D.T2.4.7

Mazovian Energy Action Plan Version n°2: 10/2021

D.T2.4.7:Mazovian Energy Action Plan

A.T2.4 Regional Energy Action Plan definition

Partners involved

PP 3 - MAE

Interreg CENTRAL EUROPE

Priority:	2. Cooperating on low-carbon strategies in CENTRAL EUROPE
Specific objective:	2.2 To improve territorial based low-carbon energy planning strategies and policies supporting climate change mitigation
Acronym:	**PROSPECT2030**
Title:	**PROmoting regional Sustainable Policies on Energy and Climate change mitigation Towards 2030**
Index number:	CE1373
Lead Partner:	Piemonte Region
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Table of Contents

1. EXECUTIVE SUMMARY

The document presented below has been prepared in accordance with and after an analysis of the available EU and national strategic documents, as well as after a thorough analysis of the structure and needs of the Mazovian Voivodeship. It is a proposal of actions concerning, inter alia, conducting the energy policy of the region in order to achieve real energy results and the required reduction of greenhouse gas emissions. When creating the document, data from the regional energy profile and tools provided by the package leader were used to determine energy indicators.

The goal of the Regional Energy Action Plans is to be the starting point that will drive Mazovia region to the transition towards low carbon economy. The innovative concept and process behind Energy Action Plans implementation, leading to energy planning strategies using public funds in a more effective way, will be transferred to a wider decision makers audience to guarantee the durability of the project even beyond its lifetime.

2. INTRODUCTORY OVERVIEW

2.1 Status quo summary

The Mazovian Voivodeship is located in the central-eastern part of Poland. It is the largest voivodship in the country and covers an area of 35558 km^2, which accounts for 11.38% of Poland's territory. The voivodship has about 5.4 million people, which places them first in the country in terms of population. The population density is 149 people per km^2. Urban population constitutes about 64% of the total population of the voivodship. The Mazovian Voivodship consists of 37 poviats. Poviats are divided into 314 municipalities - 35 urban, 53 urban-rural and 226 rural.

Residents of Mazovian Voivodeship have very good life perspectives if compared to the status of persons from other regions in Poland. It is confirmed by figures indicating the lowest unemployment rate and relatively high level of income. The area is characteristic of high diversity of business activity, considerable financial outlays for development of science, high education level of population, high activity of residents and varied professional qualifications. Those factors affect the advantage of the Mazovian Voivodeship over other voivodeships in the country. Mazovia is one of the most economically developed regions in Poland. The region is the fastest developing region in reference to developed regions in European Union as a result of the highest participation in GDP generation of the country and high pace of growth of the economy.

In the region there is a big problem with access to regional energy data. The energy related data are available only on national level and in general view o regional level. The final energy consumption from official statistics in the Mazovia Region for 2016 is app. 22.612 GWh. The share of the regional consumption is around 7% of the total national final consumption. The amount of CO_2 emissions, based on energy consumption, was estimated to an amount of app. 268.5 Million tons per year. The national final energy consumption in Poland is characterized by a low share of renewable sources with 11% in heat and electricity, and very high share of solid fossil fuels and crude oil and petroleum products. On regional level the share of renewables is even lower with app. 5%

Mazovian Voivodeship is one of the largest electricity consumers in Poland, produced mostly from coal. Now many cities in Mazovia face huge problem of air pollution and smog. Challenges for the region is mostly reduction of contamination and investments in sustainable energy.

2.2 Current development trends

DEVELOPMENT STRATEGY FOR THE MAZOVIAN VOIVODESHIP UP TO 2030 Innovative Mazovia- the plan include objective called Environment and Energy and the goal to assure the economy of the region diversified supply into energy at sustainable farming resources the environment. The directions of activities described in the document are:

- Diversification of energy sources and its effective use
    - Development and pro-ecological modernization of installations for the production of electricity and heat in the region, including increasing the share of energy obtained from renewable sources
    - Development of energy and gas cross-border connections and analysis of the possibilities and costs of shale gas use and possible construction of a system for its extraction and transmission
    - Increasing energy efficiency
- Supporting the development of the ecological industry and eco-innovation
    - Creating organizational and financial conditions for knowledge transfer and eco-innovation
    - Stimulating the development of the ecological industry by creating economic and organizational support mechanisms
- Ensuring permanent and sustainable development and preserving the high values of the environment
    - Conducting monitoring of environmental pollution
    - Spreading environmental awareness
- Modernization and expansion of local energy networks and improvement of transmission infrastructure
    - Improving local energy security through the modernization and expansion of local distribution networks
    - Expansion and modernization of the power transmission system, including adaptation to receive energy from distributed sources
    - Development and modernization of natural gas and liquid fuels transmission infrastructure
- Counteracting natural threats
- Improvement of water quality, waste recovery / neutralization, restoration of contaminated areas and reduction of pollutant emissions
- Production of energy from renewable sources
    - Increasing the use of renewable energy sources in rural areas
    - Improving the security of energy supply to cities through the construction and modernization of local installations for energy production, with particular emphasis on cogeneration technologies and the use of renewable energy sources

Poland's energy policy until 2040 (PEP40) sets the framework for the energy transformation in Poland. It contains strategic decisions regarding the selection of technologies for building a low-emission energy system. PEP2040 is a national contribution to the implementation of the EU climate and energy policy. The policy takes into account the scale of challenges related to the adjustment of the national economy to the EU regulatory conditions related to the 2030 climate and energy goals, the European Green Deal, the economic recovery plan after the COVID pandemic and the pursuit of climate neutrality in line with national possibilities, as a contribution to the implementation of the Agreement Parisian. PEP2040 describes the state and conditions of the energy sector.

Poland's energy policy until 2040 is divided into three pillars identified (1st pillar Just energy transition, 2nd pillar Zero-emission energy system, 3rd pillar Good air quality) , on which eight specific objectives were based:

- Optimal use of own energy resources focusing on transformation of coal regions
- Development of electricity infrastructure focusing on smart grids
- Diversification of supplies - expansion of the network infrastructure of natural gas, crude oil and liquid fuels (Baltic Pipe)
- Development of energy markets - electromobility
- Implementation of nuclear energy
- Development of RES focusing on PV and Offshore wind energy
- Development of heating and cogeneration (DHN)
- Improving energy efficiency

By implementing the specific objectives, a low-emission energy transformation will be carried out with the active role of the end-user and the involvement of the domestic industry, giving an impulse to the economy, while ensuring energy security, in an innovative, socially acceptable manner and with respect for the environment and climate.

Along with the strategy, goals and energy indicators were also indicated, e.g.:

- Till 2030 share of coal in electricity generation will not exceed 56%
- In 2030 primary energy consumption will be reduced by 23%
- By 2040, the heat needs of all households will be covered by DHS or low-emission individual sources
- By 2030, GHG emissions will be reduced by approx. 30% compared to 1990
- In 2033, 1st nuclear power plant with a capacity of app. 1-1.6 GW will be put into operation
- Share of RES in gross final energy consumption will be at least 23% in 2030
    - 32% in electricity (mainly wind and PV)
    - 28% in heating

National energy and climate plan for 2021-2030 presents the assumptions and goals as well as policies and actions for the implementation of 5 dimensions of the Energy Union:

- Energy security,
- The internal energy market,
- Energy efficiency,
- Emissivity reduction,
- Research, innovation and competitiveness.

The National Energy and Climate Plan was prepared to establish a stable framework that fosters a favorable environment for a sustainable, economically efficient and fair transition towards a low-carbon economy. This document is to enable synergy with the implementation of activities in the interrelated five dimensions of the Energy Union, taking into account the principle of "energy efficiency above all." The national plan was developed taking into account the conclusions of interministerial arrangements and public consultations, as well as conclusions of regional consultations and recommendations of the European Commission. The document was prepared on the basis of national development strategies approved at the governmental level.

The document sets the following 2030 climate and energy goals:

- 7% reduction in greenhouse gas emissions in non-ETS sectors compared to 2005 levels,
- 21-23% share of RES in gross final energy consumption (the 23% target will be possible to achieve if Poland is granted additional EU funds, including for a just transition), taking into account:
- 14% share of renewable energy in transport,
- annual increase in the share of renewable energy sources in heating and cooling by 1.1 percentage points percent annually on average.
- 23% increase in energy efficiency compared to PRIMES2007 forecasts,
- reduction of the share of coal in electricity production to 56-60%.

The strategy for sustainable transport development until 2030 is a planning document whose main goal is to increase the country's transport accessibility and improve the safety of road users and the efficiency of the transport sector by creating a coherent, sustainable, innovative and user-friendly transport system at the national, European and global level. The document also points to modern solutions that facilitate the functioning of the entire transport sector, reducing its negative impact on the environment and climate, so that it is possible to create a sustainable transport system in the country by 2030.

The document indicates the following measures necessary to achieve the main goal by 2030:

- building an integrated and interconnected transport network for a competitive economy;
- improving the organization and management of the transport system;
- changes in individual and collective mobility (including promotion of collective transport);
- improving the safety of road users and transported goods;
- reducing the negative impact of transport on the environment;
- improving the efficiency of using public funds for transport projects.

2.3 Development potentials

Renewable energy sources

Wind energy

In Poland, the conditions for the development of wind energy are moderate - the best are in northern Poland. Mazovia has favorable conditions outside its north-eastern part. Very favorable conditions are found in the north-western part of the region. Installations using wind energy are the most developed renewable energy technology, because they have obtained a relatively high economic profitability. Investing in wind farms is associated with the lowest financial risk compared to other devices using natural energy carriers, and the potential gains are the easiest to quantify. For this reason, in the coming years, we should expect an increase in the capacity installed in wind farms, despite their significant negative impact on the environment, mainly related to the emission of noise and vibrations and significant interference in the landscape.

Hydro energy

In Poland, only the potential of rivers is used, which is estimated at 23 TWh per year, of which it is technically possible to use 12.1 TWh per year, and economically viable 8.5 TWh per year. In Poland, there are unfavorable conditions for the development of the hydropower industry due to the low intensity of water flow and the predominant lowland type of terrain.. In the Mazovia Region the most favorable conditions for the construction of flow plants exist on the river Vistula. The rivers of Radom, Wkra, Prawny Law, Orzyc, Iłżanka and Liwiec enable the development of small hydropower plants. In many rivers (Wkra, Radomka) there are former water reservoirs suitable for energetic use (around 150). The energy potential of the Vistula River is still not used. Since the construction of large hydro power plants is associated with significant financial expenditures, the future development of small hydropower plants, which is characterized by relatively low investment expenditures, relatively short return period and ecological advantages can be foreseen in the future. Therefore, the forecasts do not provide for a significant development of the hydropower sector, as most of the convenient locations are used, and the rest do not show any economic potential

Solar energy

The conditions for the development of solar energy in Poland are moderate due to the specificity of the climate characteristic for this latitude. On average, energy in the range of 950-1100 kWh / m2 reaches Poland during the year. About 80% of this value is generated during the six spring and summer months (from the beginning of April to the end of September).. Average annual insolation for Mazovian voivodeships range from 1400-1550 in the western part, and 1600-1650 in the east. Total solar radiation is 985 kWh / m2 in the western part of the year and 1081 kWh / m2 in the east. The general conditions of sunshine in the Mazovian voivodeship are good and therefore solar installations can be used throughout. The conditions of solar energy development are similar in the entire Mazovian Voivodeship. Large urban agglomerations are characterized by slightly worse conditions (due to increased levels of air pollution), while the use of solar energy is greater in them due to a much higher density of power and thermal energy demand. Most of the voivodeship's area is characterized by annual total radiation ranging from 1 000 - 1 050 kWh / m2. Only in the western part of the voivodeship average annual radiation exceeds 1055 kWh / m2. Further rapid development of the solar energy market in Poland is forecast for the coming years. Both international organizations make such forecasts dealing with this subject, as well as the Polish government.

Biomass

Forests in the Mazovian voivodship occupy an area of 810 thousand. ha, which constitutes about 23% of the structure of land distribution. The highest forest cover is characterized by county: Ostrołęka, Legionowo, Otwock, Przyuski and Szydłowiec (forest index of over 30%). Lowland forests occur in the poviats: Płońsk, Grójeckie, Sochaczew, Grodzisk, Pruszków and Zwoleń (less than 15%). The area of protective forests in the voivodship is 28.6% of the forest area. In 2010 from the forests was acquired 1 867.2 thousand.m3 merchantable timber, mainly from state forests. The main assortments were sawmill wood and paper wood. In recent years interest in the use of wood for energy purposes has increased again. In households - due to increasing prices of traditional fuels, in the power industry due to regulations. In Mazovian Voivodeship there are 2.38 million ha of agricultural land (67.1% of the total area). The

concept of development of agricultural land for the production of energy crops in Poland was not successful. At present, there is no emphasis on the production of plants for solid fuels.

Geotherm

80% of Poland's territory has geothermal potential. The water temperature ranges from 30–130 ° C (in some places it exceeds 200 ° C), and the thickness of the sedimentary rocks is 1–10 km. The largest resources are found in the following geothermal districts: Szczecin-Łódź, Grudziądz-Warsaw, Przedkarpackie. According to estimates, 40% of Poland's territory has technical and economic possibilities to use geothermal energy, but many of these areas are urbanized and valuable in terms of agriculture. Most of the territory of Mazovia coincides with the area designated by the Grudziądz-Warsaw geothermal district. These are areas with significant potential energy resources on a national scale. The richest deposits in Mazowsze are in the Gostyniński Lake District and in the vicinity of Żyrardów and Sochaczew. It is estimated that in these areas, at a depth of 2 km, water can reach a temperature of approx. 80 ° C. It is in this area that the geothermal heating plant is located - the Geothermal Plant in Mszczonów. The use of geothermal energy in conjunction with the gas system installed in the heating plant completely solved the problem of dust and sulfur compounds emissions in the city. As this example shows, the replacement of energy obtained from burning coal with energy from geothermal sources has a positive ecological effect. The local energy potential is used, unlimited by annual cycles and weather changes, which positively affects the security and regularity of energy supplies to end users. However, infrastructure costs are high and localization options are limited. There is also a high risk of failure, which unfortunately accompanies the exploration work. Nevertheless, there is an untapped potential of geothermal energy in Mazovia, which is expected to be used in upcoming years.

Better waste management

Mazovian voivodeship is the largest voivodeship in the country, both in terms of area and number of inhabitants. The largest number of inhabitants results in the largest amount of municipal waste collected in the country. The inhabitants of Mazovia produce about 2 mln Mg (tonnes) of municipal waste annually. Unfortunately, only a small percentage of waste is disposed of using modern thermal methods. There is also no well-developed system for controlling selective waste collection, for example with glass, paper, plastic and other waste. Because the current system operates mainly on the basis of single-municipal landfills not related by a complex system. Moreover, in Mazovia there are still wild landfill sites and some waste is still burned in domestic ovens. The current changes in the politics of the country and the region make it possible to predict that soon the region will use the waste potential more effectively

Energy retrofitting of buildings

Mazovia, especially rural areas, is characterized by a large number of residential buildings as well as public utility buildings that were built in the 20th century and do not meet the energy requirements set out in Polish legislation. The reason for this is often that all regulations specifying what the characteristics of buildings should be were introduced in the 21st century. Therefore, there are many buildings in Mazovia that do not meet these requirements. Unfortunately, the owners of households and local government units managing public utility buildings cannot afford effective energy modernization of the building due to the long-term

payback period for thermal modernization. Currently, the voivodeship authorities, in order to improve the efficiency and environmental friendliness of heating solutions in buildings, have introduced legislation to limit and prohibit the use of solid fuel heat sources in residential buildings and offer modest funding for this - but it depends only on the owner of the building. As can be seen, there is therefore a great potential in reducing energy consumption and introducing pro-ecological solutions in Mazovia, including renewable energy sources. Therefore, more effective measures should be introduced to replace heating devices and energy modernization of private and public buildings.

Sustainable transport

In 2017, a government team for electromobility was established to develop a concept for the implementation of this solution in Poland. The Member States of the European Union adopted various strategies in this respect, which were united by one common denominator - the desire to increase the number of electric vehicles on the roads. The solutions used in Europe include such mechanisms as tax incentives, operating and accounting allowances, social education and low emission zones. Unfortunately electrification process is still didn't move forward. The pilot program of direct subsidies for the purchase of electric vehicles has not brought a breakthrough in the development of electromobility. There is still huge lack in charging station and tariffs regulations

Electricity grid

Electricity production is and will be particularly burdened due to activities related to climate policy. The problem is not only energy generation, but also its distribution. In the European Union, the actual energy losses in transmission and distribution networks reach 6%, which gives us a level of around EUR 7 billion per year. In Poland, the situation is similar, average losses amount to 7-8%, but it is worth emphasizing that the best ones are able to reduce them even to 6%. In distribution networks, the percentage of losses is higher and reaches 10%. Modern energy technologies supported by information technology and communication are an excellent extension of the measures taken today to increase energy efficiency and additionally increase the reliability of the network

DHN

About 50% of Polish citizens buy heat energy from system heating companies. The production of district heat in Poland is based mainly on hard coal The remaining heat demand is met by individual or small local sources that usually are very inefficient. The development and modernization of the heating system is one of the greatest challenges of the energy transformation. District heating producers need to development more efficient, cheap and clean solutions and modernizations. Apart from the development of renewable energy sources, cogeneration is one of the technological solutions that meet the stricter environmental requirements (e.g. EU climate policy), including EU standards for gas emissions. It is part of the sustainable development policy, especially in terms of reducing air emissions, water consumption and reducing waste in the energy production process.

3. MISSION STATEMENT

Analyzing the potential of the region, as well as EU and national strategies and available forecasts of development agencies six Mazovia's mission statement components were defined

1. **Centralized energy planning**

Data on energy sector on regional level in Mazovia Region are very limited. There is a lot of data on national level but when it comes to Mazovian voivodeship data are collected only on general level there are no accurate statistics. This makes it difficult to assess the real needs of the region and to see the full picture of the current energy situation. Very large gaps exist especially in the heating sector in housing and data on individual heat sources. Collecting and systematizing this data is the first step to further energy planning

Compulsory low-carbon economy plans and plans to supply the municipality with heat, electricity and gaseous fuels are often made on a quantity basis and do not fully reflect the reality. The structures of the plans are very general and allow for wide variation. Structuring the plans by involving municipalities in the Covenant of Mayors, creating a SEAP / SECAP for them, as well as their subsequent mandatory monitoring, can help in more centralized and well detailed structures in energy planning.

Regional plan development and data systematization which will set up specific goals locally but also help with public fund distribution

There is also an issue of better waste management. Waste management reduces the effect of waste on the environment, health and quality of living. It can also help reuse or recycle resources, such as; paper, cans, glass etc. Unfortunately all responsibilities for waste management is pushed to local governments without strict national legalizations. Municipalities inundated with duties they cannot cope with and weighed down by rubbish fees that keep growing they need constant support and monitoring of the situation. Standardization and support of municipalities in the field of waste management is necessary

2. **Energy efficiency in buildings**

As mentioned above many buildings in Mazovia that do not meet EE requirements. There is therefore a great potential in reducing energy consumption and introducing pro-ecological solutions in Mazovia, including renewable energy sources. Therefore, more effective measures should be introduced to replace heating devices, implement obligatory energy monitoring, introduce RES solutions integrated in buildings and thermo modernization of private and public buildings.

