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POLITYKA ENERGETYCZNA POLSKI DO 2040 R.

Ministry of Energy

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Table of content

Introduction

Legal background and a place in a country development management system

Polityka energetyczna Polski do 2040 r. *– strategia rozwoju sektora paliwowo-energetycznego* (Energy Policy for Poland until 2040 - a strategy for development of fuel and energy sector) (PEP2040) is a response to the most important challenges to be faced by the Polish energy sector in the coming decades and established directions for development of the energy sector, taking into account tasks that need to be executed on a short-term basis.

Energy Policy for Poland until 2040 is one of the nine strategies resulting from the country development management system, which are based on a medium-term strategy for the development of Poland, i.e., ***Strategia na rzecz Odpowiedzialnego Rozwoju*** (Sustainable Development Strategy (SOR) adopted on February 14, 2017. Its main objective is to create conditions for an increase in income of citizens of Poland, with simultaneous increase in cohesion perceived from social, economic, environmental and territorial point of view. *Energy* is one of the areas contributing to this objective.

Of other strategies resulting from SOR, PEP2040 is most strongly linked to *Polityka ekologiczna państwa do 2030* (Ecology policy for Poland until 2030)[1], *Strategia zrównoważonego rozwoju transportu do 2030 roku* (The strategy for sustainable development of transport until 2030) in relation to reduction in emissions of CO_2 and low-emissions, *Strategia zrównoważonego rozwoju wsi, rolnictwa i rybactwa do 2030* (The strategy for sustainable development of rural areas, agriculture and fishing until 2030) concerning the use of agriculture and rural areas potential for energy purposes, and *Strategia produktywności i Krajowa strategia rozwoju regionalnego* (The strategy for productivity and National strategy for regional development) in a context of mutual relations between the energy sector, economy productivity and development of the country.

In more indirect way PEP2040 is linked to *Strategia rozwoju kapitału ludzkiego* (The strategy for human capital development), *Strategia rozwoju kapitału społecznego* (The strategy for social capital development) and *Strategia „Sprawne i nowoczesne państwo”* (The strategy "Efficient and modern country"), which all form a background for PEP2040. Human capital influences quantity and quality of knowledge, and skills and potential available in the society, which influence possibilities for development of the energy sector. A condition of social capital influences relations in the society and social responsibility, which in turn influence the way in which PEP2040 is implemented. It should also be noted that PEP2040 goes beyond time frames of SOR. Changes in the energy sector occur through many years, and their results are visible on a long-term basis, and this is reflected in energy forecasts.

The Energy Policy for Poland is developed by a minister competent for energy, under Articles 12, 13–15 of the *Energy Act*, and in accordance with the *Act on principles of implementing the development policy*, and a number of entities, especially the Minister of Energy and the Cabinet, are responsible for its implementation.

Poland, similarly as all other European Union (EU) Member States, develops the *National Energy and Climate Plan for 2021-2030* (NECP)[2]. This document will be consistent with *The Energy Policy for Poland until 2040*, where the NECP scope and layout correspond to a challenge of implementing the energy union, while PEP2040 also addresses other national needs. With adopting of PEP2040, *The Energy Policy for Poland until 2030* from 2009 and *Strategia „Bezpieczeństwo Energetyczne i Środowisko – perspektywa do 2020* (The strategy "Energy Security and Environment - a perspective until 2020) from 2014 are repealed.[3]

Document layout

PEP2040 contains a **description of a situation and conditions** in the energy sector, **the aim of the current energy policy** (Chapters 1-2), and then it establishes eight **directions** for the policy with areas of intervention and necessary **actions** (Chapter 3).

[1] In the text, names of legal acts and strategic documents are abbreviated, and their full names can be found in chapter 7.

[2] Development of NECP results from Regulation (EU) 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union.

[3] A part of BEiŚ strategy was repealed with adopting of *Polityka ekologiczna Państwa 2030 – strategia rozwoju w obszarze środowiska i gospodarki wodnej* (The Ecology Policy - the development strategy concerning the environment and the water management), i.e., in its part concerning Objective 1. Sustainable management of environmental resources (excluding Action 2. Striving to maintain coal mining in Poland at a level ensuring covering of the national demand) and Objective 3. Improvement of the environmental situation.

Implementation of the directions is planned for 20 years, but to ensure realistic operational planning, a significant part of the actions is planned for several or even several dozen years. The actions are of executive nature and can undergo dynamic changes due to changing environment. The consequences of implementation of directions and actions are reflected in the prognostic part, spanning the period to 2040.

The directions and the actions cover the entire energy supply chain - from obtaining of materials, through generation and supply of energy (transmission and distribution), up to methods of its use. Each of eight PEP2040 directions and actions included in them have been established within three elements of the PEP2040 objective - energy security; competitiveness and improved energy efficiency of the economy; and reduction in the environmental impact.

To facilitate understanding, each direction is highlighted in a different color, also used to highlight blocks indicating ***areas of intervention****. As a part of description accompanying the area,* ***actions*** *have been distinguished, which are listed in tables summing up each direction, indicating deadlines for their implementation and responsible entities. When no date is provided, a given action is of a continuous nature. Each action was also referred to three components of the main objective ( ), as explained in Chapter 2. Key areas of intervention for all directions are briefly presented in a table at the beginning of Chapter 3.*

DIRECTION

area of intervention

A strategic project, of particular importance for development challenges, was specified for each direction. In the case of directions 2–4, a project was specified for each part. Thus, PEP2040 contains 12 strategic projects. They expand the list of SOR projects from the "energy" area. Two strategic SOR projects are included in the document, but are not strategic PEP projects, because after SOR was adopted it was noted that assigning to the energy area is not their key role (concerns projects SOR 3(2) and 3(4)).

1. STRATEGIC PEP PROJECT
– SOR PS.4(1)

Further sections of this document contain **a description of implementation and monitoring** and **sources of financing** for PEP2040 (Chapters 4–5). They are followed by PEP2040 abstract (Chapter 6). Furthermore, **reference documents** for PEP2040 at the national and the EU level are listed (Chapter 7).

Three appendices are attached to PEP2040, forming its integral part:

1. ***Evaluation of implementation of the previous energy policy for Poland*** - the document sums up implementation of priorities indicated in the *Energy Policy for Poland until 2030* and directions resulting from *The strategy "Energy Security and Environment - a perspective until 2020*.
2. ***Conclusions from prognostic analyses for the energy sector*** – the document presented a series of forecasts for the fuel and energy sector, taking into account execution of actions established in PEP2040. In particular, proposals for the use of primary and final energy are presented, by fuel types and by sectors, forecasts for electricity generation and installed power, and prices for each group of recipients. Necessary investment expenditures in the energy sector are also included.
3. ***Strategic environmental impact assessment for PEP2040*** **(SOOŚ)** – the document presents an assessment of possible positive and negative environmental impacts of PEP2040 implementation - as per the *Act on making information about the environment and its protection available, the society share in environmental protection and environmental impact assessments.*

1. Description of a situation and conditions[4]

The previous energy policy of Poland has ensured implementation of the statutory objective; however, due to changes that occurred in the Polish economy, as well as new challenges, it is necessary to update directions towards which the Polish energy sector, and indirectly, the entire economy should aim. *The assessment of implementation of the previous energy policy for Poland (until 2030)* attached to PEP2040, indicates actions executed since 2009 in the energy sector and forms a basis for specification of further actions established in this document. At the same time, more extensive diagnosis is included in each direction of PEP2040.

The current situation in the energy sector, together with a structure and forecasts for energy consumption, the sector organization and relations, as well as a relatively large share of industry in the Polish economy, are of crucial importance for **creation of a vision for the energy sector.** A decision concerning the coal-based economy made in the previous century is also very important, as investments made then have long-term economic, social and territorial consequences. At the same time, it is necessary to execute international obligations, and technological progress and overall economic development necessitate continuous changes in the sector.

climate and energy policy

The European Union (EU) climate and energy policy significantly influences changes in the sector. In 2009, a set of regulations specifying three basic targets for climate change prevention until 2020 was adopted (a 3 x 20% package), where the Member States participate to the extent possible for them. Poland is obliged to:

- increase energy efficiency by reducing primary energy consumption by 13.6 Mtoe in 2010–2020 versus forecast fuel and energy demand from 2007;
- increase to 15% the share of RES energy in the gross final energy consumption by 2020;
- contribution to overall EU reduction in greenhouse gases emissions by 20% (versus 1990) by 2020 (when expressed at levels from 2005: -21% in EU ETS and -10% in non-ETS sectors).

In 2014, the European Council maintained a direction for prevention of climate changes and approved four targets for the entire EU in the 2030 perspective, which after a revision of 2018 are as follows:

- reduction in greenhouse gases emissions by 40% versus emissions of 1990 (when expressed at levels from 2005:-43% in EU ETS and -30% in non-ETS sectors);
- at least 32% share of energy from renewable sources in gross final energy consumption;
- an increase by 32.5% in energy efficiency;
- finalization of building of the internal EU energy market.

The above targets represent EU contribution to performance of climate agreements. For the current policy and actions, the **Paris Agreement** concluded in December 2015 during the 21st conference of the parties to *The United Nations Framework Convention on Climate Change* (COP21) is of key importance. It implies a need to limit the temperature increase at a level below 2°C versus the levels before the industrial era, and efforts should be made to limit it to no more than 1.5°C. During the 24th conference (COP24) in December 2018, during the Polish residency, the Katowice climate package was signed, implementing the Paris Agreement. A particular attention was focused on the fact that *transformation* resulting from the Paris Agreement must be conducted in a fair and supportive way.

In 2019, works on a package of regulations called *Clean energy package for all Europeans*, continued since 2016, were completed, and it stipulates a way of putting into operation the EU climate and energy targets for 2030,

[4] Figures used in PEP2040 refer to 2018, unless specified otherwise. No footnote means that source data come from the Ministry of Energy.

and is to contribute to **implementation of the energy union** and **building of a uniform EU energy market.** The Polish government actively participated in shaping of final provisions, as these regulations strongly influence functioning and determination of the future for the energy market model in Poland. The package of eight regulations included:

four regulations:

- regulation on the internal energy market;
- regulation on The Agency for the Cooperation of Energy Regulators (ACER);
- regulation on readiness for a risk in the power generation system;
- regulation on the energy union management;

four directives:

- revision of the directive concerning common rules for the electricity market;
- revision of the RES directive;
- revision of the energy performance directive;
- the directive on the energy performance of buildings.

Prospectively, further revision of key EU regulations concerning the energy sector are assumed, which will focus on targets and tools of the European Union energy and climate policy for time frames exceeding 2030. This applies, in particular, to provisions concerning a long-term vision for reduction of greenhouse gases emissions in EU by 2050. For this reason, in most cases the perspective after 2030 has been specified only in terms of its direction, although forecasts prepared for PEP2040 have a perspective until 2040, as required in the statutory requirements.

fair transformation

In last several years, Poland has made a great progress in reduction of the environmental impact of the energy sector, mainly through modernization of its generation capacities and diversification in the energy generation structure. Still, our dependence on coal fuels is significantly higher than in other EU Member States, and for this reason the ***fair transformation*** is so important to us, as it means taking into account the social context of the transformation and prevention of uneven spreading of costs between countries, more burdensome for economies with a high use of coal fuels. It should be noted that costs are related both to mining regions, and to entire economies, which must bear expenditures on new capacities on a short time basis, frequently also on economically immature more expensive technologies and grid infrastructure, and this is also reflected in energy prices. At the same time, efforts should be made for these actions to be undertaken in a supportive way, i.e., also by countries with the highest share in emissions of pollutants and greenhouse gases on a global scale, which will influence the improvement of the environmental situation and protect competitiveness of economies undertaking climate and environmental challenges (including protection against escape of emissions).

Transformation planned in PEP2040 is of **evolutionary**, and not revolutionary nature, so costs of changes can be spread over time, and the risk of not reaching technological and economic maturity by new technologies is also controlled. The crucial principles characterizing PEP2040 include:

- **transformation,**
- **security,**
- **development,**
- **investments,**
- **reduction in emissions**.

primary and final energy consumption

Poland uses ca. 4 400 PJ of **primary energy**, with the majority coming from bituminous coal and petroleum, followed by natural gas, lignite and renewable sources. Households and transport still play a crucial role in the final energy consumption, but relations between them are gradually changing - the improved energy efficiency leads to a reduced demand in residential housing, while the increased consumption in the transport is associated with its increased contribution to GDP. Forecasts for primary and final energy consumption by a type of fuel and by sector are presented in Appendix 2. The subject of energy savings and improvements in energy efficiency is more extensively discussed in direction 8, which serves as a summary for actions indicated in other directions, such as modernization of the generation sector or transmission grids, or an increase in the RES share.

energy resources

To a large extent, the demand for **bituminous coal** is covered by domestic[5] material (deposits located mainly in Silesian and Lubelskie regions), and import-export exchange results from the demand location and availability of material of specific parameters. The mining sector underwent a significant restructuring, and this contributed to an improvement in profitability of fuel extraction, although further actions are necessary for optimum use of the resources. A demand for **lignite**, due to its properties, is covered near mining locations (deposits located in central and south-west Poland). Poland has prospective deposits, however the use of this material for energy purposes is and will be difficult, as it must meet the environmental requirements and is burdened by costs of climate and environmental policy.

Poland does not have significant resources of **petroleum and natural gas** (the deposits are located mainly in the Polish Lowlands and the Carpathian Foreland), therefore, the Polish demand is covered mainly by import, of ca. 96% and 78%, respectively. These materials are imported to Poland mainly from the East, but recently, a significant change in the structure of import directions has occurred. This is a result of an effective trade policy, but mainly of an increase in technical possibilities for reception and storage of the material. Further actions enabling a real diversification in supply sources are necessary, to ensure secure deliveries.

Availability of **biomass and biogas** is relatively even throughout the country, although their local availability, from agriculture, forest areas, and non-agricultural waste, is a crucial determining factor. A potential of **solar energy** is similar in the whole country, although conditions are slightly better in southern and south-east parts of the country. The best **wind conditions** can be found in Wielkopolska and Pomorze regions, and the wind reaches its highest speeds over the Baltic Sea. **Geothermal resources** in Poland are associated with presence of groundwaters, and the geothermal potential is particularly high in the Polish Lowlands, inner Carpathians (Podhale) and in the Carpathian Foredeep. The hydrological resources of Poland belong to the lowest in Europe, and with small differences in levels the **hydro energy potential** of our country is relatively low, although it should be noted that the retention function is crucial for potential hydrological structures.

An approach to covering the demand for materials, that is, to the import-export dilemma, is described in direction 1. Other directions contain references to energy resources that are not subject to this dilemma (non-combustible RES - direction 6) or which currently are not of a high importance, but their foreseen development may influence changes in the energy market (e.g., alternate fuels, nuclear fuel - directions 4 and 5).

energy markets

The liberalization initiated in the middle of the 1990s' resulted in changes in the functioning of the energy sector, and at the same time influenced more competitive shaping of the energy prices. The technological progress and changes in the EU regulations enforce further changes in the **energy markets**. Apart from deregulation of prices and admitting various entities to the market, the consumer position, also as an energy generator, was strengthened as well. The electricity and natural gas markets still need to be regulated, because they cover basic needs of the society and the economy. The fuel market is fully liberal, but requires monitoring. As the demand for heat is covered locally, the national heat market does not exist, thus regulations in this area are of a different nature. These issues are more extensively described in direction 4, divided into three parts.

electricity

The demand for **electricity** (ca. 171 TWh per annum) is covered mainly by domestic power plants (majority of which is professional). The main materials used to cover that demand are bituminous coal and lignite, but the share of renewable energy sources (RES) and natural gas

[5] See Figure 24. Geological resources of certain materials, *The strategy for responsible development until 2020 (with a perspective until 2030).*

is gaining in importance. The further increase in the RES share in this balance is expected due to implementation of the EU obligations, which determine further changes in the national power generation system (KES). The system faces a challenge of ensuring flexibility and reliability of operation, while generation capacities based on fossil fuels are subject to strict requirements of the environmental policy. In the nearest future, i.e., by 2021, it will mainly focus on adapting the generating units to the Industrial Emissions Directive (IED Directive) and best available techniques conclusions (BAT conclusions). Only in 2020 alone ca. 2.5 GW of capacity will be withdrawn, because their modernization will not be justified from technical or economic point of view.

Although meeting of environmental requirements contributes to an improvement in energy efficiency and a reduction in the environmental impact, it may lead to earlier ending of generating unit operation. Due to the expected significant withdrawal of capacities in the next several years (due to the end of useful life or for ecological and economic reasons) and an increase in the electricity demand, the expansion of generating resources will be necessary. The **power market** will have a significant influence on the shape of this sector and on sufficiency of the power, and in consequence, from 2021 the energy market will include two types of goods: power and electricity. This mechanism is a guarantor for electricity supply to recipient in next several years. These issues are more extensively described in direction 2.

heat demand

The heat demand in Poland is covered by district heating or individual systems, with bituminous coal as the main fuel. The thermo-modernization of building and new standards for energy performance of buildings lead to an improvement in energy efficiency and reduced demand for heat. However, besides emissions from transport, the individual covering of heat demand still has a crucial influence on **the air quality**. The number of household that use fossil fuels of low quality and waste for heating is still too high, contributing to ***low emissions.*** At the same time, covering of the demand for heat is associated with a problem of **energy poverty**, due to a crucial share of heat in the household energy demand. Due to a great importance to the society of both these issues, as well as the scale of indirect costs (particularly, healthcare costs), the government has focused specifically on their elimination (*Clean air* program). These issues are more extensively described in directions 7 and 8.

horizontal issues

Despite specific nature of individual energy subsectors, several horizontal issues can be distinguished, which also represent challenges for development.

Development of scientific research and innovations that will contribute to sector transformations simultaneously ensuring maintaining of the competitiveness of the economy, is crucial for development of the energy sector. A number of research centers and commercial entities are involved in these activities. Implementation of *The European Strategic Energy Technology Plan* (SET Plan) may prove to be of significance. A communication accompanying this plan defines 10 priority areas, under which joint initiatives and research, innovative, and innovation projects are executed. Additional resources and a positive effect of the cooperation synergy aim at **accelerating development and implementation of innovative energy technologies.** Taking into account the current shape of the sector and directions for its changes, the greatest expectations are associated with development of economically effective low-emission technologies for energy generation, improvement in energy efficiency, as well as storage of energy and digitalization of the power generation system. Solutions enabling development of capacities based on renewable energy sources in a way that does not pose a hazard to safety of KSE work are very desirable.

The system of science and higher education meeting the needs of the market, as well as coordinated actions and involvement of many institutions at the central and the regional levels are equally important for the future of the sector.

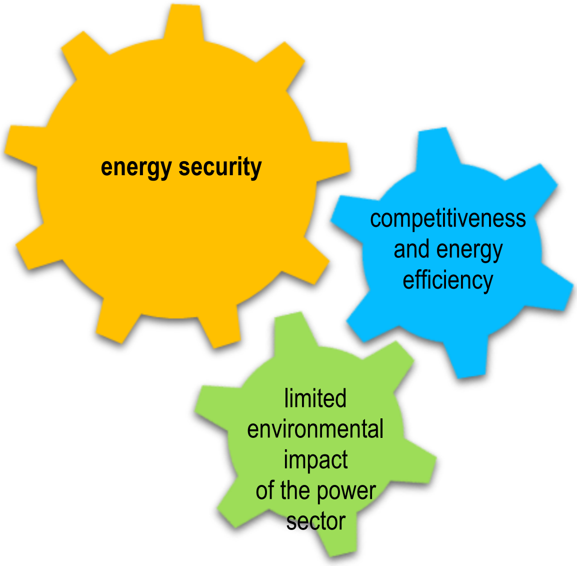
Recently, **cybersecurity** has become an important part of the social and economic life. In consequence, it also plays an important role in the energy sector. The **National Cybersecurity System** was created by implementation of the NIS Directive to the Polish legal system in July 2018, and it aims at ensuring undisturbed provision of **key services** - i.e., those that are of a crucial importance for maintaining critical social or economic activities - and ensuring servicing of incidents through **achieving of required level of security of information systems** used to provide those services.

The economic activity conducted in the energy sector from mining of minerals, through transmission, distribution and storage of electricity, heat, natural gas and petroleum, up to services and deliveries for the energy sector, **was also**

considered a key service. The minister competent for energy is responsible for control over this area. The responsibility for security of the teleinformation systems means a need to execute many new tasks, but at the same time raises the importance of these activities in ensuring security of the state.

2. Aim of the energy policy for Poland

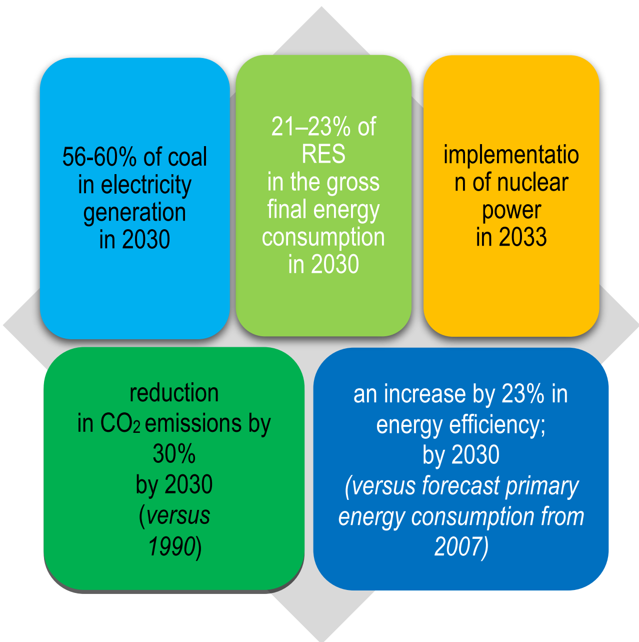
The aim of the energy policy for Poland is **energy security**, while ensuring **competitiveness of its economy**, energy efficiency and **reduction in the environmental impact of the energy sector**, with optimal use of own energy resources.



Energy security means the current and the future covering of demand of customers for fuels and energy in a way that is technically and economically justified, while respecting the environmental protection requirements. This means ensuring security of current and future supplies of materials, and of generation, transmission and distribution, i.e., of the entire power supply chain.

The cost of energy is hidden in each action and product manufactured in the economy, thus the energy prices are reflected in **competitiveness of the entire economy**. At the same time, emissions of pollutants from the energy sector **have an impact on the environment**, therefore, the energy balance must take this aspect into account.

All eight directions, presented further in this PEP2040, contribute to execution of the objective, and this was marked with a symbol of the objective. In the tables summing up the directions, all actions were referred to components of the objective, and this is highlighted with relevant colors ( ). The indices specified below were assumed as a global measure for implementation of the PEP2040 objective, where execution of the objective for RES at a level of 23% will be possible if Poland receives additional EU funds, including those for fair transformation:



3. Directions for *The Energy Policy for Poland until 2040*

1. Optimal use of own energy resources	2. Expansion of electricity generating and grid infrastructure	3. Diversification of gas and petroleum deliveries and expansion of the grid infrastructure	4. Development of energy markets	5. Implementation of nuclear power	6. Development of renewable energy sources	7. Development of heating and co-generation	8. Improvement in energy efficiency of economy
reasonable use of energy resources	covering demand for electricity	covering of the demand for natural gas and liquid fuels	fully competitive markets for electricity, natural gas and liquid fuels	reduced emissions from the power generation sector and security of the system operation	reduced emissions from the power generation sector and diversification of energy generation	general access to heat and low-emission generation of heat in the whole country	increased competitiveness of the economy
transformation of mining regions; **bituminous coal:** — sector profitability — reasonable extraction, use and distribution — innovations in extraction and use **lignite:** — reasonable extraction — innovations in use **natural gas:** - exploration of new deposits (including unconventional) and supplementing of domestic supply with diversified deliveries **petroleum:** - exploration of new deposits and supplementing of domestic supply with diversified deliveries **biomass and non-agricultural waste:** - reasonable own use	**generation capacities:** - ability to cover the demand with own capacities (stable, flexible, environmentally friendly) - implementation of the power market - increase in demand covered by capacities other than conventional coal - **coal** - 56–60% share in generation in 2030 - **nuclear power** – 6–9 GW in 2043 - **RES** - increase in the use - **natural gas** - mainly as control capacities **grid infrastructure:** - expansion of transmission and distribution grids - secure cross-border connections - increase in quality of distribution and security of power supply - efficient actions in emergency situations - development of storage	**natural gas**: - possibilities for receiving import (*Baltic Pipe, LNG terminal*) - efficient cross-border connections - expansion of the transmission and the distribution grids and underground gas storage facilities - investment impulses - regional security **petroleum and liquid fuels**: - expansion of the transmission grid and storage facilities for petroleum and liquid fuels - cyclic forecast for demand	**electricity**: - strengthening of the consumer position - protection of competitiveness of the energy-intensive industry - flattening of the power demand curve - transformation of systemic services into market oriented ones - reform of the energy trade - plan for making cross-border transmission capacities available **natural gas**: - market deregulation - strengthening of Poland's position in the European gas market (*a regional center*) - new segments for the use of gas and the grid **petroleum products and liquid fuels**: - market transparency - development of petrochemicals markets - reduction in emissions	- start-up of the first nuclear unit of 1-1.5 GW by 2033, and subsequent five units by 2043 (ca. 6–9 GW in total) - ensuring formal, legal and financial conditions for construction and functioning of nuclear power - well-qualified personnel - development of nuclear regulatory authority - providing a landfill for low and medium activity waste	- 21–23% of RES in the gross final energy consumption in 2030 - *in heating and cooling* -1.1 percentage point of annual increase in consumption - *in power generation* - ensuring the growth (*particularly, the use of solar energy and offshore wind power generation*) - *in transport* – 14% in 2030 - development of diversified power generation (prosumers of renewable energy, energy clusters) - ensuring balancing of RES (*storage facilities, regulatory sources*) - support of RES development (*with security of grid operation ensured*)	- active local energy planning - development of a heat map **District heating:** - an increase in the use of high-performance CHP - use of RES and waste - expansion of heat and cooling supply systems - use of heat storage facilities - competitiveness to individual sources - obligatory connection of recipients to the grid **Individual heating:** - increased use of non-solid fuels - *gas, non-combustible RES, electricity* - effective monitoring of pollutant emissions - reduced use of solid fuels	- 23% savings on primary energy vs. the forecast for 2030 from 2007 - legal and financial encouragement to actions promoting efficiency - public sector entities as role models - promotion of improvement in efficiency - intensive thermo-modernization of residential buildings - reduction of low emission - reduction of energy poverty

DIRECTION 1. Optimal use of own energy materials

TARGET: covering demand for energy resources

Covering demand for primary energy represents one of the main elements of **energy security of the state.** The high effectiveness of raw material extraction and use contributes to its more reasonable use, thus supporting **lower environmental impact of the power generation sector.** The efficiency of raw material extraction is also reflected in costs of energy generation, which is directly translated into **competitiveness of the economy.**

The main resource covering the demand for primary energy is **bituminous coal**, followed by **petroleum, natural gas, lignite and renewable sources**. Poland has resources of all listed materials; however, they do not ensure a complete energy independence of the country. Forecasts for fuel prices, domestic energy generation, and energy consumption by a type of fuel and by sector are presented in Appendix 2 to PEP2040.

*A concept for covering the domestic demand for individual resources is discussed below. The strategic project in this direction is **transformation of mining regions**.*

* * *

covering demand for bituminous coal

Bituminous coal is a foundation of the national energy balance (with consumption of ca. 75 million tons per annum), because Poland has large resources of this material, and power plants that use it ensure continuous and stable power supply to recipients. Coal mining and power generation sectors also have a significant social and economic importance, as they provide numerous jobs and income for the state budget (also indirectly, from entities providing services to mining and power generation sectors); furthermore, they frequently provide the main source of income in the region.

A need to diversify the structure of electricity generation will contribute to decreasing of the role of coal in the balance; however, it will remain an important item in the energy balance. In the coming several years, the use of this material by professional power generation sector will go down at much slower rate than at households, which use coal in less effective way, thus contributing to *low emission*.

