ANALYSIS OF SAVINGS POTENTIAL

Eli Beamlines

COMPANY PRESENTATION:

Name:	PKV BUILD s.r.o.
Company headquarters:	Vlněna 526/3, 602 00 Brno
Billing address:	Senožaty 284, 394 56
Company ID:	281 49 785
VAT number:	CZ281 49 785
Represented by:	Jiří Pech and Ondřej Vaněk

Our philosophy:
Energy consumption can be lower, while living comfort can be higher. We seek solutions that create an energy-efficient world and strive to improve conditions that affect our health. Our decisions are based on detailed data analysis, and we keep pace with the latest technological innovations.

Core activities of the company:

- **We provide energy audits/analyses and energy specialist services.**

The easiest way to accurately map the current situation and identify potential savings is to conduct an energy audit. Proper understanding is preceded by an analysis of the customer's needs, including the size of their portfolio. Each audit is unique and tailor-made, and we take the same approach to other energy services. Thanks to the legislative obligations for large companies, it is possible to combine business with pleasure in this case.

- **We design, plan, and implement**

We look for the most suitable implementation of the proposed energy-saving measures. We recognize the differences between each investment and focus on the client's realistic possibilities and requirements. We do not deliver a final product, but a comprehensive solution.

- **We provide energy services with a guarantee (EPC and EC)**

Every saving has a rational reason and an expected result. We work with these facts in EPC (Energy Performance Contracting) and EC (Energy Contracting) methods, through which we guarantee savings that generate funds to repay the initial investment. Then it is just a matter of agreeing who will finance the proposed measure.

- **We create Smart Cities**

We focus on improving quality of life, efficient energy use, eliminating environmental burdens, and data sharing. The key areas where we apply our expertise are buildings, transportation, and security. We use energy-efficient, digital, information, and communication technologies.

**Conten
ts**

1 IDENTIFICATION DATA

1.1 Contracting authority

Table 1.1.1: Basic information about the contracting authority:

Contracting authority's business name:	**Institute of Physics, Czech Academy of Sciences**
Address:	Na Slovance 1999/2, 182 00 Prague
Company ID:	683 78 271
Representative:	doc. Ing. Martin Nikl, CSc.

1.2 Energy nd specialist

Table 1.2.1: Basic information about the energy specialist

Energy specialist:	**PKV BUILD s.r.o.**
Legal form:	Limited liability company
Company ID:	281 49 785
VAT number:	CZ281 49 785
Address:	Senožaty 284, 394 56 Senožaty
License number:	1865
ES - Designated person:	Ing. Jiří Španihel
Authorization number:	1601
Collaborated with:	Martin Bořil

1.3

Table 1.3.1: Identification of APÚ subject:

Item:	**Eli Beamlines**
Cadastral area:	Dolní Břežany [628794]
Parcel number:	st. 1095, st. 1096
Location (address):	Za Radnicí 835, 252 41 Dolní Břežany
Property relationship to the contracting authority:	The contracting authority owns the property in question

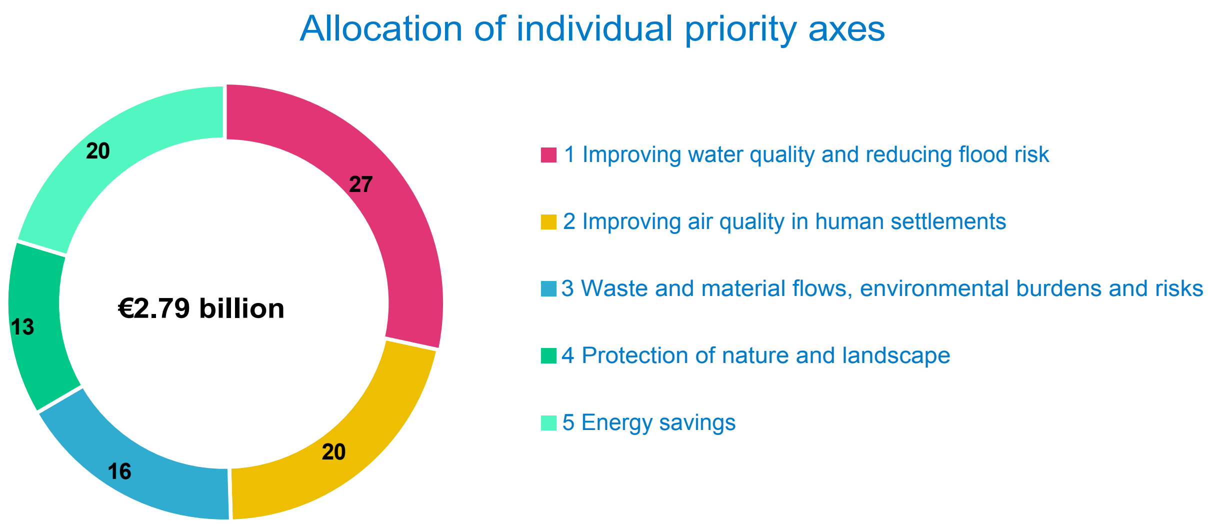
2 INFORMATION ABOUT THE SUBSIDY TITLE

2.1 OPŽP

The Operational Program Environment (OPŽP) is scheduled for the period 2014–2020, during which almost EUR 2.79 billion has been allocated for applicants. The managing authority is the Ministry of the Environment, and the intermediary bodies are the State Environmental Fund of the Czech Republic for all priority axes except priority axis 4.

The Operational Program Environment is divided into five priority axes:

Priority axis 1 - Improving water quality and reducing flood risk Priority axis
2 - Improving air quality in human settlements
Priority axis 3 - Waste and material flows, environmental burdens and
risks Priority axis 4 - Protection and care for nature and the landscape
Priority axis 5 – Energy savings



2.2 Priority axis 5 - Energy savings

Priority axis 5 – Energy savings, which focuses on the energy performance of public buildings, the use of renewable energy sources, and support for the construction of new public buildings that meet passive energy standards. The aim is to reduce final energy consumption and reduce the consumption of non-renewable primary energy through the use of local renewable sources in public buildings.

Allocation for Priority Axis 5: **19.69% OPŽP = approx. €549 million**

Specific objectives of Priority Axis 5:

5.1 Reduce the energy intensity of public buildings and increase the use of renewable energy sources

5.2 Achieve a high energy standard for new public buildings

5.3 Reduce energy intensity and increase the use of renewable energy sources in central government buildings

Specific objective 5.3, Reducing energy intensity and increasing the use of renewable energy sources in central government buildings, was assessed as the most appropriate specific objective within the OP Environment.

2.3 Rules for applicants and recipients of support under the OP Environment

The rules and conditions below are based on the regularly updated OPŽP document "Rules for applicants and recipients of support."

Eligible applicants - recipients of support

> State organizational units, state-funded organizations,

> Public research institutions and research organizations pursuant to Act No. 130/2002 Coll., on support for research, experimental development, and innovation from public funds and on amendments to certain related acts (Act on Support for Research, Experimental Development, and Innovation), as amended, if they are public entities.

Types of supported projects and activities

a) Total or partial energy-efficient renovations of public buildings, including projects implemented using the EPC method:

> insulation of the building envelope,

> replacement and renovation (refurbishment) of window and door frames,

> implementation of measures that have a demonstrable impact on the energy performance of the building or improve the quality of the indoor environment (e.g., reconstruction and modernization of interior lighting, heating and ventilation measurement and control systems, measures to improve room acoustics, measures to prevent summer overheating),

> implementation of forced ventilation systems with waste heat recovery,

> implementation of systems utilizing waste heat,

> replacement of heating, cooling, or hot water preparation sources with a capacity of less than 5 MW using fossil fuels or electricity with efficient sources using biomass, heat pumps, natural gas condensing boilers, or combined heat and power or cooling equipment using renewable energy sources or natural gas,

> installation of a photovoltaic system,

> installation of solar thermal collectors.

b) Separate measures for replacing a source with a capacity of less than 5 MW using fossil fuels or electricity for heating, cooling, or hot water preparation with efficient sources using biomass, heat pumps, natural gas condensing boilers, or combined heat and power or cooling equipment using renewable sources or natural gas. installation of solar thermal collectors, installation of a photovoltaic system, and installation of a forced ventilation system with waste heat recovery, provided that the public building meets certain energy efficiency requirements and, in the case of the installation of a forced ventilation system with heat recovery, does not meet the requirements for ensuring sufficient air exchange.

As part of the renovation of buildings defined by Act No. 20/1987 Coll., on State Monument Care, as amended, as cultural monuments or buildings that are not cultural monuments but are located in a monument reserve, monument zone, or protected zone of an immovable cultural monument, immovable national cultural monuments, heritage reserves or heritage zones (hereinafter referred to as "heritage-protected buildings") and architecturally valuable buildings, partial activities leading to a reduction in the energy performance of the building will also be supported, regardless of whether the parameters for the overall energy performance of the building are achieved.

Eligible expenses

Eligible expenses are generally considered to be construction work, supplies, and services directly related to the subject of the support, in particular:

a) construction work, supplies, and services related to improving **the** energy **performance of building envelopes,**

b) construction work, supplies, and services related to other measures that have a demonstrable impact on **the energy performance of the building or improve the quality of the indoor environment**,

c) construction work, supplies, and services related to the implementation of forced ventilation systems with waste heat recovery,

d) construction work, supplies, and services related to the implementation of **photovoltaic systems**,

e) construction work, supplies, and services related to **the replacement of fossil fuel or electricity sources** with efficient sources using:

- biomass,
- heat pumps,
- condensing natural gas boilers,
- combined production of electricity and heat or cooling using renewable energy sources or geothermal energy
- photothermal solar systems,

f) construction work, supplies, and services related to the implementation of **systems using waste heat**,

g) construction work, supplies, and services related to **the construction and reconstruction of hot water heating systems**,

h) costs of tests or trials related to bringing assets into a condition suitable for use and to proving compliance with technical parameters, but only in the period up to final approval (commissioning).

Eligibility rules for certain types of expenditure:

Project preparation, author and technical supervision, OHS coordinator

15%	for projects whose total eligible direct implementation expenses are	**< CZK 1 million,**
12	for projects whose total eligible direct implementation costs are	**< CZK 3 million,**
9%	for projects whose total eligible direct implementation costs are	**< CZK 10 million,**
6%	for projects whose total eligible direct implementation costs are	**> CZK 10 million.**

2.4 Amount of support

Support will be provided in the form of a subsidy with a maximum percentage limit of the total eligible project costs.

The percentage of the subsidy depends on the fulfillment of the following criteria:

Maximum amount of support for activities 5.3. a)

> **Ordinary buildings**

Table 2.4.1: Maximum amount of support for activities 5.3. a) - Ordinary buildings

Amount of support	%	80 [1) 4)]	85 [1) 4)]	95 [1) 4)]
Monitored parameter	Unit			
Total energy savings	%	≥ 20	≥ 40	≥ 60
Average heat transfer coefficient of the building envelope	U_{em} $[W.m^{-2}.K^{-1}]$	-	≤ 0.9 x $U_{em,R}$	≤ 0.8 x $U_{em,R}$
Heat transfer coefficient of individual building structures for which support is requested (excluding doors, roof windows, and skylights)	U_{em} $[W.m^{-2}.K^{-1}]$	≤ 0.85 x U_{rec}	according to ČSN 730540-2:2011 and Decree No. 264/2020 Coll.	
Heat transfer coefficient of windows for which support is requested	U_w $[W.m^{-2}.K^{-1}]$	≤ 0.8 x U_{rec} [2)]		
Heat transfer coefficient of doors, roof windows, and skylights for which support is requested	U_{em} $[W.m^{-2}.K^{-1}]$	≤U_{rec} [2)]	according to ČSN 730540-2:2011 and Decree No. 264/2020 Coll.	

> **Listed buildings**

Table 2.4.2: Maximum amount of support for activities 5.3 a) - Listed buildings

Amount of support	%	85 [1) 4)]	95 [1) 4)]
Monitored parameter	Unit		
Total energy savings	%	≥ 10	≥ 30
Heat transfer coefficient of individual building structures for which support is requested (excluding doors, roof windows, and skylights)	U $[W.m^{-2}.K^{-1}]$	≤ 0.90 x U_{rec} [3)]	
Heat transfer coefficient of doors, roof windows, and skylights for which support is requested	U $[W.m^{-2}.K^{-1}]$	≤U_{rec} [2) 3)]	

1) It is possible to obtain a 5% bonus for applicants who carry out total or partial energy-saving renovations eligible for support, energy management, and other energy-saving measures using the EPC method, or who award a public contract according to the Design&Build methodology, including contractual energy management and a guarantee for the energy savings achieved for at least the duration of the project's sustainability.

2) An exception may be made for window and door fillings in accordance with ČSN 730540-2, point 5.2.8.

3) An exception may be applied with regard to the opinion of the relevant monument preservation authority. For architecturally valuable buildings, an independent assessment provided by the SFŽP ČR will also be added.

4) A 5% bonus is available to applicants who, in conjunction with the energy-efficient renovation of a public building, install renewable energy sources that cover at least 40% of the building's total energy consumption after the measures have been implemented.

Maximum amount of support for activities 5.3 b)

Table 2.4.3: Maximum amount of support for activities 5.3. b)

Project type	Amount of support (%)
Separate measures to replace heat sources with a capacity of less than 5 MW using fossil fuels or electricity for heating or hot water preparation with natural gas condensing boilers or combined heat and power plants using renewable sources or natural gas.	85
Individual measures to replace heat sources with a capacity of less than 5 MW using fossil fuels or electricity for heating or hot water preparation with efficient sources using biomass, heat pumps, solar thermal collectors, and photovoltaic systems.	100
Installation of a photovoltaic system, implemented simultaneously with a forced ventilation system with waste heat recovery.	100
Installation of forced ventilation systems with waste heat recovery.	100

3 al evaluation of the applicant

Applicant characteristics:

Table 3.1: Characteristics of the applicant

Characteristics of the applicant	
Applicant name:	**Institute of Physics, Czech Academy of Sciences**
Legal form of the applicant:	Public research institution
Applicant's activity:	682: Rental and management of own or leased real estate 72200: Research and development in the field of social sciences and humanities 773: Rental and leasing of other machinery, equipment, and products
Expected intention:	Energy savings - Installation of a photovoltaic power plant and cogeneration unit

Evaluation:

As the subject is a public research institution, the subsidy would amount to a maximum of 85% for the installation of a cogeneration unit and 100% for the installation of a photovoltaic power plant.

4 DESCRIPTION OF THE CURRENT SITUATION

4.1 Input data

The analysis was prepared using data obtained from the client. The input data was obtained primarily from documents on energy consumption at the operating site.

List of materials received:

- The client provided complete project documentation for the construction part of the EP subject and technical equipment.

- The client provided electricity and natural gas consumption and costs for 2017, 2018, 2019, and 2020 in the form of invoices. Access to online electricity consumption management was also provided.

- Other facts were ascertained during an on-site investigation by a technician.

4.2 Basic information about the subject of the analysis

The subject of the savings potential analysis is the Eli Beamlines research center of the Institute of Physics of the Czech Academy of Sciences. The research center is located in Dolní Břežany, in the cadastral area of Dolní Břežany [628794]. The building stands on parcel numbers st. 1095 and st. 1096.

The ELI Beamlines center aims to operate the most intense laser system in the world on a long-term basis. With ultra-high powers of 10 PW (petawatts) and focused intensities of up to 1024 W/cm², we offer our users a unique source of radiation and particle beams. These so-called beamlines enable pioneering research not only in physics and materials science, but also in biomedicine, laboratory astrophysics, and many other fields.

The ELI Beamlines Center is part of the ELI (Extreme Light Infrastructure) project, a new research infrastructure of pan-European significance, and part of the European Strategy Forum on Research Infrastructures (ESFRI) plan.

The laser center in Dolní Břežany was opened to user experiments in 2018.

The analysis focuses on assessing the possibility of installing a cogeneration unit and a photovoltaic power plant with a view to drawing on subsidies from the OPŽP program under the Energy Savings subsidy program.

4.3 site layout

The following figure shows the building located on the research center premises.

Figure 4.3.1: Site plan of the building

4.4 APÚ course description

Eli Beamlines Building

The Eli Beamlines building consists of two parts. The northern part houses administration, a restaurant, teaching facilities, and offices. The southern part houses laboratory facilities.

The floor plan of the building is irregular in shape, with approximate dimensions of 130 m x 106 m.

The floor above the outdoor area (P1) consists of a reinforced concrete slab and thermal insulation with a thickness of 200 mm and a thermal conductivity coefficient of $\lambda = 0.039\ W \cdot m^{-1} \cdot K^{-1}$. The floor on the ground without thermal insulation (P2, P3) consists of a reinforced concrete slab. The floor on the ground with 150 mm thick thermal insulation (P4) consists of a reinforced concrete slab and and thermal insulation 150 mm thick with a thermal conductivity coefficient $\lambda = 0.039\ W \cdot m^{-1} \cdot K^{-1}$. The floor on the ground with TI thickness 100 mm (P5) consists of a reinforced concrete slab and thermal insulation thickness 100 mm with thermal conductivity coefficient $\lambda = 0.039\ W \cdot m^{-1} \cdot K^{-1}$.

The flat green roof with TI (S1, S2) consists of a reinforced concrete slab and thermal insulation with a thickness of 160 mm and a thermal conductivity coefficient of $\lambda = 0.039\ W \cdot m^{-1} \cdot K^{-1}$. The flat roof with thermal insulation (S3, S4) consists of a reinforced concrete slab and thermal insulation with a thickness of 140 mm and 100 mm with a thermal conductivity coefficient of $\lambda = 0.039\ W \cdot m^{-1} \cdot K^{-1}$. The flat roof to the ground with a thickness of 760 mm (S5) consists of a reinforced concrete slab and thermal insulation with a thickness of 160 mm and a thermal conductivity coefficient of $\lambda = 0.039\ W \cdot m^{-1} \cdot K^{-1}$. The flat roof to the ground, thickness 1600 mm (S6), consists of a reinforced concrete slab and thermal insulation, thickness 160 mm, with a thermal conductivity coefficient $\lambda = 0.039\ W \cdot m^{-1} \cdot K^{-1}$.

The wall facing the outdoor space with TI thickness 160 mm (Z1, Z3) consists of masonry made of lime-cement blocks with thermal insulation thickness 160 mm with thermal conductivity λ = 0.039 $W \cdot m^{-1} \cdot K^{-1}$. The wall to the outdoor space with TI thickness 200 mm (Z2) consists of a reinforced concrete wall and thermal insulation thickness 200 mm with thermal conductivity λ = 0.039 $W \cdot m^{-1} \cdot K^{-1}$. The wall to the outside space with a thickness of 460 mm with TI (Z4) consists of a reinforced concrete wall with thermal insulation with a thickness of 260 mm and thermal conductivity λ = 0.039 $W \cdot m^{-1} \cdot K^{-1}$. The wall to the outside space, 1260 mm thick with TI (Z5), consists of a reinforced concrete wall with thermal insulation 260 mm thick with thermal conductivity λ = 0.039 $W \cdot m^{-1} \cdot K^{-1}$. The wall facing the exterior with 100 mm thick thermal insulation (Z6) consists of a reinforced concrete wall and 100 mm thick thermal insulation with thermal conductivity λ = 0.039 $W \cdot m^{-1} \cdot K^{-1}$.