3. **Renewable energy sources**

Mazovia Region has still the untapped potential of the use of renewable energy sources. Taking into account geological, climatic conditions and current development courses, the greatest potential is in wind, solar, geothermal and biomass energy, and they will play a key role in the further sustainable development of the region. Renewable Energy Sources are necessary to achieve EU targets set in the energy strategy for 2030 and achieving carbon neutrality in 2050. The power industry is based mainly on fossil fuels, and it is estimated that the reserves of coal alone can only suffice in the world for less than 100 years of its operation. The use of energy from renewable sources contributes directly to the reduction of energy consumption from fossil

sources and the reduction of pollution emissions. Given the actual level of energy consumption and future increase in demand, the RES installations development should be speed up. Regional programs gives more opportunities and more subsidies for funding new installations. Further RES development and promotion is pivotal in any local energy plans. This is crucial in private buildings, giving residents the opportunity to lower their energy bills

4. Sustainable transport – electromobility

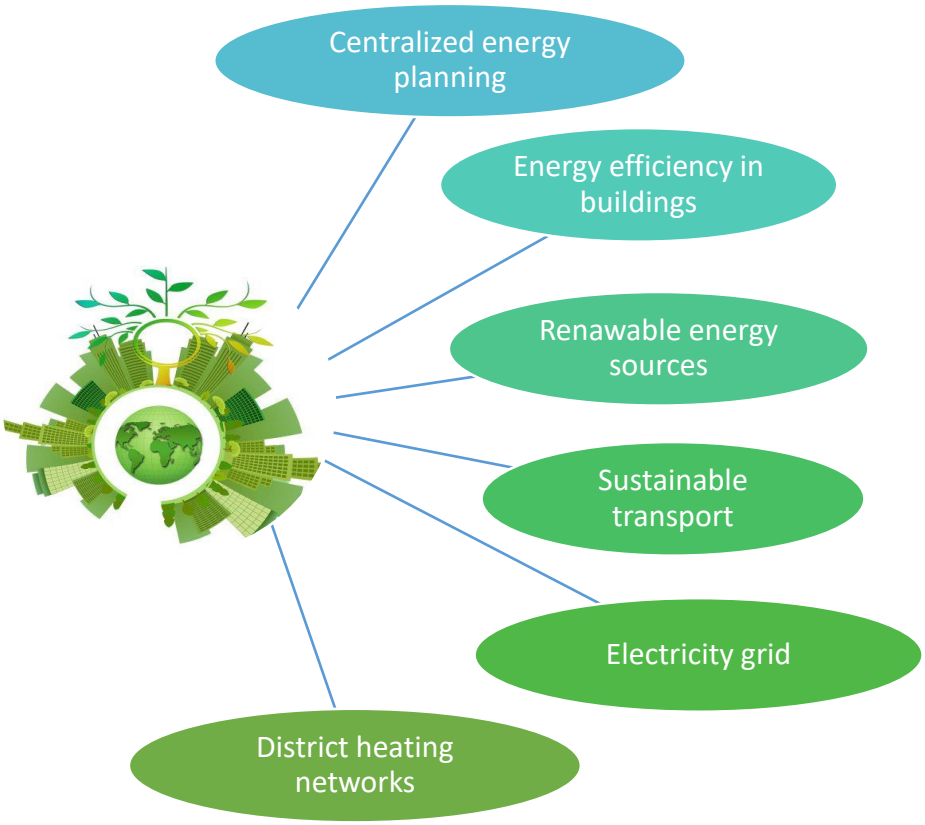
Policy development depends on the political conditions of the country, but the current forecasts and planned subsidies allow for assuming fast electromobility, building charging stations and investing in electric and hydrogen buses, especially in urban areas, but also in rural areas

5. Electricity grid

It is indispensable for the further development of the power sector and the reduction of emission losses. The Mazovian Voivodeship needs large investments in renewable energy, but also in the reconstruction of transmission networks - this is a big problem that may stand in the way of the development of green energy. Most of the transmission networks are in poor condition. Transmission networks are not adapted to today's energy needs for several reasons: first, old networks are based only on one-way transmission of energy - from the producer, i.e. the power plant, to the recipient. The growing number of prosumers strongly undermines the legitimacy of the operation of the old type of transmission networks. The second age and age structure - about 75% of high and medium voltage resources were created more than 25 years ago, and 37 to 42% even more than 40 years ago. Relatively the youngest are low voltage lines and underground medium and low voltage cables, most of which have been built over the last dozen or so years. Another fact that deteriorates the condition of the network is the extreme weather conditions that the old overhead transmission lines are not resistant to. Most of the lines are overground lines, which can break down relatively easily due to strong winds or high temperatures (the oldest overground lines are extremely susceptible to stretching at high temperatures). The renovation of transmission grid is needed to further develop RES (such as mentioned above hydro using potential of Vistula river, wind energy and PV)

6. DHN

The heating infrastructure (generation sources, heating networks) is technically and economically very diverse (age of devices, degree of their wear, modern technological solutions). The technical potential of this sector is constituted by heating systems consisting of generation sources (which include, among others: power plants, commercial and industrial CHP plants, commercial and industrial heating plants, local boiler houses, renewable sources), transmission networks, connections, heat centers and external installations receiving. The most obvious characteristic of this potential is the thermal power for generation and the length of the network for transmission. It is necessary to continue work on connecting households to the heating network and gradually abandoning individual heat sources, as well as further development of heating towards cogeneration, as well as renewable energy sources such as biomass, geothermal energy, but also the use of gaseous fuels.



3.1 Key energy priorities, priority matrix and timeframes

Key energy priorities and development path were divided into mission components described below. Each energy priority was categorized according to the type (policy, technology or mixed), level (supportive, standard or crucial) and implementation timeframe (short term, medium term or long term)

Key energy priorities	Type	Level	Timeframe
Centralized energy planning			
Organization and systematization of energy data	Policy	Supportive	Short term
SECAP plan development	policy	Supportive	Short term
Financial and technical support to municipalities	policy	supportive	Short term
Better waste management	Policy	Crucial	Short term
Energy efficiency in buildings			
Obligatory energy monitoring in all buildings	Policy/technology	standard	Medium term

Energy retrofitting of public buildings	Policy/technology	Crucial	Medium term
Energy retrofitting of private buildings	Policy/technology	standard	Long term
Promotion of renewable sources in private buildings	policy	crucial	Short term
Renewable energy sources			
Decarbonatization of energy sector	Policy/technology	Crucial	Long term
Development of wind energy	Technology	Standard	Long term
Development of PV	technology	Crucial	Medium term
Sustainable transport			
Electrification of the mobility sector	Policy/technology	Standard	Long term
Electromobility in public transport	Policy/technology	Crucial	Medium term
Electricity grid			
Renovation of electricity distribution grid	technology	Crucial	Long term
RES integration	technology	Crucial	Long term
District heating networks			
Boost and optimize the use of district heating (especially promoting co-generation and tending to a net-zero carbon district heating system)	Technology	Crucial	Long term
Development of geotherm	Technology	Standard	Long term
Gasification of thermal systems.	technology	standard	Medium term

3.2 Compliance with European and national targets and strategies

Planned missions components, along with priorities and later described scenarios for the region comes in line with European and national targets and strategies. Before systematizing activities, these strategies were analyzed and adjusted to the needs and priorities of the region in order to jointly achieve one goal of the energy transition.

4. MISSION MAPPING

All the mission components described below, as well as their characteristics, require different forms of planning, implementation and execution. The methodology of actions for each of the priorities described below should be analyzed separately detailing the time frame, responsible entities, expected indicators and SWOT.

4.1 Levels of policy/governance

Centralized energy planning

Collecting and systematizing energy data, as well as energy planning should be performed at the lowest possible government level, in order to take into account the diversity of society, and adapt them to the specificity of the region and its needs. The actors involved here should be local governments which, with the support of regional energy and advisory agencies, will implement targeted energy planning that includes a comprehensive analysis of all sectors within the region.

The analysis of these activities will be carried out through the implementation of SECAPs, i.e. Sustainable Energy and Climate Action Plans, which will be developed for local government units in Mazovia. In order for these activities to be implemented effectively, when developing the types of activities presented in the SECAP, working groups at the municipal level should clearly define the energy profile of a given region, define the energy opportunities / potential, especially in terms of the supply of fuels for the production of thermal energy, delivery, supplies depending on the needs and type of the end recipient. Of course, to implement energy planning in an efficient and sustainable way (based on SECAP), local government must have the right tools. These tools are energy agencies and energy consulting units that will present solutions that:

- are tailored to the energy profile and needs of the region
- lead to the energy development of the region / commune
- they are the most economical and long-lasting
- comply with local and national laws
- are integral to the objectives of the EU.

The energy agency / energy advisor, in consultation with the stakeholders (inhabitants of the region) and members of the working groups, should verify these activities at the SECAP stage and implement them later. The composition of the working groups should include:

- representative of the local authority office - the administrator - supervising the activities and performing a decision-making and representative function (e.g. in the case of obtaining subsidies, decisions etc.)
- energy management manager or a person responsible for energy planning in the municipality - acting as a coordinator of activities within projects implemented in the municipality, leading function in cooperation with an agency / advisor
- employees of a local government unit, including employees from the financial department (treasurer) and departments related to environmental protection

- Mayors.

The following target groups should be the main beneficiaries of the solutions implemented as part of energy planning:

- residents of municipalities;
- managers of public buildings;
- small and medium companies;
- farms.

Introducing to local governments the need to have and implement SECAP will clearly indicate directions for the development of sustainable local energy and enable easy division of responsibilities among stakeholders, as well as staging activities.

Energy efficiency in buildings

The process of implementing activities related to increasing energy efficiency in buildings in the region should be closely related to the energy planning of the region, especially in the assumptions presented in the SECAP for a given commune.

In Mazovia, the greatest potential in terms of increasing energy efficiency is found in rural areas, especially in single-family buildings, the use of which causes excessive consumption of thermal energy from fossil fuels and undried forest biomass burned in ineffective heating devices. Additional potential is also visible in public buildings, which have been used for decades and during their operation, modernization works are rarely carried out.

At present, there are campaigns and promotional channels that particularly popularize energy activities in single-family buildings. There are also financial mechanisms to encourage, in particular, changes to heat sources in Mazovia, as well as legislation forcing the replacement of ineffective heat sources with those meeting the ecodesign requirements and EU implementing regulations. However, the activities carried out by voivodship and national operators do not reach the inhabitants of Mazovia, and information about voivodship resolutions rarely reaches the awareness of building users.

Therefore, as part of this task, it would be necessary to create and promote a point of comprehensive service such as "One Stop Shop" for all inhabitants of Mazovia regions. Each 'One Stop Shop' should have its own regional area where beneficiaries could quickly access consultations and obtain support to carry out energy refurbishment of the building. This point would support the implementation of the project from the design concept, through obtaining a subsidy, to supporting the implementation and settlement of the subsidy with the supporting unit. Each local point of the "One Stop Shop" type will be responsible for the implementation of energy modernization activities and its task is to provide advisory services to the inhabitants of the region (who is the beneficiary of the measure) and remove their responsibility for the formal correctness of the activities carried out. The introduction of the "One Stop Shop" together with an appropriate financial mechanism will make residents more willing to use energy-efficient solutions. Of course, the beneficiaries of this measure, apart from the residents, will also be private entities and budgetary entities interested in carrying out the energy modernization of the building.

Renewable energy sources

The implementation of activities related to the development of renewable energy sources in Mazovia has been carried out for the last ten years and it can be seen in the number of available subsidies and programs addressed to local government units and individuals. This is especially visible in the Regional Operational Program of the Mazovian Voivodeship for 2014-2020. The policy of introducing renewable energy sources should be continued to an even greater extent, especially by building more generating units for large-scale energy production. In order to continue to operate effectively in this area, it is necessary to further verify the areas where there are large amounts of possibilities for the construction and implementation of renewable energy sources in terms of natural conditions (construction of geothermal energy, the possibility of pellet production, the possibility of land development), as well as the needs of the society (the need to supply energy) In order to meet all these requirements, it is necessary to identify stakeholders and entities responsible for tasks in a given area. This is especially true of locations where heat and electricity sources should be decarbonized in urban areas due to the high cost of energy production related to environmental charges.

This action should be carried out through a partnership (consortium) of local government units with energy companies, enterprises involved in the implementation of renewable energy sources and energy advisors who will support local government activists in carrying out investments in terms of implementation, energy and technical.

The municipality / city, as the investor and organizer of the action, is responsible for ensuring the feasibility of the project. All activities in the project should be performed in a consortium established by the participants. The project consortium should be established well before the implementation of energy projects aimed at the installation of renewable energy equipment and should fulfill not only an implementation function, but also a partnership function through the exchange of experiences and good practices.

The main recipients of the results of activities should be residents, local entrepreneurs, public bodies such as educational institutions and hospitals.

Sustainable transport – electromobility

In the case of the development of electric transport in Mazovia, it is necessary to take into account the most sustainable way to provide access to the infrastructure supplying cars with electricity. Therefore, a network of electric car charging stations should be created in Mazovia along with the transfer of cars intended for public transport to all municipalities in Mazovia. In order for such an action to be carried out, an association should be created, covering all local governments in Mazovia, as well as the Board of the Mazovian Voivodeship, which, with the support of an energy agency / energy advisor, will implement the above-mentioned actions. It is also worth considering invitations to the association of partners from outside Mazovia or international associations that implement solutions developing electromobility on a daily basis and could transfer know-how and correct methods of implementing such a process on a large scale.

In addition, as part of these activities, units that finance activities related to electromobility should also be involved. As part of their activities, it is necessary to develop a solution that

will first implement them by local government units that are the most excluded in terms of public transport based on electric cars, and in the next those local governments whose characteristics require further development of this type of infrastructure by indicating a large supply.

In order for the implementation to be transparent, based on energy planning in a given region, and in particular SECAP, the resources needed to implement the action should be determined, as well as the required capacity of the charging stations in the area.

In addition to the network of charging stations, activities related to the purchase of new commune rolling stock - electric buses, which will constitute ecological means of transport in Mazovia, should also be implemented, which will also be in line with the Electromobility Strategies adopted by communal units.

The main recipients of the results of the measures should be residents who may become users of the energy supply infrastructure or as users of public transport.

Electricity grid

The development of power grids in Mazovia along with the construction of new generation capacities is one of the key tasks that will lead the region to a significant reduction in the emissivity of electricity production in the voivodeship.

In order to implement such activities, it is necessary to explore the possibilities and potential of energy as widely as possible (it is related to Renewable Energy Sources), through, inter alia, establishing international consortia with partners who are already experienced and implemented projects based on new technologies, not yet implemented in Mazovia. This may result in the inflow of know-how, which will make these solutions more tailored to the needs, as well as simpler in their implementation and further development.

In addition, at the voivodeship level, a consortium should also be established (headed by the Mazovian Voivodeship) with local governments where the need for comprehensive modernization of the power grid will be identified and energy companies, in which the modernization / replacement of generation units with ecological ones should take place. In the case of the construction of generating units in the form of renewable energy sources (wind turbines, photovoltaic farms), the help of specialists in this area should also be used to define the actual framework of operation and organizational chart related to the division of duties. Of course, all arrangements should be agreed with the manager of electricity networks in Poland, which are PSE- Polskie Sieci Elektroenergetyczne, as well as all entities that generate electricity in the voivodeship. Responsibility between all actors should be divided according to the framework defined in the organization chart, as well as according to competences.

The main sectors to which activities related to the development, expansion / modernization of the power grid will be directed are all economic sectors dependent on the supply of electricity in Mazovia.

The main recipients of this measure will be all end users of electricity in the region.

DHN

In the case of district heating development, the same scheme of division of duties and the formation of a consortium should be adopted as in the case of the development of electricity networks, described above, with the proviso that partners in an international consortium should be selected so that their characteristics are similar to those of local government units, in which activities related to the modernization of heating networks will be carried out.

At the voivodeship level, the consortium (headed by the Mazovian Voivodeship) will be established only with the cities where the need to carry out activities will be identified.

The consortium will also include thermal energy companies appropriate for cities, which deal with the production and / or distribution of heat to end users in the cities. The main task of the consortium will be to participate in talks on the preparation and implementation of solutions in the Mazovia region. In order to increase the competences of the consortium, one should also use the expertise of an energy advisor / energy agency (which will also be part of the consortium). The advisor / agency will be responsible for the design concept in terms of technical and implementation. Responsibility between all actors should be divided according to the framework defined in the organization chart, as well as according to competences.

The main sectors to which activities related to the development, expansion / modernization of the heating network will be directed are all economic sectors dependent on the supply of heat energy from the heating network in Mazovia.

The main recipients of this measure will be all end users of thermal energy in the Mazovia cities.

4.2 Spatial focusses

The Mazovian Voivodeship is divided into 314 communes, including as many as 225 rural communes (almost 72%) and 54 rural-urban communes (17%). The share of rural areas is dominant and this is where the main activities should be intensified. Rural areas will be locations where the method of energy management and planning should be more comprehensive and adapted to the needs of residents.

In Mazovia, the greatest potential in terms of increasing energy efficiency is found in rural areas, especially in single-family buildings, the use of which causes excssive consumption of thermal energy from fossil fuels and undried forest biomass burned in ineffective heating devices. Actions will be necessary to connect these areas to the DHN, but also to take into account the problem of energy poverty. In this topic, it is crucial to increase awareness, but also to propose rational, cheap and effective solutions that can be provided by the further development of renewable heat sources implemented with the help of available subsidies.

In the case of urban areas, the implementation will focus on the modernization of the electricity and heating networks, as well as the further development of electromobility and RES.

4.3 Specific measures for the transition

Transition will focus mostly on decarbonization of energy sector, increase of renewables in regional energy mix and decrease of carbon emission. To meet this goal following 6 mission statement components the following measures will be taken into account:

1. Centralized energy planning
    - I. Promotion of Covenant of Mayors initiative and advisory activities in the field of SEAP, SECAP creation in Mazovia municipalities
    - II. Continuous education and promotion on existing financial instruments and funding schemes for both local and regional authorities, SMEs that will include continuous monitoring of existing funding opportunities in the region and promoting public funds but also raising public awareness on private funding opportunities such as EPC, ESCO, PPP, leasing, crowdfunding ETC and also promotion of already existing successful project to show the outcomes (e.g. generated energy and money savings) and encourage units to import the solutions
    - III. An inventory of energy data especially heat sources in all buildings in municipalities
2. Energy efficiency in buildings
    - I. Location of buildings that require urgent renovation through inventory activities of energy data in municipalities
    - II. Promotion of RES in private buildings that will include organization of awareness campaigns in Mazovia municipalities and increasing the social acceptance of RES installations
    - III. Promotion of deep renovation and heat sources financing instruments in residential buildings and social housing
    - IV. Mandatory energy monitoring in the buildings project funded from the programme
    - V. Creation of one-stop-shop in each municipality to provide the required and needed consultation
3. RES
    - I. Identification the best locations of RES and their specific development potentialities
    - II. Development of research projects that will increase the quality of RES installations in terms of environmental impacts, added value for the whole energy system, etc.
    - III. Promotion of RES in private buildings that will include organization of awareness campaigns in Mazovia municipalities and increasing the social acceptance of RES installations
4. Sustainable transport
    - I. Creation of a regional electromobility strategy that will set the goals of the development, including reconstruction of the road infrastructure of municipalities, increased accessibility and promotion of collective transport services, expansion of the network of bicycle paths, construction of infrastructure for charging electric vehicles
    - II. Promotion activities to increase the social knowledge about electromobility
5. Electricity grid
    - I. Development of research EU project and share findings with electricity distributors

II. Creation of international stakeholder networks to exchange knowledge and new solutions
III. Promotion of DSR among energy consumers

6. District heating network
   I. Engagement of district heater producer, distributors in EU research and development project
   II. Promotion of existing financing instruments construction and reconstruction of cogeneration units
   III. Creation of international stakeholder networks to exchange knowledge and new solutions
   IV. Identification of the best locations of new project and specific development potentialities
   V. Promotion of DHN among private consumers

4.4 Enabling and restraining factors

SWOT Analysis is useful framework for analyzing strengths, weaknesses, opportunities, and threats. It helps to build on the focus, minimize risks, and to take the greatest possible advantage of chances for success. All activities described in prepared REAP were analyzed and put in SWOT analysis report below:

Strengths	**Weaknesses**
• Big RES and EE potential • region's policy focused on EE and sustainable development • developed RES and EE market in Mazovia (many regional, national companies working in the field of energy) • Great interest in renewable energy • Possibility for energy savings • Many funding opportunities	• Poor availability of the regional energy data • Low level of energy knowledge of local government units • Deeply entrenched carbon patriotism • Energy poverty • Limited own resources of municipalities and private persons • High costs of RES production when compared to conventional energy production sources • Limited knowledge on EE and energy poverty
Opportunities	**Threats**
• New financing perspective with high impact on energy sector • Rising energy prices • Constant development of technology related to energy infrastructure • National Reconstruction Plan • Increased public awareness of RES • Restrictions imposed by the EU	• Unpredictable of RES • New political resolutions, changes in state priorities • Changes in governments • COVID-19 pandemic situation

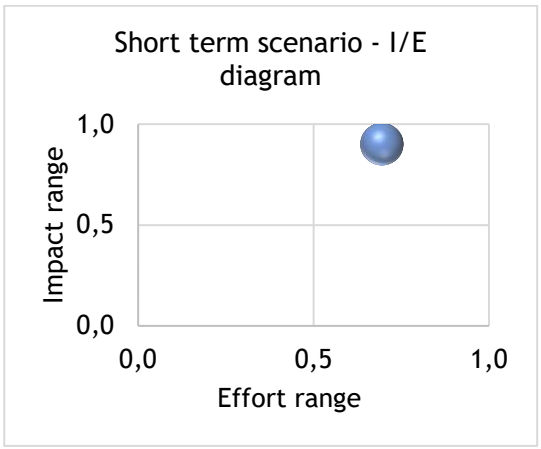
4.5 Challenges, estimation of efforts and impact

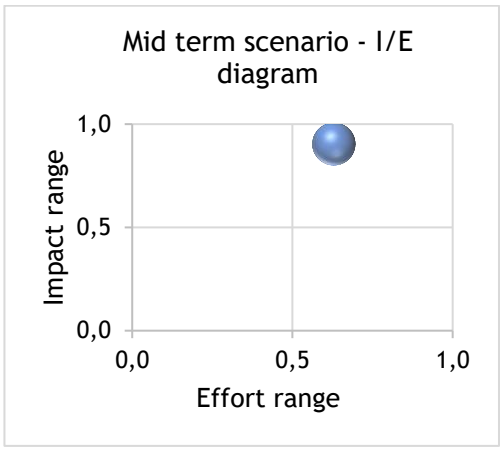
Main challenges that may appear during the implementation of the described assumptions will mostly be linked with involvement and commitment of specific stakeholders. In this regard, it will be necessary to present them with a specific plan with the benefits to be achieved.