The demand for bituminous coal should be covered by mines located in Poland, and the import should only occur in justified cases. The cost of coal mining in Poland should be competitive in relation to the imported material, enabling the use of the domestic potential while strengthening the economy. With the technological progress, new and modernized coal-fired units are characterized by higher efficiency, and this influences reasonable and effective consumption of the material and reduction in environmental impact of the power generation sector. The economics of coal-based generating units are negatively affected by a priority given to RES energy brought to grid. Furthermore, coal energy is burdened with costs of the climate and energy and the environmental policies. For this reason, the highest possible **reasonable extraction and use of the material** must be ensured, to which the following projects contribute:

a. **Ensuring profitability of the bituminous coal mining sector** - in recent years, restructuring operations have been undertaken, so the situation of mining companies has improved. Further activities must focus on achieving and maintaining a stable financial and organizational situation in the sector. The following actions will contribute to this aim:
    a. **rationalization and optimization of costs of current operation** - the actions should be extensive, from reduction in overhead costs up to optimization of administrative functions. Implementation of economically effective innovative solutions contributing to reduction in the costs of work and improved security is also of significance;
    b. **changes in the coal selling system** - modifications should influence the increase in effectiveness of trade structures, a complex nature of the sales structure, and the use of new technologies in the sales process;
    c. **creation of stabilizing mechanisms for a period of recession** - coal companies should consistently maintain special purpose assets to cover operating needs during periods of low global prices of coal;
    d. **review of fees paid by the sector** (changes in legislation) - the mining operations are currently burdened by nearly 30 types of fees and taxes - from taxes on working to fees for geological information. A method for

calculation of some of them is insufficiently defined, while others represent a considerable cost, disproportionate to benefits.

b. **Reasonable management of open deposits and opening of new deposits** - in this respect, the key issues are:
    a. **deepening of shafts, construction of new or expansion of existing operated levels,** wherever it is justified from the economic point of view;
    b. **further exploration works and making available of new mining areas** - geological studies indicate several potential deposits with large resources of high-quality coal. Depending on geological conditions and other aspects (including economic, social and environmental ones), new deposits should be opened;
    c. **developing a map of strategic bituminous coal resources with a concept for a target management model** - currently, the companies operate on a basis on geological information on paper, made available by geological administration bodies. The said tool should show in 3D both operated and potential deposits, so decisions on extraction at specific levels can be made on a regular basis. This tool should also solve a problem of lack of knowledge about places of mining in neighboring mines, which may lead to ground movements (sinkholes).

c. **Reasonable distribution of the material** - to achieve the highest possible environmental effects and cost effectiveness, the material should be transported over the shortest distances possible. Energy generating units should cover their demand for raw material from the nearest mines. Covering of the demand also depends on offered parameters of the fuel, therefore, combustion systems in new generating units should be planned taking into account covering of their fuel demand with material offered by Polish mines located in their vicinity.

d. **Use or sale of mining by-products** (methane, hydrogen, minerals) - this will contribute to implementation of the *circular economy*, and, at the same time, costs and negative environmental impacts of their storage will be eliminated.

e. **Innovations in mining and use of raw materials** - new solutions are to contribute to higher effectiveness and flexibility in the use of the material (e.g., in its gaseous form) and to reduction in quantities of emitted pollutants. A cooperation of companies with other entities, and research institutes in particular, plays a significant role in research, development and commercialization of effective solution.[6]

covering demand for lignite

Lignite is mainly used by the electricity generation sector (with the domestic consumption at a level of ca. 58 million tons per annum). Physical properties of this material determine its use within a small distance from a place of mining of this material, therefore, the market for lignite does not exist. Coal-firing power plants ensure stable energy generation, and due to low mining costs, lignite is a cheap source of energy. However, high emissions associated with this material are a significant disadvantage. This leads to higher costs of purchasing CO_2 emission allowances, with a simultaneous risk that lignite-firing units will not meet successive requirements for reduction in emission of pollutants (the EU climate and environmental policy). These factors are of a great significance for economic effectiveness and the very possibility to generate power from lignite.

Mining of open deposits and management of potential deposits will be completed. Złoczew and Ościsłowo deposits are considered as potential ones, while Gubin is treated as a reserve deposit. The main role in management of new potential deposits will be played by **prices of CO_2 emission allowances** and **development of new technologies**. Innovations will be used to implement low-emission technologies and alternate use of the lignite. The gassed material (synthesis gas) is characterized by lower emissions and its use can be synchronized with the demand. The syngas can be used in electricity and heat generation, as well as for production of synthetic gasoline and many other chemical products.[7]

transformation of mining regions

To maintain social and environmental order, **actions conducted after mining of a deposit ends or a generating unit is withdrawn from the system** are of importance. Not only mines in which deposits were extracted should be secured, but **the entire mining regions must be transformed.**

1. STRATEGIC PEP PROJECT – SOR PS.4(1)

[6] A detailed description of activities in the bituminous coal mining sector is presented in *Program dla sektora górnictwa węgla kamiennego w Polsce (perspektywa 2030 r.)* (The program for bituminous coal mining sector in Poland (2030 perspective), 2018.

[7] A detailed description of activities in the lignite mining sector is presented in *Program dla sektora górnictwa węgla brunatnego w Polsce (perspektywa 2030 r.)* (The program for lignite mining sector in Poland (2030 perspective), 2018.

In many cases a mine and/or a power plant, and companies providing services to them are main employers in a region, therefore, when no actions are conducted, social and economic problems may develop. It is necessary to implement special development programs for such regions, e.g., by special support to development projects, creating favorable conditions for running and development of business activities, or for additional mechanisms in the labor market, as well as simulation of modernization of the sector and investment in low-emission and emission-free generation sources. It is particularly important when operations of a mine or a power plant are discontinued due to **energy transformation** of the economy, and thus earlier than its technical capabilities indicate. The transformation must be **fair**, and this means that a rate of changes cannot lead to a drastic increase in energy prices, and regions exposed to negative effects of these changes are offered support. **For this purpose, a plan for restructuring of regions where bituminous coal and lignite are mined will be developed in 2020, using EU funds.**

Poland will conduct activities aiming at **supportive** undertaking of challenges posed by the transformation, to ensure sufficient compensation for countries and regions that are at a different starting points in the energy transformation. Striving to reduce emissions associated with energy generation is a very important issue for EU, therefore it is foreseen that the EU financial perspective will provide for special resources to support fair transformation of mining regions.

covering demand for petroleum

Poland does not have rich **petroleum** deposits, so the domestic extraction covers only part of its demand (ca. 4% out of 27 million tons per annum). Exploration of new deposits in Poland will be continued, but newly found deposits will replace extraction from recovered deposits, therefore the supply of domestic material will remain on a similar level (*as per principles established in the Material Policy for Poland*).

The main way for covering demand for petroleum will be import. It is important to ensure diversification of directions and routes of delivery, and the national infrastructure must be developed to a degree enabling the use of the raw material[8]. Dependence on one supplier and one route of deliveries is associated with a risk of lack of supply to a refinery of materials of sufficient quantities or quality, and thus disruptions in supply of petroleum products, including fuel, to the market.

As per sector forecasts, the use of liquid fuels in Poland will remain on a relatively stable level, as it is foreseen that petroleum will continue to play a significant role in the primary energy balance, due to development of transport, as well as due a demand for petrochemical products, i.e., new uses. A demand for petroleum products will slow down due to an increase in the use of alternate fuels, including biocomponents and electromobility[9]. To ensure stable supplies of petroleum as well as supply of fuels and other petroleum products to the internal market, it is necessary to provide conditions for further diversification and sufficiently developed infrastructure.

covering demand for natural gas

The domestic extraction of **natural gas** cover ca. 22% of the demand amounting to over 18 billion m^3 per annum. For several years, the use of natural gas in the economy regularly rises. The demand for natural gas will increase, as this material is used in power plants ensuring flexibility of the power generation system, and is characterized by lower emission levels when compared to other fossil fuels, both in power and in heat generation sectors. Its use in the residential and municipal sector will also increase to improve the air quality.

Similarly as in the case of petroleum, exploration of new deposits (also on the bottom of the Baltic Sea) to replace the depleted deposits and improvements in extraction effectiveness will be continued (*as provided for in principles of the Raw Materials Policy for Poland*). At the same time, domestic companies should continue to expand their operations in extraction of the material abroad, especially at the Norwegian continental shelf (with which Poland will be connected by a gas pipe, the Baltic Pipe, in 2022) and in other areas with high extraction potential.

SOR PS.3(3)

Apart from traditional extraction of natural gas, development of **unconventional extraction methods** is expected. A progress in obtaining gas from mine deposits is expected. In this method, gas (methane) is obtained by hydraulic fracturing of a coal seam, and then extracted before, during or after completed extraction of the coal seam (methane removal), and brought into the gas grid or used for

[8] See Direction 3, part C.

[9] See Direction 4, part C - the use of biocomponents, and development of electromobility and alternate fuels.

energy generation purposes. This will facilitate an increased use of material from domestic sources. It is estimated that this technology will be used more extensively after 2020. Further studies on possibilities to extract gas from unconventional deposits (including shale), which were discontinued due to lack of economic grounds and significant uncertainty, are also considered. A demand for gas fuels can be partly covered also by the use of national potential for **biomethane** production. When relevant technical conditions are met, it can be pumped to the gas grid, and this will positively promote its use.

The import will still remain the main way for covering demand for natural gas. Therefore, similarly as in the case of petroleum, it is important to ensure diversification of directions and routes of delivery, and the national infrastructure must be developed to a degree enabling the use of the raw material[10].

covering demand for biomass

Apart from fossil fuels, the energy sector also uses combustible renewable materials[11], i.e. **biomass**, understood as many solid or liquid substances of plant or animal origin, as well as other biodegradable substances.

The energy sector should use specifically **biomass classified as waste (non-agricultural)**, which cannot be used in other sectors of economy, such as biodegradable municipal waste, residues from forestry, households, and agricultural, food and processing (furniture, paper, etc.) industries. A large potential is present in sewage sludge, industrial waste, waste statutory defined a hazardous (including hospital), and in municipal waste. This process must be conducted according to a rule for hierarchical disposal of waste, meaning that biomass should first be recycled, and when it is not possible, recovered and disposed, thus enabling a reasonable use of the biodegradable fraction.

The use of biomass for energy purposes - both thermal and anaerobic one in bio-gasworks, and for production of biofuels - will rise due to the increasing stream of biological waste from growing consumption, as well as in consequence of stricter regulations for waste management, gradually making landfilling of biological waste impossible[12]. This solution is also consistent with the concept of *circulatory economy.*

The agricultural biomass will still play a significant role in covering the demand for raw material, and it is crucial to ensure that there is no competition for raw materials between the energy sector and agriculture, agricultural and food production, and processing industries. Furthermore, biomass should be **used at the shortest possible distance from a place of its production**, so its transport and associated costs do not affect negatively the environmental impact and economic results.

TERRITORIAL DIMENSION

The regional approach to the analyzed direction is closely associated with location of individual materials. In many cases, the use of raw material plays a significant role in a given region, therefore, it is particularly important to ensure that **alternate development policies** are prepared sufficiently in advance for regions in which the use of a given raw material is discontinued, to minimize a risk of social and economic problems. In many cases, areas at which the discussed operations were ended can be used for new economic activities.

	Actions	Deadline	Responsible
1.1.	Ensuring covering of a demand for bituminous coal through: – ensuring profitability of bituminous coal mining sector; – reasonable management of open deposits and opening of new ones; – reasonable distribution of raw material; – use or sale of by-products from mining; – searching for innovations in extraction and use of the material	–	ME, MF, MEN, coal companies, institutes

[10] See Direction 3, parts B and C.

[11] This part focuses solely on biomass, as it is the only renewable source that is considered in terms of raw materials or covering of demand. The territorial potential of other RES categories is specified in Chapter 1 and discussed in direction 6.

[12] Since 2016 already it has been forbidden to landfill specific fractions of municipal waste and derived from treatment of municipal waste, including waste containing organic carbon in the amount exceeding 5% of its dry weight and the heat of combustion above 6 MJ/kg d.w.

1.2.	Ensuring covering of a demand for lignite through: – reasonable management of open deposits and opening of new ones; – searching for innovative ways for the use of lignite	–	ME, coal/energy companies
1.3.	Ensuring support for a transformation of mining regions, including developing a plan for restructuring of regions where bituminous coal and lignite are mined in 2020, using EU funds **1. STRATEGIC PEP PROJECT**	–	ME, MIiR, local governments, coal/energy companies
1.4.	Ensuring a possibility for covering of a demand for petroleum and fuels through: – optimizing the use of Polish deposits of petroleum, (*as provided for in principles of the Raw Materials Policy for Poland*); – diversification of sources of supply and directions of import for petroleum; – use of biocomponents and alternate fuels	–	ME, MŚ, PRSIE, oil companies, MIiR, MRiRW
1.5.	Ensuring covering of a demand for gas through: – optimizing the use of Polish deposits of natural gas, including the use of unconventional methods for gas extraction, (*as provided for in principles of the Raw Materials Policy for Poland*); – diversification of sources of natural gas supply; – use of domestic potential for biomethane production and pumping into the gas grid	–	ME, MŚ, PRSIE, gas companies
1.6.	Ensuring covering of a demand for biomass, assuming a local use of raw materials, through: – use of the potential of waste (non-agricultural) biomass; – maintaining the use of residues and waste from agriculture, and from agricultural and food processing	–	ME, MŚ, MRiRW, MIiR

– energy security, – competitiveness of the economy, – reduction of the environmental impact of the sector

DIRECTION 2. Expansion of electricity generating and grid infrastructure

TARGET: covering demand for electricity

The use of a significant part of currently used generating infrastructure will be finished within the next several years, while a demand for electricity continues to grow steadily. For this reason, to **ensure safety of electricity supply**, it is necessary to expand the generating infrastructure and ensure efficient transmission and distribution. The selection of the fuel and the technology (including associated additional costs, such as CO_2 emission allowances), low transmission and distribution losses, and security of supply play a crucial role in shaping of electricity prices, influencing **competitiveness of the entire national economy.** The same factors are decisive for **the energy sector's environmental impact**, although they can be of a different nature. Energy security has a priority in a process shaping the structure of energy generation, therefore, it must have a decisive influence on a relation between reasonable costs of the system functioning and the environmental aspect.

PART A) Expansion of electricity generating infrastructure

In 2018, the Polish economy used nearly 171 TWh of electricity, mainly using own generation, which increased over 17 times since the middle of the 20th century. At the end of 2018, the installed power in the national power generation sector (KSE) amounted to nearly 46 GW, of which over 36.6 GW represents professional, mainly coal and lignite based power plants; over 6.6 GW are professional installed power in RES, and the remaining part of ca. 2.7 W corresponds to industrial power plants (various fuels)[13]. At the end of 2018, the installed power of all renewable sources amounted to 8.5 GW (including 5.8 GW of wind power), of which 5.2 GW were covered by independent sources, i.e., those operating outside the structures of companies from the power generation sector.

A demand for electricity steadily rises, although the growth rate in the energy demand is slower than it would be suggested by an increase in the number of devices used by the industrial and service sectors, and by the society, due to the technological progress and activities supporting efficiency.

In the coming several years (especially after 2029), **a significant part of currently used generating units will be withdrawn from the system.** Only in 2020 alone, ca. 2.5 GW of the installed power in the centrally dispatched generating units (JWCD) will be decommissioned[14], because their adaptation to environmental requirements resulting from BAT conclusions, in force since 2021, is impossible or not justified.
The end of operation can be *natural*, meaning that further operation is not possible from a technical point of view. The second, more extensive category, are decommissionings of *economic and environmental nature* - for some units of low operational parameters, costs of purchase of CO_2 emission allowances will make energy generation uncompetitive, while other generating units will not meet EU environmental regulations and their modernization will be unprofitable or impossible.

To cover the increasing demand, in a situation of significant withdrawal of generating units from the electricity generating system, and to balance increase in power dependent on weather conditions, a power market has been implemented, being an investment impulse to ensure security of supply. This mechanism will be of crucial importance for expansion of the current generating powers, but the final shape of the energy balance will be influenced by development of new technologies, implementation of innovations, changes associated with implementation of the uniform European Union energy market - in particular, the regulation concerning the internal electricity market and the directive concerning common rules for the internal electricity market.

The conditions for the operation of the electricity generating systems, as well as a concept for covering the national demand for electricity are discussed below. The strategic project in this part of the discussed direction is ***the power market****.*

[13] Source: *Raport roczny z funkcjonowania KSE w 2018 roku* (Annual Report on KSE functioning in 2018), PSE S.A.

[14] In 2019–2020, ca. 4.2 GW of new generation capacities of JWCD using coal or natural gas will be connected to KSE, and this will compensate for decommissioned units and cover the increased energy demand. See Attachments 1 and 2.

* * *

A way for the system expansion must ensure energy security of the state, but also reasonable costs of the system operation, with the reduced environmental impact of the sector. At the same time, a process for shaping the balance structure must meet many demands, of which the most important ones are:

- **the climate and energy policy of the European Union, other international obligations, and implementation of low-emission economy**

  Poland, as the EU Member State, will contribute to the EU targets and other international obligations, according to its possibilities. It should be expected that decisions concerning establishing stricter emission standards and a reform of the EU CO_2 emission allowances trading system (*European Union Emissions Trading System* - EU ETS), as well as a need to adapt generation capacities to environmental regulations (IED directive and BAT conclusions) will influence costs of use of fossil fuels for energy-generation purposes.

  The task of the Polish government is to negotiate such provisions in regulations that will not undermine competitiveness of the energy sector, and, indirectly, of the entire economy. At the same time, to help the industry and subsectors of power generation to meet innovative and investment challenges related to transition to low-emission economy, the best possible use of support mechanisms (including tools available within the EU ETS system, i.e., the innovations fund, the modernization fund, or the special purpose fund for transformation of the energy sector) is important;

- **limited availability of fossil fuels and a need to diversify the energy generation structure**

  At the current mining rate, the national industrial resources of bituminous coal will last for next several dozen years, therefore, they must be managed in a reasonable and effective way. The use of new innovative technologies should facilitate diversification, while ensuring meeting of the main target of the energy policy;

- **disruptions and changes in the energy market**

  The market for electricity has been significantly disrupted by functioning of subsidized renewable energy sources (RES) in it, which are characterized by significant instability of operation and a priority of bringing energy to the grid. This reduces the actual time of conventional units operation, but does not decrease the need to maintain them to secure the continuous covering of consumers' demand for electricity, and this negatively affects economics of such power plants;

- **control options and flexibility of generation**

  The amount of installed power from sources depending on weather conditions continuously grows. Storage technologies are not developed sufficiently, therefore, KSE must include powers generation of which will ensure flexible operation of the system according to the demand for energy (also due to its non-linear course)[15];

- **need to implement innovations**

  Implementation of innovations aims at ensuring a competitive edge, as well as keeping pace with changes occurring in the industry. New solutions should contribute to better operational efficiency of the energy system and easier RES integration, as well as to widely understood reduction in the sector's environmental impact and increase in energy efficiency. For this reason, research and development, and obtaining funds for their execution, play an enormous role in implementation of innovations.

To ensure energy security, together with competitiveness of economy and improved energy efficiency, as well as to reduce the environmental impact of the energy sector, the Government will support implementation of assumptions made below, operationalization of which was also included in other directions described in this document.

[15] It must be remembered that the price of energy generated by conventional capacities replaced in KSE by RES or treated as a reserve for RES should not be compared directly with RES energy prices. Such power plant produces less energy than possible according to its technical possibilities, and withdrawals decrease its lifespan, increase a need for modernization, and represent a cost of lost possibilities. The overhead costs are spread over lower amount of generated energy units, and this negatively affects an average cost of operation. At the same time, it is conventional units that ensure security of energy supply to customers.

covering demand for power

Poland will strive to **ensure a possibility to cover its power demand with own raw materials and sources**, taking into account a possibility of cross-border exchange. **An increased demand for electricity** will be covered by sources other than conventional coal-fired power plants.

The structure of generation capacities must **ensure flexible operation of the system**, and this is associated with differentiation in technologies and generating capacities, and with activating customers in regulated markets. A **development of energy storage technologies** (including solutions provided by development of electromobility) will be of enormous importance for changes in the shape of the energy market. It is particularly significant due to an increase in the share of RES dependent on weather conditions. This way, the energy can be stored in periods when its generation exceeds demand, and it will support covering of demand for electricity in unfavorable weather conditions or in a period of significant increase in the demand for power. **Research in new technologies** and **implementation of innovations** will bring a particular contribution to changes in shaping of the structure of the power balance.

2A. STRATEGIC PEP PROJECT
– SOR PS.1(1)

In 2021, the **power market** will start to operate, and its implementation is of crucial importance for **guaranteeing secure and stable energy supply to customers.** The market of two commodities (electricity and power) should provide an investment impulse for generating sources, which will ensure deliveries of power to the system. The power market will also contribute to development of services for reduction in the demand.

On a basis of balance analyses and forecasts for market development, two years before the last main auction in the power market (2023), the Minister of Energy will decide whether further functioning of the power market is necessary, taking into account EU regulations valid at that time.

reduction in emissions of pollutants from the sector

Execution of PEP2040 also aims at **reduction in emissions of pollutants from the power generation sector.** In particular, it will be conducted through:

– modernization of energy generating units and decommissioning of units exceeding emission standards of an average annual efficiency below 35% (including with EU ETS support mechanisms);
– implementation of nuclear power and an increase in the use of renewable energy sources;
– increased use of other low-emission energy sources and implementing modern technologies;
– improved energy efficiency.

coal role in the power balance

Concerning **the role of coal in the power generation balance** it should be indicated that the national coal resources will remain the main element of the energy security of Poland and a basis for the energy balance of the country. The annual consumption of bituminous coal in the professional power sector will not be increased. Due to an increased demand for electricity, the coal share in the sector will change. In 2030, the total share of coal in electricity generation will be at a level of ca. 55%–60%.

Investments in new coal-fired units undertaken after 2025 will be based on co-generation or other technology meeting the emission standard at a level of 450 kg CO_2 per 1 MWh of generated energy. For the best possible use of raw material and reduction in the environmental impact, new methods for the use and processing of coal will be researched, such as gasification, oxy-combustion and other clean coal-based technologies[16].

nuclear power role in the power balance

Taking into account the desirable environmental impact, no costs of the climate and environmental policy charged, and a stable electricity generation, the proven **nuclear power** technology will be included in the power generation balance. In Poland, the first unit of a nuclear power plant (of 1–1.5 GW) will be started up around 2033. The subsequent 5 units, of a total power of 5–7.5 GW, will be started up every 2 to 3 years.[17]

[16] See also: direction 1.
[17] See also: direction 5.

renewable energy sources role in the power balance

Development of the use of **energy from renewable sources** is one of the instruments limiting the environmental impact of the energy sector. Poland will contribute to achievement of the target for the whole EU concerning the share of renewable energy sources in the gross final energy consumption in 2030 to the extent that does not put the energy security of the country at risk. The RES share in the final energy consumption should result from cost effectiveness and possibilities for energy balancing in KSE.

The target of 23% RES share in gross final energy consumption[18] in 2030 will translate into ca. 32% RES share in net electricity generation, although it will require significant economic and organizational efforts. The development of **photovoltaic** (especially since 2022) and **offshore wind farms** (the first offshore wind farm will be started up ca. 2025) will play a crucial role in achieving the target for electricity generation due to an increase in profitability of these sources and the expected increase in the market flexibility, necessary for RES development.

In the coming years, **community energy** will develop, which will be mainly based on renewable sources. These capacities will not replace the systemic energy because capacities of individual systems are too low and energy supply is not secure, but they will at least partly cover individual needs, improve the air quality, and ensure more informed use of energy.[19]

natural gas role in the power balance

The **role of natural gas** will also gain in importance in the electricity generation balance. The degree of the use of capacities will depend in particular on a need to balance the national electricity generation system, especially uncontrolled RES, but also on raw material prices. The advantage of gas resources are their emissions which are significantly lower than in the case of conventional coal-based resources, as well as a high level of control. Actions aiming at increasing options for diversification of the raw material supplies to Poland and expansion of the internal infrastructure will ensure the secure use of the natural gas for energy generation.[20]

The charts provided below present the forecast structure of the installed power and electricity generation in 2020–2040. The charts also include possible share of coal and RES in the power and electricity generation balance in 2020, 2030 and 2040. The charts indicate that the use of new capacities, mainly RES and gas, but also nuclear ones, will increase. By 2030, the coal-based fuels will predominate in the energy generation structure. In successive years they will be responsible for the security of the system operation to a greater extent than for basic operation.

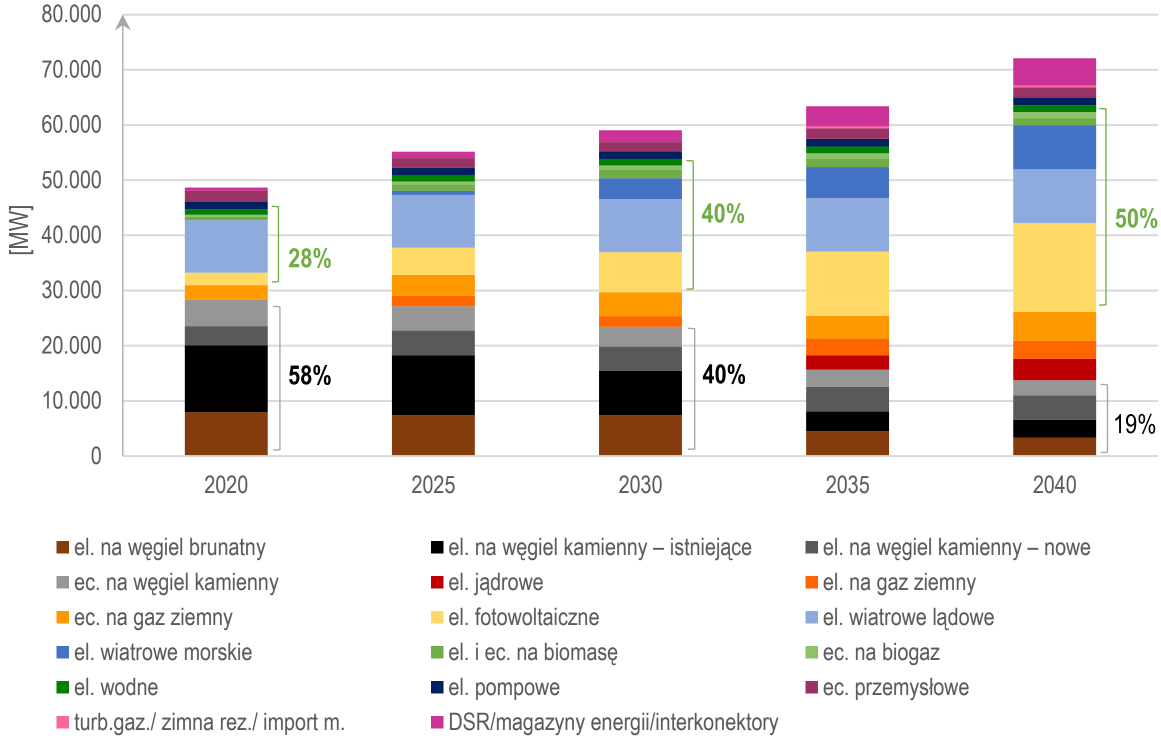
The more extensive analyses (charts and tables) for the electricity generation system are provided in Appendix 2 to PEP2040.

[18] The gross consumption of final energy consists of consumption of electricity, heating and energy for transport purposes.

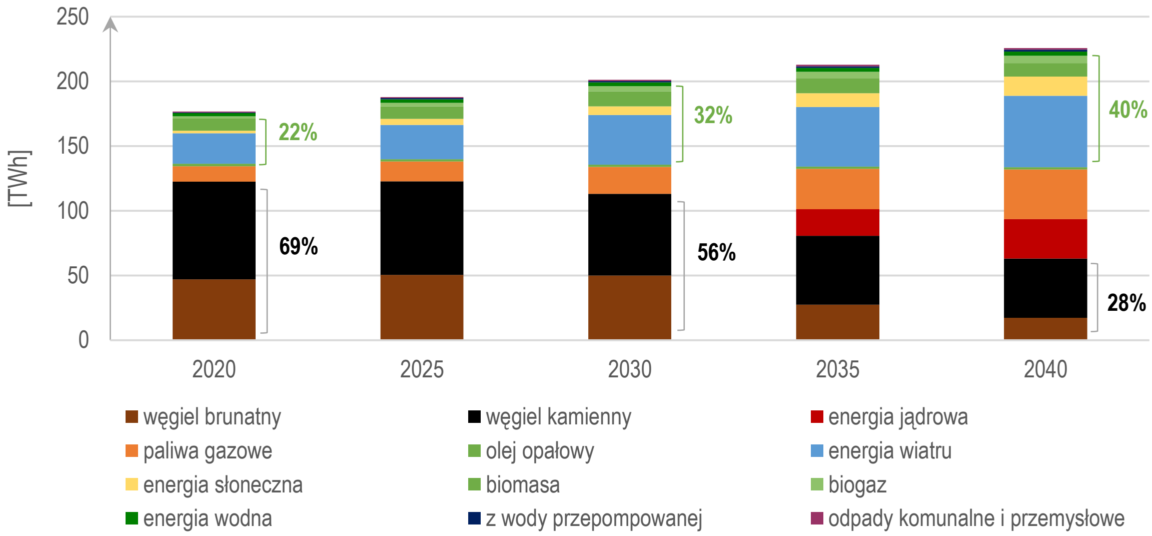
[19] See also: direction 6.

