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Challenges for Poland in the non-ETS sectors

2030 – 2050

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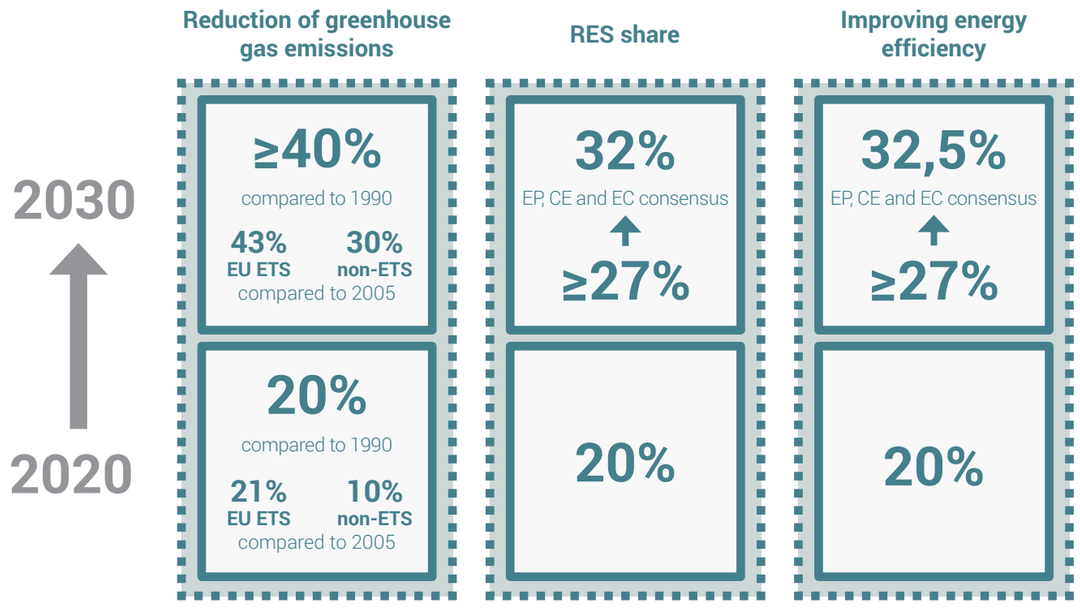
Introduction

Since 1994, Poland has been a signatory country to the United Nations Framework Convention on Climate Change and in 2002 it signed the Kyoto Protocol. Consequently, it participates in the international community's efforts to limit climate change. In the first period of commitments resulting from Poland's ratification of the Kyoto Protocol, Poland undertook to reduce greenhouse gas emissions in 2008-2012 by 6% compared to base year emissions. In the second commitment period, i.e. 2013- 2020, Poland does not implement its individual reduction target, because the European Union, its Member States and Iceland have concluded an agreement on the joint fulfilment of the target. The common reduction target was expressed as a commitment to achieve average annual emissions at the level of 80% of the total emissions of all countries in base years.

In the long term perspective, the European Union already in 2014 agreed on its reduction targets for 2030 – the total target and the target broken down to EU ETS and non-ETS. The EU has also adopted ambitious targets for RES and energy efficiency, which were further increased in 2018[1]. While these climate policy targets apply to the European Union as a whole, the details of contribution and participation of Member States and economic sectors to their achievement are defined in various ways at this stage. A comparison of EU commitments up to 2030 with the 2020 targets is shown in Fig. 1.

The European Union realises its objectives through the Union's policies and the national policies of the Member States, with EU emissions divided into: emissions covered by the EU Emissions Trading Scheme (EU ETS) and not covered by it (non-ETS). In the EU ETS system (which covers large industrial and energy installations), the EU Member States have no emission reduction commitments, as these emissions are limited at the level of the entire EU and not at the level of individual countries. On the other hand, EU law imposes emission limits in non-ETS on Member States (including Poland).

Fig. 1. EU commitments by 2030 in relation to the 2020 target

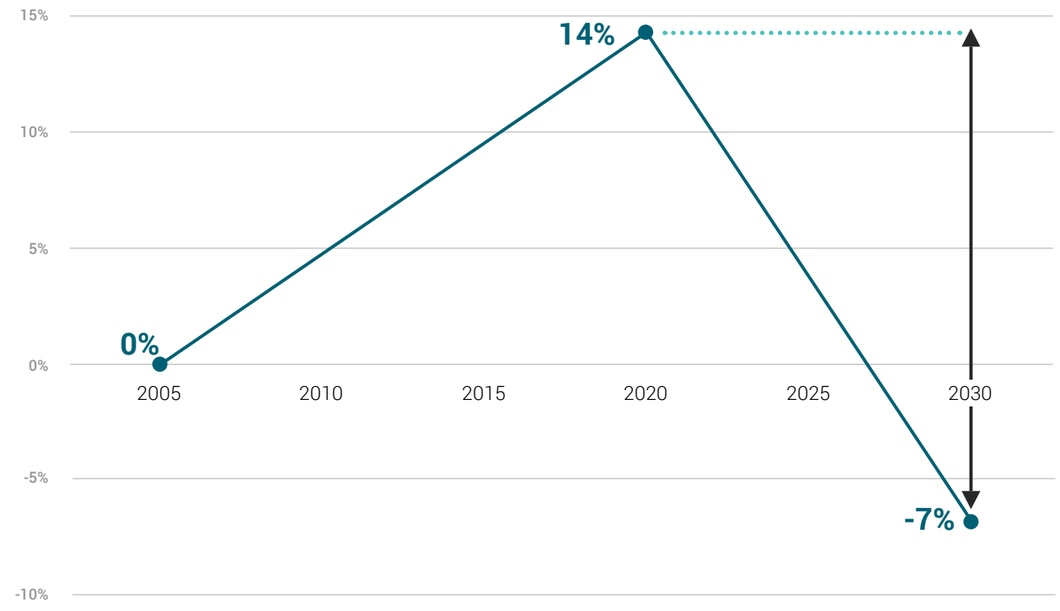


Source: Own study by KOBiZE

[1] RES target – from 27% to 32%, target in the scope of Energy efficiency from 27% to 32.5%. Source: http://europa.eu/rapid/press-release_IP-18-4229_en.htm

The 2030 reduction target for non-ETS has been "shared" among EU Member States. For Poland it is -7% in relation to non-ETS emissions in 2005. This is a very ambitious target taking into account that in the period from 2013 to 2020 Poland has the right to increase non-ETS emissions by 14% compared to 2005 (see Fig. 2).