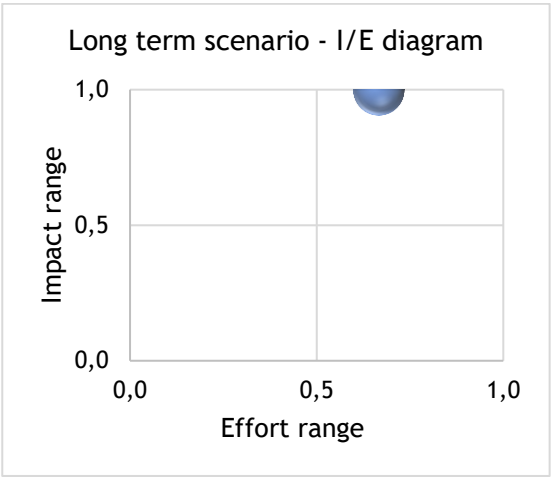
•Classification of priorities by expected impact and effort is presented below. Higher emphasis should be placed on priorities with the highest level of impact and the lowest possible effort, however all priorities should be taken into consideration.

High Impact, low effort			**High Impact, high effort**		
Obligatory energy monitoring in all	Better waste management	Energy retrofitting of public buildings	Energy retrofitting of private buildings	Development of geothermy	Decarbonatization of energy sector
	Development of PV	Electromobility in public transport	Development of wind energy	Boost and optimize the use of district heating	Renovation of electricity distribution grid
				Financial and technical support to municipalities	Electrification of the mobility sector
SECAP plan developme nt			Promotion of renewable sources in private buildings		Organization and systematization of energy data
Low Impact, low effort			**Low Impact, high effort**		

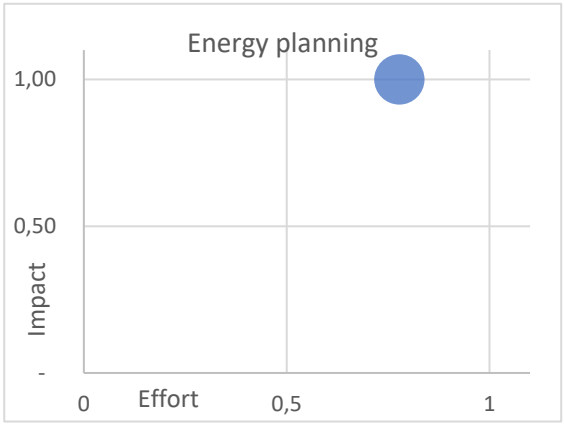
The I/E diagrams analyzing measures in the specific timeframe are presented below:

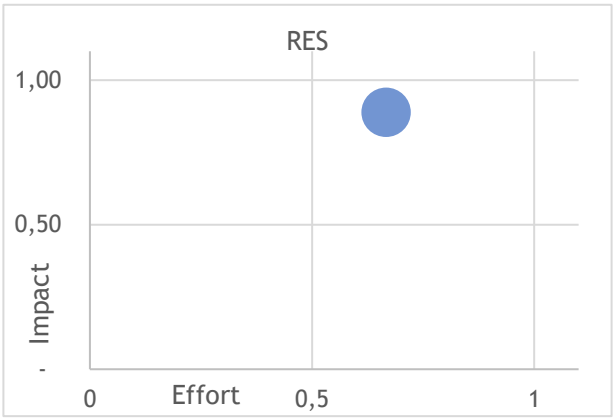


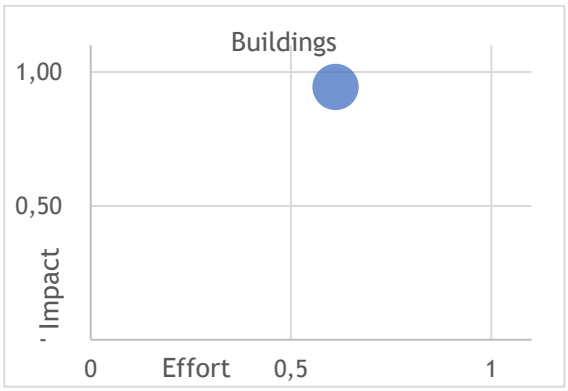


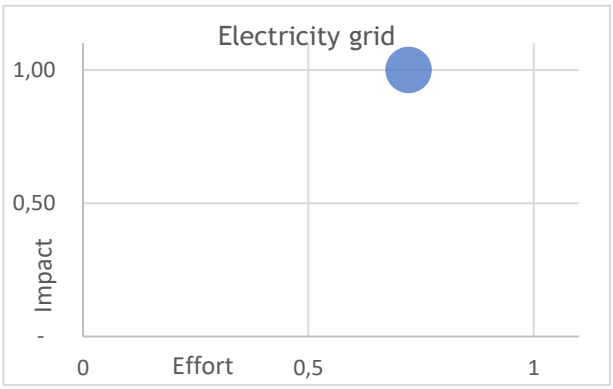


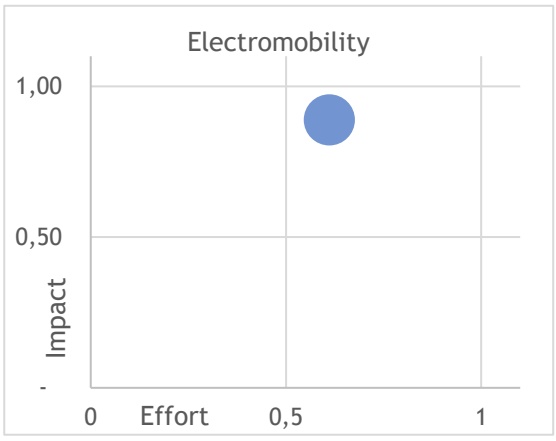
The I/E diagrams analyzing measures in the specific mission component are presented below:

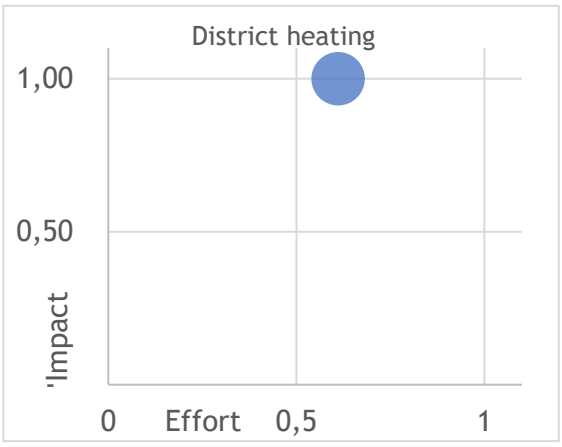





Buildings
1,00
0,50
Impact
0
Effort
0,5
1


Electricity grid
1,00
0,50
Impact
0
Effort
0,5
1


Electromobility
1,00
0,50
Impact
0
Effort
0,5
1


District heating
1,00
0,50
Impact
0
Effort
0,5
1

5. ACTION DEFINITION

Below were defined the actions to take for the realization of the priorities, based on the SWOT analysis of the corresponding measures. Actions contain the main activities regarding priorities in order to promote the priority development with the highest possible impact. This includes also a set of actions to counteract real or potentially obstructive conditions. 21-+541i

5.1 Energy efficiency

Action definition: Replacement of all heating devices till 2030

Actions to take on policy levels:

Based on the systematization of regional energy data and the already implemented investment scales, as well as strategic plans created by local authorities, it is necessary to analyze the possibilities of implementing tasks related to the replacement of heating devices by indicating priority areas (characterized by a low rate of replacement of ineffective heat sources, the lack of an active heating or gas network, and high energy poverty rate). Special emphasis should be placed on these areas to increase their accessibility to subsidies, technology and expert energy advice.

These institutional activities include:

1. Identifying areas of urgent intervention and prioritizing them under the next perspective.

2. Verification of the currently existing subsidy mechanisms and modification of the regulations for the call for applications under the competition for local government units.

3. Development of a promotional strategy.

4. Establishing an advisory body of the "One Stop Shop" type to help in the implementation of activities aimed at increasing energy efficiency in single-family buildings. This body is to play an advisory role for the commune throughout the entire project implementation period.

Above the preparatory activities will also be combined with field / strategic activities, which will include increasing the awareness of users of heating devices about their characteristics and environmental impact through:

- social and educational campaigns,
- poster and leaflet campaigns,
- meetings with residents.

Actions to take on technical level:

As part of the technical solutions, a methodology for selecting heating devices suitable for installation in single-family houses should be developed (through the use of an advisory body, e.g. an energy agency or consultant). As part of these activities, the minimum energy efficiency

parameters of the boilers should be determined, which are to replace any ineffective heat sources. This will allow you to create a database of devices that can be approved for implementation under the project.

Actions to take on financial level:

An appropriate structure for the implementation and settlement of funds should be prepared. In total, EUR 23 million is earmarked for the replacement of heating appliances. Subsidies should be awarded on the basis of the scores achieved by local government units, until the amount of the allocation of funds is exhausted.

In total, by 2030, approximately 10,000 ineffective and emission-related heat sources should be replaced in Mazovia (it results only from the activated mechanism). Only boilers that do not meet the requirements of class 5 may be replaced.

Of course, in parallel, apart from the grant launched in Mazovia, residents will be obliged to replace heating devices as a result of the legislation, including the anti-smog resolution.

Contribution of actions to the EU 2030 targets

The action will have a clear positive impact on achieving the EU indicators required for 2030.

Action definition: Thermomodernization of all public buildings till 2030

Actions to take on policy levels:

In political terms, an appropriate tool should be prepared to verify buildings that require energy retrofitting. The method of verifying the areas where the buildings are located will be carried out in a similar way to the replacement of heating devices described in Action above.

Therefore, first of all, the regulations for the call for applications, the implementation of activities and material and financial settlement under the competition for local government units should be properly prepared.

However, apart from creating a framework for action, it is also important to create the possibility of reliable implementation of the project implemented by the units selected for co-financing. This possibility may be provided by an entity established as a "One-Stop-Shop", which is an advisory and support function in the implementation of activities aimed at increasing energy efficiency in buildings. The One-Stop-Shop will be a regional institution running beneficiaries during the project, from its commencement until its settlement.

In addition to these activities, there are also planned promotional activities consisting in conducting social and educational campaigns for the managers and users of public buildings, as well as private owners, showing the economical benefit of conducting thermomodernisation as well as aiming at behavioral changes towards reducing energy consumption.

Actions to take on technical level:

As part of the technical conditions, it is necessary to outline the degree of technical advancement that the building should correspond to after the energy modernization. Indicators assessing technical advancement should be considered indicators such as the primary energy index, the final energy index, as well as the heat transfer coefficients of external partitions, including: walls, roofs, floors, window and door joinery. These indicators must be consistent with the requirements of the applicable regulations, guidelines, standards and technical conditions.

These indicators should define the minimum energy standard of the building that should be achieved after the energy modernization. Based on these data, sample models of buildings after energy modernization should be prepared along with estimated cost savings. These models should be used to disseminate their effectiveness.

Actions to take on financial level:

As part of the action, competition regulations for two separate sub-actions should be developed. As part of the first sub-measure, regulations should be prepared, addressed only to single-family buildings, which will clearly define the financial requirements and the maximum amount of subsidies obtained by the resident.

In total, EUR 33 million is earmarked for the renovation of private buildings.

The maximum amount of co-financing for a resident, in the case of completing all activities related to thermal modernization (according to the catalog of improvements), the resident may receive a maximum grant of PLN 50,000 = EUR 11,000.

The second sub-measure should only cover activities related to the thermal modernization of public buildings. These regulations will include the minimum requirements for the profitability of investments by applying a cost index indicating the amount of co-financing spent in order to save 1 MWh of energy.

The allocation of funds for the thermal modernization of public buildings will amount to EUR 77 million.

A local government unit may obtain PLN 500,000 (EUR 111,000) of funding for a maximum of one public utility building.

Contribution of actions to the EU 2030 targets

The action will have a clear positive impact on achieving the EU indicators required for 2030.

5.2 Renewable energy supply

Action definition: Renewable Energy Sources in grid, electromobility and domestic heating system

Actions to take on policy levels:

In each of the sectors implemented, ranging from the power grid, through heating networks, to electromobility (including vehicle charging infrastructure), consortia should be established to carry out implementation, technical, financial and supervisory tasks. Each consortium should have bodies that have the tools to do so, and also manage such tools at provincial and national levels. Therefore, in the case of supplying electricity to power grids with electricity, a consortium should be established that will develop activities related to large-scale electricity production - wind, PV and electricity production from biomass. The consortium should include:

- local government authorities at the voivodship level;
- electricity network managers;
- developers of technical solutions;
- energy advisers;
- local representatives from the municipal level.

Together, all these entities, after verifying the technical feasibility, should prepare an overall action strategy, which will include organizational charts, methods of implementation and coordination of activities, the degree of involvement and obligations of individual parties, financing of activities and determination of the schedule of activities implementation.

For district heating networks and electromobility infrastructure, the structure will be similar but will include other infrastructure managers. However, before such solutions are reached, technical verification must be carried out. This verification should be carried out by an energy advisor / energy agency appointed or contracted for this activity. After this assessment, one should refer to the units concerned with a proposal to establish cooperation for which these activities will bring the most tangible results.

Actions to take on technical level:

Technical activities start at the stage of initial implementation of activities. They are aimed at shelling out areas, which are financial, analytical and technical support, especially in the area of large generation sources, i.e. wind turbines, power plants / combined heat and power plants / biomass heat plants, photovoltaic farms, geothermal sources.

It is crucial to identify locations with the highest production potential and where there is the largest deficit in terms of heat / electricity supplies and the need to transport it from other areas of Poland, as well as to indicate places where modern technical solutions will cause the unit costs of energy produced to be relatively low. Appropriate cost estimate preparation as a result of an in-depth inventory of heat / energy sources in the studied area and reliable preparation of the design concept may bring appropriate results and help in the proper location of generating units. To achieve this, cooperation with other units is needed, with which a consortium will be established and activities will be coordinated. After verifying the areas and establishing consortia, proceed to the implementation of the prepared concept and its implementation in technical terms.

Additionally, in addition to energy production in large generating units, distributed generation will be promoted, including photovoltaic installations, heat pumps, biomass boilers and, to a lesser extent, solar collector installations.

Actions to take on financial level:

As part of the measure, an appropriate allocation should be prepared to achieve the material and energy effects specified in this document.

In total, EUR 500 million is planned for the installation of equipment producing energy from renewable energy sources.

Therefore, separate calls for proposals (as sub-measures) should be launched:

1. Renewable energy sources in the power sector
2. Renewable energy sources in the heating sector
3. Renewable energy sources in the electromobility sector
4. Renewable energy sources as a distributed generation in single-family buildings

The largest funds should be allocated to the electricity and heating sectors (PLN 200 million each), and to a lesser extent, funds should be allocated to electromobility and distributed generation (PLN 50 million each)

Contribution of actions to the EU 2030 targets

The action will have a clear positive impact on achieving the EU indicators required for 2030.

5.3 Sustainable mobility

Action definition: Electromobility infrastructure network

Actions to take on policy levels:

Due to the low level of advancement of the transport infrastructure regarding the possibility of charging and using electric cars, as well as the lack of a specific strategy for individual regions in Mazovia, the first step should be to develop an electromobility strategy in all municipalities, which will indicate the appropriate development direction and regional plans for building an appropriate infrastructure - road and charging.

Due to little experience and the lack of adequate facilities in Mazovia, all local government activists and associations should look for proven and effective solutions. Therefore, contacts should be established (by establishing a consortium / associations) with foreign partners in order to obtain good practices on the implementation of activities in the field of electromobility.

On the basis of the developed strategies and acquired competences, the planned solutions should be implemented. The first step will be the signing of an agreement in Mazovia, the main goal of which will be to make the charging infrastructure available to all interested parties, so that used electric cars can operate without restrictions. As part of this agreement, a decision should be made on the method of implementation of the action, as well as on the layout of

the grid, so that it enables the implementation of the task and complies with the adopted electromobility strategies.

The agreement will include local government units with strategies and interested in the action, Mazovian Voivodeship, associations dealing with electromobility and energy agencies / advisers.

As part of the agreement, they should indicate the framework operating principles, organizational chart, time frames for action, develop a common strategy for Mazovia, which will define step by step the activities carried out to purchase transport infrastructure (including electric vehicles).

Actions to take on technical level:

Technical activities should play an important role in planning, especially in arranging charging stations so that each electric car available on the market can easily (its range allows) go from one charging station to another. It is also important that they are located in the main communication points and close to highways or expressways. From the technical point of view, the characteristics of vehicle charging stations should also be adapted - they must be compact, easy and safe to use. They should quickly charge the car for at least 100 km of the route.

In addition to charging stations, the measure also provides for the purchase of a car fleet for interested municipalities, which should ensure transport to all users of the fleet.

As part of the measure, it is planned to locate at least one electric car charging station in all municipalities in Mazovia and to purchase two electric vehicles for the municipal rolling stock, which will be used for school transport or in the municipality.

In total, at least 600 cars will be purchased and handed over for public transport and 300 car charging stations for individual municipalities, mainly in rural areas where access to such stations is not available at the moment.