The wall to the ground without TI (Z7) consists of a reinforced concrete wall. The wall to the ground with TI 100 mm thick (Z8) consists of a reinforced concrete wall with thermal insulation 100 mm thick o thermal conductivity λ = 0.039 $W \cdot m^{-1} \cdot K^{-1}$. The wall to the ground with TI thickness 100 mm (Z9) consists of a reinforced concrete wall with thermal insulation thickness 200 mm with thermal conductivity λ = 0.039 $W \cdot m^{-1} \cdot K^{-1}$. The wall to the ground with a thickness of 680 mm with TI (Z10) consists of a reinforced concrete wall with thermal insulation with a thickness of 200 mm and thermal conductivity λ = 0.039 $W \cdot m^{-1} \cdot K^{-1}$. The wall to the ground, 1780 mm thick with TI (Z11), consists of a reinforced concrete wall with thermal insulation 200 mm thick with thermal conductivity λ = 0.039 $W \cdot m^{-1} \cdot K^{-1}$. The perimeter structure, a lightweight perimeter shell (Z12), has a thermal insulation filling with a thickness of 200 mm and thermal conductivity λ = 0.039 $W \cdot m^{-1} \cdot K^{-1}$.

The openings are filled with aluminum windows with insulated double glazing (O1) with a heat transfer coefficient of U = 1.2 $W.m^{-2}.K^{-1}$, aluminum doors (D1) with glass panels with a heat transfer coefficient of U = 1.5 $W.m^{-2}.K^{-1}$, and skylights with a heat transfer coefficient of U = 1.5 $W.m^{-2}.K^{-1}$.

Table 4.4.1: Summary of thermal parameters of building envelope structures

Building characteristics						
Enclosed space of the heated zone of the building V (m^3)						178445.00
Total area of cooled surfaces enclosing the enclosed space of the heated zone of the building A (m^2)						35,594.30
Total energy-related area of the building (m^2)						28030.80
Geometric characteristics of the building (volume factor) A/V (m^{-1})						0.20
Predominant indoor temperature during the heating season Q_{im} (°C)						20.0
Characteristics of energy-related data for cooled structures						
Structure		Area A_i (m^2)	Heat transfer coefficient U_i ($W.m^{-2}.K^{-1}$)	Required heat transfer coefficient value $_{UN,20}$ ($W.m^{-2}.K^{-1}$)	Temperature reduction factor (-)	Specific heat transfer loss of the structure H_{ti} ($W.K^{-1}$)
Horizontal structure						
P1	Floor above outdoor space	102.00	0.22	0.24	1.00	22
P2	Floor on ground without TI (Z2)	8230.00	1.31	0.45	0.07	790
P3	Floor on ground without TI (Z1)	425.80	1.31	0.45	0.31	175
P4	Floor on ground with TI thickness 150 mm	690.00	0.51	0.45	0.46	160
P5	Floor on ground with TI thickness 100 mm	2429.00	0.36	0.45	0.55	474
S1	Flat green roof with TI (Z2)	5137.60	0.20	0.24	1.00	1,033
S2	Flat green roof with TI (Z1)	1,891.60	0.20	0.24	1.00	380
S3	Flat roof with TI thickness 140 mm	102.00	0.20	0.24	1.0	20
S4	Flat roof with TI thickness 100 mm	425.80	0.43	0.24	1.00	183
S5	Flat roof to ground, thickness 760 mm	3720	0.25	0.24	1.00	915
S6	Flat roof to ground, thickness 2200 mm	404.60	0.22	0.24	1.00	90
Vertical construction						
Z1	Wall to outdoor space with TI 160 mm thick (Zone 1)	1248.00	0.28	0.30	1.00	348
Z2	Wall to outdoor space with TI thickness 200 mm	490.40	0.24	0.30	1.00	117
Z3	Wall to outdoor space with TI thickness 160 mm (Zone 2)	929.40	0.28	0.30	1.0	259
Z4	Wall to outdoor space Thickness 460 mm with TI	2497	0.20	0.30	1.00	492
Z5	Wall for outdoor space Thickness 1260 mm with TI	818.00	0.19	0.30	1.0	152
Z6	Wall to outdoor space with TI Thickness 100 mm	432.10	0.39	0.30	1.0	170
Z7	Wall to ground without TI	40.80	2.96	0.45	0.34	42
Z8	Wall to ground with TI thickness 100 mm	650.00	0.33	0.45	3.13	662

Z9	Wall to ground with TI thickness 200 mm	157.30	0.22	0.45	4.63	160
Z10	Wall to ground, thickness 680 mm	1953.00	0.23	0.45	4.47	1,990
Z11	Wall to ground, thickness 1780 mm	923.00	0.21	0.45	4.95	941
Z12	Lightweight perimeter shell	976.00	1.20	0.30	1.00	1,171
Filling of openings						
O1	Plastic window - insulated double glazing	676.2	1.20	1.50	1.00	811
D1	Plastic doors - with glass panels	49.50	1.50	1.70	1.00	74
SV1	Skylight - glass concrete	195.20	1.50	1.40	1.00	293
Total		**35,594.30**				**11,924**
Thermal bonds (0.02 * A)						712
Total specific heat loss of structures (W.K^{-1})						**12,636**
Specific heat loss through ventilation (W.K^{-1})						**44,277**
Total heat loss of the building (kW)						**1,821.21**

Note: The values of heat transfer coefficients U_i marked in green meet the requirements of the ČSN 73 0540-2 standard: Table 3 - Required values $U_{N,20}$, while the values marked in red do not meet the requirements.

4.5 Description of technical equipment and systems that are the subject of the analysis

Technical equipment of buildings

The chapter contains a description of the technical characteristics of the technical equipment under analysis, enabling the formulation of energy inputs and thus the determination of the energy intensity of the initial state of energy management. The analysis aims to propose a set of energy-saving measures to eliminate the disadvantages of the initial state and ensure the utilization of the potential energy savings provided by parts of the building's technical equipment.

Finally, an assessment is made of the impact of all HVAC appliances and technology on energy demand and the sources of potential savings are defined.

The energy intensity of the current state of the analyzed energy management in terms of HVAC and technology is defined by energy consumption parameters given by the technical condition of the equipment for heating, hot water heating (TV), ventilation (VZT), cooling (C), lighting (OSV), air humidity control (UVZ), and other energy appliances.

Heating

The building in question is heated by a central hot water gas boiler room. The boiler room contains two Viessmann Vitoplex 200 stationary hot water gas boilers with outputs of 900 kW and 700 kW. The gas boilers are connected in cascade. The heating system is hot water with a temperature gradient of 80/60 °C. Hot water is distributed to radiators and to the heat exchangers of the air handling units. The heating system is divided into 7 heating branches. The heating surfaces consist mainly of panel radiators and air distribution outlets.

There are two electric radiant panels, each with an output of 300 W, in the entrance atrium on the first floor.

Table 4.5.1: List of heating sources

Heating source	Energy carrier	Heat output (kW)	Number of units (pcs)	Total output (kW)	Efficiency /COP	Heats
Viessmann Vitoplex 200 - I	ZP	900.00	1	900.00	90.5	Eli Building Beamlines
Viessmann Vitoplex 200 - II	ZP	700.00	1	700.00	90.5	Eli Building Beamlines
Electric radiant panel	EE	0.30	2	0.60	99	Entrance atrium
Total EE				**0.60**		
Total ZP				**1600.00**		
Total				**1600.60**		

Figure 4.5.1: Viessmann Vitoplex 200 boilers

Hot water heating (TV)

Hot water is provided by Viessmann Vitoplex 200 central boilers with an output of 900 kW and 700 kW in a 1500 l indirect heating tank. The output of the heat exchanger in the indirect heating tank is 80 kW.

Table 4.5.2: List of hot water heating sources

Hot water heating source	Energy carrier	Heat output (kW)	Number of units (pcs)	Total output (kW)	Efficiency /COP	Provides water heating for:
Viessmann Vitoplex 200 - I	ZP	900.00	1	900.00	90.5	Entire building
Viessmann Vitoplex 200 - II	ZP	700.00	1	700.00	90.5	Entire property
Total				**1,600.00**		

Figure 4.5.2: Indirect DHW storage tank

Ventilation (HVAC)

The building has 38 ventilation units installed to regulate the indoor environment, 13 of which are located in the administrative section and 25 in the laboratory section. The units provide ventilation, heating, cooling, and humidity control. The supply air is heated by central gas boilers in heat exchangers with a temperature gradient of 60/40 °C. Cooling is provided by heat exchangers connected to the central cooling distribution system from the cooling machine room and also from local air conditioning units. Some of the units are equipped with air humidity control devices. Most of the units are equipped with rotary or plate recuperators. The total power consumption of the fans is 193.1 kW.

List of indoor environment control units:

Table 4.5.3: HVAC 1 - Gea Cair Plus

VZT 1 - Gea Cair Plus	
Provides air conditioning for:	Administrative part of the building
Ventilation	2x fan (supply 7.5 kW, exhaust 3 kW)
Cooling	Cooling exchanger - output 49 kW (water)
Heating	66 kW hot water exchanger - (water from boiler room 60/40)
Humidity control	Humidifier - power consumption 60 kW
Recuperation	Rotary recuperator - efficiency 65%

Table 4.5.4: HVAC 2 - Gea Cair Plus

VZT 2 - Gea Cair Plus	
Provides air treatment for:	Restaurant
Ventilation	2x fan (supply 7.5 kW, exhaust 3 kW)
Cooling	Heat exchanger - output 49 kW (water)
Heating	Hot water exchanger 66 kW - (water from boiler room 60/40)
Humidity control	Humidifier - power consumption 60 kW
Recuperation	Rotary heat exchanger - efficiency 65%

Table 4.5.5: VZT 3 - Gea ATPicco

VZT 3 - Gea ATPicco	
Provides air treatment for:	Kitchen - supply only
Ventilation	1x fan (supply 3 kW)
Cooling	Heat exchanger - output 29 kW (water)
Heating	Hot water exchanger 45 kW - (water from boiler room 60/40)
Humidity control	-
Recuperation	-

Table 4.5.6: HVAC 4 - Gea Cair Plus

VZT 4 - Gea Cair Plus	
Provides air treatment for:	Kitchen - exhaust only
Ventilation	1x fan (1.1 kW exhaust)
Cooling	-
Heating	-
Humidity control	-
Recuperation	-

Table 4.5.7: VZT 5 - Gea Cair Plus

VZT 5 - Gea Cair Plus	
Provides air treatment for:	Meeting room
Ventilation	2x fan (supply 2.2 kW, exhaust 1.1 kW)
Cooling	Cooling exchanger - output 17 kW (water)
Heating	Hot water exchanger 13 kW - (water from boiler room 60/40)
Humidity control	Humidifier - power consumption 15 kW
Recuperation	Rotary recuperator - efficiency 74.5%

Table 4.5.8: VZT 6 - Gea Cair Plus

VZT 6 - Gea Cair Plus	
Provides air treatment for:	Lecture hall
Ventilation	2x fan (supply 3 kW, exhaust 1.5 kW)
Cooling	Cooling exchanger - output 38 kW (water)
Heating	Hot water exchanger 30 kW - (water from boiler room 60/40)
Humidity control	Humidifier - power consumption 19 kW
Recuperation	Rotary recuperator - efficiency 81.5%

Table 4.5.9: HVAC 7 - Gea ATPicco

VZT 7 - Gea ATPicco	
Provides air treatment for:	Classrooms, corridors
Ventilation	2x fan (supply 1.5 kW, exhaust 0.8 kW)
Cooling	Heat exchanger - output 22 kW (water)
Heating	Hot water exchanger 22 kW - (water from boiler room 60/40)
Humidity control	Humidifier - power consumption 15 kW
Recuperation	Rotary recuperator - efficiency 67%

Table 4.5.10: HVAC 8 - Gea ATPicco

VZT 8 - Gea ATPicco	
Provides air treatment for:	Atrium
Ventilation	1x fan (supply 2.1 kW)
Cooling	-
Heating	Hot water exchanger 24 kW - (water from boiler room 60/40)
Humidity control	-
Recuperation	-

Table 4.5.11: VZT 9 - Exhaust fans

VZT 9 - Exhaust fans	
Provides air treatment for:	Administrative part of the building
Ventilation	8 units - total 2 kW
Cooling	-
Heating	-
Humidity control	-
Recuperation	-

Table 4.5.12: VZT 10 - Door curtain

VZT 10 - Door curtain	
Provides air treatment for:	Atrium
Ventilation	1x fan (supply 11.7 kW)
Cooling	-
Heating	Electric heater 12 kW
Humidity control	-
Recuperation	-

Table 4.5.13: VZT 11 - Door curtain

VZT 11 - Door curtain	
Provides air treatment for:	Atrium
Ventilation	1x fan (supply 1.6 kW)
Cooling	-
Heating	Hot water exchanger 35 kW - (water from boiler room 60/40)
Humidity control	-
Recuperation	-

Table 4.5.14: HVAC 12 - Door curtain

VZT 12 - Door curtain	
Provides air conditioning for:	Administrative part of the building
Number of units:	2
Ventilation	1x fan (supply 0.05 kW)
Cooling	-
Heating	Hot water exchanger 18 kW - (water from boiler room 60/40)
Humidity control	-
Recuperation	-

Table 4.5.15: HVAC 13 - Gea Cair Plus

VZT 13 - Gea Cair Plus	
Provides air treatment for:	Laboratories
Ventilation	2x fan (supply 4 kW, exhaust 1.5 kW)
Cooling	Heat exchanger - output 27 kW (water)
Heating	Hot water exchanger 46 kW - (water from boiler room 60/40)
Humidity control	Humidifier - power consumption 39 kW - steam generator
Recuperation	Rotary recuperator - efficiency 57%

Table 4.5.16: HVAC 14 - Gea Cair Plus

VZT 14 - Gea Cair Plus	
Provides air treatment for:	Clean rooms
Ventilation	2x fan (supply 7.5 kW, exhaust 5.5 kW)
Cooling	Heat exchanger - output 70 kW (water)
Heating	Hot water exchanger 76 kW - (water from boiler room 60/40)
Humidity control - dehumidification	Hot water exchanger 30 kW - (water from boiler room 60/40)
Humidity control - humidification	Humidifier - power consumption 74 kW - steam generator
Recuperation	Plate recuperator - efficiency 76%

Table 4.5.17: VZT 15 - Gea Cair Plus

HVAC 15 - Gea Cair Plus	
Provides air treatment for:	Precision workshops
Ventilation	2x fan (supply 3 kW, exhaust 1.5 kW)
Cooling	Heat exchanger - output 25 kW (water)
Heating	Hot water exchanger 16 kW - (water from boiler room 60/40)
Humidity control	Humidifier - power consumption 15 kW - steam generator
Recuperation	Plate recuperator - efficiency 68%

Table 4.5.18: HVAC 16 - Gea Cair Plus

VZT 16 - Gea Cair Plus	
Provides air treatment for:	Laser hall
Ventilation	2x fan (supply 5.5 kW, exhaust 4 kW)
Cooling	Heat exchanger - output 60 kW (water)
Heating	Hot water exchanger 30 kW - (water from boiler room 60/40)
Humidity control	-
Recuperation	Rotary heat exchanger - 75% efficiency

Table 4.5.19: VZT 17 - Gea ATPicco

VZT 17 - Gea ATPicco	
Provides air treatment for:	Laser hall
Ventilation	1x fan (supply 2.2 kW)
Cooling	Heat exchanger - output 20 kW (water)
Heating	Hot water exchanger 27 kW - (water from boiler room 60/40)
Humidity control	-
Recuperation	-

Table No. 4.5.20: HVAC 18 - Gea ATPicco

VZT 18 - Gea ATPicco	
Provides air treatment for:	Laser hall
Ventilation	1x fan (exhaust 0.8 kW)
Cooling	-
Heating	-
Humidity control	-
Recuperation	-

Table 4.5.21: VZT 19 - Gea Cair Plus

VZT 19 - Gea Cair Plus	
Provides air treatment for:	Laboratories
Ventilation	2x fan (supply 7.5 kW, exhaust 4 kW)
Cooling	Heat exchanger - output 89 kW (water)
Heating	Hot water exchanger 58 kW - (water from boiler room 60/40)
Humidity control - dehumidification	Hot water exchanger 23 kW - (water from boiler room 60/40)
Humidity control - humidification	Humidifier - power consumption 60 kW - steam generator
Recuperation	Rotary recuperator - efficiency 85%

Table 4.5.22: VZT 20 - Gea Cair Plus

VZT 20 - Gea Cair Plus	
Provides air treatment for:	Laboratories
Ventilation	2x fan (supply 7.5 kW, exhaust 4 kW)
Cooling	Heat exchanger - output 104 kW (water)
Heating	Hot water exchanger 68 kW - (water from boiler room 60/40)
Humidity control - dehumidification	Hot water exchanger 27 kW - (water from boiler room 60/40)
Humidity control - humidification	Humidifier - power consumption 60 kW - steam generator
Recuperation	Rotary heat exchanger - efficiency 83%

Table 4.5.23: VZT 21 - Gea Cair Plus

VZT 21 - Gea Cair Plus	
Provides air treatment for:	Laser hall
Ventilation	2x fan (supply 22 kW, exhaust 11 kW)
Cooling	Heat exchanger - output 293 kW (water)
Heating	Hot water exchanger 194 kW - (water from boiler room 60/40)
Humidity control - dehumidification	Hot water exchanger 78 kW - (water from boiler room 60/40)
Humidity control - humidification	Humidifier - power consumption 150 kW - steam generator
Recuperation	Rotary heat exchanger - efficiency 62%

Table 4.5.24: VZT 22 - Gea Cair Plus

VZT 22 - Gea Cair Plus	
Provides air treatment for:	Laser hall
Ventilation	2x fan (supply 5.5 kW, exhaust 3 kW)
Cooling	Heat exchanger - output 52 kW (water)
Heating	Hot water exchanger 35 kW - (water from boiler room 60/40)
Humidity control	Humidifier - power consumption 3.8 kW - steam generator
Recuperation	-

Table 4.5.25: HVAC 23 - Gea Cair Plus

VZT 23 - Gea Cair Plus	
Provides air treatment for:	Laser hall
Ventilation	2x fan (supply 5.5 kW, exhaust 2.2 kW)
Cooling	Heat exchanger - output 40 kW (water)
Heating	Hot water exchanger 27 kW - (water from boiler room 60/40)
Humidity control	Humidifier - power consumption 3.8 kW - steam generator
Recuperation	-

Table 4.5.26: VZT 24 - Gea Cair Plus

VZT 24 - Gea Cair Plus	
Provides air treatment for:	Laser hall
Ventilation	2x fan (supply 5.5 kW, exhaust 2.2 kW)
Cooling	Heat exchanger - output 38 kW (water)
Heating	Hot water exchanger 26 kW - (water from boiler room 60/40)
Humidity control	Humidifier - power consumption 3.8 kW - steam generator
Recuperation	-

Table 4.5.27: VZT 25 - Gea ATPicco

HVAC 25 - Gea ATPicco	
Provides air conditioning for:	Laser hall
Ventilation	1x fan (supply 0.8 kW)
Cooling	Heat exchanger - output 7 kW (water)
Heating	Hot water exchanger 15 kW - (water from boiler room 60/40)
Humidity control	-
Recuperation	-

Table 4.5.28: VZT 26 - Gea ATPicco

VZT 26 - Gea ATPicco	
Provides air treatment for:	Laboratories
Ventilation	1x fan (supply 0.7 kW)
Cooling	-
Heating	Hot water exchanger 18 kW - (water from boiler room 60/40)
Humidity control	Hot water exchanger 20 kW - (water from boiler room 60/40)
Recuperation	-

