



Poland 2022

Energy Policy Review

International
Energy Agency

INTERNATIONAL ENERGY AGENCY

The IEA examines the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability and sustainability of energy in its 31 member countries, 10 association countries and beyond.

Please note that this publication is subject to specific restrictions that limit its use and distribution. The terms and conditions are available online at www.iea.org/t&c/

This publication and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

IEA member countries:

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Japan
Korea
Lithuania
Luxembourg
Mexico
Netherlands
New Zealand
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

The European Commission also participates in the work of the IEA

IEA association countries:

Argentina
Brazil
China
Egypt
India
Indonesia
Morocco
Singapore
South Africa
Thailand

Foreword

The International Energy Agency (IEA) has conducted energy policy reviews of its member countries since 1976. This peer review process supports energy policy development and encourages the exchange of international best practices. By seeing what has worked – or not – in the real world, these reviews help to identify policies that deliver concrete results.

Poland has been a strong and active supporter of the IEA since becoming a member in 2008. I would like to thank the Polish government for its leadership in several critical roles that have strengthened the Agency's work. These include chairing the IEA Long-Term Financial Health Group and the 2019 IEA Ministerial Meeting, which led to the adoption of the first communiqué to be issued from an IEA Ministerial Meeting in over ten years.

After the economic disruption caused by the Covid-19 pandemic, Poland's economy has started to recover, thanks to policy efforts pursued by the government. However, this has been accompanied by a resumption of growth in energy demand and carbon emissions, which are currently not in line with what is needed to support a clean energy transition and address climate change.

In view of this, I am encouraged to see that Poland is taking significant steps to transform its energy system, especially to reduce the dominant role of coal in electricity generation and residential heating. Thanks to government support and strong consumer interest, Poland is one of the fastest-growing European markets for rooftop solar. The government has introduced a well-designed and ambitious offshore wind programme, and is planning to build its first nuclear reactor by 2033. It is also placing a strong focus on ensuring a fair and just transition in order to manage any adverse impacts transition could have on workers and regions reliant on coal production or on vulnerable consumers.

Poland has demonstrated clear leadership on energy security since well before Russia's invasion of Ukraine. The government has been actively working to reduce reliance on natural gas from Russia for many years, managing to reduce Russia's share of gas imports from 90% in 2010 to 55% in 2021 despite a notable increase in gas demand over the period. Thanks to this foresight, Poland is now relatively well placed to deal with the unilateral and contract-breaching decision made by Russia in late April 2022 to cut gas supplies to Poland. The government is also now finalising several major infrastructure projects to further diversify Poland's gas supply and plans to stop importing Russian oil by the end of the year.

Despite its notable successes in clean energy and energy security, Poland remains heavily reliant on fossil fuels. Considerable work needs to be done across all sectors to meet the country's targets for increasing the share of renewables and reducing emissions. I sincerely hope the recommendations proposed in this report will help Poland navigate the transformation of its energy system as it seeks to accelerate its transition towards a low-carbon economy that benefits all citizens and maintains energy security.

Dr. Fatih Birol
Executive Director
International Energy Agency

ENERGY INSIGHTS

Foreword.....	3
1. Executive summary	11
Overview	11
Energy and climate policy	12
Key measures	14
Key recommendations	16
2. General energy policy	17
Energy supply and demand	17
Key institutions.....	20
Energy markets.....	21
Energy and climate targets	21
Energy policy overview	23
Energy poverty.....	26
Covid-19 response.....	26
Energy transition investments.....	27
Energy taxation.....	27
Fossil fuel subsidies.....	29
Hydrogen	29
Gender equality in the energy sector	31
Assessment	32
Recommendations	35

ENERGY SYSTEM TRANSFORMATION

3. Energy and climate change	37
Overview	37
Energy-related CO ₂ emissions.....	38
CO ₂ emissions drivers and carbon intensity	40
Climate targets.....	40
Climate policy and measures.....	41
Carbon pricing	42
Long-term strategy.....	43
Methane emissions	43
Carbon capture, utilisation and storage	44

Climate adaptation	44
Assessment	45
Recommendations	48
4. Energy efficiency	51
Overview	51
Energy demand	52
Targets.....	52
Energy efficiency policies and measures	53
Buildings	54
Industry	58
Transport	60
Assessment	63
Recommendations	68
5. Renewable energy	71
Overview	71
Renewables by sector.....	72
Renewable energy targets	74
Renewable energy policy.....	75
Assessment	80
Recommendations	84
6. Energy research, development and innovation	87
Overview	87
R&D institutions	88
Energy R&D policy.....	90
Energy R&D programmes.....	91
Private sector innovation.....	94
Knowledge sharing	95
Assessment	95
Recommendations	97

ENERGY SECURITY

7. Electricity.....	101
Overview	101
Electricity demand, generation and trade.....	101
Infrastructure.....	104
Market structure	107

Electricity policy	111
Electricity security	114
Assessment	116
Recommendations	119
8. Coal	121
Overview	121
Coal production and supply	122
Hard coal trade	123
Coal demand	124
Coal policy	125
Assessment	127
Recommendations	129
9. Natural gas	131
Overview	131
Gas supply and trade	132
Gas demand	133
Infrastructure	133
Market structure	136
Gas policy	139
Gas security	140
Assessment	142
Recommendations	144
10. Oil	147
Overview	147
Crude oil trade	147
Oil products demand, production and trade	148
Infrastructure	150
Market structure	153
Oil policy	155
Assessment	158
Recommendations	160
11. Nuclear	163
Overview	163
Nuclear power policy	163
Recent progress in the new nuclear build programme	165
Radioactive waste management	169
Small modular reactors and other advanced nuclear technologies	170

Assessment	171
Recommendations	174

ANNEXES

ANNEX A: Review team and supporting stakeholders	177
ANNEX B: List of acronyms and abbreviations	181
ANNEX C: Statistical notes	184

LIST OF FIGURES AND TABLES

Figures

Figure 2.1	Overview of energy production, supply and demand in Poland, 2020	18
Figure 2.2	Energy demand by sector and fuel, and electricity generation by fuel in Poland, 2020	18
Figure 2.3	Energy supply and demand by source in Poland, 2000-2020	19
Figure 3.1	Greenhouse gas emissions by sector in Poland, 2000-2019 and 2030 target	38
Figure 3.2	Energy-related CO ₂ emissions by sector and fuel in Poland, 2000-2020	39
Figure 3.3	Energy-related CO ₂ emissions and main drivers in Poland, 2000-2020	40
Figure 4.1	Estimated energy savings from efficiency in Poland, 2000-2019	52
Figure 4.2	Total final consumption by sector in Poland, 2000-2020	52
Figure 4.3	Poland's 2020 and 2030 energy efficiency targets and status 2004-2020	53
Figure 4.4	Building total final consumption by source in Poland, 2000-2020	55
Figure 4.5	Total final consumption in industry by source in Poland, 2000-2020	59
Figure 4.6	Total final consumption in transport by fuel in Poland, 2000-2020	60
Figure 4.7	Electric vehicles and public charging points in Poland, 2012-2021	61
Figure 5.1	Renewable energy in total final energy consumption in Poland, 2000-2020	72
Figure 5.2	Renewable energy key metrics in Poland, 2020	72
Figure 5.3	Renewable energy in electricity generation in Poland, 2000-2020	73
Figure 5.4	Renewable energy in heating and cooling in Poland, 2004-2020	73
Figure 5.5	Renewable energy in transport in Poland, 2004-2020	74
Figure 5.6	Poland's renewable energy targets and status 2004-2020	74
Figure 6.1	Public spending on energy R&D per GDP in IEA countries, 2020	88
Figure 6.2	Public budget on energy R&D by sector in Poland, 2009-2021	92
Figure 7.1	Electricity demand by sector in Poland, 2000-2020	102
Figure 7.2	Electricity generation by source in Poland, 2000-2021	103
Figure 7.3	Poland's electricity imports and exports, 2000-2020	103
Figure 7.4	Poland's electricity transmission system, 2020	104
Figure 7.5	Wholesale market share by supplier in Poland, 2020	109
Figure 7.6	Electricity prices in Poland and neighbouring IEA countries, 2000-2020	111
Figure 7.7	SAIDI and SAIFI in Poland, 2016-2020	116
Figure 8.1	Share of coal in different energy flows in Poland, 2000-2019/2020	122
Figure 8.2	Coal supply and production in Poland, 2000-2020	122
Figure 8.3	Hard coal net trade in Poland, 2000-2019	123

Figure 9.1	Natural gas supply in Poland, 2000-2020	132
Figure 9.2	Poland's natural gas net trade by country, 2000-2020	132
Figure 9.3	Natural gas demand by sector in Poland, 2000-2020	133
Figure 9.4	Poland's natural gas transmission system, 2020	134
Figure 9.5	Natural gas prices for industry and households in Poland, 2000-2020	139
Figure 10.1	Poland's crude oil, trade by country, 2000-2020	148
Figure 10.2	Oil products demand by sector in Poland, 2000-2020	148
Figure 10.3	Oil products production by type in Poland, 2000-2020	149
Figure 10.4	Poland's oil products net trade by country, 2000-2020	150
Figure 10.5	Poland's oil infrastructure, 2020	151
Figure 10.6	Emergency oil stocks by type in Poland, December 2021	157
Figure 11.1	Projected share of nuclear power generation in Poland, 2025-2040	164
Figure 11.2	Total levelised cost of electricity of nuclear power in Poland as a function of the cost of capital	167

Tables

Table 1.1	Poland's 2020 and 2030 energy sector targets and 2020 status	13
Table 2.1	Poland's 2020 and 2030 energy sector targets and 2020 status	22
Table 2.2	2030 targets in Energy Policy of Poland until 2040 and 2020 status	23
Table 2.3	Energy product taxation in Poland, 2020	28
Table 3.1	Poland's non-ETS greenhouse gas emissions and targets, 2013-2020	41
Table 5.1	Required shares of biofuels by energy content in Poland, 2014-2024	79
Table 7.1	Electricity generation capacity in Poland, 2016 and 2020	105
Table 7.2	End-user connections and supplied electricity in Poland, 2020	106
Table 7.3	Retail electricity market consumers by annual demand in Poland, 2020 ..	110
Table 10.1	Oil product taxes in Poland, 2020	154
Table 11.1	Implementation schedule of the Polish Nuclear Power Programme	166

1. Executive summary

Overview

Prior to the onset of the Covid-19 pandemic, Poland experienced a decade of strong economic growth. From 2010 to 2019, Poland's gross domestic product (GDP) increased by 38% and its economic growth rate was 4.7% in 2019, significantly higher than the European Union (EU) average of 1.5%. Poland's economic growth drove a significant increase in energy demand. From 2010 to 2019, total final consumption (TFC) grew from 70 million tonnes of oil equivalent (Mtoe) to 75 Mtoe, driven mainly by increased energy demand from transport and industry. However, improvements in energy efficiency and the increasing role of the service sector have decoupled energy demand from economic growth. From 2010 to 2019, the energy intensity of Poland's economy (TFC per GDP) declined from 79 tonnes of oil equivalent (toe) to 61 toe per USD million.

The Covid-19 outbreak had a major impact on Poland's economy and energy system. From 2019 to 2020, GDP declined by 2.7%, total energy supply (TES) dropped from 103 Mtoe to 98 Mtoe and TFC fell from 77.3 Mtoe to 75.8 Mtoe. Both Poland and the EU have taken steps to address the impacts of the pandemic and support a return to economic growth. Poland's economy has begun to recover from the impacts of the pandemic, with GDP growing by 3.7% in 2021. However, the trajectory of the energy sector in 2021 (increasing demand, higher use of fossil fuels and growing emissions) are not in line with the trends needed to support the energy transition and address climate change.

Poland's energy supply remains dominated by fossil fuel (85% of TES in 2020), with the largest share coming from coal (40%), followed by oil (28%) and natural gas (17%). Coal plays a central role in Poland's energy system and economy. Among IEA member countries in 2020, Poland had the highest shares of coal in energy production, TES, TFC and electricity generation, and the second-highest share in heat production. The high shares of coal place Poland second among IEA member countries for CO₂ intensity of energy supply and fourth for CO₂ intensity of GDP.

The role of coal in Poland's energy system declined from 2010 to 2020; the share of coal fell in TES, electricity generation, district heating and TFC. Coal production is also declining, and since 2017 Poland has been a net coal importer. However, coal demand increased significantly in 2021, with coal-fired electricity generation bouncing back to 80% of total generation.

Despite the continued dominance of coal, Poland has had notable success in pushing for energy transition. Government support for solar photovoltaics (PV) has made Poland one of the fastest growing PV markets in the EU. From 2016 to 2021, Poland's PV capacity increased from just 0.2 gigawatts (GW) to 7.7 GW, driven mostly by residential deployment

of small-scale distributed PV systems (5.9 GW). Poland also has a comprehensive and well-designed offshore wind strategy that has resulted in deals for 5.9 GW of capacity to come online by 2027 and plans for at least 11 GW by 2040.

State-controlled companies have dominant roles across Poland's energy sector and there are still regulated prices in some energy markets. Poland's electricity market is mostly liberalised and every consumer has the right to choose a market offer and to change supplier. However, the majority of household consumers purchase electricity through contracts with regulated prices from incumbent suppliers. The household consumer switching rate is among the lowest in Europe and the commercial consumer switching rate is also well below the European average. Ownership of generation and wholesale and retail electricity sales are highly concentrated, with four state-controlled energy companies.

Poland is still in the process of liberalising its natural gas market, which is highly concentrated with a very low level of competition at the wholesale and retail levels. The state-owned oil and gas company PGNiG has a dominant position across Poland's entire gas sector. Most regulation of natural gas prices ended in 2017, regulation of retail gas prices for household consumers was set to end in December 2023, but was prolonged until 2027 because of government concerns over price volatility. Poland's markets for crude oil and oil products are fully liberalised, with prices set by market forces. However, there is a high level of market concentration and limited competition. State-controlled companies own all domestic oil production and all refining capacity and account for most wholesale oil products sales (almost 75% in 2020). Poland's coal sector is also dominated by state controlled companies.

Energy and climate policy

Poland's energy policy aims to reduce the carbon intensity of its energy supply through increased use of renewables and natural gas, the introduction of nuclear energy, higher electrification of energy demand (especially for transport), and improved energy efficiency. Poland places a strong focus on energy security and a just transition that maintains affordable access to energy to promote economic growth and protect vulnerable consumers. The main documents defining Poland's energy and climate policies are the National Energy and Climate Plan (NECP), which is required for all EU member states and was adopted in 2019, and the national Energy Policy for Poland until 2040 (EPP2040), adopted in February 2021.

Under national laws and EU directives, Poland has a wide range of energy and climate targets for 2030. Greenhouse gas (GHG) emissions from Poland's energy-intensive industrial facilities and electricity generation are regulated under the EU Emissions Trading System (ETS). Poland's NECP defines 2030 targets for non-ETS GHG emissions, renewable energy and energy efficiency that are intended to help achieve EU-wide 2030 targets (Table 1.1). The EPP2040 has numerous 2030 and 2040 targets that serve as indicators of Poland's energy transition progress.

Poland achieved most of its 2020 energy and climate targets. However, the status of Poland's energy sector in 2021 presents a difficult starting place for the next decade and significant additional efforts are needed to achieve the sustained reductions in GHG emissions and energy demand, and the strong growth in renewables needed to keep Poland on a path to achieving its energy transition goals.

Table 1.1 Poland's 2020 and 2030 energy sector targets and 2020 status

		2020 status	2020 targets	2030 targets
Non-ETS GHG emissions	CO₂-eq emissions versus 2005	+10%	+14%	-7%
Energy efficiency (Mtoe)	Primary energy consumption	96.5	96.4	91.3
	Final energy consumption	71.0	71.6	67.1
Renewable energy share	Gross final energy consumption	16.1%	15%	23%
	Electricity*	16.2%	19%	32%
	Heating and cooling*	22.1%	17.4%	28.4%
	Transport*	6.6%	10%	14%

* Indicative trajectories.

In December 2020, the 2030 EU-wide GHG emissions reduction target was increased from 40% to 55%, and the EU is in the process of developing more ambitious 2030 targets for renewables and energy efficiency to support the new emissions reduction target. It is likely that Poland will need to increase its 2030 targets and measures for GHG emissions, renewables and energy efficiency to support the EU-wide 55% reduction target.

A central aspect of Poland's energy policy is reducing reliance on coal, especially for electricity generation and building heating. However, a large amount of financial support is given to the coal sector, for both mining and generation. Analysis from the European Commission (EC) and the Organisation for Economic Co-operation and Development (OECD) show that Poland's fossil fuel subsidies have increased substantially and are approaching EUR 1.8 billion per year, with most of them going to coal. Poland also provides notable subsidies for renewables. For example, the government estimates that support payments for Poland's offshore wind programme will amount to around EUR 7.8 billion by 2040 and around EUR 22.5 billion over the life of the programme.

The social contract concluded in May 2021 between the government and coal trade unions aims to gradually close all of Poland's hard coal mines (excluding coking coal mines) by 2049. The contract guarantees that workers in the hard coal sector will have a job until retirement or receive a severance package, and commits to supporting economic transition in the main hard coal mining regions. The contract does not cover lignite and Poland has no targets for phasing out lignite mining or lignite-fired electricity generation. The objectives of the contract are not in line with Poland's commitments to EU climate and goals and do not reflect the reality of coal becoming less competitive.

Poland sees a major role for natural gas in supporting a secure transition away from coal, but the role of gas in long-term decarbonisation is not clear. There are some goals for decarbonising the gas supply through biomethane and low-carbon hydrogen, but these plans are too modest to offset government expectations of a large growth in natural gas demand. The current high reliance on gas to support energy security and plans to significantly expand gas-fired generation and the gas network will increase energy import dependency, the risk of stranded assets and exposure to volatile gas prices.

The government estimates that modernising the energy sector and achieving the NECP's 2030 targets will require EUR 195 billion from 2021 to 2030 (around 3.5% of annual GDP) and that the cost of energy transition from 2021 to 2040 could reach EUR 350 billion. The government expects that most investments to support the energy transition will come from the private sector, but that public funding will also make a notable contribution. The majority of public funding for the energy transition in Poland is expected to come from a

variety of EU mechanisms, but national funds will also provide notable funding. The government expects that EU and national funds will provide around EUR 72 billion for Poland's energy transition by 2030.

Key measures

Poland has a wide range of measures to support energy transition while maintaining energy security. There is a strong focus on reducing the dominant position of coal in electricity generation and heating by continuous deployment of renewables and natural gas, and introducing nuclear energy.

Deployment of renewable energy is encouraged through numerous programmes. The green certificate scheme requires all electricity suppliers and certain energy-intensive electricity consumers to obtain green certificates that are issued to renewable energy projects based on their electricity generation. Poland introduced an auction system in 2016 that supports projects generating renewable electricity through a contract for differences. Auctions held from 2016 to 2021 awarded support mostly to solar PV (6.1 GW) and onshore wind (5.1 GW).

Poland's offshore wind programme has awarded support to 5.9 GW of capacity through government decision. Small-scale distributed renewables (mainly solar PV) receive support through several measures, including the My Electricity programme (grants to cover installation costs) and net billing. A new support scheme for co-generation was introduced in 2019 that is expected to drive a transition from coal to gas. The cost of Poland's support measures for renewable generation and co-generation are covered by a fee charged to all electricity consumers.

The Polish Nuclear Power Programme defines the measures and timeline for implementing nuclear energy and ensuring safe operations, decommissioning and waste storage. Poland aims for the first reactor with a capacity of 1-1.6 GW to be in operation by 2033 and for six reactors with a total capacity of 6-9 GW to be in operation by 2043. The government estimates that by 2040, nuclear energy could account for up to 16% of generation.

Poland has several measures to drive energy transition in the transport sector. Its biofuels blending mandate requires all companies producing or importing transportation fuels to have a minimum share of biofuels by energy content in their annual fuel sales (8.7% in 2021, increasing to 9.1% in 2024). Poland aims to improve transport efficiency and reduce transport emissions through modal shifts away from private cars to walking, biking and electrified public transport.

There are numerous support measures to increase the adoption of electric vehicles (EVs) and expand EV charging infrastructure, including subsidies for EVs. The government should accelerate the alignment of vehicle taxation with the goals of higher electrification and reduced emissions, including expediting the introduction of annual taxation for all vehicles based on their efficiency, and measures to reduce the import of second-hand inefficient vehicles.

Policy in the buildings sector is mainly focused on reducing the significant health impacts of local air pollution that result from Poland's heavy reliance on coal for building heating.

The Clean Air Programme provides subsidies for owners of single-family residential buildings to replace inefficient heat systems with new ones (including gas boilers, renewable energy sources and heat pumps). To date, 45% of the applications to the programme have been to switch to gas boilers. The IEA recommends improving the Clean Air Programme to focus on the deployment of heating systems with the lowest emissions and highest efficiency to minimise the deployment of gas boilers.

Poland's main measure to improve energy efficiency across the economy is a system of tradable energy efficiency certificates (white certificates). Suppliers of electricity, natural gas, heat and liquid fuels must either achieve annual energy savings of 1.5%, purchase certificates covering any deficit or pay a fine. Any company undertaking energy-saving projects can apply for certificates and sell these to energy suppliers to help them reach their targets.

Under EU rules, large companies must complete audits every four years that cover at least 90% of their energy demand and identify cost-effective energy-saving opportunities. Poland does not require companies to implement measures identified in audits, but companies can apply for white certificates for completed projects that reduce demand. The government should consider making it obligatory to implement measures with short pay-back times identified in energy audits, as is done in other IEA and EU countries.

Poland's carbon pricing system is based mainly on the EU ETS, which covered about 47% of Poland's emissions in 2019. The government has announced a plan to set up an Energy Transformation Fund that would use 40% of ETS revenues through 2030 to modernise the energy sector.

In addition to the ETS, Poland has a national emission fee covering certain types of GHG emissions across the entire economy. However, the emission fee is much lower than the ETS price. In 2021, the emission fee was only EUR 0.07 per tonne of CO₂ (t CO₂), while the ETS price reached 89 EUR/t CO₂. Bringing the emission fee in line with the ETS price, while taking into account the issue of energy poverty, would complement and strengthen the effect of Poland's subsidy schemes supporting cleaner alternatives in buildings and transport, and discourage the use of polluting options.

Key recommendations

The government of Poland should:

- Update the Energy Policy for Poland until 2040 and the National Energy and Climate Plan with targets and measures that support the European Union's increased climate and energy ambitions, and that reflect energy market developments, technical innovation and increased European carbon prices.
- Reconsider the timeline for closing all coal-fired generation to achieve Poland's commitment to the EU's 2030 climate targets and 2050 climate neutrality goal.
- Accelerate the expansion of the transmission and distribution systems to facilitate a higher share of renewables, planned nuclear generation and increased electrification while ensuring security of supply.
- Review the regulatory framework to increase energy market competition, ensure a level playing field among all market participants, strengthen the position of consumers, and open markets for new investors and services.
- Adjust taxes, market regulations and financial support measures so that energy prices drive behaviours and investments that support a just energy transition, increase system flexibility and reduce the risk of stranded assets.
- Reconsider the need for large investments in fossil fuel infrastructure, taking into account the risk of stranded assets and the need to direct limited capital to investments supporting the Polish energy transition.

2. General energy policy

Key data (2020)

TES: 98.0 Mtoe (coal 40.6%, oil 29.6%, natural gas 17.4%, bioenergy and waste 9.3%, wind 1.4%, solar 0.3%, hydro 0.2%, electricity imports 1.2%), +2.2% from 2010 to 2019, -4.6% from 2019 to 2020

TES per capita: 2.5 toe/cap, -2.1% since 2010 (IEA average: 4.1 toe/cap)

TES per GDP: 83 toe/USD million, -27.2% since 2010 (IEA average: 92 toe/USD million)

Energy production: 54.7 Mtoe (coal 72.9%, bioenergy and waste 15.9%, natural gas 6.2%, wind 2.5%, oil 1.8%, solar 0.5%, hydro 0.3%), -11.6% from 2010 to 2019, -7.7% from 2019 to 2020

TFC: 75.8 Mtoe (oil 37.0%, natural gas 14.9%, electricity 15.6%, coal 11.6%, bioenergy and waste 12.5%, district heating 7.4%, solar 0.1%), +10.5% from 2010 to 2019, 1.9% from 2019 to 2020

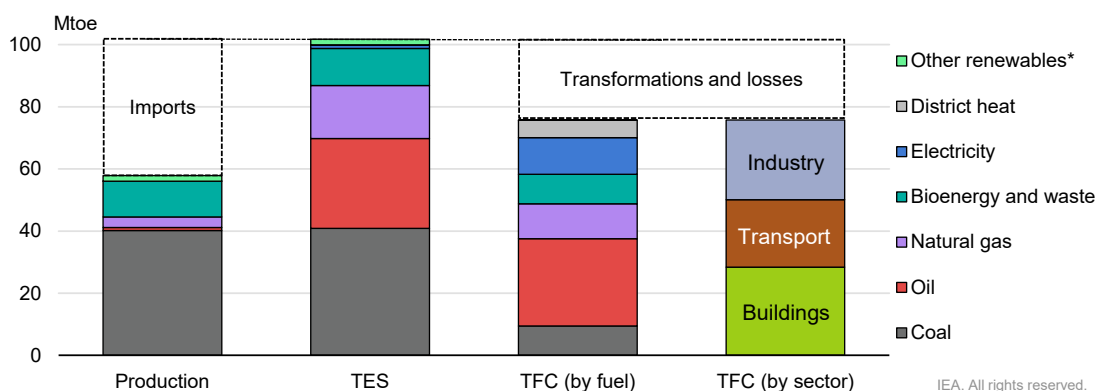
Energy supply and demand

Poland's energy supply is dominated by fossil fuels (88% of TES in 2020), with the largest share coming from coal (40.6%), followed by oil (29.6%) and natural gas (17.4%) (Figure 2.1). Poland is a small producer of oil and natural gas, and imports cover most of its oil (97%) and gas supply (80%). Coal plays a central role in Poland's energy system and is an important sector in the Polish economy, especially at a regional level. Among IEA member countries, in 2020, Poland had the highest shares of coal in domestic energy production, TES, TFC and electricity generation, and the second-highest share in heat production. The role of coal in Poland's energy system is declining. From 2010 to 2020, the share of coal fell in TES (from 54% to 41%), electricity generation (from 88% to 68.5%), district heating (from 88% to 80%) and TFC (from 20% to 13%). However, coal use increased significantly in 2021, with coal-fired electricity generation reaching 79.7% of total generation as domestic electricity demand returned to levels seen before the start of the Covid-19 pandemic and electricity exports increased.

In 2020, Poland was the tenth-largest coal producer in the world and the second-largest coal producer in the EU after Germany. Poland's coal production covers most domestic coal demand. However, coal production is declining, and since 2018, Poland has been a net coal importer (mainly thermal coal from the Russian Federation [hereafter, "Russia"] for electricity, co-generation and building heating).

Oil covers the largest share Poland's energy demand (39% of TFC in 2019), followed by electricity (16%), natural gas (15%), coal (13%), bioenergy and waste (9.2%), district heating (7.5%) and a small share of other renewables (0.1%, mainly solar thermal). In 2019, Poland's energy demand was split relatively evenly between buildings (35%), industry (34%) and transport (31%). As in most IEA member countries, oil dominates transport energy demand (Figure 2.2). Buildings energy demand is covered by a more diverse range of sources, however the share of coal in buildings energy demand (21% in 2019) was still the highest among IEA member countries and significantly higher than the IEA average of 1%. Industry energy demand is also covered by a diverse range of sources, with the largest share of industry demand covered by oil (26%) and gas (23%).

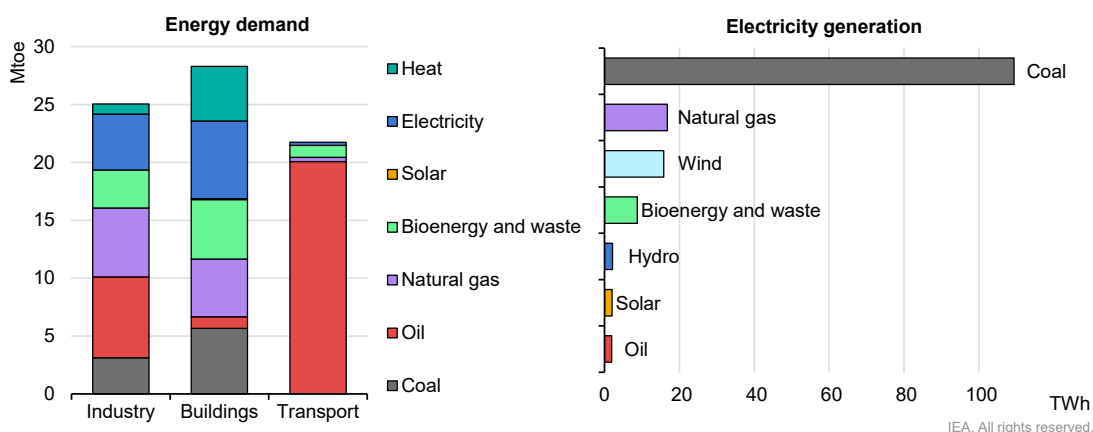
Figure 2.1 Overview of energy production, supply and demand in Poland, 2020



* Other renewables includes mainly wind and solar PV.

Source: IEA (2022).

Figure 2.2 Energy demand by sector and fuel, and electricity generation by fuel in Poland, 2020



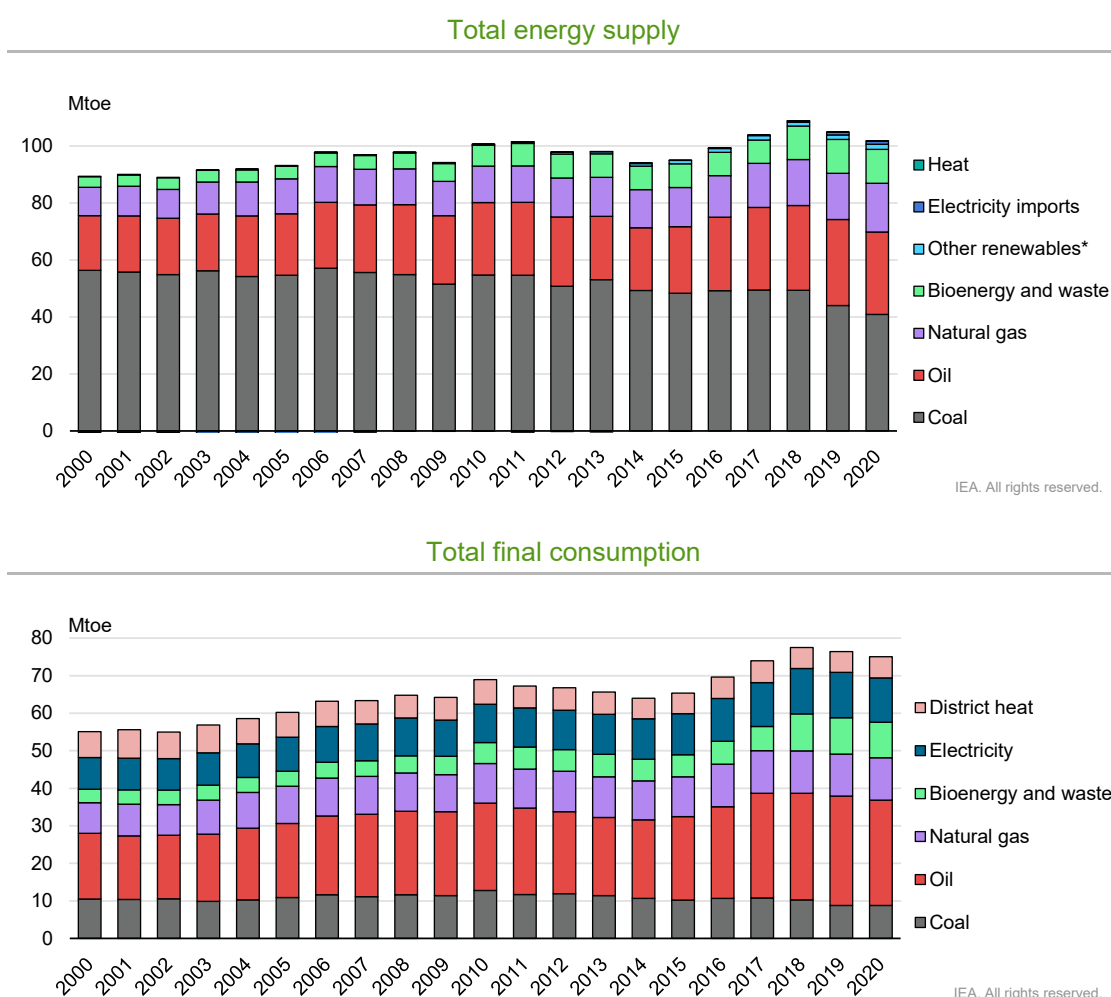
Source: IEA (2022).

From 2010 to 2019, Poland's energy supply and demand experienced an overall increase in line with growing economic activity, with TES up from 101 Mtoe to 103 Mtoe and TFC from 65 Mtoe to 75 Mtoe (Figure 2.3). The increase in TES and TFC was driven by higher transport demand for oil and increased industry demand for oil, gas and electricity. The notable decrease in coal supply from 55 Mtoe to 40 Mtoe over this period was driven mainly by lower demand for coal-fired generation, which faced increasing pressure from

higher EU ETS prices, low-cost renewable generation and electricity imports. The notable drop and rebound of data for TES and TFC from 2010 to 2018 does not accurately reflect actual energy supply and demand, but was driven by the sale of transport fuels outside the legal market with no reporting of these sales. Legislative and enforcement actions taken in 2016 helped to significantly reduce illegal sales and ensure better reporting of fuel demand, which is reflected in notable increases in oil demand (and overall TES and TFC) seen in 2016 and 2017.

The Covid-19 pandemic had a major impact on Poland's energy supply and demand. From 2019 to 2020, TES dropped from 103 Mtoe to 98 Mtoe and TFC from 77 Mtoe to 76 Mtoe. This decline was driven mainly by lower demand for road transportation fuels and a notable drop of industrial energy demand. However, GDP grew by 3.7% in 2021, driving an increase in energy supply and demand.

Figure 2.3 Energy supply and demand by source in Poland, 2000-2020



* Other renewables consist mainly of onshore wind and some hydro and solar PV.

Source: IEA (2022).

Key institutions

The Ministry of Climate and Environment is responsible for developing and implementing Poland's energy, climate and environment-related policies, including drafting legal acts and national strategies, monitoring and reporting on progress towards policy goals, supervising the EU ETS in Poland, and reporting to the United Nations Framework Convention on Climate Change (UNFCCC). The Ministry of Climate and Environment also co-operates with other ministries and government entities on implementing Poland's sustainable development strategy and energy, climate and environmental policies.

The Ministry of Infrastructure is responsible for the transport sector, maritime economy, inland navigation and water management. The Ministry of Agriculture and Rural Development is responsible for agriculture and rural development policy. The Ministry of Economic Development, Labour and Technology is in charge of the implementation of strategies covering socio-economic development, innovation, the industry sector, construction and housing. The Ministry of Finance is responsible for tax policy, including the taxation of energy products. The Ministry of Development Funds and Regional Policy manages the implementation of economic and national development strategies and spending resources from EU funds, including those for research and development (R&D).

The Government Plenipotentiary for Strategic Energy Infrastructure is responsible for exercising rights related to state control over the gas and electricity system operators and PERN, the company managing Poland's crude oil and oil products pipelines. The Ministry of State Assets oversees issues related to the extraction of coal, oil, gas and other raw materials and for the management of state property, including Poland's numerous state-controlled energy sector companies. The independent Energy Regulatory Office (ERO) regulates the activities of participants in Poland's energy markets and serves as an adviser to the government for the approval of energy infrastructure plans. The Office of Competition and Consumer Protection oversees the energy sector, where it is responsible for antitrust and consumer protection policy.

The Ministry of Climate and Environment is responsible for Poland's energy statistics, with the Energy Market Agency carrying out most energy data collection, processing and transferring to international institutions and other government entities. Some data are collected by other institutions. Statistics Poland is the main agency charged with collecting and publishing statistics related to the overall economy, population and society. The ERO collects data to support its supervision of the electricity, gas and oil, and biofuel markets. Data on imports, exports, production and stocks of liquid fuels are collected by the Governmental Agency of Strategic Reserves, which supervises the system of mandatory stocks of crude oil and liquid fuels.

The central government is responsible for most energy and climate policies. However, regional and municipal governments are responsible for implementing Poland's energy policy at the regional and local levels, including activities related to energy planning and permitting (especially related to buildings and electricity and gas distribution networks). Local governments may also introduce regulations limiting or prohibiting certain fuels and certain residential sector energy installations.

Energy markets

Poland's electricity market is mostly liberalised. The electricity network is open to any company wishing to supply electricity and consumers are free to choose their supplier, or to purchase electricity from a default supplier with prices regulated by the ERO. The majority of household consumers (63% in 2020) purchase electricity through contracts with regulated prices. Prices for commercial consumers are not regulated. In 2020, the retail market switching rate was 0.64% for household consumers and 5.4% for commercial consumers. The household consumer switching rate is among the lowest in Europe and the commercial consumer switching rate is also well below the European average (ACER, 2020). Ownership of generation and wholesale and retail electricity sales are highly concentrated, with four state-controlled energy companies (PGE, TAURON, Enea and PKN ORLEN) (see Chapter 7).

The government is working to amend the Energy Law and the Act on Renewable Energy Sources to strengthen the position of the energy consumer. The proposed regulations will include the possibility to switch supplier in 24 hours, access to a price comparison tool to help choose the cheapest or most advantageous offer, the ability to purchase electricity at dynamic prices contracts, and the ability to use aggregator services. Energy sellers will be obliged to provide comprehensive and transparent information on changes in prices.

Poland is still in the process of liberalising its natural gas market, which is highly concentrated with almost no competition at the wholesale and retail levels. The state-owned oil and gas company PGNiG has a dominant position across Poland's entire gas value chain. Since January 2017, the ERO no longer regulates prices at the wholesale level; prices for liquefied natural gas (LNG) and compressed natural gas (CNG); or prices for natural gas purchased at a virtual point or through tenders, auctions or public procurement. Since October 2017, the ERO no longer regulates retail prices for non-household consumers. Regulated retail gas prices for all household consumers were set to end on 31 December 2023, but have been prolonged to 2027 (see Chapter 9).

Poland's markets for crude oil and oil products are fully liberalised, with prices set by market forces. However, there is a high level of market concentration and limited competition at the wholesale and retail levels. Three state-controlled companies (PKN ORLEN, LOTOS and PGNiG) own all domestic oil production and refining capacity and account for most of the wholesale oil products supply (almost 75% in 2020). The government has plans to merge LOTOS and PGNiG into PKN ORLEN (see Chapter 10). Poland's coal sector is also dominated by state-owned companies (see Chapter 8).

Energy and climate targets

Under national laws and EU directives, Poland has a wide range of energy and climate targets for 2020 and 2030. GHG emissions from Poland's energy-intensive industrial facilities and electricity generation are regulated under the ETS. Poland's NECP, adopted in 2019, defines 2030 targets for non-ETS GHG emissions, renewable energy and energy efficiency that are intended to support the achievement of EU-wide 2030 targets (Table 2.1).

Poland achieved its 2020 target for renewables in gross final energy consumption, however this resulted in large part from an improved methodology to collect data on biomass use for building heating. The 2020 shares for renewables in electricity and

renewables in transport remain below their indicative trajectories (see Chapter 5). Poland achieved its 2020 targets for GHG emissions under EU accounting rules that allow credits for years when emissions were below annual targets (2013-15 and 2020) to offset for years when emissions exceeded annual targets (2016-19) (see Chapter 3). The 2020 energy efficiency target for final energy consumption was achieved in 2019, while the 2020 target of primary energy consumption was almost achieved (missed by 0.1 Mtoe). However, much of the demand reduction seen in 2020 results from temporary impacts related to the Covid-19 pandemic (see Chapter 4). Poland achieved its 2020 target of 4% electricity interconnection with bordering member states; however, this target is not in line with the 10% target required under EU directives. Poland's 2030 electricity interconnection target (8.7%) is equally not in line with the 15% target required under EU directives (see Chapter 7).

Table 2.1 Poland's 2020 and 2030 energy sector targets and 2020 status

		2020 status	2020 targets	2030 targets
Non-ETS GHG emissions	CO₂-eq emissions versus 2005	+10%	+14%	-7%
Energy efficiency (Mtoe)	Primary energy consumption	96.5	96.4	91.3
	Final energy consumption	71.0	71.6	67.1
Renewable energy share	Gross final energy consumption	16.1%	15%	23%
	Electricity*	16.2%	19%	32%
	Heating and cooling*	22.1%	17.4%	28.4%
	Transport*	6.6%	10%	14%
Cross-border electricity interconnection		4%	4%	8.7%

* Indicative trajectories.

In October 2020, the EC published its review of Poland's NECP, noting that the 2030 target for 23% renewables in gross final consumption is unambitious (the EC proposed a share of 25%). The EC also commented that Poland's 2030 energy efficiency targets were of modest ambition and that the energy efficiency first principle is not well reflected in the NECP. In February 2021, Poland adopted a new national energy strategy: the Energy Policy of Poland until 2040 (EPP2040), which aims to put the country on a path to a zero-carbon economy. However, the EPP2040 does not define a year for Poland to achieve climate neutrality.

The EPP2040 contains numerous 2030 targets that are intended to serve as indicators of Poland's energy transition progress (Table 2.2). It also contains targets related to household heating, including ending individual coal-fired heating by 2030 in urban areas and by 2040 in rural areas (coal defined as smokeless fuel by the government can be used through 2040 in urban areas). The EPP2040 also contains a target for 100% of household heating to come from district heating or zero-/low-emission systems, including heat pumps, by 2040.

In December 2020, the 2030 EU-wide GHG emissions reduction target was increased from 40% to 55%. The EU is in the process of developing more ambitious 2030 targets for renewables and energy efficiency to support the 55% emissions reduction target. Poland's NECP and EPP2040 do not account directly for the increased EU-wide GHG target and it is likely that Poland will need to increase its 2030 targets for GHG emissions, renewables and energy efficiency to support the new EU-wide 55% reduction target.