Actions to take on financial level:

In order to implement the assumptions of the Electromobility Strategy, as well as to increase access to infrastructure, an allocation of funds should be created with a division into two sub-measures. The first sub-measure should cover the creation of charging infrastructure for electric cars. Under this measure, the maximum amount of co-financing for the construction of a charging station is PLN 150,000, and the purchase of an electric car is PLN 2 million

Contribution of actions to the EU 2030 targets

The activities will contribute to the development of electromobility, and thus reduce the level of low emissions from transport

5.4 Sustainable infrastructure and spatial development

Action definition: Modernization of electricity grid

Actions to take on policy levels:

In the case of modernization of power grids, it is necessary to find solutions suitable for a given area, improving the functioning of grids located in Mazovia. To this end, modern solutions should be selected as part of an international consortium that will connect specialists from our area (especially experts from Energy Companies) and foreign specialists who will jointly develop innovative solutions combining standard grid modernization with the use of solutions leading to the development of a smart grid in the area. Mazovia.

This consortium should especially focus on regions where energy infrastructure was built / modernized in the last century. Such regions will mainly include rural communes.

The basis for the possibility of assessing the possibilities of infrastructure development under the cooperation in the consortium will be the assessment of the technical condition of this infrastructure by local energy companies, which should be involved in inventory works in each of the regions. After the assessment, a meticulous plan for the modernization of the network should be prepared (based on the method of connecting the network), so as not to take away the possibility of using energy by the residents for a longer period of time.

These activities should be carried out in parallel with the activities related to the installation of renewable energy sources, taking into account energy conditions after the implementation of the activities and increasing the production capacity. Areas with increased generation capacity will cause changes in the way electricity works and transports electricity in the grid.

Therefore, the consortia responsible for the construction of RES and modernization of the electricity infrastructure should be in close contact and connected via a coordinator

Actions to take on technical level:

At the technical level, the state of power grids in individual regions should be inventoried. This inventory should present information about the construction of given power lines, the method of their implementation (foundation, e.g. with reinforced concrete poles), assessment of the condition of the structure, the type of material used to make the cable and the method of its implementation (cable condition, e.g. by checking the conductor insulation and protective coating) as well as the type and condition of the security and associated infrastructure (e.g. insulators, connectors). As part of the inventory, the technical condition of power stations (distribution and transformer stations) should also be assessed.

On the basis of the inventory of the aforementioned infrastructure, it is necessary to determine the needs for modernization and compare the transmission efficiency and the parameters of the transmitted and converted electricity using distribution and transformer stations to the model parameters required for newly constructed ones, depending on the factors influencing the use of a given type of line.

The designed technical solutions should meet the following requirements:

- ensuring the reliability of energy supply
- comfortable and safe operation
- operational safety
- easy expansion

The proposed technical solutions, instead of the identified systems that do not meet the requirements or cause high losses or problems in transmission, should ensure energy savings (lower transmission losses), less problems with operation (in places where there are, for example, contaminated zones or limited space, a solution assuming the installation of the line should be adopted. cable).

As part of the task, 4,000 km of energy infrastructure will be modernized / built, along with distribution and transformer stations.

Actions to take on financial level:

As part of the measure, a special target fund should be created to modernize the power grid in cooperation with energy entrepreneurs (who are responsible for modernization and the power grid).

As part of this, a public-private partnership should be created under which the construction of the electricity grid will be financed.

The region's budget allocation for the activities carried out amounts to EUR 1 billion. The remaining funds for the construction and modernization of the power grid will be financed by Przedsiębiorstwo Energetyczne (Distribution System Operator).

Contribution of actions to the EU 2030 targets

The actions will increase energy efficiency, in particular by improving the efficiency of the power system. The result will be a reduction in primary energy consumption and greenhouse gas emissions.

Action definition: DHN development

Actions to take on policy levels:

In the case of the development of district heating networks, an organizational diagram and a development plan should be developed as part of the cooperation of a consortium that will help the authorities (mainly municipal) in finding appropriate technical solutions for the best possible expansion of the district heating network. The consortium will include entities with qualified personnel from our area and foreign specialists dealing with innovative activities in the field of thermal energy in the city.

The consortium will identify urban areas where the availability of district heating is limited, and the joint exchange of knowledge will lead to the fact that the implementation of activities that are currently impossible will become feasible.

In order to develop the network, in addition to support under the consortium, actions will also be carried out to effectively finance the project, including the creation of a mechanism allowing for the expansion of the network at a low cost.

In addition, at the political level, it should also be ensured that the construction of networks in new areas does not interfere with other investments carried out and that they can be carried out in a parallel manner (this also applies to the construction of new generation capacities).

Actions to take on technical level:

On the technical level, inventory activities of the current state of heating networks in the voivodeship should be carried out and the possibility of connecting new locations for connection in terms of planning should be checked. This inventory will allow to determine the possibility of connecting new buildings to the network and the need to modernize the existing installations.

At the inventory stage, particular consideration should be given to locations that are far away from a heating plant or combined heat and power plant producing heat in a given city. A considerable distance from the heat source may mean that at this moment there are no conditions for heat transfer and reception there. This is a real problem in the case of small towns where, due to the lack of an extensive heating network, multi-family buildings are heated with individual heat sources, which results in much lower energy efficiency.

After stocktaking the key areas, proceed to the selection of appropriate technical solutions, which should be made based on standards, technical conditions and have all technical approvals.

In order to obtain the best possible heat transmission conditions, a detailed network design documentation should be prepared, including the requirements for the operation of the network and the execution of pre-insulated pipelines. All materials must have valid approvals and approvals for use in heating.

As part of the task, the heating network should be expanded and modernized by at least 1000 km, including connections to buildings and accompanying infrastructure.

Actions to take on financial level:

The allocation of funds for the expansion of the power grid is EUR 444 million.

The expansion of the heating network should be carried out as part of a public-private partnership with municipal thermal power plants and heat distributors, who will jointly perform and settle the operation in financial terms.

EUR 444 million is only a subsidy from the voivodeship, while the remaining funds for the expansion of the network will be financed by the heat distributor in the city.

Contribution of actions to the EU 2030 targets

The measure will contribute to increasing the energy efficiency of multi-family and single-family buildings located in cities, which will bring a measurable effect in reducing greenhouse gas emissions and reducing final and primary energy consumption.

5.5 Catalizing factors: awareness, education, information

Promotional and educational activities are often underestimated and minimized, but they are a necessary factor to achieve results. Educating and raising public awareness is an extremely important factor in identifying and engaging with stakeholders. A promotion and education strategy should be developed in relation to each action described above, taking into account the goals, methods, target groups and results. The planned information, promotion and educational activities should translate into the achievement of specific goals, such as:

- popularization of low-emission energy sources
- expanding knowledge in the field of thermal modernization and renewable energy sources
- development of an innovative attitude of society,
- obtaining the greatest possible number of recipients of information about the activities
- the use of social media to popularize energy-saving solutions and behaviors.

6. SCENARIOS

The modeling of the scenarios is based on the precedent development of priorities and measures and thereupon defined actions. The assumptions presented below are in line with our storyline and present realistic indicators for the planned achievement in the long term.

6.1 Overview on main actions and measures on the time scale

During conducting scenario modeling our baseline is data from 2016, mid-term target is year 2030 and long- term target is year 2040. Planning in a longer perspective than indicated may generate a large margin of error due to unstable assumptions, which in such a long perspective may be very difficult to estimate.

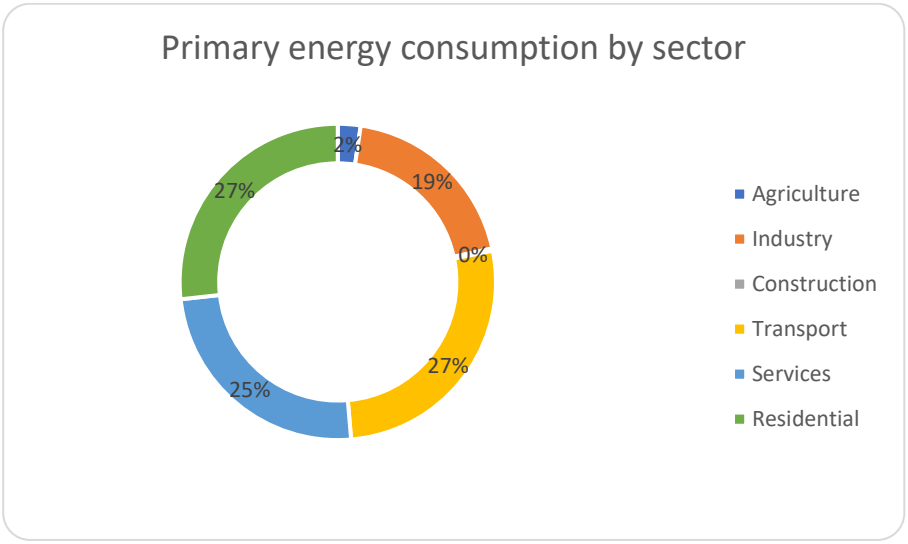
The base year was set for 2016 due to the greatest completeness and the latest data. Baseline data were collected and will be taken as a benchmark for further analysis.

As presented below share of renewables in the Region is very low -only 11.8% and do not meet EU requirements. Energy demand is very high 132 791 687 MWh and as the share of fossil is prevailing the emission is one of the highest in EU.

Baseline	Demand (MWh)	Internal supply (MWh)	Total renewable (MWh)	Share of renewable	Share of fossil
Heat and thermal process	69 611 259	69 611 259	14 552 047	20,9%	79,1%
Electricity	22 145 040	22 145 040	9 348	0,042%	100,0%
Alternative & transport fuels	41 035 389	No data	1 115 643	2,7%	97,3%

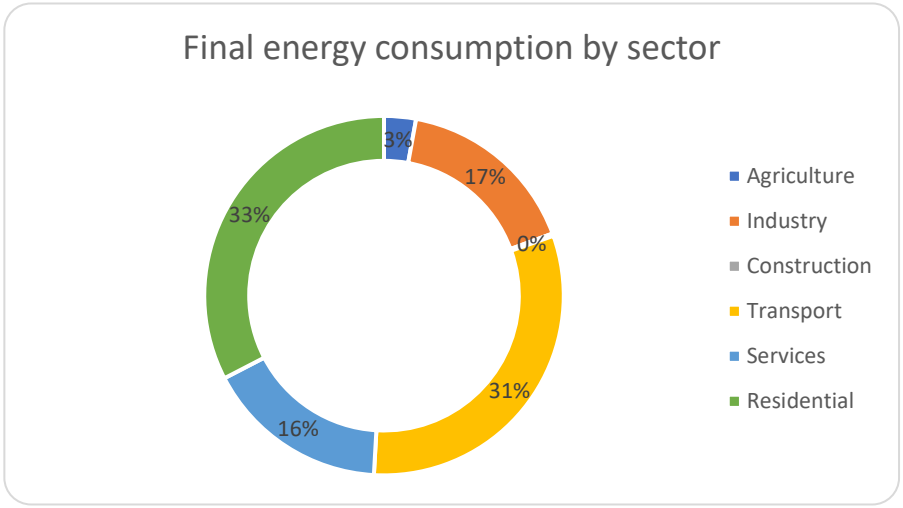
Total regional pool						
Final demand (MWh)	Internal supply (MWh)	Import (MWh)	Export (MWh)	Renewable (MWh)	Share of renewable	Emission (t/year)
132 791 687	91 756 299	41 035 389	152 374 175	15 677 039	11,8%	51 217 126

As it can see in the graph below the most dominant sector in primary energy consumption is Service, Residential and Transport



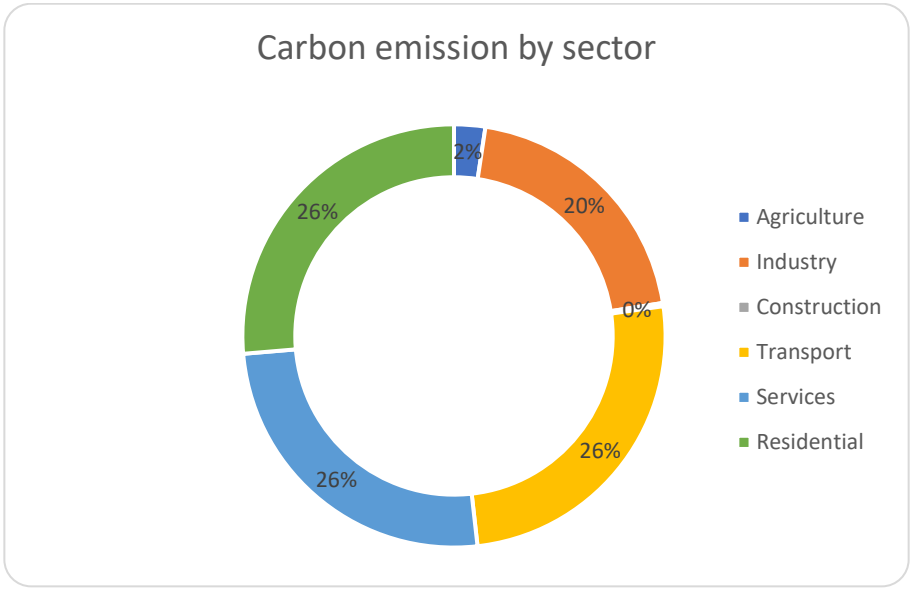
Graph 1 Primary energy consumption by sector 2016

When it comes to final energy consumption the main sector are Transport and Residential



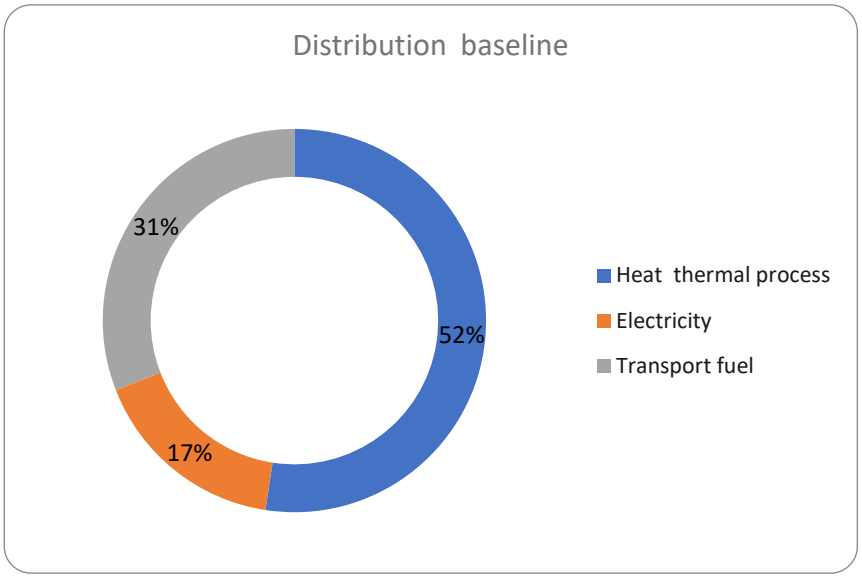
Graph 2 Final energy consumption by sector 2016

Secotrs with highest carbon emission are Transport, Services and Residential each with a 26% share



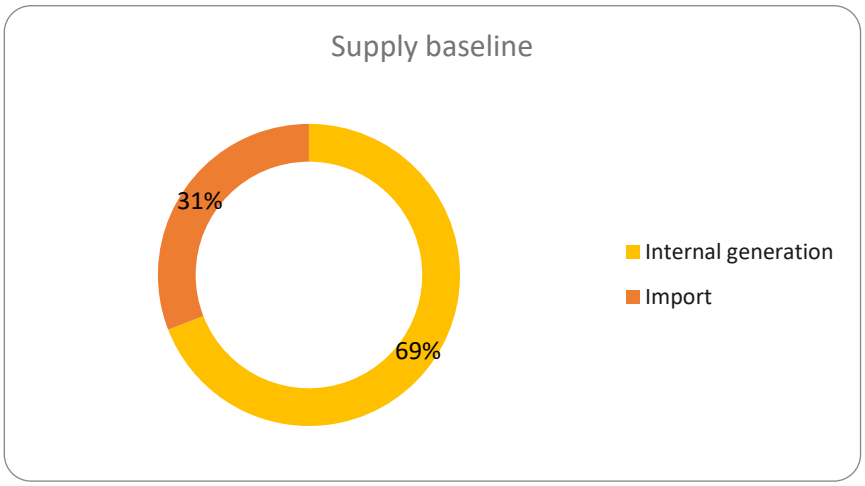
Graph 3 Carbon emission by sector 2016

Analyzing distribution baseline, presented at the graph below, the largest share has heat distribution, the lowest - electricity.



Graph 4 Distribution baseline

Supply baseline depends highly on internal generation, leaving import with only 31%



Graph 5 Supply baseline

Analyzing specialized planning documents, as well as taking into account the structure of the region and its needs, main goal of the scenario is gradual decarbonization of the region. Due to Polish national and regional fuel structure (above 80% coming from coal) scenario modeling focused mostly on shifting from solid fuels. By examination completeness and distribution of data on energy consumption and carbon emission by sectors the main focus was put on residential and service sector.

As mentioned before the main role in energy transition will play wind energy, PV, hydro, biomass and renewable waste. Also due to the fact that Poland is currently very strongly focusing on gasification of heating sector, gas will have significant role in future energy mix.

Evaluating the structure of change and population growth, it can be easily assumed increase in electricity consumption. Even with conducting renovation of transmission grid and decrease transmission losses, in Mazovia there is a trend of stable increase of electricity consumption taking into account this trend and the development of electromobility, we assumed an increase in demand for electricity. There is also very strong forecast in small decrease in heat consumption due to building renovation wave.

As the final results by 2040 prediction are to achieve above 80 % of electricity coming from RES and 40% in heat sector. The lower rate in heating is due to the intense gasification efforts of the sector, as well as the large number of individual heat sources, the complete replacement or removal of which may not be carried out so quickly globally

6.2 Scenario 2030

6.2.1 General description: Actions and measures in the scenario

General description of action and measures in 2030 scenario is described in the table below:

Business-as-usual	2030 targets measures
No municipality join and develop energy plan	60% municipalities join CoM and develop SECAPS with commitment 40% CO2 emission reduction
App. 80% heating devices do not meet energy efficiency requirements	Replacement of all heating devices till 2030 to meet EE requirements
Only 50 % public buildings already after thermomodernization	Thermomodernization of all public buildings till 2030
No significant share of RES in transport	At least 14% RES in transport including electromobility
App. 40% buildings connected to DHN	At least 60 % buildings connected to DHN
20% share of RES in heating	At least 30% share of RES in heating
No renovation - transmission losses are increasing	Renovation of transmission grid, reduction of transmission losses
0,5% share of RES in electricity	At least 60% share of RES in electricity

The state of art and indicators described below are related to the direct effects of implementing the suggested actions and achieving the designated indicators

6.2.2 State of energy efficiency, renewable energy supply, mobility, infrastructure and spatial development

As outlined above, it is expected that in 2030 there will be an intensive development of infrastructure, mobility and RES development. As presented below planned share of renewables in the Region will increase to 29,2% (31,0% in heat, 66,2% in electricity and 3,1% in fuels sector). Energy demand will slightly decrease by 1 646 053 MWh.

Mid-term target	Demand (MWh)	Internal supply (MWh)	Total renewable (MWh)	Share of renewable	Share of fossil
Heat and thermal process	65 527 061	65 527 061	20 345 393	31,0%	69,0%
Electricity	25 159 584	25 159 584	16 660 610	66,2%	33,8%

Alternative & transport fuels	40 458 990	No data	1 271 833	3,1%	96,9%

Total regional pool						
Final demand (MWh)	Internal supply **(MWh)**	Import **(MWh)**	Export **(MWh)**	Renewable **(MWh)**	Share of renewable	**Emission (t/year)**
131 145 634	90 686 644	40 458 990	117 040 527	38 277 836	29,2	44 962 439

As described in the scenario description table the 2030 goal activities will start with structural and centralized energy planning methodology proposed to all Mazovia municipalities. this will initiate local activities towards the energy transformation, locating the greatest needs and critical points of regions. As a result, each region will increase awareness of the energy transformation and will contribute more actively to real change, at least in its own areas, finally achieving at least 40% CO2 emission reduction.