Table 4.5.29: VZT 27 - Gea ATPicco

VZT 27 - Gea ATPicco	
Provides air treatment for:	Welding shop
Ventilation	3x fan (supply 3 kW, exhaust 0.8 kW + 1.1 kW)
Cooling	Heat exchanger - output 30 kW (water)
Heating	Hot water exchanger 39 kW - (water from boiler room 60/40)
Humidity control	-
Recuperation	-

Table 4.5.30: HVAC 28 - Frico PA4215WL - Door curtain

VZT 28 - Frico PA4215WL - Door curtain	
Provides air conditioning for:	Laboratories
Number of units:	2
Ventilation	1x fan (supply 1.15 kW)
Cooling	-
Heating	Hot water exchanger 25 kW - (water from boiler room 60/40)
Humidity control	-
Recuperation	-

Table 4.5.31: VZT 29 - Frico PA4210WL - Door curtain

VZT 29 - Frico PA4210WL - Door curtain	
Provides air conditioning for:	Laboratories
Number of units:	2
Ventilation	1x fan (supply 1.7 kW)
Cooling	-
Heating	Hot water exchanger 17 kW - (water from boiler room 60/40)
Humidity control	-
Recuperation	-

Table 4.5.32: VZT 30 - Frico PA3515WL - Door curtain

VZT 30 - Frico PA3515WL - Door curtain	
Provides air conditioning for:	Laboratories
Ventilation	1x fan (power consumption 0.91 kW)
Cooling	-
Heating	Hot water exchanger 21 kW - (water from boiler room 60/40)
Humidity control	-
Recuperation	-

Table 4.5.33: VZT 31 - Gea

VZT 31 - Gea	
Provides air treatment for:	Laser hall
Ventilation	1x fan (supply 2.5 kW)
Cooling	Heat exchanger - output 17 kW (water)
Heating	Hot water exchanger 42 kW - (water from boiler room 60/40)
Humidity control	-
Recuperation	-

Table 4.5.34: VZT 32 - BLOCK EP VS 1.6x1.6 - Air shower

VZT 32 - BLOCK EP VS 1.6x1.6 - Air shower	
Provides air treatment for:	Laboratories
Number of units:	2
Ventilation	1x fan (supply 5.9 kW)
Cooling	-
Heating	-
Humidity control	-
Recuperation	-

Table No. 4.5.35: VZT 33 - BLOCK EP VS 1.6x1.6 - Air shower

VZT 33 - BLOCK EP VS 1.6x1.6 - Air shower	
Provides air treatment for:	Laboratories
Ventilation	1x fan (3 kW supply)
Cooling	-
Heating	-
Humidity control	-
Recuperation	-

Table 4.5.36: VZT 34 - Exhaust fans

VZT 34 - Exhaust fans	
Provides air treatment for:	Laboratories
Ventilation	15 units - total 19.7 kW
Cooling	-
Heating	-
Humidity control	-
Recuperation	-

Cooling (C)

The building is cooled by two Carrier 19XV5555 compressor units with a cooling capacity of 389 kW and a cooling output of 2300 kW. The units are located in the cooling machine room outside the main building. Cooling is indirect; cooling water is distributed from the cooling machine room in 10 circuits to heat exchangers in individual air conditioning units and to fan coil units in the administrative part of the building. The temperature gradient of the cooling circuits is 8/14 °C. The cooling system also includes two closed B.A.C cooling towers, each with a capacity of 2670 kW, and a Cabero dry cooler with a capacity of 500 kW. During the cold season, part of the load is covered by free cooling through the cooling towers and dry cooler.

The laboratories are cooled by two Daikin split units with a cooling capacity of 0.98 kW and a cooling output of 2.7 kW, and a Daikin split unit with a cooling capacity of 1.45 kW and a cooling output of 4 kW.

The servers and UPS are cooled by six Stulz CRS 320CS precision air conditioning units with a cooling capacity of 33 kW and a cooling power of 9.43 kW, as well as a Stulz ASD 320CW room air conditioning unit with a cooling capacity of 33 kW and a cooling power consumption of 8.9 kW, and a Stulz ASD 321 A room air conditioning unit with a cooling capacity of 34 kW and a cooling power consumption of 15.6 kW. The units are flexibly mounted on a steel frame system integrated into the raised floor.

A Carrier compressor unit with a cooling power of 34.4 kW and a cooling input of 88.7 kW is installed in the building as a backup cooling source. The unit is located on the roof of the laboratory building.

Table 4.5.37: List of cooling units

Cooling source	Electric power consumptio n (kW)	Cooling capacity (kW)	Number of units (pcs)	Total capacity (kW)	EER	Provides cooling for:
Carrier 19XV5555	389.0	2300.00	2	4600.00	5.9	HVAC units
Daikin	1.45	4.0	1	4.00	2.8	Laboratories
Daikin	0.98	2.70	2	5.40	2.7	
STULZ CRS 320 CW	9.43	33.00	6	198.00	3.5	Servers, UPS
STULZ ASD 320 CW	8.90	33	1	33.00	3.7	
STULZ ASD 321 A	15.60	34.00	1	34.00	2.2	
Carrier - compact unit	34.40	88.70	1	88.70	2.6	HVAC units
Total				**4963.10**		

Figure 4.5.3: Carrier compressor cooling unit

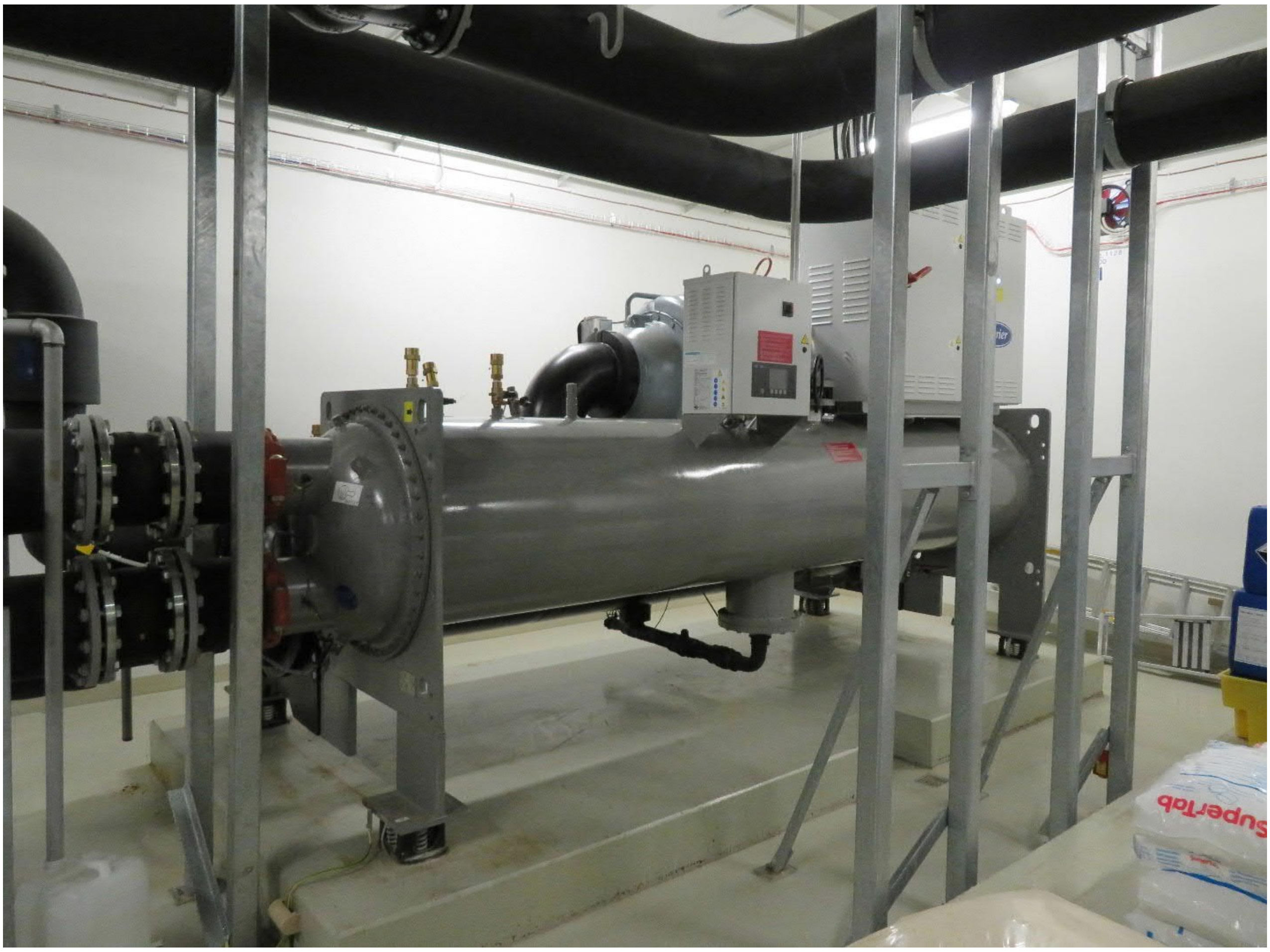


Figure 4.5.4: Cabero dry cooler and B.A.C cooling towers

Lighting (OSV)

Lighting in the complex is provided mainly by fluorescent and LED lights. The estimated lighting time in offices, administrative areas, and laboratories is 8 hours per day, in corridors 5 hours per day, and in warehouses, technical facilities, and changing rooms 2 hours per day.

The building is lit by fluorescent lights with a power consumption of 1x21 W, 2x35 W, 1x28 W, 2x21 W, 2x54 W, 2x28 W, 1x35 W, 3x35 W, 5x35 W, 6x35 W, 4x24 W, 4x18 W, 3x18 W, 1x36 W, 2x36 W, 4x36 W and 1x54 W, compact fluorescent lamps with a power consumption of 2x26 W, 2x42 W, and 35 W, and LED lamps with a power consumption of 2x2.5 W, 35 W, 80 W, 13 W, 2x45 W and 40 W, and halogen lamps with a power consumption of 100 W. The power consumption of the lighting system in the building is 315.1 kW.

Outdoor lighting is provided by halogen lamps with a power consumption of 35 W and 150 W and compact fluorescent lamps with a power consumption of 35 W.

The total power consumption of the lighting system is 338.19 kW.

Table 4.5.38: Lighting summary

Existing lighting	V Building no.	Lighting time (hours/day)	Power consumption (W)	Number of units (pcs)	Total power consumption (kW)	Illuminates
LED 2x2.5W	1	5	5	2	0.01	Corridors
Fluorescent 1x21W	1	5	25	2	0.05	Corridors
Fluorescent 2x35W	1	5	84	21	1.76	Corridors
Compact fluorescent 2x42W	1	5	101	24	2.42	Corridors
Fluorescent 1x28W	1	5	34	13	0.44	Corridors
Fluorescent 2x21W	1	5	50	24	1.21	Hallways
LED 35W	1	5	35	2	0.07	Corridors
LED 80W	1	5	80	2	0.16	Corridors
Fluorescent 2x54W	1	5	130	22	2.85	Corridors
Fluorescent 2x28W	1	5	67	6	0.40	Corridors
Fluorescent 1x35W	1	5	42	131	5.50	Corridors
Fluorescent 3x35W	1	5	126	4	0.50	Corridors
Fluorescent 5x35W	1	8	210	3	0.63	Offices
Fluorescent 6x35W	1	8	252	5	1.26	Offices
Compact fluorescent 2x42W	1	8	101	26	2.62	Offices
Fluorescent 4x24W	1	8	115	32	3.69	Offices
Fluorescent 2x18W	1	8	43	13	0.56	Offices
Halogen 100W	1	8	100	232	23.20	Offices
Fluorescent 2x54W	1	8	130	304	39.40	Offices
Fluorescent 2x28W	1	2	67	18	1.21	Technical rooms
Fluorescent 4x24W	1	2	115	4	0.46	Social services
LED 13W	1	2	13	9	0.12	Social services
Compact fluorescent 2x26W	1	2	62	175	10.92	Social services

Compact fluorescent 2x26W	1	2	62	32	2.00	Social services
Fluorescent 2x35W	1	8	84	12	1.01	Administration
LED 2x45W	1	8	90	26	2.34	Atrium
Fluorescent 2x54W	1	5	130	334	43.29	Corridors
Fluorescent 4x24W	1	5	115	70	8.06	Corridors
Fluorescent 2x28W	1	5	67	2	0.13	Corridors
Fluorescent 1x54W	1	5	65	10	0.65	Corridors
LED 13W	1	5	13	799	10.39	Corridors
Fluorescent 1x35W	1	5	42	62	2.60	Corridors
Fluorescent 1x21W	1	5	25	8	0.20	Corridors
Compact fluorescent 2x26W	1	5	62	7	0.44	Corridors
Fluorescent 4x24W	1	8	115	543	62.55	Laboratories
Fluorescent 2x35W	1	8	84	167	14.03	Laboratories
LED 40W	1	8	40	125	5.00	Laboratories
Fluorescent 2x54W	1	8	130	41	5.31	Laboratories
Fluorescent 2x54W	1	2	130	30	3.89	Technical facilities
Fluorescent 1x54W	1	2	65	4	0.26	Technical facilities
Fluorescent 2x54W	1	8	130	77	9.98	Offices
Fluorescent 4x24W	1	8	115	68	7.83	Offices
LED 40W	1	8	40	12	0.48	Offices
Halogen 100W	1	8	100	28	2.80	Offices
Fluorescent 4x24W	1	2	115	47	5.41	Social services
Compact fluorescent 2x26W	1	2	62	112	6.99	Social services
Fluorescent 2x54W	1	5	130	87	11.28	Warehouses
Fluorescent 4x24W	1	5	115	62	7.14	Warehouses
Halogen 100W	1	5	100	15	1.50	Warehouses
LED 13W	1	5	13	7	0.09	Warehouses
Halogen 150W	Outdoor	8	150	129	19.35	-
Halogen 35W		8	35	65	2.28	-
Compact fluorescent 35W		8	42	35	1.47	-
Total building no. 1 (kW)					315.10	kW
Total outdoor lighting (kW)					23.10	kW
Total fluorescent lighting					**243.56**	**kW**
Total halogen lighting fixtures					**49.13**	**kW**
Total compact fluorescent lamps					**26.85**	**kW**
Total LED luminaires					**18.66**	**kW**
Total					**338.19**	**kW**

Basic data on significant energy consumers

This chapter contains specifications of significant energy consumers in the initial state of the analyzed energy management system. Basic data on significant energy consumers mainly include data on the type of consumer, energy consumption, daily operating hours, and method of regulation.

The building houses research technology equipment (lasers), compressors, cranes, elevators, cooling and heating pumps, circulation units, and other technology. The total power consumption of the technology in the building is estimated at 2,220.09 kW.

Table 4.5.39: List of significant energy consumers

Name	Power consumption (kW)	Number (pcs)	Total power consumption (kW)	Energy	Operating utilization (hours/day^{-1})	Location/zone
Remeza BK 50 compressor	37.00	1	37	EE	8	Engine room
BSJ compressor	20.00	2	40	EE	8	Engine room
Cranes	50.00	1	50.00	EE	8	Eli Beamlines Building
Elevators	76.40	1	76.40	EE	8	Eli Beamlines Building
Heating cables	29.74	1	29.74	EE	12	Eli Beamlines Building
Heat and cooling pumps	-	-	933.70	EE	15	Eli Beamlines Building
Circulation units	-	372	553.21	EE	15	Eli Beamlines Building
Other technological facilities	500.00	1	500.00	EE	8	Eli Beamlines Building
Total		**382**	**2220.09**			

Findings:

The installed appliances are in good condition and do not affect the assessment of the proposed measures.

Conclusion:

Two energy sources are used in the building in question, namely electricity and natural gas.

Natural gas is used for heating and hot water.

Electricity is used for heating, lighting, ventilation, cooling, air humidity control, and the operation of research technology equipment.

To reduce electricity consumption from the distribution network, the installation of a photovoltaic power plant on the roof of the building is proposed.

To increase the efficiency of combined heat and power production, the installation of a cogeneration unit is proposed.

5 BALANCE SHEET CALCULATIONS

5.1 Electricity and energy consumption

The client provided electricity consumption and costs in the form of invoices for 2017, 2018, 2019, 2020, and January 2021. Access to online electricity consumption management was also provided.

In 2017 and 2018, the electricity supplier was E.ON Energie, a.s., and in 2019 and 2020, the electricity supplier was Veolia Komodity ČR, s.r.o. Since 2021, the electricity supplier has been EP Energy Trading, a.s., through a single consumption point connected to the HV distribution system via a transformer station owned by the consumer.

Specification of the consumption and transfer point (OPM):

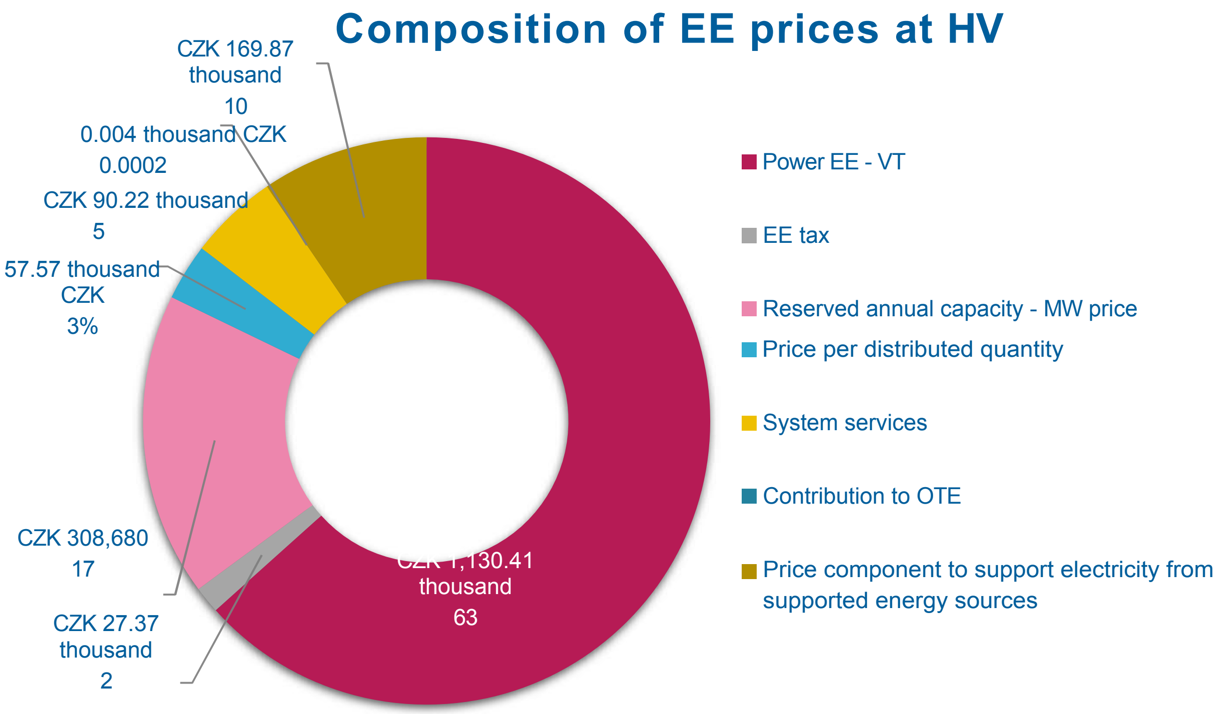
Supplier:	EP ENERGY TRADING, a.s.
Supplier address:	Klimentská 1216/46, 110 02 Prague
Address of the point of delivery:	Za Radnicí 835, 252 41 Dolní Břežany
EAN OPM:	859182400609758444
Reserved power input:	2,593 kW
Annual reserved capacity:	1,750 kW

For the purpose of analyzing the savings potential, an annual reserved capacity has been agreed upon, with only a minimal exceedance of the annual reserved capacity recorded in 2020, with a negligible impact on the price of electricity. We do not propose optimizing the reserved capacity.