Fig. 2. Comparison of the targets set out in the ESD and the ESR



Source: Own study by KOBiZE

The volume of greenhouse gas emissions classified as non-ETS in Poland is more or less similar to the volume of emissions in the EU ETS (it accounts for about 50% of national emissions).

Emissions in the non-ETS area come mainly from transport, fuel combustion in the municipal sector (e.g. in domestic furnaces) and agriculture (soil fertilisation, animal faeces), as well as from waste and small energy and industrial installations which are not covered by the EU ETS). Emissions from transport are increasing and are expected to continue to increase as a result of economic development and increasing passenger and freight transport. In this respect, the mitigation effect will be achieved, for example, by the *"Energy for the future" Plan for the Development of Electromobility in Poland*[2]. In the municipal sector, emissions will be reduced, inter alia, under the government's "Clean Air" programme, which will reduce smog and greenhouse gas emissions.

[2] https://www.gov.pl/web/energia/elektromobilnosc-w-polsce

Main challenges for Poland

in the context of emission reductions in the non-ETS area

Challenges – emissions from the transport sector and potential GHG emissions reductions in 2040

Electromobility Development Plan in Poland

The Polish government has noticed the potential of electric vehicles, alternative fuels and global trends in the dynamic development of this part of the automotive industry and has developed a policy to support the development of electric vehicles called the *"Energy for the Future" Electromobility Development Plan*. This plan was adopted by the Council of Ministers on 16 March 2017. The plan describes the main assumptions, targets, mechanisms and effects of the large-scale introduction of electric vehicles.

The most important objective of the Electromobility Development Plan is to achieve in Poland the number of **1 million electric cars by 2025**. The implementation of this target would allow to obtain specific environmental benefits related to the reduction of pollutant emissions from transport in agglomerations. The reduction of the country's energy dependence by reducing the demand for liquid fuels, and thus a decrease in the volume of crude oil imports would constitute additional effects. The increase of stability of the energy system by increasing energy demand in the load valley, assuming that electric vehicles will be charged mainly at night, could also constitute a certain indirect benefit from the development of electric vehicles. An important element of the Plan will be to stimulate conditions for the construction of electric cars in Poland, which would have a positive impact on a number of sectors of the economy related to the automotive industry. The success of the Electromobility Development Plan will depend on the synchronisation in time of activities such as support for industry and scientific and research institutions, stimulation of demand and development of infrastructure and legal regulations.

Objectives and expected effects of the Electromobility Development Plan

Environmental effects

In cities, apart from individual heating systems, road transport is one of the main sources of pollutions such as dusts, benzo(a)pyrene and nitrogen oxides. Consequently, the use of electric cars will be of the greatest importance in large agglomerations for reducing emissions of harmful pollutants having direct impact on residents. For this reason, the use of electric cars in agglomerations and the development of supporting infrastructure will have a positive impact on the health of a significant number of people.

With regard to climatic effects of the programme, their strict dimensioning, especially in the short term, is difficult due to the fact that the complex effect of replacing combustion vehicles with electric vehicles strongly depends on the technology of electricity generation for charging and on the electric vehicles' factual energy use intensity in road conditions. However, the Electromobility Development Plan should be seen in the long term perspective, taking into account current and future modernisation processes in the energy sector, including the increasing use of renewables and low- carbon fuels, improved energy efficiency in both generation and transmission and distribution of electricity. From this point of view, there is no doubt that the developing electromobility will have long- term effect on greenhouse gas emissions' reduction.

In addition, it should be noted that the development of electromobility also entails changes in the way in which greenhouse gas emissions are controlled. As a result of the transfer of part of the emissions from the transport sector, which is regulated in the non-ETS area, indirectly to the energy sector, which is covered by the EU ETS, it will be possible to control these emissions more closely. At the same time, the chances of meeting Poland's non-ETS targets by 2030 will increase.

Industry and research development

Since the production of electric cars is still at a relatively early stage of development, it seems that the barrier of entry into this industry is not as high as in the case of the production of combustion cars. Moreover, there are companies in Poland with experience in a similar area, i.e. in the production of electric buses, which may make it easier to start work on an electric car of domestic production. Nevertheless, a significant part of components necessary for the production of cars will be produced abroad, while the implementation of support mechanisms for the production of electric vehicles may lead to the fact that at least 30% of the added value associated with this production will be produced in Poland.

In October 2016, four Polish energy companies - PGE Polska Grupa Energetyczna SA, Energa SA, Enea SA and Tauron Polska Energia SA - established ElectroMobility Poland SA (EMP). EMP's task is perceived as broadly understood creation of conditions for the development of the electromobility system in Poland, including:

- coordination of activities of NCRD and NFEPWM and other institutions for the benefit of cooperation between industry and scientific institutions;
- financial support for implementation projects related to the construction of electric vehicles and necessary infrastructure;
- undertaking promotional activities;
- coordination of local activities aimed at the development of charging and servicing infrastructure for electric vehicles.

The company's activities will contribute to the growth of innovativeness and competitiveness of the Polish economy.

Energy reception stability improvement

The planned increase in the share of electric vehicles in transport will be associated with a significant increase in electricity demand, estimated in the Electromobility Development Plan at approx. 4.3 TWh per year (assuming the achieved number of 1 million electric cars). This means a significant additional burden for the energy system, as it constitutes about 3% of the final domestic demand for electricity. On the other hand, the fact that, to a large extent, it will be possible to recharge electric cars at night during low energy demand hours will mean that, with appropriate technical and legal solutions, recharging electric cars can have positive impact on the energy system and it can improve the economic efficiency of energy sources, which presently must reduce the generation in night-time valleys of demand. The introduction of a system of tariffs differentiated in specific load zones and automatic control of charging systems for electric cars included in a comprehensive system of intelligent metering and demand management, possibly also connected with energy storage systems, constitute a necessary element for the proper operation of the energy system. Moreover, taking into account the capacity needs of charging stations, it may be necessary to upgrade part of the network infrastructure (independently of the modernisation related to the maintenance of existing transmission capacities). Therefore, aspects related to the development of infrastructure for charging electric cars must be taken into account in studies and future development plans of transmission and distribution system operators.