[20] See also: direction 3.

Forecast installed power in 2020–2040



Forecast gross electricity generation by fuel type in 2020–2040



TERRITORIAL DIMENSION

Covering the country with generation capacities depends on possibilities to construct units in a given location, power output, access to fuel, and a role of a given source in the system. The predominating amount of power is installed in the south part of the country, but this tendency will be subject to further changes. Development of RES, particularly in north-west part of the country due to good wind conditions, necessity to construct control sources, as well as construction of nuclear power units in successive years, contribute to this situation. At the same time, the country will be relatively evenly covered with individual generating systems, energy clusters, and energy cooperatives. Construction of generation sources in a given location influences the labor market, an improvement in the transport infrastructure, increases tax revenues, and a general level of economic development.

	Actions	Deadline	Responsible
2A.1.	Ensuring a possibility to cover the electricity demand with own raw materials and sources, taking into account a possibility of cross-border exchange *(also see: direction 1)*	–	ME, PRSIE, TSOe
2A.2.	Ensuring a possibility to cover the increase in the electricity demand by sources other than conventional coal-firing power plants and ensuring conditions for shaping of the structure of generating capacities guaranteeing flexible operation of the system, including development of technologies for energy storage (*see also: direction 2, part B, and direction 4)*	–	ME
2A.3.	Ensuring a required quantity of stable electricity supply through; – initiation of the power market operation (2021); – making a decision about continued operation of the power market two years before the last auction (2023), taking into account limitations resulting from EU regulations. **2A. STRATEGIC PEP PROJECT**	2021/2023	ME
2A.4.	Ensuring conditions for reduction in emissions of pollutants from the power generation sector through: – modernization of energy generating units and decommissioning of units of an efficiency below 35% (including with EU ETS support mechanisms); – increased use of low-emission energy sources; – improved energy efficiency	–	ME, MŚ
2A.5.	Ensuring conditions for the coal use at a level of 56%–60% in the energy generation balance in 2030, taking into account maintaining of the emission standard at the level of 450 kg of CO_2 per 1 MWh in investments undertaken after 2025.	–	ME
2A.6.	Ensuring conditions for implementation of nuclear power in 2033 (*see direction 5*)	2033	ME
2A.7.	Ensuring conditions for RES development at a level that is not hazardous to the security of the system operation, taking into account contributions to the general EU goal of increasing the RES share in energy consumption (*see direction 6*)	–	ME, URE
2A.8.	Ensuring conditions for the use of natural gas, particularly for KES control purposes (*see direction 3*)	–	ME

– energy security, – competitiveness of the economy, – reduction of the environmental impact of the sector

PART B) Expansion of electricity grid infrastructure

Stable and secure supplies of electricity depend on the sufficiently expanded national power generation system. The key national targets concerning the infrastructure for electricity transmission are (a) balancing electricity supply and demand, and (b) ensuring long-term electricity generation system to secure reasonable needs for electricity transmission in domestic and cross-border trade.

To ensure security for deliveries, an electricity transmission system operator (TSOe) – Polskie Sieci Elektroenergetyczne S.A. (PSE S.A.) will remain a one-person company owned by the National Treasury. Distribution is a regulated activity, and electricity distribution system operators (DESe) are obliged to ensure reliable functioning of the system and realization of other duties guaranteeing security of the system operations. To ensure security of the energy supply to customers, TSOe and DESe are obliged to prepare development plans for covering of the energy demand, for 10 years and for no less than 5 years, respectively.

*A concept for expansion of transmission and distribution infrastructures, improved efficiency of actions in emergency situations, energy storage and smart grid development is presented below. The strategic project in this direction is **development of smart grids**.*

* * *

The transmission grid of high and the highest voltages is formed by over 250 lines of a length exceeding 14,000 km and over 100 stations of the highest voltages[21]. Currently, Poland has active connections **with Germany, Czech Republic, Slovakia, Lithuania** and **Sweden** (with a submarine cable)[22], and four connections with third countries, with three of them withdrawn from operation.[23] From the point of view of market rules, an option for cross-border transmissions is a precondition for building a **uniform electricity market**, which aims at ensuring competitive energy prices in entire Europe. Poland is of the opinion that cross-border connections should be an additional source of supplies, supporting the market development, reduction of energy prices, and supplies in a situation of emergency and shortages. However, security of electricity supply **should be based on well-developed generating infrastructure**.

To ensure correct functioning and development of the system in the coming years, TSOe will undertake activities for **modernizing and expansion of the transmission system**, aiming, in particular, at:

- **options for power output** from the existing generation sources;
- **connection of new capacities**, including a nuclear power plant, and onshore and offshore wind farms at a level enabling achievement of the required RES share in the energy balance of the country;
- **improvement in supply security for customers**;
- creation of secure **conditions for cooperation of uncontrollable energy sources** with other KSE elements;
- ensuring a possibility for **reduction of unplanned energy transmissions** (unscheduled transmissions) from neighboring countries and operation of transit transmissions;
- ensuring **ability for power exchange with neighboring systems** on a synchronous profile, and mechanisms for information coordination and exchange, including optimizing of methods for making transmission capacities available (designation and allocation) on a basis of physical electricity flow (flow-based allocation, FBA);
- **implementation of the uniform EU electricity market** - implementation of EU legislation and accompanying documents;
- implementation of standards related to ensuring of **cybersecurity** at the national level;
- increase in the energy efficiency of energy transmission.

expansion of domestic electricity transmission infrastructure

To implement the above targets within the entire time frames, TSOe will execute actions concerning construction, expansion and modernization of stations, distribution

[21] The transmission grid is of meshed character, which means that when one line is down, a distribution station can be supplied by a line from another direction.

[22] Poland-Germany lines: Krajnik–Vierraden; Mikułowa–Hagenwerder; Poland-Czech Republic lines: Wielopole/Dobrzeń–Nosovice/Albrechtice; Kopanina/Bujaków–Liskovec; Poland-Slovakia line: Krosno Iskrzynia–Lemešany; Poland-Lithuania line: Ełk–Alytus, Poland-Sweden line: Słupsk–Stärno (submarine cable).

[23] Poland-Ukraine lines: Rzeszów-Khmelnytskyi (withdrawn from operation); Zamość-Dobrotvir (only import); Poland-Belarus lines: Białystok-Ros (under liquidation); Wólka Dobryńska-Brest(withdrawn from operation). The Zamość–Dobrotvir (Ukraine) connection operating under market conditions provides for maximum 0.7% of the peak power demand of Poland.

stations, lines and other devices, including those for the compensation of passive power in the range of high and the highest voltages (110-220-400 kV). Realization of all investment programs by 2025 should mainly ensure[24]:

– options for power output from power plants: Kozienice, Turów, and Bełchatów, and efficient power transmission from the Dolna Odra Power Plant;
– grid expansion in the northern, north-west (where wind power plants are specially installed due to good wind conditions), and north-east part of Poland, and above and below the virtual Warsaw-Poznań line;
– better use of the cross-border connection Krajnik-Vierraden (improved conditions for cross-border exchange on the synchronous profile - Poland-Germany-Czech Republic-Slovakia);
– possibility to use the constructed submarine connection Poland-Lithuania (the Harmony Link).

secure use of cross-border power connections

As a part of the conducted modernization works and expansion of power generation **transmission infrastructure, a level of transmission of capabilities made available for the needs of the cross-border exchange will increase.** Options of the electricity exchange with neighboring countries are of importance for development of electricity trade between market areas of the EU countries, represent an additional measure that can be used in periods of power shortages in the country (e.g., import in the event of a failure of domestic generating units), as well as improve a possibility to absorb energy from renewable sources in the event of its excess (e.g., export in a very windy period and low demand).

The effective us of cross-border transmission capabilities supports **building of a uniform electricity market in EU**[25]. It is very important to ensure that the cross-border electricity exchange is conducted in conditions secure for operation of the power generation system (including provision of an appropriate number of preventive measures for secure operation of the grid, e.g., in the event of unplanned circular flow or safe energy transit). The increase in capacity of cross-border connections between Member States should be ensured, in the first place, by optimum use of the existing connections and by removing barriers blocking access to the grid to market participants, including construction of missing lines within national systems, changes in rules for making transmission capacities available between EU Member States, optimizing methods for making these capacities available to market participants (implementation of flow-based allocation (FBA) of transmission capacities) and the use of phase-shifters.

Considering the above, **investments in development of the domestic transmission grid and cross-border connections are planned** until 2030, **to**:

– improve flow efficiency on the synchronous profile covering Germany, Czech Republic and Slovakia;
– construction of a new submarine cable connection between Poland and Lithuania (the Harmony Link) and completion of synchronization of transmission systems of the Baltic States with continental Europe through the Polish transmission system.

development in electricity distribution

Further on, a security of **electricity supply to end customers** depends on efficient and secure **distribution**. The distribution grid is mainly of the radial character, and it is longer and denser than the transmission grid, and thus it is more exposed to failures. It is formed by over 700 thousand km of high-voltage (HV), medium-voltage (MV) and low-voltage (LV) lines, and by nearly 260 thousand power stations, that is part of the lines of 110 kV voltage and all below that value. The 110 kV grid is of the crucial importance for individual regions of the country (industry supply, power output from large renewable sources), which forms a basis for ensuring security of the operation of the distribution system and is coordinated with the transmission grid. Events in the MV grid, 74% of which is of the overhead type, have the greatest influence on reliability of energy supply to end customers To ensure the highest quality of electricity supply, as well as for development of electromobility (to ensure sufficient grid capacity and possibility to connect charging points), DESes should **implement targets and tasks resulting from the quality regulation** specified by the President of the Energy Regulatory Office (URE). Since 2018, the regulatory mechanism has provided both for weather anomalies and for diversity of regions (cities, poviate towns, towns and villages),

[24] More in: *Plan rozwoju w zakresie zaspokojenia obecnego i przyszłego zapotrzebowania na energię elektryczną na lata 2018-2027* (The development plan for covering current and future demand for electricity for 2018–2027), PSE S.A. 2018

[25] See Direction 4, part A - the uniform electricity market.

and for current level of development in the area of a given DESe, and this allows to draw more accurate conclusions on DESe's activities. From a prospective point of view, the tasks described below should be executed:

- **By 2025, energy supply quality indicators,** i.e., **duration and frequency of supply interruptions (SAIDI, SAIFI) in KSE should reach the average EU level and to remain at that level in subsequent years. Furthermore, 85% of connection agreements should be performed within 6 months**, and the time for providing measurement and settlement data should be shortened.
- Achievement of targets set in the quality regulation is strictly related to funds that DESe can designate for investments in a subsequent year. The significant part of the distribution infrastructure is over 25 years old, and in many cases even over 40 years old (although recently DESes have executed extensive investments). For this reason, DESes are obliged to restore the grid – **the infrastructure restoration rate should be at a level of ca. 1.5% per annum** until the average age of the infrastructure is below 25 years.
- **Rebuilding of low-voltage (LV) lines** should be conducted using isolated cables or through cable lines.
- **The share of medium voltage (MV) cable grids** is strongly correlated with SAIDI and SAIFI, and the share of cable lines in MV voltage lines in Poland (ca. 26% in 2017) is one of the lowest in Europe. Over 41 thousand km of overhead MV lines are in forest and tree-covered areas, where cable lines is of particular importance for reducing causes and consequences of a failure. Furthermore, providing medium voltage lines with remote control systems is also considered a priority task. To achieve a higher reliability of the grid operation, successive installation of cables of medium voltage grids is necessary. For this purpose, a **national plan for cable installation in the medium-voltage grid until 2040** will be developed in 2020. It will result in increased share of cable lines in the MV lines in Poland to the average EU level.

efficient actions in emergency situations

Security of energy supplies also depends on good organization and efficient handling of **emergency situations**. In 2018, DESes and TSO signed an agreement concerning cooperation in such cases, however, to ensure the highest possible efficiency in emergency situations, the following actions are necessary:

- equipping systems, and medium and low voltage lines with **control, diagnostic and network analyzing equipment** (by 2022 and 2028, respectively);
- implementation of the **digital communication system in the grid for DESes** (by 2021) - currently used analog system is faulty and it cannot be expanded - the new system should guarantee uniform and reliable connections;
- DESe ensuring a **number of employees and equipment to maintain standards** established in the regulations concerning conditions for operation of a power supply system.

development of electricity storage and recovery

In recent years, the importance of **energy storage** has gained in importance. This results from an increased awareness and a need to manage the demand to flatten the power demand curve (reduced demand peaks). Another element determining development of energy storage facilities is the increasing share of energy from uncontrollable renewable energy sources.

Currently, the energy storage in KSE is poorly developed and based on pumped storage at hydro power plants and scarce hot water storage facilities. Great hopes are associated with *development of electromobility* and more extensive use of *energy recovery from electric vehicles supplied from overhead contact lines.* Studies focusing on batteries powering electric vehicles contribute to the progress in technologies for energy storage, and electric cars can play a role of energy storage facilities. As a part of the actions aiming at development of the charging infrastructure, the *vehicle to grid* (V2G) technology will be supported, enabling a two-way electricity flow, including its return by electric vehicles to stabilize the grid work, e.g., during a morning or an afternoon peak.

DESes cooperate on the international level in research projects focusing on development of storage technologies, and the first installations can be expected after 2020. Until that time, it is necessary to **regulate a legal status of systems for electricity storage**, which can provide services to participants in the electricity market - in this respect, establishing of preferential tariffs for bringing energy to storage is crucial, as it will also influence a possibility to change a mode of operation for pumped storage at hydro power plants. Nevertheless, having storage facilities for power corresponding to 10% of installed power in wind power plants by 2023 is an ambitious target[26].

Development of other solutions enabling progress in energy storage is also desirable, particularly those that would enable the use of RES energy. Besides biogas, enabling quick reaction to the system needs, it is worth to use surplus energy from RES working in an intermittent mode to produce fuel that can be stored in a practical way. A significant role in this respect may play an increase in profitability of hydrogen production and use, as this gas is characterized by high energy density and enables a relatively long storage of fuel and possibility to react quickly to the system needs. A progress in increasing profitability of coal gasification may also become an opportunity in this area, as coal used in this technology is characterized by much lower emissions than when it is burned in a conventional way. A search for innovations that would increase flexibility of the electricity generation system is highly desirable for its normal functioning and for development of renewable energy sources.

Activities developing the national power generation grid will culminate in **implementation of *smart grid*.** A significant stage would be **establishing of an energy market information operator** (EMIO). The smart grid will enable integration of behaviors and actions of all users attached to it - generators, customers and prosumers of renewable energy, while EMIO will ensure exchange of information between the system participants. With this solution, more informed use of the energy, energy supply and demand management and reduction of losses will be possible, with a high level of quality, reliability and security of supply.

development of smart grids

2B. STRATEGIC PEP PROJECT
– SOR PS.2(1)

A foundations for this concept are formed by solutions belonging to information and communication technologies (ICT). Besides systems of two-way digital communications, they include smart telemetering systems and systems for automated monitoring, control, regulation and securing of the grid. Development of smart grids is associated with spreading of the **Internet of Things** concept. Data sharing between devices will also allow spreading of smart cities, smart houses, and efficient operation of energy clusters.
For this purpose, it is necessary to create technical, organizational, and legal conditions for EMIO functioning.

TERRITORIAL DIMENSION

Covering of the country with the transmission grid and distribution grids is correlated with a size of demand for electricity in a given region and a need for transmitting energy from generating units, and a precise course of a line also depends on a possibility for locating the infrastructure. The grid density and its good technical condition should guarantee a reliability of electricity supply and possibly low failure rate, which is independent from the region. Investment programs developed by TSOe and DESe aim at ensuring security of supply in the entire country.

Development of energy storage facilities also concerns the entire country - in the long-term perspective every customer may be equipped with energy storage facilities (including electric car). Location of storage facilities near RES sources and in energy clusters is particularly important, as it supports stable KSE operation. A similar effect can be achieved by successive implementation of smart grids.

[26] See also: Direction 4, part A - demand management and Direction 4, part C - development of electromobility and alternate fuels.

	Actions		Deadline	Responsible
	2B1.	Expansion of the internal power transmission grid - realization of investments enabling increase in the grid density, power output from large power plants and better use of cross-border connections.	-	TSOe
	2B.2.	Strengthening of cross-border power connections on a profile with Germany, Czech Republic and Slovakia	2030	TSOe
	2B.3.	Construction of a new submarine cable connection between Poland and Lithuania (the Harmony Link) and synchronization of the Baltic States with the power generation system in continental Europe	2025	TSOe
	2B.4.	Improvement in quality of energy supply to consumers - by 2025 through: − implementation of targets and tasks of the quality regulation; − achieving the average EU level for SAIDI and SAIFI; − achieving the level of execution of 85% of connection agreements in 6 months; − recreation of the infrastructure - at a level of 1.5% per annum; − development of *the national MV cable installation by 2040* (by 2021)	2025	DESe
	2B.5.	Ensuring condition for efficient operation in emergency situations − equipping systems, and MV and LV lines with control, diagnostic and network analyzing equipment (2022/2028); − implementation of the digital connection system in DESe (2020); − ensuring by DESe resources for correct functioning of the system	2020 / 2022 / 2028	MI, ME, DESe
	2B.6.	Striving to develop storage technologies - regulation of the legal status of the electricity storage systems - *enabling achievement of a level of gathered energy at storage facilities equal to 10% of installed power at wind power plants in 2023.* *(ensuring conditions for development of electromobility and smart grids - tasks in directions 4C and 7)*	2020	ME
	2B.7.	Implementation of smart power grids – − establishment of an energy market information operator; − creation of conditions for functioning of the *Internet of Things* **2B. STRATEGIC PEP PROJECT**	2023	ME

– energy security, – competitiveness of the economy, – reduction of the environmental impact of the sector

DIRECTION 3. Diversification of supply and expansion of the grid infrastructure for natural gas, petroleum and liquid fuels

TARGET: covering of the demand for natural gas, petroleum, and liquid fuels

Natural gas and petroleum are important positions in the balance of the primary energy consumption in Poland, and their domestic extractions covers only some part of the demand. For this reason, **security of supplies** of material to the country, and therefore, to customers, depends on diversification of sources, routes, and suppliers to the country, efficient cross-border connections (in consequence of building of a uniform energy market), as well as sufficiently developed internal infrastructure. Dependence on one source and lack of options for diversification limit possibility for **competitive shaping of prices** and increases possibilities for political pressures, which is extremely unfavorable for our country. At the same time, better access of end customers to these fuels contributes to an increase in competitiveness of the energy market. A higher availability of natural gas also enables its rational use in the energy sector, for example, as reserve powers for renewable energy generation, and this will influence **a reduced environmental impact of the energy sector**. Natural gas is a low-emission fuel, and its use may significantly contribute to achievement of EU climate policy, as well as positively prevent the air pollution and reduction of the low emission phenomenon.

To ensure security of supply, a transmission system operator for gas (TSOg) - Operator Gazociągów Przesyłowych GAZ-SYSTEM S.A., as well as a leading entity in the domestic logistic infrastructure in the petroleum sector - PERN S.A., remain one-person companies owned by the National Treasury. Gas transmission, distribution and storage belong to regulated activities. TSO and gas distribution system operators (DESg), as well as a storage system operator (SSO) are obliged to ensure reliable functioning of the system and realization of other duties guaranteeing security of supplies to customers and the system and the grid operations. To ensure security of supplies to customers, GAZ-SYSTEM S.A. and DESe are obliged to prepare development plans for covering of the current and future demand for gaseous fuels, for 10 years and for no less than 5 years, respectively.

A concept ensuring security of natural gas, petroleum and fuel supplies to Poland and to end customers is presented below.

PART A) Diversification of natural gas supplies and expansion of gas infrastructure[27]

To a large extent, Poland remains dependent on natural gas supplies from abroad, mainly from the east, also as a part of deliveries from Germany and Czech Republic (in 2018, 79% of natural gas used came from import, with 61% from the east). In the middle of 2016, the **regasification terminal for liquefied natural gas** (LNG) started to receive the first deliveries, and this was the first step to diversify both directions and suppliers of gas to Poland. Deliveries from Qatar, Norway and the U.S. were delivered by marine transport to the LNG terminal in Świnoujście. In the coming years, the LNG share in the natural gas consumption may represent even 30%. The Polish terminal is a crucial element of the infrastructure in terms of security of gas supply, not only to Poland, but also to the neighboring countries. It is the only facility of this size in Central Europe, and the importance of LNG trade increases in the global market for natural gas, also due to increasing price competitiveness in relation to material supplied by pipelines. The issue of ensuring an access to the material for end customers is equally important, and this requires the expansion of the domestic transmission, distribution and storage infrastructure.

*Below, a concept for diversification of sources of natural gas supply, expansion of cross-border connections and of the domestic transmission, distribution and storage infrastructure for natural gas is presented. The strategic project in this direction is **construction of the Baltic Pipe**.*

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[27] More in: *Krajowy Dziesięcioletni Plan Rozwoju Systemu Przesyłowego 2018-2027* (The National Ten-Year Network Development Plan 2018–2017), GAZ-SYSTEM S.A. 2017, *Dziesięcioletni Plan Rozwoju Systemu Przesyłowego 2018-2027* (The Ten-Year Network Development Plan 2018–2017), ENTSO-G 2017.

The **Yamal contract**[28], ensuring majority of supplies to Poland **expires with the end of 2022**, therefore, actions aiming at real diversification of supply sources must be completed before starting of the gas year 2022/2023[29], to ensure a possibility to become independent of a monopolistic way for shaping prices of the material. Besides infrastructural activities, energy companies must continue actions aiming at **contractual diversification of natural gas supplies**.

Further diversification of gas supplies directions and sources will be ensured through **expansion of import opportunities** and **expansion of connections with neighboring countries**. Thus, it will be possible to create conditions for establishing in Poland a **center for gas transmission and trade** for the countries of Central and Eastern Europe and the Baltic States[30], as well as for adapting the infrastructure to dynamically developing demand for natural gas. A favorable geographical position of Poland justifies plans for obtaining a status of a transit country for gas transmissions along East–West and North–South axes. These projects represent the Polish contribution to execution of the Three Seas concept, which aims at a deeper integration of countries from the Baltic, the Adriatic, and the Black Seas region, and to priority projects at the European Union level - **North–South gas corridor**[31] for Central and Eastern Europe countries (an alternative to the East-West corridor and reduced dependency on one gas supplier) **and a plan for the energy integration of the Baltic States.**

expansion of import possibilities for natural gas

Diversification of natural gas supplies mainly depends on ensuring possibilities for its import. The Polish strategy for this area mainly consists of two components:

3A. STRATEGIC PEP PROJECT

- **construction of the Baltic Pipe** – a gas pipeline that will connect the Polish transmission grid with deposits on the Norwegian continental shelf[32]. This investment will involve construction of Norway-Denmark and Denmark-Poland connections (a submarine connection), and expansion of the Danish transmission system. The investment will be completed by October 2022, enabling import of ca. 10 billion m^3 and export of 3 billion m^3 of natural gas.
- **expansion of LNG terminal** – with expansion of the global LNG market, a decision was made to expand the terminal to achieve a capacity (for reception and regasification) of 7.5 billion m^3 per annum by 2021 (current regasification capacities amount to 5 billion m^3 per annum) and to expand services provided by it with LNG bunkering, LNG transshipment to ships and railway by 2023. In a perspective to 2030, further expansion of regasification capabilities of the terminal is possible, when such need results from a market analysis.

Due to a dynamic increase in demand for natural gas in the Polish economy, and a high level of contracting and use of the terminal in Świnoujście, as well as noticing a global revolution in the LNG market, **placing of a floating storage regasification unit** (FSRU) **for natural gas in the Gulf of Gdańsk** is justified. The first stage, ensuring the capacity at a level of at least 4.5 billion m^3, should be put into operation in 2025. The future expansion of FSRU will depend on the market development in the region and the increase in demand for natural gas in Poland. According to forecasts, this development will result from expansion of co-generation based on natural gas.

efficient cross-border gas connections

Expansion of connections with neighboring countries, accompanied by development of the domestic transmission grid and expansion of gas storage facilities, form the second component of the diversification strategy for natural gas supplies, and at the same time will create conditions for the market development and an increase in importance of Poland as the *regional center for natural gas transmission and trade.* Currently, apart from deliveries to the LNG terminal, Poland mainly receives Russian gas through Belarus and Ukraine, and deliveries from Germany and Czech Republic are also executed. To increase export and import capacities, Poland will strive to **construct or expand connections with:**

- **Slovakia** - to reach the annual capacity of 5.7 billion m^3 for import and of 4.7 billion m^3 for export (by 2021),

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[28] A contract for deliveries of natural gas to Poland, concluded between PGNiG and Gazprom and signed in 1996.

[29] A gas year covers a period from October 1 to September 30 of the subsequent year.

[30] The issue of the gas *center* is more extensively described in direction 4, part B.

[31] The North–South gas corridor will connect the LNG terminal in Świnoujście and the Baltic Pipe through southern Poland, Czech Republic, Slovakia and Hungary with markets in Southern Europe as a part of the Three Seas concept.

[32] A concept for connection of the Danish and the Polish system is included in targets of the EU energy policy specified in *The Baltic Energy Market Interconnection Plan* (BEMIP).

- **Lithuania** (GIPL) - to reach the annual capacity of 1.9 billion m^3 for import and of 2.4 billion m^3 for export (by 2021),

Furthermore, designs of **new interconnectors have been prepared,** but a decision about their construction will depend on agreements with foreign partners and development of the natural gas market in Poland**:**

- **Czech Republic** - to reach the annual capacity of 6.5 billion m^3 for import and of 5 billion m^3 for export,
- **Ukraine** - to reach the annual capacity of 6.5 billion m^3 for import and of 5 billion m^3 for export.

Execution of objectives of the cross-border character must be connected to **simultaneous expansion of the domestic grid and storage infrastructure.** Only the system developed in this way enables (a) ensuring a long-term capability of the gas system to cover the reasonable demands for gas transmission and (b) balancing of natural gas supplies and demand. Executed investments not only respond to strategic needs, but also ensure ability to cover the increasing market demand for the raw material.

expansion of domestic gas transmission infrastructure

The length of the natural gas transmission grid is nearly 12 000 km. The domestic transmission grid must enable full use of the import infrastructure. Therefore, **expansion of the domestic gas transmission system is necessary –** the plan covering the coming years (until 2022, with a perspective until 2029) focuses on the grid development:

- in the western, southern, and south-east parts of Poland (*from Świnoujście to connections with Czech Republic, Slovakia, and Ukraine*) - this will enable transmission of gas from the LNG terminal and imported through the Baltic Pipe to domestic recipients, as well as export to the neighboring countries, and, furthermore, import of raw material from the south from new suppliers;
- in the north-east part of Poland (*to connection with Lithuania*) - will enable development of a gas network covering this part of the country, as well as strengthen energy integration of the Baltic States with continental Europe.

expansion of natural gas distribution grid

A significant part of the domestic grid development is **expansion and modernization of distribution.** Currently, ca. 65% of the communes in Poland have access to natural gas, and the gas network coverage will increase to ca. 77% in 2022, and in subsequent years should rise further, according to the market demands. A specific emphasis has been put on elimination of *white spaces* - areas with no access to the material. When construction of a pipeline is not justified, projects of **using regasification stations for liquefied natural gas (LNG)** ("virtual LNG pipelines") will be executed to supply "island" distribution zones. Alternately, these zones can be supplied by biomethane (biogas purified and treated to achieve quality of natural gas) from local bio-gasworks, when there is potential for its production in the region.

