] was published in 2013 which lists essential characteristics and requirements for a new, coordinated balancing market design. It recommends the role of TSO to be efficient planning and procuring of balancing services, to organise and run the balancing market with limited involvement and ensure transparency of information. There is still some discussion ongoing on the models and level of harmonisation.

As an example, Slovenia introduced an electricity balancing market in October 2012. It's operated by Borzen, market operator, supported by BSP Southpool, power exchange. Its price is influenced by the market size and limited cross-border capacities. During the first year of operation some positive experiences were collected, transparency and available volumes increased, enabling more flexibility to the TSO. For further development and cross-border opening of the Slovenian balancing market a recent study by Auer H. et al. [47] recommends an integrated model of balancing market with its neighbours, Austria and Italy. The study develops the features and options for an integrated balancing market in line with the network codes expected. This proposal is accompanied by a thorough risk analysis [48].

A growing increase in renewable energy, especially the share of photovoltaics, will increase the price volatility at daily and hourly levels and also impact the electricity balancing market as shown by Haas et al. [49]. A growing relevance of intraday and secondary market is expected, and increased level of competition at decentralised balancing organisations [49]. These options should be further analysed in the process of future balancing market design.

In the field of gas, the market model foresees trading at a virtual trading point to balance the imbalances within a day inside entry-exit system of zones and tariffs. However, these virtual points are not yet functioning and thus TSOs are procuring or selling gas for balancing purposes differently. Also, gas is presently being traded within a day in a form of within-day products which significantly differ between Member States. Different nomination regimes, in some cases high imbalance charges, different balancing periods and

within-day obligations are additional barriers to cross-border trade. A draft Network Code on gas balancing is already on way of being adopted [50]. In combination with other Network Codes, particularly with NC on capacity allocation mechanisms [51], which is already enforced, significant progress is expected. A market based balancing regime will be introduced in which the TSOs will have to procure and sell most of the gas for balancing in form of short-term standardised products on the wholesale market and continue to carry out residual balancing. Imbalance charges will have to be cost-reflective and incentives for network users to balance the portfolio retained. The new balancing regime will also facilitate gas market integration through a higher level of harmonisation in balancing periods but still allowing the application of within-day obligations under specific conditions. This will also provide appropriate price signals and contribute to the development of a competitive gas wholesale market in the EU.

6.3. Capacity remuneration mechanisms

Past electricity market developments insufficiently incentivised the generators to provide in long-term the necessary reserve capacity necessary for secure operation. The problem aggravated in some MS with increasing volumes of intermittent RES energy injections. To counteract possible security problems CRMs (capacity remuneration mechanisms) were introduced in almost half of the EU to ensure long-term generation adequacy. These mechanisms are designed to ensure security of supply at national level but shall not distort the market. The Agency for the Cooperation of Energy Regulators in its opinion [52] advocates market integration, but is also aware that sufficient resource adequacy can only be delivered by the commodity market under certain conditions which are very difficult to fulfil. Therefore it proposes to limit the introduction of such mechanisms to the minimal extent necessary to provide sufficient incentive for the required investments, while having as little influence as possible on the energy markets. Details on each specific CRM in the EU and their effects are specified in the first Agency report on CRM and the internal market for electricity [53]. CRM are expected to be maintained at least until the internal energy market integrates its components day-ahead markets, balancing markets and intra-day markets. Flexibility issues will be addressed also by Network Codes on Electricity Balancing and on Load-frequency Control and Reserves.

6.4. Public interventions in electricity markets

The European Commission published in 2013 a guide on public intervention in electricity market [54]. To achieve environmental targets, the RES share will continue to strongly increase, making public support schemes more than necessary. This guide intends to minimise the impact of public intervention on the market. It encompasses guidance for provision of generation adequacy, for support schemes for RES, cross-border cooperation in RES support schemes, and demand response measures. In relation to capacity payments, Member States may use state interventions as last resort to ensure security of supply. And in relation to RES support, the preferred solution is premium to market price.

7. Customer protection mechanisms

Directives [30] and [31] require Member States to provide specific customer protection measures like transparency of prices, availability of customers data (consumption), supplier switching without costs or other hindrances, as well as clear bills. Also, a single point of contact has to be available to customers for information on their rights. Customers shall also be given the right to settle customer disputes in an efficient, fast and cheap out-of-court procedure.

The European Commission addresses some relevant aspects of customer protection in its Energy Policy for Consumers [55]. In it some emphasis is put to retail market functioning, role of NRAs, but also energy efficiency to reduce energy bills. The poorest customers don't, to a high extent, benefit from the options on the market due to low trust, insufficiently transparent information and unclear benefits of the markets for them. Unaffordable prices of energy require targeted measures. European Commission, Member State authorities, national regulatory authorities and stakeholders, including consumer organisations, standardisation bodies and ombudsmen discuss regularly customer issues, examples of good and bad practices, and recommend further actions at annual Citizen Energy Forums.