Reduction of dependence on crude oil import

Currently, the vast majority of crude oil used to produce liquid fuels for transport is imported. Domestic production does not cover even 4% of demand, so the growing use of electric vehicles may be an opportunity to reduce dependence on imported raw materials and thus improve the country's energy security. The scale of this effect, however, depends not only on the success of the Electromobility Development Plan, but also on the changes that will take place in the entire energy production sector.

Barriers and threats for the Electromobility Development Plan implementation

The main barrier to the development of electromobility is currently the cost of electric vehicles, which is still much higher than in the case of their combustion equivalents. This is particularly important in countries such as Poland with a relatively low average income per capita compared to countries in Western Europe. In addition, batteries constitute about 30-35% of the cost of an electric car. It is an element that is subject to wear and tear over time, causing a real reduction in travel range and a relatively fast loss of value of the vehicle. Therefore, it seems that the use of electric cars will largely depend on the rate of development of battery technology and decrease in production costs, as well as perhaps also on solutions related to the use of used automotive batteries as stationary electricity storage systems.

Although the travel range of electric cars on a single charge is usually worse to their combustion equivalents, it seems that this issue is not a big problem in the case of an urban car, which can be regularly recharged from a socket next to a parking space. On the other hand, an important barrier to the spread of electric vehicles may be the insufficient rate of construction of charging infrastructure, therefore, support for it through the implementation of local projects will be an important element of the Electromobility Development Plan.

Challenges for Poland in the non-ETS sectors

Planned actions and support mechanisms

The Electromobility Development Plan contains an initial list of instruments whose implementation will support the development of electric cars in Poland. The most important are as follows:

- launching pilot programmes in selected cities covering both the development of charging infrastructure for electric individual transport vehicles and financial support for local governments in electrification of the municipal bus fleet;
- introducing the requirement of a specific share of electric cars in the purchase of vehicles for the needs of public administration and introducing the obligation for public administration to build an appropriate infrastructure;
- development and implementation of changes in the tax system enabling the introduction of tax exemptions (excise tax, VAT, other depreciation) for users of electric vehicles;
- implementation of legal regulations enabling dynamic tariffing and development of intelligent energy consumption metering systems, which is necessary for efficient operation of the system of electric vehicle charging stations and settlement of consumed energy;
- achieving changes in legislation enabling local governments to designate low-emission zones and restrictions on the circulation of combustion vehicles, as well as the introduction of charges related to emissions from combustion vehicles;
- soft instruments for the promotion of electric vehicles, such as the possibility of using bus lanes, free parking in city centres, the possibility of entering restricted traffic zones, etc., should be taken into account.

On its present form, the Electromobility Development Plan outlines the next stages of the programme implementation in a rather general way. Particular elements, especially those related to support for industry and specific initiatives in the area of designing and construction of electric vehicles, will be developed in cooperation between the Ministry of Energy and the Ministry of Development which are leading the realization of the programme and the Ministry of the Environment and scientific institutions (NFEPWM, NCRD), under the direction of the EMP company established in order to coordinate the activities.

On 29 March 2017, the Council of Ministers adopted the "National Policy Framework for the Development of Alternative Fuels Infrastructure". The document is crucial for the support of market and infrastructure development in relation to electricity and natural gas in the form of CNG and LNG used in road and water transport.

The framework includes the following:

- an assessment of the current state and opportunities for future market development with regard to alternative fuels in the transport sector;
- national general and detailed objectives for the development of infrastructure for recharging electric vehicles and fuelling natural gas in the form of CNG and LNG and the market for vehicles powered with these fuels;
- instruments supporting the achievement of the above mentioned objectives and necessary for the implementation of the Electromobility Development Plan;
- a list of urban agglomerations and densely populated areas where publicly accessible charging points for electric vehicles and CNG refuelling points are to be established.

In 2020 in 32 selected agglomerations:

- in the electricity-powered vehicles segment:
  - there will be 50 000 vehicles on the roads;
  - there will be 6 000 points with normal charging capacity;
  - there will be 400 points with high charging power;
- in the segment of cars powered by natural gas in the form of CNG:
  - there will be 3 000 vehicles on the roads;
  - there will be 70 refuelling points;

In 2025 at the national level in Poland:

- 32 CNG refuelling points will be available along the TEN-T core network;
- there will be 14 LNG refuelling points along the TEN-T core network;
- installations for bunkering LNG vessels in ports will operate in: Gdańsk, Gdynia, Szczecin, Świnoujście.

The implementation of the National Policy Framework objectives will allow for the development of innovative and environmentally friendly transport on the territory of Poland. The programme is consistent with the Electromobility Development Plan.

The Act of 11 January 2018 on electromobility and alternative fuels creates a comprehensive legal framework for the development of the entire electromobility and alternative fuels sector. The new legal regulations are to stimulate the development of electromobility in Poland and the use of alternative fuels in transport. These are mainly electricity and natural gas - both liquefied (LNG) and compressed (CNG). Moreover, the Act implements the European Directive 2014/94/EU on the development of alternative fuel infrastructure into Polish law.

The Act provides for a system of incentives:

- the abolition of excise duty on electric cars and plug-in hybrids (PHEV);
- exemption from parking fees;
- higher depreciation write-offs for companies.

It also assumes the construction of a core network of infrastructure for alternative fuels in agglomerations, in densely populated areas and along trans-European road transport corridors in order to allow the free movement of vehicles powered by these fuels.

The Act foresees that by the end of 2020 the following will be created:

- 6 000 charging points with normal power;
- 400 high-power electricity charging points;
- 70 CNG refuelling points.

Potential effects of the electric vehicles share increase in passenger transport in Poland

The increase in the use of electricity by passenger cars will also result in reducing demand for liquid fuels. Achieving the target of one million passenger electric cars by 2025 would reduce liquid fuel consumption in the passenger car group by about 4%.