Table 2.2 2030 targets in Energy Policy of Poland until 2040 and 2020 status

Indicator	2020 status	2030 target
Coal in electricity generation	79.7% (2021)	≤ 56% to 37.5%*
Offshore wind generation capacity	0 GW	5.9 GW (8-11 GW in 2040)
Solar PV generation capacity	7.7 GW (2021)	5-7 GW (10-16 GW in 2040)
Nuclear generation capacity	0 GW	1 reactor: 1-1.6 GW in 2033 6 reactors: 6-9 GW in 2043
Renewable heating and cooling	22.1%	+1.1% per year through 2030
Natural gas network capacity hydrogen	Unknown	10%
Total CO ₂ emissions (ETS and non-ETS)	271.5 Mt	241 Mt**
Communes with an energy planning document	20.2%	100%
Households in energy poverty	10.1%	< 6%
Electricity distribution system reliability: System Average Interruption Duration Index (SAIDI)	118.7	≤ 85
Electric vehicle (EV) regular charging points	509 (2019)	49 000-85 000
EV fast charging points (above 22 kW)	375 (2019)	11 000-15 000
Zero-emission vehicle purchases in public transport***	4% (2018)	100% (2025)
Zero-emission vehicles in the public transport***	2% (2018)	100%
End consumers equipped with a smart meter	12%	80% (2028)
Households using district heating	5.28 million (2018)	1.5 million new connections

* Based on EPP2040 scenarios assuming an ETS price of EUR 35-54 per tonne in 2030 (ETS price exceeded EUR 89 per tonne in 2021).

** A 30% reduction compared to 1990 levels excluding land use, land-use change and forestry (LULUCF).

*** In vehicle fleets of cities with more than 100 000 inhabitants.

Energy policy overview

Poland's energy policy aims to decarbonise its energy supply through the expansion of renewable energy, the introduction of nuclear energy, electrification (especially for transportation) and increased energy efficiency across the economy. A central aspect of Poland's energy policy is reducing the reliance on coal, especially for electricity generation and building heating. However, a large amount of financial support is given the coal sector, both for mining and generation, and through programmes that aim to address concerns around energy security and energy poverty. This support comes both as direct public aid and through a variety of mechanisms that ensure income streams and socialise the costs and risks of coal sector activities. Analysis from the EC and OECD show that Poland's fossil fuel subsidies have increased substantially and are approaching EUR 2 billion per year, most of them for coal. Poland also provides notable funding to support renewables deployment. For example, the government estimates that support payments for Poland's offshore wind programme will amount to around EUR 7.8 billion by 2040 and around EUR 22.5 billion over the life of the programme.

There is a strong focus on energy security and a just transition that maintains affordable access to energy to promote economic growth and protect vulnerable consumers. The

social contract concluded in May 2021 between the government and coal trade unions sets a schedule to gradually close all of Poland's hard coal mines (excluding coking coal mines) by 2049. The agreement guarantees that workers in the hard coal sector will have a job until retirement or receive a severance package, and commits to support the transition of the main hard coal mining regions to other economic activity. The agreement does not cover lignite and there are no targets for phasing out lignite mining or lignite-fired electricity generation (see Chapter 8).

The main documents defining Poland's energy and climate policies are the NECP (required for all EU member states) and the national EPP2040. The NECP defines the policies and measures to achieve Poland's energy sector targets defined under EU directives. The EPP2040 sets the national framework for Poland's energy transition and is aligned with the NECP. The EPP2040 is one of nine integrated sectoral strategies resulting from the Strategy for Responsible Development, adopted in 2017, and is the key document defining Poland's medium- and long-term economic policy.

The energy transition envisaged in the EPP2040 is intended to reduce emissions, drive modernisation across the Polish economy, ensure a fair distribution of costs, protect vulnerable social groups, and give an active role to consumers and domestic industry. The EPP2040 aims to drive changes across the entire energy supply chain, from the acquisition of raw materials through energy generation, transmission and distribution to the way energy is marketed and used. The EPP2040 dedicates around EUR 60 billion, from EU and domestic funds, to support energy transition until 2030.

The EPP2040 sets three policy pillars: 1) just transition; 2) zero-emission energy system; and 3) good air quality. Just transition is defined as providing new development opportunities for the regions and communities the most negatively affected by the energy transition, by creating new jobs and industries that support the energy transition. The EPP2040 dedicates around EUR 15 billion from the EU Just Transition Fund to support transition in the regions of Poland reliant on the coal sector (see Chapter 8). In addition, the EPP2040 just transition pillar aims to ensure affordable energy, encourage consumers to participate in energy markets and create up to 300 000 new jobs in high-potential industries, especially renewables, nuclear energy, electromobility, grid infrastructure, digitalisation and thermal renovation of buildings.

The EPP2040's zero-emission energy system pillar aims to decarbonise the energy sector through nuclear energy, offshore wind generation, distributed renewable generation and the decarbonisation of industry. The good air quality pillar is centred on reducing the health impact of fossil fuel emissions by transitioning away from coal-fired heating, investing in district heating, promoting passive and zero-emission buildings, and electrification of transport and alternative transport fuels. The three pillars of the EPP2040 are backed by eight specific objectives, along with strategic projects and supporting measures. The eight EPP2040 objectives are:

1. **optimal use of own energy resources:** maintaining domestic coal production with improved economics, while reducing coal demand; just transition of coal regions; increased efficient use of domestic bioenergy; diversification of oil and gas imports
2. **expansion of electricity generation and grid infrastructure:** development of new generation, expanded transmission and distribution infrastructure, and implementation of smart grids to support new generation capacity, like natural gas

generation capacity and offshore wind, using a capacity market mechanism to encourage the development of new reliable capacity

3. **diversification of supply and development of network infrastructure for natural gas, crude oil and liquid fuels:** increased oil and gas pipeline import capacity; expanded LNG import capacity; investment in oil and gas distribution and storage
4. **development of energy markets:** further liberalisation of the electricity retail market (removal of regulated prices); development of the natural gas market; increased consumer participation in electricity markets; increased cross-border electricity transmission capacity; the development of electromobility and hydrogen market
5. **implementation of the Polish Nuclear Power Programme:** deployment of the first nuclear reactor by 2033 and six reactors by 2043; commissioning a nuclear waste repository
6. **development of renewable energy sources:** deployment of the first offshore wind projects; continued deployment of solar PV and onshore wind; bioenergy and geothermal; advanced biofuels; distributed generation (prosumers and energy communities) that support grid stability (e.g. through demand-side response and energy storage)
7. **development of district heating and co-generation:** connecting 1.5 million new households to district heating by 2030; increasing the use and efficiency of district heating and co-generation; increasing renewables and waste in co-generation; developing a new district heating market model and national heating map showing the potential of district heating and co-generation; increasing the share of communes with energy plans addressing heating demand
8. **promoting energy efficiency improvement:** nationwide thermal modernisation of residential buildings, ensuring efficient and environmentally friendly access to heat (also to reduce energy poverty), zero-emission public transport in cities with more than 100 000 inhabitants by 2030.

The NECP and EPP2040 are supported by a variety of additional policy documents, including the Raw Materials Policy (PSP2050), the National Framework for the Alternative Fuels Infrastructure Development, the Polish Hydrogen Strategy, and Poland's Recovery and Resilience Plan (developed in response to the Covid-19 pandemic).

The PSP2050 aims to identify and secure access to the raw materials required for Poland's strategic policy goals, such as energy security, economic development and energy transition (BIP, 2021). This includes determining the availability of resources important to the economy and energy system and estimating the demand for these resources in 2025, 2030, 2040 and 2050.

The PSP2050's main strategic objectives are access to and protection of mineral deposits, groundwater and geothermal resources; exploration and documentation of mineral deposits; beneficial laws and regulations for current and future investors; and development and modernisation of the geological and mining industry. It also mentions international co-operation on securing access to raw materials, supporting the development of a circular economy, promoting knowledge and ensuring consistency of strategies implemented by companies of significant importance to the economy and the energy system.

Energy poverty

The government defines energy poverty as “a situation in which a household run by a single person or by several persons together in a self-contained dwelling or in a building in which no economic activity is carried out, is unable to provide itself with sufficient heat, cooling, lighting and electricity to power appliances, as a result of a combination of low-income, high energy expenditure and low energy efficiency.” The Ministry of Climate and Environment has an energy poverty working group to review existing measures addressing energy poverty and prepare recommendations on implementing a systemic approach.

The EPP2040 sets a goal to reduce energy poverty to less than 6% by 2030. The share of households in energy poverty decreased from 11.1% in 2012 to 10.3% in 2015 and 9.3% in 2019. The pandemic drove an increase in energy poverty, which reached 10.1% in 2020 (Poland, Ministry of Climate and Environment, 2021). Poland has a programme that provides energy allowances to help cover the energy bills of vulnerable consumers; however, it only covers a small share of consumers in energy poverty. In 2019, energy allowances were paid to just 0.6% of households (75 636 households).

Energy poverty is also addressed by various programmes providing incentives for building renovations, including replacing heating systems (see Chapter 4). The Clean Air Programme, which supports the replacement of inefficient heating systems, currently has two income brackets with higher levels of support for lower income households. The government aims to add a third income bracket in 2022, which would cover 90% of heating system replacement costs (up to EUR 12 213) for households with a monthly income less than EUR 174-262 per person. There are also plans to support low-income households with pre-financing, free-of-charge technical assistance and the potential to cover 100% of heating system replacement costs.

Covid-19 response

In response to the Covid-19 pandemic, the EU established the Recovery and Resilience Facility, with EUR 672.5 billion in funding to support recovery and resilience plans developed by each EU member state. Poland submitted its Recovery and Resilience Plan to the EC in May 2021, requesting EUR 36 billion in funding (EUR 23.9 billion in grants and EUR 12.1 billion in loans), one of the largest funding requests to the Recovery and Resilience Facility (EC, 2021).

The largest investment in the plan is for the deployment of offshore wind (EUR 3.25 billion), with an additional EUR 437 million for port infrastructure supporting offshore wind. The next largest investment is for a low-carbon economy (EUR 1.11 billion) followed by hydrogen production, storage and transport (EUR 800 million). The plan also includes notable investments for energy efficiency and renewable energy projects undertaken by companies (EUR 300 million), electricity infrastructure (EUR 300 million), upgrading heating systems (EUR 300 million), replacing heat sources and energy efficiency in schools (EUR 290 million), replacing heating systems and energy efficiency in residential buildings (EUR 201 million), natural gas storage (EUR 200 million), renewables in energy communities (EUR 97 million), and energy efficiency in social activity facilities (EUR 67 million). EC approval of Poland's plan has been significantly delayed because of political issues.

Energy transition investments

The government estimates that modernising the energy sector and achieving the NECP's 2030 targets will require EUR 195 billion from 2021 to 2030 (around 3.5% of annual GDP) and that the cost of the energy transition from 2021 to 2040 could reach EUR 350 billion. The government expects that most investments to support the energy transition will come from the private sector, but that public funding will also make a noteworthy contribution. The majority of public funding for the energy transition in Poland is expected to come from a variety of EU mechanisms, but national funds will also provide notable funding. The government expects that EU and national funds will provide around EUR 60 billion to support Poland's energy transition by 2030, including the EU Recovery and Resilience Facility, EU Cohesion Policy, the EU Just Transition Fund and ReactEU, as well as new instruments (the EU Modernization Fund, the National Special Purpose Fund and the Energy Transformation Fund).

Poland's European Funds for Infrastructure, Climate and Environment programme (FEnIKS) will allocate around EUR 25 billion in EU funding from 2021 to 2027. FEnIKS supports projects covering the environment, energy, transport, culture and health. In relation to energy investments, FEnIKS will focus on decarbonisation, transitioning to an environmentally friendly and circular economy, and building an effective and resistant transport system with the lowest possible environmental impact. FEnIKS will provide around EUR 2.5 billion for investments in energy efficiency and renewables, and around EUR 2 billion for investments in electricity and gas infrastructure (Poland, Ministry of Development Funds and Regional Policy, 2021).

Poland's National Fund for Environmental Protection and Water Management funds several programmes related to the energy transition, including the Energy Plus programme for energy efficiency measures and lowering emissions of heat sources (EUR 880 million); the My Electricity programme for individual solar PV systems (EUR 242 million); the Green Public Transport programme for electric and hydrogen buses (EUR 240 million); the Polish Geothermal Plus programme (EUR 132 million); the My EV programme, which subsidises private EV purchases (EUR 110 million); a programme for energy-efficient building construction (EUR 88 million); a programme to modernise and expand residential district heating (EUR 50.6 million); and a variety of other programmes focused on renewables and efficiency (see Chapters 4 and 5).

Energy taxation

The government aims for energy taxation to drive economic growth and support energy policy, including goals for renewable energy, electrification and alternative fuels. Poland has a variety of taxes and duties applied to energy products, including a value-added tax (VAT) of 23% (Table 2.3). In 2019, revenues from excise duties on all energy products (transport fuels, electricity, natural gas and districting heating) totalled around EUR 8 billion, with 93.2% coming from transport fuels (mainly diesel and gasoline). As a result of the Covid-19 pandemic, tax revenues from energy product excise duties dropped to around EUR 7.6 billion in 2020, with 94.1% coming from transport fuels.

Separate revenues from the road tax charged on all transportation fuels are used for the construction of highways and railroads. An emission tax was introduced in 2019 for diesel and gasoline use in transportation. The emission tax is paid by fuel producers and

importers, with 95% of the revenues going to the National Fund for Environmental Protection and Water Management and 5% of the proceeds allocated to expanding local bus routes. A stockholding surcharge is applied to all oil-based energy products, with revenues used to purchase and maintain oil stocks required under IEA and EU rules.

Table 2.3 Energy product taxation in Poland, 2020

Energy product taxation	EUR per	Excise duty	Road tax	Emission tax	Stockholding surcharge (EUR/GJ)*	Total (EUR/GJ)*
Electricity	MWh	1.1				0.31
Transportation fuels						
– Gasoline	1 000 litres (L)	333	36.3	17.6	0.55	12.11
– Diesel		252	74.5	17.6	0.55	10.17
– Liquefied petroleum gas (LPG)	1 000 kilogrammes (kg)	142	43.6		0.22	4.25
– CNG, bio-CNG			43.6			1.13
– LNG, bio-LNG			43.6			0.81
Heating fuels						
– Coal and coke	Gigajoule (GJ)	0.28				0.28
– LPG		0.28			0.22	0.28
– Natural gas		0.28				0.28
– Diesel	1 000 L	51			0.55	1.98
– Light fuel oil		51			0.55	1.98
– Heavy fuel oil	1 000 kg	14.1			0.55	0.89

* Estimate based on: gasoline 33.5 MJ/L, diesel 35.8 MJ/L, LPG 46 MJ/kg, CNG 38.5 MJ/kg, LNG 53.5 MJ/kg, light fuel oil 36 MJ/L, heavy fuel oil 41 MJ/kg.

Poland has several excise duty exemptions, not all of which are aligned with energy and economic policy. Electricity generation from renewables and transport use of CNG, LNG, biogas and hydrogen are exempt from the excise duty. Electricity used for transport is charged the full tax. Diesel and gasoline used for transport are charged the full tax regardless of the share of biofuels. Energy-intensive industries (those where energy costs exceed a certain threshold of total operating costs: 10% for coal, 5% for natural gas and 3% for electricity) receive a refund of the excise duty on electricity and an exemption on the excise duty for coal and gas. There is also a full exemption on the excise duty for gas and coal used in residential heating. There are refunds and exemptions for taxes charged on sector-specific uses of fossil fuels in agriculture, fishing, shipping and aviation.

Poland has a carbon pricing scheme for emissions of CO₂ and other GHGs that is composed mainly of the EU ETS along with a small national emissions fee (different from the emission tax charge on diesel and gasoline used for transport). From 2021 to 2030, 40% of the revenues from Poland's ETS allowances will go to the national Energy Transformation Fund. Revenues from the emissions fee are also used to support energy transition (see Chapter 3).

Poland has taken some steps to align its vehicle taxation with energy policy goals of reducing transport sector emissions and encouraging the adoption of EVs (see Chapter 4).

Vehicle registration fees are lower for vehicles with lower capacity engines and for hybrid vehicles. Battery EVs, hydrogen vehicles and some plug-in hybrids are exempt from registration fees (see energy efficiency section). Poland plans to introduce annual taxation based on a vehicle's environmental performance.

Several measures were taken to reduce the impact of the sharp increase in energy prices seen across Europe in the second half of 2021. In November 2021, a package of measures with a total budget of EUR 1.1 billion was passed. It included an energy voucher (cash payment through the social aid system in 2022) and a separate monthly cash payment (up to EUR 300 per year in 2022, with broad eligibility covering 5.2 million households). In addition, transport fuels were exempted from the retail tax and taxed at the lowest excise duty allowed under EU rules from December 2021 to May 2022; the VAT was lowered from 23% to 5% for electricity and from 23% to 8% for natural gas and district heating from January 2021 to March 2022.

Fossil fuel subsidies

The EU has committed to phasing out energy subsidies, including fossil fuel subsidies. The EC reports each year on the progress of all EU member states in phasing out energy subsidies, with the 2020 report noting that from 2008 to 2018, Poland's annual fossil fuel subsidies increased from EUR 0.5 billion to EUR 1.8 billion and just under 0.2% of GDP (versus the EU average of 0.4% of GDP). Most of the growth in Poland's fossil fuel subsidies has come from increased support to the coal sector, which received the largest share of energy subsidies in 2019 (EC, 2020a).

The OECD Inventory of Support Measures for Fossil Fuels indicates that from 2010 to 2019, Poland's fossil fuel subsidies grew from EUR 1.15 billion to EUR 1.76 billion, with most of the growth from a large increase in coal subsidies. In 2019, EUR 1.35 billion of fossil fuel subsidies went to coal, followed by oil (EUR 0.4 billion) and just EUR 3.1 million for natural gas (OECD, 2021). The OECD report noted that Poland's fossil fuel subsidies come mainly from the state covering all the costs of decommissioning coal mines and of the termination of long-term power purchase agreements by coal-fired power plants. In 2018, substantial aid was provided to restructure the coal mining sector.

Poland's NECP and EPP2040 do not include any details on, or commitments to, phase out fossil fuel subsidies. The NECP does indicate government funding to support new natural gas storage, as well as funding for LNG and CNG vehicles and related fuelling infrastructure (ODI, 2019). Poland's Recovery and Resilience Plan also includes EUR 200 million for the development of new natural gas storage.

Hydrogen

In 2018, Poland produced more than 1 million tonnes of hydrogen and was the third-largest hydrogen producer in the EU after Germany and the Netherlands. Poland's hydrogen production is based mainly on steam reforming of natural gas and 90% of hydrogen is used to produce ammonia or methanol, or for refining processes. The government sees an important role for low-carbon hydrogen in the energy sector. The EPP2040's Objective 4, development of energy markets, includes general goals that support the establishment of a national hydrogen market.

In November 2021, Poland adopted the Polish Hydrogen Strategy until 2030 with a perspective until 2040. It defines six key objectives that detail plans, funding, and legal and regulatory changes to support the production, storage, transport and use of low-carbon hydrogen with a focus on hard-to-decarbonise sectors and end-uses.

Objective 1 aims for hydrogen to play a role in building heating through injection into the natural gas grid and through the use in co-generation plants supporting district heating. It also aims for hydrogen to be used in electricity generation (natural gas turbines and fuel cells) and for hydrogen storage to support grid balancing and meeting seasonal heating demand.

Objective 2 is the use of hydrogen as an alternative fuel in transport. It includes targets for 32 hydrogen fuelling stations and 250 hydrogen buses by 2025; 1 000 hydrogen buses by 2030; and for the use of hydrogen or hydrogen-based synthetic fuels in heavy trucks, trains, ships and aviation.

Objective 3 is the decarbonisation of industry, with a focus on sectors that cannot be directly electrified or powered by renewables. The objective mentions hydrogen-based steel production to reduce coal demand and hydrogen as an alternative to natural gas for industrial processes and feedstocks. There is a 2030 goal to have five or more hydrogen valleys (industrial clusters with a value chain of hydrogen production, transport and use).

Objective 4 is low-carbon hydrogen production. It sets targets for at least 50 megawatts (MW) of low-carbon hydrogen production capacity by 2025 and 2 GW by 2030, and general goals for the production of synthetic gases and ammonia from low-carbon hydrogen. It notes that hydrogen production technologies should be selected based on the lowest level of CO₂ emissions and supports both electrolysis and fossil fuel-based hydrogen production with carbon capture and storage.

Objective 5 is safe and efficient transport and distribution of hydrogen, which indicates that hydrogen will initially be transported mainly via road and rail, but defines general goals for large-scale hydrogen transport by 2030 using retrofitted gas infrastructure and new dedicated hydrogen infrastructure. There is also a goal for pilot projects testing hydrogen storage in salt caverns.

Objective 6 calls for a stable regulatory framework defining a hydrogen market, transposing related EU laws and introducing incentives for low-carbon hydrogen production by 2023. As part of this effort, Poland aims to introduce a Hydrogen Act in 2022.

The government estimates that the implementation of the Hydrogen Strategy requires combined public and private investments of around EUR 445 million by 2025 and EUR 3 billion by 2030. The strategy identifies several national and EU sources of funding. At the national level, the Hydrogen Technologies Support Programme will provide EUR 220 million (mainly for hydrogen valleys); the New Energy Programme will provide EUR 132 million for companies investing in the production, transport, storage and use of zero-emission hydrogen; and the Hydrogenation of the Economy Programme will support innovative hydrogen projects.

There is also funding for hydrogen projects in Poland through several EU mechanisms, including the Just Transition Fund, Next Generation EU, InvestEU, Cohesion Policy, the Connecting People Facility, the Innovation Fund and Horizon Europe. Poland's EU Recovery and Resilience Plan includes EUR 800 million for hydrogen production, storage

and transport. Poland also aims to attract investments in hydrogen through EU Important Projects of Common European Interest.

In July 2020, the Minister of Climate and Environment and key companies from the energy and transport sectors signed a letter of intent to establish a partnership for building a hydrogen economy, and the sectoral hydrogen agreement. The agreement aims to define the legislative, organisational, institutional and financial instruments to establish a Polish hydrogen economy. The partnership established six working groups to support the Hydrogen Strategy.

In June 2021, the Polish oil refining company PKN ORLEN announced plans to develop 250 MW of electrolysis capacity powered by wind and solar PV at six hydrogen hubs (three in Poland, two in the Czech Republic and one in the Slovak Republic). The company aims for one of the hubs in Poland to be powered by the 1.2 GW Baltic Power offshore wind project in which ORLEN holds a 51% stake. The plan also aims for the construction of three plants that will produce hydrogen from municipal waste sites in Płock and Ostrołęka in Poland and in the Czech Republic, and the deployment of a network of hydrogen refuelling stations (54 in Poland, 22 in the Czech Republic and 26 in the Slovak Republic). PKN ORLEN aims to reach an annual low-carbon hydrogen production capacity of around 50 000 tonnes by 2030 (ORLEN, 2022). In December 2020, the state-controlled oil and gas company PGNiG announced plans to spend around EUR 7 million on low-carbon hydrogen projects, including a hydrogen fuelling station and research on hydrogen production and injection into the natural gas grid (PGNiG, 2020).

Gender equality in the energy sector

In 2020, the European Institute for Gender Equality ranked Poland 24th in the EU on its Gender Equality Index (EIGE, 2020). However, Poland has made progress on closing the gender pay gap, which was 8.5% in 2019 versus an EU average of 14.1% (EC, 2020b). The gender pay gap in Poland's energy sector is lower (5.1%) than the national average and lower than the gender pay gaps in the energy sectors of Germany (20.8%), France (10.8%) and the Czech Republic (17.2%) (Eurostat, 2022). In 2019, women represented only 20% of the energy sector workforce in Poland. The EU average (22.1%) is only slightly higher and in both cases women working in the sector are generally in lower paid administrative positions with limited decision-making power (European Parliament, 2019).

The National Action Programme for Equal Treatment for 2021-2030 is a multiannual programme that sets strategic goals and priorities for actions for equal treatment. In preparing the programme, the following challenges for equality between women and men were identified: lower employment rate for women; wage gap and pension gap; low percentage of women in top positions; low levels of women in science, technology, engineering and maths. The programme sets goals to address these challenges, but there are no legally binding targets.

Assessment

Poland aims to decarbonise its energy supply by expanding renewable energy, introducing nuclear energy, electrification and increased energy efficiency. There is a strong focus on energy security and a just transition that maintains affordable access to energy to promote economic growth and protect vulnerable consumers and workers in the coal industry. A central aspect of Poland's energy policy is reducing reliance on coal, especially for electricity generation and building heating. The role of coal in Poland's energy system has declined. However in 2021, coal-fired electricity generation (the largest source of coal demand) experienced strong growth and accounted for 79.7% of total generation (up from 68.5% in 2020), as domestic electricity demand returned to levels seen before the start of the pandemic and electricity exports increased.

Under EU directives and national laws, Poland has 2020 and 2030 targets for GHG emissions, renewables, energy efficiency and electricity interconnection that are intended to help achieve EU-wide targets. Poland achieved most of its 2020 targets; however, the trajectory of its energy sector in 2021 (increasing demand, higher use of fossil fuels and growing emissions) is not in line with the trends needed to support Poland's energy policy goals. In addition, the EC has noted that Poland's 2030 targets for renewables and energy efficiency are of modest ambition. In December 2020, the 2030 EU-wide GHG emissions reduction target was increased from 40% to 55%. The EU is in the process of developing a Fit-for-55 package with increased targets for renewables, energy efficiency and other areas to support the new target.

Poland should take quick action to increase its 2030 targets, revise existing programmes and develop new measures to help achieve the enhanced EU-wide 2030 targets. These changes should be reflected as official policy in updated versions of the EPP2040 and NECP to provide certainty to investors and accelerate a sustainable energy transition. The government should increase engagement with civil society, industry and academia at the national, regional and local levels when developing and implementing energy policy, including for the needed updates of the EPP2040 and the NECP.

The government estimates that achieving 2030 energy and climate targets will require investments EUR 195 billion from 2021 to 2030 (3.5% of annual GDP). This level of investment will require substantial support from the private sector. The government needs to ensure that public financial support mechanisms are stable, transparent and predictable to effectively drive private investments along the entire energy value chain. Support also needs to be clearly aligned with energy transition and long-term carbon neutrality. This would help boost investor confidence, accelerate the deployment of needed projects and reduce the risk of stranded assets.

Poland aims to achieve its energy and climate goals by expanding renewable energy, natural gas and electrification (especially for transportation), and by introducing nuclear energy. Poland has seen notable success in rapid deployment of distributed solar PV, has an offshore wind generation programme that aims for 5.9 GW by 2030 and is working to bring nuclear generation online by 2033. However, efforts on electrification have been less successful, with weaknesses in the distribution grid noted as a particular obstacle. The government is working with distribution system operators (DSOs) to improve distribution system reliability; these efforts should be closely monitored and clearly aligned with support for increased renewable generation. Progress on energy efficiency has been slow and the energy efficiency first principle is not clearly expressed or supported in key policy

documents. The government needs to make a greater effort to ensure energy efficiency is considered in all energy-related policy and programmes. There are notable opportunities to integrate support for energy efficiency into successful existing measures, such as the My Electricity and the Clean Air Programmes.

The social contract represents a historic deal between the government and the coal industry, setting the first-ever goal to phase out hard coal mining (excluding coking coal). The social contract includes plans for generous state aid to reduce the economic impact and support the transition away from coal. Poland is also seeking EU Just Transition funding for regions dependent on hard coal and on lignite. However, the agreement allows hard coal mining through 2049 and does not cover Poland's large lignite sector. The objectives are not in line with Poland's commitments to EU goals of a 55% GHG reduction by 2030 and carbon neutrality by 2050 and do not reflect the economic reality of coal becoming less competitive. The government needs to develop a transition plan for the entire coal value chain that reflects the need for a more rapid energy transition by 2030, supports carbon neutrality and ensures a just transition.

In addition, the coal sector receives a large amount of financial support, for both mining and generation. This support comes both as direct public aid and through a variety of mechanisms that ensure income streams and socialise the costs and risks of coal sector activities. Analysis from the EC and the OECD show that Poland's fossil fuel subsidies have increased substantially and are approaching EUR 1.8 billion per year, most of which go to coal. The EU has committed to phasing out energy subsidies, including fossil fuel subsidies. Poland's NECP and EPP2040 do not include commitments to phase out fossil fuel subsidies. The government should evaluate the wide range of financial support directed to the coal value chain and determine how these resources could be more effectively directed to the energy transition, while ensuring energy security.

Poland sees a major role for natural gas in supporting a secure transition away from coal, but the role of gas in the long-term decarbonisation of the energy system is not clear. There are some goals for decarbonising the gas supply through biomethane, and the Hydrogen Strategy outlines plans for low-carbon hydrogen, but these plans are too modest to offset the government's expectation of a large growth in natural gas demand. The current high reliance on gas to support energy security and plans to significantly expand gas-fired generation and the gas network will increase energy import dependency, and might cause risks of stranded assets and exposure to volatile gas prices. Investments in the natural gas sector should be limited to areas where it is essential to support energy security and where there are no clean alternatives available. The government also needs to develop a clear plan for the full decarbonisation of the gas supply.

Poland is committed to a just transition that maintains economic growth and affordable access to energy as the role of coal declines. The EPP2040 sets a goal to reduce energy poverty to less than 6% of households by 2030 (compared to 9.3% in 2019 and 10.1% in 2020). The government significantly expanded energy allowance for vulnerable consumers to cover their electricity bills in 2022. Only covering energy costs will not address key issues driving high energy bills for low-income consumers, which often live in poorly insulated buildings and lack the financial resources for needed renovations. The IEA recommends that the government develop a holistic programme to reduce energy poverty, with a strong focus on energy efficiency. It is also important to leverage low-cost distributed generation and energy communities to help lower the energy bills of vulnerable consumers, while giving them an active and empowered role.

Poland is in the process of fully liberalising its energy markets. Electricity prices are still regulated for households and a gas market liberalisation is being developed. Many of the key actors in Poland's energy sector are state-owned companies that maintain dominant positions in the electricity, oil and gas markets, at the wholesale and retail levels. The government should take strong action to remove barriers for new companies and services in energy markets. Increasing competition is one key option to help reduce energy costs, which would benefit all consumers, including those facing energy poverty.

In addition, the government should empower consumers to make informed choices about their energy suppliers. Currently, consumers rarely switch suppliers because of non-transparent energy bills, regulated tariffs and the lack of comparison tools. Also, the incumbent suppliers are too closely linked to the DSOs, so consumers do not see the difference between suppliers and DSOs. Under such circumstances, consumers cannot act as an engine to get competition going.

The government should adopt a comprehensive plan to drive competition in the electricity market that decreases the dominance of incumbent companies, ends regulated prices, and facilitates new market entrants by introducing a well-functioning price comparison tool and supplier of last resort mechanism, and automated consumer switching procedures; allow small and medium-sized private companies to participate in capacity allocations and apply appropriate measures to increase liquidity on wholesale and retail markets. The current plans to amend the Energy Law and the Act on Renewable Energy Sources are in line with the needed changes and the IEA encourages the government to quickly pass and implement the amendment.

Poland has taken some steps to align energy taxation with climate and energy goals. An emissions tax was introduced in 2019 for diesel and gasoline use in transport, with 95% of revenues going to the National Fund for Environmental Protection and Water Management, which co-finances a variety of energy transition programmes. However, overall energy prices in Poland are not well-aligned with energy transition goals, there are numerous tax breaks and support mechanisms lowering the cost of fossil fuels. Poland's emissions fee has good economy-wide coverage, but is too low to meaningfully affect energy prices. Several support programmes for energy transition in electricity generation pass costs on directly to end consumers, reducing the incentives for electrification. The government needs to better align price signals with energy transition goals, e.g. by increasing the emissions fee, while ensuring vulnerable consumers are given the resources needed to access affordable energy.

Poland's response to the impacts of the Covid-19 pandemic on the energy sector is mainly directed through the EU Recovery and Resilience Facility. Poland submitted its plan to the EC in May 2021 requesting EUR 36 billion (including grants and loans), with notable projects for offshore wind, hydrogen and natural gas. EC approval of Poland's plan is still pending. As the funding must be spent by 2026, the government should be ready to quickly disperse recovery funds in an efficient and effective manner, and secure future domestic funding for these programmes to continue beyond 2026. The government should also disperse this funding in a manner that maximises private sector investment.

Recommendations

- Update the Energy Policy for Poland until 2040 and the National Energy and Climate Plan with targets and measures that support the EU's increased climate and energy ambitions, reflect energy market developments, technical innovation and increased European carbon prices.
- Ensure stable, transparent and predictable public financial support to boost private investments along the entire energy value chain in line with long-term carbon neutrality.
- Review the regulatory framework to increase energy market competition, ensure a level playing field among all market participants, and strengthen the position of consumers and open markets for new investors and services.
- Adjust taxes, market regulations and financial support measures so that energy prices drive behaviour and investments that support a just energy transition, increase system flexibility and reduce the risk of stranded assets.
- Develop a transition plan for the entire coal value chain that reflects the need for a more rapid energy transition by 2030, supports carbon neutrality and ensures a just transition.

References

- ACER (European Union Agency for the Cooperation of Energy Regulators) (2020), ACER Market Monitoring Report 2019: Energy Retail and Consumer Protection Volume, https://documents.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/ACER%20Market%20Monitoring%20Report%202019%20-%20Energy%20Retail%20and%20Consumer%20Protection%20Volume.pdf
- BIP (Ministry of Climate and Environment) (2021), State Raw Materials Policy (web page), <https://bip.mos.gov.pl/strategie-plany-programy/polityka-surowcowa-panstwa>
- EC (European Commission) (2021), Recovery and Resilience Facility: Poland submits official recovery and resilience plan, https://ec.europa.eu/commission/presscorner/detail/en/IP_21_2221
- EC (2020a), Final Report Energy Subsidies, <https://op.europa.eu/en/publication-detail/-/publication/92ae71b0-173a-11eb-b57e-01aa75ed71a1/language-en>
- EC (2020b), Gender pay gap levels vary significantly across EU, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Gender_pay_gap_statistics#Gender_pay_gap_higher_in_the_private_sector
- EIGE (European Institute for Gender Equality) (2020), Gender Equality Index 2020 Poland, https://eige.europa.eu/sites/default/files/documents/20203357_mhag20010enn_002.pdf
- Eurostat (2022), Gender pay gap in unadjusted form by NACE Rev. 2 activity (database), https://ec.europa.eu/eurostat/databrowser/view/EARN_GR_GPGR2_custom_90502/default/table?lang=en (accessed on 17 March 2022)
- European Parliament (2019), Women, Gender Equality and the Energy Transition in the EU, [https://www.europarl.europa.eu/RegData/etudes/STUD/2019/608867/IPOL_STU\(2019\)608867_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/STUD/2019/608867/IPOL_STU(2019)608867_EN.pdf)
- IEA (International Energy Agency) (2022), World Energy Balances (database), <https://www.iea.org/data-and-statistics/data-product/world-energy-balances> (accessed on 18 February 2022)
- ODI (Overseas Development Institute) (2019), Fossil fuel subsidies in draft EU National Energy and Climate Plans, <https://cdn.odi.org/media/documents/12895.pdf>
- OECD (Organisation for Economic Co-operation and Development) (2021), OECD Inventory of Support Measures for Fossil Fuels: Country Notes, <https://doi.org/10.1787/5a3efe65-en>
- ORLEN (2022), Press releases (web page), <https://www.orklen.pl/en/about-the-company/media/press-releases-categories/all>
- PGNiG (2020), PGNiG launches new hydrogen program (web page), <https://en.pgnig.pl/news/-/news-list/id/pgnig-launches-new-hydrogen-program/newsGroupId/1910852>
- Poland, Ministry of Climate and Environment (2021), Energy Poverty 2020, <https://www.gov.pl/attachment/98c097e4-f2ea-4adf-9b05-e3bd8ba7e24c>
- Poland, Ministry of Development Funds and Regional Policy (2021), EUR 25 billion from European Funds for Infrastructure, Climate, Environment – we are waiting for your vote (web page), <https://www.funduszeuropejskie.gov.pl/strony/o-funduszach/fundusze-na-lata-2021-2027/aktualnosci/25-mld-euro-z-funduszy-europejskich-na-infrastrukture-klimat-srodowisko-czekamy-na-twoj-glos>

3. Energy and climate change

Key data

GHG emissions without LULUCF (2019): 390.8 Mt CO₂-eq, -3.6% since 2005, -17.9% since 1990

GHG emissions with LULUCF (2019): 375.7 Mt CO₂-eq, +5.8% since 2005, -15.7% since 1990

Energy-related CO₂ emissions (2020):

CO₂ emissions from fuel combustion: 271.5 Mt CO₂, -7% from 2010 to 2019, -5% from 2019 to 2020

CO₂ emissions by fuel: coal 57.7%, oil 28.3%, natural gas 12.0%, non-renewable waste 2.0%

CO₂ emissions by sector: electricity and heat generation 43.5%, transport 22.6%, industry 20.1%, buildings 13.8%

CO₂ intensity per GDP: 0.226 kg CO₂/USD (IEA weighted average 0.188 kg CO₂/USD)

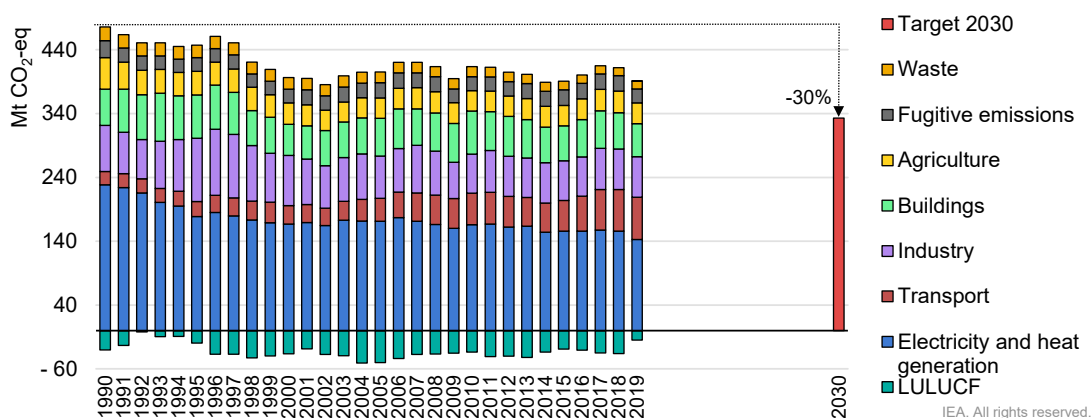
Overview

The high shares of coal in Poland's energy supply place it second among IEA member countries for CO₂ intensity of energy supply and fourth for CO₂ intensity of the economy. Poland's electricity and heat generation is heavily reliant on coal (82% of generation in 2021) and is the main source of CO₂ emissions (58% in 2020). Between 2005 and 2019, total GHG emissions excluding LULUCF experienced a slight overall reduction, from 405 million tonnes of CO₂-equivalent (Mt CO₂-eq) to 391 Mt CO₂-eq, in line with a gradual reduction of the share of coal in the energy system. However, emissions experience significant annual fluctuations, e.g. in 2017, emissions reached 415 Mt CO₂-eq, driven mainly by higher emissions from industry and transport (Figure 3.1). The Covid-19 pandemic notably reduced GHG emissions, driven mainly by lower transport emissions; however, total GHG emissions rebounded in 2021 as energy demand returned and the share of coal-fired generation increased.

The EPP2040 sets a target to reduce total CO₂ emissions (excluding LULUCF) to 241 million tonnes (Mt) by 2030 (a 30% reduction versus 1990 levels). Under EU regulations, Poland has a target to reduce GHG emissions outside the EU ETS by 7% by 2030 versus 2005 levels. Poland's measures to reduce emissions focus on reducing the carbon intensity of energy supply and increasing both energy efficiency and electrification of demand. Key measures to lower GHG emissions include reducing coal-fired generation, expanding renewable generation, especially from offshore wind and solar PV, and introducing nuclear generation. Efforts to reduce emissions from buildings

focus on moving away from coal-fired heating. Efforts to reduce transport emissions focus on electrification of road transit and modal shift away from private cars to public transit and active mobility. Measures to lower industrial emissions focus on increasing energy efficiency.

Figure 3.1 Greenhouse gas emissions by sector in Poland, 2000-2019 and 2030 target



Source: UNFCCC (2021).

Poland's LULUCF has historically acted as a notable emission sink, reducing overall GHG emissions by an average of 37.8 Mt CO₂-eq per year from 2000 to 2018. In 2019, emissions reductions from LULUCF dropped to just 15 Mt CO₂-eq as a result of significant damage to Poland's forests caused by extreme storms. The government estimates that emissions reductions from LULUCF will decrease over the long-term because of the advanced age of Poland's forests and increasing climate change impacts on forest health.

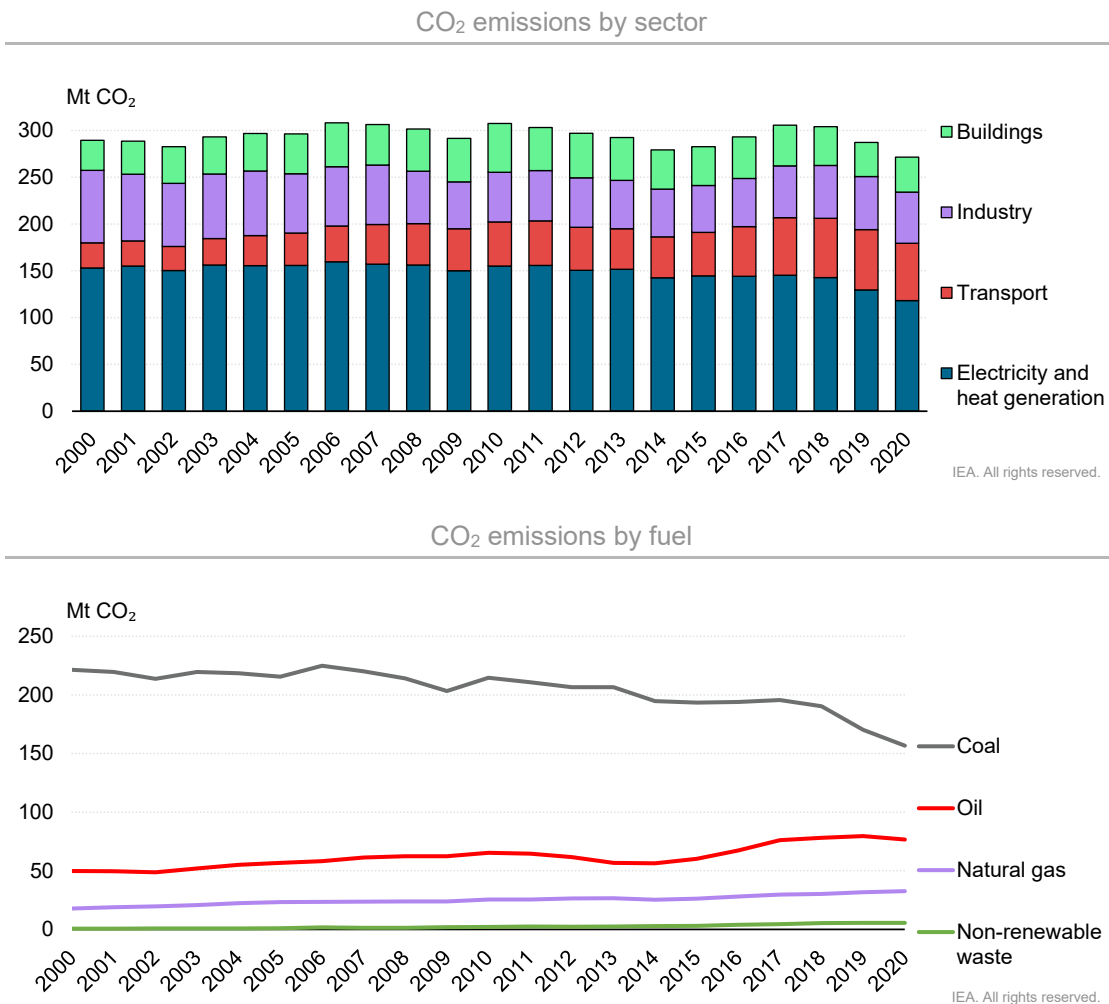
Energy-related CO₂ emissions

From 2010 to 2020, Poland's energy-related CO₂ emissions decreased from 308 Mt CO₂ to 271 Mt CO₂, with the Covid-19 pandemic accelerating a trend of decreasing emissions that started in 2018 (Figure 3.2). However, emissions increased in 2021, driven by a rebound in energy demand and a notable increase in the share of coal-fired generation. Most of Poland's energy-related emissions came from electricity and heat generation (43% in 2020), followed by transport (23%), industry (20%) and buildings (14%).