Next step will be replacement of all individual heating devices. As The Management Board of the Mazovian Voivodeship approved the Mazovian Anti-Smog resolution that indicates that:

- From November 11, 2017 only eco-design compliant boilers may be installed.
- By the end of 2022 fireplaces must be replaced with eco-design compliant
- From January 1, 2023, it is not allowed to use boilers for coal or wood that do not meet the requirements for classes 3, 4 ,5 according to PN-EN-303-5-2012
- From January 1, 2028:
    - coal or wood-fired class 3 or 4 boilers according to PN-EN-303-5-2012 standard must not be used
    - class 5 boilers according to the PN-EN-303-5-2012 standard can be used until the end of their service life

As the result the goal for 2030 is to replace all individual heating devices to meet specific EE requirements. This will also influence the society to more willingly connect to the heating network, which, with the simultaneous expansion of the system, will result in a greater percentage of households becoming the recipient of network heat.

At the same time, the already commenced thermal modernization of public utility buildings and, to a lesser extent, private buildings will be carried out. As municipalities prioritize actions aimed at energy and cost savings, it is one of the first steps towards the energy transformation. By 2030, it is estimated that all public buildings will undergo thermal modernization.

Due to the increasing population, as well as greater demand for cars and mobility, which causes great air pollution especially in urban centers. Municipalities and cities will increasingly invest in expanding he electromobility infrastructure. Due to the emerging new subsidies for electric buses, municipalities will use the funds and also expand the charging infrastructure

To meet EU requirements and high emissions penalties, energy companies began to invest more vigorously in renewable energy. By 2030, this trend will increase. In the strategic documents of energy companies such as PGE (electricity production and distribution), PGNiG Termika

(heat production and distribution), which operate in the region, large investments in renewable energy are planned, especially involved in PV, geotherm, biogas, and wind. Due to this expansion of the grid towards renewable energy, it will also be necessary to invest in the renovation of the grid, which, without it, will not bring maximum economic benefits to companies.

6.2.3 Required investments

Required investments to achieve described scenario consists of:

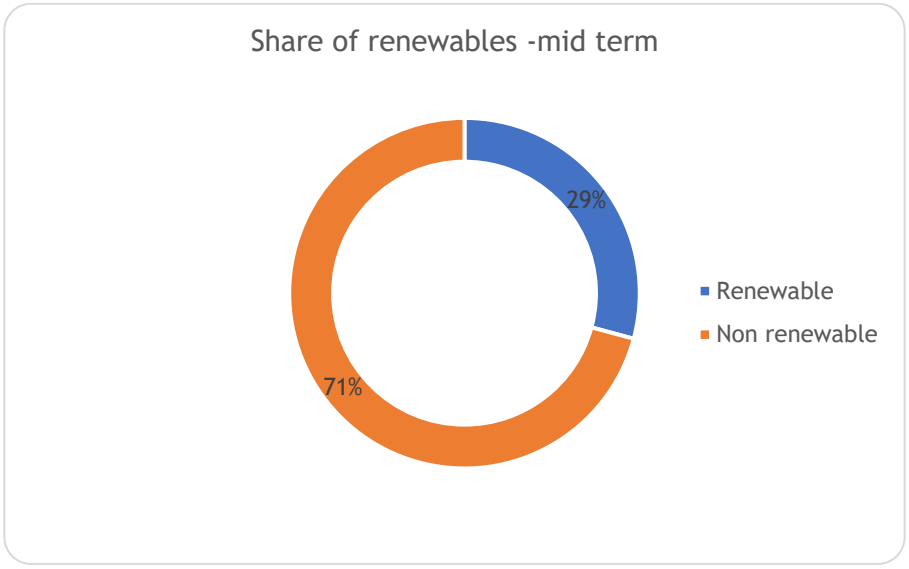
- Energy planning – SECAP development in Mazovian municipalities
- Energy efficiency in buildings – thermomodernization of all public buildings, replacing heating source in private buildings
- Sustainable transport - construction of charging station in municipalities along with the purchase of vehicles for 1-2 vehicles per municipality
- Electricity grid - modernization and extension of the power grid in urban areas, new RES capacity installations
- DHN- construction of a heating network in Mazovia together with heat nodes, construction of gas sources for heat needs

Estimated costs of required investments are described in the table below.

Component	Costs 2030
Energy planning	7 Million €
EE in buildings	133 Million €
Sustainable transport	222 Million €
Electricity grid	1 500 Million €
DHN	444 Million €
TOTAL	**2 306 Million €**

6.2.4 Renewable energy in supply and consumption

As mentioned in the in previous chapters the main role in energy transition will play wind energy, PV, hydro, biomass and renewable waste. There also be a small role geotherm and biogas. As it is presented in the graph below the total share of renewables in regional energy mix will reach 29% by 2030.

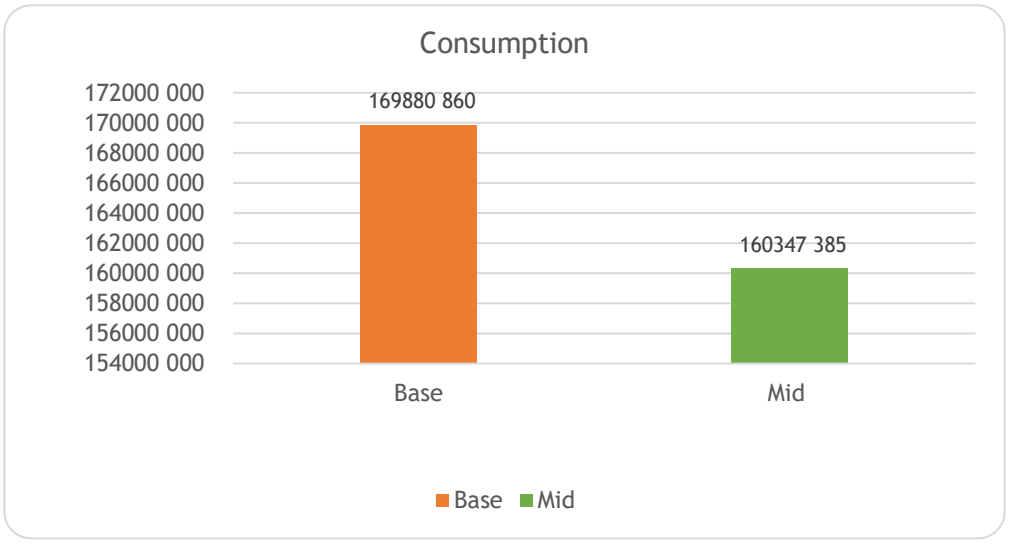


Graph 6 Share of renewables -mid term

Total renewable share in heat will reach 31% (increase in heat generation from solid biomass, geothermal, biogases, waste and solar), in electricity 66% (increase in electricity generation from PV, wind, hydro), alternative & transport fuels 3%.

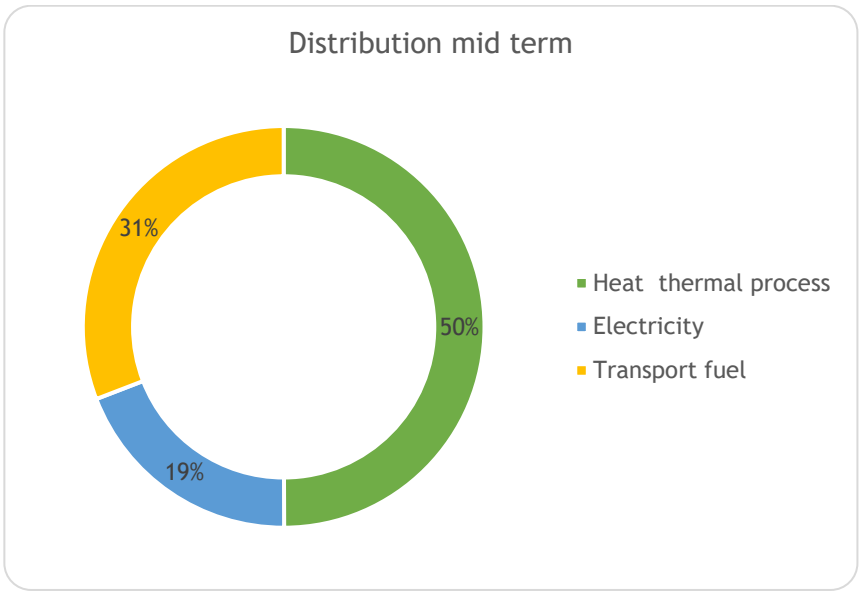
6.2.5 Primary energy in supply and consumption

The decrease in primary energy consumption is presented in the graph below. In 2030 scenario the consumption will be app. 5,61% lower than in the 2016 baseline.



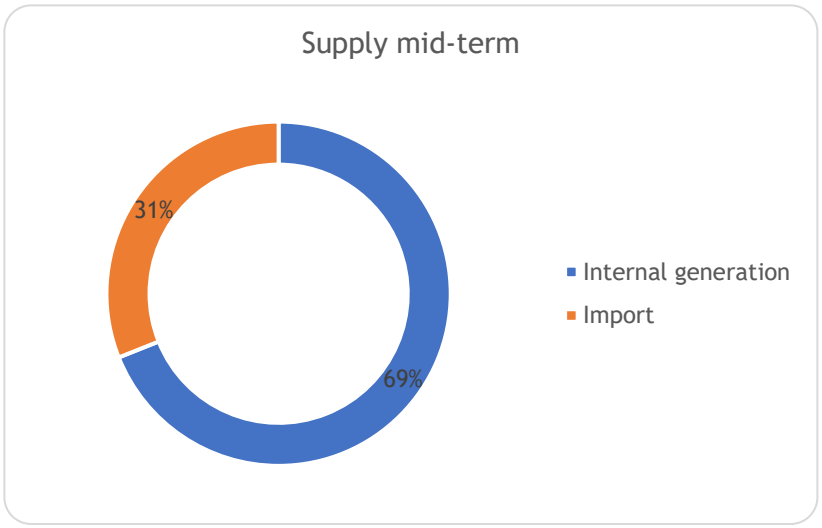
Graph 7 Change in primary energy consumption 2030

Analyzing distribution baseline, presented at the graph below there is 2% movements from distribution of heat to distribution of electricity.



Graph 8 Distribution mid term

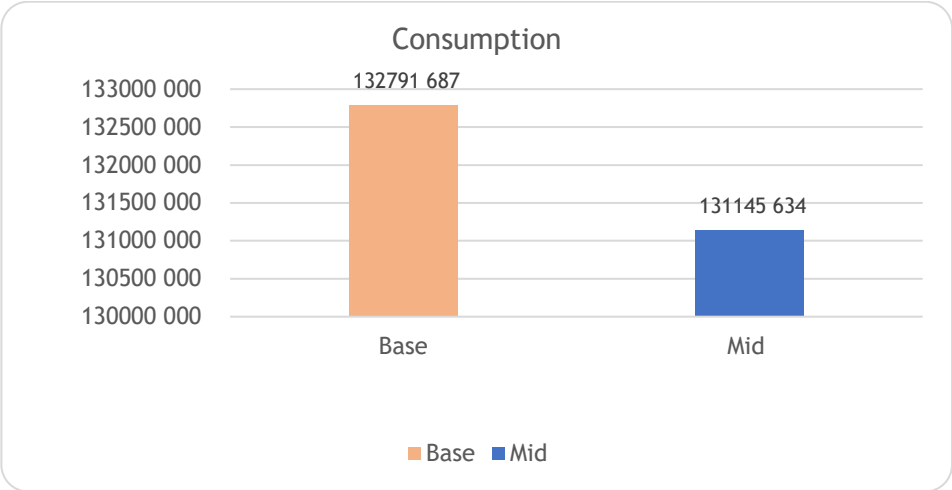
As can be seen on a graph below supply baseline did not change significantly.



Graph 9 Supply mid-term

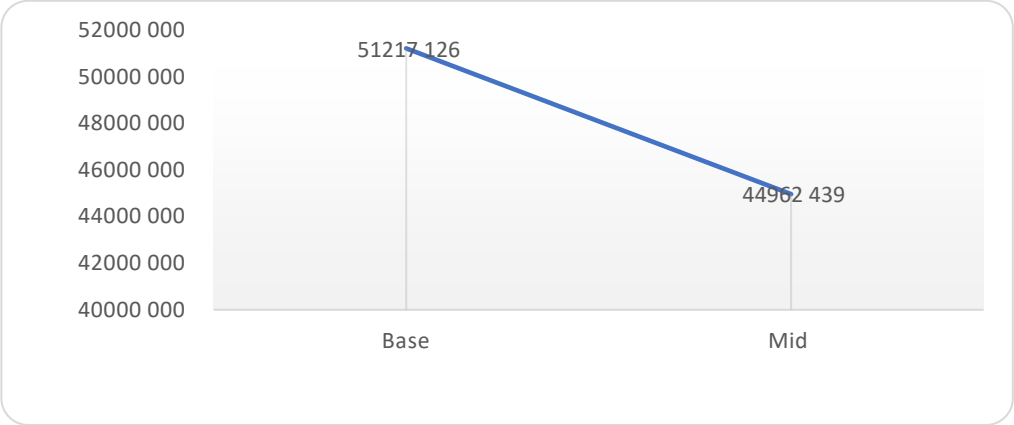
6.2.6 Final energy consumption and GHG emissions

The decrease in final energy consumption is presented in the graph below. In 2030 scenario the consumption will be app. 1,24% lower than in the 2016 baseline.



Graph 10 Change in final energy consumption 2030

The most importantly, there will be high decrease in GHG emission. Due to the switch to RES and decarbonization by implementing described action the Region will achieve 12% GHG reduction by 2030