Estimating the emission impact of electric vehicles is more difficult and requires a number of additional assumptions. Undoubtedly, in large agglomerations, as a result of reduced traffic of vehicles with internal combustion engines, low emissions of particulate pollutants, nitrogen oxides and benzo(a)pyrene will be reduced. This is a very important effect from the point of view of human exposure to direct pollution impact. On the other hand, the total effect related to greenhouse gas emissions depends to a large extent on the structure of electricity generation in a given period of time.

The conducted analyses confirm that in addition to the reduction of local pollutant emissions, in the future, electromobility will be an important element in the reduction of national greenhouse gas emissions. In order to achieve the effect of reducing CO_2 emissions, it is necessary (apart from wide implementation of electric vehicles) for the national electricity generation structure to evolve towards a greater share of low and zero emission sources.

An estimation of the impact of electric car deployment on CO_2 emissions was carried out for two scenarios of electromobility development in Poland, assuming that the share of electric cars in the passenger car structure will reach 30% or 50% by 2050. The results of the calculations indicate the possibility of achieving CO_2 emission reductions between 2.4 and 3.7 million tonnes in 2040 and between 5.1 and 8.3 million tonnes in 2050, depending on the degree of saturation of the passenger car fleet with electric vehicles.

In addition to reducing local pollutant emissions, electromobility will in the future be an important element in reducing national greenhouse gas emissions. In order to achieve the effect of reducing CO_2 emissions, it is necessary (apart from wide implementation of electric vehicles) for the national electricity generation structure to evolve towards a greater share of low and zero emission sources.

The above estimates of emission effects are based on a comparison of unitary energy consumption in combustion passenger cars and electric cars under Polish conditions. For both groups of cars, the analysis of specific CO_2 emissions associated with the operation of the vehicle was carried out, and:

- in the case of combustion vehicles, both direct emissions and emissions from refinery processes were taken into account;
- for electric cars, the emissions related to electricity generation were estimated - according to the current and projected fuel structure - taking into account losses at the transmission and distribution stage.

It should be stressed that the presented results are very sensitive to the assumed technical parameters of particular groups of vehicles (in particular the assumed level of unitary consumption of fuel and energy) and the assumptions concerning their efficiency improvement. The key assumptions and data sources used in this analysis are presented below:

- consumption of liquid fuels per kilometre according to Polish MTS[3] estimates, electricity consumption in electric cars according to MTS, IEA[4], EPA[5] data;

[3] Motor Transport Institute (MTS), Expert forecasts for changes in road transport activities., Warsaw 2017.

[4] International Energy Agency (IEA), Global EV Outlook 2018 r., 2018.

[5] Environmental Protection Agency (EPA), Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2017.

- emission indicators for petrol, diesel and liquefied gas according to the reports by KOBiZE[6];
- unitary emissions from oil refining processes as estimated by EPA and IJEE[7];
- CO_2 emissions at the stage of electricity production, taking into account change in the fuel mix - according to the ARE[8] Forecast by 2040 with further extrapolation according to own assumptions;
- reduction of energy intensity by 25% by 2050, both for cars with combustion engines and electric cars (these estimates are more cautious than those presented in the IJEE, where efficiency improvement of even up to 35% by 2050 is assumed).

Summary of electromobility development prospects

Summarizing up the prospects for the introduction of electromobility in Poland, it can be noted that:

- replacement of combustion vehicles with electric vehicles will first of all contribute to the reduction of pollutant emissions in agglomerations and thus to the improvement of health conditions, which should be the main premise for the implementation of electric vehicles;
- in relation to the national carbon balance, significant benefits should be expected in the longer term, as initially even a slight increase in carbon dioxide emissions is possible and economies of scale will depend on a number of factors, among which changes in the structure of electricity generation, improved energy efficiency and overcoming barriers to electromobility development will be crucial;
- the spread of electromobility will reduce carbon dioxide emissions in the transport sector;
- at the same time, the need to generate additional electricity will burden the energy sector and increase its emissions;
- consequently, there will be a "shift" of emissions from the transport sector, not covered by the EU ETS, to the EU ETS, which is subject to strict regulation;
- the increase in electricity consumption associated with the need to charge electric cars can have a positive impact on the stability of the electricity system, provided that solutions are put in place to ensure that charging installations are properly controlled (night-time charging, with low energy demand).
- moreover, the awareness of the existence of barriers and the way to overcome them may determine the success of electromobility implementation in Poland; the most important barriers are as follows: the cost of vehicles, especially batteries, and sufficient development of appropriate infrastructure for charging electric vehicles.

Challenges – emissions from the municipal and household sector and potential GHG emissions reduction in 2040

The main challenges facing the municipal and housing sector by 2050 require a significant improvement in the energy performance of old buildings as the sector's contribution to the long-term global temperature target of limiting the global temperature increase by the end of the century by less than 2°C compared to the pre-industrial period. With the adoption by the international community of a long- term global temperature target of 1.5°C, global greenhouse gas emissions should reach zero level by 2050. The municipal and housing sector have to significantly accelerate the modernisation of existing resources or replacing them with zero-emission resources[9]. Zero carbon emissions presupposes the use of renewable energy by the municipal and housing sector, which reinforces the challenge facing the sector and makes a complete, accelerated transformation of the energy sector crucial for the success of the necessary measures.

Emissions from the municipal and housing sector come from fuel combustion resulting from energy consumption for heating and cooling buildings and their lighting and power supply for domestic appliances and appliances used for the provision of services. In this sector, carbon dioxide accounts for the vast majority of GHG emissions, while emissions of other gases are negligible. In Poland, in the municipal and housing sector, the most important emissions related to energy demand come from energy consumption mainly in households and housing, and to a much lesser extent – from trade, services and public institutions. In Poland, this sector is responsible for about 30% of the volume of domestic greenhouse gas emissions in the non-ETS area.

Reducing the consumption of heat and electricity by individual consumers, trade and services is a prerequisite for achieving the reduction targets both in the municipal and housing sector (which is part of the non-ETS) and in the ETS energy sector. This requires solutions leading to energy demand reduction resulting from increased energy efficiency of buildings and household appliances, electrical appliances used in services and commerce, and of equipment such as stoves and heating and cooling appliances. Changes in consumer behaviour leading to informed use of energy are also necessary.