Table 5.1.1: Composition of the EE price from HV for January 2021

Breakdown of EE price from HV for January 2021				
Power electricity				
Item	Unit	Unit price (CZK/Unit)	Quantity (Unit)	Total price (CZK)
Power EE - VT	MWh	1,169.00	967	1,130,411.31
Tax on EE	MWh	28.30	967.0	27,365.82
Distribution				
Item	Unit	Unit price (CZK/Unit)	Quantity (Unit)	Total price (CZK)
Reserved annual capacity	MW	176,388.00	1.75	308,679.00
Price per distributed quantity	MWh	59.54	967.0	57,574.58
System services	MWh	93.30	967.0	90,220.17
Contribution to OTE	month	3.91	1	3.91
Price component to support electricity from POZE	MW	65,510.69	2.59	169,869.22
Total (excluding fixed salaries) VT	**MWh**	**1,350.14**	**967.0**	**1,305,571.88**
Fixed salaries	**month**	**478,552.13**	**1**	**478,552.13**
Total including fixed salaries	**MWh**	**1,845.03**	**967.0**	**1,784,124.01**

Chart 5.1.1: Composition of EE prices from HV for January 2021



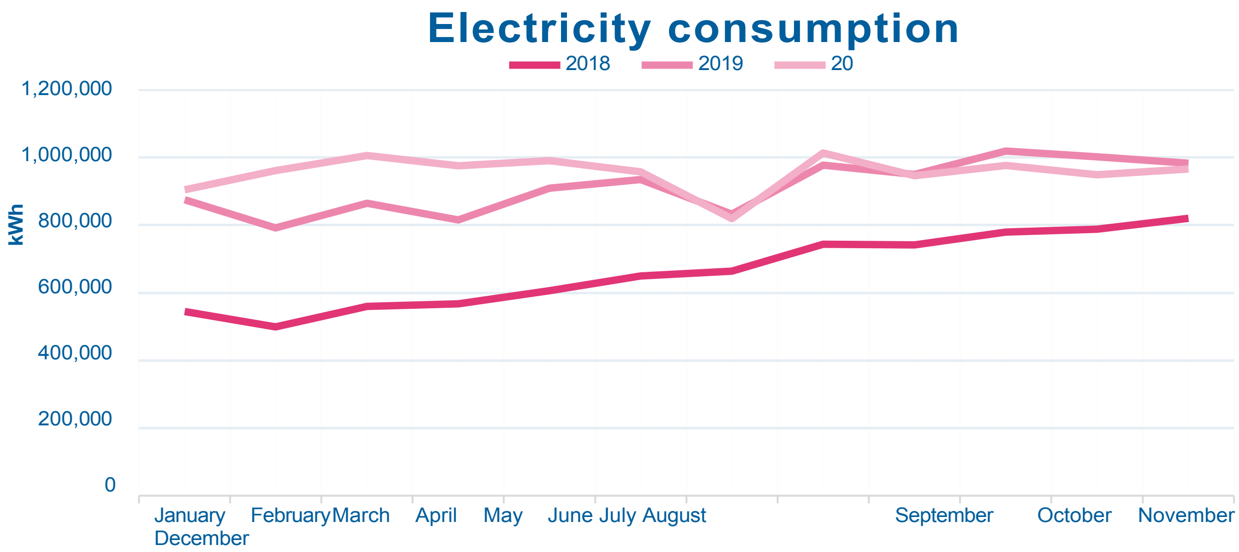
The above graph shows the breakdown of the electricity price based on the invoice for January 2021.

The graph shows that the largest share of the electricity price structure is accounted for by the high-tariff power EE component and the annual reserved capacity.

Table 5.1.2: Overview of electricity consumption in kWh

Month	2018			2019			20		
	Consumption [kWh]	Cost [CZK]	CZK / kWh	Consumption [kWh]	Cost [CZK]	CZK / kWh	Consumption [kWh]	Cost [CZK]	CZK / kWh
January	544,440	915,726	1.68	874,370	1,683,623	1.93	903,620	1,852,932	2.05
February	498,745	877,105	1.76	791,250	1,517,148	1.92	960,776	1,941,077	2.02
March	559,648	940,359	1.68	863,981	1,616,081	1.87	1,005,526	2,010,091	2.00
April	567,148	983,298	1.73	815,114	1,549,610	1.90	975,055	1,948,364	2.00
May	605,298	1,022,691	1.69	909,056	1,677,395	1.85	990,454	1,969,144	1.99
June	649,222	1,058,554	1.63	933,865	1,711,142	1.83	957,133	1,917,756	2.00
July	663,180	1,082,549	1.63	832,210	1,621,398	1.95	818,987	1,704,709	2.08
August	742,896	1,164,979	1.57	977,169	1,818,578	1.86	1,013,095	2,004,061	1.98
September	740,658	1,172,223	1.58	948,890	1,765,948	1.86	945,989	1,900,569	2.01
October	778,621	1,211,480	1.56	1,018,900	1,855,933	1.82	975,770	1,946,498	1.99
November	787,073	1,220,220	1.55	1,001,790	1,832,659	1.83	948,160	1,903,927	2.01
December	820,134	1,294,416	1.58	982,543	1,806,475	1.84	965,458	1,947,944	2.02
Total	7,957,063	12,943,600	1.63	10,949,138	20,455,990	1.87	11,460,023	23,047,072	2.01

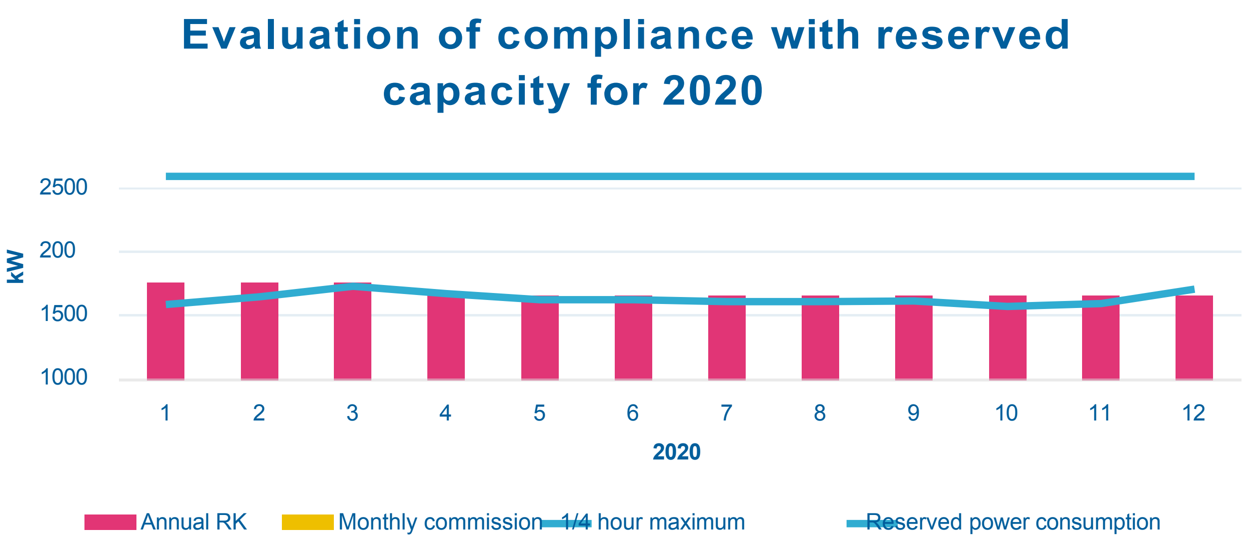
Chart 5.1.2: Electricity consumption



Findings:

The graph above shows that electricity consumption in 2018 was significantly lower than in subsequent years because the center was not operating at full capacity. In 2019, consumption is already close to the 2020 level, when the center was operating at full capacity. The consumption trend throughout the year is constant, with a slight decline in July. The relatively constant electricity consumption is mainly due to the use of technology, ventilation, and humidity control, which have stable consumption throughout the year. Consumption, costs, and unit prices are increasing year-on-year.

Chart 5.1.3: Evaluation of reserved capacity compliance for 2020



Finding:

Between January and March, an annual reserved capacity of 1.75 MW was agreed. Since March, the annual reserved capacity has been reduced to 1.65 MW. In April, the annual reserved capacity was supplemented by a monthly reserved capacity of 15 kW. The reserved capacities were exceeded only in December, with a negligible impact on the price of electricity. We do not propose optimizing the reserved capacities.

5.2 Natural gas consumption

The contracting authority provided monthly electricity consumption and costs in the form of invoices for 2017, 2018, 2019, 2020, and January 2021. Hourly natural gas consumption for 2020 was also provided.

The natural gas supplier is Pražská plynárenská, a.s., through a single supply point. Specification of

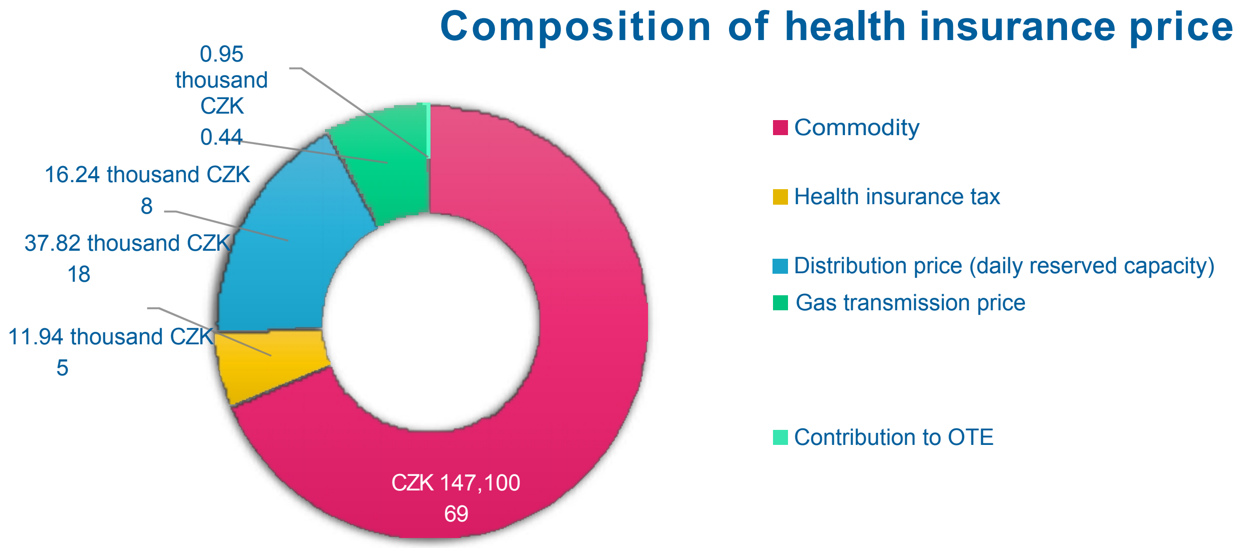
the supply and transfer point (OM):

Supplier:	Pražská plynárenská a.s.
Supplier address:	Národní 37/38, 110 00 Prague
Address of the collection point:	Za Radnicí 835, 252 41 Dolní Břežany
EIC OM:	27ZG100Z0579511N
Daily reserved capacity:	2007 m³

Table 5.2.1: Composition of the ZP price for January 2021

Composition of the ZP price for January 2021				
Commodity				
Item	Unit	Unit price (CZK/unit)	Quantity (Unit)	Total price (CZK/unit)
Commodity	MWh	377.00	390.2	147,097
Tax on electricity	MWh	30.60	390.2	11,939
Distribution				
Item	Unit	Unit price (CZK/Unit)	Quantity (Unit)	Total price (CZK/unit)
Distribution price (Daily reserved capacity)	month	1,766.19	21.4	37,821
Price for gas transmission	MWh	41.61	390.2	16,235
Contribution to OTE	MWh	2.44	390.2	952
Total (excluding fixed salaries)	**MWh**	**451.65**	**390.2**	**176,223**
Total fixed salaries	**month**	**1,766.19**	**21.4**	**37,821**
Total including fixed salaries	**MWh**	**548.58**	**390.2**	**214,044**

Chart 5.2.1: Composition of health insurance prices for January 2021



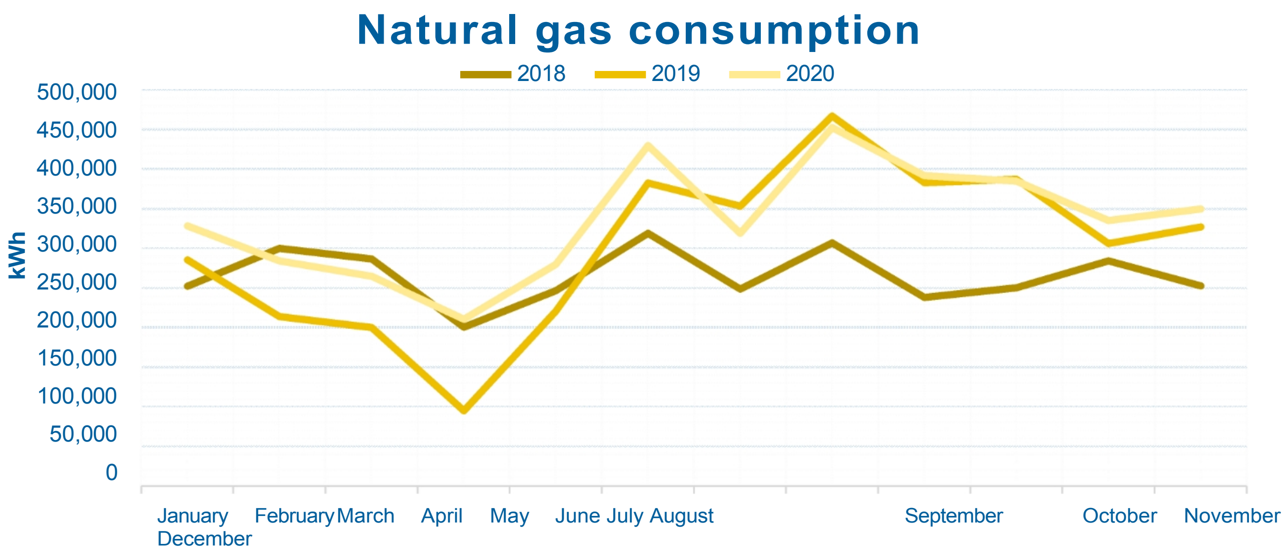
The above chart shows the breakdown of the natural gas price based on the invoice for January 2021.

The graph shows that commodities account for the largest share of the price structure.

Table 5.2.2: Overview of natural gas consumption in kWh

Month	2018			2019			20		
	Consumption [kWh]	Cost [CZK]	CZK / kWh	Consumption [kWh]	Cost [CZK]	CZK / kWh	Consumption [kWh]	Cost [CZK]	CZK / kWh
January	252,100	152,151	0.60	285,610	209,400	0.73	328,270	213,875	0.65
February	300,100	176,632	0.59	213,920	163,431	0.76	284,330	190,261	0.67
March	286,790	169,844	0.59	200,040	154,530	0.77	264,938	179,837	0.68
April	200,720	125,939	0.63	94,960	112,686	1.19	210,674	150,675	0.72
May	246,510	149,297	0.61	220,536	167,674	0.76	279,700	187,777	0.67
June	319,130	186,342	0.58	382,640	271,628	0.71	429,832	268,451	0.62
July	248,540	150,333	0.60	353,650	253,039	0.72	318,980	208,882	0.65
August	306,770	180,034	0.59	467,510	326,047	0.70	452,698	280,739	0.62
September	238,100	145,006	0.61	383,140	271,946	0.71	391,876	248,053	0.63
October	250,180	151,168	0.60	387,270	274,593	0.71	385,138	244,432	0.63
November	284,070	168,456	0.59	306,220	222,621	0.73	335,371	217,687	0.65
December	252,710	152,462	0.60	327,026	235,961	0.72	349,675	225,374	0.64
Total	3,185,720	1,907,664	0.60	3,622,522	2,663,556	0.74	4,031,482	2,616,043	0.65

Chart 5.2.2: Natural gas consumption



Findings:

The graph above shows that consumption fluctuates from month to month, with gas consumption peaking in the summer months. Natural gas consumption is growing year-on-year, while costs and unit prices rose in 2019 and fell slightly in 2020. The highest consumption was recorded in August 2019.

Summary of energy consumption and prices in 2018–2020

The following table summarises consumption and costs for the period 2018–2020. As the research centre did not operate at full capacity in 2018 and 2019, data from 2020 are used as calculation values for the subsequent calculations.

Table 5.1: Energy consumption and prices in the period 2018–2020

Energy carrier		2018	2019	20	Calculation hours
Electricity	Consumption [MWh]	7,957.06	10,949.14	11,460.02	11,460.02
	Consumption [GJ]	28,645.43	39,416.90	41,256.08	41,256.08
	Costs [CZK]	12,943,600	20,455,990	23,047,072	23,047,072
Natural gas	Consumption [MWh]	3,185.72	3,622.52	4,031.48	4,031.48
	Consumption [GJ]	11,468.59	13,041.08	14,513.34	14,513.34
	Costs [CZK]	1,907,664	2,663,556	2,616,043	2,616,043
Total	Consumption [MWh]	11,142.78	14,571.66	15,491.51	15,491.51
	Consumption [GJ]	40,114.02	52,457.97	55,769.42	55,769.42
	Costs [CZK]	14,851,264	23,119,546	25,663,115	25,663,115

5.4. Evaluation of the initial status

The total energy balance is calculated based on invoiced or otherwise documented energy consumption over the last three years for the long-term climatic average of outdoor temperature conditions, with all input data used to convert consumption to the long-term average of outdoor temperature conditions being specified. The conversion is performed using degree days.