From 2010 to 2018, emissions from electricity and heat generation decreased from 155 Mt CO₂ to 143 Mt CO₂, driven by lower use of coal and increasing renewable generation (mainly onshore wind). In 2019, emissions from electricity and heat generation dropped sharply to 130 Mt CO₂ as coal-fired generation decreased by 9%, and in 2020 they dropped further to 118 Mt CO₂, as the decrease was sharpened by the Covid-19 pandemic. From 2010 to 2020, industry sector emissions increased from 53 Mt CO₂ to 55 Mt CO₂, with slightly lower coal demand offset by higher demand for oil and natural gas; building sector emissions decreased from 52 Mt CO₂ to 37 Mt CO₂, driven mainly by lower demand for coal in residential buildings and higher use of electricity.

From 2010 to 2019, transport sector emissions increased from 47 Mt CO₂ to 64 Mt CO₂, driven mainly by an increase in road transport demand, which is fuelled almost exclusively by oil. Emissions from transport decreased by 5% to 61 Mt CO₂ in 2020, as a result of the restrictions caused by the Covid-19 pandemic. The notable drop and rebound of data for transport emissions from 2010 and 2015 does not accurately reflect actual transport emissions, but was driven by the sale of transport fuels on the grey market, as sales were not reported, the associated emissions could not be calculated. Legislative and enforcement actions taken in 2016 helped to significantly reduce illegal sales and ensure better reporting of actual fuel demand, which is reflected in notable increases in transport emissions in 2016 and 2017.

Figure 3.2 Energy-related CO₂ emissions by sector and fuel in Poland, 2000-2020



Source: IEA (2022).

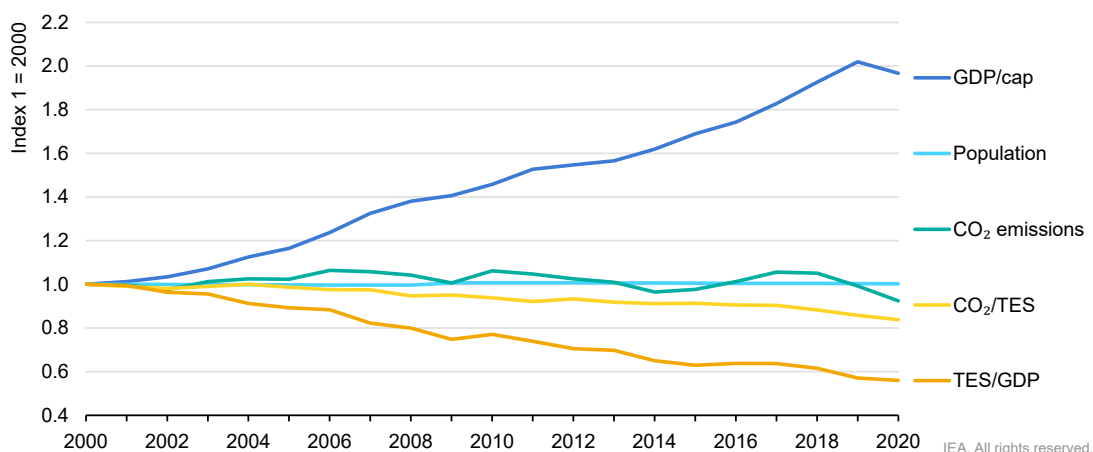
Poland's energy-related CO₂ emissions come mostly from coal (58% in 2020), which is used for electricity generation, building heating and by industry. Oil accounted for 28% of energy-related emissions, mostly from transport, followed by industry and a small share from building heating. Natural gas accounted for 12% of energy-related emissions, with most gas-related CO₂ emissions coming from industry, residential building heating and co-generation. From 2010 to 2020, CO₂ emissions from coal decreased, from 215 Mt CO₂

to 157 Mt CO₂, while CO₂ emissions from oil increased overall, from 63 Mt CO₂ to 77 Mt CO₂, and CO₂ emissions from natural gas increased from 26 Mt CO₂ to 33 Mt CO₂.

CO₂ emissions drivers and carbon intensity

Poland's GDP per capita increased by an impressive 102% from 2000 to 2019, but experienced a notable drop of 3% from 2019 to 2020 as a result of the Covid-19 pandemic. From 2010 to 2020, Poland's population dropped slightly from 38.5 million to 38.3 million (Figure 3.3). Despite a strong increase in GDP, CO₂ emissions have been relatively stable, with a notable drop from 2018 to 2020, reflecting a decrease in the carbon intensity of the economy and the energy supply. From 2010 to 2020, the energy intensity of the economy (TES/GDP) dropped by 27%, and the carbon intensity of energy supply (CO₂/TES) dropped by 11%. Despite the recent improvements, the high shares of coal in Poland's energy supply place it second among IEA member countries for CO₂ intensity of energy supply, at 65 t CO₂ per terajoule (TJ) versus an IEA average of 50 t CO₂/TJ in 2020, and fourth for CO₂ intensity of the economy (226 t CO₂ per million USD versus an IEA average of 188 t CO₂ per million USD).

Figure 3.3 Energy-related CO₂ emissions and main drivers in Poland, 2000-2020



Source: IEA (2021).

Climate targets

Poland has GHG emissions targets for 2020 and 2030 that are defined by EU directives. Emissions of CO₂, nitrogen oxide (NO_x) and perfluorocarbon from Poland's large electricity plants, energy-intensive industrial facilities and domestic aviation are regulated under the ETS, which uses tradable emissions allowances to drive emissions reductions at ETS regulated facilities in the EU, Iceland, Liechtenstein and Norway. The ETS has targets to reduce emissions from regulated facilities by 21% by 2020 and 43% by 2030 (both versus 2005 levels). All of Poland's other GHG emissions (non-ETS) are subject to a 2020 target under the EU Effort Sharing Decision (ESD) and a 2030 target under the EU Effort Sharing Regulation (ESR). In combination, the ETS, ESD and ESR aim for a 20% reduction in EU-wide GHG emissions by 2020 and a 55% reduction by 2030 (both versus 1990 levels). In

2019, 53% of Poland's GHG emissions were from non-ETS sources, with the largest shares from transport (36%) and buildings (30%) (EEA, 2021).

Under the ESD, Poland has a target to limit non-ETS GHG emissions to a 14% *increase* by 2020 versus 2005 levels. In 2018, Poland's non-ETS emissions were 21% higher than in 2005. However, it is likely that Poland will just meet its 2020 ESD target under EU accounting rules that allow credits from years when emissions were below annual ESD targets to offset deficits for years when emissions exceeded annual targets (Table 3.1).

Table 3.1 Poland's non-ETS greenhouse gas emissions and targets, 2013-2020

Non-ETS emissions (Mt CO ₂ -eq)	2013	2014	2015	2016	2017	2018	2019	2020
Annual emissions budget	194	195	196	197	200	202	203	205
Validated annual emissions	186	182	187	199	212	213	209	202*
Cumulative net credits to offset emissions	7.5	20.9	30.3	29.0	17.4	6.1	0.1	

*Provisional data from Eurostat (2022), validated emissions are not available for 2020.

In line with the ESR, Poland's NECP sets a target to reduce non-ETS GHG emissions by 7% by 2030 versus 2005 levels. In addition to targets from EU directives, the EPP2040 sets a target to reduce total CO₂ emissions (excluding LULUCF) to 241 Mt by 2030 (a 30% reduction versus 1990 levels). In December 2020, the EU-wide GHG emissions reduction was increased from 40% by 2030 to 55%. Poland will likely need to increase its 2030 targets for GHG emissions (along with those for renewables and energy efficiency) to support the new EU-wide 55% reduction target.

Climate policy and measures

The Ministry of Climate and Environment is responsible for the implementation of Poland's climate policy in co-operation with other ministries and entities across the government. The National Centre for Emissions Management (KOBiZE) is the main entity supporting the Ministry of Climate and Environment in relation to climate policy. KOBiZE monitors, analyses and reports on the implementation of climate measures. It is responsible for developing national inventories and future projections of GHG emissions and air pollutants and drafting national communications and reports required by the EU and the UNFCCC.

Poland's measures to reduce emissions focus on reducing the carbon intensity of energy supply (especially reducing demand for coal) and increasing energy efficiency across the economy. Key measures to lower GHG emissions include reducing coal-fired generation; expanding generation from renewable energy, especially generation from offshore wind and solar PV; and introducing nuclear generation (see Chapters 5 and 7). Efforts to reduce emissions from buildings focus on moving away from coal-fired heating and on increasing thermal efficiency (see Chapter 4).

Reductions in transport emissions are supported by programmes aiming to increase adoption of EVs and modal shift away from private cars (see Chapter 4). Under EU regulations, Poland sets CO₂ emissions performance standards for new passenger cars and new light commercial vehicles. From 1 January 2020, new passenger cars may not emit more than 95 grammes of CO₂ per kilometre (g CO₂/km) on average, while new light

commercial vehicles may not emit more than 147 g CO₂/km on average. There is an ongoing effort to introduce annual taxation based on a vehicle's environmental performance.

Measures supporting lower industrial emissions focus mainly on increasing energy efficiency and include mandatory energy audits (see Chapter 4). Poland also sees a role for low-carbon hydrogen to reduce emissions from hard-to-decarbonise sectors and end-uses. The Hydrogen Strategy, adopted in November 2021, provides the government's vision for hydrogen in Poland (see Chapter 2). Fiscal policy also supports emissions reductions with exemptions on investments related to building renovation and with an exemption on excise duties for electricity generated from renewables and vehicle registration fees that favour low- and zero-emission vehicles (see Chapters 2 and 4).

Carbon pricing

Poland's carbon pricing system is based mainly on the EU ETS, with a small component coming from a national emissions fee. In 2019, the ETS covered about 47% of Poland's emissions, with ETS emissions coming from 689 facilities (183.7 Mt CO₂-eq) and 7 domestic airlines (1.1 Mt CO₂-eq). EU rules require that funding equal to at least 50% of ETS allowance revenues must be spent to modernise the energy system and reduce GHG emissions. As of 2020, the auctioning of ETS emissions allowances has contributed around EUR 4.5 billion to Poland's budget.

The government estimates ETS allowance prices will be significantly higher going forward and that allowance revenues from Phase 4 of the ETS (2021-30) will total EUR 21.8 billion (this value could be much higher if ETS prices continue to increase). In March 2021, the government announced that 40% of the revenues of Poland's Phase 4 ETS allowances will be directed to the Energy Transformation Fund, which will start operating in 2022 to modernise the energy sector.

Under a derogation to the ETS, electricity generation facilities in Poland and seven other EU member states in Central and Eastern Europe can receive free ETS allowances. For Phase 4 of the ETS (2021-30), Poland has opted not to use the derogation and starting in 2021, electricity generation facilities in Poland covered by the ETS must acquire allowances for all their emissions. Phase 4 of the ETS also includes a Modernisation Fund that supports ten lower income EU member states (including Poland) with their energy transition by providing funds to modernise energy systems and improve energy efficiency. This includes investments in renewable energy, energy efficiency, energy storage, energy networks and just transition in carbon-dependent regions. Poland is eligible for almost 44% of the proceeds of the Modernisation Fund (EC, 2021a).

The EU is in the process of further updating the ETS to align it with increased EU-wide emissions reduction ambitions for 2030, with likely consequences for ETS-relevant installations in Poland. In addition to the ETS, Poland has a national emissions fee covering certain types of GHG emissions across the entire economy. Facilities covered by the ETS do not pay the emissions fee for any emissions that require purchasing ETS allowances. In 2021, the emissions fee was around 0.07 EUR/t CO₂ and methane (CH₄), 20 EUR/t for NO_x and 7 EUR/kg for sulphur hexafluoride and perfluorocarbons. The emissions fee is indexed to inflation, which has resulted in a slight increase over time.

From 2010 to 2019, the emissions fee for CO₂ increased from 0.05 EUR/t to 0.07 EUR/t. However, the emissions fee is much lower than the ETS price, which reached 89 EUR/t CO₂ in 2021.

Long-term strategy

In March 2020, the EU communicated a long-term strategy to the UNFCCC that aims for EU-wide carbon neutrality by 2050. The Polish government supports the EU 2050 carbon neutrality target, but has indicated that achieving carbon neutrality at a national level by 2050 will be a challenge due to the historic dependence on coal and difficulty in accessing the investment capital needed for the energy transition. Poland has committed to reducing the emissions intensity of the economy and achieving climate neutrality in line with the Paris Agreement.

Under EU regulations, Poland is required to develop a long-term energy and climate strategy reflecting the EU 2050 climate neutrality target. The Ministry of Development, Labour and Technology, in co-operation with the Ministry of Climate and Environment, is preparing Poland's Long-term Strategy for the Transformation of the Economy to Climate Neutral. The strategy will be a comprehensive document describing possible emissions reduction pathways without large-scale energy imports. The transformation scenarios will be consistent with the NECP and the EPP2040, and will be based on energy efficiency, renewables and electrification of transport.

Methane emissions

CO₂ is the main GHG in Poland (81.8% of emissions in 2019), followed by methane (11.8%) and nitrous oxide (5.4%). Methane emissions (excluding LULUCF) amounted to 1.95 Mt in 2018, equal to 48.75 Mt CO₂-eq. The main source of methane emissions in Poland is fugitive emissions from fuels (39%), followed by agriculture (30%) and waste (23%). Fugitive methane emissions from fuels come mainly from coal and lignite mines (33.8% of total methane emissions) and the oil and natural gas system (5.5%).

Current methane regulations in Poland relate mainly to maintaining the safety of the natural gas system. There are no targets for reducing methane emissions from the energy sector. Methane emissions are not covered by the ETS or Poland's emissions fee. The government is updating technical regulations for the design and operation of the natural gas system, with one goal being to lower methane leakage. The government has introduced measures to support the use of coalbed methane to produce electricity and heat (methane generated during coal mining is currently flared or escapes as fugitive emissions). There are ongoing pilot projects that aim to capture and use methane from coal mining, along with projects looking to extract methane from coalbeds even if coal is not mined (see Chapter 8).

The EU Methane Strategy aims to reduce methane emissions by 35-37% by 2030 (versus 2005 levels) to support the recently adopted EU target to reduce total GHG gases by 55% by 2030. Current EU policies are projected to reduce methane emissions by only 29% by 2030. In February 2021, the EC launched a public consultation on methane emissions reduction from the energy sector and plans to use the result of this consultation to prepare legislation supporting further reductions of energy sector methane emissions (EC, 2021b).

There are ongoing efforts to limit energy sector methane emissions in Poland. Gaz-System, the natural gas transmission system operator (TSO), is a partner of the Oil and Gas Methane Partnership (OGMP). The OGMP is a multi-stakeholder partnership launched in 2014 by the United Nations Environment Programme and the Climate and Clean Air Coalition to help oil and gas companies reduce methane emissions. In November 2020, the United Nations Environment Programme, the Climate and Clean Air Coalition, the Environmental Defense Fund, the EC, and the oil and gas companies that are partners of the OGMP launched the OGMP 2.0 reporting framework. This framework includes a performance element focused on emissions reduction, technology advancement and policy development to aid the oil and gas sector in achieving deep methane emissions reductions through 2030 that are transparent to civil society and governments (OGM Partnership, 2020).

Carbon capture, utilisation and storage

Poland does not have a national carbon capture, utilisation and storage (CCUS) strategy and CCUS is not given a clear role in the NECP or the EPP2040. In addition, Poland's legal framework on geological storage of carbon dioxide (included in the Polish Geological and Mining Law) states that CO₂ storage is only allowed for demonstration projects. The government is in the process of updating this framework to allow for industrial-scale CO₂ storage and has indicated some interest in CCUS, including to increase the use of hydrocarbon deposits, support the transformation of coal mining regions (including for coal gasification) and as one option to produce low-carbon hydrogen.

In August 2021, the Minister of Climate and Environment established an inter-ministerial working group on CCS technology development, with the participation of the main energy sector stakeholders. The main goal of this group is to identify and eliminate legal barriers for CO₂ storage development and support new CCUS pilot projects.

A CCUS study from 2012 identifies possible CO₂ storage sites, emission sources and existing pipeline infrastructure that could support CO₂ transport. The report estimated that Poland has 10-15 gigatonnes (Gt) of potential CO₂ storage capacity (equal to 50-75 years of Poland's ETS emissions at current levels). Over 90% of potential storage is onshore and less than 10% offshore. Saline aquifers have the highest storage potential (90-93%), followed by depleted oil and gas fields (7-10%), and storage in unmined coal seams (less than 1%). A regulation of the Ministry of Climate and Environment specifies an offshore area where storage sites for demonstration projects can be located.

There is currently only one operational CCUS project in Poland. This pilot project reinjects acid gas (consisting of about 80% CO₂ and 20% H₂S), which is a by-product of natural gas refining at the Borzęcin gas field. The project has been operational since 1996, and has reinjected more than 3 million tonnes of acidic gas (University of Edinburgh, 2020).

Climate adaptation

IEA analysis indicates that Poland's energy system is at risk of notable impacts from climate change (IEA, 2022). Poland's average temperature is expected to continue increasing throughout the century. Higher temperatures could significantly increase electricity demand in the summer, while also lowering the efficiency of both thermal plants

and transmission lines. Climate projections show that the intensity of precipitation will continue to increase over the next decades across the entire country, presenting a variety of risks to the energy system. In June 2020, heavy rainfall caused flooding at a coal storage site, which interrupted electricity generation from the Bełchatów power plant (the largest in Poland, which covers up to 20% of annual generation). As a result, Poland had to import electricity from Germany and Sweden and experienced a temporary increase in prices on the electricity balancing market (Euronews, 2021).

The Polish National Strategy for Adaptation to Climate Change with a time horizon to 2030 (published in 2013) outlines the impacts of climate change on 11 vulnerable sectors, including energy. It provides a list of actions for climate change adaptation of the energy sector, particularly in the context of peak winter and summer energy demand. For example, the strategy proposes the development of alternative energy production capacities at the local level, especially for heating and cooling in areas with a lower population density. It also accounts for extreme weather events, such as heavy precipitation, flooding and strong winds, and calls for more robust energy infrastructure and emergency sources for heating and cooling.

The project Development of Urban Adaptation Plans supports the development of regional adaptation plans for cities with more than 100 000 inhabitants. The Ministry of Climate and Environment provides guidelines for preparing regional climate change adaptation plans. Despite these initiatives, no regional adaptation plans have been fully developed.

Assessment

The transition of Poland's energy system offers great opportunities to reduce GHG emissions. However, Poland has been slow to move away from its heavy dependence on coal and still has a very carbon-intensive energy system. In 2019, Poland ranked second among IEA member countries for CO₂ intensity of energy supply and fourth for CO₂ intensity of the economy. The government needs to take stronger measures to ensure large and sustained emissions reductions that are in line with Poland's climate commitments. A review and update of climate and energy policies is needed to ensure they are clearly aligned with the energy transition, and to reduce the risks of directing limited financial resources to potentially stranded assets.

Poland has a target to reduce non-ETS GHG emissions by 7% by 2030 versus 2005 levels. The EPP2040 sets a target to reduce GHG emissions from the entire economy by 30% by 2030 versus 1990 levels. The emissions reduction measures to achieve Poland's 2030 emissions reduction targets are defined in the NECP and the EPP2040. However, Poland's 2030 targets and supporting measures do not yet reflect the increased EU-wide emissions reduction target which is formulated in the European Climate Law (a 55% emissions reduction by 2030 and climate neutrality by 2050). The Fit-for-55 package which supports the achievement of the EU climate and energy targets will have major implications for the Polish climate and energy policies. The policies, goals and measures which are formulated in the NECP and EPP2040 will have to be adjusted.

Under EU regulations, Poland is preparing a Long-term Strategy for the Transformation of the Economy to Climate Neutrality, but the government has not yet made a clear commitment to achieve carbon neutrality by 2050. It is recommended that the long-term

strategy include a pathway for climate neutrality in Poland by 2050 that clearly details the steps and timeline needed to reach such a goal.

One of the key measures Poland is taking to lower GHG emissions is reducing coal-fired generation by expanding renewable and gas-fired generation, and introducing nuclear generation. Poland places an emphasis on reducing emissions (and improving local air quality) by moving away from coal for both individual building heating and district heating. The main support programme for renovating building heating systems provides equal subsidies to heating systems regardless of the GHG emissions and results in a strong increase in the deployment of gas boilers. A key support programme to improve the efficiency of co-generation will also likely lead to a major growth in gas-fired co-generation plants. These programmes are not compatible with Poland's long-term climate goals.

Although replacing coal-fired generation and heating with natural gas is a more climate-friendly intermediate solution, it creates risks of stranded assets and will increase energy import dependency and exposure to gas price fluctuations. The extreme increases in gas and electricity prices seen across Europe in 2021 serve as a clear warning of the dangers of moving from heavy reliance on coal to heavy reliance on gas. The use of natural gas should be minimised and preference placed on domestic zero-emission options to support a clear path to a climate-neutral energy system (renewable and nuclear generation, increased electrification). There is also a critical need to increase efforts on energy efficiency, especially for improving the thermal efficiency of buildings.

Envisaged reductions in transport emissions are supported by programmes aiming to increase the adoption of EVs and modal shift away from private cars. Despite these programmes, transport fuel demand and emissions are not coming down and the share of electricity in transport demand actually declined from 1.7% in 2009 to 1.3% in 2019. Additional efforts are needed to improve vehicle efficiency and accelerate the uptake of EVs, public transportation and active mobility to ensure that transport sector emissions can be reduced. The government should accelerate the implementation of the planned annual taxation based on a vehicle's environmental performance.

Measures supporting lower industrial emissions focus mainly on increasing energy efficiency, with a key measure being mandatory audits that identify energy-saving measures; however, there is no requirement to implement the savings identified through these audits. The government should consider requiring industry to implement energy-saving measures with short payback times (as is done in many IEA countries) to help reduce industry emissions. The government's energy policy should also be updated with clear pathways for cost-effective industrial decarbonisation (e.g. through increased electrification).

Methane emissions account for a notable share of Poland's GHG emissions (11.8% in 2019), with the largest share of methane emissions coming from coal mines and notable emissions from the oil and gas sectors. Poland is making efforts to monitor and reduce methane emissions. The TSO and DSOs are required to report methane emissions. The technical regulation for gas network design and operation will be amended, with one goal being to further limit methane leakage. Poland will participate in the development of EU regulations on reducing methane emissions. The government should adopt a target for reducing methane emissions in line with the EU Methane Strategy and closely monitor if existing measures are effective at reducing methane emissions. Additional efforts should be made to quickly reduce methane emissions from coal mines.

Poland's carbon pricing system is based mainly on the EU ETS. In 2019, the ETS covered about 47% of Poland's emissions. As part of the Fit-for-55 package, the EU ETS will be strengthened, which will include higher ETS reduction targets and potentially expanding the ETS to cover more sectors. ETS prices are expected to rise, which will have adverse consequences on the competitive position of Poland's large fleet of coal-fired generation plants, and could result in the closure of these plants at a much faster pace than forecasted in Poland's energy policy. The government needs to update its energy policy to clearly reflect the impact of higher ETS prices and market forces on the coal sector, including plans for economic transition in coal regions.

Poland has a national emissions fee paid on GHG emissions that are not covered by the EU ETS. But the fee is very low, just 0.07 EUR/t CO₂ in 2020, especially compared to the ETS price, which reached 89 EUR/t CO₂ in 2021. It is recommended to bring the emissions fee in line with the ETS price, while taking into account the issue of energy poverty. This would complement and strengthen the effect of Poland's subsidy schemes supporting cleaner alternatives in buildings and transport and discourage the use of polluting options. The use of other policy instruments, like the clean transport zones, can also contribute to removing the most polluting vehicles from Polish roads.

While climate adaptation measures for the energy sector are clearly prioritised within climate policies, the same level of focus on adaptation is not present in energy policy. Both the NECP and the EPP2040 account for climate change impacts in demand forecasts for electricity and for heating and cooling, and the NECP mentions climate change adaptation broadly. However, climate resilience of the energy sector is not emphasised in the NECP, and the EPP2040 concentrates on climate change mitigation and optimal use of domestic energy resources, without mentioning adaptation and resilience.

Poland does not have a national CCUS strategy and CCUS is not given a clear role in the NECP or EPP2040. Poland's legal framework states that CO₂ storage is only allowed for demonstration projects, although this law is being adjusted. Poland ended its support for CCUS research, development and demonstration (RD&D) in 2017 and in 2021 there was only one active CCUS project in Poland. A task force is analysing the possible applications of CCUS in Poland; this work should be expedited and needs to address long-term liabilities related to CO₂ storage. The government should reassess the potential role of CCUS in meeting emissions reduction goals, including applications at coal-based power plants and hard-to-abate industrial facilities. The government should also consider adopting support mechanisms for large-scale CCUS projects (such as capital investment grants, tax credits or other financial mechanisms) and should join key multinational efforts to decarbonise fossil energy use, including relevant IEA technology collaboration programmes and the Clean Energy Ministerial CCUS Initiative.

Recommendations

The government of Poland should:

- ❑ Adjust targets and measures in the Energy Policy for Poland until 2040 and National Energy and Climate Plan to support the achievement of a 55% reduction in EU-wide greenhouse gas emissions by 2030, and to avoid stranded assets.
- ❑ Develop long-term energy strategies and pathways that are compatible with EU climate neutrality by 2050 and support a just transition with measures like retraining programmes.
- ❑ Increase the emissions fee to narrow the gap with the ETS price, in anticipation of expected higher non-ETS emissions reduction targets as a result of the Fit-for-55 package.
- ❑ Develop an integral strategy to reduce methane emissions to contribute to the expected increased non-ETS target.
- ❑ Reassess the potential role of carbon capture, utilisation and storage in meeting emissions reduction goals, allow for safe large-scale CO₂ storage and consider adopting support mechanisms for large-scale CCUS projects.

References

- EC (European Commission) (2021a), Modernisation Fund (web page), https://ec.europa.eu/clima/eu-action/funding-climate-action/modernisation-fund_nl
- EC (2021b), Public consultation on future EU rules for reducing methane emissions in the energy sector (web page), https://ec.europa.eu/info/news/public-consultation-future-eu-rules-reducing-methane-emissions-energy-sector-2021-feb-10_en
- EEA (European Environment Agency) (2021), EEA greenhouse gas projections – data viewer (database), <https://www.eea.europa.eu/data-and-maps/data/data-viewers/eea-greenhouse-gas-projections-data-viewer> (accessed on 11 March 2022)
- Euronews (2021), Poland's main power plant crippled by outage (web page), <https://www.euronews.com/my-europe/2021/05/18/poland-s-main-power-plant-crippled-by-outage>
- Eurostat (2022), Greenhouse gas emissions in effort sharing decision (ESD) sectors (database), https://ec.europa.eu/eurostat/databrowser/view/env_air_esd/default/table?lang=en, (accessed 13 April 2022)
- IEA (International Energy Agency) (2022), Poland climate resilience policy indicator (web page), <https://www.iea.org/articles/poland-climate-resilience-policy-indicator>
- IEA (2022), Greenhouse Gas Emissions from Energy (database), <https://www.iea.org/data-and-statistics/data-product/greenhouse-gas-emissions-from-energy> (accessed on 23 February 2022)
- OGM Partnership (Oil and Gas Methane Partnership) (2020), Oil & Gas Methane Partnership 2.0 (web page), <https://www.ogmpartnership.com>
- UNFCCC (United Nations Framework Convention on Climate Change) (2022), Greenhouse Gas Inventory Data (database), https://di.unfccc.int/detailed_data_by_party (accessed on 23 February 2022)
- University of Edinburgh (2020), Borzecin acid gas injection details (web page), <https://www.geos.ed.ac.uk/sccs/project-info/2722>

4. Energy efficiency

Key data (2020)

TFC: 75.8 Mtoe (oil 37.0%, electricity 15.6%, natural gas 14.9%, bioenergy and waste 12.5%, coal 11.6%, district heating 7.4%)

TFC by sector: industry 33.9%, transport 28.7%, residential buildings 27.5%, service sector buildings 10.0%

TFC per capita: 1.98 toe per capita (IEA average in 2019: 2.71 toe per capita)

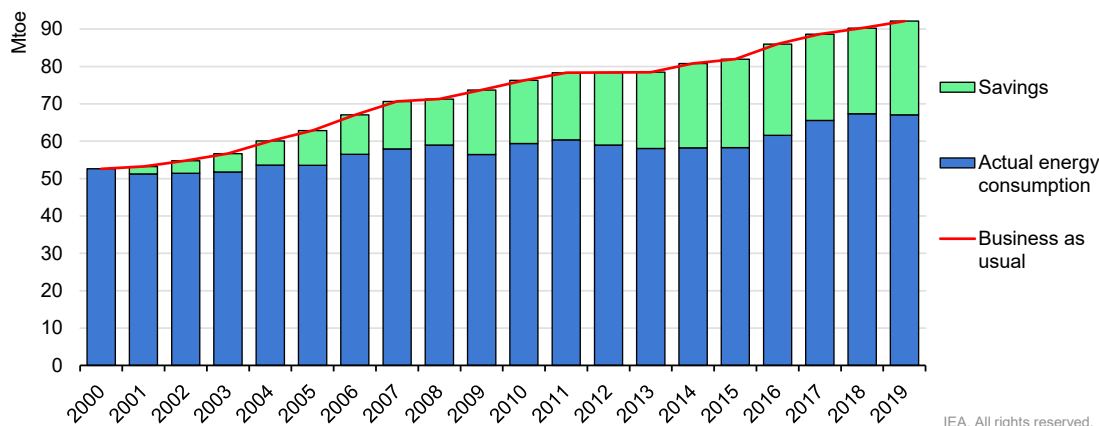
TFC per GDP: 64 toe per USD million (IEA average in 2019: 65 toe per USD million)

Overview

IEA analysis indicates that from 2010 to 2019, increased energy efficiency in Poland resulted in cumulative energy savings of 216 Mtoe (Figure 4.1). These energy savings were achieved mainly in industry (through more efficient manufacturing) and buildings (through more efficient space heating). In contrast, transport sector energy efficiency declined notably over the same period, driven by lower efficiency in the passenger car fleet that resulted mainly from increased imports of significantly older and inefficient cars, and consumer preference for sport utility vehicles (SUVs) and other large vehicles.

Energy efficiency improvements in Poland are supporting a decoupling of energy demand and economic growth. From 2010 to 2019, GDP increased by 38% while energy demand, measured as TFC, rose by just 6.5%. Over the same period, the energy intensity of Poland's economy (TFC per GDP) declined from 79 toe to 61 toe per USD million and in 2019 was lower than the average for IEA member countries (65 toe/USD million). This drop in the energy intensity of Poland's economy is in line with the trends seen in most neighbouring countries and reflects both improvements in energy efficiency and the increasing role of the service sector in the economy.

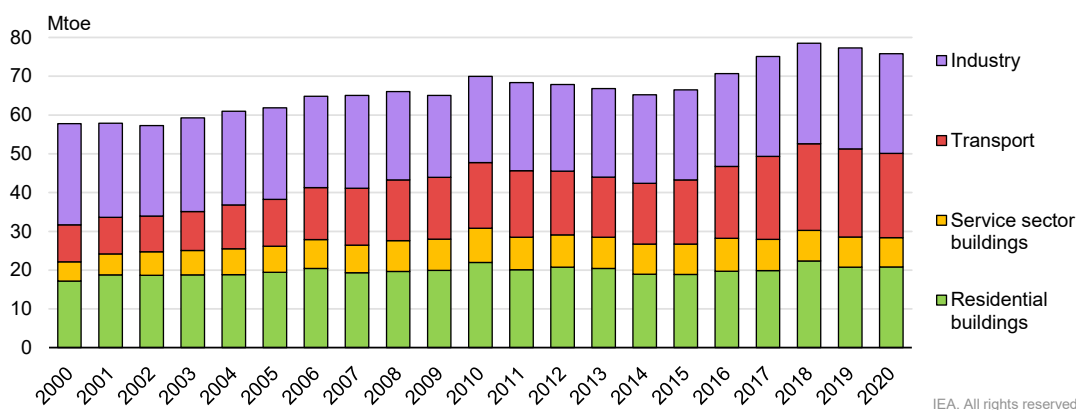
The main measures to encourage energy efficiency is a system of tradable white certificates issued for implementing efficiency projects. Energy policy in the buildings sector is focused on reducing emissions by transitioning away from coal-fired heating to less polluting/more efficient heating sources (to date mainly gas). There are some programmes focused directly on building efficiency. Energy policy in the transport sector aims to reduce emissions and improve efficiency through the uptake of EVs and modal shift toward public transport and active mobility. Measures for industry energy efficiency include energy audits and support for efficient equipment, mainly for heating.

Figure 4.1 Estimated energy savings from efficiency in Poland, 2000-2019

Source: IEA (2021).

Energy demand

From 2010 to 2019, Poland's energy demand (TFC) increased from 70 Mtoe to 77 Mtoe, driven mainly by increased transport energy demand, which grew from 17 Mtoe to 23 Mtoe, and also increased industry energy demand, which rose from 22 Mtoe to 26 Mtoe, while building energy demand decreased from 31 Mtoe to 29 Mtoe, despite a 40% increase in residential floor area (Figure 4.2). In 2020, TFC decreased to 76 Mtoe, as the Covid-19 pandemic drove down demand mainly in the transport sector, which fell by 4% with respect to 2019. In 2020, energy demand was split relatively evenly between buildings (37% of TFC, with 26% from residential buildings and 10% from service sector buildings), industry (34%) and transport (29%).

Figure 4.2 Total final consumption by sector in Poland, 2000-2020

Source: IEA (2022).

Targets

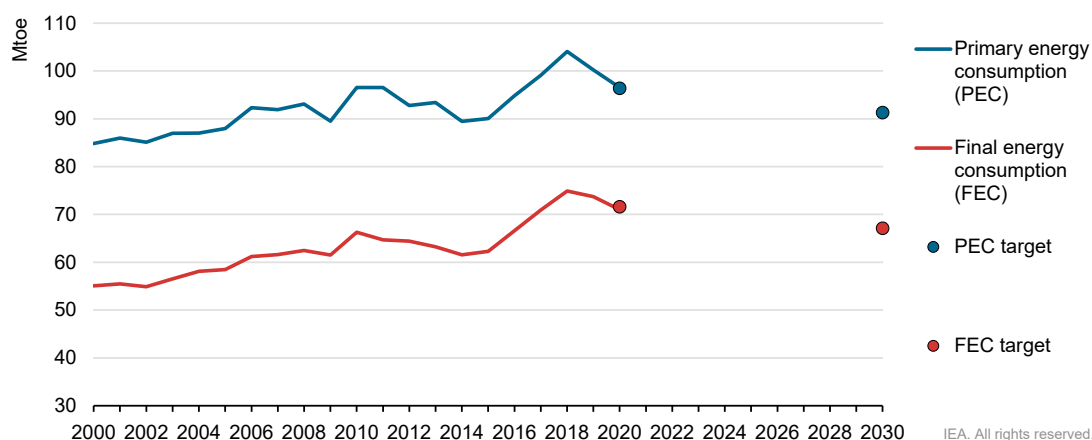
Poland's 2020 and 2030 energy efficiency targets are driven by the EU Energy Efficiency Directive (EED). Under the EED, each EU member state sets national energy efficiency

targets that contribute to EU-wide targets of reducing energy demand by 20% by 2020 and by 32.5% by 2030 (compared to a business-as-usual projection). Poland's 2020 efficiency targets and supporting measures are set in its National Energy Efficiency Action Plan. The 2030 targets and supporting measures are set in Poland's NECP and the EPP2040.

Poland's National Energy Efficiency Action Plan sets 2020 targets to reduce primary energy consumption (PEC) to 96.4 Mtoe and final energy consumption (FEC) to 71.6 Mtoe, while the NECP sets 2030 targets to reduce PEC to 91.3 Mtoe and FEC 69.1 Mtoe (Figure 4.3). In 2020, Poland's FEC was 71.0 Mtoe, just achieving the 2020 target, while PEC was 96.5 Mtoe, just missing the 2020 target. However, the Covid-19 pandemic contributed notably to the decrease of energy demand in 2020, and sustained efforts in energy efficiency are required to achieve the 2030 goals.

In October 2020, the EC provided comments on Poland's NECP, noting that the 2030 targets for PEC and FEC represent a “modest ambition” compared to the efforts needed to achieve the EU-wide target (EU, 2019). In addition, in 2021, the 2030 EU-wide GHG emissions reduction target was increased from 40% to 55%. It is likely that Poland will need to increase its 2030 energy efficiency targets (and GHG and renewables targets) to support the new EU-wide 55% emissions reduction.

Figure 4.3 Poland's 2020 and 2030 energy efficiency targets and status 2004-2020



Energy demand (Mtoe)	2019 status	2020 status	2020 targets	2030 targets
Primary energy consumption	100.2	96.5	96.4	91.3
Final energy consumption	73.7	71.0	71.6	67.1

Sources: Eurostat (2022), EU (2019).

Energy efficiency policies and measures

Poland has a wide variety of policies and measures to encourage energy efficiency, most with a sectoral focus (buildings, industry or transport). Responsibility for energy efficiency policy design and implementation of measures is divided between several ministries and a wide range of administrative entities, generally based on their sectoral competency. The EPP2040 includes a specific objective (Objective 8) for improving energy efficiency (mainly in buildings and transport), and another objective (Objective 7) for the development of district high-efficiency heating and co-generation.

Economy-wide/multisector programmes

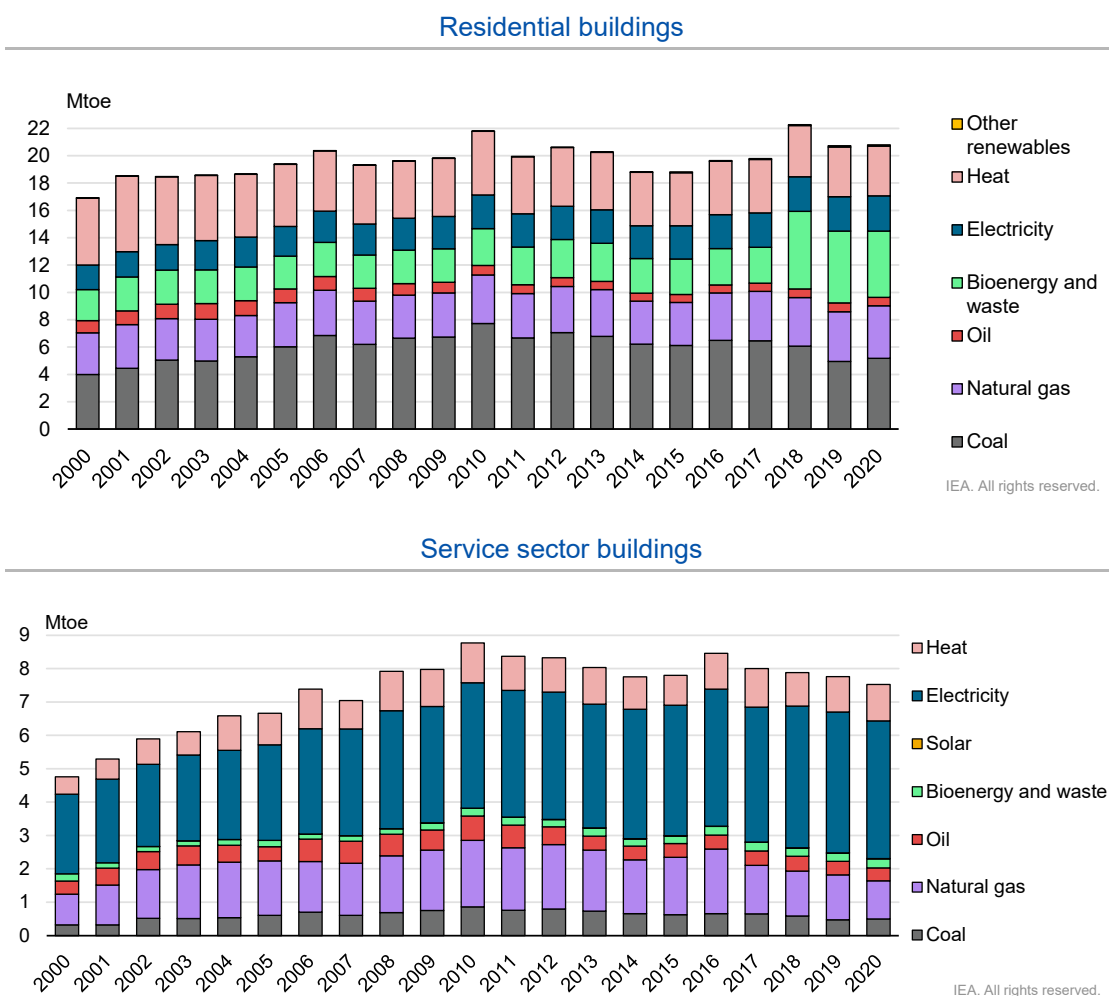
Under the EED, all EU member states are required to reduce FEC by 0.8% each year from 2021 to 2030, through an Energy Efficiency Obligation (EEO) or alternative measures. To meet the required energy savings, Poland developed a system of tradable energy efficiency certificates (white certificates) as the core of its EEO system.

Suppliers of electricity, natural gas, heat and (since May 2021) liquid fuels must either achieve a 1.5% reduction of annual energy sales to consumers or purchase certificates covering any deficit in reaching this target. Companies that fail to achieve the required savings and do not purchase certificates to cover any deficit are liable for a fine up to EUR 360 000. Any company undertaking energy-saving projects can apply for certificates and sell these to energy suppliers to help them reach their annual targets. Applications for certificates are reviewed by the ERO and each application should cover at least 10 toe of annual energy savings (URE, 2022). In recent years, the cost of certificates was around 330-380 EUR/toe.