The European Union adopted energy efficiency targets in the municipal and housing sector by the end of 2020[10] and 2050[11], taking into account milestones in 2030 and 2040. By the end of 2020, all new buildings constructed in the EU, and thus in Poland, should be buildings with energy consumption close to zero, achieved by gradual introduction of stricter technical requirements for the energy performance of buildings[12] and increased share of energy from renewable sources in final energy consumption and the spread of distributed RES. At the same time, Poland, like other EU Member States, is implementing a programme to improve energy performance of existing buildings, including those owned and rented by government institutions and housing stock, by their thorough renovation and implementation of measures changing the behaviour of building users[13].

Buildings subject to legal transactions must be equipped with energy performance certificates containing information on the amount of energy used in the course of energy consumption, which is intended to raise awareness among users and purchasers and provide an impulse for thermomodernization.

An additional incentive for conducting thermomodernization and reducing energy consumption in the municipal and housing sector in Poland will be the government programme for combating air pollution "Clean Air", to be implemented between 2018 and 2029. This programme constitutes part of the implementation of the guidelines of the National Programme for Air Protection, which assumes that by 2030, Poland will achieve the WHO standards defining the permissible concentrations of air pollution. The adoption of this programme was caused by low air quality, especially in cities, due to the contribution of emissions from transport and emissions from the construction sector, especially from single-family buildings.

Smog in Poland differs in composition from acid smog (London type) and from Californian photochemical smog (Los Angeles type). Smog in Poland is composed mainly of PM_{10} and $PM_{2.5}$, dust particles, as well as the most dangerous for health PM_1 dust - soot (BC) and numerous polycyclic aromatic hydrocarbons, including benzo(a)pyrene. Due to its composition, this type of smog can be called 'dust smog'. Dust impurities are related to the combustion of solid fuels in low efficiency furnaces. This smog is produced in high-pressure weather and at negative air temperatures. Low temperature causes increasing demand for heat, which results in an increase in pollutant emissions from individual heating appliances. Dust smog occurring in Poland is not accompanied by exceeding the SO_2 and CO concentration limits.

Air pollution causing smog comes from the so-called "low emission". Low emission is the emission of pollutants introduced into the air from sources by means of emitters of a height below 40 m. Therefore, it concerns individual heating devices used in the municipal and housing sector, including single-family or multi-family buildings, local boiler houses with a low heat output, public utility buildings, service workshops, commerce, etc. Low emissions also include emissions from the road transport sector.

Low emissions are connected to the heating of houses with individual heating devices. Consequently, appropriate actions of the owners of these houses are of the greatest importance in the fight against smog. In a large number of households, the basic fuel used in heating is bituminous coal, which in combination with old, low emission sources of combustion causes increased emission of particulate matter having a significant impact on air pollution.

[6] National Center of Emission Balancing and Management (KOBIZE), Calorific values (CV) and CO_2 emission indicators (EI) in 2015 for reporting in the framework of the Community Emissions Trading Scheme for 2018. Warsaw 2017.

[7] International Journal of Energy and Environment (IJEE) Life cycle analysis and environmental effect of electric vehicles market evolution in Portugal, Volume 5, Issue 5, 2014 pp.535-558

[8] Energy Market Agency (ARE), Atmoterm, "Analyses and forecasts for the needs of the development of the "National plan for energy and climate for 2021-2030", Warsaw, December 2017

[9] Analyses of the scenarios considered by scientists show that limiting the global temperature increase to below 1.5°C would be possible if global emissions were to fall by 45% below 2010 levels by 2030. By 2050, global CO_2 emissions must fall to zero and become negative in the second half of the century based on CO_2 reduction technologies such as Carbon Capture and Storage Compare: http://report.ipcc.ch/sr15/pdf/sr15_ts.pdf

[10] Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC.

[11] Directive 2018/844/EU of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency.

[12] Compliant to the Regulation amending the Regulation on technical conditions to be met by buildings and their location (Journal of Laws of 2013, item 926), change in the limit values of EP indexes (index of annual demand for non-renewable primary energy [kWh/(m^2·year)] for newly constructed buildings and some U-coefficients (coefficient determining requirements for thermal and humidity protection) for building envelope.

[13] The "National plan for increasing the number of nearly-zero energy buildings" was adopted in June 2015. (Resolution No 91 of the Council of Ministers of 22 June 2015).

The "Clean Air" programme is a financial tool aimed at the owners of residential buildings. The aim of the programme is to improve energy efficiency and reduce emissions of dust and other pollutants into the atmosphere from the existing single-family residential buildings or to avoid emissions of air pollutants from newly constructed single-family residential buildings. The beneficiary of the programme is the owner of a residential building satisfying housing needs, which constitutes a structurally independent whole, in which it is allowed to separate at most two residential units, or one residential unit and a commercial unit with its total area below 30% of the total area of the building.

The form of co-financing under the programme concerns a grant or a loan granted by the Provincial Funds for Environmental Protection and Water Management in the scope of investment projects.

Types of projects implemented from the programme funds aimed at reducing or avoiding low emissions related to improving energy efficiency and the use of renewable energy sources in single-family buildings are, in particular:

1) replacement of old-generation heat sources which do not meet the requirements specified in the Annex to the Regulation of the Minister of Development and Finance of 1 August 2017 on the requirements for solid fuel boilers (Journal of Laws of 2017, item 1690);

2) installation of equipment and installations meeting the technical requirements specified in Annex No 1 to the priority programme: solid fuel boilers, thermal centres, electric heating systems, oil boilers, gas condensing boilers, air heat pumps, heat pumps receiving heat from the ground or water, together with connections;