Climatic conditions

Table 5.4.1: Climatic conditions

Environmental parameters			
Location	Prague (Karlov)		
Czech Hydrometeorological Institute climate station	Ruzyně		
Climate region	I		
Altitude	-	181	m
Outdoor design temperature	t_e	-12	°C
Average indoor temperature	thousand	20	°C
Def. temperature for starting heating		13	°
Average outdoor temperature	tes	2.89	°
Number of days in the heating season	d	198	days
Number of degree days	$D° = d.(t_{is} - t_{es})$	3,388	D°

Conversion of energy consumption for heating to long-term climate average

Table 5.4.2: Conversion of energy consumption for heating to long-term climate average

Period evaluated	Year	Year	Year	Average / DDP 30
Annual energy consumption for heating based on accounting documents (GJ/year)	11,176	12,759	14,180	14,180
Number of degree days °D for average indoor temperature	2,816	3,366	3,311	3,388
Percentage of degree days relative to long-term climate norm	83	99	98	93
Annual energy consumption for heating converted to long-term climate average (GJ/year)	13,447	12,843	14,511	15,183

Table 5.4.3: Climate data and recalculation of energy consumption for heating by month – 2018

Month	Average temperature (℃)	Number of heating days	Number of degree days	Actual energy consumption for heating (GJ)	Standardized energy consumption for heating (GJ)
January	4.3	31	486	1929	2320
February	-1.0	28	588	2333	2806
March	2.9	31	531	2108	2536
April	11.3	10	87	346	416
May	0	0	0	0	0
June	0	0	0	0	0
July	0	0	0	0	0
August	0	0	0	0	0
September	16.9	5	15	61	73
October	11.9	22	178	708	852
November	5.8	30	426	1690	2033
December	3.7	31	505	2003	2410
Total	**4.7**	**188**	**2816**	**11,176**	**13,447**

Table 5.4.4: Climate data and recalculation of energy consumption for heating on a monthly basis – 2019

Month	Average temperature (℃)	Number of heating days	Number of degree days	Actual energy consumption for heating (GJ)	Standardized energy consumption for heating (GJ)
January	-0.6	31	639	2421	2437
February	2.6	28	487	1847	1859
March	6.6	31	415	1575	1585
April	9.8	26	265	1005	1012
May	10.7	26	242	917	923
June	0	0	0	0	0
July	0	0	0	0	0
August	0	0	0	0	0
September	14.2	10	58	220	221
October	9.9	27	273	1034	1041
November	5.4	30	438	1660	1671
December	2.3	31	549	2080	2094
Total	**5.1**	**240**	**3366**	**12,759**	**12,843**

Table 5.4.5: Climate data and recalculation of energy consumption for heating on a monthly basis – 2020

Month	Average temperature (°C)	Number of heating days	Number of degree days	Actual energy consumption for heating (GJ)	Standardized energy consumption for heating (GJ)
January	1.2	31	583	2496	2555
February	4.7	28	428	1835	1878
March	4.6	31	477	2045	2093
April	10.2	27	265	1133	1160
May	11.6	24	202	864	884
June	0	0	0	0	0
July	0	0	0	0	0
August	0	0	0	0	0
September	15.3	10	47	201	206
October	9.7	29	299	1279	1309
November	4.2	29	458	1963	2008
December	2.2	31	552	2364	2419
Total	**5.3**	**240**	**3311**	**14180**	**14,511**

Table 5.4.6: Determination of climate normals on a monthly basis

Month	Average temperature (°C)	Number of heating days	Number of degree days	Distribution of degree days by month (%)	Standardized energy consumption for heating (GJ)
January	1.2	31	583	17.6	2496
February	4.7	28	428	12.9	1835
March	4.6	31	477	14.4	2045
April	10.2	27	265	8.0	1133
May	11.6	24	202	6.1	864
June	0	0	0	0	0
July	0	0	0	0	0
August	0	0	0	0	0
September	15.3	10	47	1.4	201
October	9.7	29	299	9.0	1279
November	4.2	29	458	13.8	1963
December	2.2	31	552	16.7	2364
Total	**5.3**	**240**	**3311**	**100.0**	**14180**

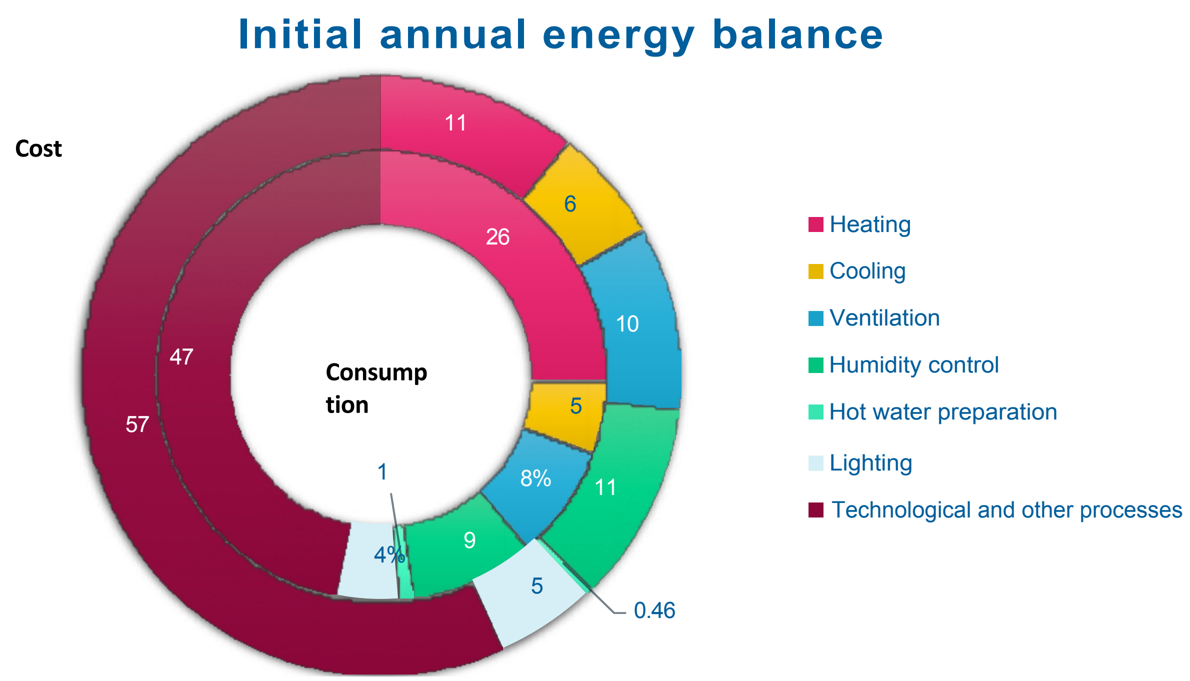
Energy balance of the current situation

Corresponds to the energy balance of average energy consumption for the period under review, converted to average climatic conditions.

Table 5.4.7: Energy balance of the current state

Energy balance of the current state				
No.	Indicator	Energy		Cost
		(GJ)	(MWh)	(thousand CZK)
1	Fuel and energy inputs	56,772.45	15,770.13	17,425
2	Change in fuel stocks	0	0	0
3	Fuel and energy consumption	56,772.45	15,770.13	17,425
4	Energy sales to third parties	0	0	0
5	**Final consumption of fuel and energy in the building**	**56,772.45**	**15,770.13**	**17,425**
6	Losses in own source and distribution systems	4,208.88	1,169.13	531
7	Energy consumption for heating	15,182.96	4,217.49	1,985
8	Energy consumption for cooling	2846.64	790.73	1,068
9	Energy consumption for hot water preparation	633.93	176.09	80
10	Energy consumption for ventilation	4572.49	1270.14	1,715
11	Energy consumption for humidity control	4960.97	1378.05	1,861
12	Energy consumption for lighting	2,437.91	677.20	914
13	Energy consumption for technological and other processes	26,137.55	7,260.43	9,803

Chart 5.4.1: Energy balance of the current situation



6 Energy specialist's recommendations regarding the assessed proposal

(Section 5(1) of Decree No. 480/2012 Coll. on energy audits and energy assessments)

This chapter contains basic information on the proposed energy-saving measures that will be included in the relevant options based on the identified amount of achievable energy savings.

The evaluation of the set of energy-saving measures determines the amount of savings achieved in both energy consumption and annual operating costs for their purchase. Knowledge of the energy intensity of the initial state and the new state of the analyzed energy management will enable an adjusted energy balance to be performed, which documents the degree of utilization of the energy savings potential.

The calculations of financial savings for individual measures were based on a unit price of CZK 1.350/kWh for electricity and CZK 0.452/kWh for natural gas. The calculated unit prices were determined from the latest invoices as unit prices without fixed fees.

All prices in the document are listed without VAT.

Evaluated economic variables

The economic evaluation is performed according to the criteria listed below, with the main decision-making criterion for selecting the optimal variant being the net present value (NPV) criterion, and the supplementary criteria for the information of the contracting authority being the internal rate of return (IRR), return on investment (ROI), and real payback period (Tsd).

Discount (r):

Discount is the so-called opportunity cost used in discounted cash flow calculations. Simply put, it is the percentage return we would receive if we invested the intended amount in another project with the same risk level or, for example, simply deposited it in an account.

For energy assessments pursuant to Section 9a(1)(e) of Act No. 406/2000 Coll. - the Energy Management Act, the discount factor is set at 1.04, i.e. 4%. This value significantly increases the real return on investment, which may be offset by a possible increase in energy prices in energy price development scenarios.

Net present value (NPV):

Net present value (NPV) is a financial measure expressing the total present (i.e., discounted) value of all cash flows related to an investment project.

It includes the project's lifetime (we consider a project evaluation period of 20 years) and the possibility of investing in another project with the same risk. It takes into account the time value of money and depends only on anticipated cash flows and alternative capital costs.

The advantage of this method is that it can be used to describe any cash flows, and also the fact that the result is the absolute value of the investment's benefit in today's prices (it can be added up). The resulting value indicates how much money the investment will bring to the company. If the NPV is positive, the project is acceptable. When comparing multiple investment alternatives, a higher NPV is preferred. If the NPV is negative, the project is either unacceptable or the evaluation period is shorter than the project's lifetime.

$$\mathbf{NPV = \sum_{t=1}^{T_ž} CF_t \cdot (1 + r)^{-t} - IN}$$

(thousand CZK /r)

$T_ž$ is the lifetime (evaluation) of the project (years)
CF_t are the annual benefits of the project (change in cash flows after project implementation) (thousand CZK) r is the discount rate
$(1 + r)^{-t}$ is the discount factor
IN is the investment expenditure of the project (in thousands of CZK)

Internal rate of return (IRR):

The internal rate of return (IRR) tells us what percentage we will earn on the evaluated project, taking into account the time value of money. The IRR is also a discount rate that, when substituted into the formula for net present value, gives NPV = 0.

IRR can only be used for investments with conventional cash flows, where the sign of the cash flows in each period changes only once. For unconventional cash flows, where the sign of the cash flows changes several times in each period, the IRR can take on multiple values. If we have only positive cash flows (e.g., we receive a subsidy for the initial investment), the IRR may not exist at all.

$$\mathbf{\sum_{t=1}^{T_ž} CF_t \cdot (1 + IRR)^{-t} - IN = 0}$$

(%)

Real payback period T_{sd}

Real payback period T_{sd} takes into account the effect of time on an investment project. It is therefore the period of repayment of the investment assuming a discount rate.

$$\sum_{t=1}^{T_{sd}} CF_t \cdot (1 + r)^{-t} - IN = 0 \qquad \text{(years)}$$

Return on investment (ROI):

Return on investment (ROI) expresses the rate of return on all invested funds as a percentage (how many units of funds were earned by one unit of funds spent). It is calculated from the ratio of the average annual profit (savings) to the investment costs of the project.

The indicator characterizes the project's rate of return and can be used to compare the profitability of the evaluated project with the usual rate of return in the industry. It can also be used to evaluate the profitability of the investment itself and to compare two or more investments in order to select the best one. In practice, ROI is used to decide whether to make a given investment, which investment will be more profitable, or which combination of investments will be most profitable within the available financial resources.

ROI = returns (savings) / investment * 100 (%)

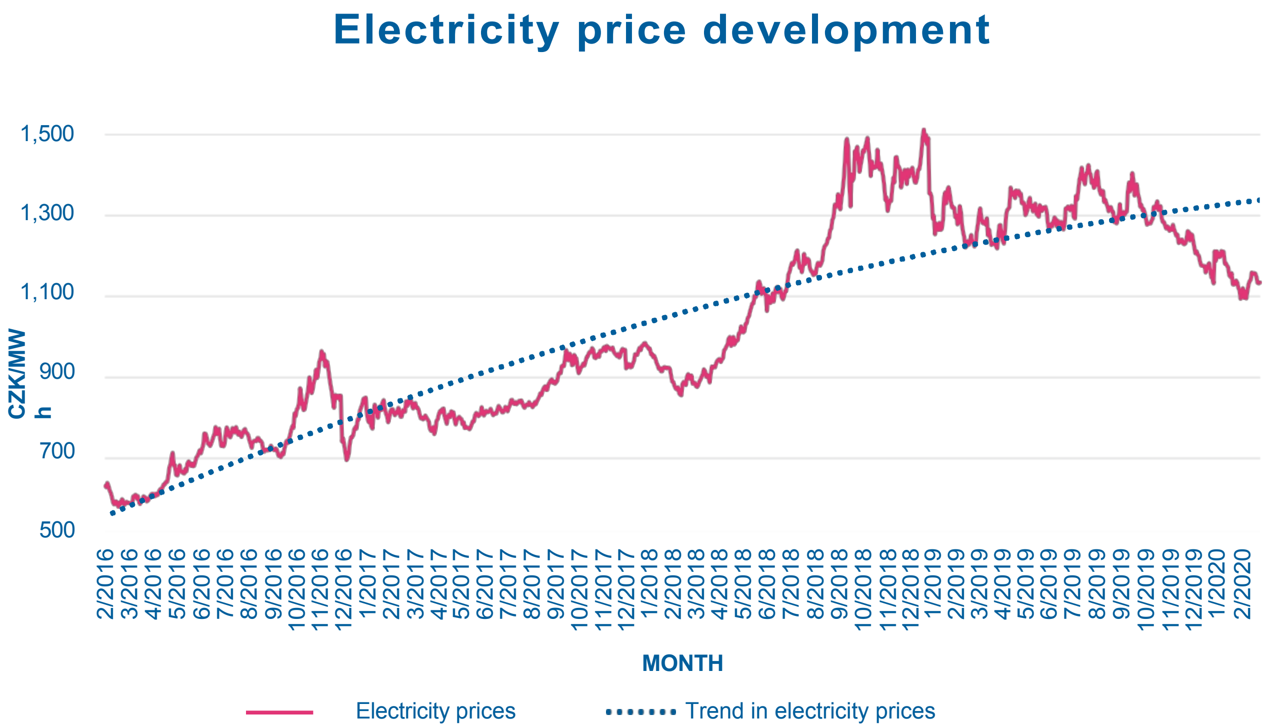
Energy price trends

Electricity price trends over the last three years

The graph below shows the development of the price of electricity on the Prague Energy Exchange. As can be seen, from the beginning of 2016 to the turn of 2018 and 2019, the price rose continuously from approximately CZK 650/MWh to approximately CZK 1,500/MWh. The price then stabilized, and only at the end of the period under review can a slight decline to approximately CZK 1,150/MWh be observed.

According to analysts, a further decline in prices is not to be expected; on the contrary, the upward trend in prices may be quite significant. The decline in prices in previous years was mainly due to falling oil and coal prices and developments on the German market, where renewable energy sources are heavily subsidized due to the shift away from nuclear energy, and supply now significantly exceeds demand. Given that Germany has committed to closing its last nuclear power plant by 2022, the situation is expected to reverse and electricity prices may rise sharply due to a shortage of domestic resources.

Chart 6.1: Electricity price trends over the last three years



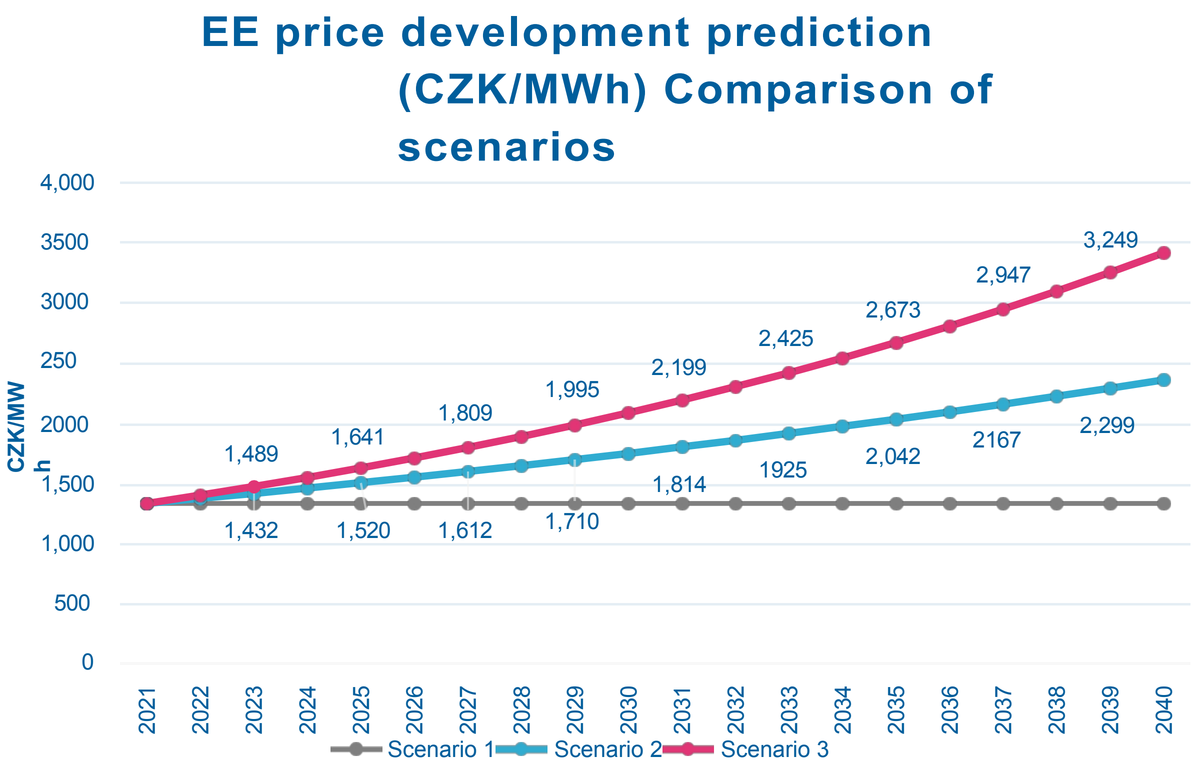
Scenarios for the expected development of electricity prices

Although it is highly unlikely that electricity prices will remain unchanged in the coming years, we do not consider an increase in electricity prices in our economic assessment, which has a negative impact on the real payback period of energy-saving measures. To capture possible price developments, we have added two scenarios below, one considering a moderate price increase and one assuming a more significant price increase. Both are created in accordance with the price development analysis and are set in conditions that are as realistic as possible. Both scenarios should primarily serve to illustrate the impact of electricity prices on the real return on investment.