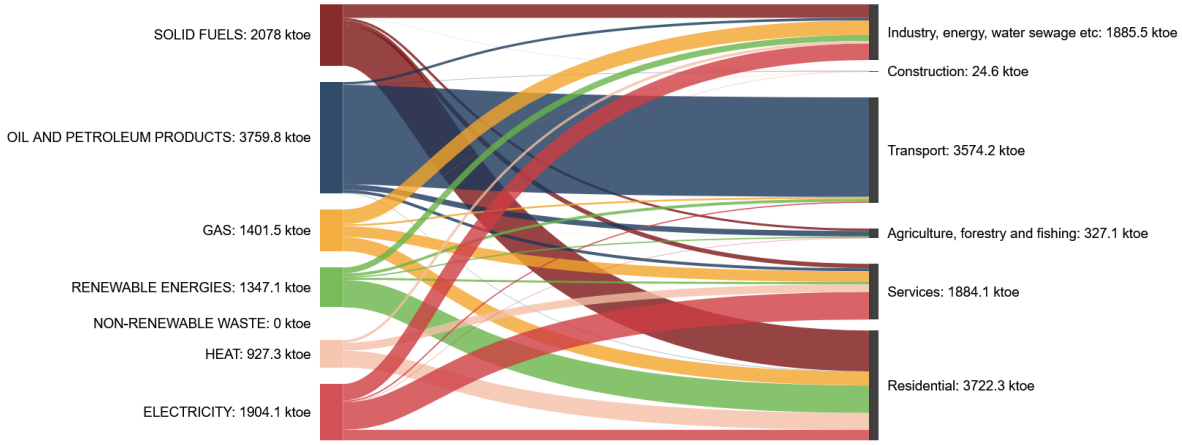


Graph 11 Change in GHG emission 2030

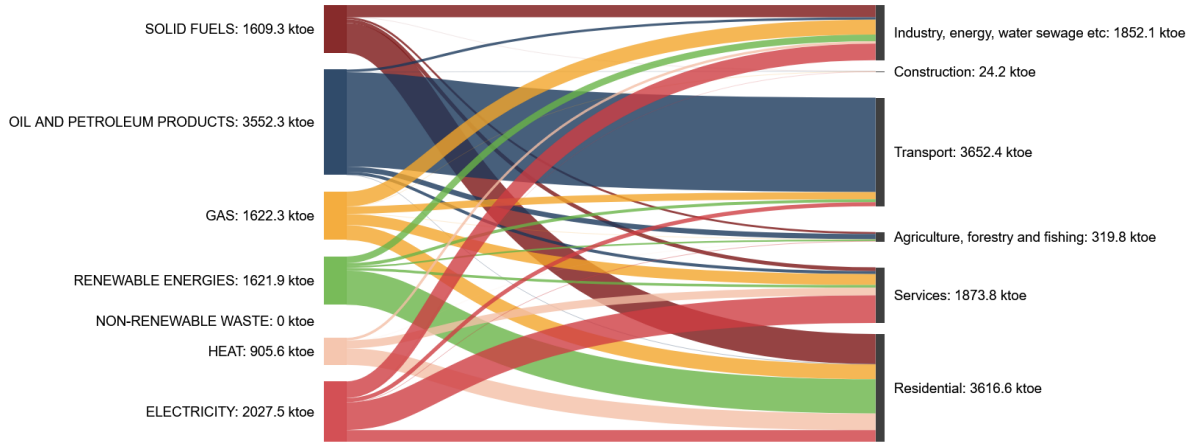
6.2.7 Sankey diagram

Final energy consumption

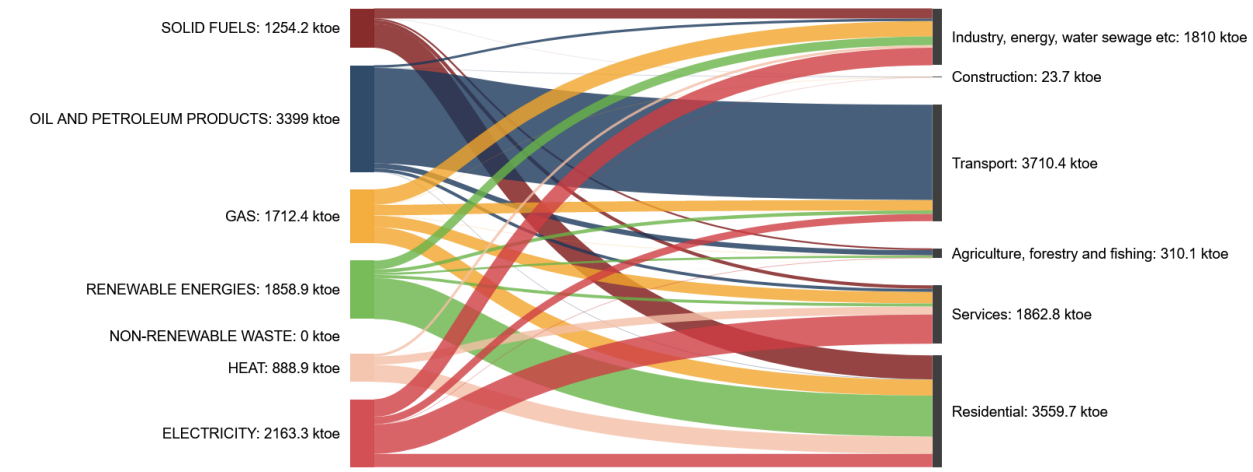
Baseline



Short term

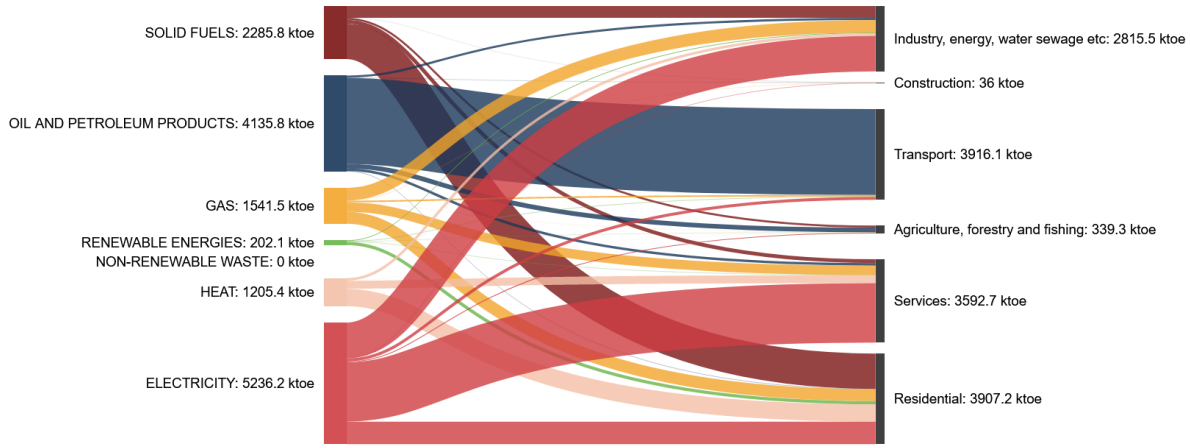


Mid term

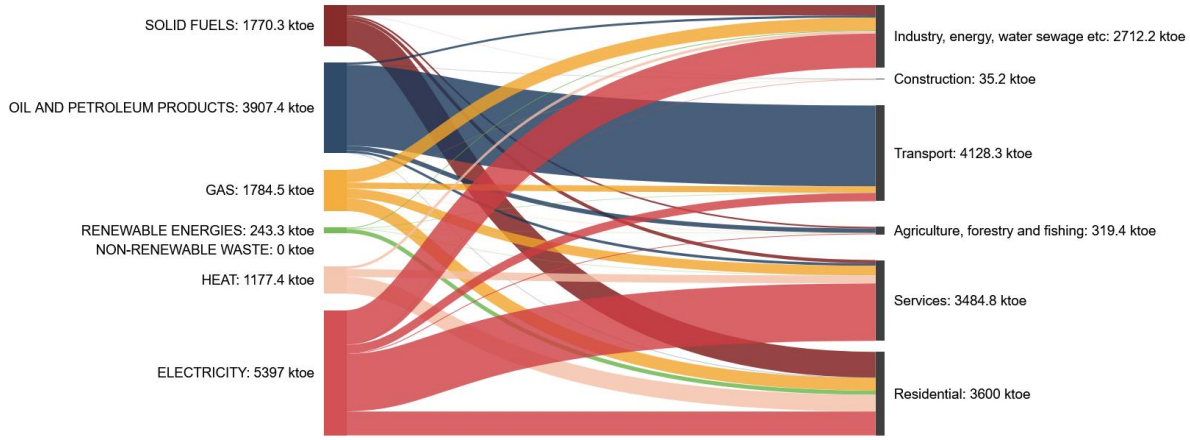


Primary energy consumption

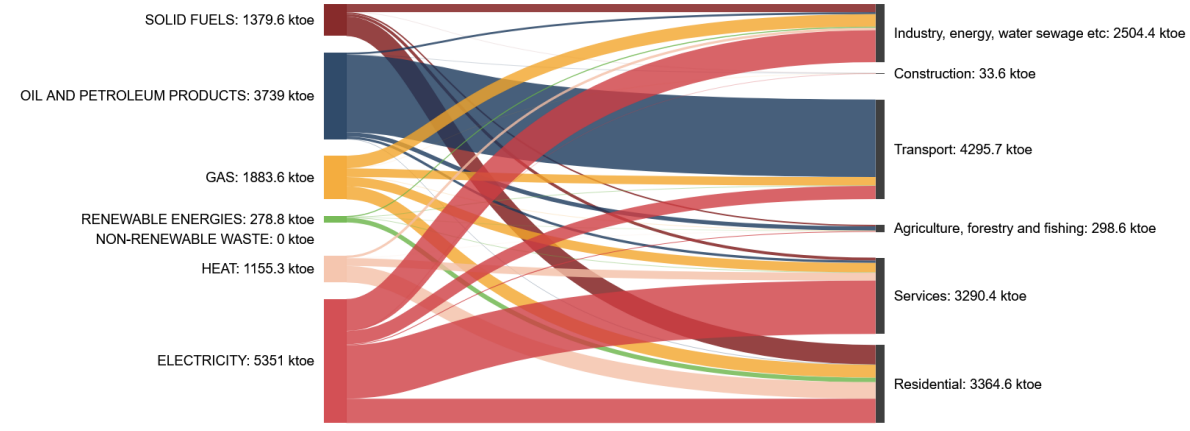
Baseline



Short term

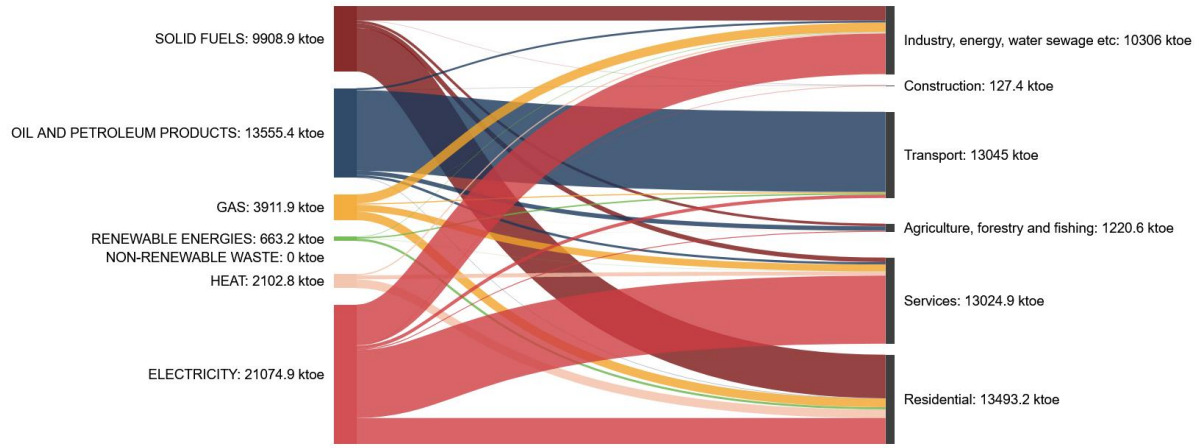


Mid term

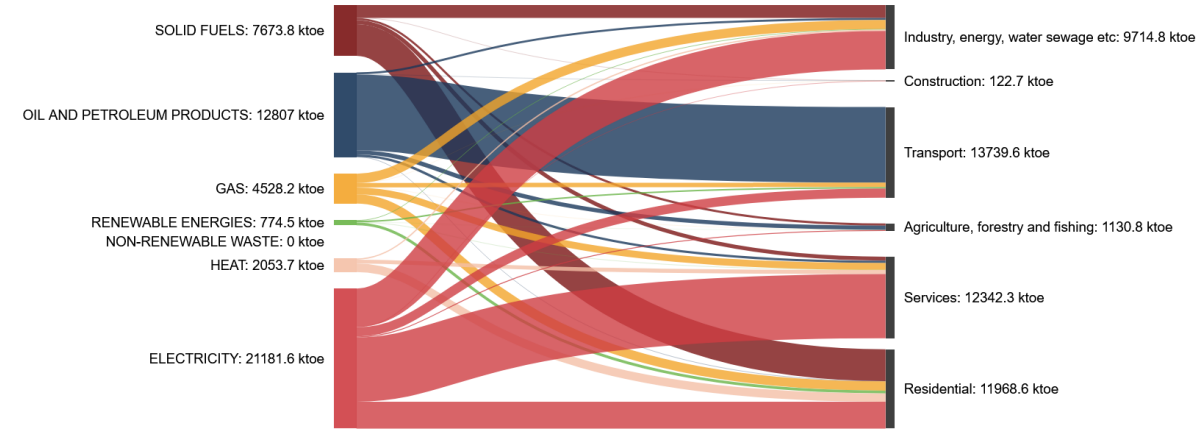


GHG emission

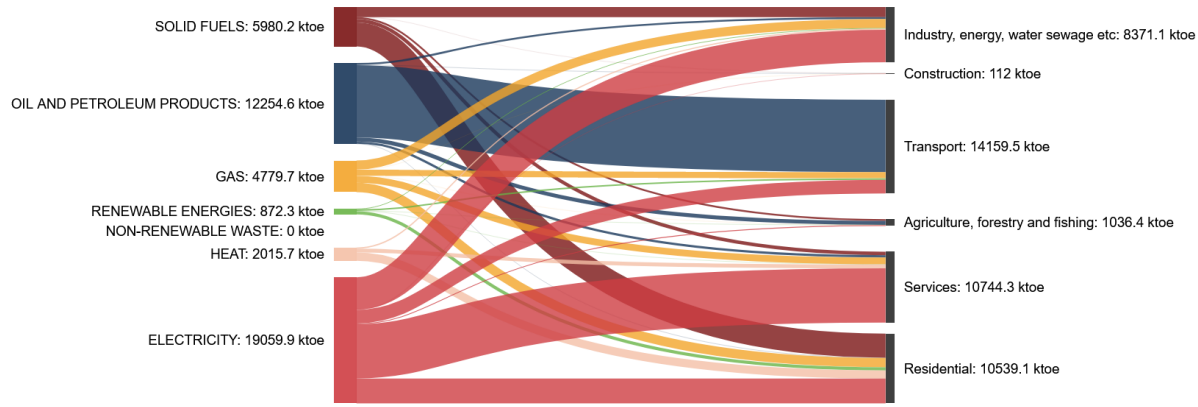
Baseline



Short term

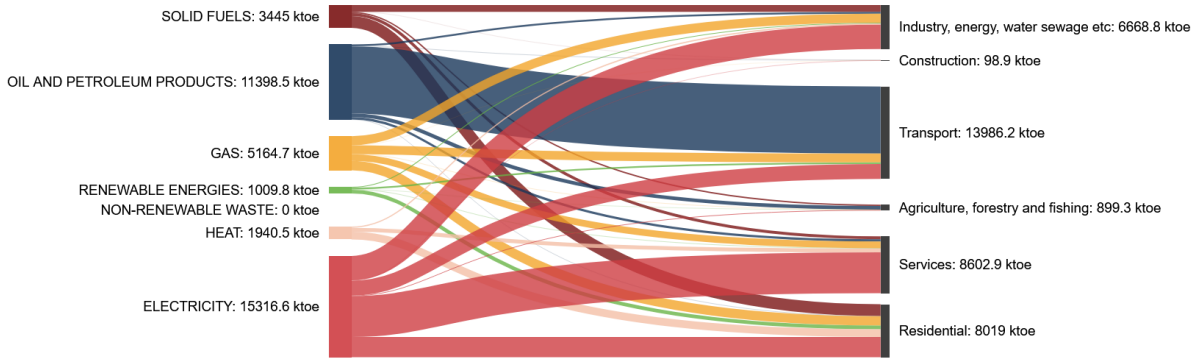


Mid term

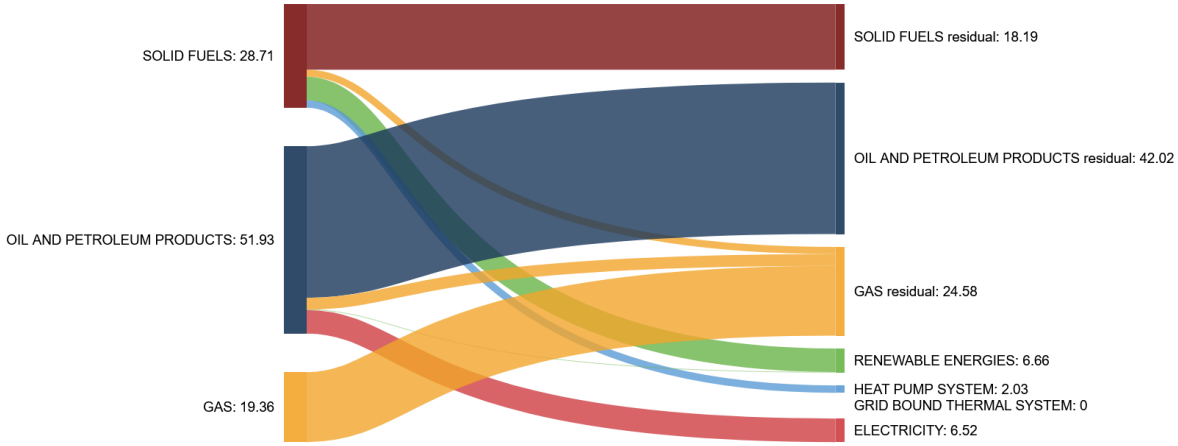


Fossil fuel shift

Short term



Mid term



6.3 Scenario 2040

6.3.1 General description: Actions and measures in the scenario

General description of action and measures in 2030 scenario is described in the table below:

2030 target measures	2040 target measures
60% municipalities join CoM and develop SECAPS with commitment 40% CO2 emission reduction	80% municipalities join CoM and develop SECAPS with commitment 55% CO2 emission reduction

Replacement of all heating devices till 2030 to meet EE requirements	RES integration in private buildings – at least 50% of private buildings and 90% of public buildings have RES integrated
Thermomodernization of all public buildings till 2030	App. 50% of all buildings (private and public) meet EE requirement
At least 14% RES share in transport including electromobility	At least 21% RES share in transport including electromobility
At least 60 % buildings connected to DHN	80 % buildings connected to DHN
At least 30% share of RES in heating	At least 38% share of RES in heating
Renovation of transmission grid, reduction of transmission losses	Further renovation of transmission grid, reduction of transmission losses
At least 60% share of RES in electricity	At least 80% share of RES in electricity
No nuclear share in regional energy mix	the appearance of a 7,5% share of nuclear energy in the regional energy mix

The state of art and indicators described below are related to the direct effects of implementing the suggested actions and achieving the designated indicators

6.3.2 State of energy efficiency, renewable energy supply, mobility, infrastructure and spatial development

As outlined above, it is expected that in 2040 there will be further intensive development of infrastructure, mobility and RES development. As presented below planned share of renewables in the Region will increase to 38,3% (38,8% in heat, 88,4% in electricity and 3,4% in fuels sector). Energy demand will further decrease by 1 965 785 MWh.

Long term target	Demand (MWh)	Internal supply (MWh)	Total renewable (MWh)	Share of renewable	Share of fossil
Heat and thermal process	62 698 812	62 698 812	24 299 059	38,8%	61,2%
Electricity	26 887 732	26 887 732	23 764 710	88,4%	11,6%
Alternative & transport fuels	39 593 306	No data	1 349 928	3,4%	96,6%

Total regional pool						
Final demand (MWh)	Internal supply (MWh)	Import (MWh)	Export (MWh)	Renewable (MWh)	Share of renewable	Emission (t/year)
129 179 849	89 586 544	39 593 306	105 927 152	49 413 697	38,3%	38 275 149

As described in the scenario description table the 2040 goal activities will start with further structural and centralized energy planning methodology proposed to all Mazovia municipalities. this will intensify local activities towards the energy transformation. As a result, 80% of Mazovian municipalities and cities will achieve at least 55% CO2 emission reduction from their baselines.

Next step after replacement of all individual heating devices will be more active actions toward RES integration. Due to the increasing prices of electricity and fuels, as well as the available subsidies, residents will increasingly invest in renewable energy sources that will support home budgets. Finally at least 50% of private buildings and 90% of public buildings have RES integrated.

Municipalities and cities will further invest in expanding electromobility infrastructure. Due to new float of electric buses and more citizens owning private electric cars, municipalities will use the funds furhter expand the charging infrastructure

Due to the high restrictions of EU energy companies by 2040 will further invest more vigorously in renewable energy. The strategic documents of energy companies such as PGE (electricity production and distribution), PGNiG Termika (heat production and distribution), which operate in the region, indicates further large investments in renewable energy, as mentioned before especially in PV, geotherm, biogas, and wind. Due to this expansion of the grid towards renewable energy, it will also be necessary to invest in the renovation of the grid, which, without it, will not bring maximum economic benefits to companies.

Another important indicator in the 2040 scenario will be the construction of a planned nuclear power plant, which will help in the transition to total energy neutrality in the region by 2050. New Polish strategic documents indicate its creation by 2040, which will affect the region's energy mix and reduce the share of fossil fuels and gas emissions.

6.3.3 Required investments

Required investments to achieve described scenario consists of:

- Energy planning – further SECAP development in Mazovian municipalities - energy planning update after the implementation of activities for 2030
- Energy efficiency in buildings – further thermomodernization of private buildings, RES integration in buildings
- Sustainable transport – further construction of charging station in municipalities

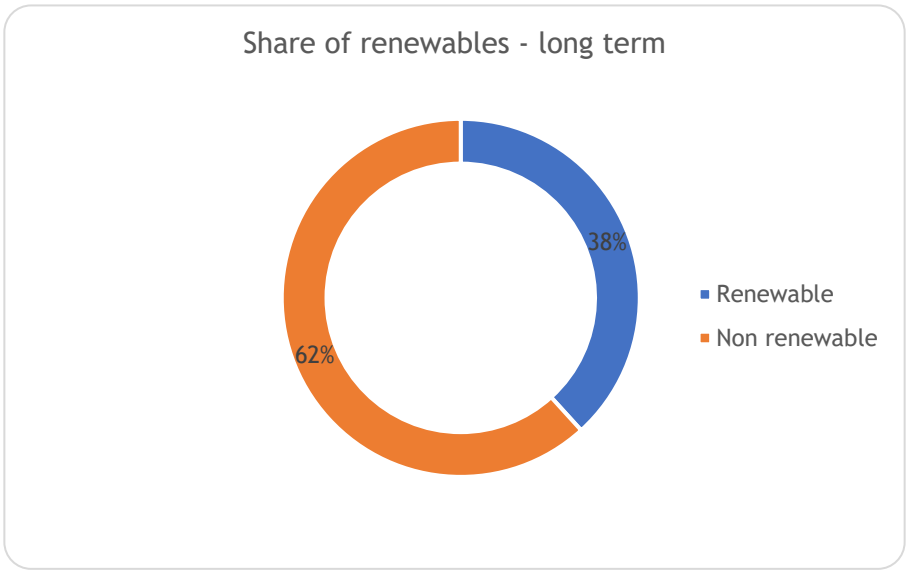
- Electricity grid – further modernization and extension of the power grid in urban areas, new RES capacity installations
- DHN- further construction of a heating network in Mazovia together with heat nodes, construction of gas sources for heat needs

Estimated costs of required investments are described in the table below.

Component	Costs 2030
Energy planning	14 Million €
EE in buildings	199 Million €
Sustainable transport	255 Million €
Electricity grid	2 389 Million €
DHN	866 Million €
TOTAL	**3 723 Million €**

6.3.4 Renewable energy in supply and consumption

The further development of energy transition will develop including gradual increase in energy production from wind energy, PV, hydro, biomass and renewable waste. As it is presented in the graph below the total share of renewables in regional energy mix will reach 38% by 2030.