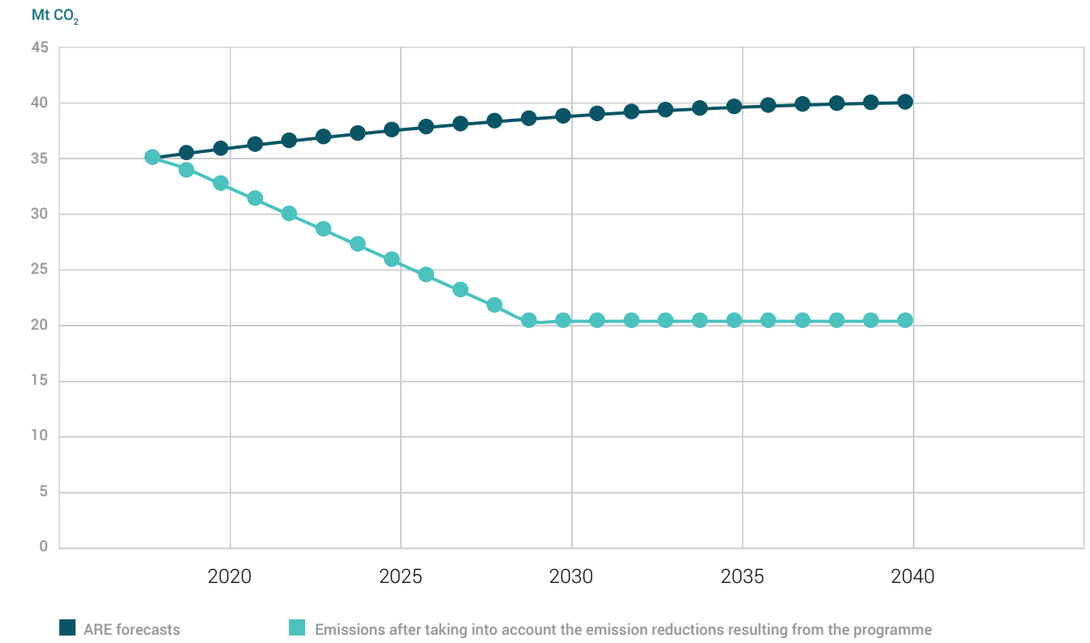
3) use of renewable energy sources (solar collectors, photovoltaic microinstallations);

4) thermomodernization of single-family buildings.

The "Clean Air" programme is planned for implementation over a period of 10 years. The budget earmarked for the implementation of the programme amounts to PLN 103 billion and the beneficiaries of the programme may apply for non-refundable grants, for which PLN 63.3 billion has been earmarked, or for loans, for which PLN 39.7 billion has been earmarked.

The programme of measures will result in improvement of the energy efficiency of buildings. Approximately 4 million single-family residential buildings will be thermomodernized and their heating devices will be replaced under the programme. The implementation of these measures will result in dust reduction, including PM_{10} and $PM_{2.5}$, as well as CO_2 emissions. The improvement of energy efficiency of residential buildings and of heat generation, and above all, the replacement of heating devices often triggering change of the fuel used, as well as change of the combustion process in new devices into less emission-intensive will all contribute to achieving the programme targets. This translates into reduction in dust emissions, including PM_{10} – 31.523 kt, $PM_{2.5}$ – 25.218 kt, and CO_2 emission reduction amounts to about 13 Mt (Fig. 3). It should be borne in mind that the reduction of emissions concerns only and exclusively emissions from residential buildings, constituting part of the municipal and housing sector emissions.

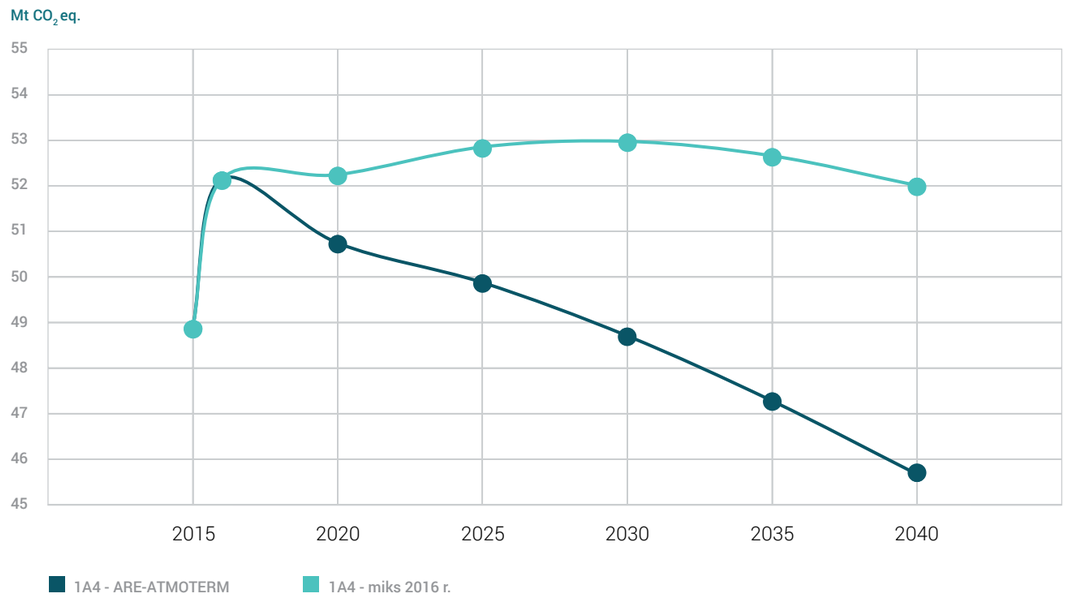
Fig. 3. Assumed reduction of CO_2 emissions in Poland resulting from measures under the "Clean Air" programme.



Source: Own study by KOBiZE

Another measure that may reduce greenhouse gas emissions in the municipal and housing sector is to change the fuel structure towards lowering the share of coal in favour of gas and RES. In 2016, in the whole category of small combustion sources, the consumption of bituminous coal amounted to approx. 24% of the total amount of this fuel burned in Poland. The shares of main fuels in this sector for 2016 were as follows: bituminous coal - 44%, natural gas - 30%, solid biomass - 18%. According to the ARE-ATMOTERM scenario, the share of bituminous coal will systematically decrease to 30% by 2040. On the other hand, the share of natural gas consumption is forecasted to increase to 41% in 2040 and solid biomass to 22%. Figure 4 shows the emissions forecast in the ARE-ATMOTERM scenario compared to the emissions that would have been in place at the same energy demand from fuels assumed, but with the fuel structure of 2016 (mix as of 2016). It is estimated that these changes in the fuel structure will result in a reduction in emissions of more than 6 Mt of CO_2 equivalent.