Table 6.1: Scenarios for expected price development

Rank	Year	Scenario 1		Scenario 2		Scenario 3	
		Price change [%]	EE price [CZK/MWh]	Price change [%]	EE price [CZK/MWh]	Price change [%]	EE price [CZK/MWh]
1.	2021	0	1,350	0	1,350	0	1,350
2.	2022			3	1,391	5	1,418
3	2023			3	1,432	5	1,489
4	2024			3	1,475	5%	1,563
5	2025			3	1,520	5	1,641
6	2026			3	1,565	5	1,723
7	2027			3	1,612	5	1,809
8	2028			3	1,661	5	1,900
9	2029			3	1,710	5	1,995
10	2030			3	1,762	5	2,095
11	2031			3	1,814	5	2,199
12	2032			3	1,869	5	2,309
13	2033			3	1,925	5	2,425
14	2034			3%	1,983	5	2,546
15	2035			3	2,042	5	2,673
16	2036			3	2,103	5	2,807
17	2037			3	2,167	5	2,947
18	2038			3	2,232	5	3,095
19	2039			3	2,299	5	3,249
20	2040			3	2,367	5	3,412

Chart 6.2: Prediction of EE price development (CZK/MWh)

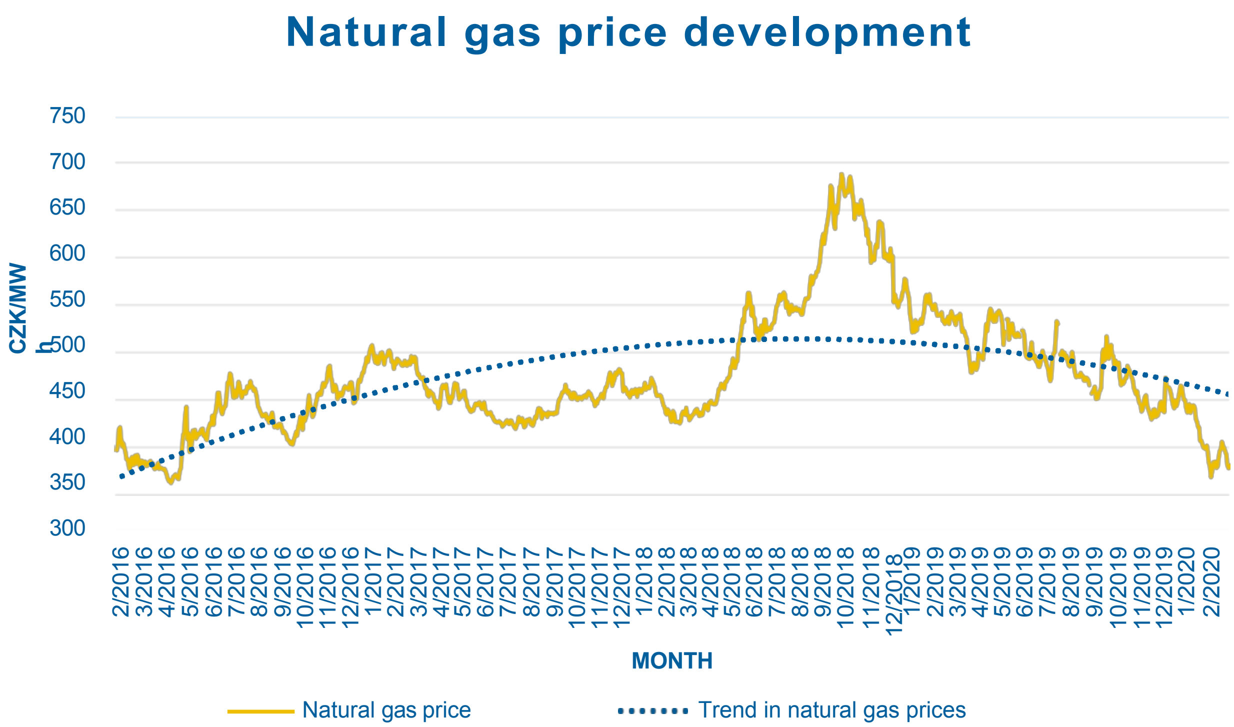


Natural gas price trends over the last three years

The graph below shows the development of natural gas prices on the Prague Energy Exchange. The graph shows that since the beginning of 2016, the price of natural gas has risen steadily to a maximum of approximately CZK 680/MWh in October 2019. Since then, a steady decline has been observed to the current value of approximately CZK 400/MWh.

Coal is one of the largest producers of greenhouse gases, and given the ever-increasing needs and pressures to reduce emissions (e.g., under the Paris Agreement, countries are committed to reducing their emissions by 40% by 2030), it is necessary to use less polluting energy sources such as natural gas. As a result, further investments in gas pipelines and the use of natural gas as an energy source are expected. Consequently, no significant increase in energy prices is currently anticipated.

Chart 6.3: Natural gas price trends over the last three years



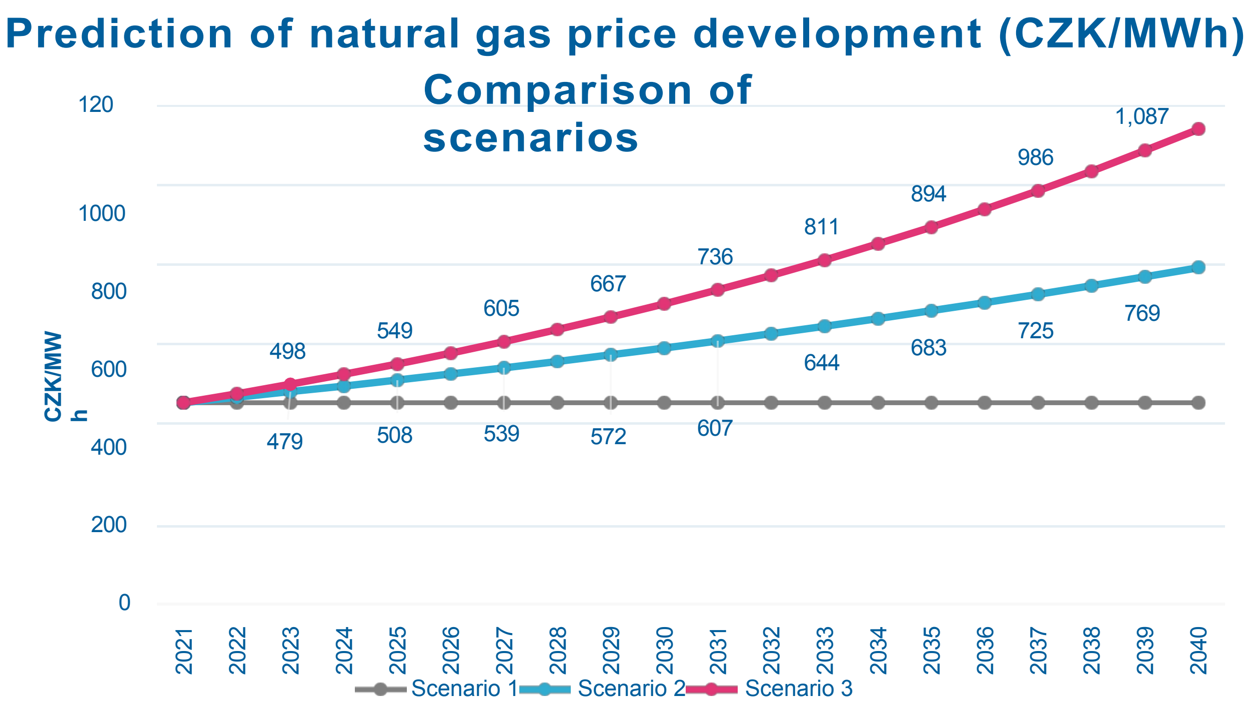
Scenarios for the expected development of natural gas prices

Although it is highly unlikely that natural gas prices will remain unchanged in the coming years, we do not anticipate an increase in natural gas prices in our economic assessment, which has a negative impact on the real payback period of energy-saving measures. To capture possible price developments, we have added two scenarios below, one considering a moderate price increase and one assuming a more significant price increase. Both are based on price trend analysis and are set in conditions that are as realistic as possible. Both scenarios should primarily serve to illustrate the impact of natural gas prices on the real return on investment.

Table 6.2: Scenarios for expected price developments

Rank	Year	Scenario 1		Scenario 2		Scenario 3	
		Price change [%]	ZP price [CZK/MWh]	Price change [%]	Gas price [CZK/MWh]	Price change [%]	Gas price [CZK/MWh]
1.	2021	0	452	0	452	0	452
2.	2022			3	465	5	474
3	2023			3	479	5%	498
4	2024			3	494	5%	523
5	2025			3	508	5	549
6	2026			3	524	5	576
7	2027			3	539	5	605
8	2028			3	555	5	636
9	2029			3	572	5	667
10	2030			3	589	5	701
11	2031			3	607	5	736
12	2032			3	625	5	772
13	2033			3	644	5	811
14	2034			3	663	5	852
15	2035			3	683	5	894
16	2036			3	704	5	939
17	2037			3%	725	5	986
18	2038			3	747	5	1,035
19	2039			3	769	5	1,087
20	2040			3	792	5	1,141

Chart 6.4: Prediction of natural gas price development (CZK/MWh)



6.1 Description of HVAC systems – proposed status

Investment measures

This chapter contains specifications for energy-saving measures for parts of the technical equipment of the APU and parts of the technological equipment, the implementation of which requires certain investment costs.

To be eligible for activities under 5.3 b), buildings must meet the average required heat transfer coefficient $U_{em} = 0.24\ W \cdot m^{-2} \cdot K^{-1} < U_{em,N} = 0.25\ W \cdot m^{-2} \cdot K^{-1}$.

Measure No. 1 Installation of a cogeneration unit

Cogeneration units enable the production of heat and electricity from a single source. They combine a combustion engine, a generator, a system of heat exchangers, and a control system that allows the units to be controlled both locally and remotely using a PC.

From a thermodynamic point of view, cogeneration units reduce the consumption of primary energy in the form of fossil fuels. This is achieved by producing electricity during heat production. Otherwise, electricity would have to be produced in conventional coal or nuclear power plants with lower efficiency.

Another major advantage directly related to primary energy savings is the positive impact on the environment. This is mainly due to lower fuel consumption, which would otherwise be consumed in the separate production of heat and electricity, and thus significantly lower negative consequences of their extraction and combustion. First and foremost, the amount of greenhouse gases (carbon dioxide) produced is reduced. Furthermore, the production of harmful oxides, such as nitrogen and sulfur oxides, is reduced.

For the purposes of analyzing the savings potential, a cogeneration unit with an electrical output of 430 kW and a thermal output of 669 kW was designed. The total efficiency of combined production is 94.5%. The number of operating hours per year was set at 8,400, taking into account the operating hours on the premises and the consumption of electricity and natural gas for heating.

The calculation of electricity production was performed in hourly increments based on hourly consumption data. The calculation takes into account the production of electricity by a photovoltaic power plant, which will be installed at the same time as the cogeneration unit. Heat production was calculated on an hourly basis based on hourly natural gas consumption. The thermal output of the cogeneration unit is considered based on hourly heat requirements.

Table 6.1.1: Evaluation of measures

Proposed cogeneration unit		
Cogeneration unit	Electrical output of the unit (kW)	430
	Thermal output of the unit (kW)	669.0
	Overall efficiency (%)	94.5
	Electrical efficiency (%)	37.0
	Thermal efficiency (%)	57.5
	Number of motor hours per year	8,400
	Total costs (CZK)	15,000,000

Electricity

Table 6.1.2: Overview of EE consumption and production

Overview of EE consumption and production					
Month	Current	Proposed status			
	Consumption (MWh)	Production (MWh)	Overflow (MWh)	Uncovered consumption (MWh)	Savings (%)
January	903.62	202.60	0.00	701.02	22.4
February	960.78	175.29	0.00	785.49	18.2
March	1005.53	162.43	0.00	843.10	16.2
April	975.06	129.24	0.00	845.82	13.3
May	990.45	170.08	0.00	820.38	17.2
June	957.13	258.23	0.00	698.90	27
July	818.99	193.79	0.36	625.55	23.6
August	1013.10	269.40	0	743.70	26.6
September	945.99	235.87	0.00	710.12	24.9
October	975.77	234.28	0.00	741.49	24.0
November	948.16	205.45	0.00	742.71	21.7
December	965.46	214.36	0.00	751.10	22.2
Total	**11,460.02**	**2,451.00**	**0.36**	**9,009.38**	**21.4**

Table 6.1.3: Overview of EE costs

Overview of EE costs	
Current electricity costs (CZK/year)	23,047,072
Electricity price (CZK/MWh)	1,350
Total annual KGJ production (MWh/year)	2,451.00
Overflows (MWh/year)	0.36
Total annual KGJ production after deducting overflows (MWh/year)	2,450.65
Total annual KGJ profit after deducting overflows (CZK/year)	**3,308,374**

Chart 6.1.1 Comparison of unmet consumption and EE production

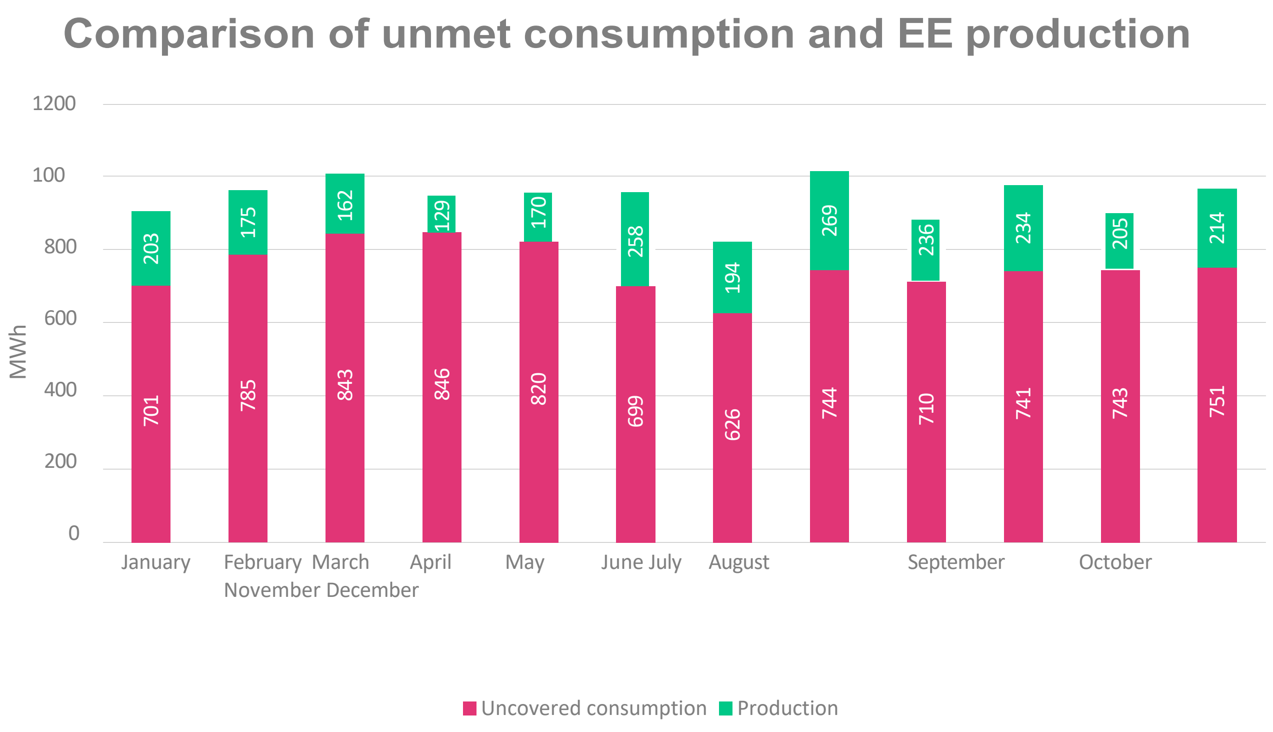
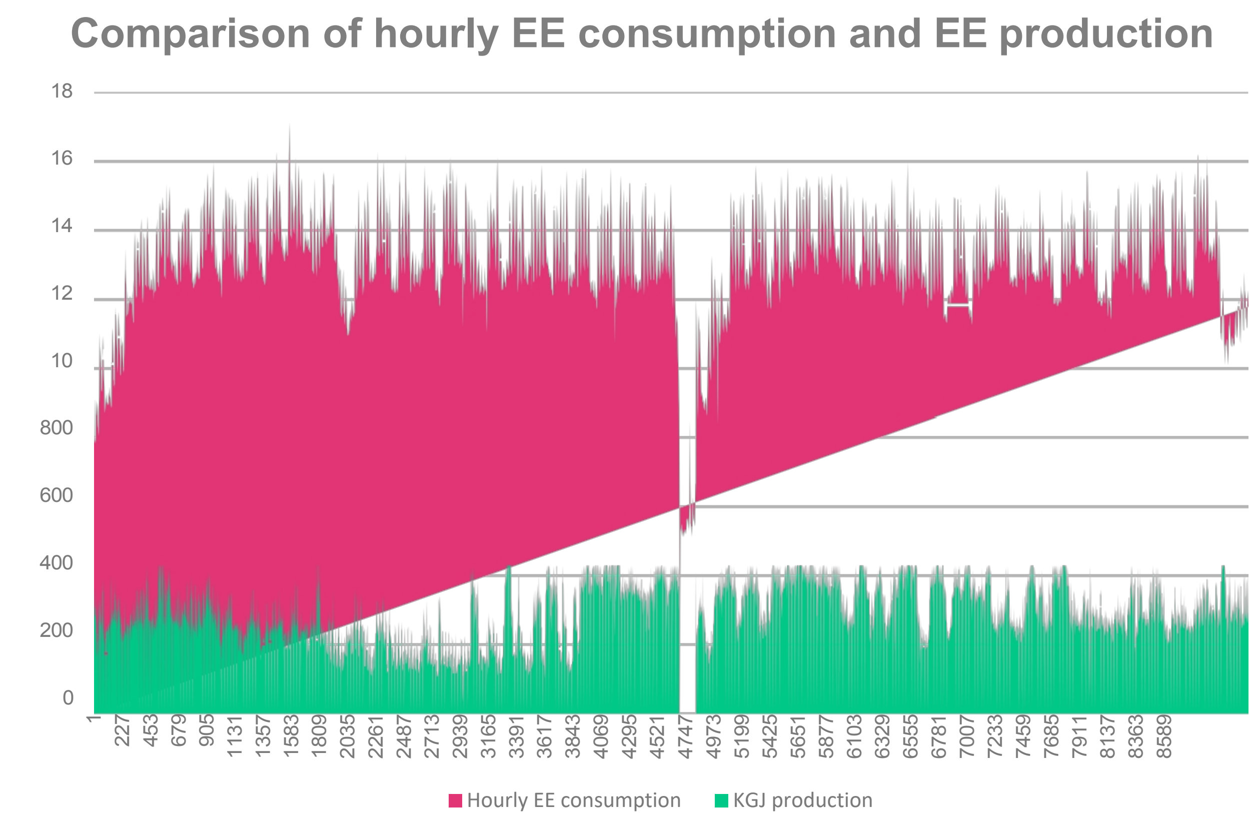


Chart 6.1.2 Comparison of hourly EE consumption and EE production



Heat

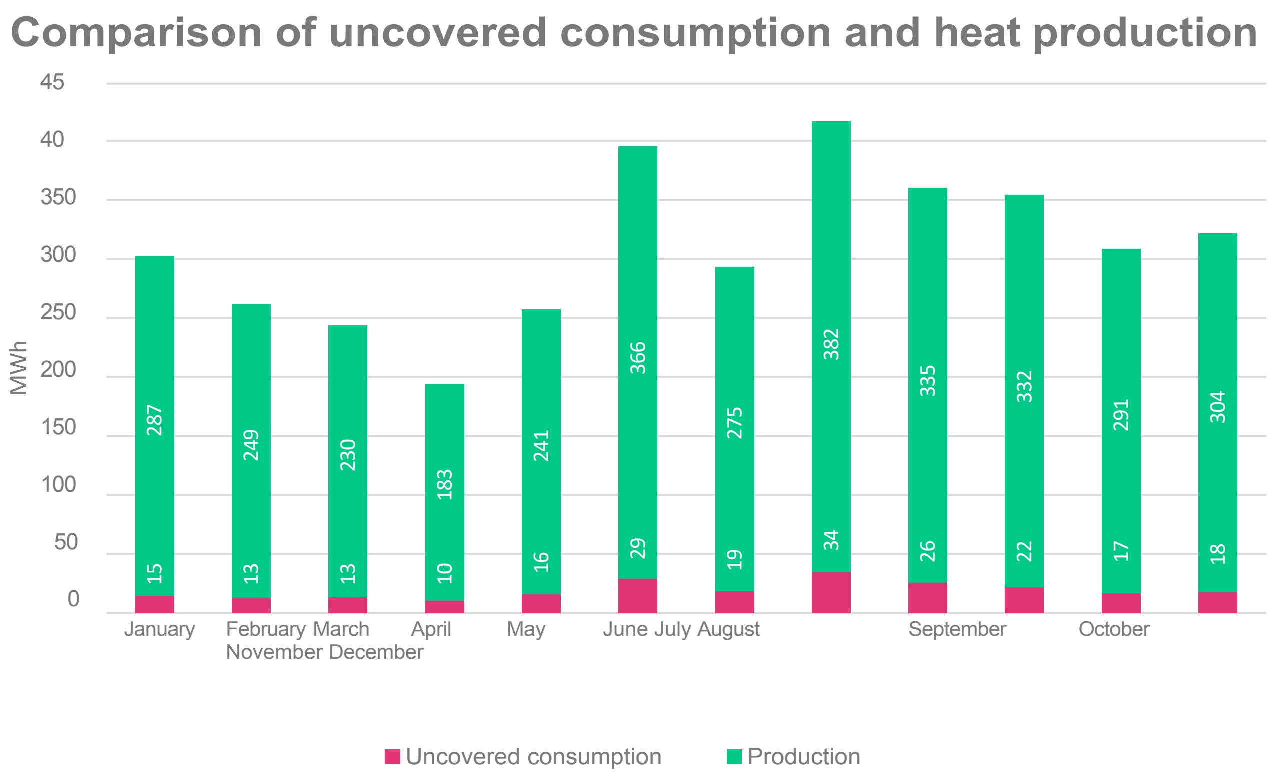
Table 6.1.4: Overview of heat consumption and production