A local access to gas enables its use in the heating and transport sectors, and as a reserve for energy from renewable sources, which are dependent on weather conditions. At the same time, the use of gas and/or renewable energy sources - as low-emission sources of heat - represents an alternative to individual boilers firing solid fuels of low quality, where access to the heating grid is not possible[33].

development of natural gas storage

From the point of view of the energy security, the sufficient **capacity of underground gas storage facilities (UGSF)** is very important. The storage facilities are used to maintain natural gas reserves. Natural gas from the storage system is used, for example, to cover peak demand for this material, as well as allows ensuring of deliveries during failures and breaks in its supply. It can also be used to cover a long-term increased demand for natural gas in autumn and winter. The current total capacity of seven underground methane-rich gas storage facilities (UGSF) amounts to nearly 3 billion m^3, corresponding to nearly 1/6 of the annual domestic consumption, and diversified geographical locations of existing storage facilities[34] is a clear advantage supporting flexibility of the gas system. For further increase of the energy security, **further expansion of UGSF** is justified, **to a level of at least 4 billion m^3** by the winter season of 2030/2031 (an increase

[33] See: direction 7.

[34] UGSF of methane-rich natural gas are located in south-west (Wierzchowice) and south-east (Swarzów, Brzeźnica, Strachocina, Husów, in Tarnów and Sanok region) parts of the country, as well as in central Poland (Mogilno) and in the north (Kosakowo near Gdańsk).

by 1/3 of the current volume), as well as **the increase in the current maximum capacity to receive gas from storage system** from 48.7 million m³/day to at least 60 million m³/day (an increase by 1/4 of the current capacity).

investment encouragements

Investments in the gas infrastructure are of great economic importance, however, current regulations concerning the investment process lead to its long duration and increased expenditures. For this reasons, a regulatory environment encouraging investments in expansion of the gas infrastructure should be ensured. This will lead to development of **a comprehensive regulation of the investment process and adopting by URE a model for imposing multiple-year tariffs**, which will contribute to improved predictability of the investment process and reduced risks.

supply security at a regional level

It should also be noted that the regulation on security of gas supplies adopted by the European Union introduced a **new organization for a gas supply security system at a regional level.** Subsequent years will mean a need to **prepare documents - plans and risk assessments** - based on EU legislation, aiming at an increased security of European gas systems operation. These documents will be updated every 4 years.

TERRITORIAL DIMENSION

Diversification activities concerning supplies of natural gas aim at ensuring security of supplies to Poland, and then to recipients, for which a sufficiently developed internal grid is necessary. Internal investments in the infrastructure follow the current and the potential demand, but also aim at increasing uniform coverage of Poland with the gas infrastructure, to eliminate *white spaces* in access to natural gas, especially in the north-east part of Poland. In this respects, changes in the gas flow direction, from the east-west direction to the north-south one, are crucial. An increase in the territorial range of access to the gas grid will not only translate to a potential for economic development in a given region, but also will contribute to a possibility to limit low emissions.

	Actions	Deadline	Responsible
3A.1.	Ensuring contractual diversification of natural gas supplies	2022	gas companies
3A.2.	Providing possibilities for import through construction of the Baltic Pipe – Norway-Denmark and Denmark-Poland connections, with expansion of transmission systems in Denmark and in Poland **3A. STRATEGIC PEP PROJECT**	2022	TSOg
3A.3.	Ensuring possibilities for import of natural gas by increasing regasification capacities of the LNG terminal in Świnoujście to 7.5 billion m³ per annum, and increasing operational flexibility and introduction of new functionalities (or possible further expansion depending on market analyses)	2021 / 2023 (2030)	Polskie LNG S.A., TSOg
3A.4.	Expansion/construction of gas connections with neighboring countries - Slovakia, Lithuania, Czech Republic, and Ukraine	2022	TSOg
3A.5.	Construction of a floating storage LNG regasification unit (FSRU) in the Gulf of Gdańsk	2025	TSOg
3A.6.	Expansion of gas transmission grid: – in western, southern Poland - possibility to transport gas from the LNG terminal and the Baltic Pipe – in north-east Poland - improved integration with the Baltic States	2022 (2029)	TSOg
3A.7.	Expansion of gas distribution - reduction of *white spots*, an increase in percentage of communes with a gas supply infrastructure from 65% to 77% in 2022, and the increase in subsequent years through: – expansion and modernization of gas distribution grid, – use of the liquid gas (LNG) regasification stations	2022	DESg
3A.8.	Expansion of UGSF to the level of total capacity of 4 billion m³ and capacity of gas reception from these facilities to a minimum level of 60 million m³/day.	2030	PGNIG S.A., SSOg, TSOg
3A.9.	Ensuring a regulatory environment encouraging to investing in expansion of the gas infrastructure (long-term tariffs, improved investment and construction process)	2021	MIiR, ME, URE
3A.10.	Drawing up of risk assessments and plans for gas supply security based on Regulation 2017/1938 (then updated every 4 years)	2020	ME, TSOg

– energy security, – competitiveness of the economy, – reduction of the environmental impact of the sector

PART B) Diversification of petroleum supplies and expansion of petroleum and liquid fuels infrastructure[35]

Due to limitations in access to domestic petroleum deposits (material extracted in Poland covers only a small part of the market demand - 4%), from the Poland's point of view, actions aiming at diversification of supplies and ensuring security of supplies of petroleum and liquid fuels are of crucial importance. In 2014, the share of petroleum supplies to Polish refineries from Russia still exceeded 90% of the total processing of that material (domestic consumption in 2014 - ca. 24 million tonnes). Since 2015, a clear change in the structure of petroleum import to Poland can be noted, which was possible due to changes in power distribution in international markets, as well as due to commercial activities of companies from the oil sector. Recently, Poland has increased import of that material from directions such as Saudi Arabia, Norway, and the United States. Although the Russian supplier still holds a dominant position for shaping of raw material prices, yet certainly diversification in directions and sources of petroleum supply has a positive effect on costs of purchase of this material and the position of Polish companies during negotiations.

Further diversification of petroleum import requires, first of all, a well-developed and efficiently operating internal infrastructure, to provide opportunities to increase import of this material by marine transport. The current condition of pipeline network and storage capacities allows handling of current needs, yet further development of the market requires possibilities **to increase storage levels and separation of different types of petroleum** imported by marine transport, and efficient and secure transmission to the refinery in Płock. The overall target is to ensure (a) undisturbed supplies of petroleum to Polish refineries and (b) supply of liquid fuels to the market at a level ensuring its normal functioning in an emergency situation.

*A concept for diversification of directions and supplies of petroleum through expansion of the transmission and storage infrastructure for petroleum and liquid fuels is presented below. The strategic project in this direction is **construction of the second line of the Pomeranian pipeline**.*

* * *

expansion of petroleum transmission infrastructure

The petroleum transmission infrastructure consists of three sections - two sections of the "Druzhba" pipeline and of the Pomeranian pipeline (ca. 890 km in total). Three lines of the Eastern Section of the "Druzhba" pipeline enable petroleum import from the east (56 million tonnes/year) to the refinery in Płock, and then in the Pomeranian pipeline to the refinery in Gdańsk (27 million tonnes/year). The Pomeranian pipeline is reversible, so raw material imported by the sea can also be transmitted to Płock (30 million tonnes/year). The two-line Western Section of the "Druzhba" pipeline supplies petroleum to German refineries and enables pumping of petroleum from/to the petroleum storage facilities in Góra, the largest in Poland, as well as transport of material extracted from Polish deposits to the west.

3B. STRATEGIC PEP PROJECT

The Pomeranian pipeline, despite its reversible character, is the weakest link in the petroleum transmission system. The pipeline contains only one line, so in the event of its failure, no alternate transport route is available at this strategic section. Furthermore, due to a two-way transport in the pipeline, the refineries in Płock and in Gdańsk compete for its capacities. At the same time, this limited capacity makes the increase of the material transported by the sea and through Naftoport in Gdańsk impossible. It is the **increase in importance of petroleum deliveries by the sea** that has a crucial importance for diversification in material supply to the Polish refineries. For this reason, PERN S.A. included in its investment plans a **construction of the second line of the Pomeranian pipeline** by 2023. Validity of this investment was confirmed in 2019, when petroleum transmitted through the "Druzhba" pipeline was contaminated with organic chlorides, damaging for the refineries. Due to temporary suspension of petroleum supplies by land from the east, the refinery in Plock was importing raw material solely by the sea, fully using the existing line of the Pomeranian pipeline. If the second line had been available, it would have been possible to simultaneously pump the contaminated petroleum north, to empty the transmission system from raw material not meeting quality standards, and petroleum from storage facilities in Góra and PERN S.A. bases in Miszewek Strzałkowski and Adamów could have been sent to the refinery in Gdańsk.

[35] See also: *Polityka Rządu RP dla infrastruktury logistycznej w sektorze naftowym* (The Policy of the Polish Government for the logistic infrastructure in the oil sector) 2017.

expansion of liquid fuels transmission infrastructure

Fuels produced in refineries by processing of petroleum are transported to different parts of Poland by pipelines, railway, and road transport - depending on availability - by one of these means or by combined transport. The pipeline transport is the most secure and effective, but profitability of the line construction depends on demand. **A network of product pipelines** (over 935 km) is of a coaxial character, and enables transport of fuels from refinery in Płock to Warsaw, Poznań, and to Upper and Lower Silesia, i.e., the regions with the highest demand.

However, the line to Upper Silesia reaches only the Częstochowa (Boronów) region, therefore the combined transport on a relatively large scale is necessary, due to high fuel consumption in this region. To use the economic potential and increase security of fuel supplies in this region, PERN S.A. initiated construction of **an additional section Boronów-Trzebinia, expanding the Płock-Koluszki-Boronów pipeline.** Further development of the fuel pipelines will be executed in accordance with market demand and on market conditions.

expansion of petroleum and liquid fuel storage base

The third strategic component in the fuel infrastructure is **storage base for petroleum and liquid fuels**. On one hand, storage facilities are to ensure continuity of the technological process for petroleum pumping (physical availability for 90 days), while on the other hands they enable storage of commercial and intervention reserves[36]. At last, a possibility to separate different types of petroleum is of crucial importance for real diversification of petroleum supplies. Three entities hold storage capacities of nearly 8.4 million m^3 for petroleum and 5.6 million m^3 for fuels, relatively evenly distributed throughout the country.

To ensure technical possibilities for diversification of sources of petroleum (and thus, diversified by its type) supplied to the domestic refineries, the overground storage infrastructure must be expanded. The most important task in this area is to **expand current storage capacities of the base in Górki Zachodnie** (near Gdańsk) and **expansion of the Oil Terminal in Gdańsk.** PERN S.A. started to expand these capacities by 0.6 million m^3 in total, i.e., to a level of ca. 1.9 million m^3 by 2020. The storage capacities for petroleum products must also be matched accordingly to a developing market for liquid fuels. To ensure efficient distribution of intervention reserves during an emergency, they must be allocated near main regions characterized by the highest fuel consumption. For this purpose, PERN S.A. is running an investment program concerning construction of 0.222 million m^3 of storage capacity at its fuel bases.

implementation of cyclic forecast of demand

The fuel market has a liberal character, therefore, to ensure appropriate bases for investor decisions, correct forecasting of demand of the refinery sector is of great significance. For this purpose, since 2020 the Material Reserves Agency (ARM) will develop cyclic (every 2 years) **forecasts for domestic demand for storage capacities** for intervention and commercial reserves of fuels and petroleum for a period of 10 years.

It should be noted that independence from material supply from one direction can also be achieved in consequence of **not increasing the demand** for that fuel, and development of a market for alternate fuels, i.e., increased use of natural gas in form of LNG, LPG and CNG (compressed natural gas), hydrogen, synthetic fuels or electricity in transport will contribute to such situation. A certain part of the market can also be supplied by biocomponents used in liquid fuels and liquid biofuels[37].

TERRITORIAL DIMENSION

Diversification activities aim at ensuring security of supplies to all customers in Poland, for which expansion of the internal infrastructure is necessary. The development of petroleum and fuel infrastructure is correlated with a demand for petroleum products and with a possibility to expand the existing pipelines which lead from the main refining center to the main economic centers in Poland. Modernization and expansion of the infrastructure is to ensure, in particular, the access to liquid fuels for large industrial centers, so the economic potential of a given region can be used.

Actions	Deadline	Responsible
3B1. Expansion of petroleum transmission infrastructure - construction of the second line of the Pomeranian pipeline	2023	PERN S.A.

[36] See Direction 4, part C.

[37] See Direction 4, parts B and C - development of electromobility and alternate fuels.

		3B. STRATEGIC PEP PROJECT		
	3B.2.	Expansion of liquid fuels transmission infrastructure - expansion of the Płock-Koluszki-Boronów fuel pipeline by construction of the Boronów-Trzebinia section	2021	PERN S.A.
	3B.3.	An increase in storage capacities of the Oil Terminal in Gdańsk and the base in Górki to the level of 1.9 million m^3 in 2020	2020	PERN S.A.
	3B.4.	Preparing of the national forecast for demand for storage capacities for intervention and trading reserves of fuels and petroleum for a period of 10 years, and its updating every 2 years.	2020-2040	ARM

– energy security, – competitiveness of the economy, – reduction of the environmental impact of the sector

DIRECTION 4. Development of energy markets

TARGET: fully competitive electricity, natural gas and liquid fuels markets

In last several dozen years, the energy sector has become significantly market oriented. In the energy market, a number of mechanisms influencing the shape of the market and development of prices increases. However, this market needs to be regulated, as energy is a "commodity" on which functioning of the economy and the society depends. In extreme cases, undesirable actions of individual players in the energy market could disturb the energy market, and in consequence, lead to breaks in power supply to end recipients or a significant increase in energy prices, which stands in opposition to a priority of ensuring **energy security** and **competitiveness of the economy**. Interventions in the market are also necessary **for environmental reasons**- due to their economic immaturity, low-emission may be discriminated in markets, and the rate of reduction in the energy sector environmental impact may prove insufficient to ensure necessary improvement in the air quality and implementation of international undertakings, including those concerning the climate.

A concept for development of electricity, natural gas and liquid fuels markets according to a specific nature of a relevant market is provided below.[38]

PART A) Development of the electricity market

The electricity market is analyzed from two points of view - entities from the power generation sector and from a consumer's position. The market is transformed due to changes in its environment, which include building of a uniform EU energy market or consumers' desire to participate in this market. A search for solutions for issues occurring in the entire energy supply chain is also important, for example, demand management.

The strengthening of consumers' position and improvement in situation of certain groups of customers, as well as putting general distribution agreements in order, demand management, an issue of transformation of systemic services into market oriented ones, and changes in electricity trade are described below. A strategic project for this part of the direction is ***preparing and implementing of an action plan to increase cross-border electricity transmission capacities.***

* * *

strengthening of a position of the electricity consumer

Development of electricity market requires **strengthening of a position of the electricity consumer**. Tasks foreseen in this area not only should result in development of current market components, but also create new solutions expanding the existing model of operation. Many of them will be implemented in the nearest 3 years, in accordance with Directive on common rules for the internal market for electricity:

- **Expansion of information policy**. A consumer should have a possibility to compare offers available in the market, and information provided with a bill should be more extensive, but clear.
- **Providing 80% of households with smart meters by 2028** They are a crucial element enabling both access to data and information, as well as informed consumption of electricity. Their installation is correlated with construction of a smart grid[39].
- Implementation of smart grids is also of great importance for increasing activity of end recipients. It means that **recipients are able to undertake an active role in all market**, from generation of electricity at their homes, sale of that energy, or its sharing within an energy community, provision of DSR (demand side response) services, and storage of

[38] The heating sector, due to its specific nature correlated with local covering of the demand, is discussed in a separate direction.

[39] See Direction 2, part A - development of smart grids.

electricity. Prosuments of renewable energy already function in the market, and they undertake active roles; later access to the market for **citizen energy communities** will be defined[40].

- Development and dissemination of aggregation services - **by offering to aggregators a possibility to operate on terms equal to those for other entities in the market** it will be possible to aggregate entities which individually can only offer small (from the point of view of the entire KSE) volumes of generation and DSR services. Only aggregated quantities may be attractive to TSOe.

putting general distribution agreements in order

Furthermore, an issue of **general distribution agreements** (GDA) concluded by energy sellers with DESe needs to be put in order. A recipient concludes a comprehensive agreement covering the energy distribution and sale. GDA enable a change of the energy seller, and this improves competitiveness in the market. To ensure a full competitiveness, **an obligation to conclude agreements with consumers based solely on GDA** - therefore, all distribution companies should sign agreements with all sales companies. Furthermore, an obligation for **GDA to be approved by URE** will be implemented; currently they are only agreed.

protection of competitiveness of the energy-intensive industry

Taking into account a significant share of electricity costs in operations of energy-intensive companies, a particular attention must be paid to protection of competitiveness in this subsector, against a background of global markets. This means, in particular, **taking into account an influence of burdens of individual market mechanisms** (i.e., a system for support of RES, high-performance co-generation, or the power market) on functioning of **energy-intensive companies** by appropriate management of their contribution in implementation of relevant mechanisms.

demand management (flattening of a daily demand curve)

From the point of view of operation effectiveness for the entire domestic power generation system, **flattening of the daily power demand curve** should be pursued[41]. An important issue is reduction of a difference between the average and the peak consumption, as well as an increased demand at night. Apart from allowing recipients to participate in regulated markets and popularization of aggregation services, the implementation of the following solutions will be useful:

- One of the tools that have already been implemented is the **anti-smog tariff**, which on one hand is to reduce a problem of low emissions, while on the other it should fill the night-time off-peak demand[42]. In a longer perspective, a possibility to use **dynamic tariffs** will be ensured - in such tariff the consumer reduces their demand when the price is the highest, and increases it during the off-peak demand, at a much lower price (energy generation costs are reflected in the consumption price as a function of time). The use of this solution is particularly effective in smart houses, where energy consumption by devices is controlled automatically.
- **Development of energy storage technologies**[43] **–** energy can be generated independently of demand, and used when the demand for it reaches a peak, so its price is the highest. The regulatory potential is ensured by electricity, heat and cold storage facilities at thermal power and CHP plants, as well as gaseous fuels like hydrogen or biogas.
- **Development of electromobility**[44] – implementation of electricity-powered vehicles will increase the global electricity consumption. These vehicles should be charged mainly at night, so time of operation of off-peak power plants can be prolonged, influencing rationalization of their costs (tariffs encouraging power consumption at night, i.e., anti-smog tariff, will contribute to this aim). At times of peak demand for electricity, the charged vehicles can become energy storage facilities. Developments in the electric vehicles sector will have a great influence on progress in storage technologies.

[40] This last term may refer, for example, to people living in one apartment block, on which photovoltaic panels were installed.

[41] A daily electricity consumption cycle on a working day is characterized by a higher demand for power during the day than during the night, and by morning and early evening peaks in demand.

[42] Under the anti-smog tariff, a consumer is offered preferential rates for electric heating at night (between 22:00 and 6:00).

[43] See: direction 2, Part B - development of energy storage and recovery, and development of smart grids, direction 7 - development of district heating.

[44] See Direction 4, part C - development of electromobility and alternate fuels.

- **Development of smart grids**[45]**,** which will enable informed use of energy and effective grid management by TSOe and DESe.

transformation of systemic services into market oriented

Another element in the electricity market development are actions aiming at **transformation of systemic services into market oriented ones.** For this purpose, legal frameworks must be established which will enable local balancing for distribution companies, as well as creation for participation of all users of the power generation system in that market, including generators, and recipients and dispatchers of electricity storage facilities. Furthermore, competencies of distributors must be increased in that respect (within 5 years). Development of energy clusters will also significantly influence local balancing[46].

uniform EU electricity market and changes in trading

In relation to **building of a uniform European energy market**, as well as **obligations resulting from implementation of the power market**, significant changes occur in the **electricity trade**. Since July 2018, no other limits in offers and prices has been used in the day-ahead market (DAM) and the present-day market (PDM) then those established as a part of *market coupling*, and since 2019, price limits in the balancing market (BM) are set at a level that is not lower than specified for the present-day market. With the first year of deliveries to the power market (2021), functioning of the current mechanisms: (a) intervention non-spinning reserve, (b) intervention operation, (c) guaranteed DSR program, and (d) operating power reserve, will end.

4A. STRATEGIC PEP PROJECT

Implementation of solutions related to the uniform electricity market will have a positive influence on the competition in the electricity market and in the future should lead to equalization of electricity prices in EU. In this respect, new requirements for the use of cross-border transmission connections, implemented by the EU internal energy market regulation, are of significance. By the end of 2025 at the latest, **operators of transmission systems are obliged to make at least 70% cross-border transmission capacities available** (while following criteria for secure operation of a power supply grid). Concerning execution of this target, Member States must allocate funds that will make fulfilment of this obligation possible. Poland **prepares an action plan to execute the specified target**.

TERRITORIAL DIMENSION

A territorial approach to the electricity market concerns, specifically, participation of recipients in these markets, who, depending on their capacities, can generate and sell energy, and provide DSR services. In this context, local energy communities, influencing covering of a local demand, as well as aggregators, whose operations depend on activities of small entities and on a summary potential of generation and DSR services offered by them in a given region, are of importance.

[45] See: direction 2, Part B - development of energy storage and recovery, and development of smart grids.

[46] See: direction 6.

Actions		Deadline	Responsible
4A.1.	Strengthening of a position of the electricity consumer: – expansion of information policy for electricity consumers (by creating a comparison engine for energy purchase offers; simplified information in bills, and attachment of detailed billings); – admitting recipients to the markets (energy generation, sale, DSR services); – development of rules for access to the market for citizen energy communities; – creation for aggregators opportunities to operate under principles equal to those for other entities in the market	2021	URE, energy trading companies, ME
4A.2.	Strengthening of a position of the electricity consumer - equipping 80% of households with smart meters by 2028.	2028	distribution companies
4A.3.	Easier change of an energy seller - putting general distribution agreement in order by implementing an obligation to: – conclude agreements with consumers only on a basis of GDA – GDA approval by URE	2020	ME, URE
4A.4.	Ensuring protection of competitiveness of the energy-intensive industry	–	MPiT, ME
4A.5	Flattening of the daily power demand curve: – providing an opportunity to use dynamic tariffs, – ensuring conditions for development of storage technologies, electromobility and smart grids *(asks in directions 2B, 4C, and 7)*	2021	ME, energy companies, URE
4A.6	Transformation of systemic services into market oriented ones and increasing competitiveness of distributors in balancing and ensuring better conditions for participation in the market of all users of the power generation system	2023	ME, distribution companies
4A.7	Implementation of changes in trading in electricity (concerns, among others, price limits, and intervention mechanisms)	2021	TSOe, ME, TGE
4A.8	Preparing an action plan for execution of a purpose of making available 70% of cross-border transmission capacities by the end of 2025. **4A. STRATEGIC PEP PROJECT**	2019	TSOe, ME, URE

– energy security, – competitiveness of the economy, – reduction of the environmental impact of the sector

PART A) Development of the natural gas market

Development of the natural gas market should be considered as several aspects - from the market deregulation, through the exchange market development, **up to the increase in natural gas consumption** and implementation of a concept for a *regional center for natural gas transmission and trade.* These actions aim, in particular, at ensuring conditions for competitive shaping of prices, but also for the use of natural gas in other forms and for new applications than previously.

Issues associated with the gas market deregulation, strengthening of Poland's position in the European natural gas market, and development of new segments for the natural gas use. A strategic project for this part of the direction is ***a regional center for gas transmission and trade (so-called gas hub)****.*

* * *

In recent years, a number of actions supporting **development of competitiveness in the Polish natural gas market** have been undertaken. In 2013, an obligation to sell 30% of volume offered in the market through the commodity exchange, and this level was gradually increased to reach 55% in 2015. Successively developed exchange tools and the mentioned obligation to trade on the commodity exchange formed foundations for creation of a liquid, wholesale natural gas market in Poland and made a customer's right to change a seller more realistic. A trend for increasing the competition in the market should be continued, both at a wholesale and at a retail market levels.

deregulation of natural gas market

The second important element for release of the natural gas market is abolition of an obligation for individual entities to have prices of natural gas officially approved. In 2017, price tariffs were abolished for large companies and all customers, excluding households. Natural gas prices (trade) for the last group, i.e., **households, will be released from the tariff obligation at the beginning of 2024**. The end of deregulation and diversification of supply sources[47] will enable further development of conditions for creation of competition. which should translate into better conditions for customers.

strong position of Poland in the European natural gas market

4B. STRATEGIC PEP PROJECT
– SOR PS.1(3)

Creation of conditions enabling establishing in Poland **a regional center for natural gas transmission and trade for countries of Central and Eastern Europe, and for the Baltic States** plays significant role in functioning of the domestic natural gas market. This project requires in particular construction of the Baltic Pipe and expansion of the LNG terminal in Świnoujście, and of connections with neighboring countries, but the regulatory and transaction part is equally important, therefore, **actions that would enable development of services and trade** through ensuring attractive market and price conditions, encouraging the use of the Polish infrastructure, are necessary. Elimination of current barriers in this respect is also very important. An increase in natural gas volumes transmitted through the territory of Poland will increase liquidity of the Polish natural gas market and will contribute to a reduction in individual rates for services provided by TSOg, and this will allow reduction of price levels for end customers. Several necessary elements have already been implemented, such as the obligation to trade on the commodity exchange or start-up of a platform for trading in transmission capacities, **but further development of natural gas exchange and the commodity exchange platform** at which trade based on bilateral agreements will also be possible, **are necessary.** Legal, infrastructural and commercial foundations for creation of the *regional center for natural gas transmission and trade* should be ready by the end of 2022.

The extensive infrastructure enables initiation of discussions with neighboring countries concerning possible **regional integration of natural gas markets.** At the same time, new conditions for functioning of the natural gas market in Poland cannot impair security of natural gas supplies to Polish customers - in the event of any disruptions in the supply to the market, **continuity of supplies to protected customers must be ensured.**

new segments for the use of natural gas

Another element of importance for development of the natural gas market is **a forecast increase in consumption of this material.** It concerns both an increase of quantities of fuel used, and ensuring access to the material and its use for new application. Currently, this gas is mainly used by the industry and households, and other small customers (by power generation

[47] See Direction 3, part A.

and transport at a much lower level). Apart from construction of gas and steam energy generating units, reasons for an increase in consumption of natural gas can be found at:

- **an increased access to natural gas for domestic recipients through a more extensive coverage of the country with a gas network**, and thus elimination of *white spots*, DESes plan to achieve a 77% level of gas coverage in Polish communes (currently 65%) by 2022;
- **an increase in gas consumption in form of LNG and CNG as alternate fuels in marine and road transport in Poland and the Baltic Sea region**[48]**;**
- **an increase in consumption of natural gas in reserve generating units for renewable energy sources and in heating systems and units** – a share of renewable energy dependent on weather conditions, for which a flexible power reserve is necessary, will increase. The gaseous sources offer an advantage of being controllable - this way, despite a higher cost of this fuel (versus coal), such units find their place in the system. At the same time, they ensure much lower levels of emission of pollutants.

expanding means of gas transport other than underground gas networks

The energy market moves towards the use of new sources of energy. Responding to these needs, as well as taking into account the plans to use **synthetic gases, biomethane and hydrogen** in European gas networks, **gas operators** must also involve in research and development activities concerning possibilities of pumping these gases into the gas networks. Technical parameters of existing networks enable only a low share of gases other than natural gas in the transported mixture of gases, and this hinders an increase in the use of the above gases. Actions should be conducted in a strict cooperation between operators and manufacturers of these gases, so they mutually consider both technical parameters of the network, and quality parameters of gases.

coupling of gas and power supply sectors

The current and forecast increase in the use of natural gas for the needs of electricity generation contributes to coupling of the power supply and the gas sectors. Taking into account the increasing dependencies between these two sectors, TSOg and TSOe must undertake activities resulting in **optimization in the operation of power supply and gas systems**, as current principles for operation of these systems don ensure fully effective cooperation between these sectors.