Fig. 4. Change in greenhouse gas emissions due to a change in the fuel mix in small combustion sources (sector 1.A.4.)



Source: Own calculations by KOBiZE based on ARE-ATMOTERM data.

Challenges – agricultural sector emissions and potential GHG emissions reduction in 2040

In terms of emissions, the agricultural sector in Poland is responsible for about 15-16% of the volume of domestic greenhouse gas emissions outside the EU ETS. Emissions from soils (nitrous oxide coming mainly from mineral and organic fertilizers) and emissions from intestinal fermentation (methane, which almost entirely comes from cattle) and from animal faeces (methane and nitrous oxide emissions) are the most important in the sector. Other sources of emissions are of minor importance, similarly to emissions of carbon dioxide released during liming and urea application, which together do not exceed 3% of the total emissions from the sector (2015).

Agriculture is one of the sectors of the economy in which the transformations initiated during the transformation period intensified with Poland's membership in the European Union and access to EU funds earmarked for the Common Agricultural Policy. The most visible social and economic changes in Polish agriculture were manifested primarily by the departure from a centrally planned economy in favour of a market economy, which made agriculture to a large extend a commodity branch of the economy, producing both for the internal market and for export. The number of people employed in agriculture clearly decreased, while the intensification of production increased, which is perceivable, among others, by the development of specialisation, commoditability and mechanisation, application of new agrotechnical and technological solutions, as well as the growing demand not only for means of production (e.g. fertilisers and feeds), but also for energy (in the form of electricity and transport fuels). The structure of agricultural holdings is also gradually changing. The number of agricultural holdings decreases and their average area is growing, although still more than half of them have not more than 5 ha and most of them are managed exclusively for self-supply of food. Agricultural production of some farms, e.g. those specialising in animal husbandry on an industrial scale, has intensified. In general, it can be stated that through the increase in commercialization of production, agriculture has become an important element of the market economy, both domestic (internal market) and international (import and export).

However, Polish agriculture - compared to western EU countries - is still characterised by relatively greater fragmentation, under-capitalisation, lower productivity and low innovation.[14]

[14] 2050.pl A journey to a low-carbon future. Bukowski M. (ed.), Warsaw, 2013, p. 96.

Growing consumption of energy, related to the progressing mechanization makes Polish agriculture similar to the western model. Modernisation of production and the use of more energy-efficient machinery reduce energy intensity in agriculture, but it concerns only a part of agricultural holdings. It seems that in the agricultural sector - so far - too little attention has been paid to improving energy intensity and using own energy resources, such as biogas and harvest residues. Similarly, there is lack of dissemination of modern and environmentally friendly methods of cultivation and animal husbandry. Although changes in agriculture are taking place slowly, they are clearly heading towards consolidation of agricultural holdings and further marketization of production by increasing its commerciality. At the same time, the number of people working in agriculture is decreasing, and thus productivity is increasing, accompanied by a growing demand for energy, machinery, fertilisers, plant protection products and feed.

The agricultural sector is likely to continue to change, and the intensity of change will depend on government policies to support agriculture and access to funds for agricultural production in the form of direct payments, loans, etc. The SRD[15] assumes that, as a result of undertaken measures, the area structure in agriculture should be improved by increasing the area of agricultural holdings and drop in the number of the smallest ones of less than 5 ha, along with a decrease in the number of employees and an increase in profitability in the sector. According to the SRD, the key intervention of the state in relation to agricultural holdings will be the support for further transformations of the agri-food sector, in particular measures stimulating the growth of its competitiveness, while ensuring the food security of the country and taking into account environmental requirements.[16]

After a period of small fluctuations in greenhouse gas emissions from the sector between 2005 and 2016, their slight but gradual increase can be observed. A further upward trend is expected, at least until 2030, as a result of the above considerations. In view of the forecasts outlined above, limiting the growth in emissions with simultaneous assumption of increase in the sector's productivity constitutes a challenge. Since emissions from cultivated soils and applied fertilizers are of key importance, further intensification of plant production should take into account good agricultural practices, among which the climate protection aspect should also be taken into account. Therefore, the use of fertilisers, including nitrogenous fertilisers, is to be rationalised in accordance with the provisions introduced to the Water Law and the Act on Fertilisers and Fertilisation and in accordance with the so-called nitrate programme[17]. This programme's requirements will oblige agricultural production entities to undertake necessary and, at the same time, long-term investment activities. According to the draft nitrate programme, agricultural producers will be obliged to adjust the area or capacity of their storage facilities for natural fertilisers (livestock manure) to the requirements set out in the programme. Similarly to soil cultivation, husbandry, which contributes to emissions from intestinal fermentation and animal faeces, should include the most effective measures to reduce emissions, the use of which should be disseminated as something necessary. The nitrate programme will therefore have a broad application in reducing emissions from animal husbandry, particularly as regards the regulation of the storage of liquid and solid animal faeces.

The challenge, therefore, seems to be, first and foremost, to change the way agricultural management is carried out, in which decisions are taken by hundreds of thousands of individual farmers who manage large areas of Poland, which is important for the effectiveness of efforts to protect the climate on a nationwide scale. Reconciling the intensification of agricultural production with the reduction of emissions will require both economic measures and appropriate dissemination of ecological awareness among farmers. The development of organic farming, which the government supports under the Rural Development Programme 2014-2020, through payments for conversion to and maintenance of organic farming practices and methods, is a sign of change in the right direction. Ecological practices and methods are environmentally friendly, serving at the same time the protection of water, soil, biodiversity and climate, and consist, among others, in abandoning the use of agricultural, veterinary and food chemicals through the use of technologically unprocessed biological and mineral resources.