Billing and customer complaints were among the first topics discussed. Switching process and protection of vulnerable customers are also permanent and priority topics. With the onset of economic crisis, more customers became vulnerable to prices and availability of different support schemes. Protection of vulnerable customers is supported by the European Council conclusion (2011): '*The Commission will regularly report on the functioning of the internal energy market, paying particular attention to consumers issues including the more vulnerable ones …* ' [5].

Council of European Energy Regulators undertook a survey in 2012 [59] which reveals a large diversity among understanding or defining vulnerable customers. Most Member States apply protection measures without defining explicitly their status or concept to protect them. The vast majority of Member States applies a combination of both energy specific measures and overall social security benefits. Protective measures encompass general prohibition of disconnection, prohibition of disconnection in critical times, adequate number of warnings and notifications before disconnection, specific protection for customers in remote areas, supplier of last resort or default supplier for customers who are not able to find one. In addition, support for energy efficiency improvements, social security benefits for vulnerable customers dedicated to support the payment of energy bills, other social security benefits, social tariffs and other assistance measures have been found. It is, however, not very clear who benefits from such protection measures.

Transparency, price comparability and sales techniques were also analysed and considerable weaknesses reported by the Working Group on Transparency in EU Retail Energy Markets [60]. Customers do not enjoy the full benefit of markets, may be misled by marketing, and frequently do not understand some information, provided in bills. Consumers will be more active participants when they have and understand the choices with clear benefits for them. A number of measures are proposed to improve transparency and market trust, inter alia, actions to improve consumer understanding of offer, enable objective price comparison tools and access to information to prevent exaggerated costs, greater level of cooperation among state authorities for consumer protection and energy, e.g. NRAs.

Energy efficiency measures and the use of smart technologies bring positive effects both to the market and to customers, as shown by Lund et al. [56]. Torriti et al. [57] find that demand response was traditionally low and various around Member States but has gained momentum over the last years due to an increasing support at national level and from the EU. Further details on the UK, Italy and Spain are provided in the same paper [57]. A recent study by Balta-Ozkan et al. [58] analyses the development of smart homes market in the UK. It finds that costs, tangible benefits and user friendliness will impact deployment of smart technologies and proposes a holistic approach to offer choice and drive efficiency to customers [58].

Energy efficiency measures and smart technologies bring short and long-term benefits to customers, but unfortunately these benefits can't be enjoyed by all customers, particularly in rural areas. For example, in the eastern new Member States a substantial part of households can't afford properly heated housing nor energy efficiency measures. This problem is not limited to the eastern Member States, as shown by a comprehensive report on addressing the poverty premium in the UK [61].

Regulated end prices are still in use in more than a half of the Member States. They are, as a general rule, used as a social tool and in many cases suppress end-user prices below sustainable levels. It's true that this measure supports also vulnerable customers but that measure is not targeted enough and also benefits those who can afford higher costs. In addition, they distort competition. Regulators have more than once expressed their recommendation to abandon regulated end-user prices or tariffs.

The supplier of last resort is usually understood as one of the social tools to supply those who are not able to find a supplier. The aspect not discussed is protection from loss of supply due to reasons on the side of supplier, e.g. insolvency. In such cases the supplier of last resort shall intervene without request and provide a transitory energy supply until the customer finds another, regular one. This model has been used in Slovenia. It is completely non-distortive for the market and is also the only acceptable protection for customers larger than households or small and medium enterprises.

Vulnerable customers are susceptible to paying higher prices for energy as a result of their weak market power. Even being 'active consumers' *per se* will not provide sufficient protection, so continuous monitoring is and will remain a role for regulators to prevent them from being exploited.

8. Conclusions and recommendations

EU is facing one of the biggest issues – the energy challenge. The goal is to achieve safe, secure, sustainable and affordable energy. Therefore, EU environmental policy requires Member States to redirect national energy policies to decarbonise. Member States will also have to balance significant costs of achieving environmental targets. Together with the security of supply and energy markets these will determine the development of energy systems. The authors recommended the balancing of all three policy objectives where competitiveness is not left behind. Significant benefits of market integration are possible and the political will supports them [42,43]. The risk that the markets would not deliver benefits, is significantly reduced if balancing markets are integrated according to the new Network Codes, once implemented, and capacity remuneration as well as RES support follow the Commission guidance [54] without distorting the market.