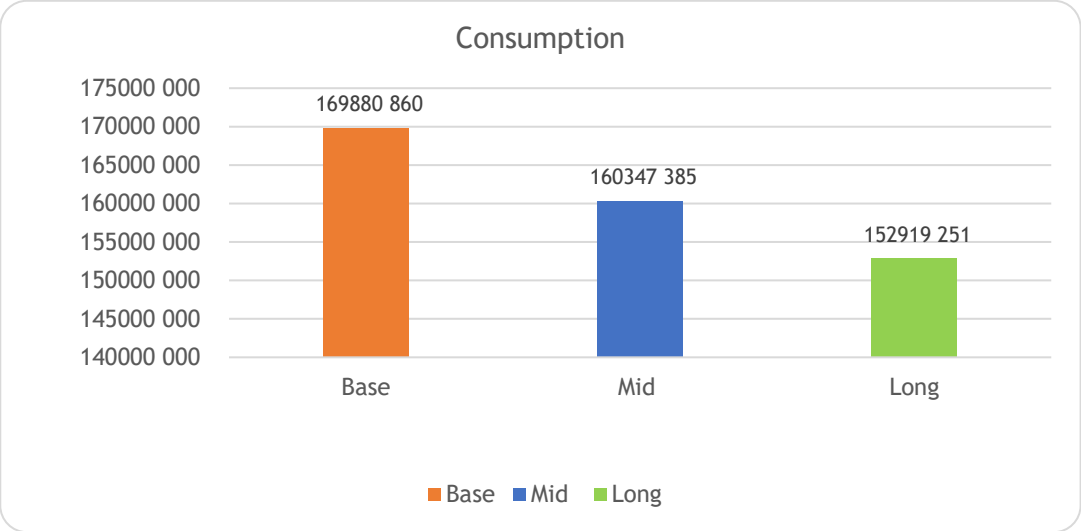


Graph 12 Share of renewables - long term

Total renewable share in heat will reach 38% (increase in heat generation from solid biomass, geothermal, biogases, waste and solar), in electricity 88% (increase in electricity generation from PV, wind, hydro).

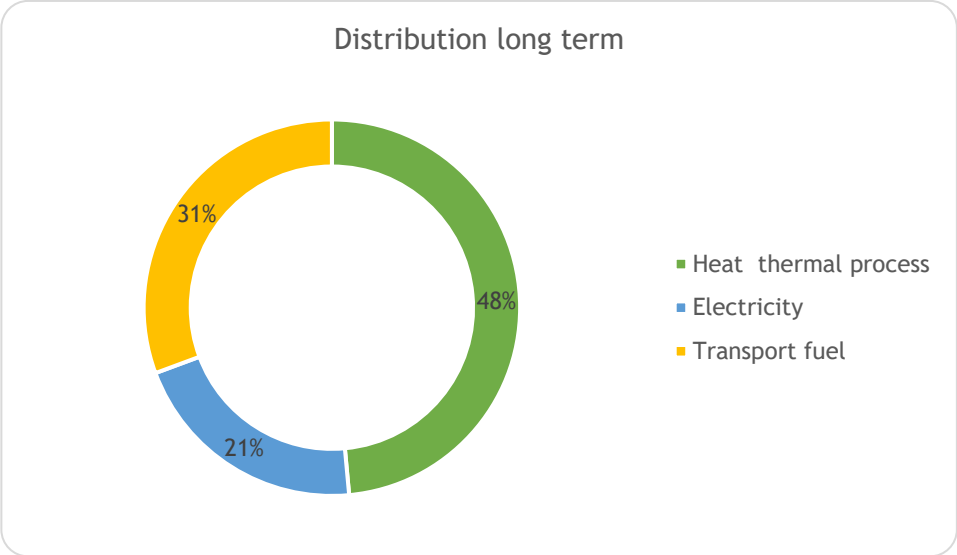
6.3.5 Primary energy in supply and consumption

The decrease in primary energy consumption is presented in the graph below. In 2040 scenario the primary energy consumption will be app. 9,98% lower than in the 2016 baseline and app.4,63% lower than in 2030.



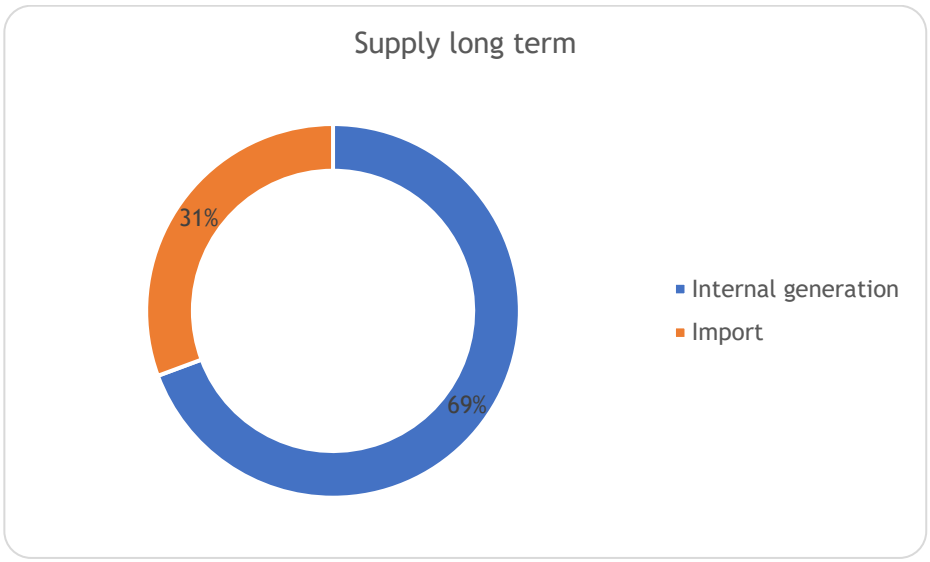
Graph 13 Change in primary enegy consumption 2040

Analyzing distribution baseline, presented at the graph below there is slight change in the breakdown of distribution in favor of electricity.



Graph 14 Distribution long term

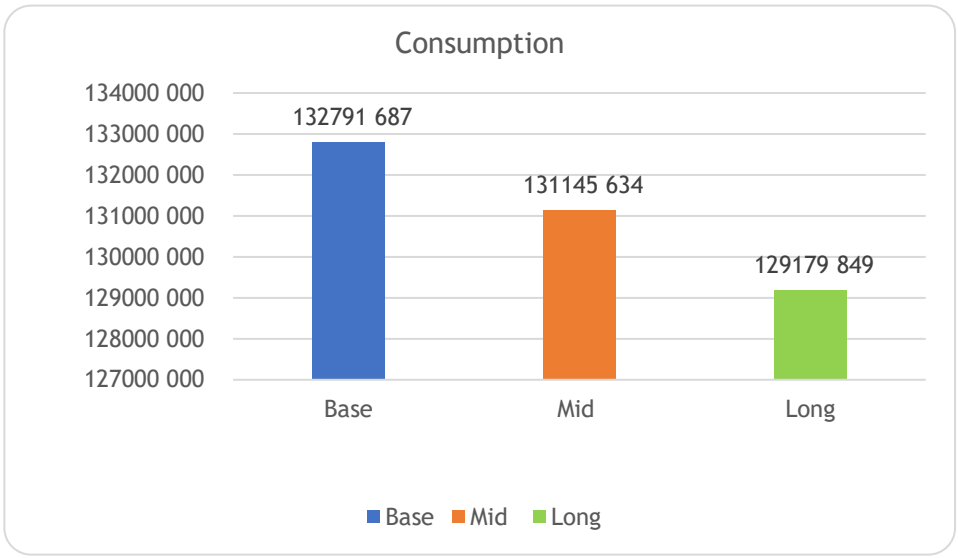
As can be seen on a graph below supply baseline did not change.



Graph 15 Supply long term

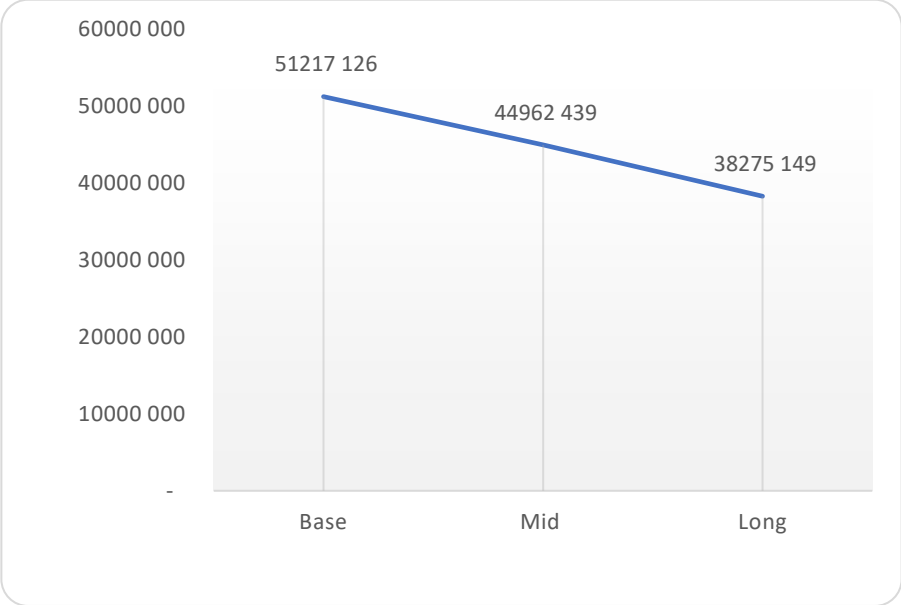
6.3.6 Final energy consumption and GHG emissions

The decrease in final energy consumption is presented in the graph below. In 2040 scenario the final energy consumption will be app. 2,72% lower than in the 2016 baseline and app. 1,5% lower than in 2030.



Graph 16 Change in final energy consumption 2040

The most importantly, there will be high decrease in GHG emission. Due to the switch to RES and decarbonization by implementing described action the Region will achieve 25,27% GHG reduction by 2040 from the baseline

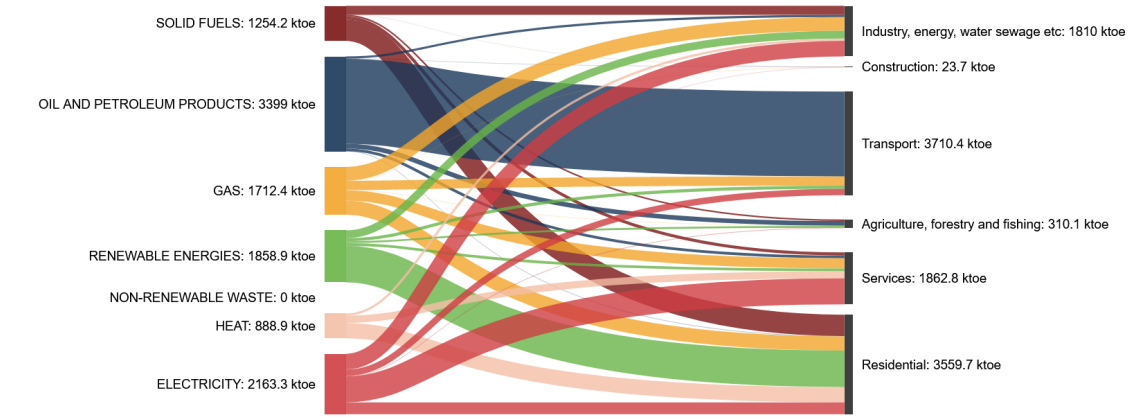


Graph 17 Change in GHG emission 2040

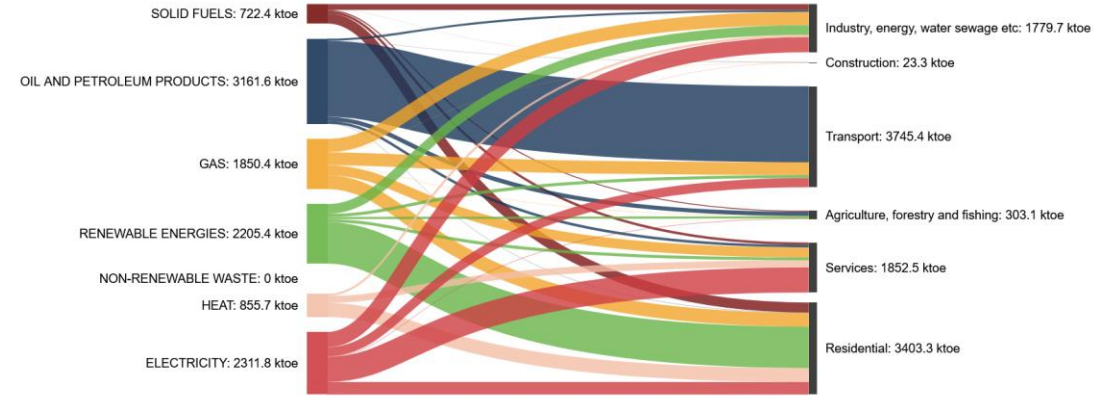
6.3.7 Sankey diagram

Final energy consumption

Mid term

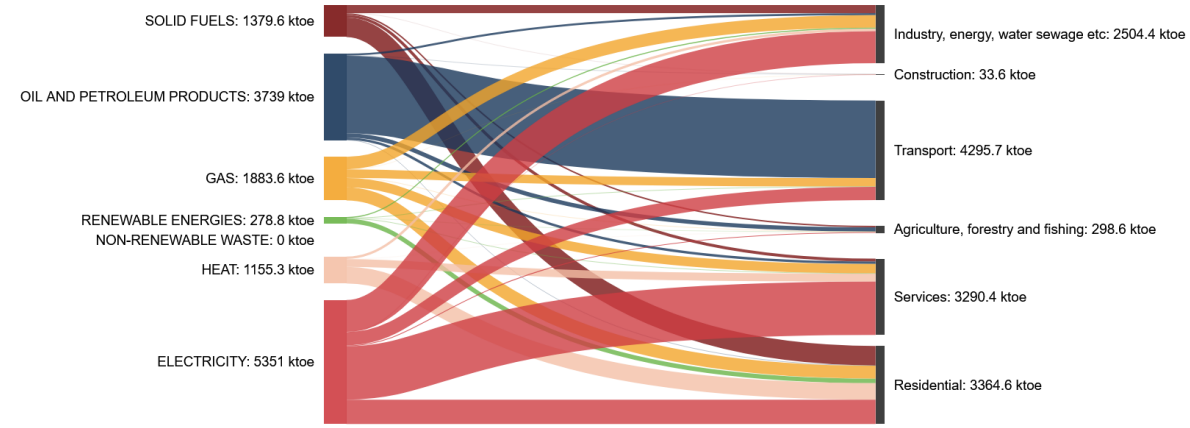


Long term

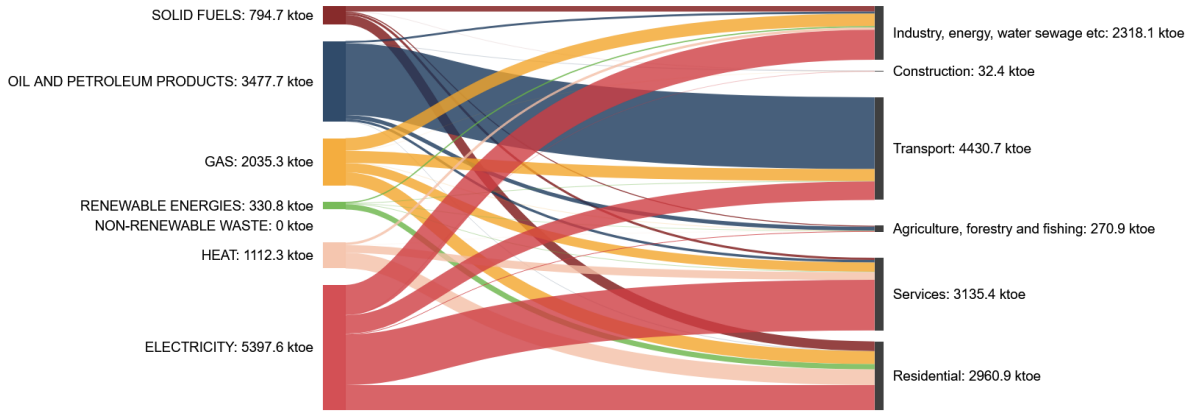


Primary energy consumption

Mid term

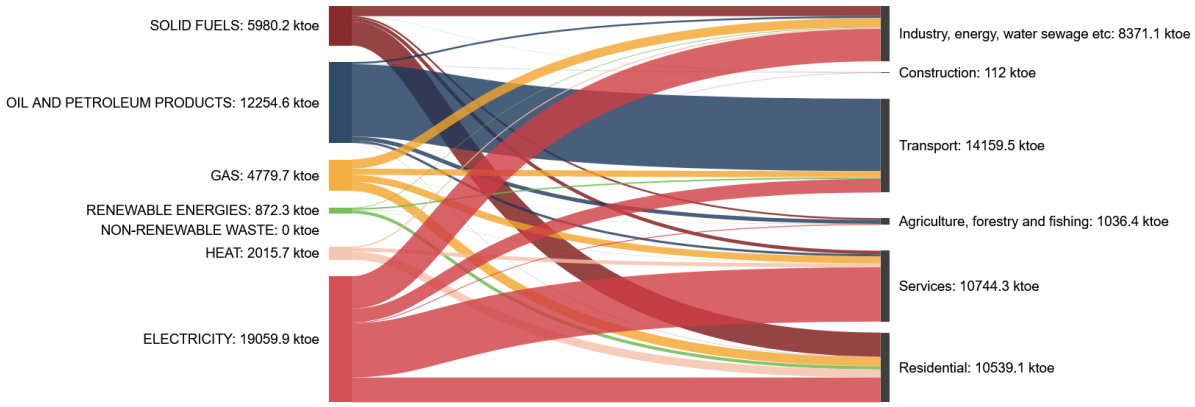


Long term

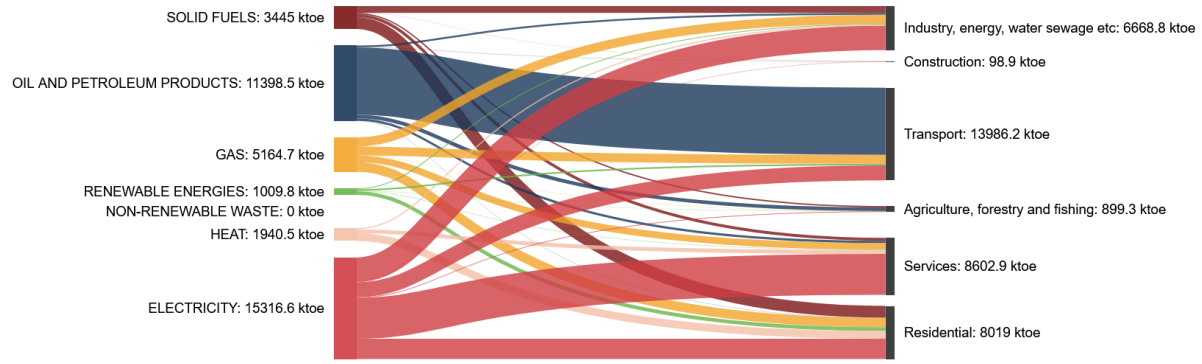


GHG emission

Mid term

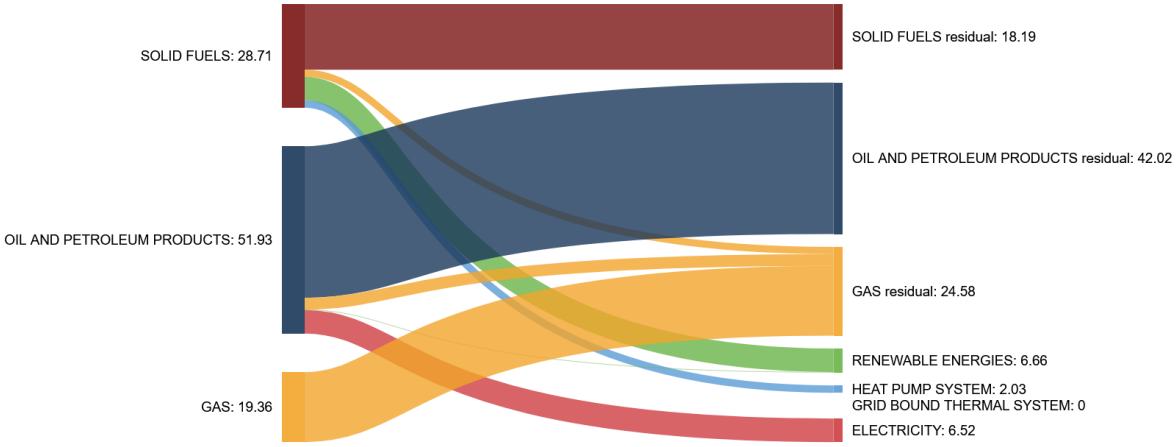


Long term

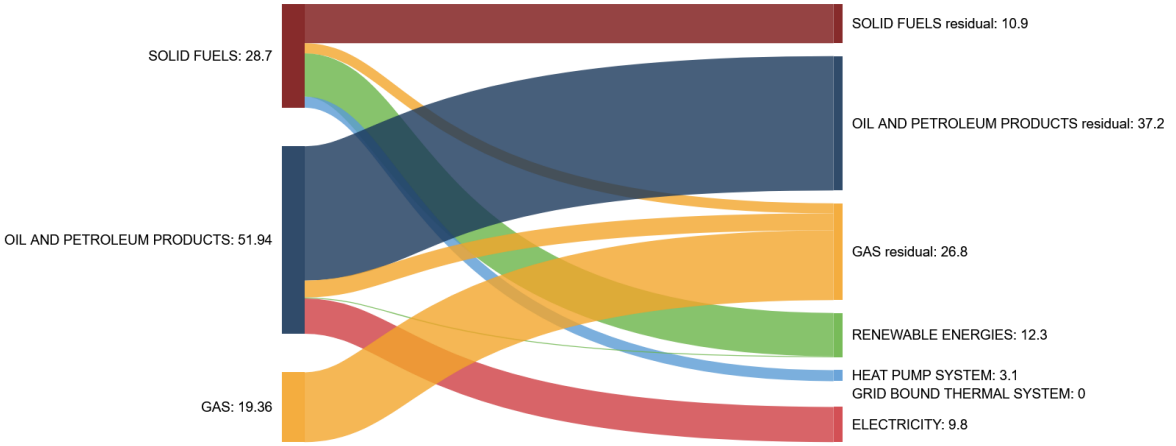


Fossil fuel shift

Mid term



Long term



7. IMPLEMENTATION MONITORING AND KPIs

7.1 Evaluating body and evaluation periods

Monitoring is an ongoing process that helps decision-makers to better understand the effectiveness of the action or system. An effective monitoring and evaluation programme require collecting and analyzing important data on a periodic basis throughout the management cycle of a project. This process often involves collecting baseline data on existing conditions, reporting on progress toward environmental/sustainability improvements, making connections between actions and intended outcomes, and making mid-course changes in program design. An effective monitoring and reporting system ideally include the following elements:

- clearly articulated targets and a set of indicators to measure performance;
- a schedule and set of guidelines for all responsible parties to report to each other;
- an opportunity for responsible parties and stakeholders to periodically meet to coordinate actions and review each other's performance.