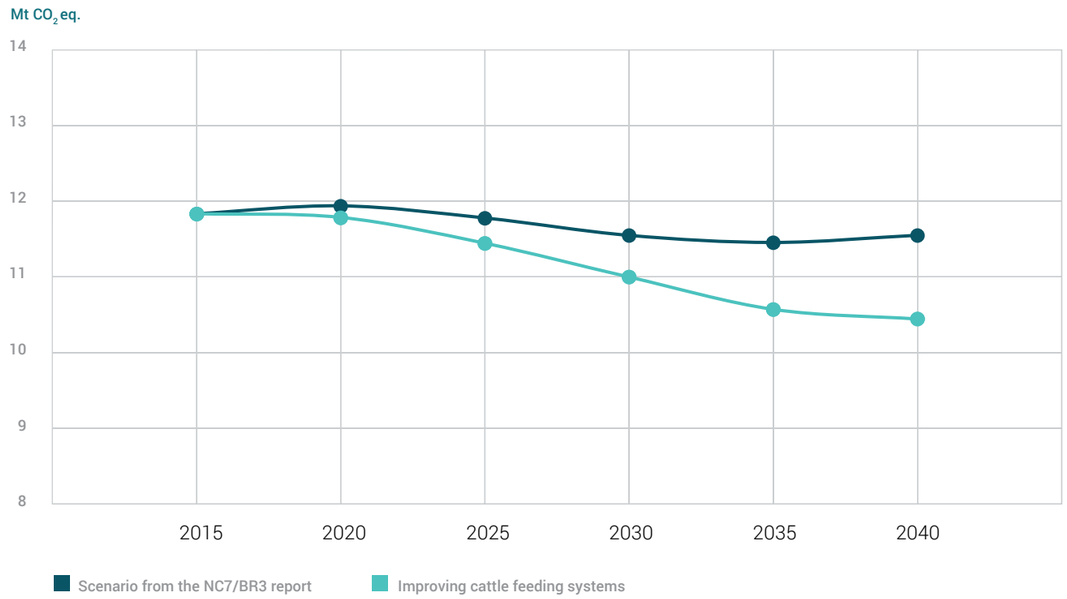
Social changes taking place in the Polish countryside, including generation change in agricultural holdings, can be considered as a chance for greater success in the implementation of measures aimed at climate protection in the agricultural sector. Such measures include the rationalization of the use of mineral nitrogen fertilizers by precise dosing of fertilizers in appropriate soil and climatic conditions, which may contribute to the reduction of nitrous oxide emissions in the period 1989-2040 by approx. 1 Mt of CO_2 eq. Moreover, further improvement of cattle nutrition (responsible for 95% of CH4 emissions from intestinal fermentation) influencing feed digestibility may contribute to the reduction of methane emissions by 0.55 Mt of CO_2 eq. in 2030 and by 1.1 Mt of CO_2 eq. in 2040. (Fig. 5).

[15] SRD – (Pl. SOR) A Strategy for Responsible Development by 2020 (with a perspective until 2030). Document adopted by a resolution of the Council of Ministers on 14 February 2017.

[16] SRD, p. 103.

[17] Draft Regulation of the Council of Ministers: "Programme of measures to reduce water pollution by nitrates from agricultural sources and to prevent further pollution" - so-called nitrate programme, issued on the basis of Article 106 of the Water Law Act.

Fig. 5. Reduction of greenhouse gas emissions from intestinal fermentation of cattle as a result of an additional measure introduced in agriculture



Source: Own calculations by KOBiZE

An additional measure that directly contributes to CO_2 sequestration as well as adaptation to climate change is the afforestation measure implemented under the Rural Development Plan 2004-2006 and the Rural Development Programme for 2007-2013 and 2014-2020 as a measure for investments in forest area development and improvement of forest vitality. The planned afforestation of agricultural land by 2020 will contribute to the sequestration of 1.4 Mt CO_2.

Summary

Poland has been pursuing an active climate policy since the economic transformation in the early 1990s. Between 1988 and 2000, Poland significantly reduced its greenhouse gas emissions. Since 2000, emissions have remained at a similar level (approx. 400 Mt of CO_2 eq. without LULUCF), despite significant economic growth. In the period of transformation after 1989, Poland witnessed one of the largest in Europe progress in terms of efficient use of energy and improvement of environmental quality. The energy and industry sectors had the largest share in this.

Moreover, Poland has good prospects for the implementation of the EU climate policy until 2030 and in the longer term until 2050, but will have to implement ambitious reduction targets in the non-ETS area, especially in the transport, municipal and housing and agriculture sectors.

In order to reduce greenhouse gas emissions in non-ETS, it will be necessary to support energy efficiency and the development of electromobility. One of the most groundbreaking technologies, apart from improving energy efficiency, may be electric transport. The Polish government, recognising the huge potential of electric vehicles, alternative fuels and global trends in the dynamic development of the automotive industry, has developed the *"Energy for the Future"* Electromobility Development Plan. The most important assumption of the plan is to achieve the number of 1 million electric cars in Poland by 2025. The implementation of this target would allow to achieve specific environmental benefits related to the reduction of pollutant emissions from transport in agglomerations. Additional effects would be the reduction of the country's energy dependence by reducing the demand for liquid fuels, and thus a decrease in the volume of crude oil imports. An important function of the programme will be to stimulate conditions for the construction of electric cars in Poland, which would have a positive impact on a number of sectors of the economy related to the automotive industry. An important element of the Electromobility Development Plan is proper synchronization in time of activities aimed at supporting industry and scientific and research institutions, stimulation of demand (e.g. through the introduction of tax exemptions, larger depreciation write-offs for companies) and development of infrastructure and legal regulations (e.g. development of energy charging points and refuelling of alternative fuels, the possibility of using bus lanes and free of charge parking).

Poland aims at synergy between actions having positive impact on sustainable development and reduction of emissions, while maintaining the competitiveness of the economy and enterprises, ensuring energy security and economic growth. In the longer term, diversification of activities and development directions is a key response to the current challenges, as only then can the risk of an average income trap be stabilised and reduced. On the one hand, Poland faces the inevitable challenge of having to reduce the use of fossil fuels, and on the other hand, it is important to focus on innovative solutions, such as electromobility. Moreover, taking into account the results of the IPCC special report[18] of October 2018 indicating the need to limit global warming by no more than 1.5°C, actions in this respect should be taken as soon as possible and apply to all sectors. This is due to the conclusion that an increase in average temperature of 1.5°C will bring about much less adverse changes than the 2°C increase.

[18] IPCC, 2018: Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (eds.)].

Challenges for Poland in the non-ETS sectors

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