Substantial infrastructure investments are needed for the security of supply and to contribute to the market integration. Regulators and ACER shall continue to deliver, inter alia, through its recommendations and opinions (e.g. on NCs) and monitoring.

Special care has to be given to the protection of vulnerable customers to enable more active participation, be better informed and efficiently protected by regulators from being exploited. Their status has to be clearly defined, and support given in a non-distortive way.

In order to preserve high quality and security of supply, continued monitoring and benchmarking quality of electricity supply is recommended together with further investigation of options to introduce a similar approach in gas. Finally, innovation shall be supported throughout the energy supply chain to the benefit of all.

References

[1] DG competition report on energy sector inquiry (SEC (2006)1724, 10 January 2007).
[2] Communication from the Commission. An energy policy for Europe. COM; 2007. 1 final.
[3] European Council 8/9 March 2007 Presidency conclusions, 7224/07; 9 March 2007. Annex 1(7).
[4] Communication from the Commission. Energy roadmap 2050. COM; 2011. 885 final, 15. 12. 2011.
[5] European Council of 4 February 2011. Conclusions on energy.
[6] CEER and BEUC. A 2020 vision for Europe's energy customers. Joint Statement; 13 November 2012 [updated 30 May 2013].
[7] Directive 2012/27/EU on energy efficiency, amending directives 2009/125/EC and 2010/30/EU and repealing directives 2004/8/EC and 2006/32/EC, OJ L 315. pp. 1–56.
[8] Directive 2009/28/EC on the promotion of the use of energy from renewable sources, OJ L 140/16.
[9] Klein DR, Olonscheck M, Walther C, Kropp JP. Susceptibility of the European electricity sector to climate change. Energy 2013;59:183–93.
[10] Wachsmuth J, Blohm A, Gößling-Reisemann S, Eickemeier T, Ruth M. How will renewable power generation be affected by climate change? The case of a metropolitan region in Northwest Germany. Energy 2013;58:192–201.
[11] Olabi AG. The 3rd international conference on sustainable energy and environmental protection SEEP 2009, Guest Editor's introduction. Energy 2010;35:4508–9.
[12] Olabi AG. Sustainable energy and environmental protection, Guest Editor's introduction. Energy 2012;39:2–5.
[13] Carton JG, Olabi AG. Wind/hydrogen hybrid systems: opportunity for Ireland's wind resource to provide consistent sustainable energy supply. Energy 2010;35:4536–44.
[14] Connolly D, Lund H, Mathiesen BV, Leahy M. Modelling the existing Irish energy-system to identify future energy costs and the maximum wind penetration feasible. Energy 2010;35:2164–73.
[15] Lund H. The implementation of renewable energy systems. Lessons learned from the Danish case. Energy 2010;35:4003–9.
[16] Lund H, Mathiesen BV. Energy system analysis of 100% renewable energy systems – the case of Denmark in years 2030 and 2050. Energy 2009;34:524–31.
[17] Kwon PS, Østergaard PA. Comparison of future energy scenarios for Denmark: IDA 2050, CEESA (coherent energy and environmental system analysis), and climate commission 2050. Energy 2012;46:275–82.
[18] Pillai JR, Heussen K, Østergaard PA. Comparative analysis of hourly and dynamic power balancing models for validating future energy scenarios. Energy 2011;36:3233–43.
[19] UCTE final report: system disturbance on 4 November 2006.
[20] ERGEG final report: the lessons to be learned from the large disturbance in the European power system on the 4th of November 2006, Ref: E06-BAG-01-06; 6 February 2007.
[21] Regulation (EU) No 994/2010 concerning measures to safeguard security of gas supply, OJ L 295/1.
[22] Winzer C. Conceptualizing energy security. Energy Policy 2012;46:36–48.
[23] Johansson B. A broadened typology on energy and security. Energy 2013;53:199–205.
[24] Johansson B. Security aspects of future renewable energy systems, a short overview. Energy 2013;61:598–605.
[25] 5th CEER benchmarking report on the quality of electricity supply; 2011.
[26] CEER and ECRB. Guidelines of good practice on the implementation and use of voltage quality monitoring systems for regulatory purposes, Ref: C12-EQS-51-03; 3 December 2012.
[27] Energy Research Center of the Netherlands and Clingendael International Energy Programme. EU standards for energy security of supply. ECN-C-06-039/CIEP; 2006.
[28] World Energy Trilemma. Time to get real – the case for sustainable energy investment. World Energy Council; Sept. 2013, ISBN 978 0 946121 22 9.
[29] Zlatar I, Kozan B, Golob R, Gubina AF. The security of electricity Supply: the economic downturn's influence in Slovenia, energy sources, part B. Econ Plan Policy 2014;9(4):351–9. http://dx.doi.org/10.1080/15567249.2010.499410.
[30] Directive 2009/72/EC concerning common rules for the internal market in electricity and repealing directive 2003/54/EC, OJ L 211. pp. 55–93.
[31] Directive 2009/73/EC concerning common rules for the internal market in gas and repealing directive 2003/55/EC, OJ L 211. pp. 94–136.
[32] Regulation (EC) No 714/2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003, OJ L 211. pp. 15–35.
[33] Regulation (EC) No 715/2009 on conditions for access to the natural gas transmission networks and repealing Regulation (EC) No 1775/2005, OJ L 211. pp. 36–54.
[34] Regulation (EC) No 713/2009 establishing an Agency for the Cooperation of Energy Regulators, OJ L 211. pp. 1–14.
[35] ACER/CEER annual report on the results of monitoring the internal electricity and natural gas markets in 2011, ISBN 978-92-95083-07-3. http://dx.doi.org/10.2851/12775.
[36] ACER/CEER annual report on the results of monitoring the internal electricity and natural gas markets in 2012; November 2013.