From 2013, when the certificate system started operating, to 2018, it delivered 8.89 Mtoe of energy savings (most of the 13.6 Mtoe of savings required under the EEO for this time period, with additional savings from alternative measures) (EU, 2020). Most of the energy savings delivered by the white certificate programme have come from projects concerning building insulation (34% of final savings), followed by industrial processes (33%). The government is developing a list of additional energy efficiency measures outside the white certificate system that could be implemented to ensure the required energy savings through 2030 are achieved. The government is also working to improve the system for collecting and reporting the energy savings required under the EEO by developing a central register of projects, which was set to start operating in January 2022.

Buildings

Building energy demand in Poland comes mostly from residential buildings (73% of demand in 2020), followed by service sector buildings (27%), and is driven mostly by space heating (63% of demand in 2019). As a result, building energy demand experiences notable annual fluctuations depending mainly on winter temperatures (Figure 4.4). However, from 2010 to 2019, building energy demand experienced an overall decline (despite a 40% increase in residential floor area) thanks to efficiency improvements that reduced the energy intensity of space heating per floor area from 195 kilowatt-hours per square metre (kWh/m²) to 140 kWh/m². This is more efficient than the Czech Republic (186 kWh/m²) but less efficient than Lithuania (125 kWh/m²), Germany (119 kWh/m²) and the Slovak Republic (106 kWh/m²). The pandemic had a slight impact on building energy demand, which dropped by 1% in 2020 (+0.3% for residential buildings and -2.9% for commercial buildings, compared to 2019).

Figure 4.4 Building total final consumption by source in Poland, 2000-2020

Source: IEA (2022).

Poland's national building stock consists of 14.2 million buildings, 61% residential buildings, 34% private service sector buildings and 5% public buildings. About one-third of residential buildings were built before 1980 and have a final energy demand higher than 200 kWh/m² per year. More than 1 million buildings (7% of total) were built before 1918 and have a final energy demand higher than 300 kWh/m² per year. Under EU standards, "low-energy" is defined as between 45 kWh/m² and 75 kWh/m² per year for most buildings.

In 2020, residential building energy demand was covered by coal (25%), bioenergy (23%), natural gas (18%), district heating (18%) and electricity (12%), while service sector building energy demand was covered by electricity (55%), natural gas (15%), district heating (14%) and coal (7%). From 2010 to 2020, the share of coal in building energy demand decreased from 28% to 20%, but was still the highest among IEA member countries and significantly higher than the IEA average of 1%. Coal-fired heating is mainly concentrated in rural areas. In 2020, 67.4% of rural households used coal for heating (down from 77.7% in 2015), compared to 18.5% for urban households (down from 22.5% in 2015). The use of heat pumps for household heating is increasing in Poland and in 2019 there were 310 000 units under operation, corresponding to 3.6% of residential buildings (PORTPC, 2020).

Policies and measures

Poland has a variety of policies and measures that aim to improve energy efficiency in buildings; these include tax incentives, requirements to report on buildings and heating system energy performance, and financial support for renovations of heating systems and buildings. There is a strong focus on transitioning away from coal-fired heating to reduce emissions and improve efficiency.

Buildings in Poland must obtain an energy performance certificate (EPC) when they are sold or rented. An EPC remains valid for ten years if no major renovation works are carried out. The EPC includes data on energy performance, fuel consumption, CO₂ emissions and share of renewable energy. EPCs are issued by experts approved by the government. In 2020, only around 10% of buildings in Poland had an EPC registered in the system.

In July 2021, Poland established the Central Building Emission Register (CEEB). All building owners and managers must submit a declaration of the heating systems in their building to the CEEB, which aims to develop an inventory of all the building heating systems in Poland to support the replacement of old and inefficient systems (INFOR, 2021). The government plans to integrate CEEB data into the EPC registry.

The Renovation with a guarantee of savings EPC Plus programme aims to improve energy efficiency in multifamily residential buildings (more than seven units) and public buildings by supporting energy performance contracts between building owners and energy service companies. The programme started with a pilot project in 2021, with a budget of EUR 2 million, and will continue in 2022 with a budget of EUR 23 million. It provides grants to housing co-operatives and local governments that cover 10-30% of the cost of energy efficiency renovations, with the level of funding linked to the level of energy savings. To receive grants, renovations must reduce a building's final energy demand from heating, ventilation and hot water by at least 30% and to less than 85 kWh/m² per year (during the pilot stage of the programme), and less than 75 kWh/m² per year (for public buildings, during the second stage).

The EPP2040 includes a target to phase out most individual coal-fired heating systems by 2030 in cities and by 2040 in rural areas (the target does not apply to district heating). Coal-based fuels defined as “smokeless” by the government would still be allowed through 2040 (see Chapter 8).

The main programme supporting the transition away from individual coal-fired heating is the Clean Air Programme, which provides grants for owners of single-family residential buildings to replace inefficient heat sources with new ones (including gas boilers, renewable energy sources and heat pumps). The programme was launched in 2018 and is planned to run until 2029 with a total budget of EUR 22.7 billion. The programme also provides subsidies for energy efficiency measures such as building insulation that are undertaken when a heating system is replaced, but these measures are not required. For most households, the grant covers 30% of the total costs up to EUR 6 500. For low-income households, the grant covers 60% of total costs up to EUR 8 000 (Clean Air Programme, 2022). The programme was amended in January 2022 to provide grants for very low-income households that would cover 90% of total costs up to EUR 15 000.

As of December 2021, the Clean Air Programme had received around 379 000 applications for subsidies to upgrade heating systems, with the majority (45%) for gas boilers, followed by biomass boilers (20%), coal boilers (16%), air-source heat pumps

(14%) ground-source heat pumps (3%), electric heating (2%), district heating (0.3%) and oil boilers (0.1%). Most of the applications (52%) were for heat system upgrades without thermal insulation upgrades, while 39% were for heat system upgrades with thermal insulation upgrades, and 9% were for thermal insulation upgrades without heat system upgrades. Subsidies for coal boilers are not allowed after 31 December 2021. Pilot projects for multifamily buildings are currently underway in several municipalities. Municipalities are also working to reduce local air pollution. In 2019, Krakow became the first city in Poland to ban coal- and wood-fired heating systems (Stadnik, 2019).

In 2019, Poland introduced an income tax deduction for the cost of thermal renovations undertaken by owners of single-family residential buildings. The thermal renovations must be completed in three years. The maximum deduction is EUR 11 500 per residence and can be deducted over six years (Sejmu, 2018).

EU member states are required to develop a long-term renovation strategy that details plans to increase building energy efficiency through 2050. Poland aims to adopt its Long-term Renovation Strategy in the first quarter of 2022. The government has indicated that it will contain goals for 3.6% of buildings to be renovated each year from 2021 to 2030, 4.1% from 2031 to 2040 and 3.4% from 2041 to 2050. The estimated investment for renovations planned under the Long-term Renovation Strategy is around EUR 330 billion from 2021 to 2050. The government has indicated that the income tax reduction for renovations is one of the measures it will use to drive the needed investments.

Under the EED, Poland has an obligation to renovate 3% of the total area of public buildings each year or achieve equivalent energy savings through an alternative approach. Poland has opted to follow an alternative approach, under which it provides the EU with a table of public buildings that do not meet the EU minimum performance requirements and commits to achieving a 3% annual energy savings to bring these buildings into compliance with the minimum requirements.

District heating

In 2019, Poland's district heating production capacity was 53.5 GW and 65% of heat production (GWh) came from co-generation. District heating is fuelled mainly by coal (76% in 2019), followed by natural gas (10%) and bioenergy (7%). Poland's numerous district heating networks had a combined length of 21 701 km in 2020, the second-largest combined network length in Europe after Germany. Households are the largest users of district heating (71% of delivered heat in 2020) followed by industry (21%) and the service sector (10%). In 2018, 5.8 million households (40% of total households) were connected to a district heating network. In 2018, 58% of urban households were connected to district heating, the highest share in Europe.

The government aims to connect around 1.5 million additional households, or approximately 70% of households. The EPP2040 includes a goal to meet heating demand for all households with zero- or low-emission heating systems by 2040, with a focus on district heating. Connecting to district heat is mandatory where it is available, unless households already use a less carbon-intensive solution.

The government is also aiming to improve the efficiency of district heating in Poland. In 2018, only about 20% of the district heating systems, which accounted for around 85% of the district heating supply, met EU criteria for being energy-efficient.¹ The EPP2040 includes a target for 85% of heating or cooling systems with a capacity higher than 5 MW to achieve a high energy efficiency standard by 2030. To achieve this target, the government has introduced a subsidy for high-efficiency co-generation with GHG emissions restrictions that exclude coal-fired co-generation (see Chapter 7). The government is preparing a strategy for heating until 2030 with a perspective until 2040 aiming to provide a clear plan for the development of the heating sector.

From 2009 to 2019, the number of energy companies in Poland in heat production, transmission, distribution and trading declined from around 800 to 396. The tariffs set by district heating companies are subject to approval by the ERO. In 2018, district heat was the least expensive heating option for households in terms of average annual expenditure (144 EUR per capita, versus 171 EUR/capita for coal and 215 EUR/capita for gas). The government is studying options to modify the tariff scheme to improve liquidity and make it easier for the industry to finance efficiency improvements and fuel switching.

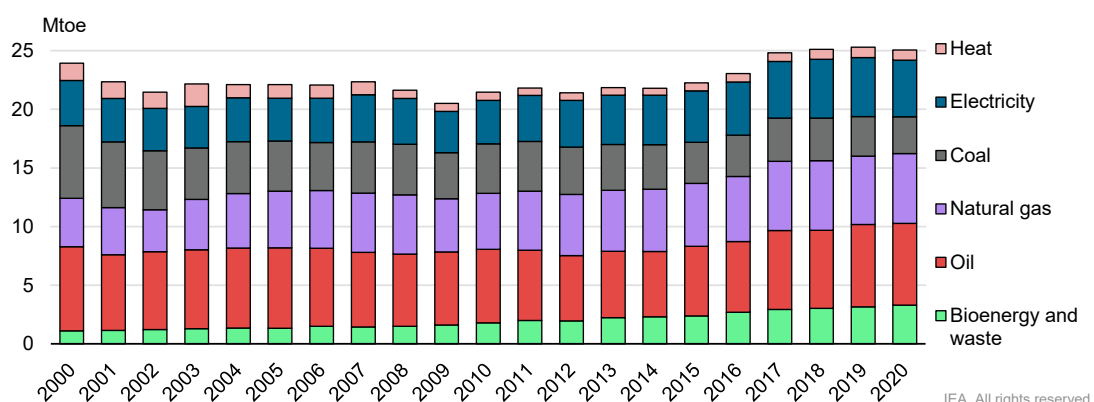
The Local District Heating Programme provides funding to district heating companies to increase efficiency and/or the share of renewables through modernisation and expansion of district heating networks and for the construction and replacement of heat production units. The programme is planned to run from 2019 to 2025 with a total budget of EUR 108 million (70% for loans, 30% for grants). One hundred seventy-one applications were submitted (83 for grants, 88 for loans), requesting approximately EUR 96 million in grant funding and EUR 128 million for loans. Poland's pandemic recovery and resilience plan proposes investing an additional EUR 300 million to expand this programme.

Industry

From 2010 to 2016, industry energy demand experienced only a slight increase. Industry energy demand increased notably in 2017 and has since been stable, reaching 25.7 Mtoe in 2020 (Figure 4.5). The Covid-19 pandemic had only a small impact, with industry energy demand falling by 1% from 2019 to 2020. Oil covers the largest share of industry energy demand (27% in 2020), followed by natural gas (23%) and coal (12%). The chemical and petrochemical sector (including feedstocks) accounts for the largest share of industry energy demand (29% in 2019), followed by agriculture and forestry (16%); non-metallic minerals (13%); food and tobacco (9%); paper, pulp and print (8%); iron and steel (7%); and wood and wood products (5%).

Industry sector energy efficiency has been improving: from 2005 to 2019, the energy intensity of industrial manufacturing decreased from 9.1 MJ/USD to 3.71 MJ/USD, also thanks to structural changes providing a decrease of energy intensity by 1.2% per year between 2000 and 2019. In comparison, the energy intensity of German industrial manufacturing was 3.07 MJ/USD in 2019.

¹ Article 2 (41) of the EED defines efficient district heating as district heating systems using at least 50% renewable energy, 50% waste heat, 75% co-generated heat or 50% of a combination of such energy and heat.

Figure 4.5 Total final consumption in industry by source in Poland, 2000-2020

Source: IEA (2022).

Policies and measures

Since 2016, the EED requires large companies in all EU member states to complete audits every four years that cover at least 90% of their energy demand and identify cost-effective energy-saving opportunities. Companies that have implemented an energy or environmental management system compliant with EU standards (such as ISO 50001, ISO 14001, or the EU Eco-Management and Audit Scheme) are exempted from the audit requirement.

In Poland, the National Energy Conservation Agency manages the audits and the ERO collects the audit results (including the savings achieved) and reports these to the government. Poland does not require companies to implement measures identified in the audits, but companies can apply for white certificates for completed projects that reduce demand. The audits were conducted in Poland for the first time in 2016 and 2017, and resulted in notifications to the ERO of 3 603 completed audits with indicated total energy savings of 1.04 Mtoe (compared to industrial energy demand of 25.4 Mtoe in 2017). A second round of energy audits had to be completed by the end 2021 and the information delivered to the ERO by 31 March 2022.

The Energy Plus programme is Poland's largest programme providing financing support for energy efficiency measures and lowering emissions of heat sources dedicated for enterprises. It was created in 2019 with a budget of EUR 885 million and is planned to operate through 2025 to support energy efficiency (and renewable energy projects) in industry. The programme is run by the National Fund for Environmental Protection and Water Management and awards mainly preferential loans with partial write-off (grants can be provided only for projects regarding organic Rankine cycle technology for electricity production) through calls for proposals. As of December 2021, over 280 applications had been submitted in two calls for proposals. These calls resulted in EUR 206 million of funding awarded to 14 projects. 79% of the projects were related to modernisation and energy efficiency in industry, and 21% were renewable energy projects. The next call for applications is going to be announced in the second quarter of 2022.

From 2018 to 2021, the National Energy Conservation Agency co-operated with the EC to develop a set of energy efficiency tools for small and medium-sized enterprises, including a manual for self-assessment of energy consumption, best practices and

recommendations for energy efficiency improvements, an electricity optimisation calculator, online assistance, and online courses on energy efficiency.

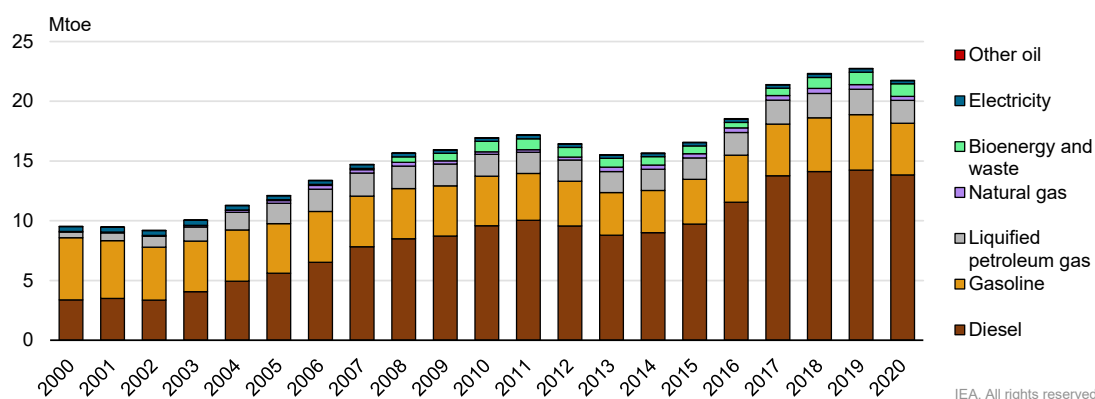
Carbon pricing is another measure pushing for higher energy efficiency in Poland. Poland's energy-intensive industry operates under the EU ETS framework, which uses tradable certificates to drive emissions reductions. Smaller non-energy intensive companies are not required to participate in the ETS. In Poland, these smaller industrial companies pay a national emissions fee; however, the cost is very low. In 2021, the emissions fee was around 0.07 EUR/t CO₂ (see Chapter 3).

Poland sees a role for low-carbon hydrogen in the industry sector. Objective 3 of the Polish Hydrogen Strategy is the decarbonisation of industry, with a focus on sectors that cannot be directly electrified or powered by renewables. The objective mentions hydrogen-based steel production to reduce coal demand, and hydrogen as an alternative to natural gas for industrial processes and feedstocks. There is a 2030 goal to have five or more hydrogen valleys (industrial clusters developing a full value chain of production and use).

Transport

From 2010 to 2019, transport sector energy demand increased significantly, from 16.9 Mtoe to 22.9 Mtoe. This growth was driven mostly by higher demand for diesel, which increased from 9.6 Mtoe to 14.2 Mtoe (Figure 4.6). In 2020, the restrictions linked to the Covid-19 pandemic caused the energy demand of the sector to decrease to 21.7 Mtoe. The notable drop and rebound in diesel and gasoline demand that Poland experienced from 2010 and 2015 does not accurately reflect transport energy demand, but was driven by grey market sales of transport fuels. It is estimated that illegal imports accounted for up to 20% of all fuel sales in Poland from 2011 to 2015. Legislative and enforcement actions taken in 2016 effectively reduced grey market sales, which is reflected in the notable demand increases in 2016 and 2017 (see Chapter 10).

Figure 4.6 Total final consumption in transport by fuel in Poland, 2000-2020



Source: IEA (2022).

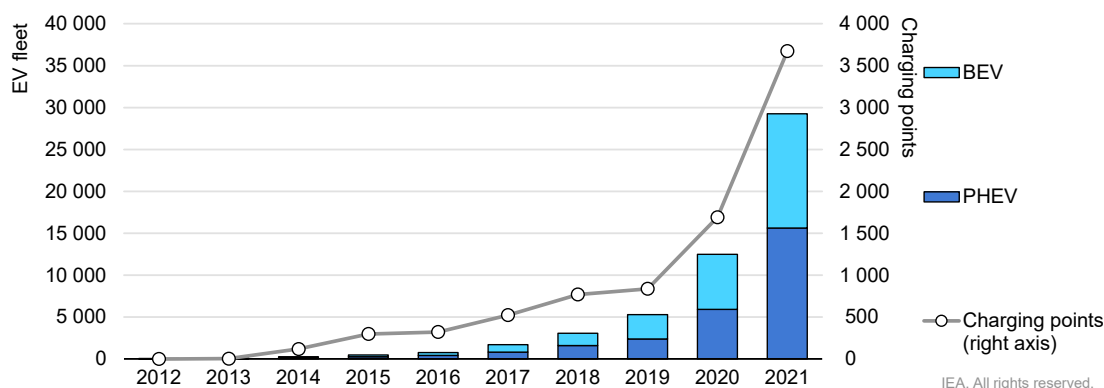
Most transport energy demand is covered by oil products, mainly diesel (64% in 2020), followed by gasoline (20%) liquefied petroleum gas (LPG) (9%) and biofuels (5%, mostly biodiesel). Small shares of transport demand are covered by natural gas (1.6%, mainly for buses) and electricity (1.3%, mainly for rail). Most transport energy demand comes from road transport (98%), with small shares from rail (2%), domestic aviation (0.2%) and

domestic shipping (0.01%). In 2019, passenger cars accounted for 55% of transport energy demand. The share of demand from road freight (41%) was the third highest among IEA member countries. Poland has seen notable improvements in the efficiency of road freight transport. From 2009 to 2019, road freight energy intensity dropped from 1.8 MJ per tonne-km to 1.0 MJ per tonne-km, below the road freight energy intensity of Germany (1.2 MJ per tonne-km in 2019).

Poland's passenger car fleet has seen a notable decline in efficiency that is out of line with the trend of improving efficiency seen in most IEA member countries. From 2010 to 2019, the energy intensity of passenger cars in Poland increased from 1.8 MJ per passenger-km to 2.1 MJ per passenger-km, compared to a decline of the IEA average from 1.8 MJ per passenger-km to 1.7 MJ per passenger-km. The drop in efficiency is driven by the import of notably older and less efficient cars and consumer preference for SUVs and other large vehicles. In 2020, used imported vehicles accounted for 64% of car registrations, while large and inefficient SUVs and crossovers represented the highest share (9%) of new vehicle registrations.

EV deployment is increasing in Poland (Figure 4.7). From 2012 to 2021, the number of registered EVs grew from just 66 to almost 30 000, with most of this growth occurring in 2021, when new EV registrations reached almost 17 000 and 3.7% of annual new vehicle registrations. However, EVs still represent just 0.12% of Poland's passenger car fleet, compared to the EU average of 1.55%. From 2014 to 2021, the number of publicly available charging points grew from just 119 to 3 674, with about half this growth occurring in 2021.

Figure 4.7 Electric vehicles and public charging points in Poland, 2012-2021



Notes: BEV = battery electric vehicle. PHEV = plug-in hybrid electric vehicle.

Source: EAFO (2022).

Policies and measures

The main policy document for Poland's transport sector is the Strategy for Sustainable Transport Development to 2030 (SRT2030). Adopted in 2019, it aims to increase transport safety, efficiency and accessibility. The strategy includes measures to shift transport from roads to railroads and waterways, electrify road transport, improve public transport, promote pedestrian and bicycle traffic, implement low-emission zones, and minimise the negative impact of air transport on the environment.

Electrification is a key aspect of Poland's transportation policy. The NECP contains a goal for Poland to have 1 million electric vehicles by 2025. The EPP2040 (adopted after the

NECP) contains a less ambitious goal for 600 000 EVs by 2030 (compared to around 12 500 in 2020). The EPP2040 also set goals for cities with 100 000 or more inhabitants: starting in 2025, these cities can only purchase zero-emission vehicles for public transport and by 2030 their entire fleet of public transport vehicles must be zero-emission. The 2018 Act on Electromobility and Alternative Fuels includes targets for the share of EVs in the national government's vehicle fleet to reach 10% by 2022, 20% by 2023 and 50% in the long run. For regional government vehicle fleets, the required EV shares are 10% by 2023 and 20% by 2025.

Poland is also aiming to greatly expand EV charging infrastructure. The SRT2030 includes goals to increase charging infrastructure along the main highways and in the largest urban areas. The EPP2040 sets 2030 goals for the deployment of 11 000-15 000 fast EV charging points (above 22 kilowatts [kW]) and 49 000-85 000 regular charging points (compared to around 650 fast charging points and 1 000 regular charging points in 2020). The Act on Electromobility and Alternative Fuels requires all government buildings to be equipped with at least one EV charging point with a capacity of at least 3.7 kW and for cities with 100 000 or more inhabitants to set targets on the number of publicly accessible EV charging points to be built by the relevant electricity DSO.

Poland has recently secured EUR 176 million funding to help companies, local government and housing co-operatives deploy EV charging and hydrogen refuelling. The National Fund for Environmental Protection and Water Management has launched application calls regarding this area under "Support for electric vehicle charging infrastructure and hydrogen refuelling infrastructure". The first calls were scheduled to run from January to March 2022.

The My EV programme, launched in July 2021, is Poland's main programme supporting EV adoption. The programme is operated by the National Fund for Environmental Protection and Water Management and provides subsidies to individuals up to EUR 4 100 for EVs costing up to EUR 49 600. Families with at least three children are eligible for a subsidy up to EUR 6 000 with no limit on the vehicle price. The programme is scheduled to run through 2025, with a budget of EUR 154 million. Poland also provides support to companies, institutions and municipalities to purchase electric mopeds, motorcycles, tricycles and quadricycles (up to EUR 880 per vehicle), cars (up to EUR 6 000) and small trucks (up to EUR 15 400). EV owners can also use bus lanes and enter and park in low-emission zones for free. EVs have distinct green licence plates to increase consumer awareness.

The Green Public Transport programme, launched in 2020, supports the purchase of electric and hydrogen buses and related charging and refuelling infrastructure. The initial budget of EUR 286 million has been increased to EUR 444 million, which should support the purchase of 386 electric buses and 130 hydrogen buses. Poland's Pandemic Recovery and Resilience Plan proposes investing EUR 1.1 billion to expand this programme. Poland also has programmes that support the purchase of electric school buses (budget of EUR 8.8 million), electric taxis (EUR 8.8 million) and electric delivery vehicles (EUR 15 million).

Poland's vehicle excise duty (paid when purchasing a new vehicle) is lower for vehicles with lower capacity engines and for hybrid vehicles. BEVs, hydrogen vehicles and some plug-in hybrids are exempt from the duty.

The government is pushing for Poland to become a centre for manufacturing of EVs and EV components. Since 2021, Poland is the largest European exporter of electric buses, with EUR 213 million in exports (PIE, 2021). The government is taking steps (including creating a special economic zone and tax relief measures) to attract investment in EV-related manufacturing and several private companies have located EV-related factories in Poland.

Objective 2 of the Polish Hydrogen Strategy is the use of hydrogen as an alternative fuel in transport. It includes targets for 32 hydrogen fuelling stations and 250 hydrogen buses by 2025; 1 000 hydrogen buses by 2030; and goals for the use of hydrogen or hydrogen-based synthetic fuels in heavy trucks, trains, ships and aviation.

Poland aims to improve transport efficiency and reduce transport emissions through modal shifts away from private cars. The SRT2030 includes specific measures to establish sustainable multimodal transport systems in Polish cities through high-quality cycling infrastructure, shared mobility, common timetables and tariff systems for public transportation and trains, and restricted access zones for cars combined with “park and ride” nodes outside city centres. The Directions for the Development of Intermodal Transport Until 2030 with a Perspective to 2040 document identifies options to further support the development of intermodal transport using EU funding between 2021 and 2027.

Poland is also looking to improve the efficiency and reduce emissions from domestic rail, shipping and aviation. The National Railway Programme to 2023 aims to strengthen the role of rail by modernising railway infrastructure, with a total budget of EUR 14.6 billion, of which EUR 10.8 billion comes from the EU Cohesion Fund. In 2016, Poland's railway network consisted of 11 883 km of electrified lines and 7 331 km of non-electrified lines. The length of lines to be rebuilt by 2023 is 9 000 km, but not all these lines will be electrified. New train locomotives are subject to emissions requirements (EU Level IIIB, including a particulate matter limit of 0.025 g/kWh). The Programme for Supplementing the Local and Regional Railway Infrastructure, adopted in 2019 with a budget EUR 1.45 billion from 2020 to 2028, aims to increase rail connections between cities of more than 10 000 people.

Assessment

Responsibility for energy efficiency policy design and implementation is spread across numerous governmental institutions, creating challenges for co-ordination and integration of measures across multiple sectors. In most IEA countries, specialised energy agencies prepare and execute energy efficiency programmes. Having a dedicated and specialised agency responsible for the implementation and monitoring of energy efficiency policies and measures can make these instruments more effective. The IEA encourages the government of Poland to consider creating a dedicated institution for this purpose.

Under the EED, all EU member states are required to reduce FEC by 0.8% each year from 2021 to 2030. Poland developed a system of tradable white certificates as the main measure for achieving this target. From the inception of the certificate programme in 2013 through 2017, annual energy savings steadily increased; however, since 2017, these savings have declined notably. The ERO and participating companies have indicated that the drop in energy savings from the certificate programme is caused by the ERO's long

delays to process applications, as it lacks the resources needed to review applications in a timely and thorough manner. This delay is reducing the effectiveness of the programme and discouraging the broad participation needed to achieve sustained energy savings in line with Poland's EED annual energy savings requirement and its climate and energy goals. The government should provide the ERO with the resources necessary to issue certificates in a timely manner and regularly review the certificate programme to ensure it is driving energy savings in line with Poland's energy sector goals.

The EC has proposed to increase the EED annual energy savings requirement from 0.8% to 1.5% to help support the increased 55% GHG emissions reduction target for 2030. If the higher EED savings target is adopted, it will further increase the need for Poland's white certificate programme to deliver energy savings in a timely and cost-effective manner. Poland has taken some steps to increase the savings delivered by the white certificate programme, including adding suppliers of liquid transport fuels to the companies obligated to deliver energy savings.

Buildings

The potential for energy savings in Poland's building stock is enormous. The EU defines low-energy buildings as those with an energy demand between 45 kWh/m² and 75 kWh/m² per year (up to 190 kWh/m² per year for certain service sector buildings). Around one-third of Poland's residential buildings were built before 1980 and have an energy demand higher than 200 kWh/m² per year. More than 1 million buildings were built before 1918 and have a final energy demand higher than 300 kWh/m² per year.

There is a strong focus on transitioning away from coal-fired heating to reduce local air pollution, which is a major health issue in Poland. The European Environment Agency (EEA) report on *Air Quality in Europe 2020* found that Poland had the highest levels of both PM₁₀ and PM_{2.5} in the EU, and that Poland's low air quality resulted in around 50 000 premature deaths in 2018. EEA data from 2020 show that the majority of Poland's municipalities had poor air quality (PM_{2.5} from 15 to below 25 micrograms per m³) (EEA, 2020).

The main programme supporting the transition away from individual coal-fired heating systems is the Clean Air Programme, which provides subsidies for owners of single-family residential buildings to upgrade inefficient heat systems with new ones (including gas boilers, renewable energy sources and heat pumps). The programme also provides subsidies for energy efficiency measures such as building insulation that are undertaken when a heating system is replaced, but these measures are not required. As of December 2021, the programme had received around 379 000 applications for subsidies to upgrade heating systems, with the majority (45%) for gas boilers.

This large deployment of natural gas boilers pushes the decarbonisation problem to future generations. Transitioning from coal to gas heating will also likely increase heating costs and exposure to price volatility, e.g. the extreme increase in gas prices seen in Europe in 2021. The IEA recommends improving the Clean Air Programme to focus on deploying heating systems with the lowest emissions and highest efficiency to minimise the deployment of gas boilers. This could include linking the level of subsidies to the efficiency and emissions reduction of each heating technology.

The replacement of heating systems should also be linked with thermal renovations. Upgrading heating systems without improving building insulation results in oversized heating systems (with higher investment costs) and inefficient heating (with higher operational costs). This is especially concerning given the high share of poorly insulated buildings in Poland and the large share of consumers experiencing or at risk of energy poverty. Linking the upgrading of heating systems with thermal renovations has the potential to provide greater overall cost reductions and energy savings. However, it requires policy to account for barriers to widespread building renovation, such as high upfront costs and disconnects between who pays for renovations and who receives the financial benefits of lower energy costs (the landlord-tenant dilemma). The government should consider prioritising subsidies for projects that combine thermal and heating system renovations.

Consumer education about the potential of buildings renovation to decrease energy costs and the available programmes are also a key part of effective energy efficiency programmes. The government should ensure that people have adequate information about existing buildings renovation programmes and the tools to access these programmes.

There is also a notable opportunity to reduce local pollution from coal-fired heating (while improving efficiency) through the expansion of district heating. Poland has an extensive district heating network. In 2018, 58% of urban households were connected to district heating, but around 20% of urban households still used individual coal boilers. Poland is working to expand district heating, including goals to add 1.5 million new connections by 2030. District heating and electric heating (especially heat pumps) should be considered before subsidising other heating sources. Conversion to district heating or electric heating moves emissions upstream, to a smaller number of larger and more efficient heating and co-generation plants. This will help Poland transition to a low-carbon economy and reduce the risk of stranded assets from the expansion of the gas grid.

To further decarbonise heat supply, the upstream heat source for district heating networks will have to be transitioned away from coal to cleaner energy sources. Poland is supporting this transition through subsidies for high-efficiency co-generation. The government should ensure that non-fossil fuel heating options for district heating are fully considered. A 2021 research project by the Krakow District Heating Company can serve as an example of how heat pumps, geothermal and other renewables can power large-scale district heating systems in Poland (Hałaj et al., 2021).

High heating costs are a major factor driving energy poverty in Poland. The government is working to develop a systemic approach to reducing energy poverty and has indicated that a key measure will be the expansion of the energy allowance to cover a larger share of vulnerable consumers. While direct payments can help to address energy poverty concerns in the short term, they do not resolve the underlying causes of energy poverty. Energy poverty programmes should focus on renovations that improve energy efficiency, to provide vulnerable consumers with housing with low energy costs and high thermal comfort. Energy poverty programmes also need to be well integrated with overall social policy addressing poverty.

Poland has an EPC programme that provides detailed information on a building's energy performance. The EPC represents a huge opportunity to encourage energy efficiency improvements through market forces, but currently only 10% of buildings in Poland have

an EPC registered in the system, greatly limiting the impact of the programme. The government needs to update the EPC programme so that it covers most buildings in Poland. The recently introduced CEEB programme, requires registration of all building heating systems in Poland to support the replacement of old and inefficient systems. The government plans to merge the CEEB data with the EPC registry. More effort is needed to ensure that the EPCs cover most buildings in Poland.

The EED requires renovating 3% of the total area of public buildings each year, or using an alternative approach to achieve the same level of savings. Poland aims to achieve the EED requirement using the alternative approach, targeting energy savings from public buildings that do not meet the EU minimum performance requirements. The government should use this requirement as an opportunity to achieve higher energy savings while helping to grow the energy service companies market, currently limited to 23 companies.

Industry

Poland's industry sector has seen improvements in energy efficiency; however, industry energy demand is still growing and there are notable opportunities for further improvements. In contrast to the building and transport sectors, there are relatively few policies and measures pushing for higher industrial energy efficiency. The government should identify the key opportunities and barriers for industrial energy efficiency and develop stronger policy tools and measures to drive efforts to improve industrial energy efficiency.

Under the EED, large companies are required to implement an energy or environmental management system compliant with EU standards, or undertake an energy audit every four years that covers at least 90% of their energy demand and identifies cost-effective options for reducing energy demand. The first round of energy audits in 2017 resulted in reported energy savings of around 1 Mtoe. The second round of energy audits was to be completed in 2021. The government should consider making to mandatory to implement measures with short payback times identified in energy audits (as is done in other IEA and EU countries).

Poland's energy-intensive industrial companies operate under the EU ETS. With the current level of CO₂ prices, the incentive is higher than ever to invest in energy efficiency or switch to renewable fuels. The industrial companies not included in the EU ETS have little incentive to decarbonise, as the national emissions fee in Poland is virtually zero. The huge gap between the EU ETS price and the emissions fee could create the wrong incentives, as companies are incentivised to invest in smaller units, thereby remaining outside the EU ETS framework. This limits the possible benefits of economies of scale, and potential applications of waste heat utilised in the district heating sector.

Transport

Electrification of road transport is a central aspect of Poland's energy policy. In 2021, Poland had almost 30 000 registered EVs, 0.12% of its passenger car fleet (the EU average was 1.55%). The My EV programme launched in 2021 is the main programme driving the uptake of passenger EVs and has the potential to drive a major increase in EV ownership. The government should closely monitor the results of the programme and be ready to make adjustment as needed.

Most new vehicles purchased in Poland (73% in 2020) are company cars, but there are currently no subsidies for EV company cars. The government should enact measures to encourage the purchase of EV company cars, as this would help to boost EV sales and support the development of a used EV market by providing more affordable used EVs for a larger share of the population, as most consumers in Poland purchase used passenger vehicles.

Some of the elements of Poland's vehicle taxation are aligned with goals of increasing electrification and transport efficiency. The excise duty paid once when purchasing a new vehicle is less for more efficient cars, and EVs can receive a full exemption. However, unlike in many IEA and EU countries, Poland does not have any annual vehicle taxation based on emissions, efficiency or environmental impact. In addition, the taxes paid when importing a used vehicle (which account for most new registrations in Poland) are very low and not linked to emissions, efficiency or environmental impact.

Poland should update its vehicle taxation system (including the introduction of annual fees) based on age, fuel efficiency and climate impact that will guide the consumer towards EVs or other low-emission vehicles, or in some cases away from car ownership at all. In addition, low-emission zones could be implemented to exclude the oldest polluting cars, or a congestion tax could be introduced with exemptions for low-emission cars. Poland also needs to quickly take steps to reduce the import of old inefficient cars, which account for the majority of new vehicle registrations (64% in 2020) and are significantly reducing the average efficiency of Poland's passenger car fleet. Taxes or other measures should be introduced to reflect the heavy environmental impact of these vehicles.

Poland's pandemic Recovery and Resilience Plan includes a goal to introduce a registration duty and a tax on ownership related to emissions under the polluter-pays principle. The goal indicates that financial and fiscal measures should be introduced to stimulate the demand for cleaner vehicles. These include higher registration fees, an internal combustion tax and measures to enhance the accelerated depreciation of electric vehicles. The amount of the planned fee and tax will depend on the CO₂ or NO_x emissions. Revenue from the fee and tax will be used to support the development of low-emission public transport. The government plans to introduce the higher registration fee in the fourth quarter of 2024 and the higher vehicle ownership tax in the second quarter of 2026. The IEA commends these steps, but recommends introducing them much sooner.

Poland needs to ensure that fuel taxation drives consumer choices that are aligned with energy and climate policy goals. Within the bounds of EU harmonised tax regulations, Poland should examine how fuel taxation can be updated to better incentivise EVs and other highly efficient vehicles. The emission tax introduced in 2019 for diesel and gasoline use in transportation is a good step in the right direction. The emission tax is paid by fuel producers and importers, with 95% of the proceeds supporting a variety of energy transition programmes, including those for EVs and alternative fuels. The remaining 5% of the proceeds are allocated to expanding local bus routes.

A first programme to support EV charging and hydrogen refuelling infrastructure was launched by the National Fund for Environmental Protection and Water Management in January 2022. However, the government should maximise efforts in developing an adequate charging infrastructure to support its high ambitions on EV deployment. A distributed presence of EV chargers helps to drive EV demand by increasing awareness of EVs and decreasing concerns over access to chargers.

Poland aims to improve transport efficiency and reduce transport emissions through modal shifts away from private cars. The SRT2030 includes specific measures to establish sustainable multimodal transport systems in Poland. The Directions for the Development of Intermodal Transport Until 2030 with a Perspective to 2040 document identifies options to further support the development of intermodal transport using EU funding between 2021 and 2027. The government should closely monitor the implementation of programmes pushing for modal shift and be ready to update or expand measures as needed.

Recommendations

The government of Poland should:

- ❑ Establish a national agency to implement and co-ordinate energy efficiency support programmes.
- ❑ Strengthen the white certificates scheme with additional funds for the Energy Regulatory Office to limit bottlenecks in delivering the certificates, and incentivise companies to use the system even more to spur further energy savings.
- ❑ Ensure that the energy performance certificate programme covers most buildings, provides easy to access data on building efficiency and is aligned with the Central Building Emission Register.
- ❑ Improve the Clean Air Programme to further prioritise the most efficient and lowest emission heating options, and focus on renovations that combine the upgrading of heating systems with the thermal modernisation of buildings.
- ❑ Accelerate the alignment of vehicle taxation with the goals of higher electrification and reduced emissions, including expediting the introduction of annual taxation for all vehicles linked to efficiency and measures to reduce the import of old inefficient vehicles.

References

- Clean Air Programme (2022), Clean Air Programme (web page), <https://czystepowietrze.gov.pl>
- EAFO (European Alternative Fuels Observatory) (2022), Poland (database), <https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/poland> (accessed on 13 April 2022)
- EEA (European Environment Agency) (2020), Air Quality in Europe – 2020 Report, <https://www.eea.europa.eu/publications/air-quality-in-europe-2020-report>
- EU (European Union) (2020), 2020 EED Annual Report, https://energy.ec.europa.eu/system/files/2020-08/fi_annual_report_eed_2020_tra_0.pdf
- EU (2019), Assessment of the draft National Energy and Climate Plan of Poland, https://energy.ec.europa.eu/document/download/cdb5e342-e932-423d-90a0-abd05bacf333_en
- IEA (International Energy Agency) (2021), Energy Efficiency Indicators (database), <https://www.iea.org/data-and-statistics/data-product/energy-efficiency-indicators> (accessed on 18 February 2022)
- IEA (2022), World Energy Balances (database), <https://www.iea.org/data-and-statistics/data-product/world-energy-balances> (accessed on 18 February 2022)
- Hałaj, E. et al. (2021), Upgrading a district heating system by means of the integration of modular heat pumps, geothermal waters, and PVs for resilient and sustainable urban energy, *Energies*, Vol. 14/9, <https://doi.org/10.3390/en14092347>
- INFOR (Internet and New Technologies European Funds) (2021), The obligation to report what we use to heat houses from July 1, 2021 (web page), https://samorzad.infor.pl/sektor/zadania/zarzadzanie_nieruchomosciami/5274182,Obowiazek-zgloszenia-czym-ogrzewamy-domy-od-1-lipca-2021-r.html
- Stadnik, K. (2019), No smoking with coal and wood in Krakow, Malopolska, <https://powietrze.malopolska.pl/aktualnosci/zakaz-palenia-weglem-i-drewnem-w-krakowie>
- PIE (Polish Economic Institute) (2021), Weekly Commercial PIE, https://pie.net.pl/wp-content/uploads/2021/02/Tygodnik-Gospodarczy-PIE_05-2021.pdf
- PORTPC (Polish Organization for the Development of Heat Pump Technology) (2020), The heat pump market in Poland in 2019 and until 2030 (web page), <https://portpc.pl/rynek-pomp-ciepla-w-polsce-w-2019-roku-i-w-perspektywie-do-roku-2030>
- Sejmu (2018), Journal of Laws 2018 item 2489 (web page), <https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20180002489>
- URE (Energy Regulatory Office) (2022), Energy Efficiency Certificates Issued (database), <https://bip.ure.gov.pl/bip/form/3,Efektywnosc-Energetyczna.html> (accessed on 11 March 2021)

5. Renewable energy

Key data (2020)

Renewables in TFEC: 11.3 Mtoe/16.1%

Renewables in electricity generation: 28.2 TWh (wind 10.0%, bioenergy 5.5%, hydro 1.3%, solar 1.2%, renewable waste 0.1%)

Renewable energy shares²: gross final energy consumption 16.1%, electricity 16.2%, heating and cooling 22.1%, transport 6.6%

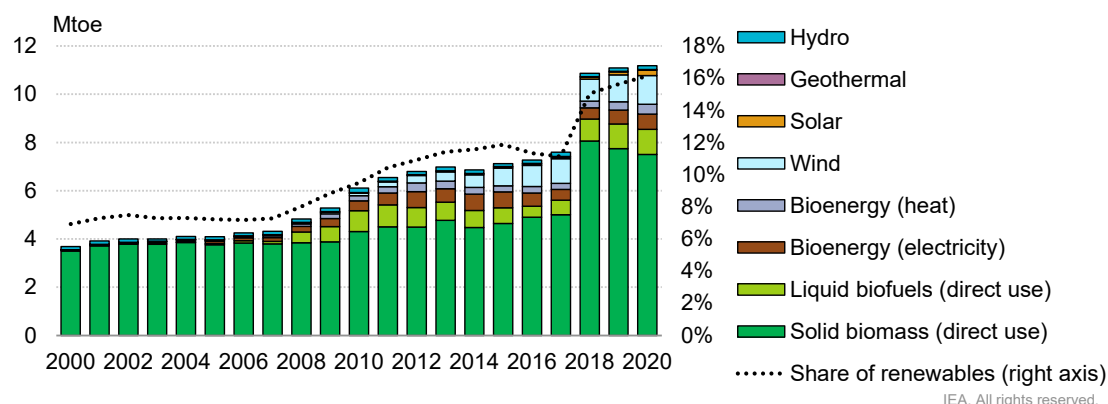
EU total renewable shares²: gross final consumption 22.1%, electricity 37.5%, heating and cooling 23.1%, transport 10.2%

Overview

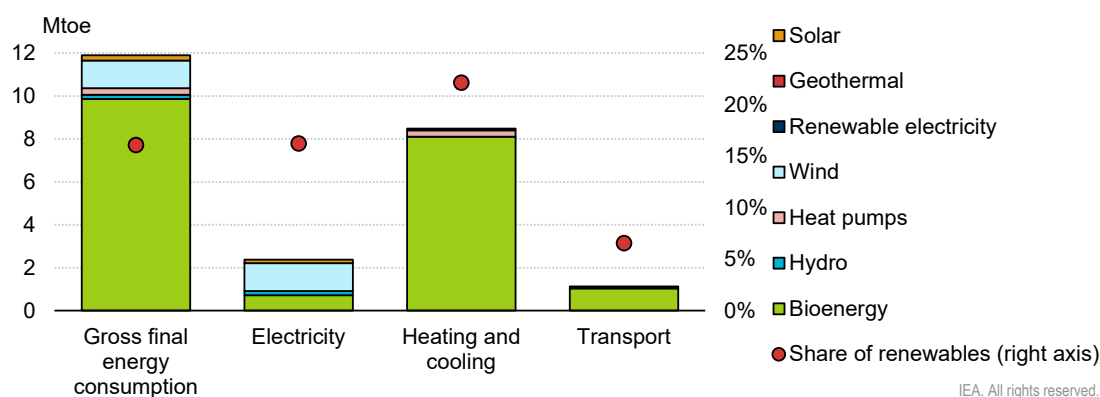
From 2010 to 2020, the share of renewable energy in Poland's total final energy consumption (TFEC) increased from 9.5% to 16%, driven mainly by growth in wind generation and in direct use of solid biomass, mainly for heating (Figure 5.1). The large increase in the share of renewables seen in 2018 resulted from improved data collection on the use of solid biomass for heating. Poland's share of renewables in TFEC remains relatively low, ranking 21st among IEA member countries in 2019. Using Eurostat's definitions, in 2020, renewables covered 16% of Poland's gross final energy consumption, 16% of electricity generation, 22% of heating and cooling demand, and 6% of transport demand (Figure 5.2).