TERRITORIAL DIMENSION

From a territorial point of view, the natural gas market should mainly be considered in terms of ensuring access to the material to the largest possible group of customers in Poland. The conducted activities aim at ensuring covering of the current and the potential demand for natural gas and elimination of *white spots* in access to natural gas, to which the expanded gas supply network and the use of gas in a form of LNG and CNG will contribute.[49]

[48] See Direction 4, part C - development of electromobility and alternate fuels.

[49] See also: Direction 3, part A.

	Actions		Deadline	Responsible
	4B.1.	Market deregulation by abolishing an obligation for official approval of natural gas prices (tariff obligation) for the last group of customers, i.e., households, in 2024.	2024	ME
	4B.2.	Ensuring regulatory conditions for execution and for the *regional center for natural gas transmission and trade* **4B. STRATEGIC PEP PROJECT**	2023	ME, TSOg, DESg, SSO, TGE
	4B.3.	Development of wholesale market of natural gas through development of services and trade in the area of natural gas trade, including the natural gas exchange	2023	ME, TGE, TSOg
	4B.4.	Providing opportunities for increased use of the natural gas in new sectors of the market through: – more extensive coverage of the country with the gas network; – increasing possibilities for the use of gas in LNG and CNG form *(see action 4C.5);* – increased use of natural gas in heating and as a reserve power for RES.	2023	TSOg, DESg, ME, MF, MIiR, gas sellers
	4B.5.	Research and development activities and an analysis of possibilities offered by the network and gas systems for transport of synthetic gases, biomethane and hydrogen	2025-2040	TSOg, DESg, SSOg, research institutes
	4B.6.	Ensuring effective cooperation in functioning of the gas and the power supply systems (*market/sector coupling*)	2021	TSOg, TSOe

– energy security, – competitiveness of the economy, – reduction of the environmental impact of the sector

Part C) Development of a market for petroleum products and alternate fuels, including biocomponents and electromobility

The fuel market is relatively stable and operates efficiently. In Poland, a demand for fuel will increase in the coming years, although this growth will be moderate due to a change in the structure of energy demand in the economy. The key element in this change is an increase in the use of alternate fuels. This will contribute to a transfer to a low-emission economy to reduce emissions from transport, but at the same time will mean an enormous pressure on entities from the refinery sector. Despite development of the market for alternate fuels in some applications, the petroleum-derived fuels for many years will remain a dominant source of supply in aviation transport, sailing, and heavy transport vehicles sectors. Therefore, it is necessary to ensure appropriate conditions for functioning and development of this market and competitiveness of entities operating in it.

Issues concerning the ownership structure in the fuel market, intervention reserves, market transparency, development of petrochemicals market, and a market for alternate fuels, including electromobility and biocomponents, which contribute to a reduction in demand for traditional fuels. The strategic project in this direction is ***development of electromobility****.*

* * *

putting ownership structure in sectors of fuel market in order

Roles of entities in the fuel and refinery market must be consistent with their objectives and functions. **Operations of refinery companies should focus on production and sale of fuels** (basic operations), and storage capacities used for own needs (*currently refineries have a significant part of the storage infrastructure, and this makes the State control over this aspect difficult*). This is of importance for competitiveness of the sector, as well as ensures predictability of this market and optimum adapting of investment decisions to actual needs for fuel production and sales needs. As the part of storage infrastructure owned by refinery companies is too large, preparing demand forecasts in this area by other entities is difficult, and thus may contribute to market instability; therefore, a company owned by the State Treasury must have a **full control over assets crucial for fuel security in terms of pipeline transport and storage of petroleum and liquid fuels, and over construction of cavern storage facilities for petroleum and fuels.**

For optimum organizing of construction and use of established underground storage facilities (caverns) for hydrocarbons (petroleum, liquid fuels, and natural gas), and for coordination of associated brine management during **construction of cavern storage volumes**, an operator responsible for transmission pipelines has been appointed[50].

For effective functioning of fuel companies, their crucial activities, **processing and distribution**, must also be **optimized.** The companies must adapt to their environment, and this also means expansion of a retail network, search for new products, and implementation of new projects, including those focusing on alternate fuels (from electricity through LNG and CNG up to hydrogen and synthetic fuels), and services (including bunkering of ships in sea ports). Development of new market segments will enable the use of competitive edge associated with pioneering approach. Furthermore, to improve their position in the international market, **the two largest entities in the fuel sectors will merge.**

maintaining of intervention reserves

In 2014 a system for establishing and maintaining **intervention reserves** of petroleum and liquid fuels was changed. Apart from obligatory reserves held by entrepreneurs, a new category of reserves was created, so-called *agency reserves*, created and held by the Material Reserves Agency, and financed by entrepreneurs through the *reserve fee.* For effective intervention in the fuel market, when any disturbance in supply occur in it, it is necessary to **maintain intervention reserves in storage facilities** (in quantities corresponding to at least a product of 90 days and an average daily net import of petroleum equivalent in a previous calendar year). At the same time, individual levels of activities have **intervention procedures** established, as per EU membership obligations and the International Energy Agency, yet due to changing market conditions and development of technologies enabling more efficient monitoring of supply security and more efficient intervention in the market, they **will require regular reviews and updates.**

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[50] See also: *Polityka Rządu RP dla infrastruktury logistycznej w sektorze naftowym* (The Policy of the Polish Government for the logistic infrastructure in the oil sector) 2017.

reduction in administrative burdens, market transparency, elimination of the grey market

Ambitious plans concerning transitions to low-emissions economy, including reduction in emissions from transport, will represent a significant challenge to entities from the refinery sector. Without undermining efforts for development of the market for alternate fuels, it should be emphasized, that petrol-derived fuels will maintain their significant role in some applications in a medium and a long-term perspective. Therefore, **ensuring optimum conditions for functioning of the fuel sector in the transition period** by reducing and simplifying administrative burdens will be crucial for competitiveness of the economy. The tightening of the tax system and a change in the monitoring system in 2016 both contributed to a significant reduction in the grey market for fuels. To ensure the full transparency of the market, activities aiming at effective monitoring of all segments of the fuel market will be continued. For this purpose, a **fuel platform** will be established, to integrate data concerning the fuel market, currently collected by different institutions. This platform should be fully functional within 5 years.

development of petrochemicals markets

It should be noted that a demand for petroleum products will also be driven by an **increase in consumption of petrochemicals**, including those derived from kerosene obtained in the refinery. This results from their greater use in production processes, and new applications, e.g., in thermal insulation systems or construction industry, foreseen increase in the role of plastics, and the use of 3D printers. To satisfy this increasing demand and to use the market chances, **production capacities for olefins, phenol and aromas will be increased.**

Efforts aiming at switching to the low-emission economy represents a great challenge to a continuously expanding transport sector. For this reason, actions are implemented in many directions. Vehicles are changed, production of low-emission liquid fuels develops, and alternate fuels are launched to the market. All these activities require investments and regulatory support, which will provide appropriate foundations for development and implementation of innovative technologies and solutions. Informing the society about benefits provided by innovations in the sector is equally important, and it should lead to increased social awareness.

reduction in emissions from traditional fuels

By 2040, the share of traditional fuels in transport will still predominate. Therefore, ensuring conditions for development of technologies **reducing emissions in production and consumption of traditional fuels** can be considered as a reasonable approach. As markets in the EU Member States are not isolated, a cooperation at the EU level is necessary, to ensure comprehensive assessment of impacts of proposed changes by individual sectors (including refinery) and development of optimum solutions for the European economy and for economies of individual EU Member States. It is important to ensure support and equal opportunities for all promising technologies.

The market will develop towards **the use of fuels other than traditional refinery products** - i.e., alternate fuels (including hydrogen, LNG and CNG, and synthetic fuels), biocomponents, and electricity used for transport purposes, not only to reduce emissions, but also to reduce its dependence on import.

use of biocomponents and other renewable fuels

First, the most developed part of the marker of alternate fuels, **i.e., the use of biocomponents in liquid fuels and biofuels,** should be considered. They are of particular significance, because they belong to renewable energy sources. In 2018, the RES share in transport corresponded to 3.6% in Poland and 8% in the whole EU.[51].

The RED II Directive, adopted in 2018, introduced an obligation to reach the **14% share of RES**

[51] RES share in transport in Poland dropped significantly in 2016 when the grey market, mentioned above, was discovered.

in transport in 2030, of which at least 3.5% should come from advanced (non-food) biofuels. When compared to obligations for 2020, resulting from provisions of the previous RES (RED I) Directive, this represents a significant increase in demand for biocomponents and electricity from RES used in transport. Additional limitations introduced by the RED II Directive, such as a limit for the use of food materials (7% and a maximum increase by 1% versus the level in 2020), higher requirements for reduction in emissions of greenhouse gases from production of biofuels, or a target for advanced biofuels indicated above, imply a need for transformation of this sector in the coming years.

It should be noted that many EU Member States have problems with increasing the RES share in transport, and this is mainly caused by: (1) Low initial share of electricity from RES in transport, (2) technologically-limited possibilities to add the first-generation biocomponents (blending wall), (3) high prices and low supply of liquid biohydrocarbons (e.g. HVO or HVO – *hydrated vegetable oil*) that can be added to liquid fuels in quantities greater than conventional biocomponents, (4) insufficient fuel infrastructure that would enable common blending of fuels and biocomponents.

To implement the target specified for RES share in transport, a **National Indicative Target (NIT)** is established, **representing a minimum share of renewable fuels and biocomponents** in the total quantity of liquid fuels and liquid biofuels used during a calendar year in road and railway transport. Detailed categories for the target for 2030 will be specified at a later date, where development of this market will be supported by:

- striving to maximise the use of traditional biocomponents produced from food and feed materials, added to liquid fuels (a consistent policy for blending of fuels E5/E10 and B7/B10), which make possible the use of existing domestic material and production potential for methyl esters and bioethanol, to the level of the *blending wall*;
- striving to increase the use of waste materials for production of biocomponents and biogas (biomethane) used in transport;
- search for alternate solutions, to: (1) popularize available production technologies that are used at a too small scale - e.g., purification of agricultural gas to the biomethane level, biomass processing by its co-hydrogenation or hydrogenation (2) improve insufficiently developed technologies that are at a pilot stage - i.e., in relation to advanced biofuels, renewable liquid and gas transport fuels of non-biological origin, and fuels produced by recycling of carbon fuels.

After 2020, the **number of new technologies for manufacturing of biocomponents** available in the market will be steadily increasing. To ensure high quality of fuels and transparency of rules binding for manufacturers of fuels and of biocomponents, processes associated with coordination of implementation of new technologies and activities aiming at quality certification and confirmation of sustainable development criteria should still be **coordinated** by the minister competent for energy.

Furthermore, aiming at reduction in potential malpractices associated with correct use of biocomponents and other renewable fuels in transport after 2020, **instruments for monitoring** e.g., of participation in building of the EU database enabling monitoring of liquid and gaseous transport fuels **will be implemented**.

The use of RES in transport is a chance for the use of domestic resources of biomass. From the point of view of material competition between the energy sector and the agriculture and food industry, and for promotion of *the circular economy*, increasing of the use of biocomponents from waste is reasonable, although the current level of technological development and organizational problems make their use on the large scale difficult. The use of biomethane generated, amongst others, from municipal waste and waste from the agricultural and food industry for transport purposes becomes particularly important, and for effective application of this technology, results of studies on expanding options for transport of gases, other than in underground gas networks[52].

development of electromobility and alternate fuels

Development of **alternate fuels** used in transport, other than RES, is the second component of a change in raw materials[53]:

[52] See: direction 4, part B: expanding options for gas transport other than underground gas networks

[53] More in: *National frameworks for a policy for development of an infrastructure for alternate fuels,* ME, 2017; *Plan for development of electromobility in Poland*, ME 2017. Liquid biofuels also belong to alternate fuels, however, this part of the market is at a more advanced stage of development. Furthermore, it is a crucial component in execution of objectives for the RES use in transport.

4C. STRATEGIC PEP PROJECT
– SOR PS.3(1)

- **electricity (electromobility)** – although a technology enabling its use in transport is at a relatively early stage and still not very popular, it is expected that is promotion will not only influence the fuel market, but will also contribute to reduction of the problem of low emissions in cities. Development of technologies for energy storage, so important for a shape of the electricity market, will also be supported. To ensure development of electromobility, the relevant infrastructure must be constructed, and mechanisms for management of demand and smart grids must be developed, and capacities of distribution grids, [54] required for connection and operation of charging points, must be increased.

- **liquefied** (LNG) and **compressed** (CNG) **natural gas** - currently there are 24 publicly available stations for refueling with compressed natural gas (CNG), but it is expected that in a few years environmentally-friendly CNG powered vehicles will take over a certain share in the market, although smaller than electric vehicles; furthermore, the interest in bunkering sea ships with LNG increases;
- **hydrogen** - 1 kg of hydrogen allows covering of a distance of ca. 100 km. The technology for hydrogen manufacturing and use develops robustly, but its commercial use may be postponed in time. The infrastructure for fueling must be constructed. At the same time, it should be noted that hydrogen can be used for energy purposes in many different ways;
- **synthetic fuels** - obtained from natural gas (*gas to liquid*), coal (*coal to liquid*), biomass, and from plastics (municipal waste). These fuels can be used by vehicles with conventional engines, and do not require construction of a new infrastructure.

Promotion of electromobility and the remaining alternate fuels not only reduces a demand for petroleum fuels, but has an enormous significance for improvement of the air quality. It is particularly important in urban centers, as transport is one of the main causes of air pollution in urban areas. For this reasons, technologies ensuring a high level of reduction in emissions in the transport sector should be promoted. Their development requires a sufficiently developed infrastructure, but also appropriate legal regulations governing functioning of this market.

In 2018, the *Electromobility and Alternate Fuels Act* was passed, which established legal framework for functioning of the market of electromobility and other alternate fuels in transport. A range of technical regulations and objectives concerning development of an infrastructure for alternate fuels were specified, together with a catalogue of instruments of financial (e.g., exemption from the excise duty, advantageous depreciation rate) and non-financial (amenities such as allowing electric vehicles to drive in lanes for buses, free parking for electric vehicles in paid parking zones) support to stimulate development of this sector. A robust development of these technologies will be regularly reviewed as a part of annual assessment of implementation of targets specified within the *National framework of a policy for infrastructure development for alternate fuels* pursued by a minister competent for energy, and this will form a basis to be supplemented by regulations creating the required support.

The established **Low-Emission Transport Fund** (LETF) is of crucial importance for financial support for development of this part of the market, and it will be used to finance projects associated with development of electromobility and of transport based on alternate fuels (including from renewable sources). A scope of project eligibility is very extensive. The support can be provided to entrepreneurs building infrastructure for charging of electric vehicles and for fueling with alternate fuels, to manufacturers of environmentally friendly vehicles, and to local governments investing in clean public transport or entities planning a purchase of new, zero-emission vehicles.

To increase the use of alternate fuels, very ambitious targets were established for individual directions:

- in the area of **electromobility**, the following levels are to be achieved:
  electric vehicles: one million vehicles n 2025[55];

[54] See also: direction 2, part B - expansion in distribution of electricity; development of electricity storage and recovery, and smart grids; direction 4, part A - flattening of a daily demand curve.

[55] It should be noted that the number of electric vehicles will depend on many factors - technological progress in development and improvement of electric drives, including changes in technologies for production of batteries, so the price of electric vehicles can be lowered. Furthermore, with the increasing social awareness, environmentally friendly trends, and greater commitment to fight for the environment, potential users of cars may decide to use to a greater extent the public

charging points installed in freely available charging stations: 6 thousand points and 400 points of high charging capacity in 32 agglomerations in 2020 (emissions from transport is of greatest importance in cities);

- in the area of **CNG and LNG**, the following levels are to be achieved:
  CNG vehicles: 54 thousand vehicles in 2025;
  fueling points: 70 CNG in 2020, 14 LNG and 32 CNG along the most important roads (TEN-T network of base stations) in 2025,
  bunkering points for liquefied natural gas (LNG): four largest ports – Gdańsk, Gdynia, Szczecin and Świnoujście: a possibility to bunker ships with LNG by 2025, bunkering also possible at the LNG terminal in Świnoujście.

Due to extensive possibilities of use and enormous interest, **hydrogen production and use** in transport and in other sectors, requires special attention. Currently, hydrogen is used in the refining industry, steel industry, and in production of fertilizers, but the demand for this gas will increase, when it will be possible to add it to the gas grid and use in fuel cells to generate electricity. Then it will be possible to use it successfully in the transport sector (cars, trucks, public transport, sailing, aviation), heating, and power generation (in fuel cells and gas turbines), beside its current applications.

As previously the use of hydrogen for energy purposes was unprofitable, this technology is at an initial stage of its development. However, when physical properties (it is light, reactive, can be stored and has high energy content per mass unit), environmentally friendly nature (a sole product of its combustion is steam), and high production capacities of companies in Poland (currently ca. one million tons per annum) of hydrogen are considered, the issue of using hydrogen for energy purposes attracts increasing attention. A situation when production of hydrogen uses RES is desirable, also as a way for managing surpluses from energy generation.

This market will be stimulated by research projects, and by exchange of previous experiences between interested entities, as well as by establishing a regulatory zone for the use of hydrogen in the transport and energy sector. **Legal frameworks for the use of hydrogen will be developed by 2021**, so the market can fully develop by 2030.

TERRITORIAL DIMENSION

A level of market development for petroleum products should respond to possibilities of covering the demand in the entire country. Apart from the organizational issues, an important aspect concerns ensuring an appropriate distribution of the fuel infrastructure[56], including commercial and intervention storage bases, as well as development of branches that would cover a part of the demand, from biocomponents up to alternate fuels and electromobility. These subsectors will develop in the entire country; however, it should be noted that production of biocomponents has a stronger effect on rural areas, and the use of electromobility will be more extensive in urban areas.

transport or other forms of shared mobility, such as *car-sharing* or *car-pooling,* and this may result in a decrease in the number of purchased vehicles.

[56] See more: Direction 3, part B.

Actions		Deadline	Responsible
4C.1.	Putting ownership structure for fuel infrastructure in order: – refining companies focusing on fuel production and trade, – the state taking a full control over assets of crucial importance for pipeline transport and storage of petroleum and fuels, – construction and management of cavern capacities for hydrocarbons, and brine management coordinated by one company	2020	refining companies, PERN S.A., TSOg, KPRM
4C.2.	Optimizing a system of reserves and enhancing a role of ARM president in maintaining of intervention reserves	2029	ME
4C.3.	Reduction in administrative burdens for the fuel sector and ensuring transparency of the fuel market: – reduction in reporting duties, – creating and ensuring the full functionality of the fuel platform, – improvement in regulations concerning bunkering of sea ships	2023	ME
4C.4.	Increase in petrochemical production capacities	2030	refining companies
4C.5.	Ensuring conditions for development of technologies reducing emissions in production and consumption of traditional fuels	–	ME
4C.6.	Providing conditions for functioning and development of a market for biocomponents to achieve the target of 14% of RES in transport in 2030 by striving to: – maximize blending of liquid fuels, – increase the use of waste materials for production of biocomponents, – search for alternate solutions for known and new technologies especially through: – maintaining coordination for implementation of new technologies and activities related to quality certification by ME, – implementation of instruments for control of correct use of biocomponents	–	ME, companies implementing NIT, other entities
4C.7.	Providing conditions for functioning and tools supporting the alternate fuels market, and in particular: – **electromobility** 4C. STRATEGIC PEP PROJECT – CNG and LNG, – synthetic fuels in transport, – hydrogen	–	ME, DESg PGNIG S.A., Polskie LNG S.A.

– energy security, – competitiveness of the economy, – reduction of the environmental impact of the sector

DIRECTION 5. Implementation of nuclear power

TARGET: reduced emissions from the power generation sector and security of the system operation

Currently there are no nuclear power plants in Poland. The nuclear power program executed in the 1980s' (construction of nuclear power plants Żarnowiec and Warta) was discontinued with a resolution of Cabinet from 1990.

In the current situation, implementation of nuclear power is fully consistent with implementation of three components of the target of the Energy Policy for Poland. Nuclear power units ensure **stable energy generation with zero emissions of pollutants to the air.** At the same time, **diversification of an energy generation structure at a rational cost is possible** - high investment expenditures are compensated by a low variable cost of manufacturing within a long-term perspective covering several dozen years. The fuel share in the cost of production of one unit of energy is relatively low, and a small size of fuel cassettes enables storage of supply for many years, thus ensuring stability of costs. It is also important that the fuel can be purchased from different directions, mainly from countries with a stable political situation. Furthermore, the lifespan of nuclear units exceeds 60 years (with a possibility to prolong it to 80 years),

and this is at least 20 years longer than the lifespan of coal or gas units. Currently used technologies (of 3rd and 3rd+ generation) and strict global standards for nuclear security and radiological protection ensure **safe operation of the nuclear energy** and waste landfilling.

After the accident at Fukushima, some countries in Western Europe decided to gradually withdraw from or reduce the use of nuclear power; however, increasingly often these statements are reviewed. This results from problems with ensuring stable energy supplies , assuming elimination of coal sources – a simultaneous reduction in nuclear power share and reduction in CO_2 emission levels is not possible[57]. At the same time, as many as 50 new projects are executed, of which 6 are conducted in Europe. It should be noted that countries having access to low-cost deposits of petroleum and natural gas and the best climate conditions for development of renewable power generation, like the United Arab Emirates and Saudi Arabia, also initiate nuclear power programs on a very large scale.

The conducted analyses indicate that social support for the use of nuclear power has been restored in Poland. It should be noted that the construction of nuclear power plant can be conducted by Polish companies in cooperation with scientific and research centers **up to 60% of the project value.** Currently, more than 60 Polish companies have experience in nuclear power gained during last ten years (mainly by executing orders for foreign nuclear power plants), and over 250 companies have competencies from similar sectors which can be used in the nuclear industry following some adaptations.

A concept for implementation of nuclear power to the national power supply system is presented below. Details of implementation of this technology in Poland were presented in the updated version of the "Polish Nuclear Power Program" from 2014, which consistent execution is a strategic project under PEP2040.

5. PEP2040 STRATEGIC PROJECT – SOR PS.3(3)

* * *

Start-up of the first unit (of ca. 1-1.5 GW[58]) **of the first nuclear power plant is planned for 2033**. **Start-up of five such units** is planned for subsequent years, every 2-3 years. These dates are based on the power balance in the national energy supply system. Without additional investments in new energy sources, exactly at that time further shortages in covering of the increased demand for power will occur, resulting from the end of the useful life of existing generating units, especially

[57] Within at least several coming years it will not be possible to ensure security of energy supply in the balance with predominating RES, because these technologies are not sufficiently developed and do not ensure flexibility of the energy supply system.

[58] In "*Conclusions from prognostic analyses to "The Energy Policy for Poland until 2040"* (Appendix 2 to PEP2040), the unit power at a level of 1.3 GW was assumed. This is an intermediate power of nuclear power plants available in the global market, therefore, it means that conclusions about the selected technology should not be drawn. A selection of the technology is one of executive tasks specified in PEP2040.

coal-based. At the same time, this will enable **reduction in Polish emissions of greenhouse gases and air pollutants** (CO_2, and other, e.g., NO_X, SO_X, dust) from the energy sector.

financing, investment selection, formal improvements

Generation of the first unit of energy from the nuclear power plant in Poland requires execution of a number of actions. First, **a model for financing this investment will be developed**, and the **technology and a general contractor of the design** will be selected. **Selection of the location** is determined by access to cooling water, but also by possibilities for power output and decommissioning of other power with relevant parts of Poland. For this reason, the main locations considered for construction of nuclear power plant are a sea coast (Kopalino or Żarnowiec) and/or central Poland (Bełchatów area).

Later on, a possibility to use small nuclear reactors in the heating sector and industry (technological heat) may appear. This will require gaining experience in operation from prototype systems that will be started up in other countries and which will confirm failure-free and effective operation of this type of reactors.

To limit possible formal and legal problems (which influence possible delays in execution of the project), **the formal side of the investment project will be improved.** Changes are necessary mainly due to *an unprecedented character of this investment*. This should be understood in particular as: precise specification or changes in regulations concerning construction of nuclear facilities, a zone of planned use, a start-up of the nuclear power plant, environmental tests, an environmental impact assessment, prolonging a validity of a decision specifying the location to 10 years, or improving flexibility of procedures for the award of contracts.

providing human resources for the nuclear power sector

technical strengthening of the regulatory authority

To implement nuclear power, **sufficient human resources** must be ensured, for correct operation of the nuclear power plant, and for nuclear regulatory authorities. **To estimate required human resources**, a selection of the technology will be crucial, as it will determine a demand for power plant employees. Another important task is to activate the scientific and research potential, to **provide technical support tools for regulatory authorities** (President of National Atomic Energy Agency, President of the Office of Technical Inspection). Human resources demand, and ways and methods to achieve established objectives will be specified in 2020 in *The Program for development of human resources for needs of the nuclear power sector*, which will be implemented until 2030.

providing a landfill for radioactive waste

During first several dozen years after production, the spent fuel will be stored at the power plant premises, and a decision concerning its further management will be made in the future, in accordance with the *National plant for management radioactive waste and spent nuclear fuel.* Low and medium activity waste will be stored at a Polish landfill for radioactive waste; however, the currently used landfill will not cover all needs, therefore, a **new landfill for** low and medium activity waste will be opened.

Analyzes conducted to this date indicate that Poland does not have industrial quantities of uranium from conventional sources, however, a potential is available in unconventional deposits (e.g., ashes, copper mining spoils). This potential can be studied in successive years.

TERRITORIAL DIMENSION

The impact of construction of nuclear units and of the landfill for radioactive waste on the region in which they are located will mainly concern an increase in available jobs - both at the power plant itself, as well as in its neighborhood, significant revenues from local taxes, and development of traffic and hydrotechnical infrastructure, and this will translate into economic attractiveness of surrounding areas and an improvement in local conditions of living.

	Actions	Deadline	Responsible
	Implementation of the Polish Nuclear Power Program **5. STRATEGIC PEP PROJECT**	–	
5.1.	Implementation of legislation changes limiting delays in execution of NPP construction for non-technical reasons (formal)	2020	ME
5.2.	Development of a financial and business model for the nuclear program	2020	ME
5.3.	Specification of a location for the first nuclear power plant - Kopalino/Żarnowiec (followed by selection of locations for successive power plants)	2020 (2022)	ME, investor
5.4.	Selection of a technology and a general contractor for the first nuclear power plant	2021	
5.5.	Development of *The program for development of human resources for needs of the nuclear power sector* and its implementation	2020	ME, investor
5.6.	Development of competencies of nuclear regulatory authorities and technical support institutions	2030	ME
5.7.	Opening of a new landfill for low and medium activity waste	2030	ME
5.8.	Construction and start-up of nuclear power units: – the first nuclear power unit; – successive five nuclear power units (every 2–3 years)	2024-2043 (by 2033) (by 2043)	investor

– energy security, – competitiveness of the economy, – reduction of the environmental impact of the sector

DIRECTION 6. Development of renewable energy sources

TARGET: reduced emissions from the power generation sector and diversification of energy generation

Energy generation from renewable resources enables diversification of the energy generation structure, reduces dependence of the country on fuel import, as well as contributes to **reduction in the environmental impact of the energy sector** due to small/zero emissions of pollutants[59]. The use of RES reduces import of fuels and contributes to less intense use of fossil fuels, thus improving the **energy security**.

An additional advantage of RES is a possibility to use the local potential (including in less developed regions and rural areas) and diversification in the location of generating infrastructure, which is located mainly in the southern part of the country. Decentralization of the generating units and their location close to recipients also contributes to reduction in transmission losses, although it requires maintaining the local distribution infrastructure in a good operating condition. Current RES technologies are not sufficiently competitive to function with the energy system without any limitations, however, the technological progress reduces this barrier year by year. Although the system for RES support and priority for bringing energy from these sources into the grid have disrupted functioning of the energy market, it is expected that on a long-term basis the use of RES will contribute to a decrease in the energy prices, and thus to the **increase in competitiveness of the economy.**

*A concept for ensuring secure use of RES, by sources dependent and independent of weather conditions is provided below, taking into account an issue of local and national balancing and ways to support RES development. The strategic project in this direction is **development of offshore wind energy.***

* * *

The increase in RES share in energy consumption is one of three priorities in the EU climate and energy policy. The EU target amounts to 20% for 2020, and to 32% for 2030 (specified in 2018)[60].