[37] ACER's annual report on its activities under REMIT in 2012; November 2013.
[38] Regulation (EU) No 1227/2011 on wholesale energy market integrity and transparency. OJ L 326. pp. 1–16.
[39] ACER report to the European Commission on the implementation of the ITC mechanism in 2012; October 2013.
[41] Country reports. http://ec.europa.eu/energy/gas_electricity/internal_market_en.htm.
[42] Communication from the Commission. Making the energy market work. COM; 2012. 663 final, Brussels 15.11.2012.
[43] European Parliament, ITRE. Report on making the internal energy market work (2013/2005(INI)); 16 July 2013.
[44] Pollitt MG. The role of policy in energy transitions: lessons from the energy liberalisation era. Energy Policy 2012;50:128–37.
[45] Booz&Co., Newbery D, Strbac G, Pudjianto D, Noël P, LeighFisher. Benefits of an integrated European energy market. Final Report. DG for Energy, European Commission; 20 July 2013.
[46] Impact assessment on European electricity balancing market. Final report; March 2013. EC DG ENER/B2/524/2011.
[47] Auer H, Rezania R, Lettner G. Market architectures for cross-border procurement and activation of balancing reserves and balancing energy. Vienna: Vienna Technical University, project eBadge D2.1; September 2013.
[48] Brunner H, Burnier de Castro D, Esterl T, Ghaemi S. Analysis of changes, risk and possibilities for cross border market opening between Austria, Italy and Slovenia. Vienna: Austrian Institute of Technology, project eBadge D2.2; September 2013.
[49] Haas R, Lettner G, Auer H, Duic N. The looming revolution: how photovoltaics will change electricity markets in Europe fundamentally. Energy 2013;57:38–43.
[50] Draft commission regulation establishing a network code on gas balancing of transmission networks. D028021; October 2013.
[51] Commission Regulation (EU) No 984/2013 establishing network code on capacity allocation mechanisms in gas transmission systems, OJ L 273/5.
[52] Opinion of the Agency for the Cooperation of Energy Regulators No 05/2013 on capacity markets of 15 February 2013.
[53] Agency for the Cooperation of Energy Regulators reports on. Capacity remuneration mechanisms and the internal market for electricity; 30 July 2013.
[54] Communication from the Commission. Delivering the internal electricity market and making the most of public intervention. C; 2013. 7243 final. 5.11.2013.
[55] Commission Staff Working Paper. An energy policy for consumers. SEC; 2010. 1407 final. 11. 11. 2010.
[56] Lund H, Andersen AN, Østergaard PA, Mathiesen BV, Connolly D. From electricity smart grids to smart energy systems – a market operation based approach and understanding. Energy 2012;42:96–102.
[57] Torriti J, Hassan MG, Leach M. Demand response experience in Europe: policies, programmes and implementation. Energy 2010;35:1575–83.
[58] Balta-Ozkan N, Davidson R, Bicket M, Whitmarsh L. The development of smart homes market in the UK. Energy 2013;60:361–72.
[59] Veigl-Guthann C. Vulnerable customers, CEER status review of customer and retail market provisions from the 3rd package as of 1 January 2012. London: 13–14 November 2012.
[60] Working group report on transparency in EU retail energy markets, prepared for the 5th Citizens' Energy Forum – November 2012.
[61] Hirsch D. Addressing the poverty premium. Approaches to regulation. Consumer Futures; March 2013.
[63] Regulation (EU) No 347/2013 on guidelines for trans-European energy infrastructure, OJ L 115. pp.39–75.