Poland's energy policy gives a key role to renewable energy in several strategic areas of its energy transition. Renewable electricity generation, especially from offshore wind and small-scale solar PV, is one of the main options to displace coal-fired electricity without increasing import dependency and to increase the role of prosumers in electricity markets. Poland places a focus on reducing transport sector oil demand through biofuels and renewable electricity. There is a push for renewables in heating and cooling, with support for bioenergy and heat pumps. Poland is also aiming to decarbonise its gas supply with biomethane and hydrogen produced from renewable electricity. The targets and supporting measures for renewable energy are defined in Poland's NECP, the EPP2040, and numerous national laws and regulations.

² Eurostat applies formulas to normalise fluctuations of electricity generation from wind and hydro, and multiplication factors that give higher shares to transportation use of advanced biofuels and renewable electricity. The share of renewables in gross final energy consumption includes domestic renewables and statistical transfers of renewables from other EU member states allowed under EU rules.

Figure 5.1 Renewable energy in total final energy consumption in Poland, 2000-2020

Source: IEA (2022).

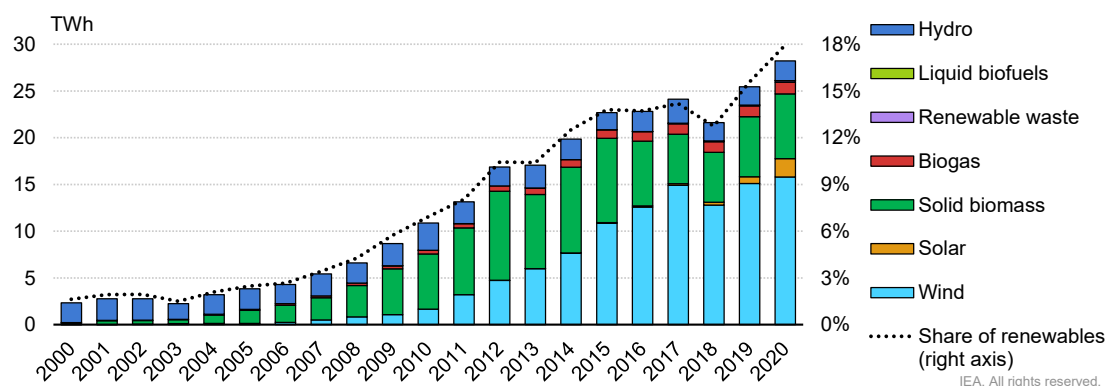
Figure 5.2 Renewable energy key metrics in Poland, 2020

Source: EC (2022).

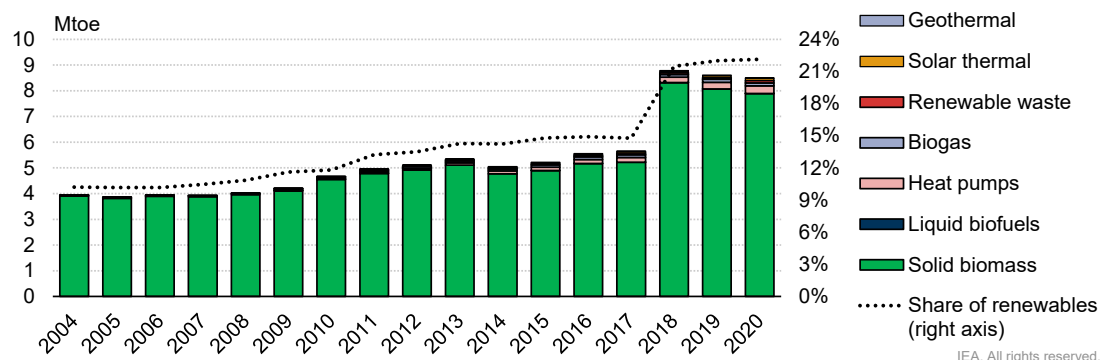
Renewables by sector

From 2010 to 2020, renewable electricity generation increased almost threefold, from 10.9 terawatt hours (TWh) to 28.2 TWh, while the share of renewables in generation increased from 7% to 18% (Figure 5.3). This growth was driven mainly by increased onshore wind generation (from 1.7 TWh to 15.8 TWh) and solid biomass (from 4.9 TWh to 6.9 TWh), while solar PV also experienced fast growth (from 0.2 TWh in 2017 to 2.0 TWh in 2020). Electricity from hydropower fluctuated at around 2 TWh between 2010 and 2020 and electricity generated from biogas increased from 0.4 TWh to 1.2 TWh.

Renewables in heating and cooling grew between 2010 and 2020 from 4.7 Mtoe to 8.5 Mtoe and from 12% to 22% of total heating and cooling demand, with a notable increase in 2018 resulting from improved data collection on the use of solid biomass for heating, specifically the use of firewood (Figure 5.4). Solid biomass accounts for most renewable heating and cooling (93% in 2020), followed by heat pumps (3.5%), biogas (1.3%) and renewable waste (1.1%).

Figure 5.3 Renewable energy in electricity generation in Poland, 2000-2020

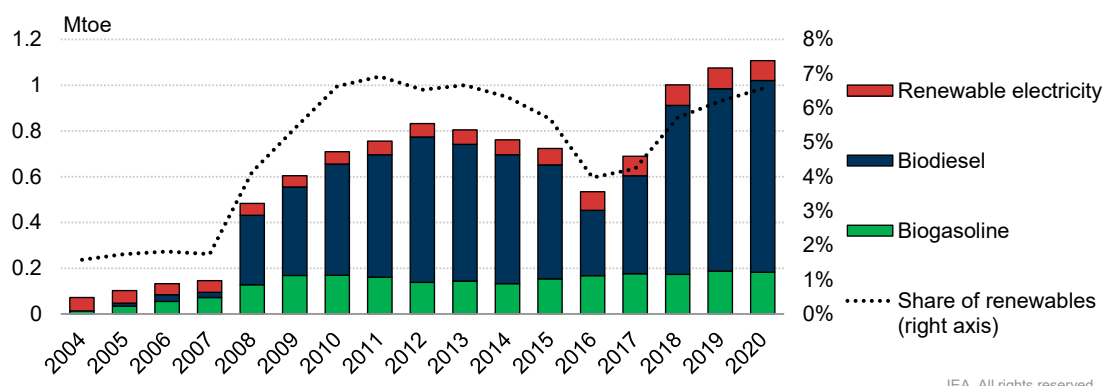
Source: IEA (2022).

Figure 5.4 Renewable energy in heating and cooling in Poland, 2004-2020

Sources: EC (2022).

The growth of renewables in transport was less spectacular between 2010 and 2020, with an overall increase from 0.9 Mtoe to 1.1 Mtoe. The notable drop and rebound of data for renewables in transport in 2010 and 2015 was driven by the sale of transport fuels outside the legal market. This significantly reduced the demand for fuel sold through official retail stations, which must provide fuels with a minimum biofuels content. Legislative and enforcement actions taken in 2016 helped to significantly reduce illegal sales and ensured better reporting of actual fuel demand, which is reflected in notable increases in data for renewables in transport in 2016 and 2017 (Figure 5.5).

Renewables in transport consists mainly of biofuels blended with diesel and gasoline, along with renewable electricity in rail. In 2019, biodiesel accounted for 76% of renewables in transport, followed by biogasoline (16%), renewable electricity in rail (7.1%) and renewable electricity in road transport (0.2%).

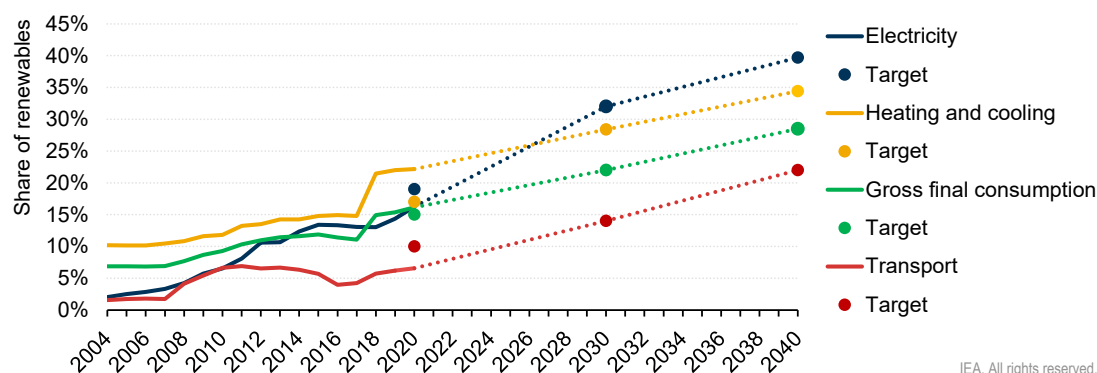
Figure 5.5 Renewable energy in transport in Poland, 2004-2020

IEA. All rights reserved.

Sources: EC (2022).

Renewable energy targets

Under the EU Renewable Energy Directive (RED), Poland has 2020 and 2030 targets for renewables in gross final consumption, and indicative trajectories for renewables in electricity, heating and cooling, and transport (Figure 5.6). The RED targets and trajectories are intended to support the achievement of EU-wide targets for renewables in gross final consumption to reach 20% by 2020 and 32% by 2030. Poland's 2020 targets and supporting measures are set in its National Renewable Energy Action Plan. The 2030 renewable targets and support measures are set in Poland's NECP and the EPP2040.

Figure 5.6 Poland's renewable energy targets and status 2004-2020

IEA. All rights reserved.

	Status	Targets and trajectories		
Renewable energy share	2020	2020	2030	2040
Gross final energy consumption	16.1%	15%	23%	28.5%
Electricity	16.2%	19%	31.8%	39.7%
Heating and cooling	22.2%	17.4%	28.4%	34.4%
Transport	6.6%	10%	14%	22%

Source: EC (2022).

Poland achieved its 2020 target for renewables in gross final energy consumption. However, this resulted in large part from the change in methodology to calculate biomass

use for building heating. The 2020 shares for renewables in electricity and in transport remain below their indicative trajectories.

In October 2020, the European Commission published its review of Poland's NECP, noting that the 2030 target for a 23% renewable energy share in gross final consumption was unambitious and that a 25% share is necessary to support the EU-wide renewables target (EC, 2020). In December 2020, the EU-wide GHG emissions reduction target for 2030 was increased from 40% to 55%. The EU has indicated that it will update the RED to increase the EU-wide renewable energy target from 32% to 40%. It is likely that Poland will need to increase its 2030 renewable energy targets to support EU-wide targets for renewables and GHG emissions.

Renewable energy policy

Renewables in electricity

Poland's energy policy places a focus on increasing renewable electricity generation to support a reduction in coal-fired generation. Poland is also pushing for higher electrification of energy demand (especially for road transport) to allow increased renewable generation to increase the shares of renewables across the energy system. Poland has a wide range of measures supporting renewable electricity generation. Electricity generated from renewable energy is exempt from the excise duty of EUR 1.1 per megawatt hour (MWh) charged on all other generation. Renewable energy projects with a capacity less than 5 MW receive reduced grid connection charges, and renewable micro-installation (capacity of 50 kW or less with a connection under 110 kV) are connected for free. Renewable generation is given priority dispatch by system operators.

Poland's green certificate scheme (in place since 2005) requires all electricity suppliers to obtain a certain volume (MWh) of green certificates based on their annual generation. The share of required certificates is set annually by the Ministry of Climate and Environment and steadily increased from 15% in 2016 to 19.5% in 2020, remained at 19.5% for 2021, and reduced to 18.5% for 2022. Industrial companies with an annual electricity demand over 100 GWh are also obliged to obtain a volume (MWh) of certificates equal to the same share set for electricity suppliers, but based on their electricity demand. The government provides partial refunds of the certificate costs for obliged industrial consumers, with the refunds totalling EUR 29 million in 2019 and EUR 100 million in 2018 (EC, 2019).

Green certificates are issued by the Poland's energy sector regulator, the ERO, to renewable projects for each MWh of generation. Certificates are issued for 15 years starting from the commissioning of a project. They serve as an additional revenue source to support renewable projects. Obligated energy suppliers and large consumers must purchase the required volume of certificates and deliver them to the ERO each year or pay a substitution fee for any missing certificates. The level of the fee is set annually by the Minister of Climate and Environment. Since 2017, the fee is equal to 125% of the average certificate price from the previous year. Certificates are traded on the Polish Power Exchange, with averages certificate prices around 31 EUR/MWh in 2020. Since September 2021, certificate prices reached up to 60 EUR/MWh.

The Act on Renewable Energy Sources (adopted in 2015 and amended in 2021) made notable changes to Poland's policy for supporting renewable generation. The act includes

a continuation of the green certificate obligation through at least 2035, but renewable energy projects commissioned after July 2016 will no longer receive green certificates. The government has also passed legislation extending the eligibility to receive green certificates beyond the 15-year limit for existing small hydropower and biogas installations with a capacity less than 1 MW that are already part of the green certification scheme.

The Act on Renewable Energy Sources established several new support measures for renewables, including annual auctions. Projects selected in auctions receive a guaranteed price for electricity generated for 15 years through a contract for differences (if the market price is below the guaranteed price, the difference is covered by the government). Projects selected in the auction with a capacity below 500 kW have a guarantee of purchase of their generation. Projects selected in the auction above 500 kW have to find buyers for their generation.

The first auction took place in December 2016 and the government plans to hold auctions through 2027. The government sets the volume (MWh) to be awarded and a maximum price each year. The total volume of each auction is spread between separate tenders for wind, solar, geothermal, bioenergy (biogas and biomass) and hydropower, with each technology having separate tenders for projects below and above 1 MW. Projects meeting certain basic qualifications submit bids for a volume of generation (MWh) at a certain price. The ERO runs the auctions and selects projects based on the lowest price. Projects must start generating electricity within 42 months of being selected, except for onshore wind (33 months) and solar (24 months). Projects that do not meet these deadlines or that fail to generate the awarded volume are subject to financial penalties.

Auctions held from 2016 to 2021 awarded support for 259.9 TWh of generation to 4 253 projects with a total planned capacity of 11.5 GW, mostly solar PV (6.3 GW, with 3.6 GW to projects under 1 MW and 2.7 GW to projects over 1 MW) and onshore wind (5.1 GW). If all projects selected in the auctions are developed, it would result in a major increase in solar PV capacity (4 GW in 2020 and estimated at 7.7 GW at the end of 2021) and onshore wind capacity (6.3 GW in 2020). Despite technology specific tenders, the auction system awarded support to only 0.3 GW of technologies other than solar and wind, mainly for 0.29 GW of hydropower projects over 1 MW.

The 2021 amendment to the Act on Renewable Energy Sources also allows the state-owned national agricultural support centres to lease land without a tender to state-owned energy companies for renewable energy projects. The amendment exempts renewable projects with a capacity up to 500 kW from the requirement to be included in municipal spatial development plans (the previous exemption cap was 100 kW) and increased the capacity for renewable projects exempt for concession obligations from 500 kW to 1 MW (electricity) and 0.9-3 MW (co-generation).

The 2016 Act on Windfarms placed significant new requirements on new onshore wind projects. The distance of a wind project from buildings, farms and natural areas is set at ten times the height of a wind turbine, approximately 1.5-2 kilometres. The act also increased property taxes on wind farms. The government has recently taken steps to reduce these restrictions. The increased property tax was removed in 2018, with the government providing a one-time payment to municipalities to compensate for reduced tax revenues. The government aims to pass legislation in 2022 that would allow municipalities to reduce the ten times distance rule on a project-by-project basis.

Poland's energy policy aims for offshore wind to play a major role in electricity generation. The EPP2040 sets targets for offshore wind in Poland's section of the Baltic Sea to reach 5.9 GW by 2030 and 8-11 GW by 2040. The 2020 Act on the Promotion of Electricity Generation at Offshore Wind Farms specifies areas for offshore windfarm deployment based on the Spatial Development Plan for Polish Sea Areas and seeks to balance wind resource quality, environmental concerns and competing uses such as commercial fishing and aviation. The act also established a support programme for offshore wind. The aid will be granted in the form of a two-way contract-for-difference premium lasting 25 years or until the project reaches 100 000 full load hours per MW of installed capacity. Under this model, the premium is calculated as the difference between a reference price and the market price for electricity.

All offshore wind project must pay the cost of offshore infrastructure needed to connect to the onshore grid. The electricity TSO pays for upgrades to the onshore grid needed to connect the offshore wind projects. The EC approved the support system in May 2021.

Through June 2021, support was awarded to 5.9 GW of projects by administrative decision setting. These projects are eligible to receive a maximum support of 71 EUR/MWh and include the Baltica 2 and Baltica 3 projects (2.5 GW) being developed by a joint venture of the Danish offshore wind developer Ørsted and PGE, a state-owned company that owns the largest share of generation assets in Poland. Also selected was a 1.2 GW project being developed by a joint venture of Northland Power (a private Canadian company with offshore wind experience) and the state-owned PKN ORLEN, Poland's largest oil and gas company. Other projects include the MFW Baltic II and MFW Baltic III developed by a joint venture of the Polish company Polenergia and the Norwegian Equinor (1.44 GW), FEW Baltic II (0.35 GW) developed by Baltic Trade and Invest (RWE) and BC Wind (0.37 GW) developed by OW Ocean Winds (EDPR and Wngie JV).

The majority of support awarded via administrative decisions has gone to projects that are joint ventures between Polish energy companies and experienced offshore wind developers. Going forward, support will be awarded through competitive auctions planned for 2025 (2.5 GW) and 2027 (2.5 GW). The government estimates that total support payments will amount to around EUR 7.8 billion by 2040 and around EUR 22.5 billion over the life of the programme.

Poland is aiming to support offshore wind development with funding from its Recovery and Response Plan (developed as part of the EU's economic response to the Covid-19 pandemic). The largest investment in the plan is for the deployment of offshore wind generation (EUR 3.25 billion), with an additional EUR 437 million for port infrastructure supporting offshore wind. The government is also working with the offshore wind industry to establish a robust supply chain so Poland can sustain a high level of offshore wind deployment and maximise the economic benefits. In September 2021, the government and offshore wind energy industry representatives signed a Polish Offshore Wind Sector Deal that defines specific areas of co-operation for the development of an offshore wind industry in Poland.

Poland is also supporting renewable energy deployment by expanding electricity transmission and distribution infrastructure. The electricity TSO's ten-year development plan for 2021-30 includes scenarios accounting for significantly higher renewable generation, including 3.6-10.1 GW of offshore wind. The TSO is also working with DSOs

to increase the connections and co-ordination between transmission and distribution systems (see Chapter 7).

Poland's energy policy places a strong focus on increasing the number of prosumers and energy communities using renewable energy. The EPP2040 sets a goal of reaching 1 million prosumers and 300 energy communities by 2030 and for solar PV to reach 5-7 GW by 2030 and 10-16 GW by 2040 (with most of this capacity expected to come from prosumers). As of December 2021, Poland had 60 energy communities and 845 505 prosumers (compared to just 4 000 prosumers in 2015). The total capacity of prosumer installations in December 2021 was 5 860 MW, with around 99.9% being solar PV, equal to 77% of total PV capacity.

Prosumers have been compensated under a net metering scheme that lasts for 15 years from the connection of their system where each kW of renewable electricity generation delivered to grid gives a prosumer credit for 0.7-0.8 kW of grid electricity that can be settled within 12 months. In April 2022, the net metering scheme was replaced with a net billing scheme under which surplus generation is remunerated at the average monthly wholesale market price. Prosumers who connected their renewable system to the grid before April 2022 will continue to use the net metering scheme. In October 2021, the government introduced definitions for collective and virtual prosumers with support-based net billing.

Poland's My Electricity programme aims to increase the number of prosumers by providing co-financing grants for residential solar PV systems of 2-10 kW. The third round of the programme (closed in October 2021) offered grants covering up to 50% of eligible costs (up to EUR 660 per residential consumer). A fourth round is being prepared. The government is planning to update and extend the programme beyond 2025. Poland's Agroenergy Programme helps energy farmers become prosumers. Under the programme, farmers can receive grants up to EUR 5 500 to cover the costs for 10-50 kW of heat pumps, solar PV or wind generation. It was extended in October 2021, with a budget of EUR 44 million. Poland also aims to support energy communities with EUR 97 million in funding from its Recovery and Response Plan.

The government is working on a range of changes to increase the market participation of prosumers and integrate more distributed renewable generation (see Chapter 7). These include introducing aggregators to co-ordinate prosumers' market transactions and offer other services, increasing the deployment of smart meters and launching the Central Energy Information Exchange System (CSIRE) to facilitate efficient and transparent exchange of digital information (including data from smart meters). The government is taking steps to support increased deployment of energy storage to facilitate the integration of renewable generation, including a plan for the next round of the My Electricity programme to provide funding for distributed storage and a plan for renewable energy auctions held in 2022 to include a specific bracket for renewable generation deployed with storage.

The National Fund for Environmental Protection and Water Management also supports renewables deployment. It ran a programme for residential buildings from 2015 to 2019 that provided EUR 32.2 million for wind, solar, biogas and biomass projects with capacities up to 40 kW. A programme for companies is scheduled to run from 2015 to 2023, with a budget of EUR 133 million supporting wind, solar, biogas, biomass and hydropower projects with capacities ranging from 30 kW to 5 MW depending on the technology. It offers reduced rate loans of up to EUR 9.3 million to cover up to 85% of the project costs.

Poland supports generation from hydropower, biogas and biomass through a feed-in tariff and feed-in premium. The feed-in tariff is available for projects with a capacity of less than 500 kW for 15-17 years. These projects sell electricity generation to an obliged supplier at 95% of a reference price, which is set annually by the government. The feed-in premium is available for projects with a capacity from 500 kW to 1 MW, which are compensated for the difference between the market price and 90% of the reference price for 15 years. Both the feed-in tariff and feed-in premium are scheduled to end in 2035. The Polish Geothermal Energy Plus Priority Programme aims to increase the use of geothermal energy in Poland, for both heat and electricity generation. It provides grants and loans to companies to construct or modernise a geothermal heat, electricity or co-generation plant.

The cost of Poland's support programmes for renewable electricity generation are covered by a fee charged to all electricity consumers, which is calculated each year by the ERO. In 2021, the fee was 0.47 EUR/MWh, equal to about EUR 0.08 per month for the average household consumer. The cost of the green certificate scheme is also passed on to consumers and equalled 9.7 EUR/MWh in 2021, about EUR 1.61 per month for the average household consumer.

Renewables in transportation

Poland's policy for renewables in transport is focused on biofuels and increasing the use of EVs powered with renewable electricity. Under the RED, Poland has targets to increase the share of renewables in transport to 10% by 2020 and 14% by 2030; the share was 6.6% in 2020. As in many EU member states, Poland's main policy mechanism for meeting the RED targets is a biofuels blending mandate that requires all companies producing or importing transportation fuels to have a minimum share of biofuels by energy content in their annual fuel sales for all transport modes (Table 5.1). Companies that have achieved 85% of the required blending share are eligible to pay a substitution fee instead of fully meeting the target. Biofuels are taxed at the same rate as whatever transportation fuel they are blended with.

Table 5.1 Required shares of biofuels by energy content in Poland, 2014-2024

2014-17	2018	2019	2020	2021	2022	2023	2024
7.1%	7.5%	8.0%	8.5%	8.7%	8.8%	8.9%	9.1%

The RED requires that a certain share of biofuels used in transport come from advanced biofuels (not based on food or animal feed crops; at least 3.5% by 2030), and awards shares higher than the actual energy content for advanced biofuels (and renewable electricity). Poland has incorporated advanced biofuel requirements into its biofuel blending mandate. The government indicates that the required share of advanced biofuels will be met mostly through hydrogenated vegetable oil blended with diesel and biomethane used in natural gas-powered vehicles, primarily buses and heavy transport.

Poland aims to maximise local production of biofuels as part of its goal to promote domestic energy sources. In 2020, its production of bioethanol was about 0.3 Mt, compared 0.2 Mt in 2015 and a production capacity of about 0.7 Mt. Production of biodiesel was about 0.9 Mt, compared to 0.75 Mt in 2015 and a production capacity of about 1.4 Mt. Domestic production covers most of Poland's biofuels demand.

Poland places a strong focus on increasing renewable energy in transport through electrification, despite the still high share of coal-fired generation. The government has developed several measures to support the uptake of EVs and the deployment of EV charging infrastructure (see Chapter 4). The Ministry of Climate and Environment is currently working on a renewable energy credit scheme for operators of charging stations.

Renewables in heating and cooling

Poland's policy on renewable heating and cooling is less clear than for electricity or transport. The government indicates that biomass has the greatest potential for renewable heating and notes a significant role for heat pumps, especially in connection with the rapid growth of distributed solar PV. The potential roles for solar thermal, geothermal and biogas are not well defined. Poland's policy on heating aims primarily to reduce local air pollution from individual coal boilers. The Clean Air Programme provides subsidies for heating system upgrades including for heat pumps, but in recent years most subsidies have gone to natural gas boilers (see Chapter 4).

Poland has support measures to improve the thermal efficiency of new and existing buildings, many of which include support for renovations that combine energy efficiency measures with renewable heating and cooling (see Chapter 4). Poland also places a focus on expanding district heating supplied by high-efficiency co-generation. The support scheme for high-efficiency co-generation is mainly targeted at a transitioning from coal to natural gas, but also supports bioenergy (see Chapter 7).

Renewable gases

The EPP2040 sees a role for renewable and low-carbon gases in supporting the decarbonisation of Poland's gas supply, and sets a 2030 goal for the natural gas grid to be able to transport 10% low-carbon hydrogen, which could support the decarbonisation of heating, industrial processes and natural gas-fuelled vehicles. The plans for developing low-carbon hydrogen production are detailed in the Poland's Hydrogen Strategy and include a goal for 2 GW of electrolyser and low-carbon hydrogen production capacity by 2030 (see Chapter 2). As with EVs, hydrogen production via electrolysis faces challenges given the low share of renewable energy in Poland's generation mix. The EPP2040 calls for increased biomethane production in Poland, with an emphasis on grid injection or use as a transport fuel. The government is preparing an act to define needed regulations to support the development of a biomethane sector, including rules for biomethane producers, and quality parameters for biomethane.

Assessment

From 2009 to 2019, the share of renewable energy in Poland's TFC increased from 9% to 12%, driven by growth in renewable electricity generation (mainly wind and solar PV) and increased use of solid biomass, mainly in heating. However, Poland's share of renewables is still low, ranking 21st among IEA member countries. Poland's NECP sets 2030 targets for renewables shares of 21-23% in gross final energy consumption, 32% in electricity, 28% in heating and cooling, and 14% in transport.

The European Commission's review of Poland's NECP noted the modest ambition of Poland's 2030 targets. Since this review, the EU increased its 2030 GHG emissions reduction target to 55% (compared to 1990) and is developing stronger 2030 renewables

targets. This will likely require Poland to increase its ambitions on renewables. The government should move quickly to identify clear options for an accelerated deployment of renewables in all sectors.

Renewables in electricity

The EPP2040 places an emphasis on increasing renewable electricity generation to drive the energy transition, especially on solar PV and offshore wind. It includes targets for solar PV capacity of 5-7 GW by 2030 and 10-16 GW by 2040, and for Poland to have 1 million prosumers using distributed renewables (mainly PV) by 2030. Although the EPP2040 was released in February 2021, it does not reflect the reality of PV deployment in Poland. At the end of 2021, PV capacity had already reached around 7.7 GW, mainly from prosumers (5.9 GW). This strong deployment of prosumer PV was supported by the popular My Electricity programme and favourable net metering. In addition, utility scale PV has been the main winner of recent renewable energy auctions. Industry indicates that PV capacity could reach 10 GW by 2023 and 18-20 GW by 2025.

The rapid deployment of PV, especially by prosumers, is a notable policy success for Poland. The government should take steps to ensure that this strong success with PV can be continued and safely integrated in the grid. The IEA encourages the government to accelerate investment in distribution grids and quickly add support for distributed energy storage to the My Electricity programme. It would also be beneficial to introduce market reforms such as dynamic pricing and a strong role for aggregators. The government is working on legislation that introduces the legal framework for dynamic pricing and aggregators. However, the government has indicated that full use of dynamic pricing will only be possible once the CSIRE energy data system is fully operational in 2024.

Poland has developed a strong offshore wind policy and contracts are in place for 5.9 GW of wind farms that should be fully operational by 2027. These projects are eligible to receive a maximum support 71 EUR/MWh. The majority of these projects are joint ventures between Polish energy companies and experienced offshore wind developers. The next rounds of offshore wind projects will be selected through competitive auctions planned for 2025 (2.5 GW) and 2027 (2.5 GW). The government should take steps to ensure that these auctions attract competitive bids that result in a minimal level of subsidies. Recent offshore wind auctions for projects in the North Sea have been highly successful while offering no direct subsidies; however, in most of those cases, the TSO covered the cost of the undersea connection, while in Poland this must be covered by the project developer.

Onshore wind has historically been the main driver for growth in Poland's renewable generation. However, onshore wind deployment has significantly slowed, with capacity only increasing from 5.8 GW to 6.4 GW between 2016 and 2020. This slowdown in wind deployment has coincided with the passing of a law in 2016 that places notable restrictions on wind farm deployment. The government recently proposed allowing municipal authorities to relax wind generation siting requirements, which has been welcomed by wind developers. The government should quickly pass the law relaxing the siting requirements for onshore wind, monitor onshore wind deployment and take additional steps as needed to drive robust onshore wind deployment.

Both offshore wind and onshore wind deployment will require notable transmission system investments to bring wind generation from the north of the country to demand centres in the south. The government should work closely with the TSO to ensure that expansion of the transmission system keeps pace with wind development.

Although Poland's renewable energy auction system has separate baskets for bioenergy, geothermal and hydro generation projects, there have been very limited bids for these technologies and no major projects commissioned in recent years. The government and the ERO should continue to consult with representatives from these industries to better understand how the auction system could be adjusted to support bioenergy, geothermal and hydro generation.

Poland has a small capacity of energy storage that consists mainly of pumped hydro (with a capacity of 1.7 GW and 7.6 GWh in 2020). There is limited deployment of battery storage in Poland, with total battery storage capacity of around 15.4 MW and 35 MWh in 2021. Energy storage can play a critical role in supporting the secure integration of variable renewable generation, while providing additional benefits to increase overall system flexibility. The government has set targets for 1.0 GW of energy storage (excluding pumped storage) by 2040 and made significant changes to the Energy Law to support the deployment of storage. The government should build on these efforts and develop a comprehensive energy storage strategy that includes a clear assessment of the role energy storage can play in the electricity system and markets (especially in relation to integrating renewables) and identifies key barriers and solutions to address these.

The government should update national strategic documents like the EPP40 and the NECP to take into account the new reality of the PV market, planned relaxation of onshore wind-siting rules and enhanced EU GHG emissions reduction targets. This would provide all market participants with long-term visibility on the government's plans and help to build a sustainable market, increase competition, drive down the costs and help grid operators efficiently integrate higher shares of renewables.

Renewables in heating and cooling

From 2010 to 2020, renewables in heating and cooling grew from 4.7 Mtoe to 8.5 Mtoe and from 12% to 22% of total heating and cooling demand; however, most of this increase comes from a new methodology to calculate biomass use for building heating. Poland's policy on heating is primarily focused on reducing the use of coal and improving air quality and energy efficiency, especially through expanded use of district heating. There is a strong focus on transitioning to natural gas, but the role for renewables is less clear. The government should develop a dedicated strategy for renewable heating and cooling based on a clear assessment of the potential for each technology (biomass, biogas, heat pumps, geothermal, solar thermal, etc.) and include strong sustainability criteria for bioenergy that clearly identify limits on feedstocks.

This strategy should cover renewable heating and cooling for both individual heating systems and district heating. A 2021 research project by the Krakow District Heating Company can serve as an example of incorporating renewable energy in large-scale district heating systems in Poland (Hałaj et al., 2021). The strategy and support programmes for renewable heating and cooling should be closely aligned or integrated with programmes for energy efficiency. This will allow renewable heating and cooling systems to be optimally sized, increasing efficiency and reducing costs. The government should develop an approach that supports deep renovations of a large number of buildings to create economies of scale that can further reduce heating demand and the costs of renewable heating and cooling.

Renewables in transport

From 2009 to 2020, the share of renewables in transport increased only slightly, from 5.4% to 6.6%, driven mainly by increased blending of biofuels. This is well below the target for 2020 (10%) and not in line with the growth needed to meet the 2030 target (14%), which will likely be increased under the updated RED.

Poland is also aiming to advance renewable energy in transport through the deployment of EVs in tandem with increased electricity generation from renewables. This pathway is challenged by Poland's high share of fossil fuel generation and the limited deployment of EVs and charging infrastructure. The government should ensure that the majority of electricity demand growth from EVs is covered by renewables. Additional work is also needed to ensure that deployment of charging infrastructure keeps pace with and helps to drive the desired level of EV adoption and is co-ordinated with renewables deployment.

The strong growth in residential PV systems presents a good opportunity for EV charging with minimal impact on the electricity grid. The government should consider updating the My Electricity programme to include support for installing residential charging infrastructure in tandem with PV systems. This would reduce overall costs and help to properly size PV systems to support EV charging. It is also critical to ensure access to charging infrastructure at workplaces and for people who do not have dedicated parking spaces for their vehicles.

The EPP2040 aims to increase the use of biomethane in transport (primarily public buses) to help meet the EU requirements for advanced biofuels. The government should develop an assessment of the sustainable biomethane potential with a clear understanding of the barriers that must be addressed to reach this potential. It should also examine whether biomethane could be used more effectively to support energy transition in other, harder to decarbonise, sectors. For example, Poland is already a leader in electric bus deployment, and biomethane could help decarbonise high-temperature industrial processes or serve as feedstock to replace natural gas.

Recommendations

The government of Poland should:

- Update 2030 renewable energy targets to reflect the rapid deployment of solar PV and anticipated growth of onshore wind, and to prepare for the higher level of ambition needed to meet upcoming EU goals; drive accelerated decarbonisation; and account for continuing cost reductions in wind, PV, energy storages and other key technologies.
- Ensure that electricity system development provides both additional capacity and increased flexibility to support the secure integration of renewables.
- Develop a strategy for accelerated deployment of energy storage to increase electricity system flexibility and support the integration of renewables generation.
- Develop a clear strategy to accelerate the deployment of renewable heating and cooling that covers both individual and district heating, considers all renewable technologies, and is aligned with energy efficiency policy and support programmes.
- Deploy renewable generation and charging infrastructure to maximise the potential for electric vehicles to increase the share of renewables in transport.
- Develop a strategy for the use of bioenergy across all energy sectors and support the development of a domestic industry for the production of sustainable feedstocks.

References

EC (European Commission) (2022), Shares, Energy from Renewable Source (database), <https://ec.europa.eu/eurostat/web/energy/data/shares> (accessed on 14 March 2022)

EC (2020), Assessment of the draft National Energy and Climate Plan of Poland, https://energy.ec.europa.eu/document/download/cdb5e342-e932-423d-90a0-abd05bacf333_en

EC (2019), Competition policy (web page), https://ec.europa.eu/competition/elojade/isef/case_details.cfm?proc_code=3_SA_37345

Hałaj, E. et al. (2021), Upgrading a district heating system by means of the integration of modular heat pumps, geothermal waters, and PVs for resilient and sustainable urban energy, *Energies*, Vol. 14/9, <https://doi.org/10.3390/en14092347>

IEA (International Energy Agency) (2022), World Energy Balances (database), <https://www.iea.org/data-and-statistics/data-product/world-energy-balances> (accessed on 18 February 2022)

6. Energy research, development and innovation

Key data (2020)

Public energy R&D expenditure: EUR 78.7 million

Public energy R&D share of GDP: 0.015% of GDP (IEA average: 0.04%)*

* 2020 data not available for Australia, Finland, Greece, Italy, Luxembourg, New Zealand, Spain or Turkey.

Overview

There are numerous documents that define Poland's approach to energy research and R&D. These documents generally concur and push for energy R&D that supports economic competitiveness, energy security and the decarbonisation of energy supply. There is no overarching strategy for energy R&D and no single entity with responsibility for it. Responsibility for designing and implementing research policy (including for energy) is mainly given to the Ministry of Science and Higher Education, while responsibility for designing and implementing policy for demonstration and development is spread across several sectoral ministries. The Ministry of Climate and Environment is responsible for setting innovation policy for the energy sector.

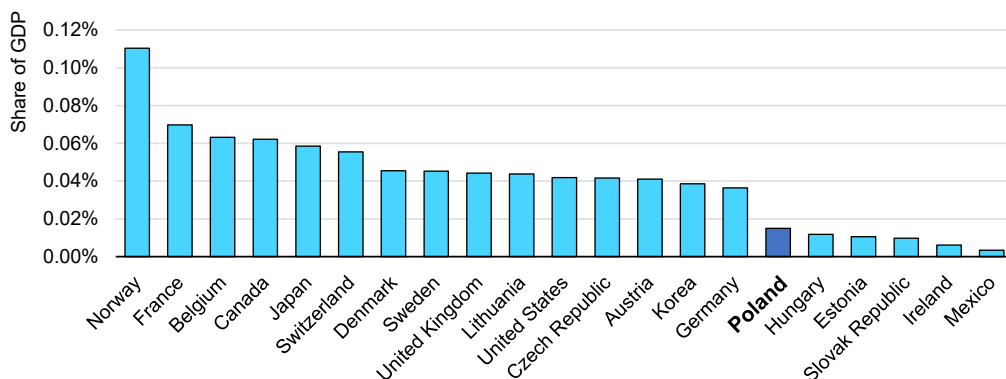
The EU Innovation Scoreboard provides an annual comparative assessment of the research and innovation performance of EU member states and the relative strengths and weaknesses of their research and innovation systems. The 2021 scorecard notes that Poland's strengths are in digitalisation, intellectual assets and the use of information technologies. Poland's performance on innovation has steadily increased every year since 2014. In 2021, performance improved for only eight EU member states, with the highest rate of performance increase for Poland (20%) driven by strong improvements in product and business process innovators, broadband penetration, employment in innovative enterprises, and public R&D expenditures.

Despite sustained improvements, Poland still ranks in the scorecard's lowest group (emerging innovators), indicating performance on innovation below 70% of the EU average. However, Poland outperformed two strong innovators and six moderate innovators in relation to intellectual assets as a result of a relatively large number of trademarks and design applications (EC, 2021a).

Despite significant recent increases in public R&D budgets, Poland still spends relatively little to support energy R&D. In 2020, it spent 0.015% of its GDP on energy-related R&D, the seventh-lowest share of GDP for energy-related R&D among IEA member countries and notably lower the IEA average of 0.04% of GDP (Figure 6.1). A significant part of

Poland's public R&D funding (including for energy-related R&D) comes from various EU funding mechanisms. For example, EU funds cover most of the R&D spending of the National Centre for Research and Development (NCBR), one of the key sources for R&D funding in Poland. EU funds covered 75% of NCBR spending in 2019, 79% in 2020 and 78% in 2021. Poland's NECP sets a 2030 target for overall R&D spending to reach 2.5% of GDP. In 2019, Poland spent 1.3% of GDP on overall R&D. The EU has a 2030 target for overall R&D spending to reach 3% of EU-wide GDP by 2030. In 2018, the EU spent 2.2% of GDP on overall R&D. Neither Poland nor the EU have a specific target for energy R&D spending.

Figure 6.1 Public spending on energy R&D per GDP in IEA countries, 2020



IEA. All rights reserved.

Note: 2020 data not available for Australia, Finland, Greece, Italy, Luxembourg, New Zealand, Spain or Turkey.

Source: IEA (2022).

R&D institutions

Numerous ministries and government entities are involved in setting and implementing Poland's energy R&D policy. There is no single entity with responsibility for energy R&D. The Ministry of Science and Higher Education has the main responsibility over energy-related research. The Ministry of Climate and Environment is in charge of innovation policy for the energy sector and for most programmes funding energy-related demonstration and development projects.

The Ministry of Economic Development and Technology is responsible for setting Poland's overall innovation policy. The Ministry of Science and Higher Education defines and implements Poland's policy for science and technology research and manages the budget that is the prime source of public funding for research. It is also responsible for financing basic and applied research projects, experimental development, and research infrastructure. It also deals with international co-operation and facilitates technology transfer.