In 2018, the RES share in the final gross energy consumption in Poland reached 10.9%. The greatest volume of renewable energy is used in heating and cooling, followed by power generation, with the lowest share in transport. The share of production from the renewable sources in these subsectors amounts to 14.6% in heating and cooling, 13.91% in electricity generation, and 3.6% in transport[61].

21–23%* of RES in the gross final energy consumption in 2030

According to the EU obligations, in 2020 Poland should achieve the share of energy from renewable sources in the gross final energy consumption at a level of 15%[62]. It is assumed that auctions for purchase of electricity for RES planned for 2019 and 2020, and the support for prosumer energy generation will allow to achieve this purpose, although the increase in this share in transport faces numerous obstacles.

It is assumed that when competitiveness of renewable sources, technical possibilities for their work within KSE, as well as challenges associated with RES development in transport and heating are taken into account, it is possible to achieve the 21% share of RES in the final gross energy consumption in 2030.

As its contribution in implementation of the EU target for 2030, Poland declares achievement of **21–23* share of RES in gross final energy consumption in 2030** (total consumption in power, heating and cooling sectors and for transport purposes). **Poland emphasizes that execution of the objective for RES at a level of 23% will be possible if Poland receives additional EU funds, including those for f*air transformation.***

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[59] Biomass burning is accompanied by emissions of pollutants, however it absorbs CO_2 in the process of photosynthesis during the growing season.

[60] The national targets for 2020 have been specified in an annex to Directive 2009/27/EC on the promotion of the use of energy from renewable sources – in accordance with technical and economic potential. The Member States themselves specify targets for 2030, also on a basis of technical and economic conditions.

[61] In 2010-2015, the RES share in the final gross energy consumption in transport ranged from 6.25 to 6.85%, but the discovery of the grey market in 2016 resulted in a significant reduction of this rate, to the level of 3.9%.

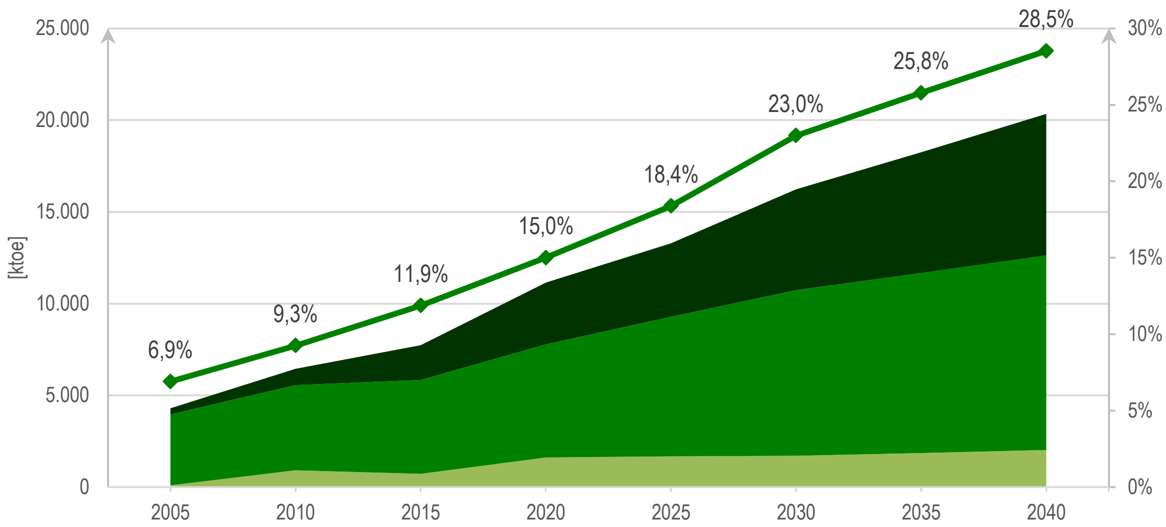
[62] A way to reaching this level is described in *The National Action Plan for energy from renewable sources until 2020*, 2010.

Forecasts for the fuel and energy sector presented in Appendix 2 to PEP2040 have been developed taking into account the 23% target for RES. These projects indicate that in 2040, the RES share may reach 28.5%.

A **technological progress** will significantly influence the scale of RES use, both for currently known methods of energy generation (e.g., increased use of the wind by wind farms or of solar radiation by photovoltaic panels) and in completely new technologies, as well as in technologies for energy storage. **The RES target will be implemented by increasing RES use in all three subsectors**, but the most difficult, especially during the initial years, will be the increase in RES use in transport.

The chart below presents a forecast increase in the use of renewable energy in the specified subsectors, and a course of the increase in RES share in the gross final energy consumption in the 2040 perspective. The table provided beside the key shows the possible RES share, in total and in relevant subsectors.

Forecast for renewable energy consumption in 2020–2040



Key		2020	2030	2040
share of energy from renewable sources in gross final energy consumption	**share of energy from RES in gross final energy consumption**	**15.0%**	**23.0*%**	**28.5%**
gross consumption of final energy from renewable sources in power generation	share of RES energy in power generation	22.1%	31.8%	39.7%
gross consumption of final energy from renewable sources in heating and cooling	share of RES energy in heating and cooling	17.4%	28.4%	34.4%
gross consumption of final energy from renewable sources in transport	share of RES energy in transport (with multiplicators)	10.0%	14.0%	22.0%

RES use in transport,

EU regulations oblige Poland to reach the 14% share of renewable energy **in transport** by 2030. The use of biocomponents (blended with liquid fuels and liquid biofuels used in transport), with an increased emphasis on the use of advanced (non-food) biofuels and fuels from recycled carbon fuels, as well as the use of electricity in transport will contribute to achievement of these targets. This means the increasing RES influence on the fuel market, dominated by petroleum fuels[63].

RES use in heating and cooling

The RES share **in heating and cooling** will grow by ca. 1.1. percentage points per annum. The use of RES in this subsector will be supported by the use of[64]:

[63] The use of biocomponents and electricity for transport purposes was described in Direction 4, part C, as their development has a strong influence on the fuel market.

[64] See also: direction 7.

- **energy from biomass** (and heat from waste) - this source is a good solution for households and for co-generation; it has the highest potential for execution of the RES target in heating, due to fuel availability, and technical and economic parameters of the systems. The biomass-firing generating units should be located near location of its generation (the rural areas, centers of wood industry, areas where municipal waste is generated) and at locations where maximization of the use of the primary energy contained in the fuel is possible, to minimize the environmental costs of transport. Biomass use for energy also contributes to the better waste management;
- **energy from biogas** - the use of biogas will be particularly useful in the co-generation of electricity and heat. Its advantages include a possibility to store energy in biogas that can be used for control purposes. From the general economic point of view, biogas represents an additional added value, as it enables management of particularly onerous waste (e.g., animal waste or landfill gases);
- **geothermal energy** – although its current use is at a relatively low level, an increasing trend is foreseen. Determining of the geothermal potential requires significant financial expenditures with a high level of uncertainty, but the use of energy of this type may be decisive for development of a given area (e.g., recreational complexes);

SOR PS.3(2)

- **heat pumps** - their use is increasingly popular in households, and their potential is estimated to be at the same level as that of the geothermal energy. They require electricity for their use, therefore, combining the installation with another RES source generating electricity is a good solution in this case;
- **solar energy** - a significant increase in its use for heating purposes depends on the technological development due to an inverse correlation between levels of sunshine and heat needs. However, this type of energy will play a crucial role in covering the demand for cold -photovoltaic panels will cover summer peak demands for electricity for cooling purposes.

RES use in power generation

In the coming years, the increase in RES use for **electricity generation**[65] will remain on a stable level, and its dynamics will increase after 2025, as it is expected that individual technologies will reach their technological and economic maturity. It is estimated that the RES share in power generation will amount to ca. 32% in 2030, and to nearly 40% in 2040. The increase in the use of RES in power generation will be supported by the use of:

- **solar energy** (photovoltaics) - the advantage of this technology is a positive correlation between the intense sunshine levels and the daily demand for electricity and the increased generation in the summer correlated with demand for cold. These installations are of relatively low power, but the importance of their total installed power for the KSE will steadily grow. Its use represents an alternative for the use of post-industrial areas and grounds of poor quality, and of building roofs. They are of great importance for current robust development of microsystems[66], strengthened by dedicated programs of financial support. It is estimated that photovoltaic sources will achieve their economic and technical maturity after 2022;
- **offshore wind energy** - at sea the wind achieves relatively high speeds and does not meet any obstacles (low terrain roughness), so offshore wind power plants are characterized by higher productivity than those located onshore. To start investments in this power, works on strengthening of the transmission grid in the northern part of the country must first be completed, so this power can be delivered further inside the country. It is estimated that the first Polish offshore wind farm will be added to the power generation balance around 2025. The Polish shore offers possibilities for implementation of other new offshore installations, but a possibility of their balancing in the KSE will be of crucial importance for the investment. It is assumed that by 2040 these sources will provide the greatest share of the electricity generated from RES;
- **onshore wind energy** - on medium term it is assumed that the increase in the share of these technologies in the energy balance will be less robust, when compared to previous years. The onshore use of the wind energy generation is significantly hindered by a lack of relationship between its operation and demand for energy, therefore, the rate of its development should depend on costs and possibilities for its balancing. A diversified level of acceptance of wind farm construction by local communities represents another problem. To reduce possible conflicts, investors should consider development of systems enabling inhabitants participation in project execution;

[65] See also: Direction 2, part A.

[66] At the end of 2017, ca. 28.8 thousand microstations, of the total power of ca. 183 MW were connected to the six main DESes. At the end of 2018, that value was almost doubled to ca. 54.2 thousand microstations, of the total power of ca. 343 MW, and after the third quarter of 2019, the level of 106 thousand stations of the total power of 684.8 MW was exceeded.

- **energy from biomass and biogas** - their potential will mainly be used for heating, but some resources will also be used for electricity generation, especially in co-generation and transport. A possibility to use biogas for control purposes is its advantage, as it is particularly important for flexibility of KSE operation;
- **hydroenergy** – due to a limited national water potential, no significant increase in the use of energy of flowing waters is planned. In a long-term perspective, the hydro energy generation may be influenced by development of inland waterways and revitalization of dams, which are of importance for control of water courses and flood prevention. It should be noted that operation of run-of-river power plants can be controlled, although to a limited extent. Pumped storage plants are not included in RES, but have a control function in KSE. Taking into account the regulatory potential of hydro energy, new ways of its use are worth seeking, also on a small scale.[67]

SOR PS.3(4)

Currently conditions of functioning of all technologies are regulated, although the RES market is very dynamic, therefore, the legislation must be adjusted on a regular basis and conditions for their further development must be ensured. The area of **offshore wind power generation** is an exception here, as to this date there was no investment of this type in Poland, and current regulations do not provide sufficient legal frameworks for its development and functioning within KSE. Therefore, **in 2020 they will be described in a separate legal act**, to enable start-up of the first Polish offshore wind farm in 2025, and further development of this technology in Polish conditions.

development of offshore wind energy

6. STRATEGIC PEP2040 PROJECT

Generation of energy from RES, *and electricity in particular*, should also be considered from the entities' point of view. Apart from systems constructed as a part of business projects executed by various business entities, **the scattered energy generation**, based on systems of relatively small power, has also started to develop. It aims at covering mainly own power demand, and surpluses are brought to the grid. Two groups can be distinguished here:

scattered energy generation

SOR PS.3(3)

- individual or industrial **prosumers of renewable energy** - they generate energy in microsystems for their own needs, and bring the surpluses to the grid. They can take back a significant part of that energy in shortage periods. The community energy allows reasonable use of the RES potential at a local level, and it also contributes to effective energy management. In this direction, self-balancing of prosumers is worth pursuing, e.g., by bringing surplus energy to energy storage facilities, to **minimize their external needs** in period of unfavorable weather conditions, to make renewable energy prosumers fully independent and to reduce a negative impact on the power supply grid and disturbances in the energy market;
- energy-balanced areas – **energy clusters** (an area of five neighboring communes or a poviate) and **energy cooperatives**. They are established to make use of the local potential - energy sources, raw materials, human relations, and to create new areas for economic development. Making a given area independent of energy supplies from the national grid and possibility for the cluster to provide DSR services to DES are equally important. Eventually, the certainty of balancing in the cluster should be sufficiently high, so energy demands of such areas will not need to be considered by TSOe in the planned power reserves. It is estimated that in 2030, ca. **300 energy-balanced areas** will function in Poland **at a local level.**

An increase in RES use has many advantages, however, without KSE adjustment, too high amount of this power may have a negative impact on energy security. A significant part of generating power from renewable energy sources installed in Poland is based on unstable sources, dependent on weather conditions, and working for a small number of hours per year (wind, sun, partly water). From the system point of view, this has an adverse effect on efficiency and costs of energy generation, as reserve powers and significant flexibility of the entire system must be maintained, generating an increase in costs of energy. This applies not only to work of large systems, but also to

RES balancing - storage facilities, regulatory sources

[67] Hydro energy development is a strategic SOR project, however, due to a small water potential of Poland, this project is strongly connected with water resources management, particularly, with control and retention functions.

significant surplus energy generated by diversified energy generation in small and micro-systems, and increased energy uptake by prosumers of renewable energy and clusters during unfavorable periods.

For this reason, for the best possible use of the RES potential, development of energy storage facilities and smart energy management systems is necessary, as well as providing encouragement to improvement in price flexibility for energy demand (DSR) and promoting aggregators[68]. Research and development in these technologies are equally important, to increase the use of RES potential. In the longer perspective, **connection of an unstable energy source** should be associated with **ensuring a possibility to cover the reserve** during periods of inactivity. Potential solutions in this area may include, e.g., construction of a storage facility or a balancing source, balancing within a cluster, energy community, or a group of companies, as well as payment of relevant balancing fees and compensations to systemic reserve sources, which would allow inclusion of generated systemic costs in costs of RES energy.

support of RES development

Created mechanisms of support and promotion of generation of RES energy, similarly as a time horizon of support, will be adopted to market needs (although it is assumed that it will be needed until ca. the end of 2030), and they will promote the solutions that:

- ensure **maximum availability** (high efficiency and a rate of use, controllability, **use of energy storage facilities**), with the lowest relative cost of energy generation;
- covering **local energy demand** (heat, electricity, transport), but also solutions associated with waste management (according to the waste management hierarchy) and the use of local potential.

The type of the support will depend on the source type and size, and it can be divided into the following forms:

- **priority of access to the grid** - currently covers all RES systems and represents a key element of support;
- **auctions** - intended for professional sources, i.e., ensuring availability and sufficiently high power. The selection of supported areas depends on preferences for stimulation of development of RES areas taking into account economic, environmental and climate conditions, and ensuring energy security;
- **a system of guaranteed feed in tariffs** and **feed in premiums** - they are intended for systems of relatively small power, and used to manage energy that was not used by the small generator;
- **subsidies, repayable assistance** - a mechanism dependent on local needs, distributed in particular in the regions;
- **guarantee of origin** – a document confirming for an end customer that a relevant amount of electricity brought to the grid was generated from RES – it has a form of a certificate, and a demand for it is generated by customers who want to be perceived as an environmentally friendly company or to demonstrate their high energy performance (e.g., building managers, SME, or operators of chargers for electric cars);
- **assistance mechanisms dedicated to specific technologies** - it is a solution dedicated to sources that do not have any competition in the market because they are a new technology (e.g., offshore wind power generation), but their implementation into the market is important for the country, for various reasons - e.g., significant use of the power during the year.

TERRITORIAL DIMENSION

Energy generation from renewable sources has a significant territorial impact due to its scattered nature. Systems are frequently owned by small generators (individual or industrial), and substrates also come from sources located at a relatively small distance. Development of energy clusters and cooperatives will have even greater influence on increasing involvement of local entities. It also has a positive influence on an overall development of a region, starting with the infrastructure, up to strengthening of relations in local communities.

	Actions	Deadline	Responsible
6.1.	Ensuring conditions for achievement of the RES share in the gross final energy consumption at a level of 15% in 2020 and 21–23% in 2030. – **in heating and cooling** - an annual growth in the RES share by ca. 1.1. percentage points per annum.	2020 / 2030	ME and other entities

[68] See Direction 3, part A.

		– **energy generation** - a growth of RES share in electricity generation, especially after 2022 (due to an increase in profitability of use of some technologies). – **in transport** - achieving the 14% RES share in 2030, including the increase in the use advanced biofuels *(tasks executed also under directions 2, 4 and 7)*		
	6.2.	Determining legal frameworks for functioning of offshore wind energy generation **6. STRATEGIC PEP PROJECT**	2020	ME
	6.3.	Providing conditions for development of diversified power generation - prosumers of renewable energy, energy clusters, energy cooperatives	–	ME, local governments, other entities
	6.4.	Ensuring conditions for balancing of renewable sources	–	ME
	6.5.	Providing financial support for RES and improving its existing forms , taking into account the role of technologies in KSE *(until the economic maturity is achieved)*	–	ME, NFEP&WM, VFEP&WM other entities

– energy security, – competitiveness of the economy, – reduction of the environmental impact of the sector

DIRECTION 7. Development of heating and co-generation

TARGET: general access to heat and low-emission generation of heat in the whole country

Covering demand for heat is one of the elements of **energy security.** Securing of heat supply is of particular significance for households, in which over 80% of supplied primary energy is used for heating of rooms and water. The situation of energy poverty is strongly related to insufficient covering of heat demand, and its background is multidimensional.

Heat generation is accompanied by emissions of pollutants. While professional and industrial energy sectors are obliged to maintain strict emission standards, households only cannot incinerate waste. For the highest possible efficiency of the use of energy materials, as well as possibly **large reduction in pollutants, competitiveness** of effective and low-emission solutions must be ensured. More broadly, costs of healthcare and unreasonable management of resources exceed differences in investment and/or operating costs of clean technologies.

The heat market is characterized by its local character due to technical possibilities of heat transmission, which do not exceed 20 km. Households obtain heat either from an individual source of heat or from a connection to a heating system (district heating), similarly to companies and entities from the public sector. Although since 1990s', a great progress has been achieved in terms of energy efficiency of heat generation and supply, and reduction in the environmental impact of these processes, there is still a wide range of actions to be undertaken in relation to heat management.

*The paragraph below presents a concept of covering the heat demand of the economy, divided into the systemic and the individual heating, and discusses other general economic issues associated with covering a demand for heat. The strategic project in this direction is **development of district heating**.*

* * *

energy planning at a local level

Commitment of local government and local energy planning both play specific roles in implementation of the state policy for heating, as heat demands are covered at a place of living. In 2018, only 22% of communes had a planning document concerning supply of heat, electricity and liquid fuels Therefore, **communes, poviates and voivodships** must be encouraged **to implement energy planning**, which mainly leads to a reasonable energy management, development of clean sources of energy and improvement in the air quality. This planning should be based on real cooperation between local government units, using possibilities offered by local synergies, and not just to perform their duty.

development of a heat map of Poland

A **system for collection of data for a heat map of Poland** will be a useful tool for energy planning. Access to that data will help regions, communes and companies in estimating potential for development of heating networks and co-generation, and will also provide the new investors with information about the supplied infrastructure.

Heat demand should be **covered** mainly by using **the district heating**. This ensures high efficiency of raw material use, improves comfort of living for inhabitants, and reduces the problem of *low emission*[69]. When connection to a heating system is not possible, actions should focus on using individual sources of the lowest possible emission rate. The established target assumes that **by 2040 heat demand of all households will be covered by district heating or by zero- or low-emission heat sources.**

The heat supply efficiency depends on a source and a system for its supply. As per EU and Polish regulations, **the system is energy efficient** when it uses in at least:

[69] See also: direction 8.

- 75% heat from combined heat and power generation (CHP), or
- 50% waste heat (a by-product of industrial processes), or
- 50% energy from RES, or
- 50% combined heat and power, mentioned above, is used, for production of heat and cold.

Currently, the criteria for the energy efficient system are met by ca. 20% of heating or cooling system, which provide ca. 85% of the total volume of systemic heat in Poland. In 2016, ca. 15.9% of electricity and ca. 61% of systemic heat were generated in co-generation processes.

The aim is to expand and improve efficiency of heating, and in particular, to construct new and transform existing systems in **energy efficient heating systems. It is expected that in 2030 at least 85% of heating or cooling systems in which ordered power exceeds 5 MW, will meet criteria for energy effective heating system.** The following actions will be decisive for achieving the above objective:

development of district heating

7. STRATEGIC PEP PROJECT

- **Development of co-generation**, i.e., combined generation of electricity and heat, which is the most environmentally effective way for using the fossil fuels. A cost of such installation can be higher than in the case of construction of a thermal power plant, however, profits come from sale of two energy carriers. To encourage the use of the CHP technology, in a high-performance way, **a support for electricity generated by high-performance generation will be maintained**. The system will remain active for as long as the market requires intervention. Later on, the systemic heat should be generated mainly by CHP.
- **Increase in RES use in the systemic heating** - it will mainly be achieved by using local resources of renewable energy, i.e., biomass, biogas, or geothermal energy, as well as solar collectors, especially in clusters. The RES share in heating and cooling should grow by ca. 1.1. percentage points per annum[70].
- **Increased use of waste in systemic heating**[71] (mainly in CHP) – contrary to household furnaces, waste incinerators are equipped with highly effective systems for purification of flue gases, and very high temperatures ensure burning out of majority of volatile components. With the EU hierarchy of waste management maintained, thermal processing of waste fits well into the concept of *circular economy*. In a long-term perspective, thermal treatment of waste without recovery of energy should not be practiced.
- **Use of heat generated at power plants** - for the highest possible efficiency of fuel use, the heat accompanying generation of electricity should not be waste. In cooperation with the commune, it should be considered whether there is potential for heat market development at a given location, which also may become a reason for development of a given region.
- **Modernization and expansion of the heat and cold distribution system** - to reduce losses, the heating agent should be transported in previously insulated grids. Newly created grids are constructed using such technologies, but an intense modernization of the existing transmission infrastructure characterized by poor thermal insulation must be ensured. To increase the range of heating networks, the investment process for their construction must also be simplified.

  The district heating must also be used to generate cold, and this is particularly important in the summer, as demand for electricity can be reduced and the potential of sources of heat can be used to higher extent, especially on a basis of absorption and adsorption technologies. This solution is particularly attractive for newly constructed commercial buildings.
- **Promotion of heat storage facilities** - heat accumulated during the off-peak demand can be used during periods of increased demand, to increase efficiency of heating system. This solution is also very important when coupled with unstable RES, e.g., with solar collectors, but also to balance the demand in clusters.
- **Popularization of smart grids** - high-performance sources, correctly insulated grids and heat reservoirs achieve their highest efficiency when combined with smart grids. Modern methods of management ensure optimum management of heat uptake, reduction in losses during heat transmission, detection of defects or improvement in efficiency of operating services.

[70] The issue of the renewable sources is more extensively described in a separated direction - see: direction 6.

[71] See also: Direction 1 - covering demand for biomass

All these **actions will require** financial and organizational support, but also relevant amendments in legislation. Equally important is education of the society in effective and environmentally friendly ways for covering its heat demand, as well as in advantages of the use of waste by professional power generation sector, versus its use in individual systems.

increased use of district heating

In the areas, where technical conditions for heat supply from energy efficient heating system exist, **customers should first use the district heating,** unless they use more environmentally friendly solution. For these reasons, investment support for individual sources of heat should only be provided when it is not possible to connect the recipient to a heating system. In 2015, 61% households were connected to the grid in the urban areas - the aim is to regularly increase this ratio. The established target is **70% of households connected to the heating system in urban communes.**

The increase in the number of connected recipients and departure from individual heating in areas where the grid is available contribute to fighting with low emission, and at the same time improves the comfort of life of inhabitants, previously using furnaces firing solid fuels. In 2019, the obligation to connect all facilities to the heating system when it is technically and economically possible was expanded[72], and performance of this obligation is verified in the process of application for a building permit. Construction of heat grids and connections in voivodships with the diversified ownership status still remains a barrier to efficient development of district heating. For this reason, in 2021 **regulations facilitating access to land in external ownership** will be implemented, and this will facilitate effective management of investments in heating line infrastructure.

The use of the district heating will increase due to **tasks described in the part concerning development of district heating** - competitive prices of heat from such source should encourage the use of district heating. To avoid a situation where heating companies create prices taking advantage of their monopolistic position, and ensure the price level is acceptable for customers, while covering reasonable costs and ensuring a return on capital employed, **a change in a model of the heat market and the tariff policy**, and **search for new stimuli to cost optimization of heat supply and an increase in the number of undertaken tasks influencing the improvement inefficiency** are justified.

low-emission individual sources

When connection to the heat grid is not possible in a given area, heat demand should be **covered by individual sources of the lowest emission possible**, especially, by:

- systems based on non-combustible RES (including heat pumps),
- electric heating:
- gas system
- use of solid fuel firing boilers of at least 5th class or so-called eco-design boilers[73].

Increasingly often the use of environmentally friendly heat sources is encouraged by combined sales offers[74], and by various forms of public financial support. Local governments and local grass-roots initiatives play an enormous role in building of environmental awareness and need.

monitoring of emissions from individual systems

In many cases, waste is used as a fuel, although consequences of burning waste in households systems are well-known. Another problem concerns incorrect operation of coal-fired systems, including a way of firing-up and adding fuel, as well as failure to observe or incorrect performance of the obligation to clean chimneys, which contribute to incomplete burning of the fuel and emission of volatile parts. Development of environmental awareness and motivation of local communities play an enormous role in activities promoting environmentally friendly methods for covering of heat demand. At the same time, it would be necessary **to increase monitoring of emissions from detached houses** and **impose consequences against those responsible for pollution[75].**

[72] The obligation is implemented provided a facility is not equipped with an individual source of heat characterized by a rate of input of non-renewable primary energy at a level not exceeding 0.8, or with a heat pump or electric heating, or when prices of heat exceed the average sale price for a given fuel.

[73] Boilers conforming to the eco-design directive - i.e., meeting the strictest standards for emissions of harmful compounds to the natural environment.

[74] For example, preferential prices for combined purchase of the system and the fuel.

reduction in the use of solid fuels at households

To reduce emissions from one of the main sources of low emissions, but also for reasonable use of raw materials (low efficiency of coal burning at household systems), gradual reduction of the use of **solid fuels in low-performance boilers at individual households** is necessary. This process will need to be spread overtime due to its capital intensity, extensive range, time-consuming nature and technical problems related to replacement of a heating system, and will require support. This will also allow less well-off households to gradually adapt to new regulations, so the *energy poverty* is not increased. It is also a time for performance of thermal modernization activities, which will rationalize heat demand through a significant improvement in energy performance of buildings[76].

TERRITORIAL DIMENSION

Heat demands are covered at a local level, therefore, it is extremely important to ensure energy planning at commune and its consistency with the national energy policy. Efforts should be made to use the district heating, and individual low emission heat sources should only be used in low-urbanized areas. Monitoring and imposing consequences for excessive emissions of pollutants should also occur at a local level.

[75] Actions related to emissions of pollutants have been specified in *The ecological policy of Poland, 2030*.

[76] See also: Direction 8 - energy poverty and thermal modernization.

	Actions		Deadline	Responsible
	7.1.	Activation of regions in energy planning by changing an obligation to prepare planning documents for heat, electricity and gas fuel demand.	2022	MSWiA, ME, MIiR
	7.2.	Development of a system for data collection for the heat map	2020	GUS, ME, URE
	7.3.	Ensuring conditions for development of environmentally friendly and effective heating systems through financial, organizational and legal support: – increase in the use of high-performance co-generation (support system); – increase in the use of RES and waste in district heating; – connecting power plants to the heating system; – modernization and expansion of the heating systems and development of technologies for cold generation from district heating; – promotion of heat storage facilities and smart grids **7. STRATEGIC PEP PROJECT**	–	ME, MŚ, MIiR, local governments, companies, NFEP&WM, VFEP&WM and other entities, depending on adapted solutions
	7.4.	Ensuring conditions for increased use of district heating, especially through: – simplifying investment procedures in the district heating infrastructure; – change in the heat market model and the tariff policy	2021 / 2020	ME, MIiR, PRMCzP, MŚ, NFEP&WM
	7.5.	Creating encouragements for the use in individual heating systems of other types of fuels instead of solid - *natural gas, non-combustible RES, electricity*	–	NFEP&WM, local governments, ME
	7.6.	Increased monitoring of emissions from residential single- and multi-family buildings	–	MŚ, MIiR, IOŚ
	7.7.	Reduction in the use of solid fuels at households in low-performance boilers	–	

– energy security,, – competitiveness of the economy, – reduction of the environmental impact of the sector

DIRECTION 8. Improvement in energy efficiency of economy[77]

TARGET: increased competitiveness of the economy

Energy efficiency is a relation between the usable effect and the energy input. The lower the energy intensity of a given facility, technical system or a plant, the higher its efficiency, which is translated to the entire economy. A relation between the effect and the energy expenditure concerns each activity in the economy, from industry, through services, transport, or use at households, up to energy generation.