Overview of heat consumption and production					
Month	Current	Proposed status			
	Consumption (MWh)	Production (MWh)	Overflow (MWh)	Uncovered consumption (MWh)	Savings (%)
January	302.03	287.41	0.00	14.62	95.2
February	261.60	248.67	0.00	12.94	95.1
March	243.76	230.42	0.00	13.34	94.5
April	193.83	183.34	0.00	10.50	94.6
May	257.34	241.27	0.00	16.07	93.8
June	395.48	366.32	0.00	29.15	92.6
July	293.48	274.91	0.00	18.57	93.7
August	416.51	382.17	0.00	34.35	91.8
September	360.55	334.60	0.00	25.95	92.8
October	354.35	332.36	0.00	22.00	93.8
November	308.56	291.45	0.00	17.11	94.5
December	321.73	304.09	0.00	17.63	94.5
Total	**3,709.24**	**3,477.01**	**0.00**	**232.24**	**93.7**

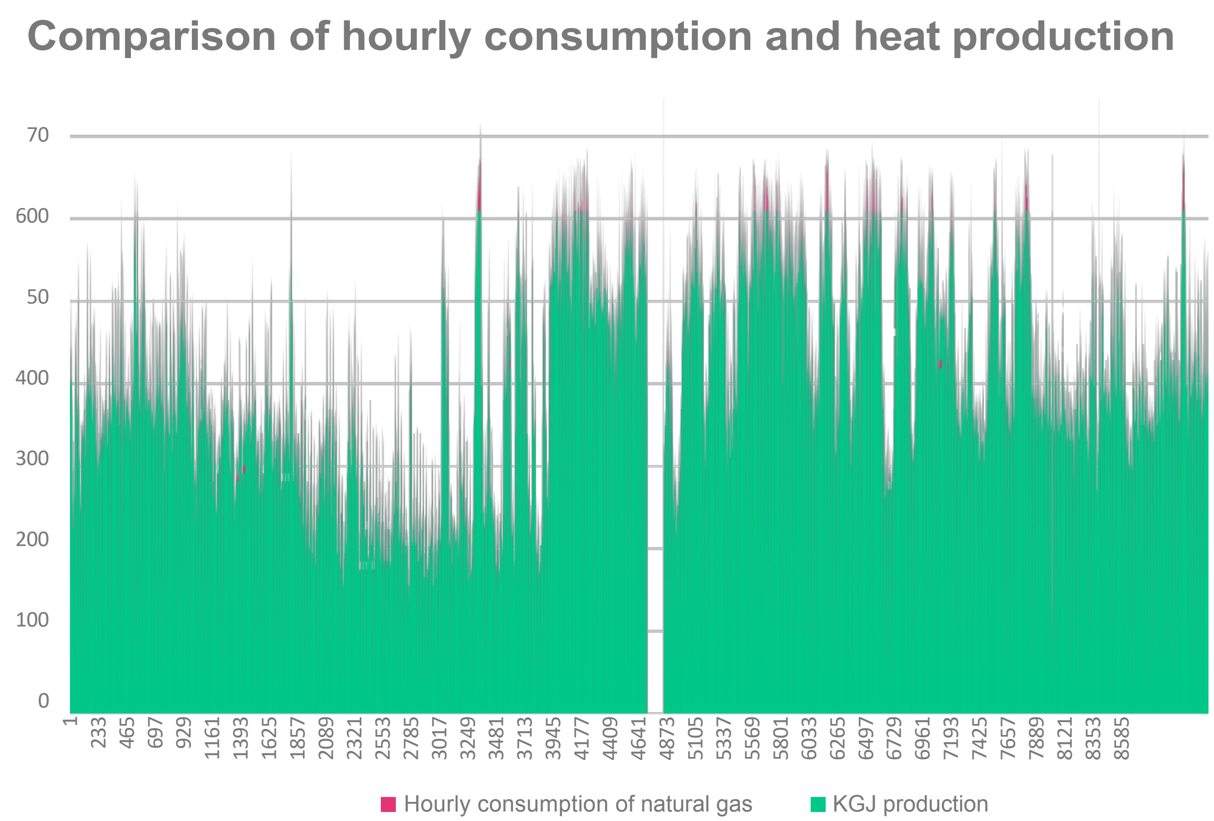
Table 6.1.5: Overview of heating costs

Overview of heating costs	
Current natural gas costs (CZK/year)	2,616,043
Natural gas price (CZK/MWh)	45
Total annual KGJ production (MWh/year)	3,477.01
Transfers (MWh/year)	0
Total annual KGJ production after deducting overflows (MWh/year)	3,477.01
Total annual KGJ profit after deducting overflows (CZK/year)	**1,571,607**
Total savings on natural gas for heating (CZK/year)	**1,736,582**

Chart 6.1.3 Comparison of uncovered consumption and heat production



Graph No. 6.1.4 Comparison of hourly consumption and heat production



Natural gas

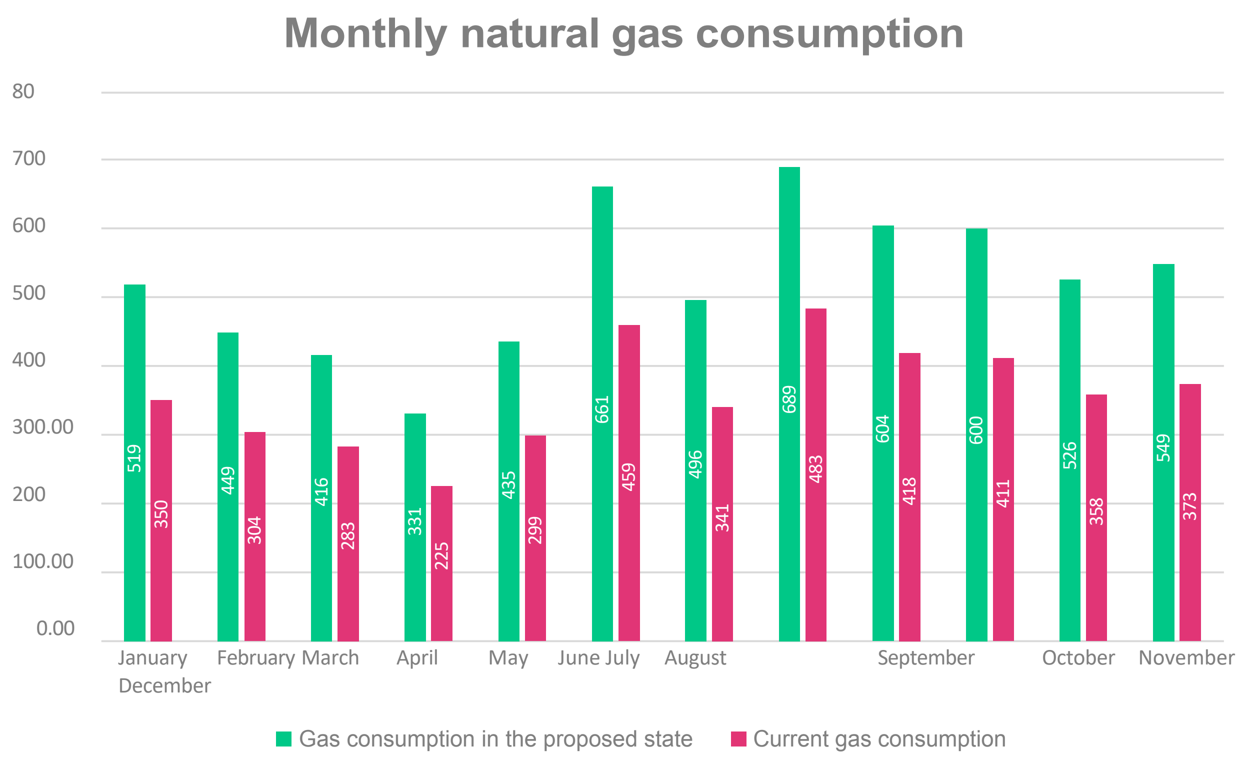
Table 6.1.6: Overview of natural gas consumption

Overview of natural gas consumption					
Month	Current status		Proposed status		
	Natural gas consumption (MWh)	EE consumption (MWh)	Gas savings (MWh)	EE savings (MWh)	Consumption (MWh)
January	350.48	903.62	317.58	202.60	518.5
February	303.56	960.78	274.77	175.29	448.6
March	282.86	1005.53	254.61	162.43	415.7
April	224.93	975.06	202.58	129.24	330.8
May	298.62	990.45	266.60	170.08	435.3
June	458.91	957.13	404.78	258.23	660.9
July	340.56	818.99	303.77	193.79	496.0
August	483.32	1013.10	422.28	269.40	689.5
September	418.39	945.99	369.73	235.87	603.7
October	411.19	975.77	367.25	234.28	599.6
November	358.06	948.16	322.05	205.45	525.8
December	373.33	965.46	336.01	214.36	548.6
Total	**4,304.20**	**11,460.02**	**3,842.00**	**2,451.00**	**6,273.0**

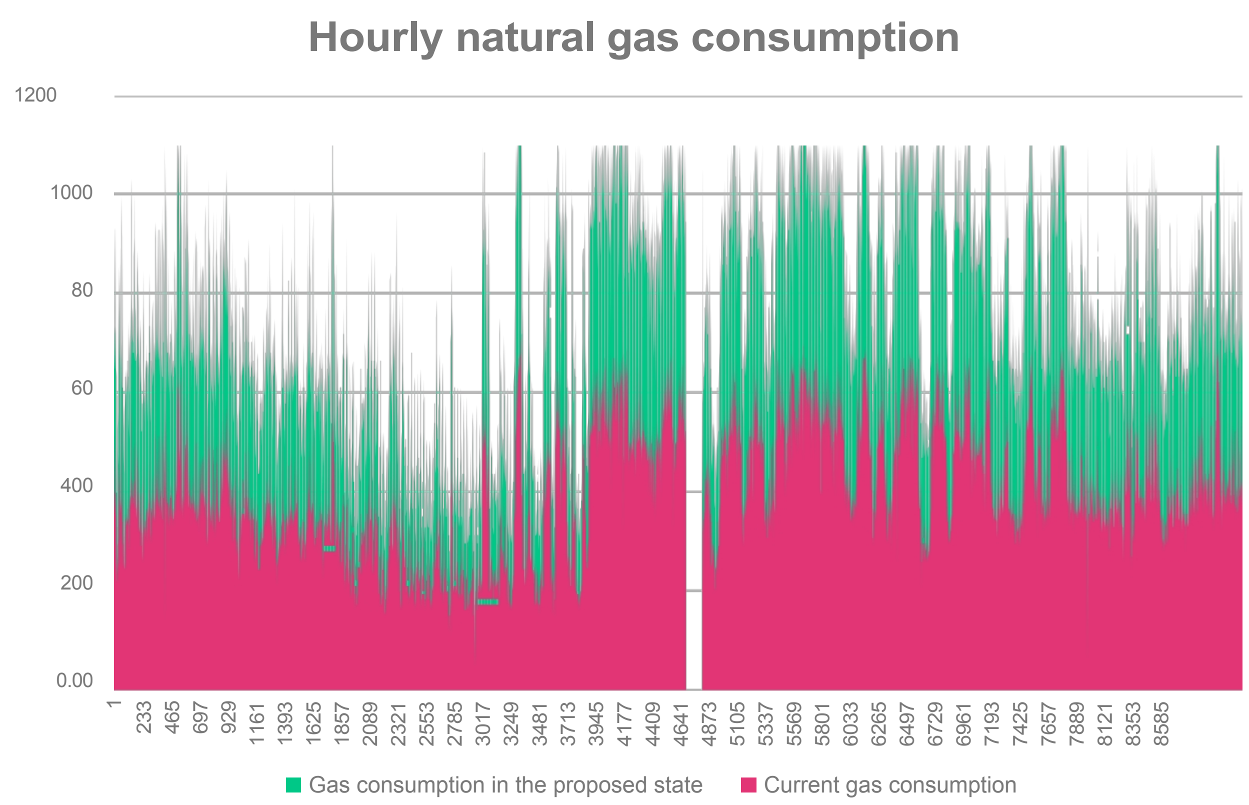
Table 6.1.7: Overview of natural gas costs

Overview of natural gas costs	
Current natural gas costs (CZK/year)	2,616,043
Natural gas price (CZK/MWh)	54
Total annual KGJ consumption (MWh/year)	6,273.03
Total annual costs of KGJ operation (CZK/year)	**3,441,274**

Chart 6.1.5 Monthly natural gas consumption



Graph No. 6.1.6 Hourly gas consumption



Evaluation of savings and finances

Table 6.1.8: Total energy savings

Total energy savings	
Current EE consumption (MWh/year)	11,465.93
Current natural gas consumption (MWh/year)	4,304.20
Current status – total consumption (MWh/year)	**15,770.13**
Energy savings (MWh/year)	2,451.00
Natural gas savings (MWh/year)	3,842.00
Gas consumption for KGJ operation (MWh/year)	6,273.03
Proposed status – total consumption (MWh/year)	**15,750.15**
Total savings (MWh/year)	**19.97**

Table 6.1.9: Total financial savings

Total financial savings	
Current EE costs (CZK/year)	23,047,072
Current ZP costs (CZK/year)	2,616,043
Current status – total costs (CZK/year)	**25,663,115**
Energy savings (CZK/year)	3,308,856
Health insurance savings (CZK/year)	1,736,582
KGJ operating costs (CZK/year)	3,441,274
Proposed status – total costs (CZK/year)	**24,058,951**
Total savings (CZK/year)	**1,604,164**

Table 6.1.10: Evaluation of measures

Measure No. 1	**Installation of a cogeneration unit**		
Acquisition costs (CZK)	Annual savings		
	Energy savings		
	(MWh/year^{-1})	(%)	(CZK/year^{-1})
15,000,000	19.97	0.13	1,604,164
Economic evaluation of measures			
Scenario	**Scenario 1**	**Scenario 2**	**Scenario 3**
Simple payback period (r)	9.35		
Real payback period (r)	10.46	6.58	6.15
NPV (CZK thousand)	11,230.37	33,717.69	45,359.61
IRR (%)	8.67	16.87	19.14
ROI (%)	10.69	20.25	25.41

Findings:

The installation of a cogeneration unit will result in total energy savings of 19.97 MWh, which will bring the client financial savings of CZK 1,604,164 per year. The acquisition costs were set at CZK 15,000,000. The simple payback period was set at 9.4 years. The client can receive a subsidy of up to 85%, which amounts to CZK 12,750,000. The simple payback period with the subsidy is 2.3 years.

Measure No. 2 Photovoltaic power plant (FVE)

To reduce electricity consumption and costs, we propose a photovoltaic power plant (PVPP) system with a capacity of 254.5 kWp using reference panels with a peak capacity of 360 Wp and a reference efficiency of 20.4% (other parameters are listed in Table 6.1.11). The total output of the PV system was designed for maximum possible electricity savings, with the size of the roof as the limiting factor. The PV system with an area of 1,248 m^2 will be located on the roof of the laboratory part of the building. We propose PV panels with a slope of 15° and a south-facing orientation of 9°, see Figure 6.1.1 below.

The PV system design is based on a 3D model of the panel layout, reflecting spacing distances and shading elements. The calculation of the PV system's electricity production was performed in hourly increments based on data from climatological stations, with additional calculations according to the exact location of the PV system. Overflows into the distribution network were calculated from the hourly electricity consumption diagram and the hourly electricity production of the PV system.

The utilization of installed capacity for own consumption of the proposed PV plant is 1,016 hours, thus fulfilling the OPŽP condition for utilization of installed capacity greater than 750 hours/year. At the same time, the condition for maximum annual electricity production from the PV plant, which must not exceed the annual electricity consumption in the building, is also fulfilled.

Table 6.1.11: Parameters of the proposed PV system

Parameters of the proposed PV system	
Photovoltaic panel material	Monocrystalline silicon
Manufacturer	SunPower Maxeon 2
Reference efficiency	20.4
Power output of 1 panel (Wp)	360
Expected panel lifespan	min. 30 years
Unit price of PV system (CZK/kWp)	23,500

Table 6.1.12: PV system design

PV system design	
Azimuth angle of the sunlit area γ (relative to south)	9
Panel tilt angle	15°
Total area for photovoltaic installation (m^2)	1,248
Installed capacity (kWp)	254.5
Total PV parameters	
Total area for photovoltaic installation (m^2)	1,248
Total number of panels for total installed capacity	707
Electricity price (CZK/MWh)	1,350
Total installed capacity (kWp)	254.5
Total annual PV production (MWh/year)	**258.8**
Total annual PV profit after deducting overflows (CZK/year)	**349,186**
Production surplus (%)	0.1
Use of installed capacity for local consumption (hours/year)	1,016