In their respective areas of expertise, sectoral ministries (Climate and Environment, Economy, Transport, Agriculture, Health) are responsible for supporting development and demonstration projects as well as for the deployment of new technologies. Sectoral ministries also fund small-scale research programmes and projects. The Ministry of Development Funds and Regional Policy plays a key role managing Poland's EU funding (including for R&D) and co-ordinating with the various agencies implementing Poland's R&D support programmes.

Poland's Innovation Council was established in 2016 to co-ordinate activities related to increasing innovation in Poland and to define the overall goals of government innovation support programmes. It is chaired by the Minister of Economic Development and includes representatives from the Ministries of Science and Higher Education, Culture and National Heritage, Development Funds and Regional Policy, Finance, Digital Affairs, Health, National Education, Agriculture and Rural Development, and a representative of the Chancellery of the Prime Minister. The council does not include representatives from academia or the private sector.

The National Fund for Environmental Protection and Water Management manages a significant share of Poland's EU funding (including for R&D) and is also responsible for allocating a notable share of national funding for the deployment of R&D projects. It is a public financial institution that co-finances projects that are aligned with the government's environmental and climate policy. The fund implements R&D deployment programmes covering numerous areas, including renewable energy, heating, hydrogen, smart grids and digitalisation.

The NCBR, an executive agency in the Ministry of Science and Higher Education, is one of the main government entities implementing support programmes for applied and industrial R&D. It uses both bottom-up and top-down funding schemes, including strategic R&D programmes defined by the Minister of Science and Higher Education. The NCBR is the government focal point for the main EU innovation funding programmes (Horizon 2020 and Horizon Europe) and one of the main co-ordinators for international R&D co-operation.

The National Centre for Science (supervised by the Ministry of Science and Higher Education) is responsible for managing and funding basic research projects in a variety of sectors, mainly through a bottom-up approach based on calls for proposals. The Polish Agency for Enterprise Development is responsible for programmes that support entrepreneurship and private sector innovation, including public-private partnerships.

The Institute of Power Engineering is one of Poland's largest public research institutes in the field of energy technologies. It is supervised by the Ministry of Climate and Environment and conducts research covering numerous energy topics, including fuel cells, renewable energy and low-emission technologies for coal. Public R&D on energy is also carried out by other national research institutes (including nuclear research by the Institute of Nuclear Chemistry and Technology and the National Centre for Nuclear Research) and by Poland's numerous universities.

Other key research stakeholders in Poland include the Medical Research Agency supervised by the Minister of Health, the first and only sector-focused research funding agency in Poland; about 100 national research institutes supervised by respective ministries, including the Łukasiewicz Network of 32 applied research institutes; the autonomous Polish Academy of Sciences with a network of 69 research institutes; and the Foundation for Polish Science.

Energy R&D policy

Numerous documents and strategies define Poland's approach to energy R&D, including the National Research Programme, the Directions of Energy Innovation Development (DEID), the National Smart Specialisation Strategy, the Research Agenda of the Ministry of Climate and Environment, the EPP2040, the NECP, and the Hydrogen Strategy. The National Research Programme from 2011 defines seven priority research areas, including a priority for new energy technologies and several others related to energy research. A National Science Policy (currently being developed) will replace the National Research Programme and define new national priority research areas. Priorities concerning clean energy and climate issues will be reinforced. The EPP2040 serves as a basis for which areas of energy R&D will be reinforced (see Chapter 2).

In 2017, the Ministry of Climate and Environment published the DEID, which aims to harmonise the numerous strategic documents covering energy innovation policy. The DEID describes the ministry's plans for energy innovation to support energy security and the competitiveness of the Polish energy sector, including technologies, processes, sources and mode of financing, and implementation. The DEID used an analysis of Poland's energy sector and resources and global technology trends to identify four key areas of energy innovation: 1) integrated and interconnected energy systems giving the energy user a central role; 2) effective and flexible energy generation and raw material acquisition, combining the reduction of environmental impact with energy security; 3) diversification of production technologies and effective use of energy; and 4) ecological and energy-efficient cities. The ministry uses the DEID as a basis for dialogue with energy sector entities for increasing their involvement in energy innovation projects (Poland, Ministry of Climate and Environment, 2022a).

The Ministry of Climate and Environment's Research Agenda (currently under development) presents 41 research areas to support the development of technologies and services the government sees as necessary to achieve the energy transition defined in the EPP2040, the Hydrogen Strategy, and other key energy and climate policy documents. The Ministry of Climate and Environment has created an online platform (Innovations in Energy) for the public to submit proposals for energy innovation policy and projects. Inputs from the public are examined by specialists from the Department of Innovation and Technology Development (Poland, Ministry of Climate and Environment, 2022b).

Poland's National Smart Specialisation Strategy defines 15 specialisations (NSS) as priorities for innovation with the greatest potential to increase economic competitiveness, improve quality of life and protect the environment. Several NSSs are relevant for energy R&D, including NSS 4 (high-efficiency, low-emission and integrated energy generation, storage, transmission and distribution systems), NSS 5 (smart and energy-efficient construction) and NSS 6 (environmentally friendly transport solutions). The NSS strategy is managed by the Polish Agency for Enterprise Development and is used to decide how funding from certain EU mechanisms is directed to innovation projects. From 2014 to 2020, around EUR 8.31 billion in EU funding was directed to NSS innovation projects from the EU Smart Growth Operational Programme (KIS, 2021).

In November 2021, Poland adopted the Polish Hydrogen Strategy until 2030 with a perspective until 2040 (see Chapter 2). The Polish Hydrogen Strategy is a strategic document that details plans, funding, and legal and regulatory changes to support the production, storage, transport and use of low-carbon hydrogen to help to achieve Poland's

energy and climate goals and maintain the competitiveness of the Polish economy. The strategy focuses on developing innovative hydrogen technologies focused on hard-to-decarbonise sectors and end uses. The government intends for the strategy to serve as a guiding document for hydrogen R&D priorities. The government is committed to developing EU Important Projects of Common European Interest for hydrogen in Poland. The Ministry of Climate and Environment, in collaboration with the Ministry of Development, Labour and Technology, co-ordinates Poland's applications for the EU Important Projects of Common European Interest and has selected nine projects related to hydrogen to seek EU funding.

Poland ended its support for R&D related to CCUS in 2017. In addition, Poland's legal framework for geological CO₂ storage only allows for demonstration projects, while industrial-scale storage is banned. The government has indicated that it is considering revising this policy.

In response to the Covid-19 pandemic, the EU established the Recovery and Response Facility, which has EUR 672.5 billion in funding to support recovery and resilience plans developed by each EU member state. Poland submitted its Recovery and Resilience Plan to the EC in May 2021 requesting EUR 36 billion in funding (EUR 23.9 billion in grants and EUR 12.1 billion in loans), one of the largest funding requests to the Recovery and Response Facility. EC approval of Poland's plan has been significantly delayed due to political issues.

According to the 2018 Law on Higher Education and Science, comprehensive evaluation of the quality of R&D activities is conducted at least once every four years by teams of experts. The last evaluation was conducted in 2021. The evaluations identify R&D entities with a high level of performance and steps to improve overall R&D performance. The evaluations are also used to determine which research entities should receive additional financing to improve the quality of R&D in Poland and the ability of Polish R&D entities to compete at an EU and international level.

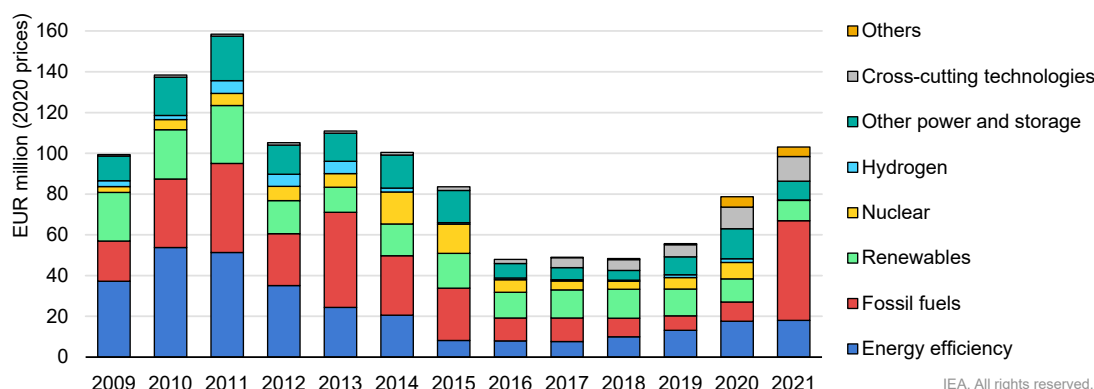
Energy R&D programmes

Poland has a wide range of programmes to promote energy R&D. The majority of them are resource-push programmes that directly fund specific types of R&D. Poland also has a small number of market-pull programmes to support the commercialisation of R&D results. In total, Poland's budget for public energy R&D peaked at EUR 158 million in 2011 and decreased significantly through 2016, with most of this reduction due to lower budgets for R&D on energy efficiency and coal (Figure 6.2). Public spending on energy R&D remained relatively flat through 2019, but notably increased in 2020 and 2021. In 2021, almost half (47%) of the public budget on energy R&D went to fossil fuels (mostly for coal), followed by energy efficiency (17%), cross-cutting technologies (12%), renewables (10%), other power and storage technologies (9%), and 5% not allocated.

The EU research and innovation funding programme is the main mechanism funding innovation in the EU and is an important source of energy R&D funding in Poland. The programme is updated every seven years. Horizon 2020, the programme for 2014-20, provided a total of EUR 80 billion for R&D through a competitive process open to all EU public and private R&D entities and aimed to increase public-private partnerships and international co-operation. Horizon 2020 provided a total of EUR 743 million of funding for R&D in Poland, with over EUR 178 million going to energy- and climate-related R&D,

including EUR 50 million for advanced manufacturing and processing; EUR 47 million for secure, clean and efficient energy; EUR 41 million for smart, green and intelligent transport; and EUR 40 million for climate action, environment, resource efficiency and raw materials (EC, 2022).

Figure 6.2 Public budget on energy R&D by sector in Poland, 2009-2021



Source: IEA (2022).

Horizon Europe, the EU research and innovation framework programme for 2021-27, was launched in February 2021. It aims to provide EUR 95.5 billion in R&D funding for projects across the EU, will continue to support energy-related R&D, and sets goals to increase international R&D co-operation (EC, 2021b). The NCB, through its Office of International Cooperation and its National Contact Point for Horizon Europe, provides a wide range of services to help Polish organisations attract Horizon Europe funding. These include trainings, study visits, information campaigns and matchmaking with Horizon Europe national contact points in other EU member states. The NCB, as funding institution, is also taking part in European partnerships such as Clean Energy Transition or Driving Urban Transition which, together with national funding, will provide funding for new energy R&D programmes in the coming years. Such activities were also conducted under Horizon 2020 through ERA-NETs and continue to provide funds to new R&D programmes.

The EU Smart Growth Operational Programme is another major source of EU funding for R&D in Poland. It provides co-financing to entrepreneurs and scientists to support R&D projects aimed at commercialising technologies, products and services. From 2014 to 2020, the programme provided around EUR 8.31 billion for innovation projects in Poland (KIS, 2021). Poland also receives support for R&D from the European Environment Agency and Norway Grants programme (supported by Norway, Iceland and Liechtenstein), which has provided around EUR 150 million in funding for R&D since 2012.

The New Energy Programme has a budget of approximately EUR 550 million for 2021-26 to support innovative green energy projects in several areas, including energy clusters, smart cities, hydrogen technologies, multi-fuel energy storage systems and zero-emission energy production. The programme is run by the National Fund for Environmental Protection and Water Management and uses a competitive tender process to award funding. The first tender was announced in July 2021 with a budget of around EUR 84 million with agreements on funding expected to be signed in 2022 (National Fund for Environmental Protection and Water Management, n.d.). A second tender is planned for 2022 with a budget of EUR 0.45 billion. Other similar programmes are in the design stage, including a Hydrogen Programme and a New Heat/Energy Programme.

The New Technologies in the Field of Energy is a funding programme run by the NCBR to help achieve climate neutrality in Poland by developing solutions that increase energy security and the competitiveness of the Polish economy. Its main objectives are: increase the potential of the renewable energy industry, including prosumers; develop intelligent energy network infrastructure; and lower the emissions intensity of the energy sector by increasing the use of biodegradable raw materials and waste products. The programme has a budget of EUR 176 million to support projects with a technology readiness level of 8-9 related to solar energy, onshore and offshore wind energy, the production and use of hydrogen, energy storage, energy and heat microgrids, waste to energy, and geothermal energy.

Poland has notable programmes that fund fossil fuel R&D. The Bloki+ 200 programme provides EUR 38 million in funding to support research to develop solutions for the modernisation, reconstruction or operating rules for Poland's fleet of coal-fired power plants with capacities around 200 MW. The aim is to develop technical, organisational and legal solutions that support least-cost solutions to allow these coal plants to operate with greater load variability and a large number of shutdowns and start-ups, so that they can be operated in an efficient manner in a system with growing shares of variable renewables (NCBR, 2022).

The INNKARP is a EUR 4.4 million project that supports the development of new sources of crude oil in Poland through more effective seismic imaging in the Outer Carpathian Mountain range (INIG, 2022). The DD-MET project aims to demonstrate application of long reach underground directional boreholes drilled above mined coal seams for methane drainage in longwall mining of coal (DD-MET, 2019). The Subsurface Evaluation of CCS and Unconventional Risks (SECURE) is a Horizon 2020 project to develop best practices for unconventional hydrocarbon production and geological CO₂ storage in Poland and several other countries (Secure, 2020).

Poland also has funding programmes for nuclear energy R&D. The Gospostrateg programme was launched in 2017 with EUR 4 million in funding to support research on high-temperature gas-cooled reactors. In 2019, the Ministry of Education and Science and the National Centre for Nuclear Research signed an agreement for the next round of high-temperature gas-cooled reactor design work. The government aims for high-temperature reactors to provide an emission-free source of high-temperature heat (and electricity generation) for industrial processes (WNN, 2021).

The NCBR Grand Challenge Energy programme, announced in 2019 with a budget of EUR 250 000, aims to support the development of small-scale systems combining wind generation and energy storage (Science in Poland, 2019).

Poland's Innovation Incubator 4.0 programme, established in 2020, provides financial support to innovation incubators set up by public R&D entities. The programme supports the commercialisation of R&D results and co-operation of the scientific community with the private sector (Science in Poland, 2019). The Green Technology Accelerator is an innovation programme run by the Ministry of Climate and Environment designed to drive domestic and international commercialisation of advanced green technologies developed by Polish entrepreneurs. Its main purpose is to help Polish small and medium-sized enterprises to enter into international contacts and to provide them with the necessary tools to enable their dynamic development.

Poland's Innovation Sapper Procurement Strategy supports innovative projects that address key energy security and energy transition challenges through market pull. Through "Innovation Sapper", the NCBR has launched several projects to support Poland's energy transition in line with EU climate and energy goals, in particular for renewable heating and cooling. There are also projects to improve the performance of heating and cooling systems and others supporting the circular economy related to rainwater collection and wastewater treatment. Innovation Sapper projects are funded with a budget of EUR 46 million from the EU Smart Growth Operational Programme. The results of the projects must be delivered by the end of 2023.

The District Heating Plant of the Future project aims to develop innovative, affordable and easily repeatable solutions to replace domestic heating systems based on fossil fuels with district heating based on renewable energy. The project aims to demonstrate market feasibility by deploying a district heating plant powered by at least 80% renewables.

The Combined Heat and Power Plant in the Local Energy System project aims to develop innovative solutions to transform existing district heating systems based on fossil fuels into affordable systems combining co-generation based on renewable energy with energy storage to allow balancing local power systems. The project aims to demonstrate market feasibility by deploying a co-generation plant powered by at least 80% renewables.

The Innovative Biomethane Plant project aims to develop a highly efficient, odourless and self-sufficient biogas plant capable of using a wide range of agricultural waste substrates to produce high-quality biomethane (for injection into gas distribution networks or use for transportation) and post-fermented mass suitable for uses as an organic fertiliser. As a technology demonstrator, a full-scale biomethane treatment plant will be constructed.

The aim of the Process and Energy-Efficient Building Construction project is to develop innovative prefabricated and modular technologies for the construction of affordable and positive or zero-energy balance single-family and multifamily buildings. The project aims to reduce the low-carbon footprint of buildings through recycled materials and the use of rainwater for utility purposes. The direct result is three demonstration buildings: a single-family building, a multifamily building and a building for elderly people.

The Electric Power Storage project aims to develop recyclable, high energy density, long-life galvanic battery cells with production based as much as possible on domestic resources. It aims to deploy a demonstration battery and a demonstration electric power storage system. The Heat and Cold Storage project aims to develop high-efficiency storage systems that maximise the use of renewables for both heating and cooling for household and industrial applications.

Private sector innovation

Data on Poland's private sector innovation come from an Innovation Survey that is completed on line by enterprises (mainly private, but also public). The survey covers a range of topics, including the level of expenditure on innovation activities (including R&D). There are no specific questions on energy R&D. Poland has been conducting innovation surveys on an annual basis using the *Oslo Manual*, the international reference guide for collecting and using data on innovation (OECD/Eurostat, 2018). Starting in 2023, Poland

will carry out the Innovation Surveys every two years in alignment with the schedule for the Community Innovation Survey, the reference survey for innovation by enterprises in EU member states (EU, 2018).

Poland's most recent Innovation Survey covers 2018-20 and was carried out as part of the 2020 Community Innovation Survey. The results are based on responses from around 63 000 enterprises and estimate that in 2020, the Polish private sector spent around EUR 4.3 billion on innovation activities (including R&D) in the manufacturing sector, EUR 3.7 billion in the service sector and EUR 194 million in transport. The main private energy-related innovation investments occurred in manufacturing of basic metals (EUR 1.2 billion); manufacturing of automobiles (EUR 994 million); coke, chemical and petrochemicals (EUR 682 million); and mining and quarrying (EUR 128 million) (Statistics Poland, 2021).

Knowledge sharing

The Ministry of Climate and Environment is involved in a number of international initiatives supporting energy innovation, including the European Clean Hydrogen Alliance and the Accelerator Research and Innovation for European Science and Society. Poland participates in only one of the 38 IEA technology collaboration programmes. Poland became a member of the Clean Energy Ministerial in 2021 and supports its initiatives for nuclear innovation and electric vehicles.

The NCBR has developed international co-operation with partners from various countries and regions, including: the People's Republic of China (hereafter, "China"), Iceland, Israel, Liechtenstein, Norway, Singapore, South Africa, Turkey and the United States. In May 2021, the Polish and Japanese governments signed the Action Plan for the Implementation of their Strategic Partnership for 2021-25, with strengthened co-operation in the energy sector, focusing on e-mobility, clean transport based on electricity and hydrogen, and sharing information on developing national hydrogen strategies.

The National Agency for Academic Exchange (supervised by the Minister of Science and Higher Education) supports international co-operation by Polish higher education entities, including international mobility of Polish and foreign students and researchers.

Assessment

Numerous documents define Poland's approach to energy R&D. These documents generally concur, pushing for energy R&D that supports economic competitiveness, energy security and the decarbonisation of energy supply. However, there is notable overlap between the documents and there is no overarching strategy for energy R&D and no single entity with responsibility over energy R&D.

The government should define one overarching strategy for energy R&D, the implementation of which should be supervised by an extra-ministerial co-ordination body comprising ministries, government agencies, academia and industry. All energy-related R&D programmes should be coherently integrated into and supportive of the main strategy. This strategy could include targets for increasing the share of overall R&D funding directed to energy R&D. This strategy also needs to address co-ordination on managing

the large volume of funding available from the EU. This includes greater efforts to inform researchers about upcoming calls and programmes, support their applications, but also working to clearly align EU-funded research with Poland's energy and climate goals.

It is critical that the results Poland's R&D programmes are monitored, evaluated and updated as needed to ensure they are driving cost-effective research in line with Poland's climate and energy goals.

Besides compulsory co-operation through EU programmes, international research collaboration is rather limited. Poland only participates in one IEA technology collaboration programme, although many others would be highly relevant and helpful to Poland's energy system transformation. The IEA recommends that Poland expand its international collaboration on R&D.

Poland significantly expanded R&D spending in 2020 and 2021. Despite these increases, Poland still spends relatively little on energy R&D. In addition, fossil fuels (notably coal) received the largest share of Poland's limited R&D budget in 2021. While most of Poland's fossil fuel R&D aims to reduce emissions, it also includes projects focused on expanding the production and use of fossil fuels. The IEA recommends that Poland further increase R&D funding, but with a focus on innovation that supports clean energy transition and is aligned with Poland's R&D capacities. Given Poland's continued large share of coal-fired generation, additional R&D on CCUS is warranted. Poland's energy policy gives nuclear energy an important role in meeting climate goals, and as such, additional R&D on nuclear energy is warranted, especially in relation to reducing costs.

Most of Poland's R&D funding programmes, notably those implemented by the NCBR, are aimed at demonstration and deployment of mature technologies with technology readiness levels greater than 7. Only very limited funding is available for R&D with lower technology readiness levels. Highly innovative lower technology readiness level R&D is needed to address many of Poland's difficult decarbonisation challenges. The government should implement a transparent, open and accessible funding scheme for energy R&D across the full range of technology readiness levels. Highly innovative, yet risky projects relevant for Poland's energy transition should be eligible for funding. In addition, more work is needed to ensure technology transfer and the commercialisation of academic research and to support small companies and start-ups in the energy sector.

Poland could benefit from innovation clusters that support collaboration, networking and knowledge sharing between academia, industry, civil society and the public sector. Clusters focused on the key challenges that Poland faces in relation to clean energy transition and energy security would allow a more coherent discussion on how limited R&D resources could be best directed, and create opportunities for shared projects leveraging economies of scale. Such clusters should include partners from across the innovation value chain to help promising ideas lead to new technologies, products and services targeting the needs of Poland's energy system. Poland's Green Technology Accelerator programme can serve as a model for additional innovation clusters.

Recommendations

The government of Poland should:

- Define one overarching energy R&D strategy that distributes R&D funds in line with energy and climate goals, and which is implemented and supervised by an extra-ministerial body with stakeholders from ministries, government agencies, academia and industry.
- Implement a transparent, open and accessible funding scheme for energy research at a variety of technology readiness levels. Highly innovative, yet risky projects relevant for Poland's energy transition should be eligible for funding.
- Introduce a programme that supports research and innovation in industry with a focus on technology transfer and the commercialisation of academic research, supporting small companies and start-ups in the energy sector.
- Support projects at the crossroads of technology and social science that foster public-private-people partnerships, to accelerate the energy transition via public acceptance of new technologies, concepts and models.

References

- DD-MET (2019), Advanced methane drainage strategy-technology employing underground directional drilling technology for major risk prevention and greenhouse gases emission mitigation (web page), <https://dd-met.inig.pl>
- EC (European Commission) (2022), H2020 country profile – Poland (web page), <https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726/sheet/0c8af38b-b73c-4da2-ba41-73ea34ab7ac4/state/analysis/select/Country/Poland>
- EC (2021a), European Innovation Scoreboard 2021, <https://ec.europa.eu/docsroom/documents/46013>
- EC (2021b), Horizon Europe (web page), https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en
- EC (2018), Community Innovation Survey (database), <https://ec.europa.eu/eurostat/web/microdata/community-innovation-survey> (accessed on 15 March 2022)
- IEA (International Energy Agency) (2022), Energy technology RD&D budgets (web page), <https://www.iea.org/data-and-statistics/data-product/energy-technology-rd-and-d-budget-database-2>
- INIG (Oil and Gas Institute) (2022), Development of an innovative concept for the search for hydrocarbon deposits in the deep structures of the outer carpathians (web page), <https://www.inig.pl/projekty/13-projekty/924-opracowanie-innowacyjnej-koncepcji-poszukiwania-zloz-weglowodorow-w-glebokich-strukturach-karpat-zewnetrznyc2h>
- KIS (Krajowa Inteligentna Specjalizacja) (2021), Krajowa inteligentna specjalizacja [National smart specialization] (web page), <https://smart.gov.pl/en>
- National Fund for Environmental Protection and Water Management (n.d.), New energy (web page), <https://www.gov.pl/web/nfosiow/nowa-energia>
- NCBR (2022), Bloki 200+ programme (web page), <https://www.gov.pl/web/ncbr/program-bloki-200>
- OECD/Eurostat (Organisation for Economic Co-operation and Development) (2018), Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities, <https://doi.org/10.1787/9789264304604-en>
- Poland, Ministry of Climate and Environment (2022a), Directions of Development of Energy Innovations (web page), <https://www.gov.pl/web/klimat/kierunki-rozwoju-innowacji-energetycznych>
- Poland, Ministry of Climate and Environment (2022b), Innovations for energy – applications (web page), <https://www.gov.pl/web/klimat/innowacje-dla-energii-zgloszenia>
- Science in Poland (2019), Grand challenge energy: PLN 1 million for compact wind power installation creator, <https://scienceinpoland.pap.pl/en/news/news%2C79785%2Cgrand-challenge-energy-pln-1-million-compact-wind-power-installation-creator.html>
- Secure (2020), Subsurface evaluation of CCS and unconventional risks (web page), <https://www.securegeoenergy.eu>

Statistics Poland (2021), Innovation activities of enterprises in the years 2018-2020, <https://stat.gov.pl/en/topics/science-and-technology/science-and-technology/innovation-activities-of-enterprises-in-the-years-2018-2020,3,6.html>

WNN (World Nuclear News) (2021), Poland plans next stage of HTR development (web page), <https://world-nuclear-news.org/Articles/Poland-plans-next-stage-of-HTGR-development>

7. Electricity

Key data (2020)

Electricity generation: 157 TWh (coal 68.5%, natural gas 10.7%, wind 10.1%, hydro 1.3%, solar PV 1.3%, oil 1.2%), +0.02% since 2010

Electricity net imports: 13.3 TWh (imports 20.6 TWh, exports 7.4 TWh)

Installed capacity: 51.8 GW, +25% since 2016

Electricity consumption: 148.2 TWh (industry 45%, services sector 32%, residential sector 20%, transport 2%), +14.5% since 2010

Overview

Poland has seen higher electricity demand across all sectors in line with its growing economy and increasing electrification of demand. Electricity demand increased by 24% between 2009 and 2019, then dropped by 2.5% in 2020 as a result of the Covid-19 pandemic. Electricity demand rebounded by 13.6% in 2021. Poland's electricity supply is dominated by domestic coal-fired generation and the country has continued to invest in new coal plants, adding 4.3 GW of new coal-fired capacity from 2016 to 2020. Poland had the second-highest carbon intensity of electricity supply among IEA member countries in 2020, after Australia. Coal-fired generation has been declining (falling from 88.1% to 68.5% of total generation between 2010 and 2020) in the face of increasing ETS prices, competition from low-cost renewables, electricity imports and natural gas. However, the share of coal in total generation bounced back to 79.7% in 2021.

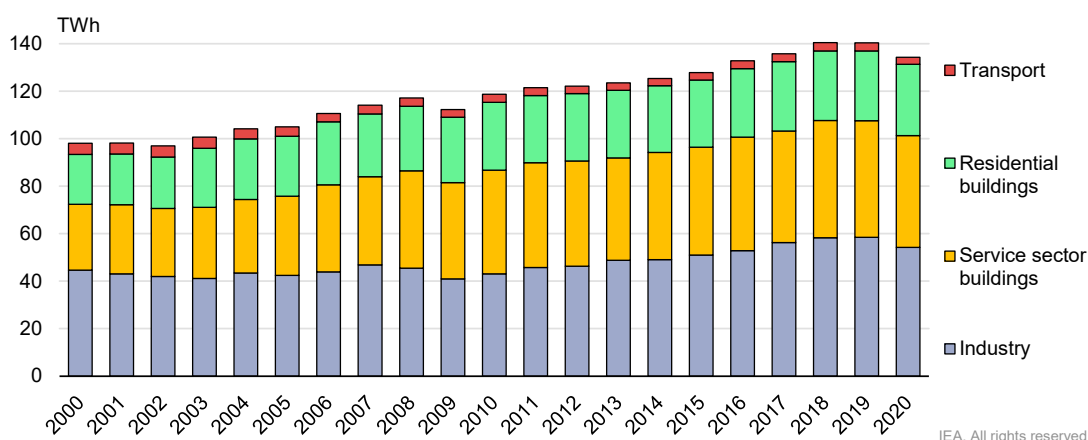
Poland's energy policy aims to decarbonise electricity generation while maintaining electricity security. There is a focus on reducing coal-fired generation by expanding renewable and gas-fired generation and introducing nuclear generation. There is also a push for distributed generation, especially solar PV, an active role for consumers in electricity markets and increased electrification of demand, especially for road transport.

Electricity demand, generation and trade

From 2010 to 2019, Poland's electricity demand increased from 129 TWh to 152 TWh, driven by higher demand in all sectors, with the largest demand increase coming from industry (+16.3 TWh), followed by service sector buildings, (+5.4 TWh), residential buildings (+0.8 TWh) and transport (+0.1 TWh, almost all from rail) (Figure 7.1). In 2020, the Covid-19 pandemic caused one of the largest drops ever in Poland's electricity

demand, which fell by 3.8 TWh to 148 TWh. Demand fell in most sectors, the largest of which was from industry (-3.0 TWh), followed by service sector buildings (-1.1 TWh) and transport (-0.2 TWh). Demand in residential buildings increased slightly (+0.6 TWh), likely driven by the impacts of the pandemic (increased teleworking, closure of public spaces, etc.). Poland has seen a slight increase in electrification of energy demand. From 2009 to 2019, the share of electricity in TFC increased from 14.8% to 16.2%, versus an IEA average of 21.7%. The share of electricity in TFC increased for buildings (from 21% to 26%, compared to the IEA average of 38%) and industry (from 17% to 20% against the IEA average of 35%), but fell for transport (from 1.7% to 1.3%, versus the IEA average of 1.5%).

Figure 7.1 Electricity demand by sector in Poland, 2000-2020

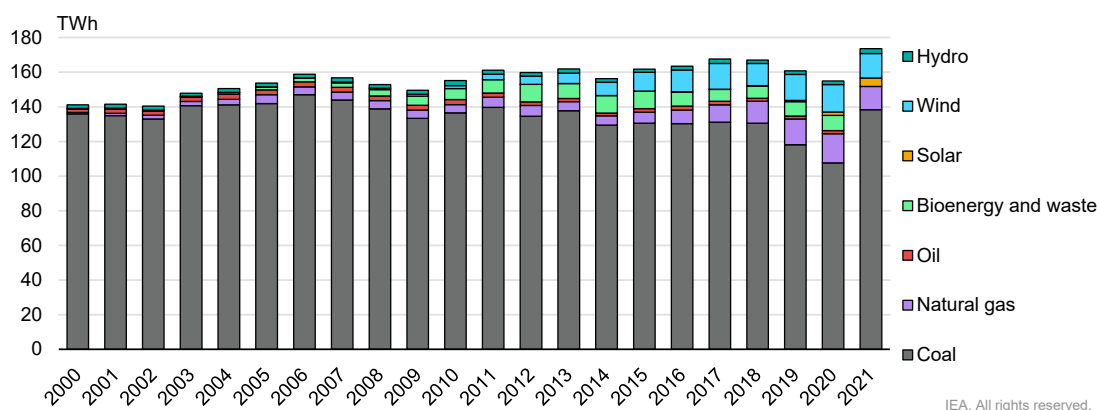


Source: IEA (2022).

From 2010 to 2020, Poland's peak electricity load fluctuated from a low of 28.0 GW in 2016 to a high of 31.7 GW in 2018. The main factors driving the fluctuations in peak load were annual variations in heating demand correlated to temperature and industrial demand linked to economic activity. Peak load was 29.4 GW in 2019, but dropped to 28.9 GW in 2020 as a result of the Covid-19 pandemic. Poland's peak load is significantly lower than its generation capacity (51.9 GW in 2020). Import capacity was 11.8 GW in 2020.

Most of Poland's electricity supply comes from domestic generation (mainly coal); however, since 2015, an increasing share of electricity supply has been covered by imports. Poland's electricity generation experienced an overall increase from 2010 to 2017, from 157 TWh to 170 TWh in line with increasing demand (Figure 7.2). Generation declined to 163 TWh in 2019, reflecting a strong increase in electricity imports. Generation dropped significantly to 157 TWh in 2020 because of the sharp drop in demand from the Covid-19 pandemic and a continued strong increase in electricity imports.

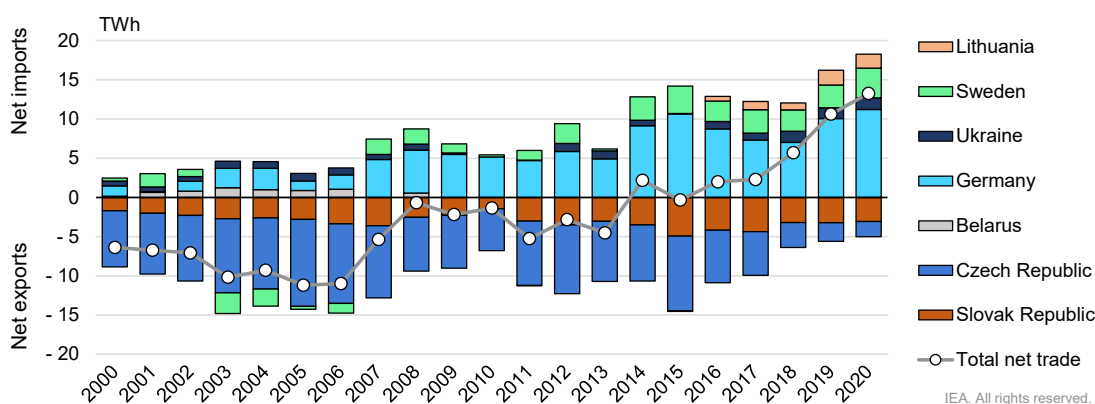
Data from S&P Global Platts show a strong rebound in electricity generation in 2021, reaching a record high of 173.6 TWh, with a major year-on-year increase of generation from coal. The strong increase in generation was driven by growth of electricity demand (up 13.6% versus 2020) and a notable drop in electricity imports as increased electricity generation costs across Europe made domestic coal-fired generation more cost competitive.

Figure 7.2 Electricity generation by source in Poland, 2000-2021

Sources: IEA (2022); 2021 data from S&P Global Platts (2022).

Poland's electricity generation is still dominated by coal, but from 2010 to 2020 the share of coal in total generation declined from 86.9% to 68.5%. The reduction in coal-fired generation results from a notable increase in generation from renewables and natural gas and higher imports. However, coal-fired generation rebounded in 2021 to reach 79.7% of total generation (S&P Global Platts, 2022). From 2010 to 2020, renewables grew from 11 TWh to 28 TWh and 18% of total generation, with most of this growth coming from increased onshore wind generation (1.7 TWh to 15.8 TWh), followed by bioenergy and waste (6.3 TWh to 8.8 TWh). Generation from solar PV is still small, but from 2018 to 2020, solar PV generation increased from 0.3 TWh to 2.0 TWh. From 2010 to 2020, gas-fired generation increased from 4.8 TWh to 16.8 TWh and 10.7% of generation.

Poland has traditionally been a net exporter of electricity; however, electricity imports have been increasing and in 2014 Poland was a net electricity importer for the first time (Figure 7.3). Net electricity imports increased notably in 2019 and 2020, as sharp increases in the price for allowances from the EU ETS increased the cost of Poland's coal-fired generation. In 2020, net electricity imports reached a historic high of 13.3 TWh.

Figure 7.3 Poland's electricity imports and exports, 2000-2020

Source: IEA (2022).

Infrastructure

Poland's electricity infrastructure consists of a large generation fleet, an extensive transmission and distribution network, and interconnections that integrate Poland into the European electricity system (Figure 7.4). Ownership and operation of Poland's electricity infrastructure (generation, transmission and distribution) is highly concentrated with a few companies that are owned or controlled by the State Treasury. The ERO is responsible for overseeing electricity infrastructure operations, including issuing licences to generators and concessions to system operators, and approving grid tariffs. It also advises the government on the TSO's and the five largest DSOs' development plans.

Figure 7.4 Poland's electricity transmission system, 2020



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Poland is planning large investments in electricity infrastructure, including up to 6 GW of new gas-fired generation, up to 16 GW of new renewables generation (mainly wind and solar PV), and a major expansion of the transmission and distribution systems to integrate new generation and support higher electrification of demand. The TSO's and the five largest DSOs' most recent development plans (approved in June 2020) include a total of around EUR 11 billion in investments through 2025. The EPP2040 estimates that investments in the electricity network will total EUR 21 billion from 2021 to 2030 and EUR 19 billion from 2031 to 2040. Investments in new generation capacity are estimated at EUR 24 billion to EUR 36 billion through 2030 and EUR 71 billion to EUR 76 billion through 2040.

Installed generation capacity

From 2016 to 2020, Poland's installed generation capacity increased by 10.5 GW to reach 51.8 GW (Table 7.1). Most of this growth came from increased capacity of coal (+4.1 GW) and solar PV (+3.8 GW), along with smaller additions of gas (+1.9 GW) and wind (+0.6 GW). Most growth in PV came from small-scale distributed PV systems, which accounted for around 75% of total PV capacity in 2020. Coal accounts for most of Poland's installed capacity (66% in 2020), followed by renewables (27%) and natural gas (6%). A significant share of Poland's installed capacity comes from co-generation plants that support Poland's extensive district heating network.

Table 7.1 Electricity generation capacity in Poland, 2016 and 2020

Capacity (GW)	2016	2020	Change	2020 share
Coal (total)	30.0	34.1	+4.1	66%
- Hard coal	20.7	24.8	+4.1	48%
- Lignite	9.3	9.3	–	18%
Natural gas	1.3	3.2	+1.9	6%
Wind	5.8	6.4	+0.6	12%
Solar PV	0.2	4.0	+3.8	8%
Hydro (total)	2.41	2.40	-0.01	5%
- Pumped storage	1.42	1.42	-	3%
Bioenergy	1.1	1.2	+0.1	2%
Other	0.5	0.5	–	1%
Total	41.3	51.8	+10.5	

Poland's Bełchatów lignite-fired power plant is the largest coal-fired plant in Europe (5.3 GW) and accounted for 5.5% of Poland's generation capacity and 20% of total electricity generation in 2020. In May 2021, construction was finished on a new 0.5 GW unit at the Turów lignite power plant; this is planned to be the last unabated new coal-fired unit in Poland. The EPP2040 estimates that coal-fired capacity could drop by around 10 GW by 2030; under these projections, coal would still be a key aspect of Poland's generation mix, with 25 GW of capacity (17.6 GW hard coal and 7.4 GW lignite).

However, Poland is expecting a notable shift in the mix of its generation capacity. The government has targets to deploy 5.9 GW of offshore wind by 2030 and 6-9 GW of nuclear from 2033 to 2043. Industry players have plans to build around 6 GW of new gas-fired capacity and around 4 GW of new onshore wind and 6 GW of new solar PV by 2030. Solar PV capacity has already exceeded the EPP2040's estimates, reaching an estimated 7.7 GW at the end of 2021.

Interconnections

Poland has six high-voltage alternating current (AC) interconnections that link it to the Czech Republic, Germany, the Slovak Republic and Ukraine, and two high-voltage direct current (DC) interconnections that link it to Lithuania and Sweden. In 2020, Poland's total interconnection capacity was 11.8 GW, with capacity projected to increase only slightly, to 12.5 GW, by 2025.

The only planned new interconnection is the 0.7 GW Harmony Link DC undersea cable to Lithuania. In June 2021, the TSOs of Poland and Lithuania reached a final investment decision and started initial work on the project, which has an estimated cost of EUR 700 million, around 72% of which is funded by the EU. The Harmony Link is part of an ongoing project to fully integrate the Baltic states (Estonia, Latvia and Lithuania) into the European electricity system. This project includes the conversion of the existing DC interconnection between Poland and Lithuania to an AC interconnection to allow synchronisation of the Baltic states' electricity systems with the Continental Europe synchronous area. This project is expected to be completed in 2025 (EC, 2021).

Under EU regulations, all member states need to achieve an interconnection target of 10% by 2020 and 15% by 2030 (the target is defined as a ratio of import capacity and generation capacity). Most EU member states did not meet the 2020 target (European Parliament, 2019). Poland achieved an interconnection level of just 4% in 2020 and Poland's NECP sets a target of just 8.7% by 2030. The EU has updated the methodology for the interconnection target and is looking at other factors to ensure adequate interconnection between EU member states (ENTSOE, 2016). The EU regulations require all TSOs to make a minimum of 70% of cross-border capacity available to market participants by the end of 2025. Poland's TSO is working to ensure that the 70% target will be achieved.

Transmission and distribution

In 2020, Poland's transmission and distribution system supplied around 131.5 TWh to over 18 million consumers (Table 7.2). The largest number of consumers (over 99%) are connected to the distribution grid; however, 19% of supplied electricity went to large consumers connected to the transmission system (220-750 kV).

Table 7.2 End-user connections and supplied electricity in Poland, 2020

	Voltage level			Total
	High (220-750 kV)	Medium 110 kV	Low 10-30 kV	
Total connections	567	42 115	18 142 218	18 184 900
New connections in 2020	27	1 226	248 454	249 707
Electricity supplied (TWh)	24.4	51.7	55.4	131.5

In 2020, the Polish electricity transmission network consisted of 15 316 km of lines (114 km at 750 kV, 7 822 km at 400 kV and 7 380 km at 220 kV) and 109 substations. Poland's TSO, PSE, is 100% owned by the State Treasury. From 2016 to 2020, PSE invested around EUR 1.5 billion to add 1 661 km of new lines (mainly 400 kV), refurbish 93 km of

lines and construct 22 new substations. The PSE Grid Development Plan includes new investments of about EUR 3 billion from 2021 to 2030, with plans to add 6 330 km of new lines (mainly 400 kV), refurbish 4 283 km of lines and construct 65 new substations.

In 2020, the Polish distribution network consisted of 848 225 km of lines (34 085 km at 110 kV, 319 694 km at 1-60 kV and 494 364 km of low-voltage lines) and around 271 305 substations. In 2020, there were 188 DSOs in Poland; however, the 5 main DSOs owned around of 97% of the distribution network and served about 99% of consumers. Four of these DSOs (PGE, TAURON, Enea and ENERGA) are controlled by the State Treasury and serve areas covering most of the country. Each of these four DSOs owns a (legally unbundled) energy supply company that accounts for most of the generation capacity and electricity sales in their respective service areas. The private German company E.ON is the DSO operating the network serving Warsaw and its immediate surroundings.