Pro-efficiency activities mean lower costs of energy consumption. They are also associated with implementation of new technologies and an increase in innovativeness of the economy, influencing its attractiveness and **competitiveness**. It is also visible in energy intensity of GDP. The lower the energy consumption, the lower is the share of energy costs in a given activity, influencing its profitability. Decreasing energy intensity means faster growth of GDP when compared to the energy consumption rate. *The energy intense industry is an exception here, as in general it absorbs large quantities of energy, but may represent a national competitive edge.*

The improved energy efficiency is indirectly influences **energy security**. A reduction in a relationship between the energy demand to economic growth and the reasonable use of energy is tantamount to savings of energy which does not need to be generated, and thus a risk of a failure to deliver it is limited. This translates directly to a **reduced environmental impact of the energy sector**, because pollutants are not emitted and less raw materials is used, while the economic growth remains undisturbed. Apart from energy savings and prevention of climate changes, the improved energy efficiency contributes to improved health and comfort of living for people.

The increase in the energy efficiency should be taken into account as a part of implementation of all actions specified in PEP2040 directions. An improvement in energy efficiency is of horizontal nature, but a decision was made to approach this issue individually as a separate direction for intervention, due to a great importance of reduction in the energy consumption.

*The paragraph below presents concepts for supporting the increase in energy efficiency of the economy, and answers to associated issues, i.e., energy poverty and low emissions. The strategic project in this direction is **promotion of improvement in energy efficiency**.*

* * *

Energy efficiency is one of the three priority areas of the energy and climate policy of EU, which undertook to increase its energy efficiency by 2020 by reduction in primary energy consumption by 20% versus forecasts from 2007.[78] **The Polish contribution to implementation of that target means a reduction in primary energy consumption by 13.6 Mtoe in 2010–2020[79]**, and this means a **reduction in primary energy consumption by 12.4%**, when compared to the value of forecasts for 2020 from 2007. Although the energy intensity of the Polish economy differs from the EU average, in recent years we have made a great progress in the reduction of our energy consumption. Poland overachieved the intermediate target for 2016 – understood as achieving in the final energy saving in the amount of at least 9% of the average national consumption of that energy in 2001–2005.

23% savings on primary energy vs. the forecast for 2030

In 2014, the European Union maintained energy efficiency as a priority, undertaking to achieve 27% energy savings versus forecasts, and in 2018 the (indicative) target was increased to 32.5% at the EU level. Poland means to continue a direction of the increase in energy efficiency of the economy. On a basis of an analysis of effects, an impact on GDP, and potential savings, Poland declares **the national target for improvement in energy**

[77] More in: *The national Action Plan for energy efficiency of Poland, 2017*, 2018.

[78] Each Member State set an estimated national target value for the energy efficiency on a basis of its consumption of primary or final energy, savings of primary or final energy, or energy intensity. Furthermore, target values in categories of the absolute level of primary and final energy consumption in 2020. The final energy consumption is determined on a basis of conversion factors.

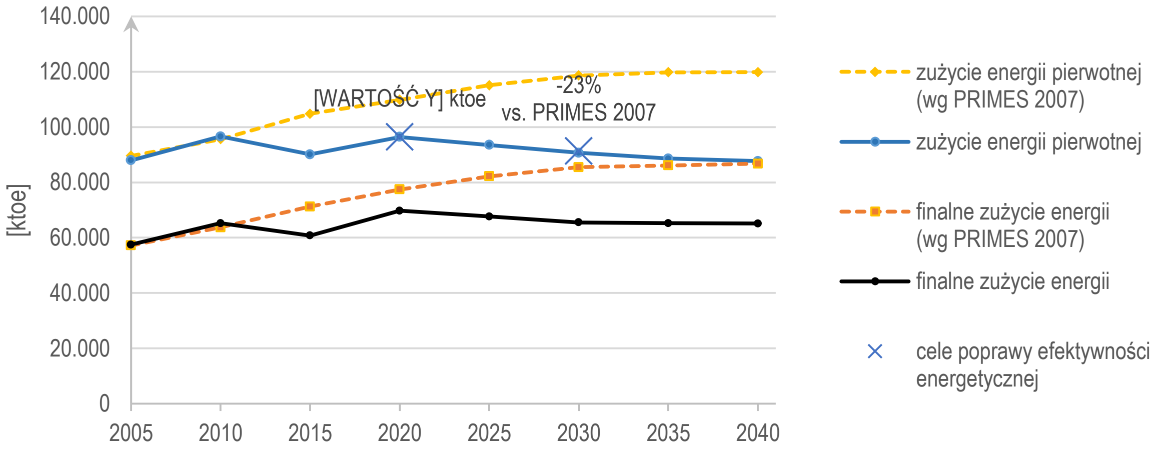
[79] In a prognosis prepared for the European Commission (PRIMES – Baseline 2007), a forecast consumption of primary energy by Poland is at a level of 110 Mtoe in 2020. Taking into account a reduction in energy consumption by 13.6 Mtoe, 96.4 Mtoe was obtained.

efficiency at a level of 23% by 2030 in relation to forecast primary energy consumption from 2007.

Actions contributing to improvement in energy efficiency by 23% until 2030 should result in excess of benefits over costs. At the same time, it is an **opportunity to implement the obligation to increase the share of RES energy**, as many efficiency-promoting actions may be executed using renewable sources, which allow to obtain the same volume of final energy without the input of primary energy (in calculations).

The figure below illustrates a forecast for primary and final energy consumption as a result of PEP2040 implementation, versus the European Commission forecast PRIMES from 2007. Furthermore, targets for 2020 (quantitative) and for 2030 (percentage rate of savings versus forecasts) are presented.

Forecast for renewable energy consumption in the final energy for 2020–2040 [ktoe]



A potential for improvement in energy efficiency is available nearly in the entire economy. Below the sectors of economy are specified, indicating areas in which coordinated actions can result in significant benefits:

- **energy sector - electricity and heat generation, gas and fuel sector** - improvement in performance of existing conventional sources; improvement in efficiency of transmission and distribution; storage; use of smart solutions; increase in production from diversified energy sources; increase in systemic RES generation;
- **households** - thermal modernization of buildings (thermal insulation of construction partitions, replacement or modernization of central heating/utility hot water systems), heat recovery from ventilation and the use of energy-saving lighting, and audio-video and household appliances;
- **savings** - thermal modernization of buildings (comprehensive thermal modernization, followed by implementation of heat recovery); modernization of lighting fixture of light sources, replacement of IT equipment, lighting of squares and streets;
- **industry** - improvement in energy intense processes in production (especially energy intense products, i.e., steel, paper and cement);
- **transport** – promotion of electromobility (the profit results from nearly three times higher effectiveness of electric drives when compared to conventional engines)[80], increase in the share of public transport in passenger transport.

It should be noted that not every projects aiming at improvement in energy efficiency is reasonable in economic terms. A return on investments in form of savings may require too long period and have a too strong effect on GDP. At the same time, actions concerning energy efficiency should be considered within a perspective exceeding a period of return, to implement the concept of *circular economy*. In the energy sector, this has a greatest influence in the area of the use of waste for energy generation, but also economic use of waste from the energy sector (e.g., limestone, sulphur).

financial support for improvements in energy efficiency

First, it should be noted that there is a very extensive offer of **financial support for projects contributing to improvement in energy efficiency** in all areas specified above - including domestic and foreign, especially EU, funds. Specific mechanisms are determined

[80] Road transport is responsible for ca. 90% of the total primary energy consumption by this sector.

according to identified needs, and particular attention should be focused here on loans, subsidies and other instruments offered by The National Fund for Environmental Protection and Water Management and operational programmes associated with European Funds, or resources from EU ETS, which will partly be used on investments improving effectiveness in the widely understood energy sector. It is assumed that financial support for improved energy efficiency will be ensured in the entire perspective of PEP2040. The improvement in the energy efficiency will also be supported by innovative solutions, therefore, it is very important to conduct development studies on solutions supporting a reduction in primary and final energy consumption.

A very important issue in financing of projects promoting efficiency is ensuring the highest energy effect, and this is guaranteed by a financing model based on an *agreement on improving energy efficiency.* An energy supplying company delivers a service improving energy efficiency of a beneficiary, and it receives the remuneration (reimbursement of costs) for the service from savings achieved by a reduction in costs of energy used, resulting from implemented solutions. Such agreements can be used both in public and in private sectors.

legal framework for energy efficiency - eco-design, construction sector, labelling

Top-down activities aiming at improved energy efficiency involve, directly or indirectly, the entire economy. Similar frames have been established for all EU Member States and will be developed, according to technological development and economic possibilities. The areas described below should be distinguished in particular:

– **eco-design** - to reduce environmental impact, including energy consumption, requirements are established for product design, including household appliances and devices used in services and industrial sectors, in such way that they represent the lowest possible burden to the environment during their life cycle; they involve successively a gradually increasing range of devices, from audio/video equipment up to boilers and ventilation systems.
– **reduction in energy consumption in buildings** - besides continued general thermal modernization of buildings, a long-term strategy for renovation of national resources of residential and non-residential buildings is being developed, and it will specify further policies and actions stimulating renovations of buildings. At the same time, already in January 2019 a requirement was implemented that all public utility buildings must be designed and executed as buildings with low energy consumption[81], while all newly constructed buildings will be covered by the same requirement from January 2021. It is an enormous challenge, requiring implementation of a number of innovative solutions concerning the use of appropriate materials, adapting thickness of partitions in buildings, and ventilation, heating and lighting systems;
– **energy labelling** - regulations specify information that should be included in the energy label, it is intended to influence awareness of consumers concerning the actual energy consumption of products and to influence their decisions related to energy saving and environmentally friendly solutions;
– **energy audits** – every "large" entrepreneur is obliged to conduct an energy audit of its company every 4 years- the review covers consumption of energy in buildings, systems, devices, and in transport. This obligation aims at making entrepreneurs aware of a potential of efficiency supporting actions, which, at the same time, should translate to reduction in its costs of energy.

public sector entities as role models

Furthermore, it should be noted that the **public sector has been assigned an exemplary role** in improved energy efficiency in the entire term of PEP2040. A range of actions supporting improved efficiency is extensive - from thermal modernization, through purchase of equipment and vehicles, and providing services characterized by low energy consumption (so-called environmentally friendly public tenders) up to implementation of environmental or energy management systems. Execution of projects in a form of public-private partnership, particularly concerning street lighting, will also be developed.

"certificates of improvement in energy efficiency"

An additional mechanism implemented to achieve energy savings is a **system obliging a specific group of economic entities** (including companies from the energy sector) **to execute a project aiming at improving of the energy efficiency or to purchase energy performance certificates** (known as *white certificates*, confirming energy savings resulting

[81] A detailed definition of such building is provided in *The national plan to increase a number of buildings with low energy consumption,* 2015.

from projects improving energy efficiency, achieved at a declared level). The system will remain in force until 2030, and can be prolonged, if necessary.

promotion of improvement in energy efficiency

All actions indicated above must be accompanied by **improvement in knowledge on reasonable use of the energy, by various educational initiatives** - it is necessary to stimulate the society awareness on potential energy savings at home and at work, for example, by rational heat management, effective fuel burning, use of energy-saving lighting and audio-video/household appliances, and methods and results of thermal modernization. Energy counselling at a local level and **actions** (e.g., campaigns) **promoting energy savings**, such as energy audits and other various educational activities, will be of importance.

8. STRATEGIC PEP PROJECT

The issue of energy efficiency is accompanied by two important social and economic issues - low emission and energy poverty. Implementation of a future strategy for renovation of domestic resources of residential and non-residential buildings will be extremely important for these two problems, but it is also expected that later on, implementation of regulations concerning nearly zero-use of energy by new buildings, mentioned above, will also play a significant role in this respect.

reduction of low emission onerousness

Inefficient use of energy is strongly associated with a problem of **low emission**[82]. It results from: burning of coal of low quality and waste at households (frequently, with incorrect operation of furnaces); burning of coal at local small low-performance thermal plants; and emissions from traffic[83].

To reduce individual emission, first heat needs of households must be rationalized[84] by **thermal modernization of buildings** (thermal insulation, replacement of door and window joinery, increased awareness). The second step is to **provide an efficient and environmentally friendly source of heat**[85]**.** The funds allocated to the program "Clean air" and the Thermal Modernization and Refurbishment Fund will play an important role for actions in this area -concerning single- and multi-family residential buildings, as the way and amount of support will depend on financial standing of a beneficiary. Activities of local governments, concerning both promotion and co-financing of activities, will also be crucial here.

Reduction in emissions from traffic will also be influenced by **implementation of electromobility and a number of actions planned for alternate fuels**[86]. Systemic changes in transport, i.e., promotion of low-emission public transport, car-sharing or *recovery of energy from electric vehicles supplied from overhead contact lines* (e.g., railway, trams, underground) will also be of significance.

reduction of energy poverty

Households affected by **a problem of energy poverty** largely contribute to low emission because they burn waste, sludge and flotoconcentrates, usually in buildings of low energy performance. Special support conditions for the poorest as a part of the above programs supporting thermal modernization are a key way for fighting energy poverty (in households, over 80% of primary energy is used for heating of rooms and water). Then the aid should cover replacement of sources of heat, to prevent burning of waste and solid fuels of low quality. The currently applied subsidy supports *vulnerable recipients*, but it is not an overall answer to the problem, therefore **new, effective ways for fighting the energy poverty** will be sought.

[82] Low emission means air pollutants from vehicle traffic and a process of burning coal of low quality and/or waste at households furnaces (frequently with their incorrect operation) and at local old thermal plants.

[83] Transport has greater impact on low emission in urban than in rural areas, where pollutants come from individual heating.

[84] Actions aiming at improvement of the heating sector situation have been described in direction 7.

[85] See also: direction 7.

[86] See Direction 4C - *development of electromobility and alternate fuels.*

TERRITORIAL DIMENSION

The level of the energy efficiency is associated with economic development of a given region, which is influenced by a financial situation of its inhabitants, and by a condition of local companies. The implemented mechanisms affect the entire country, and the extensive range of facilities aims at ensuring savings to these entities that have problems with executing them on their own. At a regional level, the Voivodship Funds for Environmental Protection and Water Management play a very important role due to a local character of distribution of these funds.

	Actions	Deadline	Responsible
8.1.	Ensuring support and development for financial support programs for projects increasing energy efficiency of the economy	2030	NFEP&WM, VFEP&WM, MŚ, ME, MPiT
8.2.	Providing legal framework for energy efficiency concerning, for example, products and energy performance characteristics of buildings	2020	ME, MI, MIiR
8.3.	Ensuring that the public sector is a role model in improvement of energy efficiency	–	public sector
8.4.	Ensuring an efficient functioning of a system of white certificates and its possible continuation after 2030	2030 (possible continuation)	ME, URE
8.5.	Promotion of improvement in energy efficiency **8. STRATEGIC PEP PROJECT**	–	ME, MŚ, NFEP&WM
8.6.	Support for general thermal modernization of residential buildings and searching for new solutions to reduce onerousness of low emission	–	PRMCzP, NFEP&WM, ME, MPiT
8.7.	Searching for new, effective ways for fighting with energy poverty	–	ME, MRPiPS, MIiR, PRMCzP

– energy security, – competitiveness of the economy, – reduction of the environmental impact of the sector

4. PEP2040 implementation and monitoring

Implementing entities

A number of entities is responsible for implementation of *The Energy Policy for Poland until 2040* - government and local government administration bodies, government agencies, entities from the fuel and energy sector, as well as business entities performing statutory obligations and implementing good practices in energy use. This list also includes households, which become active in the energy market, but also should ensure reasonable use of the energy. The section below presents entities specially involved in performance of the state energy policy, with a short description of their roles.

Minister competent for energy has a role of a leader and coordinator in creation and performance of the state energy policy, as provided for in the Energy Law of 10 April 1997. They supervise companies from the energy sector and on research institutes in the energy area. Furthermore, the minister competent for energy supervises the Material Reserves Agency and the President of the State Mining Authority. They also enforce property rights due to the State Treasury in relation to companies from the energy sector.

President of the Energy Regulatory Office (URE) is a central, independent government agency performing tasks associated with regulation of fuel and energy management (including establishing tariffs and concessions), and promotion of competition. The URE President regulates operations of energy companies, to balance the interests of energy companies and customers. They are also responsible for maintaining an extensive range of registers and lists, as well as for conducting auctions for sale of RES electricity.

Government Representative for Strategic Energy Infrastructure executes an ownership supervision over an operator of a power transmission system, an operator of a gas transmission system, and PERN S.A. on behalf of the State Treasury.

Minister competent for environment, conducts and is responsible for the materials policy as a part of the state energy policy, including coordination of exploring, documenting and management of deposits of energy materials, controls actions related to operation of the national system for management of the national ceiling emissions of greenhouse gases and other substances, and actions related to management of deposits of energy materials. Furthermore, the minister competent for environment supervises the President of the National Atomic Energy Agency, and the National Fund for Environmental Protection and Water Management.

Representative of the Prime Minister for the "Clean Air" program coordinates actions of the government administration and cooperates with entities of local government and non-governmental organizations on issues concerning improvement in the air quality, which in the relation to PEP2040 concern in particular heating and energy efficiency.

President of the National Atomic Energy Agency (PAA) is a central government administration body competent for nuclear regulatory issues and radiology protection, and PAA tasks concerning preparing of drafts of documents related to the state policy on nuclear regulatory issues and radiology protection, taking into account PPEJ and internal and external hazards, are of crucial importance for implementation of PEP2040.

National Fund of Environmental Protection and Water Management is the state legal entity entrusted with financing of environmental protection and water management. In terms of implementation of the state energy policy, the main NFEP&WM tasks include, in particular, financing of widely understood green investments and implementation of EU funds concerning energy efficiency.

Minister competent for regional development coordinates drafting and implementation of development strategies, and cooperates in obtaining of development funds from the European Union for the energy sector.

Minister competent for agriculture and rural development undertakes actions under the state energy policy concerning development of electricity and gas supply in rural areas, as well as certain actions focusing on energy potential of rural areas, as well as widely understood biomass, biogas, biocomponents and biofuel issues.

Minister competent for construction, planning, land development and residential issues undertakes actions relate to energy aspects of the construction industry, including improvement in energy performance of buildings, and cooperates in implementation of the energy policy concerning planning and land development issues.

Minister competent for marine economy and inland navigation is responsible, in particular, for implementing activities associated with development of port infrastructure and use of the RP marine areas for energy purposes, as well as cooperates in issues associated with the use of hydro energy potential; furthermore, they conduct activities related to environmental aspects of water use (the impact of water use by the energy industry).

Minister competent for economy cooperates, in particular, on issues related to competitiveness of business entities (including energy intense companies) in a context of the impact of burdens resulting from energy purchases; furthermore, they support activities concerning energy generation for own purposes by industrial companies.

Minister competent for foreign affairs provides support for implementation of activities specified in the state energy policy in these aspects which concern Poland's relations with other countries and international organizations, and are associated with representing and protecting Poland's interests abroad.

Minister competent for public finances cooperates in implementation of the energy policy in particular in areas concerning establishing rules for execution of revenues from direct and indirect taxes, and fees from entities operating in the energy sector.

Minister competent for science and higher education undertakes actions aiming at development of the system of science and higher education adapted to the market needs.

Minister competent for education undertakes actions to ensure uniform qualifications for professions in the energy sector included in the catalogue of the Integrated System of Qualifications.

Government Centre for Security ensures, in particular, circulation of information between national and foreign emergency management bodies and structures, and monitors implementation of executive activities of the energy sector resulting from the Emergency Management Act and from the National Program for Protection of Critical Infrastructure.

Transmission system operators and **distribution system operators** for electricity, gas and petroleum, conduct as a part of the state energy policy activities concerning drafting of grid development plans, restoring and strengthening existing, and construction of new connections between systems, especially facilitating cross-border exchange with neighboring countries.

Storage system operators, as a part of the state energy policy, conducts especially activities including ensuring operation, maintenance, overhauls and expansion of storage facilities and equipment, in a way ensuring security and reliability of their operation, as well as manages capacities of storage facilities.

Local government bodies (communes, poviates, and voivodships) are responsible for implementation of the state energy policy at a local level, including actions associated with energy planning at a local level, they are involved in local low-emission economy and support of entities by energy counselling.

Research and development institutes and universities conduct research and development works on innovative solutions and conduct activities aiming at their implementation in the market, taking into account adaptation of research works to the market needs.

Sector entities - energy companies, coal companies, oil companies, gas companies, refining companies, energy trade companies, companies implementing the National Indicative Target - they perform specific tasks related to the state energy policy, in particular, related to initial investments.

Companies and households are main stakeholders of the state energy policy, which is to ensure for them a stable access to energy at acceptable prices. Recently, they have been increasingly active in a role previously unavailable to them, of energy generators or entities providing services of demand management.

Monitoring system

Implementation of *The Energy Policy for Poland until 2040* will be monitored at a level of its main target and five main indicators, as well as at a level of individual directions for executed activities and strategic projects. A report on its implementation will be a part of an annual *report on monitoring of the Strategy for Responsible Development and nine development strategies*.

Strategic projects included in PEP2040 will be a subject to cyclic strategic monitoring conducted by the Government Office for Project Monitoring at the Chancellery of the Prime Minister of Poland, and to regular operational monitoring conducted by the Ministry of Innovations and Development[87].

5. Sources for PEP2040 financing

Financial framework of PEP2040 is based on parts and sections of the state budgets, expenditures of entities of government and local government institutions, a budget of European funds (PEP2040 is a part of priorities of the European cohesion policy, so a substantial part of expenditures can be co-financed from European funds, with the nearest perspective covering years of 2021–2027), and other foreign funds. A significant part of the expenditures will be covered by funds of companies from the fuel and energy sector, private funds or by loans. The pool of sources should also list support systems, indirectly covered by energy recipients.

The table below lists sources of financing that will contribute to PEP implementation, but this **is not an exhaustive catalogue of sources of financing.** A horizon for expenditure of these funds is shorter that the PEP2040 perspective, but at the same time new instruments are created, which can be used to implement this policy. Directions and tasks of PEP2040 should also be one of determinants of financial assembling of new programs and funds, and of reserving funds for their implementation. It should also be noted that in many cases PEP2040 indicates problems for which the solutions are currently unknown or their details have not been specified precisely, and sources of their financing will be a part of these solutions.

It should be noted that implementation of development services must ensure **maintaining of macroeconomic stability**, especially the sector of public finances. The conducted budget policy must take into account limitations associated with current financial rules and striving to gradually achieve the medium term budget target, which implementation will ensure entering a path towards a stable balance of the public debt. This implies a need for effective stimulation of **investments of the private sector** (from domestic and foreign funds) and further increase in effectiveness of development expenditures of the public sector. The use of EU funds should focus on projects ensuring the highest added value and positive external effects. It is assumed that in coming years actions related to implementation of SOR will lead to **mobilization of the private capital** (domestic and foreign), and this will increase its investment activity. As stability of public finances must be ensured, **it is the private capital which will play a crucial role in achievement of the planned investment rate in the economy.**

Actions undertaken by the **public sector** (both **investment and regulatory**) support improvement in “boundary conditions” determining the economic rationality and profitability of operations of entities from the private sector. A robust development of the private sector translates into the increase in its income and profits, with simultaneous increase in the remuneration of the labor factor, and this will lead to the **increase in the budget revenues.** This will contribute **to the increase in revenues of the government and local government institutions, providing means to finance tasks resulting from the state functions.**

The macroeconomic condition of the Polish economy in the coming several years should be favorable for this approach. Forecasts of national institutions, as well as renowned international centers indicate that the **relatively high** economic growth rate **may be maintained** (although it will be lower than the rate noted in 2017–2018 and forecast for 2019–2024). According to long-term forecasts of the Ministry of Finances,[88] in 2025–2030 the growth rate in real terms will range from 3% in 2025 to 2.7% in 2030, and this will translate into the average annual growth rate at a level of 2.8% for this period. **With the economic growth, the income of the public finances sector will also rise, and this should enable financing of development activities in that part of their execution for which the use of public funds is planned.**

[87] Monitoring of projects is executed using the tool MonAliZa. The system ensures uniform monitoring for projects under all integrated strategies, taking into account a specific nature of an organization, a scope of a project, and good practices and recommended standards. Appointed project leaders provide data required as an input for the MonAliZa system, and use it to present risks and achieved results.

[88] *Guidelines for use of uniform macroeconomic indicators forming a basis for evaluation of financial consequences of planned Acts*.

Works on **taxonomy**, conducted in the EU**, i.e., on a uniform EU system for classification which is to involve the private capital in financing of low-emission transformation,** should also be noted. Harmonized criteria will be implemented, assisting in determining whether a given economic activity is environmentally sustainable. This taxonomy will apply to finance products including sustainability criteria in their investment strategies.

Probably, the costs of financing with the private capital of activities that are not perceived as sustainable will be higher than in the case of economic activity perceived as sustainable - and this means it will be difficult to finance with commercial loans.