This system can be as simple as using standardized reporting forms to facilitate the collection and compilation of data up to an entirely computerized data-sharing system. Nevertheless, what counts is not the level of high-tech computer application that is installed to manage data, but whether the indicators chosen and the items monitored accurately reflect the progress of implementation and allow for an analysis of deviation from targets and goals.

In terms of the set PROSPECT2030 REAP monitoring and evaluation should be carried out annually by local region authorities and energy companies and delivered to the Mazovian Voivodeship Board, which, with the support of the regional energy agency, analyzes them and issues guidelines and recommendations for further implementation, as well as monitoring and mitigation of the risks and challenges encountered.

This activities will involve measuring and determining the actual impact after implementation and the extent to which the measure is meeting the set targets. The two stages of evaluation conducted for these measures/ improved policies:

- Process – process analysis evaluates the progress of the measure based upon capacity building and regulation (qualitative assessment),
- Impact – evaluates the energy savings and financial savings brought about by the measure implementation. (quantitative assessment),

7.2 KPIs for impact monitoring

Evaluation is based on defined key performance indicators. In the table below there are specific set of KPIs already mentioned in the each scenario description that have to be achieved to fulfill presented regional action plan. Those indicators have to be monitored and evaluated, as described in section 7.1

KPI	2030 target	2040 target
Individual heating devices meeting EE requirements	100%	100%
Buildings connected to DHN	60	80%
Buildings after thermomodernization	100% public buildings	50% of all buildings (private and public)
Renwables share in regional energy mix	29,2%	38,3%
RES integration in private buildings	In at least 30% of private buildings and 50% of public buildings	In at least 50% of private buildings and 90% of public buildings
Renewables share in heating supply	30%	38%
Renewables share in electricity supply	60%	80%
Renewables share in transport	14%	21%
Carbon emissions reduction	40% reduction per municipality/city from baseline	55% reduction per municipality/city from baseline
Emission reduction	12%	25,3%
Share of nuclear energy in the regional energy mix	0%	7,5%
Primary energy reduction	5,61%	9,98%
Final energy reduction	1,24%	2,72%
Investments in energy-decarbonization	2 306 Million €	3 723 Million €

8. ASSESSMENT OF SUITING BUSINESS MODELS AND FUNDING SCHEMES

8.1 Existing business models with regional relevance for low carbon energy supply and development potentials

PUBLIC FUNDING

Public support mechanisms financed by EU for investments in EE, RES and low emission energy generation technologies are organized in Poland at two levels:

- regional – organized by regional governments for regional and local public institutions investing in modernization or developing public infrastructure to meet EU EE, RES and low emission requirements:
  - RPO WM – Regional Operational Program;
  - MFOŚ – Regional Mazovia Fund of Environment Protection;
  - De Minimis Aid – Program of subsidies not colliding with principles of European free market for SME in the value up to 200 000 euro for 3 years.
- countryside organized by Polish government:
  - NFOŚ – National Fund of Environment Protection;
  - POIŚ – Program for Infrastructure and Environment Protection;
  - Jessica – Joint European Support for Sustainable Investments in Citi Areas;
  - FROM – Development Fund for Cities in 3 Polish regions including Mazovia.

These public funds form regionally and nationally wide programs may be applied for EPC and RES projects financing.

FINANCING ENERGY INVESTMENTS BY BANKS IN POLAND

The banking sector has gradually developed its involvement in the RES market, responding to the investors' demand and encouragement from former and present Polish governments, indicating the need to build infrastructure for renewable energy in Poland, among others due to the necessity to fulfill international obligations of the country in the scope of CO_2 reduction.

Representatives of the banking community assess the prospects for further development of this market in Poland as being subject to relatively high risk. The main problem is, above all, the huge instability of the national regulatory environment, especially the legal one.

Examples are especially:

- destabilization of the green certificates market;
- modification of the calculation method of the so-called substitution fee without introducing a minimum level (only the maximum level was introduced), which led to a

negative stability change in the economic conditions for the continuation of long-term renewable energy projects;

- the ease with which the energy companies controlled by the State Treasury are trying to completely withdraw from the execution of the long-term CPA and PPA agreements that were the basis for financing the RES projects in the project finance formula.

All of the above factors caused either the lack of interest of banks in financing investments in renewable energy sources or a significant limitation of accessibility and raising the prices of their financing. As a result, the problems with access to external financing are also noted by investors seeking EU funds. The financial and timely feasibility of these projects may be questionable. Bankers stress the need for the Polish state to rebuild confidence among investors and financial institutions. Lack of this confidence will cause reluctance to finance not only the RES sector, but also other projects exposed to regulatory risk. Bankers also emphasize the need to undertake information and education activities in the public space on the economics of renewable energy sources, including the role of the banking system. Attention was drawn to appearing of unreliable or misrepresented information about banks participation in the development of renewable energy in Poland.

BOŚ BANK

Bank Ochrony Środowiska S.A. is a Polish bank whose majority shareholder is the National Fund for Environmental Protection and Water Management. The Bank specializes in supporting projects and activities for environmental protection.

BOŚ offers a wide range of banking products and services:

- investment and revolving financing;
- supplementing the offer of NFOŚiGW and WFOŚiGW;
- European Offer - a package for companies interested in EU subsidies;
- investment advisory;
- leasing;
- preferential financing - implementation of projects that reduce the heat demand for heating the building or water, reducing primary energy losses in the local heat source and other investments aimed at reducing the negative impact on the environment.

Examples of preferential financing provided by BOŚ Bank in association with international financing institutions:

- Bank credit in cooperation with KfW Bankengruppe - the objects of the loan are pro-ecological investments and the loan period is 4-10 years with a maximum amount of up to 250 000 euro. The grace period for loan repayment is up to 2 years. Debt service is reduced in relation to the average market values: preparatory commission (1%), own contribution (15%), margin (by 0.3 pp). The recipients of the loan are micro, small and medium enterprises;
- Credit from the CEB (Council of Europe Development Bank) line - the loan is granted for a period of 4 years, with the loan amount not exceeding 50% of the investment costs. The subjects of the loan are investments related to the development and maintenance of infrastructure and environmental protection. The grace period is up to 2 years, in addition,

the preparatory commission has been reduced (at least 0.5%). The loan is intended for Local Government Units and municipal companies;

- EBI Climate Action investment credit - a credit from the European Investment Bank for financing the Energy Efficiency and RES area), which is on the bank's offer since the third quarter of 2017. The bank grants this type of financing for a maximum of 10 years and up to 75 million euros.
- JESSICA – Joint European Support for Sustainable Investment in City Areas – organised by European Commission and EIB initiative operated by Polish bank - BGK as a revolving fund to finance for up to 20 years solid investments in Polish revitalized cities. Repayment reduction up to 80% as well as one year vacations for justified reasons are possible;
- NFOŚ worked out from national funds a new "clean air" program for owners and co-owners of single family houses in order to support their activity in improving energy efficiency and lowering dust emission of their households. The program will be in operation for a period of 10 years till the end of 2029 and financed out of national funds in the total amount of 103 billion PZL. Also thermo-modernization of houses as well as some RES and heat recuperation installation can be supported out of the program.

INVESTMENT FUNDS

Investment Fund (IF) may be a public or private investing institution usually specializing in certain branches of activities. Usually they operate in consortiums with banks and insurance institutions providing finances to large scale of EPCC projects execution resulting in development of new business opportunities, e.g an EPC modernization project of DH installation which creates new business opportunities to interested bodies. At investment completion IF may sell, lease or hire a professional operator to run a newly developed installation.

GREEN BONDS

At the edge of 2016/2017 Poland issued Green Bonds in cooperation with HSBC, JPMorgan and PKO BP at the amount of 750 000 000 Euro. They are granted in countrywide auctions to private companies interested in RES technology investments. They might be used for financing and refinancing projects that coincides with Green Bond Framework worked out by The Ministry of Finance according to ICMA Green Bond Principles.

8.2 Alternative business models and regional applicability

EPC

The terms of EPC may have in Poland double mining:

EPC(1) – Engineering, Procurement & Construction contracting, defines total contractor responsibility for project execution – in this document to avoid confusion we will use the term of EPCC;

EPC(2) – Energy Performance Contracting defines the purpose and goals of modernization contracting, which mostly calls for EPCC type of contracting responsibility range, in this case further down we will continue to apply the term of EPC;

EPC may be applicable for both types of clients: - public as well as private. Total scope of responsibility for contract execution (engineering, procurement & construction) is assigned to the contractor except an early design development stage which specifies investment program, feasibility study, contracting conditions and financing – the stage of tender documentation development. Energy Performance Contracting aims mainly for energy economy improvement by lowering energy demand and consumption in buildings, city building districts and industrial installation.

Public clients are usually unable to develop necessary for EPC documentation which specifies energy performance targets and project technical vision, feasibility study, financing and contract documentation – so called the early design stage documentation. Usually they call for support to external auditing firms which as an early design stage contractor support the client in modernization processes.

The large scales of EPC usually are financed by consortia of Investment Funds and Banks. In case of public firms EPC can be financed from Public Support mechanisms. The EPC early design phase is usually financed out of bank credits.

PUBLIC-PRIVATE PARTNERSHIP

Public-Private Partnership is a venture organized to perform difficult just for public organization on its own complex projects due to technical (lack of expertise), financial (lack of financial resources – third party financing - TPF) or formal reasons. PPP is usually performed under long time agreement – contract of which target is to modernize public infrastructure e.g.: EPC of public property infrastructure.

For public institutions as kindergartens, schools, universities and hospitals or local governments buildings it would be difficult to collect funds for modernization of their premises as well as to receive loans for improving energy performance of their premises, so an idea of financing modernizations out of energy savings had been developed in USA and spread out in Europe.

Public-Private Partnership also defines the type of contracting relation between public property owner and private contractor which rewards himself out of operational savings after modernization. The contractor that undertakes this type of activity is called an ESCO. Unfortunately this term in Poland has double meaning. In ESCO mode contractors finance projects execution out of their own funds or out of banking loans usually not more than up to 80%. In this case, banks usually require good references and proven history of ESCO project execution from contractors. Depending on the project size, ESCO projects in Poland are financed by international banks in cooperation with Investment Funds, where they usually play roles of payment guarantors.

LEASING OF INVESTMENT IN ENERGY EFFICIENCY AND RES

PolSEFF was the first program among all SEFF programs implemented by the European Bank for Reconstruction and Development in other countries, which enabled investment financing through leasing. This form of financing turned out to be the most popular among Polish entrepreneurs. As much as 70% of all investment projects carried out under PolSEFF were financed in the form of leasing.

Basic causes explaining this result can be:

- leasing has become a natural choice of entrepreneurs to finance the purchase of materials and equipment from the LEME list (List of Eligible Materials and Equipment);
- simplified procedures and a very short time for the decision to grant a lease from the moment an entrepreneur applies for financing;
- categories of materials and devices registered on the LEME list were co-created with leasing institutions that were aware of the needs of small and medium-sized enterprises.

Leasing also proved to be the optimal form of financing the purchase of products registered on the LEME list (preferred by suppliers who, while promoting products covered by the PolSEFF program, also promoted the entire program).

CROWDFUNDING

Crowdfunding (subscription) – is a form of financing for different type of projects organized by a group of people. In crowdfunding case a project is financed by a group of people donating relatively small sums of money by those interested in project execution. In principle, the crowdfunding is an activity consisting in some kind of funds collection and allocation for financing a project execution in order to achieve certain goals, eg.: improvement in energy distribution installations within a building by occupiers in order to decrease costs of living. In most of the European countries crowdfunding is not legally regulated. In Poland a Polish Society of Crowdfunding operates, which provides legal support to interested groups of people.

8.3 Usable funding schemes: applicability and possible gaps to be filled

One of the gaps of usable funding schemes is that the vast majority of potential EE&RE projects can be defined as small and micro scale projects and tend to have long payback period, it is hard for the potential beneficiaries to attract financial investors to participate in the projects via provision of equity.

Another issue is that the pool of funds available via subsidies is usually limited and in most cases subsidies do not cover 100% of necessary funds, which means that potential beneficiaries are often in need to use other financial instruments in order to implement projects.

Financial instrument used to finance EE&RE projects that is the easiest to obtain and most commonly used is the debt from financial institutions. However, debt financing involves several aspects that may discourage potential EE&RE projects beneficiaries from using this kind of financing method and result in withdrawals from the projects. This aspects include i.a.:

- the necessity of provision of collateral,

- risk related to necessity of debt repayment even when the project does not generate expected results,
- the necessity of preparation of proper documentation presenting the feasibility of the potential project in order to convince financial institution to provide financing.

In some fields, such as wind energy, it may be hard for beneficiaries to finance investments through debt, or the cost of financing proves to be high due to priced-in risk resulting from the instability of the regulatory framework in Poland.

Complementarity between regional and national incentives and regulations is important in order to generate a positive effect and fill gaps and avoid creating speculative opportunities in several sectors and leaving others sectors without sufficient support. In addition, medium to long-term synergies will allow more investors to plan and implement initiatives with less risk

One of the most important aspects to be implemented in future (especially in long-term perspective) financing systems is the stability of the system itself over the years. In fact, until now most incentives have been set up suddenly as demand increases. Lower but more stable incentives can prevent market distortions and create speculative situations for investors, and can also allow market participants to adapt and build business plans over a longer time horizon.

9. CONCLUSIONS

9.1 Summary of findings

As mentioned in the introduction the goal of the Regional Energy Action Plans is to be the starting point that will drive Mazovia region to the transition towards low carbon economy. This goal will can be accomplished by focusing into 6 regional mission statement

1. Centralized energy planning
2. Energy efficiency in buildings
3. Renewable energy sources
4. Sustainable transport
5. Electricity grid
6. District heating network

Those mission statements and proposed action described in the document can develop a path towards regional energy transformation and sectoral decarbonisation.

By estimating slow, linear population growth (between +3-6%) and increase in energy needs (especially electricity) it is crucial to develop more appropriate regional energy that does not have a critical impact on the environment. Following the described in the REAP actions and focusing on detailed measures can lead into significant primary and final energy consumption decrease (primary energy -9,98%, final energy -2,72%) and accordingly emission reduction (-25,3% from 2016).

With those well-documented road steps and actions to be taken, given the many available public and private funding opportunities, the energy challenges imposed by the EU towards climate neutrality by 2050 can be met.

9.2 Challenges for the regional authorities and stakeholders

The energy sector is facing many challenges. On the one hand, the regions must follow the low-emission trend, and at the same time ensure energy security and the rationality of incurring costs for changes in the sector. Currently, the market of energy generated from RES installations is not sufficient. Decarbonization is key to the energy transition. For this reason, the participation of regional authorities and important stakeholders will be essential and they must be actively involved at every stage of the transformation. It is also fundamental to understand the needs of the region and its inhabitants, as well as a rational approach to opportunities and investments.

Various actors (policy-makers, social scientists, etc.) seem to slowly agree that energy transformation is needed and inevitable but the main challenge will be for all of those actors coming from different background and experiences taking one path and manage to ignore the differences in internal prioritization of activities resulting from the needs of only one sector. There is a need for intersectoral communication and multi-stakeholder participation, as well as for the increased involvement of citizens whose needs, but also direct actions will be of key importance in achieving the intended results of the energy strategy

The biggest challenge will surely be finding a common language to reach the set energy goal, but also mobilizing residents and society to be actively involved and change some of their behavior, views and habits.

9.3 Expected impact on regional economy

One of the main problems of the region is the lack of long-term competitiveness of the economy. Maintaining the high pace of economic development in the next decade requires the modernization of the economy, and thus an increase in the share of innovative products in sales. However, to make it possible, it is necessary to provide energy with appropriate parameters. The condition for building a modern economy is ensuring energy security. Ensuring the safe operation of the system significantly affects economic growth, which is reflected in the increase in income and the quality of life of the inhabitants.

The result of the energy transformation will be considerable benefits for citizens, including by controlling energy costs with declining fossil fuel resources, a cost-effective approach to the consumption of dwindling water resources or a reduction in health costs caused by polluted air. Despite the fact that energy will become more expensive, its independent production and storage will be a tool to control rising costs.

9.4 Gaps to fill for proper implementation (technical, regulatory, financial)

For the full implementation of the presented regional energy plan for the Mazovian Voivodeship, it is necessary to receive support from the authorities of the Mazovian Voivodeship, as well as from the regulations and policies on the national level. Due to the consistency of the document with strategic documents, there should be no big dissonance in achieving common goals. However, it is necessary to monitor the laws and ideas of the authorities at the national level, which will have a direct impact on regional laws.

In addition, it is necessary to monitor the new financial perspective and new sources of financing, which may open up completely new paths towards the energy transformation of the region.

The last factor that has to be taken into account and be detailed monitored is the issue of new technologies. The market for new solutions is inexhaustible and every day gives new, more effective, more innovative and profitable solutions that can be used. Therefore, it is not worth focusing on only one option, but keeping track the new technological possibilities that may turn out to be a more advantageous solution.