From 2016 to 2020, the five largest DSOs invested around EUR 6.8 billion in the distribution system to add 26 429 km of new lines and perform other system upgrades. The EPP2040 estimates that new investments by DSOs will total EUR 16 billion from 2021 to 2030, with a strong focus on increasing the reliability of distribution systems through the conversion of medium-voltage overhead lines into underground cables. These DSOs are also using EU funds to help integrate increasing solar PV generation, primarily via the construction of new high- to medium-voltage substations.

Market structure

Poland's electricity market is mostly liberalised; there is legal separation between commercial activities and network operations. The electricity network is open to any company wishing to supply electricity and consumers are free to choose their supplier, or to purchase electricity from a default supplier (the DSO in their region) with prices regulated by the ERO. The majority of household consumers (63% in 2020) purchase electricity through contracts with regulated prices. Prices for commercial consumers are not regulated. The ERO is responsible for monitoring market operations and ensuring compliance with market rules. Ownership of generation and wholesale and retail electricity sales are concentrated with four state-controlled energy companies (PGE, TAURON, Enea and PKN ORLEN).

PGE is the largest player in the Polish electricity market. In 2020, it owned the largest share of Poland's generation capacity (34%, 17.8 GW), accounted for the largest share of wholesale electricity supply (41%) and was the largest retail supplier by sales (29%). PGE also owns the second-largest DSO and a large share of Poland's coal mines.

TAURON is active in coal mining and electricity generation and sales. In 2020, it owned 9% of Poland's generation capacity (4.6 GW), accounted for 6% of wholesale electricity supply and was the second-largest retail supplier by sales (23%). TAURON also owns the largest DSO and controls approximately 29% of Polish hard coal resources.

Enea is active in coal mining, electricity generation and sales. In 2020, it owned 11% of Poland's generation capacity (6.3 GW), accounted for 16% of wholesale electricity supply and was the fourth-largest retail supplier by sales (15%). Enea also owns the fourth-largest DSO and controls approximately 29% of Polish hard coal resources.

PKN ORLEN is active in electricity generation and sales, both directly and through a 93.3% ownership of ENERGA, an electricity supplier and the third-largest DSO. In 2020, PKN ORLEN owned 6% of Poland's generation capacity (3.4GW), accounted for 9% of wholesale electricity supply and was the third-largest retail supplier by sales (20%).

Capacity market

Poland's electricity market functions mainly as an energy-only market where suppliers are paid for electricity delivered to consumers. In 2018, Poland introduced a capacity market to address resource adequacy concerns by encouraging the deployment of new generation, electricity storage and demand-side response (DSR), and retention of existing generation. The capacity market provides payments outside the energy market, based on guaranteed availability of capacity. Projects are selected for participation in the capacity market through competitive auctions designed to anticipate the capacity required to cover peak demand. Poland has received approval from the EC to hold auctions for the delivery of capacity from 2021 to 2030, with payments possible through 2047 (PSE, 2021a).

The first auctions took place in 2018 for delivery from 2021 to 2023 and awarded support of EUR 55 million per GW to 22.4 GW of capacity. Payments started in 2021, with the duration depending on several factors and the longest contracts lasting for 15 years. Around 79% of the capacity selected in the 2018 auctions went to coal-fired generation, mainly existing units (Forum Energii, 2019). The capacity payments are funded through a charge to all electricity consumers. The cost of capacity payments was EUR 1.1 billion in 2021 and is expected to be EUR 1.08 billion in 2022 (URE, 2021). The total cost of the capacity remuneration mechanism will depend on the prices and capacities awarded in future auctions.

Since 2021, units exceeding emissions of 550 g CO₂/kWh cannot participate in capacity auctions. This requires coal-fired units to have sufficient co-firing of biomass or to use carbon capture. In the 2021, over 1 GW of units co-firing coal and biomass won the support in the auction for capacity delivery in 2026. Additional auctions will be held through 2025, with auctions taking place five years prior and one year prior to the delivery year. With the introduction of the capacity market mechanism, Poland is working to end a number of existing mechanisms that provide payments to generation and DSR assets to address concerns around generation adequacy.

Wholesale market

Poland is part of a wholesale electricity market that links over 20 European countries. This market has been consistently expanded and more tightly integrated as part of the ongoing project to create a single European internal electricity market. The wholesale market manages day-ahead and intraday electricity trading between interconnected European bidding zones. Most bidding zones are correlated with national borders and Poland is a single bidding zone.

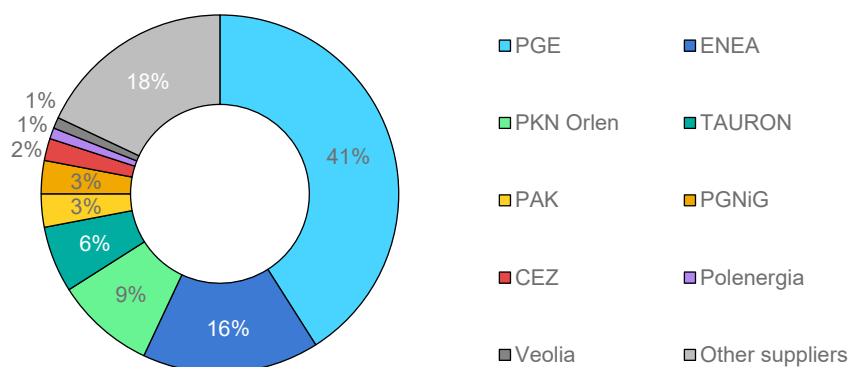
Poland has taken several recent actions to support increased wholesale market coupling with the rest of Europe. These include the launch of a single intraday coupling mechanism (November 2019), implementation of multi-NEMO arrangements for day-ahead market coupling (January 2021) and the launch of an interim day-ahead market coupling mechanism (June 2021). There are plans to move to flow-based market coupling in the CORE region (Austria, Belgium, Croatia, the Czech Republic, France, Germany, Hungary, Luxembourg, the Netherlands, Poland, Romania, the Slovak Republic and Slovenia) in 2022.

In 2020, around 63% of Poland's wholesale electricity supply was delivered through wholesale market trading, while 37% was delivered through bilateral contracts. Most wholesale supply comes from domestic generation, but since 2015, a growing share of

supply has come from electricity imports. In 2020, the four large incumbent electricity suppliers (PGE, Enea, PKN ORLEN and TAURON) owned over two-thirds of the domestic generation capacity and accounted for 72% of wholesale electricity supply (Figure 7.5).

In 2017, the market shares of PGE and Enea significantly increased when they purchased all EDF's and ENGIE's (two French energy companies that completely exited the Polish wholesale electricity market) Polish generation assets. These acquisitions caused the Herfindahl-Hirschmann Index (HHI) for Poland's wholesale market sales to jump from 1 640 in 2016 to 2 281 in 2017. The HHI has since declined to 2 020 in 2020 (driven mostly by the increased renewable generation sold by smaller market players), but still reflects a concentrated market.

Figure 7.5 Wholesale market share by supplier in Poland, 2020



IEA. All rights reserved.

Source: URE (2022).

Retail market

In 2020, there were 153 active suppliers in Poland's retail electricity market (based on a survey of the 38 largest DSOs). The retail market is dominated by four state-controlled energy suppliers (PGE, Enea, PKN ORLEN and TAURON), which are linked to the four largest DSOs (following EU rules on unbundling). In 2020, these four companies accounted for almost 90% of retail electricity supply and the HHI of Poland's retail electricity market was 2 315 for households and 2 164 for commercial consumers, indicating a moderate level of market concentration. The switching rate in 2020 was 0.64% for household consumers and 5.4% for commercial consumers. The household consumer switching rate is among the lowest in Europe and the commercial consumer switching rate is also well below the European average (ACER, 2020). System operators are obliged to allow electricity consumers to switch suppliers no later than 21 days from the day the relevant operator was informed about the conclusion of an agreement with a new supplier. There is no independent platform allowing consumers to compare offers from retail suppliers.

In 2020, there were just under 18 million retail electricity consumers in Poland, with the vast majority (99.4%) consuming less than 50 MWh per year (Table 7.3). Most household consumers (63% in 2020) received their electricity supply from the default supplier at a regulated price. Poland has a public service obligation that prevents disconnecting household consumers if the existing supplier stops providing electricity. These consumers

are transferred to a supplier of last resort, normally the default supplier. In 2020, just 0.1% household consumers (14 520 consumers) were served by a supplier of last resort.

Table 7.3 Retail electricity market consumers by annual demand in Poland, 2020

Consumer annual demand (MWh)	Number of consumers	Share of consumers	Demand (MWh)	Share of demand
> 2 000	6 073	0.03%	68 392 286	49%
50-2 000	110 803	0.62%	27 643 330	20%
< 50	17 817 588	99.40%	43 682 613	31%
Total	17 934 464		139 718 229	

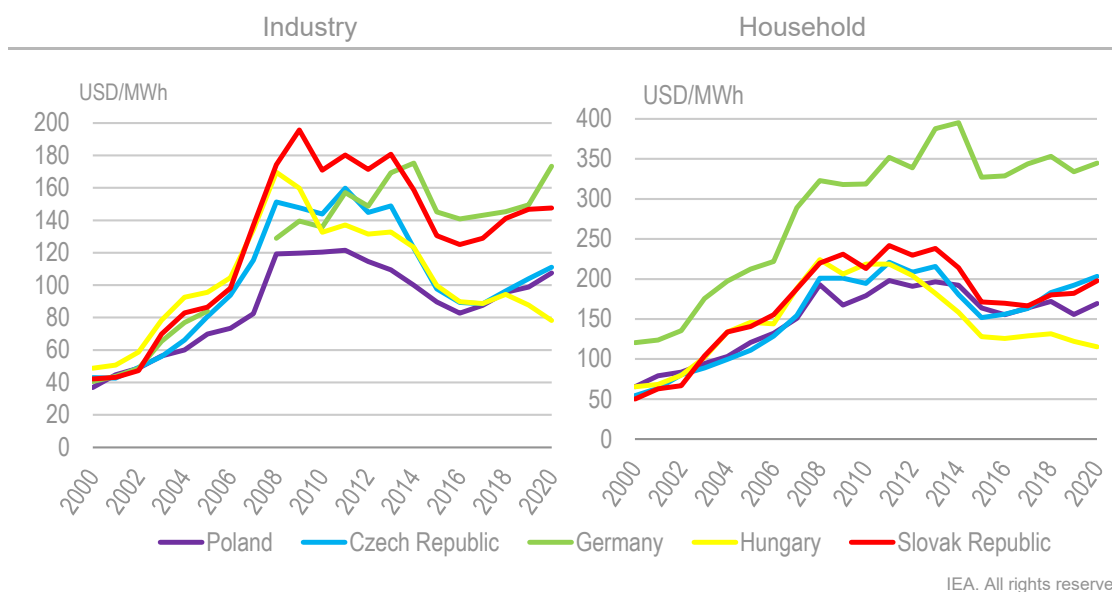
Retail prices and taxes

Retail electricity prices in Poland are composed of wholesale electricity costs; network tariffs; an excise duty; VAT of 23%; and fees that support renewable energy, co-generation and capacity mechanism payments. In 2021, the average household electricity bill was composed mostly of electricity costs (40%), followed by network tariffs (32%); VAT and excise duty (19%); and the fee supporting renewable energy, co-generation and capacity mechanism payments (9%).

The fee covering subsidies for renewable energy is calculated each year by the ERO. In 2021, it was 0.47 EUR/MWh, equal to about EUR 0.08 per month for the average household consumer. The cost of the renewable energy green certificate scheme is also passed on to consumers and was 9.7 EUR/MWh in 2021, about EUR 1.61 per month for the average household consumer. Generation from renewables is exempt from the excise duty. Electricity used by energy-intensive industry is partly or fully exempted from the excise duty, with the level of exemption depending on a range of factors. The fee covering subsidies for capacity mechanism payments is determined each year by the ERO. All household consumers and non-household consumers with a connection up to 16 kW are charged a flat monthly fee that increases with higher demand and ranged from around 0.5-2.75 EUR per month in 2022. All other consumers pay a fee of around 200 EUR/kWh (URE, 2021). The fee covering subsidies for co-generation is set by the Ministry of Climate and Energy. It was set to zero in 2021 (to address concerns around high energy prices) and to around 900 EUR/MWh in 2020.

Poland's industrial electricity price has been lower than prices in its neighbouring countries for most of the past two decades and followed a similar trend with prices falling from 2011 to 2016, then increasing through 2019 (Figure 7.6). In 2020, Poland's average retail electricity price for industrial consumers was 107.5 USD/MWh, with a tax rate at 1%, close to the IEA median price but with one of the lower tax components.

Poland's household electricity price has followed a similar trend to prices in its neighbouring countries, with steady increases through 2008, followed by annual fluctuations with an overall decline through 2019. In 2020, Poland's average retail electricity price for household consumers was the tenth-lowest among IEA member countries at 169.5 USD/MWh, with a tax rate of 19%.

Figure 7.6 Electricity prices in Poland and neighbouring IEA countries, 2000-2020

Source: IEA (2021).

The Polish government recently took *ad hoc* measures to address concerns over high energy prices. In 2019, the excise duty for electricity was reduced from 4.4 EUR/MWh to 1.1 EUR/MWh. In November 2021, Poland passed legislation providing EUR 1.1 billion in 2022 to fund a cash payment (up to EUR 300 per year, with eligibility covering nearly 7 million households) to support households in purchasing electricity, natural gas and food. In addition, from January 2021 to July 2022, the VAT is lowered from 23% to 5% for electricity, and taxes will be reduced on transportation fuels, natural gas and district heating (see Chapter 2).

Electricity policy

Poland's energy policy aims to decarbonise its electricity supply, increase electrification, and maintain electricity security and affordability. The EPP2040 sets several key goals for the electricity sector, with a focus on lowering carbon intensity by reducing coal-fired generation; expanding generation from renewables, natural gas and high-efficiency co-generation; and introducing nuclear generation. There is also a push for distributed generation (especially solar PV) and an active role for consumers in electricity markets.

The EPP2040 includes targets to reduce coal-fired generation to 37.5% by 2030 and 11% by 2040 under a high CO₂ price scenario that assumes ETS prices of 54 EUR/t in 2030 and 60 EUR/t in 2040. ETS prices have already exceeded these levels, reaching 89 EUR/t in 2021. Poland is aiming to significantly expand gas-fired generation to compensate for the reduction in coal-fired generation. The government expects gas-fired generation to increase from 16 TWh in 2020 to around 54 TWh by 2030 and around 70 TWh by 2040.

Poland plans to separate coal-fired generation assets from state-controlled utilities and transfer them to a new state-controlled entity, the National Energy Security Agency (NABE). NABE would take ownership of coal-fired electricity plants, while co-generation plants would remain with state-owned utilities. The proposed transfer is intended to

improve the ability of Poland's state-controlled utilities to access financing for investments in natural gas and renewable energy. In March 2022, the government approved plans to establish NABE and complete the transfer of relevant coal plants by the end of 2022. The government noted that it would use its legal right to exempt the establishment of NABE from assessment by Poland's competition authority. The creation of NABE is subject to discussions with the EC regarding competition rules.

Renewables

Expanding renewable generation is a key aspect of Poland's plan to reduce coal-fired generation and decarbonise the electricity supply (see Chapter 5). Poland has a target for renewables to cover 32% of electricity generation by 2030 (versus 18% in 2020), with most of this generation expected to come from wind (offshore and onshore) and solar PV. Onshore wind reached 6.4 GW in 2020, with at least 4.3 GW of projects planned for deployment. Poland has developed a strong offshore wind policy and contracts are in place for 5.9 GW of wind farms to be fully operational by 2027. Auctions are planned for 2025 (2.5 GW) and 2027 (2.5 GW), with a target to reach up to 11 GW by 2040. Poland has a rapidly growing solar PV market, with capacity reaching an estimated 7.7 GW at the end of 2021 (compared to just 0.2 GW in 2016).

Poland has a wide range of measures supporting renewable electricity generation, including a green certificate scheme, an auction system, a dedicated programme for offshore wind, a feed-in tariff and feed-in premium for medium-scale hydropower and bioenergy, and several loan and grant programmes to finance small- and medium-scale renewable energy projects. The cost of subsidies awarded through the renewable energy auction and other renewable support measures are covered by a fee charged to all electricity consumers.

Nuclear

The introduction of nuclear power is another key element supporting the reduction of coal-fired generation and decarbonisation of the electricity supply (see Chapter 11). The Polish Nuclear Power Programme, adopted in 2014 and updated in 2020, defines the plans for implementing nuclear energy in Poland and ensuring safe operations, decommissioning and waste storage. The programme aims to construct two nuclear power plants with three reactors each, with the first reactor (1-1.6 GW) to be in operation by 2033 and for all six reactors (6-9 GW) to be in operation by 2043. The government estimates that by 2040, nuclear energy could account for up to 16% of total electricity generation.

Implementation of the nuclear programme requires legal and regulatory changes, and selection of a financing model. The government is still in the process of selecting the locations, technology and contractor for the construction of the nuclear power plants and a radioactive waste repository. The government is also working to ensure there are adequate human resources for the construction and operation of the plants and for nuclear supervision.

Co-generation

Poland's energy policy aims to increase the share of co-generation in the electricity supply, improve co-generation efficiency and reduce the share of coal-fired co-generation. In 2019, co-generation accounted for 17% of electricity generation and 65% of district heating supply. Poland has several measures to support the development of high-

efficiency co-generation. The electricity TSO and DSOs are required to provide a connection to all high-efficiency co-generation plants that meet certain conditions.

Until the end of 2018, co-generation was supported through a certificates of origin system. The Act on the Promotion of Electricity from High-Efficiency Cogeneration introduced a new support scheme in 2019. A co-generation plant needs to be authorised by the ERO before it can receive support under the new scheme, and support is only available to plants with CO₂ emissions not exceeding 450 kg/MWh of heat and electricity. This excludes coal and oil-fired co-generation and requires high efficiency from gas-fired co-generation. The ERO runs auctions to award support to new co-generation plants. A separate system awards support to existing or modernised plants. The maximum support is 64 EUR/MWh for 15 years for new plants and 5-7 years for modernised plants. There are limits on the total support a plant can receive each year. The budget for the entire programme is around EUR 8 billion and is covered by a fee charged to all electricity consumers.

Electrification of demand

Poland is pushing to increase electrification of energy demand, especially for road transport (see Chapter 4). The EPP2040 sets 2030 targets for the deployment of 600 000 EVs, including battery EVs and hybrid EVs, 60 000 EV charging points (49 000 regular and 11 000 fast charging), and for all public transport vehicles in cities with more than 100 000 inhabitants to be zero-emission. Poland provides several support measures to increase the adoption of EVs, including cash subsidies. Poland is also pushing for electrification of building energy demand through support schemes for building and heating system renovations. Poland's energy efficiency measures for industry (energy audit and a white certificate system for efficiency projects) also support electrification.

Energy storage

Poland has a small capacity of energy storage that consists mainly of pumped hydro (1.7 GW and 7.6 GWh in 2020), which is used by the TSO mainly for system balancing. There is limited deployment of battery storage in Poland, with total battery storage capacity reaching around 15 MW and 35 MWh in 2021. These systems are connected to the distribution system and used mainly to stabilise voltage. Poland aims to increase energy storage capacity to support the integration of variable renewable generation and increase system flexibility. PGE (the main electricity supplier) aims to build 0.8 GW of energy storage by 2030 (Tsanova, 2020).

In May 2021, Poland's Energy Law was amended with several changes to support energy storage, including a clear licensing process and regulatory status, elimination of the electricity storage tariff and double charging of grid tariffs, a 50% discount on grid connection fees, exemption from fees that support the capacity market and the subsidies for renewables and co-generation. The amendment also allows projects combining energy storage with renewables, co-generation and energy efficiency to receive support through existing subsidy programmes, and for DSOs to recover the cost of electricity storage through tariffs if the investment is in line with EU rules that greatly limit ownership and operation of storage by system operators. Under the new regulations, battery systems over 50 kW need to register with the relevant system operator, while systems over 10 MW require licensing.

The government is also planning for the next round of the My Electricity programme (support for distributed solar PV) to include funding for distributed storage (see Chapter 5).

In 2021, 2 GW of storage (mainly pumped hydro) were selected to participate in Poland's capacity market. The government plans to include a specific bracket in the 2022 renewable energy auction to support renewable generation deployed with storage.

Poland is also looking to develop industrial capacity for battery manufacturing. In February 2021, the private company Northvolt announced plans to invest around EUR 169 million to build what could be Europe's largest battery module factory in Gdańsk, Poland. Northvolt plans to start operating the factory in 2022 with a production capacity of 5 GWh of batteries per year, with potential plans to expand capacity to 12 GWh per year (Northvolt, 2021).

Smart grids and prosumers

Poland aims to transition to a smart grid (especially at the distribution level) to increase the number of prosumers, improve system flexibility and reliability, and support the integration of renewables (especially PV). The government has set a target for 80% of consumers to have a smart meter by 2028. In 2020, 14.7% of consumers (2.7 million) had a smart meter. The EPP2040 sets a goal of reaching 1 million prosumers and 300 energy communities by 2030. As of December 2021, Poland had 60 energy communities and 845 505 prosumers (compared to just 4 000 prosumers in 2015). Prosumers account for an estimated 5 860 MW of generation capacity, around 99.9% of which is solar PV (equal to 77% of Poland's total PV capacity in 2021).

The government is developing a CSIRE to facilitate efficient and transparent exchange of digital information (including data from smart meters) to support system flexibility and a high share of prosumers. In July 2021, the Polish TSO was appointed to the newly created role of energy market information operator and charged with setting up and operating the CSIRE. This effort is being undertaken in collaboration with DSOs and energy suppliers. The government aims for the CSIRE to be fully operational by July 2024 (PSE, 2021b).

Poland is developing a Strategy of Distributed Energy to better define the role of distributed energy, prosumers and energy communities. The government is considering a range of changes to increase the market participation of prosumers and make distributed renewable generation easier to integrate. These changes include transitioning from net metering to prosumers selling surplus electricity to an obligated seller at a market price (net billing), and the introduction of aggregators to co-ordinate market transactions of numerous prosumers and offer other services.

Electricity security

Poland's security of electricity supply is regulated by the Energy Law, which defines the procedures for dealing with electricity supply disruptions. The law gives the responsibility for maintaining security of supply to Poland's TSO and empowers the TSO (in co-operation with DSOs) to take a range of measures to prevent, respond to and recover from any supply disruptions. The law also requires electricity generators to take certain action to ensure electricity security, for example thermal units larger than 100 MW have an obligation to test, on a regular basis, their capability for island operation.

Poland relies first on market-based instruments to address supply disruptions. However, in the event of a threat to the security of electricity supply, the TSO (in co-ordination with DSOs) may introduce limitations on electricity generation or demand (load shedding) for

72 hours. A longer duration of restrictions requires authorisation from the Council of Ministers. The Energy Law defines an order of load shedding, with priority placed on maintaining supply to protected consumers (households; entities providing social services such as clinics, hospitals and schools; and small and medium-sized enterprises).

Co-ordinated DSR measures can also be used as part of the response to emergency situations. Prior to 2021, DSR was used only as an intervention mechanism to address critical generation reserve deficits. In 2020, around 700 MW of DSR capacity was available for this purpose. In 2021, this programme was replaced by DSR participation in the capacity market specifically to allow long start time coal-fired generation to come online. In 2021, 570 MW of DSR was participating in the capacity market, with plans for 950 MW in 2022. Only commercial and industrial consumers can operate DSR in the capacity market, and over 98% of this DSR capacity is contracted by aggregators.

Every year the TSO assesses the adequacy of emergency response measures and defines which electricity supply and demand restrictions it plans to use in case of an emergency during the following year. The ERO is responsible for reviewing and approving these measures. Under the current scheme, restrictions consist of limiting peak electricity demand and daily electricity demand of consumers with contracted capacity higher than 300 kW. To ensure adequacy of supply, the TSO arranges control services for centrally dispatched generation units, contracts must-run services with non-centrally dispatched generators and hydro units with a total of 1.7 GW, and 0.8 GW of cold (non-operating) reserves. Bilateral agreements with TSOs in neighbouring countries provide an additional 0.3 GW of capacity to ensure generation adequacy.

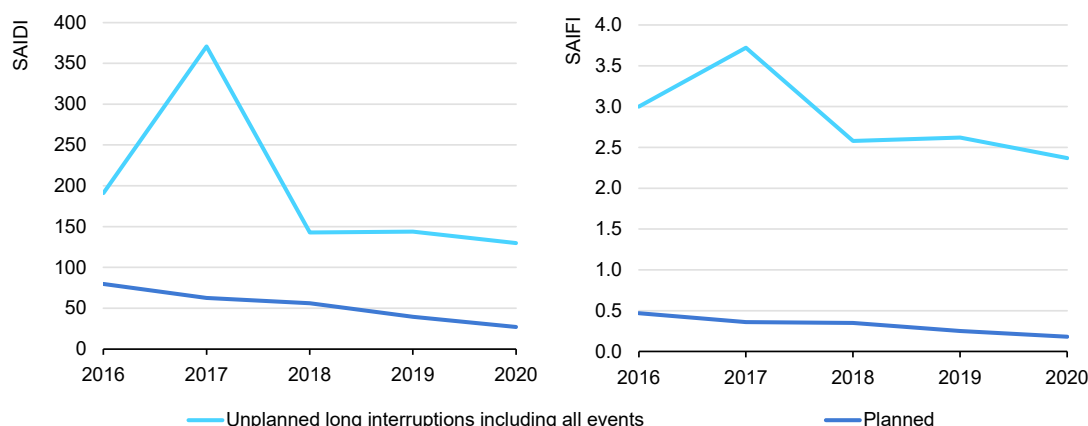
The TSO is required to maintain a restoration plan that details how the electricity system can recover from a full or partial blackout. This plan identifies and places certain requirements on black start units. A unit's black start capability is tested twice a year according to the agreement signed between the TSO and the respective power plant owners. The ERO monitors the level of coal stocks in centrally dispatched generating units with a threshold for alarm set at 20 days of demand. At the end of October 2021, as many as ten companies reported lower stocks to the ERO, showing some supply constraints reflecting high coal prices and rising demand.

System performance

Poland's System Average Interruption Duration Index (SAIDI)³ and System Average Interruption Frequency Index (SAIFI)⁴ are based on the performance of the five main DSOs (Figure 7.7). Poland is aiming to improve the operation of its electricity distribution systems, in particular shortening the duration of energy supply interruptions. The EPP2040 calls for DSOs to make investments to reduce SAIDI to 85 minutes or less, compared to 118.7 minutes in 2020 and an EU average of 61 minutes in 2020 (Eurelectric, 2020).

³ SAIDI is a system index of average duration of interruption in the power supply indicated in minutes per customer per year. It is measured by multiplying the average duration of customer interruptions by their total number then dividing by the total number of customers in the system.

⁴ SAIFI is a system index of average frequency of interruptions in power supply, measured as a total number of interruptions divided by the number of all customers.

Figure 7.7 SAIDI and SAIFI in Poland, 2016-2020

Source: PTPIREE (2021).

Assessment

Poland's energy policy aims to decarbonise its electricity supply and increase electrification of demand while maintaining electricity security and affordability. Poland's electricity sector will undergo unprecedented changes in the coming years, resulting primarily from the planned reduction of coal-fired generation. Although the share of coal in total generation declined from 86.9% in 2010 to 68.5% in 2020, it bounced back to 79.7% in 2021. From 2010 to 2021 the share of gas-fired generation increased from 3.1% to 7.7%, and renewables grew from 6.9% to 12.6%.

Adopted in February 2021, the EPP2040 sets several key goals for the electricity sector, including reducing coal-fired generation to 37.5% by 2030 and 11% by 2040 under a high CO₂ price scenario, with these reductions supported mainly by increased renewable and gas generation and the introduction of nuclear generation. However, the high CO₂ price scenario assumes ETS prices of 54 EUR/t in 2030 and 60 EUR/t in 2040, which are lower than the price in 2021 of 89 EUR/t. This indicates that market forces could greatly accelerate the transition away from coal. The government should update the EPP2040 and NECP to reflect a likely acceleration in decreasing electricity generation from coal power plants given higher ETS prices and more ambitious EU climate and energy targets.

Poland is expecting a notable expansion of gas-fired generation. Industry players have plans to build around 6 GW of new gas-fired capacity, compared to 3.1 GW of gas-fired capacity in 2020. While natural gas is a better choice than coal for electricity generation given its lower emissions, the government of Poland needs to bear in mind that transitions to more renewables and nuclear, accelerated by technological developments, can happen faster than planned, can push out gas-fired generation and can make it, together with the associated infrastructure, a stranded asset. The government should also consider the energy security risks and increased import dependency associated with higher gas demand. The updated EPP2040 and NECP should aim to increase flexibility and security while minimising investments in natural gas power plants to reduce the risk of stranded assets and support strong emissions reductions. Steps can also be taken to reduce emissions from existing and planned new gas plants through stronger efforts to decarbonise the gas supply and by examining the cost effectiveness of carbon capture.

In 2020, Poland's total interconnection capacity was 11.8 GW, with capacity projected to increase only slightly to 12.5 GW by 2030. The level of interconnectivity (4% in 2020) is still relatively low and Poland is still far from reaching the target of 15% by 2030 set by EU legislation. Poland should increase investments in the electricity grid that support increased electricity trade and higher regional integration (including interconnection capacity in line with EU targets), as this supports system flexibility and the integration of variable renewables.

More integration with the rest of Europe will also increase electricity security, provide opportunities for electricity exports and lower electricity costs through more efficient electricity trade. The government is in the process of reforming the balancing market, which if properly implemented could reduce the need to apply allocation constraints. The first phase of updating the balancing markets have been completed and the second phase is in progress.

In 2018, Poland established a capacity market mechanism to address concerns over the adequacy of generation capacity. The mechanism provides payments outside the energy market based on guaranteed availability of capacity to projects selected through competitive auctions. The first capacity auction took place in 2018 and awarded support of EUR 55 million/GW to 22.4 GW of capacity with around 79% going to coal-fired generation, mainly existing units. Since 2021, units exceeding emissions of 550 g CO₂/kWh can no longer participate in capacity auctions. This requires coal-fired units to have sufficient co-firing of biomass or to be deployed with carbon capture. In 2021, over 1 GW of units co-firing coal and biomass won support in the auction for capacity delivery in 2026. The government should closely monitor the results of the capacity mechanism and adjust it as needed to ensure it supports a wide range of technologies (including non-fossil generation).

Solar PV generation is growing much faster than anticipated in the EPP2040. The government should work with the TSO, DSOs and the ERO to implement development plans to reflect the recent strong growth and the need for continued growth in renewables to meet increased EU ambitions on renewable generation.

The distribution grids will have to play a major role in the transition towards a decarbonised and more flexible electricity system. The number of prosumers is expected to increase rapidly in the coming years and DSOs will have a pivotal role in enabling self-consumption, smart grid services, distributed storage and DSR, and facilitating aggregators and the expansion of EV charging infrastructure. Consequently, a new operational model compatible with the changing market needs should be developed, with DSOs having a role of securing flexibility and stability via local balancing of flexible supply and flexible demand. The government should work with the TSO, DSOs and the ERO to ensure that the development of the network and market support a flexible energy system that can securely integrate growing shares of renewable generation.

In 2020, the four large incumbent electricity suppliers owned over two-thirds of the domestic generation capacity and accounted for 72% of wholesale electricity supply. The state-controlled company PGE was by far the largest wholesale supplier (with a 41% market share). In 2020, there were 153 active suppliers in the retail market, and the largest suppliers are operated by DSOs with legal unbundling. In 2020, the HHI of the electricity retail market in Poland was 2 315 for households and 2 164 for commercial consumers. The industry retail segment has a switching rate of 5.4% per annum, very low in

international comparison, while switching hardly occurs in the residential retail segment (0.64% switching rate). The procedure for switching suppliers should be improved, e.g. by introducing a reliable price comparison tool.

The ERO regulates Poland's electricity market, which is mostly liberalised. However, the majority of household consumers (63% in 2020) purchase electricity through contracts with regulated prices. Poland has low retail electricity prices compared to most central European countries, both at the industrial and household level. However, regulated tariffs for households discourage consumers to switch suppliers and are a barrier to the development of a fully functioning retail market that provides the benefits of competition, including the potential for lower cost electricity. Poland should abolish regulated tariffs and increase consumer awareness and introduce price comparison tools to trigger retail market competition and reduce market concentration.

Accommodating a wide portfolio of market participants and technologies, such as energy communities, prosumers, energy storage, DSR and EVs, requires a stable and predictable legal and regulatory framework with provisions to ensure regulatory compliance. Strong regulatory supervision is also critical to ensure that the different players fulfil their legal and contractual obligations in the areas of generation, transmission, distribution, trading and supply to serve the public interest, ensure quality of service and security of infrastructure, and maintain free and healthy competition. Moreover, the government should initiate new policy measures to increase competition at the wholesale and retail level, including regulatory measures to ease entry to the wholesale and retail markets.

Poland has a small capacity of energy storage that consists mainly of pumped hydro (1.7 GW and 7.6 GWh in 2020). There is limited deployment of battery storage in Poland, with total battery storage capacity around 15 MW and 35 MWh in 2021. Energy storage can play a critical role in supporting the secure integration of renewable generation while providing additional benefits to increase overall system flexibility. The government made significant changes to the Energy Law to support the deployment of storage. It should build on these efforts and develop a comprehensive energy storage strategy that includes a clear assessment of the role energy storage can play in the electricity system and markets (especially in relation to the integration of renewables) and identifies key barriers and solutions to address these.

Recommendations

The government of Poland should:

- ❑ Accelerate the expansion of the transmission and distribution systems to facilitate higher shares of renewables, planned nuclear generation and increased electrification while ensuring security of supply.
- ❑ Develop a clear and effective regulatory framework and timetable of coal power plant closures at a pace that aligns with the increasing generation from renewables and planned generation from nuclear.
- ❑ Ensure that interconnection capacity with neighbouring countries adds to regional flexibility, provides an additional tool of system balancing and increases cross-border trade.
- ❑ Adopt a comprehensive plan to drive competition in the electricity market that decreases the dominance of incumbent companies, ends regulated prices and facilitates new market entrants by introducing a well-functioning price comparison tool and supplier of last resort mechanism, and automated consumer switching procedures; allow small and medium-sized private companies to participate in capacity allocations and apply appropriate measures to increase liquidity on wholesale and retail markets.

References

- ACER (European Union Agency for the Cooperation of Energy Regulators) (2020), ACER Market Monitoring Report 2019 – Energy Retail and Consumer Protection Volume, https://documents.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/ACER%20Market%20Monitoring%20Report%202019%20-%20Energy%20Retail%20and%20Consumer%20Protection%20Volume.pdf
- EC (European Commission) (2021), Baltic Synchronisation Project Phase II. Preparatory phase for Harmony Link interconnector (web page), <https://ec.europa.eu/inea/en/connecting-europe-facility/cef-energy/4.8.9-0008-ltpl-s-m-19>
- ENTSOE (European Network of Transmission System Operators for Electricity) (2016), 2030 targets for interconnection capacities (web page), <https://tyndp.entsoe.eu/2016/exec-report/sections/chapters/05-2030-targets-for-interconnection-capacities.html>
- Eurelectric (2020), Distribution Grids in Europe, <https://cdn.eurelectric.org/media/5089/dso-facts-and-figures-11122020-compressed-2020-030-0721-01-e-h-6BF237D8.pdf>
- European Parliament (2019), Legislative train schedule (web page), <https://www.europarl.europa.eu/legislative-train/theme-resilient-energy-union-with-a-climate-change-policy/file-communication-on-achieving-a-15-electricity-interconnection-target>
- Forum Energii (2019), Capacity Market for Review, https://forum-energii.eu/public/upload/articles/files/Capacity%20market%20for%20review_net.pdf
- IEA (International Energy Agency) (2022), World Energy Balances (database), <https://www.iea.org/data-and-statistics/data-product/world-energy-balances> (accessed on 18 February 2022)
- Northvolt (2021), Northvolt expands in Poland to establish Europe's largest factory for energy storage solutions (web page), <https://northvolt.com/articles/systems-poland>
- PSE (Polish Power Grids) (2021a), Guideline on Participation in Polish Capacity Market for Foreign Capacity Providers, https://www.pse.pl/documents/20182/98611984/Guideline_on_participation_in_Polish_capacity_market_for_foreign_capacity_providers_Version_1.0.pdf
- PSE (2021b), PSE became the energy market information operator (web page), <https://www.pse.pl/web/pse-eng/-/pse-became-the-energy-market-information-operator>
- PTPiREE (Polish Society of Transmission and Distribution of Electricity) (2021), Electricity Distribution and Transmission in the New PTPiREE Report, <http://www.ptpiree.pl/opracowania/raporty>
- S&P Global Platts (2022), European gas daily, Volume 27, Issue 8, <https://www.spglobal.com/commodityinsights/en/support/delivery-platforms/dimensions-pro>
- Tsanova, T. (2020), Polish PGE to be climate neutral in 2050, reach 50% renewables by 2030, Renewables Now, <https://renewablesnow.com/news/polish-pge-to-be-climate-neutral-in-2050-reach-50-renewables-by-2030-717981>
- URE (Energy Regulatory Office) (2021), Capacity market: The President of the ERO calculated the amount of the fee for maintaining energy security in 2022 (web page), <https://www.ure.gov.pl/pl/urzad/informacje-ogolne/aktualnosci/9800,Rynek-mocy-Prezes-URE-wyliczyl-wysokosc-oplaty-za-utrzymanie-bezpieczenstwa-ener.html>
- URE (Energy Regulatory Office) (2022), National Report of the President of the Energy Regulatory Office 2021, <https://www.ure.gov.pl/download/2/525/Raport2021en.pdf>

8. Coal

Key data (2020)

Production: 100.4 Mt/39.9 Mtoe, -17% in 2009-19, -10% in 2019-20

Net imports: 8.0 Mt (12.7 Mt imports, 4.6 Mt exports)

TES: 109.6 Mt/39.8 Mtoe

Share of coal: 69.5% of energy production, 40.2% of TES, 68.5% of electricity generation, 11.5% of TFC

Coal demand by sector: electricity and heat generation 75.6%, industry 14.5%, buildings 9.9%,

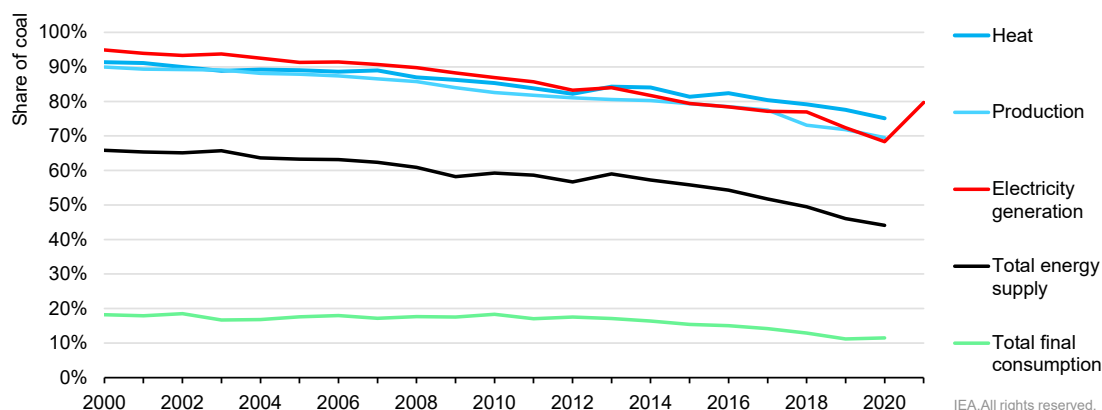
Overview

Coal dominates Poland's energy system, accounting for the highest share of domestic energy production, TES, electricity generation and heat production in the country (Figure 8.1). Among IEA member countries, in 2020, Poland had the highest shares of coal in domestic energy production, TES, TFC and electricity generation, and the second-highest share in heat production. However, the role of coal in Poland's energy system is declining. From 2010 to 2020, the share of coal reduced in domestic energy production (from 83% to 70%), TES (from 55% to 40%), electricity generation (from 87% to 69%), district heating (from 85% to 75%) and TFC (from 18% to 11%). Three-quarters of Poland's coal demand comes from coal-fired electricity, co-generation and heat plants, followed by industry (15%, mainly for steel production) and individual coal-boiler building heating systems (10%, mainly from residential buildings). Poland is a major coal producer, the second largest in Europe in 2020, but coal production has been falling and is expected to continue to decline.

Poland's energy policy aims to reduce coal demand and production while ensuring a just transition for coal workers and communities. However, Poland's key energy policy documents indicate that coal will continue to play a key role in the energy sector through 2050. The EPP2040 sets goals to reduce the share of coal in electricity generation from 70% in 2020 to a range of 37.5-56% by 2030 and 11-28% by 2040. The government and coal trade unions have developed a plan to gradually phase out domestic hard coal production by 2049 and provide benefits to impacted workers and alternative economic development in affected regions. There are no plans or targets for phasing out lignite production or lignite-fired generation. Additional efforts to reduce domestic coal demand are required to support Poland's commitment to EU 2030 climate targets and the EU 2050 climate neutrality goal. The government should prepare for the likelihood that market

forces (including EU carbon pricing) drive coal out of Poland's energy system much faster than anticipated in current energy policy.

Figure 8.1 Share of coal in different energy flows in Poland, 2000-2019/2020

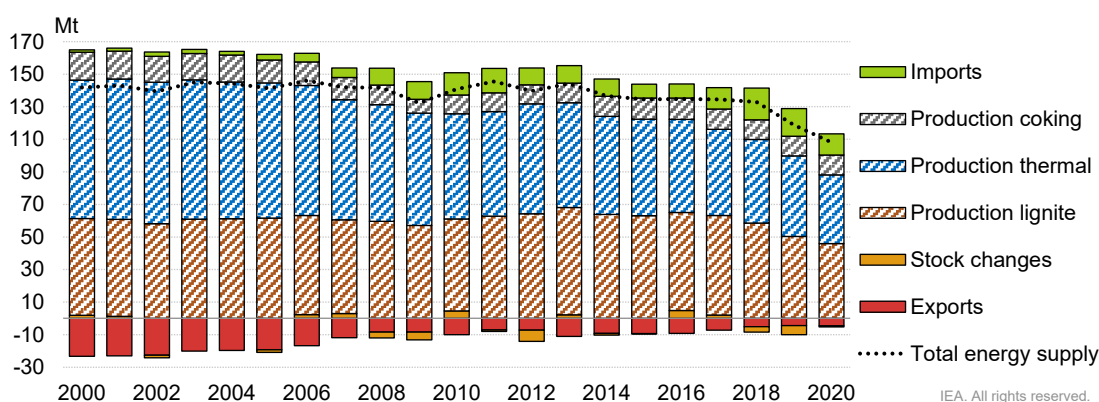


Source: IEA (2022), 2021 data from S&P Global Platts (2022).