LIST OF THE POSSIBLE SOURCES FOR FINANCING OF PEP2040 - DOMESTIC AND FOREIGN FUNDS[89]

name/type	area of financing	amount of funds	horizon	additional information
State budget - parts 47 and 48	mining and quarrying industrial processing public administration expenditures of entities from the government and self-government agencies sector	PLN 10,684.28 million	2021-2025	The horizon results from the methodology for planning of the State budget in a long-term perspective
State Aid SA.46891 (2017/N) – Poland – Bituminous coal mining restructuring in 2015–2023	assistance to cover extraordinary costs resulting from final closing of mining units	PLN 12,671.64 million	2015-2023	State aid for the bituminous coal mining sector to cover extraordinary costs is provided in form of: subsidies, exemption from obligatory fees and fines, exemption from payments to PFRON and payments and penalties to NFEP&WM and PGWWP; exemption from the tax on civil law transactions (TCL); exemption from the corporate income tax (CIT); exemption from payments from profit; exemption from an obligation to obtain a license for methane mining The following entities are responsible for providing aid: - Minister of Energy - The National Fund for Environmental Protection and Water Management (NFEP&WM); - State Fund for the Rehabilitation of Disabled People (PFRON); - National Water Management Board. - 1st Silesian Tax Office in Sosnowiec. - Minister of Environment - National Water Management Board
NFEP&WM funds including: a) *Energia Plus* b) *Ciepłownictwo Powiatowe – pilotaż* c) *Agroenergia* d) *Polska Geotermia Plus*	actions improving energy efficiency low-emission energy sources, including renewable energy sources and high-performance co-generation district heating	*a) PLN 4 000 million* *b) PLN 500 million* *c) PLN 200 million* *d) PLN 600 million*	2019-2025	Details concerning sources of funding for NFEP&WM and offers are available at: https://nfosigw.gov.pl/o-nfosigw/o-nas/ http://nfosigw.gov.pl/oferta-finansowania/

[89] This list is not an exhaustible catalogue of sources of PEP2040 financing, and was developed on a basis of information available as of a middle of 2019.
When "-", the amount or the horizon is difficult to specify.

name/type	area of financing	amount of funds	horizon	additional information
e) Drive *f) Co-financing of projects financed under Axis 1 Operational Programme Infrastructure and Environment 2014–2020* *g) "Clean air" program*	environmental education other green investments improvement in air quality low-emission transport	*e) PLN 1,000 million* *f) PLN 2,000 million* *g) PLN 1,003 million*		* The Program Mój Prąd financed by the climate account, the funds come from ETS, and NFEP&WM acts as a National Operator of Green Investments System
Thermal Modernizations and Refurbishment Fund	thermal modernization projects	–	since 1999	The fund financed by the State budget In 1999–2018 PLN 2,575 million was transferred to the Fund, further amounts are difficult to specify https://www.bgk.pl/samorzady/fundusze-i-programy/fundusz-termomodernizacji-i-remontow/
Low-emission Transport Fund (FNT)	development of electromobility and transport based on alternate fuels, including CNG, LNG, biocomponents (including for purchases of fleet, loading infrastructure, public transport, promotional and educational activities)	PLN 6,700 million	2021-2025	FNT income includes: – special subsidies from the State budget, – funds transferred by TSOs, – income from substitution fee, – income from emission fee, The Minister of Energy is an operator of this Fund, and its management was entrusted to NFEP&WM. https://www.gov.pl/web/energia/fundusz-niskoemisyjnego-transportu
Support system of "white certificates"	improvement in energy efficiency of companies	–	2030	Possible prolonging of the horizon
RES support systems: "green certificates"*, auctions for purchase of green energy generated from RES, FiT and FiP tariffs	development of renewable energy sources	PLN 40,000 million*	2040	*In accordance with the EC decision concerning a notification of the RES support system the auction mechanism should not exceed the amount specified for 2040. FiT and FiP tariffs supplement the auction system, therefore, the specified amount includes their cost. The amount of funds for certificates is difficult to estimate due to market conditions
Support system - power market	ensuring the investment stimulus for stable and secure energy supplies	ca. PLN 4,000 million (per annum)	2020*-2042	Costs of the mechanism will be included in electricity bills. *In force from 3Q of 2020, therefore this year the cost will be lower

name/type	area of financing	amount of funds	horizon	additional information
Support system for high-performance co-generation	development of high-performance co-generation	PLN 36,300 million	2019-2047	Costs of the mechanism will be included in electricity bills.
National Centre for Research and Development funds research projects	research and development, early implementation of innovative solutions	–	–	Domestic funds, EU funds, and other funds available under international programs
EU funds - operational programmes under the financial perspective 2014–2020	a) RES b) energy efficiency of buildings c) energy efficiency in companies d) heating grids e) high-performance co-generation f) power generation infrastructure g) gas infrastructure	a) EUR 150.00 million b) EUR 486.54 million c) EUR 78.11 million d) EUR 559.20 million e) EUR 200.88 million f) EUR 573.67 million g) EUR 750.00 million	2014-2020	Funds currently being used, implementation of projects to execute PEP2040 even until 2023/ http://www.funduszeeuropejskie.gov.pl/ https://www.gov.pl/web/energia/co-robimy-fundusze-europejskie
EU funds - operational programmes under the financial perspective 2021-2027	a) RES b) energy efficiency of buildings c) energy efficiency in companies d) heating grids e) high-performance co-generation f) power generation infrastructure g) gas infrastructure	Estimated to be above EUR 6,000 million (possibly ca. EUR 3,000–4,000 million in national programs and similar allocation to Regional Operational Programmes)	2021-2027	Funds at the stage of financial assembling - the total framework of funds and allocation to individual programs are unknown
EU funds -Connecting Europe Facility (CEF)	construction and modernization of the energy infrastructure, smart power grids, CCS (including Projects of Common Interest, PCI)	EUR 4,700 million* PLN 40.00 million	2014-2020 2021-2025	*The amount to 2020 represents the total budget of the facility, allocated to non-reimbursable subsidies. The amount from 2021 is included in the State budget. http://www.funduszeeuropejskie.gov.pl/strony/o-funduszach/zasady-dzialania-funduszy/program-

name/type	area of financing	amount of funds	horizon	additional information
				laczac-europe/informacje-o-cef/
EU funds - Fair Transformation Fund as a part of the "Green Deal for Europe"	transformation of mining regions	EUR 5,800 million	2021-2027	Funds during financial assembling. The specified amount is an estimate from the 1st half of 2019.
Modernization Fund	modernization of the energy sector	ca. EUR 2,000–4,800 million	2021-2030	The fund will be financed from auctions of 2% of all emission licenses under the EU ETS system. The amount of funds will depend on license prices. The Fund will be available to EU states in which GDP per capita is below 60% of the EU average, including Poland. Projects concerning generation of energy using solid fuels will be excluded, apart from district heating in Bulgaria and Romania.
InvestEU	low-emission infrastructure, R&D, MŚP, development of competencies	Estimated at a level above EUR 6,000–7,000 million (difficult to estimate allocation for the energy sector)	2021-2027	As a part of the current *Investment Plan for Europe* (Juncker Plan), investments in Poland were allocated over EUR 3.7 billion for execution of investments worth nearly EUR 18.6 billion.
Horizon Europe	research and development	–	2021-27	Successor of programme Horizon 2020
LIFE programme	environmental and climate protection	ca. EUR 5,000 million	2021-27	Continuation of the program started in 1992.
The program supporting structural reforms	support of national institutions (ministries, central bodies, and local governments) in implementation of structural reforms	EUR 222.8 million*	2014-2020	*This amount represents a total (for all EU Member States) budget of the tool; execution of projects supports PEP2040 implementation
Norwegian Financial Mechanism, EEA Financial Mechanism	high-performance co-generation, modernization of grids and sources in heating system, improved energy efficiency at schools, geothermal, small hydro power generation, projects concerning manufacturing of pellet	PLN 862.35 million	2021-2025	The amount specified in the state budget can be increased by co-financing using the funds from NFEP&WM. A mechanism covering a wider scope than the *energy* area
World Bank funds	in particular, anti-smog operations and improved energy efficiency	–	–	Programs and mechanisms are developed on a regular basis, as a response to observed needs

6. Abstract

Polityka energetyczna Polski do 2040 r. – *strategia rozwoju sektora paliwowo-energetycznego* (Energy Policy for Poland until 2040 - a strategy for development of fuel and energy sector) (PEP2040) is a response to the most important challenges to be faced by the Polish energy sector in the coming decades and established directions for development of the energy sector, taking into account tasks that need to be executed on a short-term basis.

At the same time, PEP2040 is one of nine integrated sector strategies resulting from the *Strategy for Responsible Development*. *The national plan for energy and climate for 2021–2030* will be consistent with *The Energy Policy of Poland until 2040.*

PEP2040 contains **description of a situation and conditions** of the power generation sector, **the target for the energy policy**. Then **eight directions** of the policy were indicated together with **activities** necessary for their execution, as well as **strategic projects** and **sources for financing**.

The directions cover the entire energy supply chain - from obtaining of materials, through generation and supply of energy (transmission and distribution), up to methods of its use. Each of eight directions of PEP2040 contributes to executions of three components of the PEP2040 objective.

The PEP2040 horizon spans 20 years, but to ensure realistic execution, a significant part of the actions is planned for several or even several dozen years. They are of executive nature and can undergo dynamic changes due to changing environment.

The following documents are attached hereto (1) the assessment of implementation of the previous energy policy for Poland (2) conclusions from prognostics analyses, and (3) strategic environmental impact assessment for PEP2040.

Aim and indicators for the energy policy for Poland

The aim of the energy policy for Poland is **energy security**[90], while ensuring **competitiveness of the economy**[91], energy efficiency, and **reduction in the environmental impact of the energy sector**, and with the optimal use of own energy resources.

The following indices were assumed as a global measure for implementation of the PEP2040 objective:

- ✓ 56-60% of coal share in the electricity generation in 2030;
- ✓ 21–23%[92] of RES in the gross final energy consumption in 2030.
- ✓ implementation of nuclear power in 2033;
- ✓ improvement in energy efficiency by 23% until 2030 versus forecasts from 2007;
- ✓ reduction in CO_2 emissions by 30% until 2030 (versus 1990)

Directions of PEP2040

Direction 1. Optimal use of own energy resources.

Poland is able to cover its demand for coal and biomass, but our sources are insufficient to cover demand for natural gas and petroleum. Taking into account the finite nature of resources, as well as economic and environmental aspects, reasonable use of raw materials is of crucial importance here.

Demand for **bituminous coal** will be covered by own resources, and the import-export relation will be of supplementary nature. To enable this, first of all we must ensure profitability of the sector and reasonable extraction, use and distribution of the material. An important element is implementation of innovations in coal mining and use, to improve competitiveness of

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[90] As per the *Energy law,* the energy security means the current and the future covering of demand of customers for fuels and energy in a way that is technically and economically justified, while respecting the environmental protection requirements. This means ensuring security of current and future supplies of materials, and of generation, transmission and distribution.

[91] The cost of energy is hidden in each action and product manufactured in the economy, thus the energy prices are reflected in competitiveness of the entire economy.

[92] The achievement of a higher level, i.e., 23% share of RES in energy consumption, will require additional support as a part of *fair transformation,* as the Polish economy will not be able to perform this independent change on its own.

Polish coal versus the imported one, and versus other fuels, as well as to limit their negative environmental impact. For social and economic reasons, post-mining areas will be restructured, mainly for industrial purposes.

A demand for **lignite** will be covered by domestic resources, at a small distance from a place of its use. **Mining of open deposits and management of potential deposits will be completed.** Złoczew and Ościsłowo deposits are considered as potential ones, while Gubin is treated as a reserve deposit. The main role in management of new potential deposits will be played by prices of CO2 emission allowances and development of new technologies. Development of innovative methods for the use of the material (e.g., gasification or the use outside the energy sector) will be of significance for exploration of new deposits, due to high emission character of this material, which may lead to reduced possibilities of its use in the power generation sector, as well as to its lower competitiveness, because of costs of the EU climate and energy policy imposed on it.

A demand for **natural gas and petroleum** will be mainly covered by imported material, where activities aiming at real diversification of directions and sources of supply will be executed. Simultaneously, exploration of new deposits in Poland will be continued (also using unconventional methods), which will replace supply from depleted deposits. A part of the demand for petroleum will be reduced by an increase in importance of biofuels and alternate fuels (including electricity, LNG, CNG, hydrogen).

Demand for **renewable materials (biomass)** will be covered at the shortest possible distance from a location of its generation. Actions will focus on increasing the role of waste biomass, to prevent its competing with the use of agricultural crops for food purposes. Potential accumulated in waste other than agricultural should also be used.

PEP2040 STRATEGIC PROJECT for direction 1: *Transformation of mining regions*

Direction 2. Expansion of electricity generating and grid infrastructure

A power balance must ensure stable energy supply and flexible grid operation, as well as implementation of international obligations. It also must respond to changes in the energy market and to global trends. At the same time, only an efficient and sufficiently expanded infrastructure will ensure security of energy supply.

Poland will strive **to cover its demand for power with own resources**. The domestic coal deposits will remain the main component of the energy security of Poland and a foundation of the national energy balance, but the increase in demand will be covered by sources other than conventional coal-based capacities. **Coal use** by the energy sector will remain at a stable level, but the coal share in energy consumption structure will decrease (to ca. 56%–60% in 2030). Due to a contribution to an overall EU target RES share in final energy consumption, the role of **renewable sources** will gain in importance - their level in the domestic electricity consumption may amount to ca. 32%. Implementation of this objective will mainly be possible due to development of photovoltaics (from 2022) and offshore wind farms (after 2025), which have the greatest perspectives for development due to economic and technical conditions. To achieve such level of RES in the balance, development of **energy storage technologies** and expansion of **gas-fired units** as control capacities are necessary. To **reduce emissions of** pollutants from the energy sector, generating units of low efficiency will be modernized and/or withdrawn from the use, and gradually replaced with powers of higher efficiency (including co-generation). The main tool for reduction in emissions will be implementation of **nuclear power** in 2033 - by 2043, 6 nuclear blocks of total capacity of 6–9 GW will be created.

Expansion of the grid infrastructure will be ensured by **expansion of a domestic transmission grid** as a part of implementation of seven investment programs, which will also contribute to improvement in flow at cross-border connections. A quality of supplies to final recipients not only depends on the grid density, but also on cables installation in medium voltage grids. Poland will strive to achieve the average EU levels for indicators for duration and frequency of interruptions in energy supply. To improve effectiveness of operation in emergency situations, a digital system for communication between operators of the distribution systems will be implemented, and their infrastructure will be equipped with control devices. Furthermore, **smart power supply grids** will be implemented, to integrate behaviors and actions of all entities and users connected to it.

PEP2040 STRATEGIC PROJECT for direction 2: *A. Power market, B. Implementation of smart power grids*

Direction 3. Diversification of gas and petroleum deliveries and expansion of the grid infrastructure

The strong Poland's dependence on **natural gas** supplies from one direction requires diversification activities. For this purpose, the **Baltic Pipe** (a connection between Norway-Denmark-Poland) will be constructed, the LNG terminal in Świnoujście will be expanded, and a floating storage unit (FSRU) will be constructed in the Gulf of Gdańsk. Connections with the neighboring countries will also be expanded. To use possibilities for import natural gas and to eliminate *white spaces*, the national transmission and distribution grid (including the use of LNG regasification stations and biogas), and the storage infrastructure will be expanded.

Poland is dependent on **petroleum** supplies to even higher extent, therefore, it is necessary to ensure conditions for petroleum reception and an efficiently operating internal infrastructure. Possibilities for deliveries by marine transport will be expanded, by expansion of the Pomeranian pipeline, and of storage bases for petroleum and liquid fuels. Deliveries of petroleum products depend on a sufficiently developed network of pipelines, particularly, in the southern part of Poland.

PEP2040 STRATEGIC PROJECTS for direction 3: ***A.*** *Construction of Baltic Pipe,* ***B.*** *Construction of the second line of the Pomeranian pipeline*

Direction 4. Development of energy markets

The electricity market is transformed due to changes in its environment, i.e., building of a uniform EU energy market or consumers' desire to participate in this market. Strengthening of the consumer position is necessary for development of the electricity market. This means that the information policy must be improved, customers must be allowed to participate in markets, aggregation services need to be promoted, and general distribution agreements must be put in order. To protect competitiveness of Polish energy-intensive companies, mechanisms reducing too high loads will also address this group. Taking into account consequences of variability in a daily power demand, actions aiming at flattening of the daily power demand curve will be conducted. It is also necessary to transform systemic services into market oriented ones and improve competitiveness of distribution companies to ensure local balancing. An option to make transmission capacities available should also be increased.

The natural gas market requires finalization of its deregulation, meaning a release from a tariff obligation of the last group of customers, i.e., households. Another component focuses on strengthening Poland's position in the European gas market, and this will be mainly achieved by creation of a regional center for gas transmission and trade, and for this purpose, further development of a service and trade sphere is necessary. Market development can also be achieved through penetration to new sectors -from improved gas grid coverage in Poland to the use of this material in RES reserve units.

Petroleum products market is relatively stable, although it will be transformed in successive years. An ownership structure of fuel market sectors must be clarified, so the refining companies focus on fuel production and trade, and the State controls infrastructure that is crucial for fuel security. The market must respond to the increased use of petrochemicals in the economy (from 3D printers to construction industry), therefore, production capacities in areas of olefins, phenol and aromas will be increased. At the same time, a part of demand for petroleum products will be covered by an increased use of biocomponents (14% share in fuel consumption in transport in 2030), alternate fuels (LNG, CNG, hydrogen, and synthetic fuels), and **development of electromobility** (1 million electric vehicles in 2025).

PEP2040 STRATEGIC PROJECTS for direction 4: ***A***. *Preparing and implementation of an action plan to increase cross-border transmission capacities for electricity,* ***B.*** *A regional gas transmission and trade center, C. Development of electromobility*

Direction 5. Implementation of nuclear power

The first nuclear unit (of a capacity of ca. 1–1.5 GW) will be started in 2033, and further five, of a total capacity of 5–7.5 W, successively every 2–3 years. These dates result from a foreseen decrease in capacities in KSE, which is also associated with an increased demand for electricity. Nuclear power plants ensure **stable energy generation with zero emissions of pollutants to the air.** At the same time, **diversification of an energy generation structure at a rational cost** is possible. Currently used technologies (of 3rd and 3rd+ generation) and strict global standards for nuclear security ensure **safe operation of the nuclear energy** and waste landfilling. A significant part of the nuclear project can be implemented with participation of Polish companies.

Implementation of nuclear power requires previous changes in the legislation, to facilitate execution of this project and complete works on a model of its financing. When tests are completed, a location for the first block (Żarnowiec or Kopalino) will be finally decided, and then successive locations will be selected and a new landfill for low and medium activity waste will be started. Furthermore, a technology and a general contractor for construction works will be selected. Technical support for the nuclear regulatory authority will be ensured.

PEP2040 STRATEGIC PROJECT for direction 5: *Update and implementation of the Polish Nuclear Power Program*

Direction 6. Development of renewable energy sources

An increase in the role of renewable energy sources results from a need to diversify the energy balance, a need to contribute to the general EU target of 32% share of RES in the final energy consumption, as well as from a global trend to use this energy due to decreasing technological costs. Poland declares that it will achieve **21–23% share of RES in the final energy consumption** in 2030 (*in power generation* - possible increase in the share to 32%, *in heating and cooling* - 1.1 percentage point increase YoY in the share, and 14% in *transport*). A significant part of RES generation capacities is installed in sources dependent on weather conditions, and this negatively impacts KSE operations. However, at the same time these sources ensue the best unit cost effectiveness. Taking into account the expected technological development, a particular role in implementation of the RES target will be played by **offshore wind farms** (relatively large use of capacities) and **photovoltaics**, the work of which is correlated with summer peak demand for electricity.

A number of **prosumers** of renewable energy will also increase and **energy clusters and energy cooperatives** will develop. The individual use of RES should be accompanied by energy storage facilities, so the prosumer minimalizes its uptake from and bringing of surplus generated energy to the grid, while balancing in the clusters will facilitate combination of different technologies. Due to the **support mechanisms**, solutions ensuring maximum availability, with a relatively low energy generation costs and covering local energy demands will have a privileged position.

PEP2040 STRATEGIC PROJECT for direction 6: *Development of offshore wind energy*

Direction 7. Development of heating and co-generation

Heat demands are covered at a local level, therefore, it is extremely important to ensure **energy planning at commune** and regional levels - this is crucial for reasonable energy management, as well as for reduction in emissions accompanying generation of heat. A start-up of the Heatmap of Poland will also be a useful tool, facilitating planning for covering heat demands.

The aim is to expand and improve efficiency of heating, and in particular, to construct new and transform existing systems in **energy efficient heating systems. It is expected that in 2030 at least 85% of heating or cooling systems in which ordered power exceeds 5 MW, will meet criteria for energy effective heating system.** A technical **expansion of the district heating** is crucial, and it will be supported by development of co-generation, connection of power plants to the heating system, increased use of RES and waste in the district heating, modernization and expansion of systems for heat and cold distribution, and promotion of heat storage facilities and smart grids.

In the areas, where technical conditions for heat supply from energy efficient heating system exist, **customers should first use the district heating,** unless they use more environmentally friendly solution. This obligation should be consistently enforced. At the same time, a new model will be developed for this market, so the heat prices are acceptable for customers, but at the same time cover reasonable costs with return on capital employed.

Sources of the lowest possible emission levels (gas, non-combustible RES, heat pumps, electric heating, and low-emission solid fuels) should be used to cover **heat demands in individual way**, gradually departing from solid fuels. At the same time, monitoring of emissions from detached houses should be increased and consequences should be imposed against those responsible for pollution.

PEP2040 STRATEGIC PROJECT for direction 7: *Development of district heating*

Direction 8. Improved energy efficiency

Actions focusing on efficiency lead to a reduced energy consumption and lower costs of energy. They are also associated with implementation of new technologies and an increase in effectiveness of the economy, influencing its attractiveness and competitiveness. The general EU target for 2030 is 32.5%, and Poland declares **23% primary energy savings** versus forecasts from 2007. A potential for improvement in energy efficiency is available almost in the entire economy, but not every project targeting improved energy efficiency is reasonable, therefore, the savings should be referred to expenditures.

An increase in the economy effectiveness will be created by obliging groups of entities to improve their energy efficiency or to purchase energy performance certificates, but also by using legal and financial measures to encourage actions promoting efficiency. An improvement of awareness of reasonable energy consumption is also of enormous importance.

Ineffective use of energy is strongly related to a problem of **low emission** (burning of low-quality coal and waste at households; incorrect operation of systems, burning of coal at local low-performance thermal power plants; and transport emissions). A general thermal modernization of residential buildings and ensuring effective and environmentally friendly access to heat is the main tool in a fight against this problem, and it will also influence a reduction of **energy poverty.** Reduction in emissions from transport will also be influenced by implementation of electromobility and a number of actions planned for development of a market for alternate fuels.

PEP2040 STRATEGIC PROJECT for direction 8: *Promotion of improvement in energy efficiency*

7. Reference documents

Non-legislation documents

energy efficiency –	*The national Action Plan for energy efficiency of Poland, 2017*, 2017 *The national plan to increase a number of buildings with low energy consumption,* 2015.
electromobility and alternate fuels –	*Plan for development of electromobility*, 2017. *National frameworks for a policy for development of an infrastructure for alternate fuels,* ME, 2017.
emissions of pollutants –	*Ecological policy of Poland, 2030 - a development strategy in the area of the environment and water management*
nuclear power –	*The national plan for handling of radioactive waste and spent nuclear fuel,* 2015 *Polish Nuclear Power Program,* 2014
electricity –	*The Ten-Year Community Network Development Plan*, ENTSO-G 2016. *The development plan for covering current and future demand for electricity for 2018–2027,* PSE 2018 *The quality regulation for 2018–2025 for Distribution System Operators (who separated their operations as of July 1, 2007)*, URE 2018.
natural gas –	*Ten-Year Network Development Plan (TYNDP),* ENTSO-G 2017. *Domestic Ten-Year Plan for Development of the Transmission System 2018–2027* GAZ-SYSTEM S.A. 2017 *Baltic Energy Market Interconnection Plan* (BEMIP), 2009, updated in 2015.
renewable energy sources –	*National Action Plan for energy from renewable sources until 2020*, 2010.
waste, waste incinerators –	*National waste management plan 2022*, 2016.
petroleum and petroleum fuels –	Polityka Rządu RP dla infrastruktury logistycznej w sektorze naftowym (The Policy of the Polish Government for the logistic infrastructure in the oil sector) 2017.
raw materials –	*Materials Policy for Poland*, 2019 (draft)
bituminous coal and lignite –	*The program for bituminous coal mining sector in Poland (2030 perspective)*, 2018. *The program for lignite mining sector in Poland (2030 perspective)*, 2018.
strategies resulting from the country development management system –	*The strategy for Responsible Development until 2020 (with a perspective until 2030)* and integrated strategies (excluding PEP2040) *(1) Environmental policy for Poland, 2030, (2) Sustainable development strategy for rural areas, agriculture and fishing, 2030, (3) Sustainable development strategy for transport until 2030, (4) Productivity strategy, (5) National regional development strategy, (6) "Efficient and modern country" strategy, (7) Social capital development strategy, (8) Human capital development strategy*

National acts of the greatest importance for the energy sector

The Energy Law of 10 April 1997 (Journal of Laws of 2019, item 755).

The Nuclear Law of 29 November 2000 (Journal of Laws of 2018, item 792).

The Environmental Protection Law of 27 April 2001 (Journal of Laws of 2001, No. 62, item 627, as amended).

The Act on biocomponents and liquid biofuels, of 25 August 2006 (Journal of Laws of 2006, No. 169, item 1199)

The Act concerning rules for conducting a development policy, of 6 December 2006 (Journal of Laws of 2006, No. 227, item 1658, as amended).

The Act on reserves of petroleum, petroleum products, and natural gas, and rules for proceeding in situations of a threat to fuel security of Poland and disruptions in the oil market, of 16 February 2007 (Journal of Laws of 2018, item 1323, as amended)

The Crisis Management Act of 26 April 2007 (Journal of Laws of 2007, No. 89, item 590)

The Act on communicating information about the environment and its protection, society share in environmental protection and environmental impact assessments, of 3 October 2008 (Journal of Laws of 2008, No. 199, item 1227_

The Geological and Mining Law of 9 June 2011 (Journal of Laws of 2011, No. 163, item 981)

The Act on preparing and execution of investments in nuclear power facilities with accompanying investments, of 29 June 2011 (Journal of Laws of 2018, item 1537).

The Waste Act of 14 December 2012 (Journal of Laws of 2019, item 701).

The Renewable Energy Sources Act of 20 February 2015 (Journal Laws of 2018, item 2389, as amended)

The Act on Electromobility and Alternate Fuels, of 11 January 2018 (Journal Laws of 2018, item 317).

The National Cybersecurity System Act of 5 July 2018 (Journal of Laws of 2018, item 1560).

EU Regulations

directive concerning the natural gas market – Directive (EC) 2009/73 of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive (EC) 2003/55 (OJ L 211/94)

IED Directive – Directive (EU) 2010/75 of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (OJ L 334/17)

MCP Directive – Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 concerning the limitation of emissions of certain pollutants into the air from medium combustion plants (OJ L 313/1)

NIS Directive – Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union (cybersecurity) (OJ L 194/1)

Energy Efficiency Directive/EED – Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive (EU) 2012/27 on energy efficiency (OJ UEL 328/210) [from package "Clean energy for all Europeans"]

Energy Performance of Buildings Directive – Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive (EU) 2010/31 on the energy performance of buildings and Directive (EU) 2012/27 on energy efficiency (OJ L 156/75) [from package "Clean energy for all Europeans"]

Reserves Directive – Council Directive (EC) 2009/119 of 14 September 2009 imposing an obligation on Member States to maintain minimum stocks of crude oil and/or petroleum products

RES Directive/RED II Directive – Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (transformed version) (OJ L 328/82) [from package "Clean energy for all Europeans"]

market directive/directive on common rules for the internal market for electricity - Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive (EU) 2012/27 [from package "Clean energy for all Europeans"]

MCP Directive – Directive (EU) 715/2009 of the European Parliament and of the Council of 13 July 2009 concerning the limitation of emissions of certain pollutants into the air from medium combustion plants (OJ L 211/36)

ESR regulation - Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013 (O L 156/26)

energy union management regulation / *governance* regulation– Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council [from package "Clean energy for all Europeans"]

market regulation/regulation on the internal market for electricity – Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (OJ L 158/54) [from package "Clean energy for all Europeans"]

SOS regulation – Regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010 (OJ L 280/1)

regulation on The Agency for the Cooperation of Energy Regulators (ACER) – Regulation (EU) 2019/942 of the European Parliament and of the Council of 5 June 2019 establishing a European Union Agency for the Cooperation of Energy Regulators (OJ L 158/22) [from package "Clean energy for all Europeans"]

regulation on readiness for a risk in the power generation system – Regulation (EU) 2019/941 of the European Parliament and of the Council of 5 June 2019 on risk-preparedness in the electricity sector and repealing Directive 2005/89/EC (OJ L 158/1) [from package "Clean energy for all Europeans"]

List of Abbreviations

BAT – best available techniques
CNG – compressed natural gas
DSR – demand side response
NP – nuclear power plant, nuclear power
ENTSO-E – . *European Network of Transmission System Operators for Electricity*
ENTSO-G – . *European Network of Transmission System Operators for Gas*
EU ETS – . *European Union Emissions Trading System*
FBA – flow-based allocation, a method for determining and allocating cross-border transmission capacities on a basis of physical electricity flow
FSRU – floating storage regasification unit
FTN – Low-emission Transport Fund
GUD – general distribution agreements
GUS – Central Statistical Office
HTR – high temperature reactor
ICT – information and communication technology
IOŚ – Institute of Environmental Protection
JWCD – centrally dispatched (by TSO) generating units
KSE – national power generation system
LNG – liquefied natural gas
ME – minister competent for energy
MI – minister competent for infrastructure
MIiR – minister competent for investments and development
MRPiPS – minister competent for social policy
MSWiA – minister competent for interior and administration
MŚ – minister competent for environment
NIT – National Indicative Target (concerns RES share in transport)
LV – Low-voltage power supply lines
EMIO – energy markets information operator
DESe – electricity distribution system operators
DESg – gas distribution system operators
TSOe – an electricity transmission system operator – Polskie Sieci Elektroenergetyczne S.A. (PSE S.A.)
TSOg – a gas transmission system operator Operator Gazociągów Przesyłowych GAZ-SYSTEM S.A.
RES – renewable energy sources
PMG – underground gas storage facilities
PPEJ – *Polish Nuclear Power Program*
PRMCzP – Representative of the Prime Minister for the “Clean Air” program
PRSIE – Government Representative for Strategic Energy Infrastructure
SAIDI – . *System Average Interruption Duration Index*
SAIFI – . *System Average Interruption Frequency Index*
MV – Medium-voltage power supply lines
SOR – *Strategia na rzecz Odpowiedzialnego Rozwoju (Strategy for Responsible Development)*
EU – European Union
URE – Energy Regulatory Office