Figure 6.1.1 Layout of PV panels

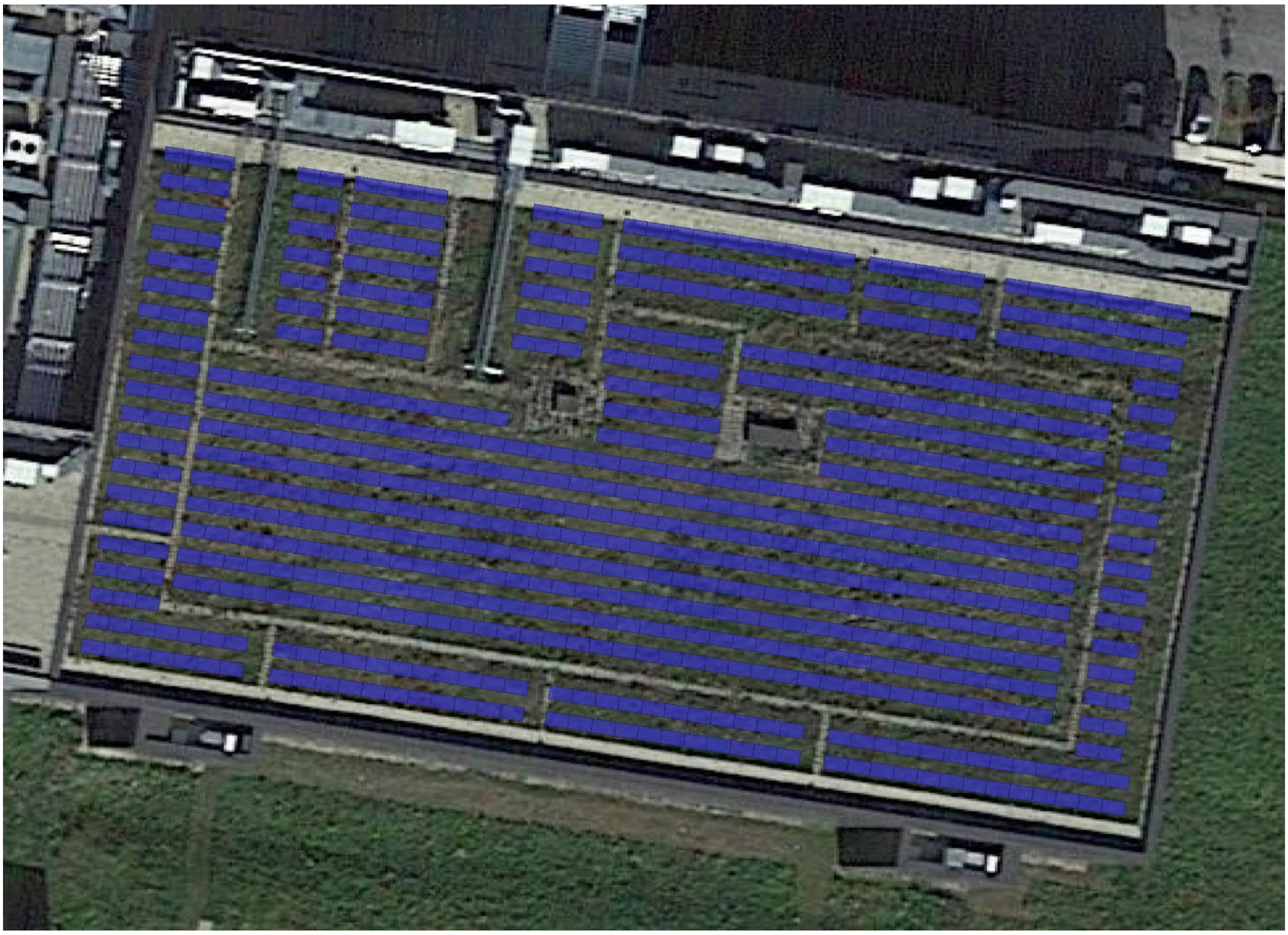


Chart 6.1.7 Comparison of electricity consumption with PV production

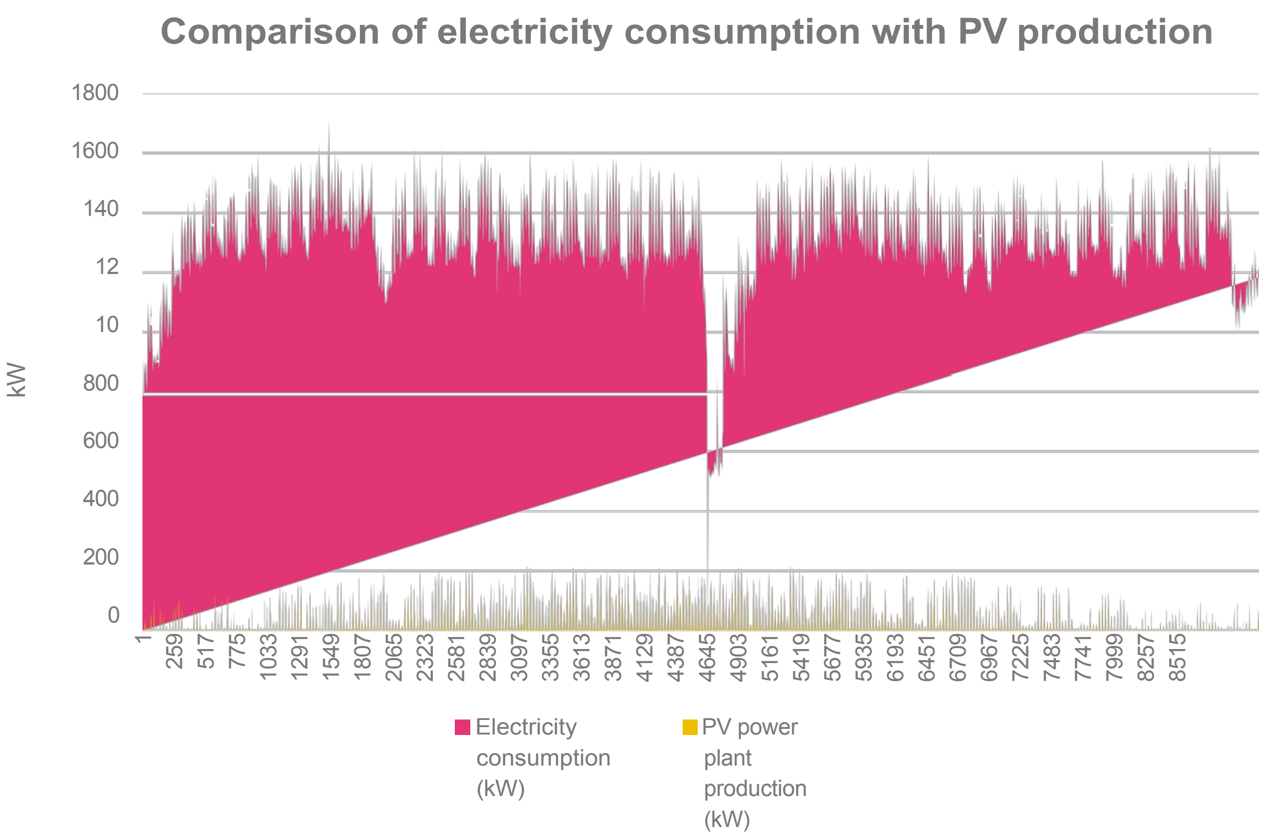


Chart 6.1.8 Comparison of electricity consumption with PV production

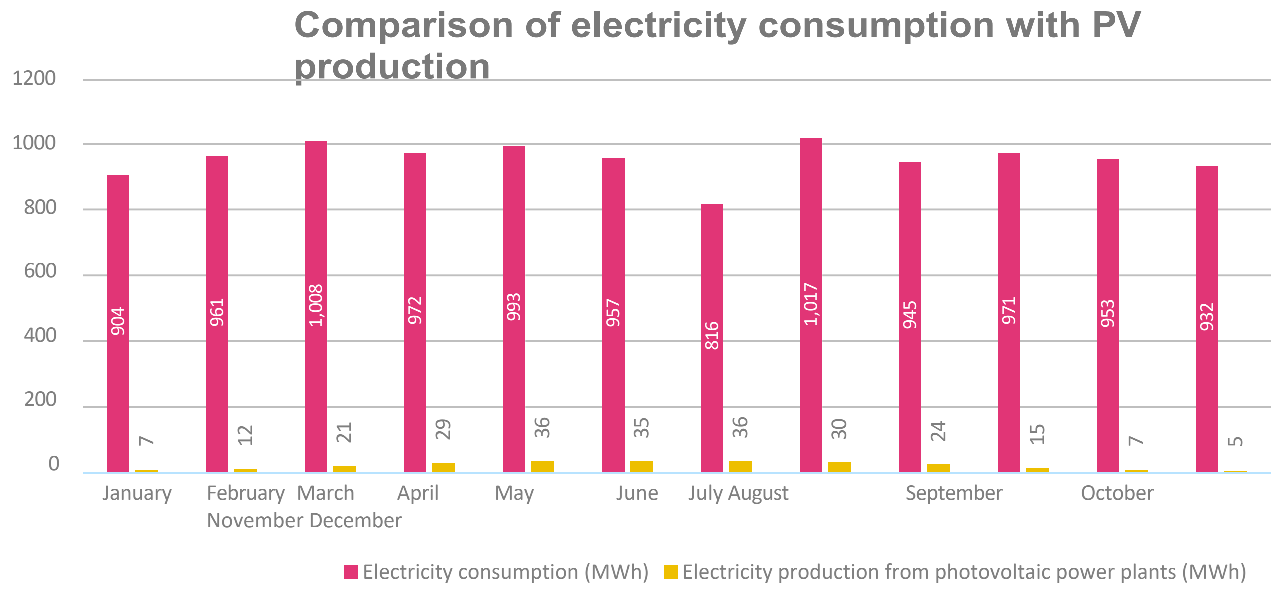


Table 6.1.13: Evaluation of measures

Measure No. 2	Photovoltaic power plant (PV)		
Acquisition costs (CZK)	Annual savings		
	Electricity savings		
	(MWh/year-1)	(%)	(CZK/year-1)
5,726,250	258.80	2	349,186
Economic evaluation of measures			
Scenario	Scenario 1	Scenario 2	Scenario 3
Simple payback period (r)	16.40		
Real payback period (r)	20.07	15.13	13.25
NPV (CZK thousand)	-16.56	2028.17	3881.22
IRR (%)	1.97	5.04	7.08
ROI (%)	6.10	8.44	10.59

Findings:

We propose the installation of a photovoltaic power plant with a total output of 254.5 kWp. The total investment costs have been estimated at CZK 5,726,250. The measure will reduce the amount of electricity consumed from the grid by 258.8 MWh/year, which represents a financial saving of CZK 349,186 per year. The simple payback period is 16.4 years. The contracting authority can obtain subsidy support of up to 100% for the implementation of this measure, which amounts to CZK 5,726,250.

We recommend the implementation of this measure in view of the fulfillment of the objectives of this document, mainly due to the favorable payback period.

The utilization of the installed capacity for own consumption of the proposed PV plant is 1,016 hours, thus fulfilling the OPŽP condition for the utilization of installed capacity greater than 750 hours/year. At the same time, the condition for the maximum annual electricity production from the PV plant, which must not exceed the annual electricity consumption in the building, is also fulfilled.

6.2 Total energy-saving measures

The following measures are considered in the proposed state:

Measure No. 1: Installation of a cogeneration unit Measure No. 2: Photovoltaic power plant (PVP)

Table 6.2.1: Adjusted energy balance

Comparison (annual values)	Before project implementation			After project implementation		
Indicator	Energy consumption		Operating costs	Energy consumption		Operating costs
	GJ/year^{-1}	MWh .year^{-1}	CZK/year^{-1}	GJ.year^{-1}	MWh .year^{-1}	CZK/year^{-1}
1 Fuel and energy inputs	56,772.45	15,770.13	17,424,599	55,768.88	15,491.36	15,471,249
2 Change in fuel inventories	0	0	0	0.00	0.00	0
3 Fuel and energy consumption	56,772.45	15,770.13	17,424,599	55,768.88	15,491.36	15,471,249
4 Sale of energy to third parties	0.00	0.00	0	0.00	0.00	0
5 Final fuel and energy consumption in the building	**56,772.5**	**15,770.1**	**17,424,599**	**55,768.9**	**15,491.4**	**15,471,249**
6 Losses in own resources and distribution	4,208.88	1,169.13	531,489	4,157.88	1,154.97	521,355
7 Energy consumption for heating	15,182.96	4,217.49	1,985,140	15,134.00	4,203.89	1,961,265
8 Energy consumption for cooling	2,846.64	790.73	1,067,599	2,780.42	772.34	891,320
9 Energy consumption for hot water preparation	633.93	176.09	79,532	519.98	144.44	37,274
10 Energy consumption for ventilation	4,572.49	1,270.14	1,714,863	4,466.13	1,240.59	1,659,457
11 Energy consumption for humidity control	4,960.97	1,378.05	1,860,558	4,957.61	1,377.11	1,822,884
12 Energy consumption for lighting	2,437.91	677.20	914,310	2,381.20	661.44	839,182
13 Energy consumption for other processes	26,137.55	7,260.43	9,802,597	25,529.55	7,091.54	8,259,866

Table 6.2.2: Savings values for the set of measures

Comparison (annual values)	Savings after project implementation			
Indicator	Savings (potential)			
	GJ.year^{-1}	MWh/year^{-1}	%	CZK/year^{-1}
1 Fuel and energy inputs	1,003.57	278.77	1.8	1,953,350
2 Change in fuel stocks	0	0	0	0
3 Fuel and energy consumption	1,003.57	278.77	1.8	1,953,350
4 Energy sales to third parties	0.00	0.0	0	0
5 Final consumption of fuels and energy in the building	**1,003.57**	**278.77**	**1.8**	**1,953,350**
6 Losses in own resources and distribution	51.00	14.17	1.2	10,135
7 Energy consumption for heating	48.97	13.60	0.3	23,875
8 Energy consumption for cooling	66.22	18.39	2.3	176,279
9 Energy consumption for hot water preparation	113.95	31.65	18.0	42,258
10 Energy consumption for ventilation	106.36	29.54	2.3	55,406
11 Energy consumption for humidity control	3.37	0.94	0.1	37,674
12 Energy consumption for lighting	56.71	15.75	2.3	75,128
13 Energy consumption for other processes	608.00	168.89	2.3	1,542,731

Table 6.2.3: Utilized energy saving potential

After project implementation (annual values)				
Name of measure	Acquisition costs (CZK)	Energy savings		Simple payback period (years)
		(MWh/year^{-1})	(CZK/year^{-1})	
Installation of cogeneration unit	15,000,000	19.97	1,604,164	9.35
Photovoltaic power plant (FVE)	5,726,250	258.80	349,186	16.40
Total	20,726,250	278.8	1,953,350	

Table 6.2.4: Utilized energy saving potential

After project implementation (annual values) - Set of measures			
Investment expenditure	Operating cost savings		
Acquisition costs (CZK)	Energy savings		
	(MWh/year^{-1})	(%)	(CZK/year^{-1})
20,726,250	278.77	1.8	1,953,350
Economic evaluation of measures			
Scenario	**Scenario 1**	**Scenario 2**	**Scenario 3**
Simple payback period (r)	10.61		
Real payback period (r)	12.05	7.80	7.22
NPV (CZK thousand)	11,213.81	35,745.85	49,240.82
IRR (%)	6.98	13.98	16.19
ROI (%)	9.42	16.99	21.31

Economic evaluation of energy saving measures

Table 6.2.5: Economic evaluation of selected energy saving measures

Parameter	Unit	Initial state	Proposed state
Total project benefits	CZK	**-**	**1,953,350**
Total project investment expenditure	CZK	**-**	**21,969,825**
of which		**-**	**-**
costs of project documentation	CZK	**-**	
costs of energy assessment	CZK	**-**	**1,243,575**
costs of the tender procedure	CZK	**-**	
costs of technological equipment and construction	CZK	**-**	**20,726,250**
incidental budget costs	CZK	**-**	
connection costs	CZK	**-**	**0**
Total operating costs	CZK/year^{-1}	**17,424,599**	**15,340,105**
of which		**-**	**-**
energy costs	CZK per year^{-1}	**17,424,599**	**15,340,105**
repair and maintenance costs[1]	CZK per year^{-1}	**-**	**0**
Personnel costs (wages, insurance)	CZK per year^{-1}	**-**	**0**
Other operating costs [2]	CZK per year^{-1}	**-**	**0**
emissions and waste costs	CZK per year^{-1}	**-**	**0**
Evaluation period	years	**-**	**20**
Discount	%	**-**	**2**
NPV	thousand CZK	**-**	**11,214**
Simple payback period - T_s	years	**-**	**11**
Real payback period - T_{sd}	years	**-**	**12**
IRR	%	**-**	**7**
ROI	%	**-**	**9**

1) Costs mainly include material costs, equipment repairs, planned and preventive maintenance.

2) Costs mainly include the costs of operation, servicing, and inspection of equipment.

Findings:

The following measures are included in the set of energy-saving measures: installation of a cogeneration unit and a photovoltaic power plant.

The contracting authority will receive 85% support for the installation of the cogeneration unit and 100% support for the photovoltaic power plant for activities 5.3b).

To be eligible for activities 5.3b), the buildings must meet the average required heat transfer coefficient $U_{em} = 0.24\ W \cdot m^{-2} \cdot K^{-1} < U_{em,N} = 0.25\ W \cdot m^{-2} \cdot K^{-1}$.

7 EVALUATION

7.1 Evaluation criteria

1) **Total energy savings**
2) **Average heat transfer coefficient**
3) **Heat transfer coefficient of individual building structures for which support is requested**
4) **Heat transfer coefficient of windows for which the subsidy is requested**
5) **Heat transfer coefficient of doors, skylights, and roof windows for which the subsidy is requested**

7.1.1 Energy savings

Table 7.1.1.1: Energy savings after implementation of the proposed set of measures

Energy carrier	Current situation	After implementation	Difference	Savings
	(MWh/year)	(MWh/year)	(MWh/year)	(
Electricity	11,460.0	8,768.0	2,692.0	23.49
Natural gas	4,031.5	6,444.7	-2,413.2	-59.86
Total	**15,491.5**	**15,212.73**	**278.8**	**1.80**

Findings:
Energy savings after implementation of the proposed set of measures amount to 1.8%.

7.2 's general eligibility criteria

- The implementation of the measures must not commence before January 1, 2014, and must not be completed before the application for support is submitted
- Measures on dilapidated and long-term unused buildings are not supported
- Measures on new buildings, extensions, and superstructures are not supported.
- In the case of photovoltaic systems, the value of installed capacity used for local consumption must reach at least 750 hours per year $^{-1}$.
- Support for the replacement of energy sources is only provided in the case of a transition from fossil fuels or electricity energy (natural gas only older than 10 years)
- In the case of combined heat and power units, support will be provided to projects generating primary energy savings of at least 10% compared to reference data for separate electricity and heat production.
- Obligation to regulate the heating system
- Assessment of eligibility for EPC support
- If energy consumption data for the past three years is not available or if there is a change in the use of the building, it is possible to use the so-called adjusted energy balance, which will take into account the future operational use of the building.

7.2.1 CO_2savings

with reference data for separate electricity and heat production.

Energy carrier	Emission factor	Current status	After implementation	Difference	
	(t/MWh)	(t/year)	(t/year)	(t/year)	(%)
Electricity	1.0116	11,592.96	8,869.73	2,723.23	23.5
Natural gas	0.1994	804.04	1,285.33	-481.30	-59.9
Total		**12,397.00**	**10,155.06**	**2,241.94**	**18.1**

Findings

The CO2 emissions savings after implementation of the proposed set of measures amount to 18.1%.

7.3 Eligible expenditure

- Must be directly related to the implementation of the project
- Must be incurred between January 1, 2014, and December 31, 2023, and the deadline for

implementation of the measures must not be earlier than the deadline for submitting the application for support

- Before reimbursement, they must be demonstrably paid by the beneficiary and documented with accounting documents
- The maximum amount of the subsidy for EP, PD, and technical supervision activities is:

  - 15% for projects whose total eligible direct implementation costs do not exceed CZK 1 million
  - 12% for projects whose total eligible direct implementation costs do not exceed CZK 3 million,
  - 9% for projects whose total eligible direct implementation costs do not exceed CZK 10 million,
  - 6% for projects whose total eligible direct implementation costs exceed CZK 10 million

8 CONCLUSION

The Eli Beamlines building was analyzed as part of the savings potential analysis.

The following measures are taken into account in the savings measures: installation of a cogeneration unit and a photovoltaic power plant.

The investment in project preparation, which includes the costs of an energy assessment, public tender, and project documentation, was added to the investment for the implementation of the above measures. This investment was estimated at CZK 1,243,575.

Energy savings after implementation of the proposed set of measures amount to 1.8%, CO2 savings after implementation amount to 18.1%. The contracting authority is entitled to a subsidy of 85% for the cogeneration unit and 100% for the photovoltaic power plant under activities 5.3 b). The amount of savings is specified in Table 6.2.2.

The total investment for the implementation of the project was set at CZK 21,969,825.
The total achievable savings are 278.8 MWh per year, which corresponds to CZK 1,953,350 per year. The total funds available from the subsidy are CZK 18,476,250.
The investment after taking the subsidy into account will be CZK 3,750,000.

The result of the energy assessment, which will be based on the measures evaluated in the analysis in the event of a grant application, may vary slightly depending on the exact final technical solution, the bill of quantities, and the itemized budget from the project documentation, which must be submitted with the grant application.