Coal production and supply

In 2020, Poland was the tenth-largest coal producer in the world and the second-largest coal producer in the EU after Germany. Poland's coal production is in decline, dropping from 133 Mt to 100 Mt between 2010 and 2020, and is expected to continue declining (Figure 8.2). Poland produces hard coal (both thermal coal and coking coal) and lignite. Most of Poland's coal demand (93% in 2020) is covered by domestic production. In 2020, Poland accounted for 96% of the EU's hard coal production and was the second-largest lignite producer in the EU after Germany.

Figure 8.2 Coal supply and production in Poland, 2000-2020



Source: IEA (2022).

From 2010 to 2020, Poland's hard coal production decreased from 76.1 Mt to 54.4 Mt, driven by a reduction in thermal coal production from 64.5 Mt to 42.1 Mt, while coking coal production increased slightly from 11.7 Mt to 12.3 Mt. The drop in thermal coal production has accelerated in recent years (dropping by 9 Mt from 2018 to 2020) as Poland's hard coal has become more expensive to mine, and demand for thermal coal has fallen in

Poland and in the Czech Republic and Germany, the main export markets for Polish thermal coal. From 2010 to 2013, Poland's lignite production increased from 56.5 Mt to 65.8 Mt, but has since declined to 46 Mt in 2020, with most of this decline (12.6 Mt) occurring from 2018 to 2020. The drop in Poland's lignite production was driven by a reduction in lignite-fired plant capacity, which fell by around 1.3 GW from 2017 to 2020.

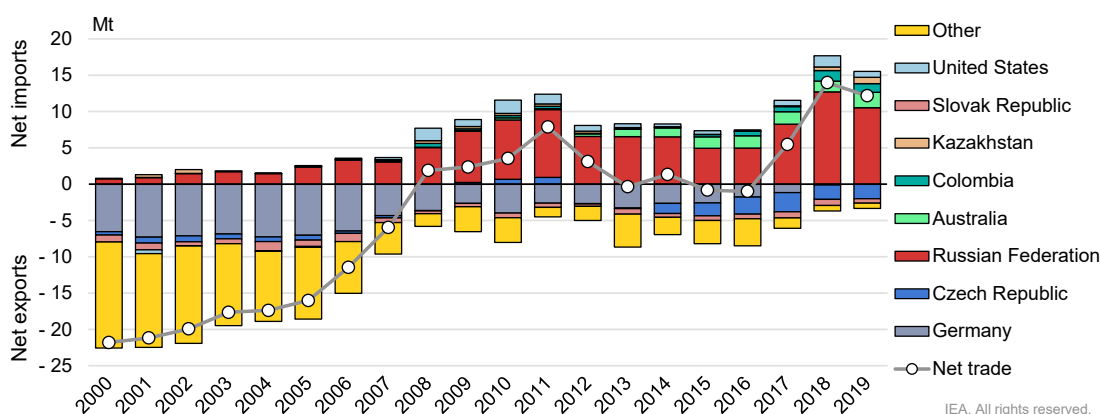
In 2020, there were 21 active hard coal mines in Poland. The main hard coal mining companies are state owned, and the largest producer is the Polish Mining Group (8 mines and 36 600 workers at the end of 2020) followed by JSW (5 mines and 22 000 workers at the end of 2020). There are also private companies active in hard coal mining. The main companies active in lignite mining are the stated-owned utility PGE and two private companies, ZEPAK and the Sieniawa Lignite Mine Company, all of which operate mines to fuel lignite-fired plants adjacent to mining sites.

Coal mining is concentrated in a few areas of Poland where it is the main driver of local economic activity. Most hard coal is extracted in deep shaft mines in the Silesia and Lubelskie regions (90% in 2020). Employment in Poland's hard coal sector declined from almost 400 000 in 1990 to around 100 000 in 2015 and 73 000 at the end of 2021. There is less employment in lignite mining, which takes place in open cast mines near Poland's numerous lignite-fired power plants. Employment in the lignite mining sector is also declining, from around 12 000 in 2013 to around 8 000 in 2021.

Hard coal trade

Poland has traditionally been a net exporter of hard coal. However, imports have been increasing, mainly for thermal coal used in electricity and heat generation as domestic thermal coal production has declined while electricity demand has increased. In 2008, Poland was a net importer of hard coal for the first time and has been a net importer since 2017, with 8.0 Mt of net imports in 2020 (Figure 8.3).

Figure 8.3 Hard coal net trade in Poland, 2000-2019



Source: IEA (2022).

Russia is the main source of hard coal imports (90% in 2020). Poland exports both coking coal (56% of exports in 2020) and thermal coal (44%). Germany was historically the largest destination for Poland's coal exports, but exports to Germany have significantly declined

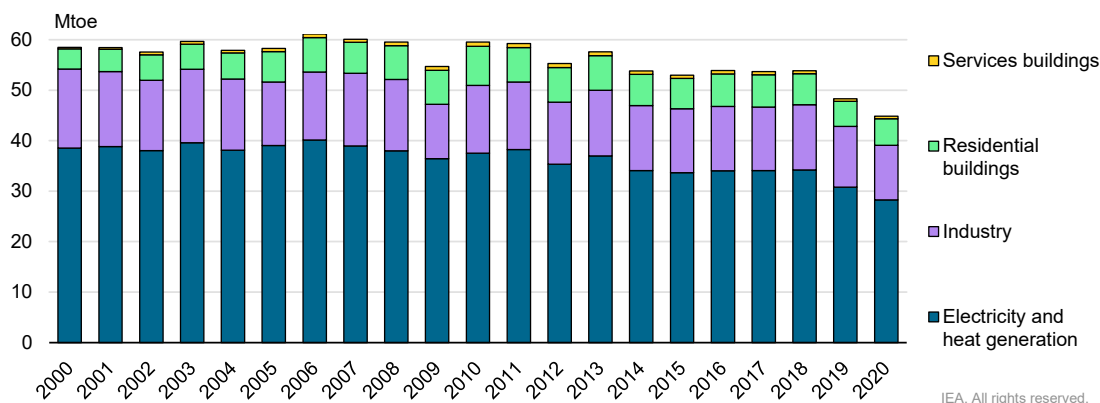
as Germany phases out coal-fired generation. The Czech Republic is now the main destination for Poland's hard coal exports.

Coal demand

From 2010 to 2020, Poland's coal demand decreased from 60 Mtoe to 45 Mtoe. Demand decreased for both hard coal (from 85 Mt to 64 Mt) and lignite (from 57 Mt to 46 Mt). Most of the reduction resulted from lower demand for both thermal coal and lignite from coal-fired electricity and heat generation plants (from 37 Mtoe to 28 Mtoe), along with lower thermal coal demand from coal-fired building heating (from 8.6 Mtoe to 5.8 Mtoe) and a slight reduction in industrial demand for thermal and coking coal (from 13.5 Mtoe to 10.8 Mtoe) (Figure 9.4).

Most of Poland's coal demand comes from electricity, co-generation and heat plants, which in 2020 accounted for 76% of total coal demand and 99% of lignite demand. That year, Poland had 34.1 GW of coal-fired electricity generation capacity (24.8 GW hard coal and 9.3 GW lignite), which accounted for 68.5% of generation and 66% of installed capacity. Poland's Bełchatów power plant is the largest coal-fired plant in Europe (5.3 GW) and accounted for 20% of electricity generation and 5.5% of installed capacity in 2020. Coal-fired co-generation and heating plants are the main source of energy for Poland's large district heating network. In 2019, 40% of households were connected to district heating and coal covered 76% of that energy demand.

Figure 8.4 Coal demand by sector in Poland, 2000-2020



Source: IEA (2022).

Individual building heating systems are a notable source of Poland's coal demand. In 2020, 7% of coal demand came from residential buildings and 0.7% from services sector buildings. In 2019, coal covered 49% of residential space heating energy demand, the highest share among IEA member countries and notably higher than the IEA average of 5%. The use of coal for building heating is more common in rural areas. In 2020, 67% of rural households used coal for heating (down from 78% in 2015), compared to 19% for urban households (down from 23% in 2015). Industry has the smallest coal demand (3.6% in 2020), with most of this demand coming from iron and steel production (46% of industrial coal demand in 2020).

Coal policy

Poland's energy policy aims to reduce coal demand and production to achieve Poland's energy and climate targets, while ensuring a just transition in the regions economically impacted by reduced coal production and demand. Poland's key energy policy documents indicate that coal production and coal-fired generation will continue to play key roles in the energy sector through 2050. The Minister of Climate and Environment is responsible for climate and energy policy, including policies that aim to reduce coal demand. The Ministry of State Assets, whose main task is managing state-owned assets, directly oversees public coal mining companies and is responsible for national policies related to coal production.

Poland plans to lower coal demand mainly by reducing coal-fired electricity generation. The EPP2040 sets goals to reduce the share of coal in electricity generation from 68.5% in 2020 to 37.5-56% by 2030 and 11-28% by 2040. The lower estimates on coal shares come from a high ETS price scenario, which assumes ETS prices of 54 EUR/t in 2030 and 60 EUR/t in 2040. The ETS price already reached 89 EUR/t in 2021, and is likely to be notably higher by 2030. The government should develop coal/energy scenarios for such high ETS prices.

The government aims to reduce coal-fired generation mainly by increasing the deployment of gas-fired generation (see Chapter 9) and renewable generation (see Chapter 6), and introducing nuclear generation (see Chapter 11). There are notable support schemes for renewable generation and electricity system operators are planning major investments to connect new generation from gas, nuclear and renewables (see Chapter 7). The government also aims to reduce coal demand from co-generation, which covered 65% of district heating demand and 17% of electricity generation in 2019, and is fuelled mostly by coal. In 2019, the government introduced a support scheme for high-efficiency co-generation to drive a transition away from coal (see Chapter 7).

The government has prioritised replacing individual coal heating systems to limit the health and environmental impacts of local air pollution and to help achieve climate targets. The EPP2040 includes a target to phase out most coal use for individual heating by 2030 in cities and by 2040 in rural areas. Coal that undergoes processing to reduce pollution from combustion (defined as “smokeless” by the government) would still be allowed through 2040. The exception for “smokeless” coal is intended to support continued demand for domestic coal while reducing local air pollution levels. Polish law allows regional governments to adopt restrictions on heating fuels beyond what is required in national law and several regional assemblies have passed resolutions banning coal-fired heating.

The EU Just Transition Fund was created in 2019 to support economic diversification in regions reliant on fossil fuels that will be the most affected by decarbonisation and to help local workforces in these areas acquire new skills. The fund has a total budget of around EUR 17.5 billion, which will be directed to regionally developed transition plans. Poland is expected to receive the largest share of funding (EUR 3.5 billion); however, ongoing political issues between Poland and the EC could prevent access to these funds.

The social contract concluded in May 2021 between the government and coal trade unions set a schedule to gradually close all of Poland's hard coal mines (excluding coking coal mines) by 2049. The agreement also guarantees that workers in the hard coal sector will have a job until retirement (employees at closing mines will be transferred to other mines)

or receive a severance package of EUR 26 800. The agreement also commits subsidies to support the transition of the main hard coal mining regions to other economic activity. The government has indicated that the financial support envisioned in the agreement will be financed by a subsidy from the state budget. The agreement must be reviewed by the EC to show compliance with EU state aid rules before it can be implemented (Wilczek, 2021). The contract does not cover lignite and there are no targets for phasing out lignite mining or lignite-fired electricity generation.

Poland is also seeking to limit the economic and social impact of the transition away from coal by siting new large-scale electricity plants (nuclear and natural gas) in areas where coal-fired generation plants will be closed. In addition, the social contract includes plans for coal gasification with CO₂ capture.

The coal sector already receives a large amount of financial support, for both mining and generation. This support comes both as direct public aid, but also through a variety of mechanisms that ensure income streams and socialise the costs and risks of the coal sector's activities. The EC noted that from 2008 to 2018, Poland's fossil fuel subsidies increased from EUR 0.5 billion to EUR 1.8 billion per year, with most of the growth coming from increased support to the coal sector (EC, 2020).

The OECD Inventory of Support Measures for Fossil Fuels (which uses definitions for subsidies differing from those used by the EU) indicates that from 2010 to 2019, Poland's fossil fuel subsidies grew from EUR 1.15 billion to EUR 1.76 billion per year, with most of the growth coming from a large increase in coal subsidies in 2018. In 2019, EUR 1.35 billion of fossil fuel subsidies went to coal, followed by oil (EUR 0.4 billion) and just EUR 3.1 million for natural gas (OECD, 2022). The OECD report noted that Poland's fossil fuel subsidies come mainly in the form of compensations for the decommissioning of coal mines and for the termination of long-term power purchase agreements with coal-fired power plants. In 2018, substantial aid was provided for restructuring the coal mining sector.

Coal-fired generation has also been the largest beneficiary of Poland's capacity market mechanism. The government estimates that the capacity market mechanism established in 2018 will provide almost EUR 20 billion in payments to coal plants through 2035. Since 2021, units exceeding emissions of 550 g CO₂/kWh can no longer participate in capacity auctions. This requires coal-fired units to have sufficient co-firing of biomass or to use carbon capture (see Chapter 7).

Coal mining companies in Poland are not required to cover the cost of decommissioning, clean up and reclamation of coal mines once they end production. Instead, these sites are usually transferred to Poland's publicly owned Mine Restructuring Company (SRK), which covers all decommissioning costs with public funding (SRK, 2000). As a result, the price of domestic coal does not reflect the full cost of mining.

In addition, Poland plans to separate coal-fired generation assets owned by state-controlled utilities and transfer them to a new state-controlled entity, NABE. NABE would take ownership of electricity plants, while co-generation plants would remain with state-controlled utilities. The proposed transfer intends to improve the ability of Poland's state-controlled utilities to finance new natural gas plants and renewable energy projects by removing coal plants from their portfolios. In March 2022, the government approved plans to establish NABE and complete the transfer of relevant coal plants by the end of 2022. The government noted that it would use its legal right to exempt the establishment of NABE

from assessment by Poland's competition authority. The creation of NABE is subject to discussions with the EC regarding competition rules.

In 2021, almost 40% of public RD&D spending was dedicated to coal-related projects. The Bloki+ 200 programme provided EUR 38 million in funding to support research on the modernisation, reconstruction or operation of coal-fired power plants with capacities around 200 MW. The aim is to develop technical, organisational and legal solutions that help these coal plants to operate with greater load variability and a larger number of shutdowns and start-ups, so that they can be operated in an efficient manner in a system with growing shares of variable renewables (NCBR, 2022). There is also RD&D examining the use of coalbed methane to produce electricity and heat (this methane is often flared or escapes as fugitive emissions). This includes pilot projects to capture and use methane from coal extraction and projects looking to extract methane from coal beds even if the coal is not mined.

Assessment

Coal dominates Poland's energy system, accounting for the highest share of energy production and supply, electricity generation, and heat production. However, the share of coal has been declining across the energy system. Coal-fired electricity and co-generation plants account for most of Poland's installed capacity (68% in 2020) and are by far the main source of coal demand (64% in 2020). However, coal-fired generation has been notably declining as it becomes less economic due to higher prices for coal and ETS allowances, and stronger competition from low-cost renewables and electricity imports.

In 2020, Poland accounted for 96% of the EU's hard coal production and was the second-biggest lignite producer, but Poland's coal production is declining. From 2010 to 2020, Poland's hard coal production decreased from 76 Mt to 54 Mt. This trend has accelerated in recent years. Poland has traditionally been a net exporter of hard coal. However, imports have been increasing, mainly for thermal coal from Russia, as domestic thermal coal production has declined while electricity demand has increased. Exports have also fallen as Germany (formerly the main destination for Poland's hard coal exports) and other countries move to phase out coal. Poland's lignite production is also declining, with a major drop from 63 Mt in 2015 to 46 Mt in 2020, driven by the closures of lignite power plants in Adamow and Patnow.

Poland's energy policy aims to decrease coal production and demand to reduce GHG emissions and local air pollution while ensuring a just transition for regions economically impacted by the closure of coal plants and mines. The EPP2040 set a goal to reduce the share of coal in electricity generation to 37.5% by 2030 and to 11% by 2040. However, these shares are based on a scenario with ETS prices of 54 EUR/t in 2030 and 60 EUR/t in 2040. The ETS price already reached 89 EUR/t in 2021, and is likely to be higher by 2030. In addition, the EPP2040 (published in February 2021) does not account for the increased EU-wide 55% emissions reduction 2030 target, nor the EU 2050 climate neutrality goal. The government should update the EPP2040 with targets and measures for coal (and other areas of the energy system) that support the EU's increased climate and energy ambitions and reflect energy market developments, technical innovation and increased ETS prices.

The social contract concluded in May 2021 between the government and coal trade unions sets a schedule to gradually close all of Poland's hard coal mines (excluding coking coal mines) by 2049 and includes plans for financial support to impacted regions and workers. The social contract guarantees work until retirement or a severance package and calls for a Silesia Transformation Fund, which will use public funds to subsidise a transition away from coal. The social contract allows for changes in the planned support system to address significant impacts on the hard coal sector, including drastically rising ETS prices, or further tightening of climate policy. The agreement does not cover lignite mining and Poland has no targets to end lignite mining.

The IEA recommends updating the social contract to cover the entire coal sector (including lignite) and to set a timeline for closing all coal-fired generation to support Poland's commitment to EU climate targets. The agreement also needs to reflect the economic reality of ETS prices and other market forces that make coal-fired generation a loss-making activity that drains state resources (e.g. continuing cost increases of domestic coal production versus continuing cost reductions for renewables, energy storage and other clean energy technologies).

Poland is also seeking to limit the economic and social impact of the transition away from coal by siting new large-scale electricity plants in areas where coal-fired plants will be closed. In addition, PGE (which owns the largest share of Poland's coal-fired capacity) has expressed interest in pilot projects to convert closed coal-fired plants into long-duration thermal energy storage facilities. The IEA notes that siting new generation and storage projects at sites of closed coal-fired plants has numerous advantages. These include making efficient use of existing grid connections and transmission capacity, maintaining grid stability by replacing closed plants with a similar level of capacity at the same site. Also, new plants can reuse infrastructure at the site itself, take advantage of existing permits and limit the economic impact on surrounding communities.

The coal sector receives a large amount of financial support, for both mining and generation. This support comes both as direct aid (e.g. government financed restructuring and buyouts) and through a variety of mechanisms that ensure income streams and socialise the costs and risks of coal sector activities, like capacity payments. Also, Polish mining companies are not required to cover the costs of mine closures or remediation; state-owned SRK takes ownership of mines that are no longer productive and is responsible for covering all decommissioning costs, which are passed on to taxpayers. Coal-fired generation receives the largest share of payments from Poland's capacity market. Estimates from the EC and the OECD indicate that the coal value chain benefits from an increasing level of subsidies that is approaching EUR 2 billion per year. While ensuring energy security, the government should examine how limited financial resources could be more effectively directed towards the energy transition.

In April 2021, Poland announced a plan to separate coal-fired generation assets from state-controlled utilities and transfer them to a new state-controlled entity, NABE. This transfer is intended to improve the ability of Poland's state-controlled utilities to access financing for investments in natural gas and renewable energy. In March 2022, the government approved plans to establish NABE and complete the transfer of relevant coal plants by the end of 2022. The government noted that it would use its legal right to exempt the establishment of NABE from assessment by Poland's competition authority. The creation of NABE is subject to discussions with the EC regarding competition rules.

The IEA recommends that the NABE should only be established if it clearly supports a cost-effective and accelerated phase-out of coal-fired generation. NABE also needs to avoid market distortions that could easily result from a single entity owning such a large share of generation capacity. The IEA recommends that Poland's competition authority assess the impacts of establishing NABE and encourages the government to engage with the European Commission regarding NABE and EU competition rules. NABE should not be used to extend the operation of coal-fired plants any longer than necessary to support generation adequacy and its structure and operations need to be aligned with Poland's energy transition.

The EPP2040 sets targets to ban coal-fired heating in urban areas by 2030 and in rural areas by 2040. However, the ban still allows uses of coal-based “smokeless” fuels through 2040. These fuels have lower pollution levels compared to standard coal and could reduce the impacts on human health. But they are more expensive to produce and will not help to reduce CO₂ emissions. Coal producers in Poland have indicated an interest in manufacturing these fuels, but also noted that the market for them is small. The government should accelerate the phase-out of coal-fired heating systems with an emphasis on deep building renovations that combine improved insulation with heat pumps.

In 2021, almost 40% of public RD&D spending was dedicated to coal-related projects. The IEA recommends that Poland continue to increase RD&D funding, but with a clear focus on innovation that supports a clean energy transition, notably energy efficiency and renewables. Given Poland's large share of coal-fired generation, additional RD&D on CCUS is warranted.

Recommendations

The government of Poland should:

- ❑ Develop a clear timeline for closing all coal-fired generation that supports Poland's commitment to the EU's 2030 climate targets and 2050 climate neutrality goal, and that accounts for the reduced economic competitiveness of coal-fired generation.
- ❑ Evaluate the wide range of financial support directed to the coal value chain and determine how these resources could be more effectively directed to the energy transition, while ensuring energy security.
- ❑ Ensure that government acquisition and operation of coal-fired generation through NABE supports an accelerated phase-out of coal-fired generation and does not distort competition on the electricity market.

References

- EC (European Commission) (2020), Energy Subsidies, <https://op.europa.eu/en/publication-detail/-/publication/92ae71b0-173a-11eb-b57e-01aa75ed71a1/language-en>
- IEA (International Energy Agency) (2022), World Energy Balances (database), <https://www.iea.org/data-and-statistics/data-product/world-energy-balances> (accessed on 18 February 2022)
- NCBR (National Centre for Research and Development) (2022a), Bloki 200+ programme (web page), <https://www.gov.pl/web/ncbr/program-bloki-200>
- OECD (Organisation for Economic Co-operation and Development) (2022b), OECD Inventory of Support Measures for Fossil Fuels: Country Notes: Poland, <https://www.oecd-ilibrary.org/sites/5a3efe65-en/1/3/39/index.html?itemId=/content/publication/5a3efe65-en&csp=2ffa7a733148fec42dccf926d7619e1c&itemIGO=oecd&itemContentType=book#section-d1e6210>
- S&P Global Platts (2022), European gas daily, Volume 27, Issue 8, <https://www.spglobal.com/commodityinsights/en/support/delivery-platforms/dimensions-pro>
- SRK (Spółka Restrukturyzacji Kopalń) [Mine Restructuring Company] (2000), SRK website, <https://srk.com.pl/english/index>
- Wilczek, M. (2021), Polish government and miners reach coal phaseout deal but doubts remain over EU approval (web page), Notes from Poland, <https://notesfrompoland.com/2021/05/31/polish-government-and-miners-reach-coal-phaseout-deal-but-doubts-remain-over-eu-approval>

9. Natural gas

Key data (2020)

Domestic production: 5.6 bcm, -8% since 2010

Net imports: 16.0 bcm (17.4 bcm imports, 1.4 bcm exports), +48% since 2010

Share of gas: 6% of energy production, 17% of total energy supply, 11% of electricity generation, 10% of district heating, 15% of TFC

Consumption by sector: industry 49%, residential buildings 23%, co-generation 19%, service sector buildings 7%, transport 2%

Overview

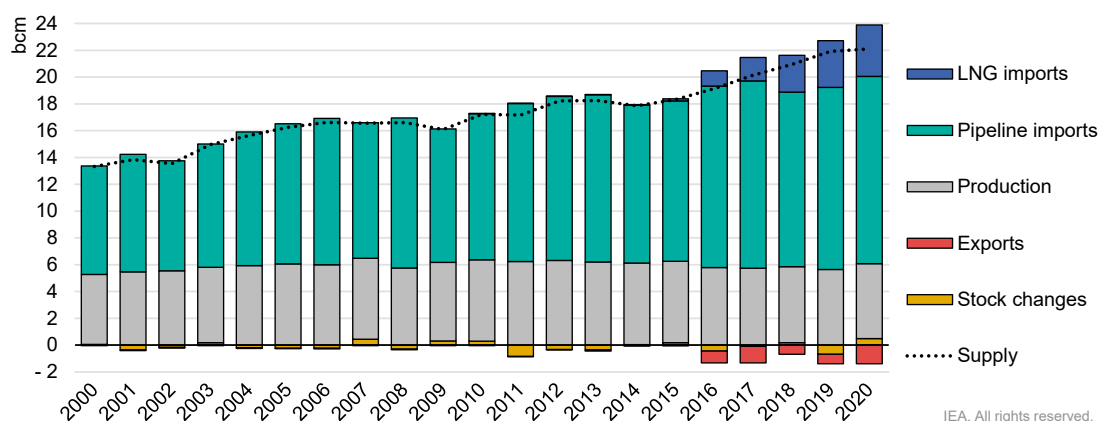
Because of Poland's historic dependence on coal, natural gas plays a relatively smaller role in the country's energy system, especially for electricity generation and building heating. However, the role of gas in Poland's energy system has been increasing. From 2010 to 2020, Poland's gas demand steadily increased from 17.2 billion cubic metres (bcm) to 21.3 bcm. This increase was driven mainly by higher gas demand from industry, which is the largest user of gas (49% of gas demand in 2020), followed by buildings (30%), electricity and heat generation (19%), and small use in transport (2%). From 2010 to 2020, the share of gas in electricity generation increased notably from 3% to 11%, but is still well below the IEA average of 23%. Poland is a relatively small producer of natural gas, and domestic production has been declining, falling from 6.1 bcm to 5.6 bcm from 2010 to 2020.

Poland's energy policy gives natural gas an important role in the transition away from coal, especially in electricity generation and building heating. The government also sees gas-fired generation as the main option to balance increasing generation from variable wind and solar PV. The government estimates that gas demand will increase to between 27.4 bcm and 31.6 bcm by 2030 (versus 21.3 bcm in 2020). There are plans to significantly expand gas infrastructure, increase gas import capacity and diversify gas supply. Poland considers natural gas to be a transition fuel, but current plans do not present a clear path to decarbonise gas supply or reduce gas demand. Poland has set general goals to increase the use of biomethane and develop a market for low-carbon hydrogen. Poland is working to establish a liberalised gas market; currently the state-owned oil and gas company PGNiG has a dominant position in Poland's gas sector.

Gas supply and trade

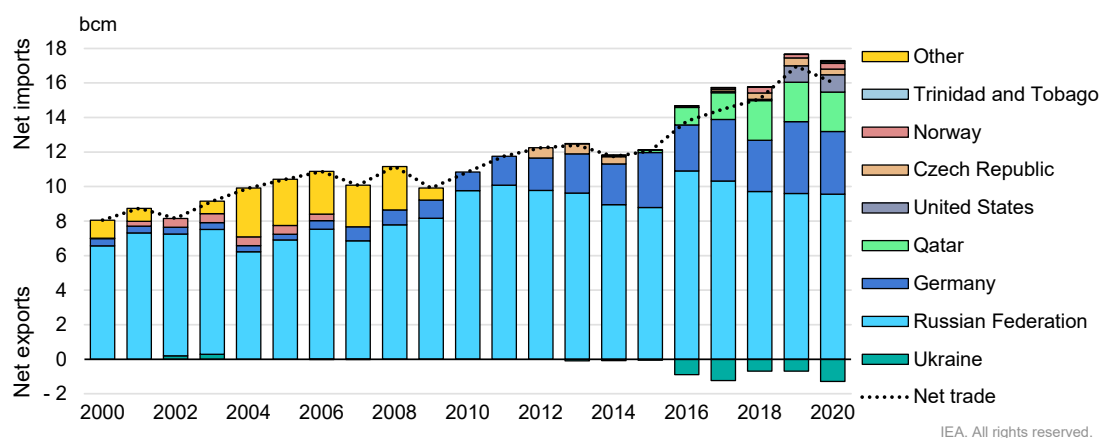
Poland relies on imports for the majority of its gas supply. From 2010 to 2020, the share of imports in the gas supply increased from 63% to 72% as gas demand grew significantly and domestic production declined slightly (Figure 9.1). Most of Poland's gas supply is delivered via pipeline (78% in 2020), but since the opening of Poland's LNG regasification terminal in 2016, the share of LNG in the gas supply increased from 8% to 22% in 2020. From 2010 to 2020, Poland's natural gas imports grew from 10.3 bcm to 16.5 bcm (Figure 9.2). Imports from Russia are still the dominant source of Poland's gas supply, but diversification of suppliers, supply sources and routes, and increased trading were assisted by expanded interconnection capacity with other EU member states and the opening of the LNG terminal.

Figure 9.1 Natural gas supply in Poland, 2000-2020



Source: IEA (2022a).

Figure 9.2 Poland's natural gas net trade by country, 2000-2020



Source: IEA (2022a).

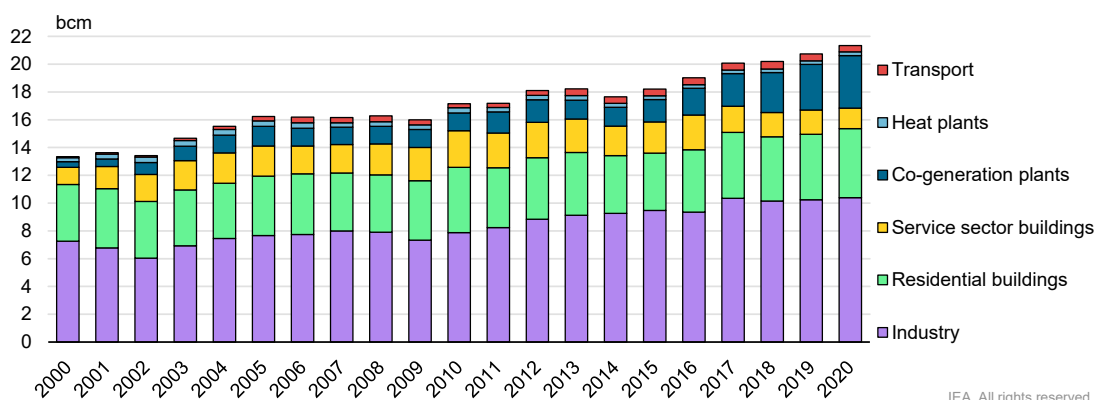
In 2020, net imports came mainly from Russia (9.0 bcm) followed by Germany (3.6 bcm), and LNG imports from Qatar (2.3 bcm) and the United States (1.0 bcm). Poland also exports a relatively small amount of gas to Ukraine (1.3 bcm in 2020). On 27 April 2022, Gazprom (Russia's state-controlled gas company) made a unilateral and contract-breaching decision to cut off gas flows to Poland and to Bulgaria.

Pipeline imports from Russia are delivered under a long-term take or pay contract with Gazprom that has been in place since 1996, but will expire at the end of 2022 (PGNiG, 2019). Under a regulation on diversification of supply, the share of natural gas that can be imported from a single source will be reduced from 70% (the limit since 2017) to 33% in 2022. To support diversification of supply and increase regional gas trading, Poland is increasing LNG import capacity and pipeline import capacity from other EU member states.

Gas demand

From 2010 to 2020, Poland's gas demand increased from 17.2 bcm to 21.4 bcm, driven mainly by higher demand from industry (from 7.9 to 10.4 bcm) and co-generation (from 1.3 bcm to 3.8 bcm). Transport saw a small increase in demand (from 0.3 bcm to 0.5 bcm), while demand from residential buildings was essentially flat (from 4.69 bcm to 4.72 bcm) and demand from service sector buildings declined (from 2.6 bcm to 1.7 bcm) (Figure 9.3). Most gas demand for electricity and heat generation comes from co-generation plants (3.8 bcm in 2020), while demand from heat-only plants was just 0.3 bcm (there are no electricity-only natural gas plants in Poland).

Figure 9.3 Natural gas demand by sector in Poland, 2000-2020



Source: IEA (2022a).

The EPP2040 estimates that annual gas demand could grow to 26.2 bcm by 2025 and to 27.4-31.6 bcm by 2030, and remain at this level through at least 2040. Despite notable impacts on the energy system, gas demand actually increased in 2020 to 21.4 bcm. The government expects higher gas demand across all sectors, with the largest increases from industry and new gas-fired generation (with the deployment of up to 6 GW of new gas-fired capacity by 2030); higher demand for gas in building heating, with an expected additional 1.5 million gas individual connections by 2024 versus 2018; and a small increase in use of LNG and compressed natural gas (CNG) in transport (there are 2025 targets to develop 32 publicly available CNG vehicle fuelling stations and 14 LNG vehicle fuelling stations).

Infrastructure

Poland's natural gas network (Figure 9.4) is composed mainly of the E system, which delivers most of the gas supply (96% in 2020) with standard natural gas that is classified

as grade E with a minimum gross calorific value of 38.0 megajoules per cubic metre (MJ/m^3). The E system is supplied with gas via numerous cross-border pipeline interconnections, the LNG terminal and by national production. A small system in Western Poland is dedicated to domestically produced high-nitrogen natural gas (L-gas) with a minimum gross calorific value of 30.0 MJ/m^3 . The L-gas system delivers gas directly to a limited number of consumers and injects gas into the E system after the L-gas is upgraded to E grade. There are also numerous smaller gas networks not connected to the main network but served by their own cross-border pipeline or by LNG delivered by trucks to small regasification units. Poland plans to significantly expand gas import, transmission, distribution, regasification and storage capacity to support higher gas demand to diversify gas supply away from dependence on Russia and to help Poland serve as a gas-trading and transit hub as part a north-south corridor running through Poland, the Czech Republic, the Slovak Republic and Hungary to a new LNG terminal in Croatia.

Figure 9.4 Poland's natural gas transmission system, 2020



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

LNG terminal

Poland's only LNG terminal (located in Świnoujście and opened in 2016) is owned and operated by Gaz-System, Poland's gas TSO. In April 2022, projects were completed increasing the LNG terminal regasification capacity from 5 bcm to 6.3 bcm, further investments aim for 8.3 bcm of capacity by the end of 2023. The project will cost around EUR 425 million, with EUR 105 million coming from the EU through the Environment and Infrastructure Operational Programme. PGNiG holds contracts for 100% of the LNG terminal's capacity through 2038. Gaz-System is planning to further expand LNG import capacity with the construction of a floating LNG terminal in Gdańsk Bay with a capacity up to 6.1 bcm, to be commissioned in 2027 or 2028.

Pipeline interconnections

In 2020, Poland's total gas pipeline interconnection capacity was 73 million cubic metres (mcm) per day imports and 13 mcm/day exports. There are seven main pipeline entry points: cross-border interconnections at Lasów (Germany), Cieszyn (the Czech Republic), Drozdowicze and Hermanowice (Ukraine), and Wysokoje (Belarus); and three offtake points from the Yamal-Europe gas pipeline at Włocławek and Lwówek in central Poland. In addition, there are smaller capacity cross-border pipelines serving areas not connected to the main gas network: Tietierowka (Belarus), GCP Gaz-System/ONTRAS point (Germany) and Branice (the Czech Republic).

The Polish section of the Yamal-Europe transit gas pipeline runs from the Polish-Belarusian border to the Polish-German border. It is a major source of gas imports from Russia to the western EU member states and also allows virtual reverse flows from Germany to Poland. The Polish section of the Yamal-Europe pipeline is owned by Europol Gaz, which is co-owned by the Russian gas company Gazprom (48%), PGNiG (48%) and Polish trader Gas-Trading (4%). The long-term transit contract for the Yamal-Europe pipeline expired in May 2020; since then, capacity is auctioned in accordance with the EU regulations (ICIS, 2019).

There are several interconnection projects being developed to increase and diversify supply and support greater regional integration. The largest is the Baltic Pipe, which will add 10 bcm of import capacity for gas produced in Norway via transit through Denmark, should start operations as of 1 October 2022, and be fully operation at the end of in 2022.

The Gas Interconnection Poland-Lithuania (GIPL) supports the integration of the gas networks of the Baltic states (Estonia, Latvia and Lithuania) with Poland and the rest of Europe, and is intended to reduce the Baltic states' reliance on gas imports from Russia. The bidirectional GIPL has a capacity of 1.9 bcm to Poland and 2.4 bcm to Lithuania, and started operating on 1 May 2022. The GIPL cost an estimated EUR 509 million, with EUR 277 million from EU funding.

The bidirectional Poland-Slovak Republic gas interconnector will have a capacity of 5.7 bcm to Poland and 4.7 bcm to the Slovak Republic, and is expected to start operation in June 2022. The project will cost an estimated EUR 406 million, with EUR 100 million from EU funding.

Transmission network

Poland's gas transmission system is operated by the state-owned TSO, Gaz-System. Poland's transmission network is composed mainly of the E system (11 056 km of

pipelines in 2020, excluding the Polish section of the Yamal pipeline), which serves the majority gas consumers and transports most of Poland's gas supply. The separate L-gas systems (551 km of pipelines in 2020) deliver high-nitrogen natural gas produced in Western Poland. The majority of gas supplied by Poland's transmission network (around two-thirds of supply in 2020) is delivered directly to large-scale gas consumers, including gas-fired co-generation plants and heavy industry mainly in the chemical and petrochemical sectors. The transmission network also supplies gas to the distribution network for delivery to households, commercial buildings and light industry. In 2020, the TSO added around 280 km of new pipelines to the E system. The TSO is planning to significantly expand the transmission network, with around 2 000 km of new pipelines to the E system in the western, southern and eastern parts of Poland by 2025.

Distribution network

In 2020, Poland's gas distribution network had a total length of 206 357 km and 52 673 connections. In 2020, Poland had 51 gas DSOs; however, PSG (a subsidiary of PGNiG) manages 95% of the distribution network. Almost 3 600 km of new pipelines and 930 new connections were added to the distribution network in 2020 (94% of new additions by PSG), which increased the share of households connected to the gas network from 69% (in 2019) to 72%. PSG is planning to add over 13 000 km of new pipelines by 2030. Poland also has LNG regasification stations that supply satellite distribution systems that are not connected to the gas transmission system. In 2020, the satellite networks delivered 14.4 mcm of gas through 52 LNG regasification stations, 35 of which were added in 2020. PSG operates the satellite networks and plans to build ten additional LNG regasification stations by 2024.

Storage

In 2020, Poland had 3.17 bcm of gas storage capacity connected to the E system (equal to 16.7% of the annual demand for E grade gas in 2020). E system storage is composed of five storage facilities in depleted natural gas reservoirs (Husów, Wierchowice, Swarzów, Brzeźnica and Strachocina) and two storage facilities in salt caverns (Mogilno and Kosakowo). Poland also has 0.2 bcm of gas storage capacity connected to the L-gas system (equal to 20% of 2020 demand for L-gas grade gas). Gas Storage Poland (a subsidiary of PGNiG) operates the E system storage facilities. PGNiG directly owns and operates the L-gas system storage facilities. It recently invested to expand the storage capacity of the E system. In 2020, 0.1 bcm of capacity was added to the Wierchowice storage facility. In 2021, 0.06 bcm of capacity was added to the Kosakowo storage facility. PGNiG is considering further expansion of E system underground gas storage capacity to maintain system balancing in line with the expectations of higher gas demand. Further decisions on the extension of the storage capacity will be taken after a thorough analysis of the market situation and security of supply issues.

Market structure

Poland's natural gas market is highly concentrated, with only limited competition at the wholesale and retail levels. The state-owned oil and gas company PGNiG has a dominant position across Poland's gas sector. It holds the long-term take or pay contract with Gazprom that covers most of Poland's wholesale gas supply. PGNiG is also the exclusive LNG importer, holding contracts for 100% of Poland's LNG regasification capacity through 2038. PGNiG subsidiaries are the main gas producers in Poland. PSG (100%

owned by PGNiG) is the main gas DSO and the largest retail gas supplier (with unbundling from distribution activities). Poland is also still in the process of liberalising the natural gas market. Since January 2017, the ERO no longer regulates prices at the wholesale level; prices for LNG and CNG; or prices for gas purchased at a virtual point or through tenders, auctions or public procurement. Since October 2017, the ERO no longer regulates retail prices for non-household consumers. Regulated retail gas prices for all household consumers were set to end in 2023 to further develop competition on the market. Because of concerns over price volatility, the government decided to prolong retail price regulation for household consumers through 2027.

Wholesale market

Poland's wholesale gas market is highly concentrated. In 2020, 185 energy suppliers had concessions to trade gas at the wholesale level, with 94 companies participating in trading. However, PGNiG Capital Group dominated, with a 91% market share, followed by Fortum (2.5%), Handen (1.6%), TAURON Sprzedaz and PGE (1% each), and other suppliers with shares of less than 1%. Wholesale gas trading takes place through the Organised Trading Facility (OTF) and the Exchange Commodity Market, both operated by the Polish Power Exchange. Since 2015, Polish law requires that 55% of the sales of wholesale traders with more than a 10% market share must take place on the trading platforms operated by the Polish Power Exchange. In practice, this requirement only applies to PGNiG.

The OTF supports trading through the intraday market, day-ahead market and commodity forward market. The Exchange Commodity Market platform allows wholesale traders to enter into bilateral contracts with buyers using the Polish Power Exchange benchmark as a reference price. From 2015 to 2020, trading on the OTF was responsible for over 60% of the wholesale gas supply. In 2020, trading on the OTF resulted in the delivery of 12.6 bcm of natural gas at an average price of 16.96 EUR/MWh, with 1.8 bcm on the day-ahead market at an average price of 12.86 EUR/MWh, 0.53 bcm on the intraday market at an average price of 12.11 EUR/MWh and 10.3 bcm on the commodity forward market at an average price of 18.70 EUR/MWh (URE, 2021).

Key stakeholders have reported barriers to the development of the gas market in Poland. The most important included unfavourable tariff conditions, excessive reporting obligations for natural gas trading, complicated licensing processes, gas stockholding obligations, lack of English versions of regulations and documents, no specific products on the spot and futures market, issues related to the functioning of market makers, auxiliary services, and the lack of future trading options (options for gas supply and trading instruments for the period beyond the year +2, bundled capacities). After this consultation, new regulations related to gas tariffs and the functioning of the gas market have been proposed. The first regulation change is under public consultation. The government has prepared legislative proposals to tackle the challenges identified during consultations, including a revision of storage system regulations. The need for further action is being analysed.

Retail market

In 2020, the number of retail consumers increased by over 98 000 to reach over 7.3 million. That year, retail gas suppliers sold 18.5 bcm, an increase of 3.5% compared to 2019, with 67.0% of retail sales going to industrial customers, 25.2% to households, 6.1% to the service sector, 1.4% to the public utility sector and 0.3% to agriculture.

As with the wholesale market, Poland's retail gas market is highly concentrated. In 2020, 240 energy suppliers had concessions to sell gas at the retail level; however, only 48 were active in the market and PGNiG Obrót Detaliczny (member of PGNiG Capital Group) accounted for 85.6% of retail gas sales, an increase of 2.9% compared to 2019. The combined retail market shares of all other gas suppliers was 27.8% in the commercial sector and 4.3% for households. PGNiG OD accounted for only 12.5% of the retail market in the LNG satellite networks. From 2018 to 2020, several gas suppliers ceased their activities in Poland for different reasons, including a lack of financial resources and breaching terms of concession. Customers from the exiting suppliers have been supplied by PGNiG OD on a temporary basis until they sign new contracts.

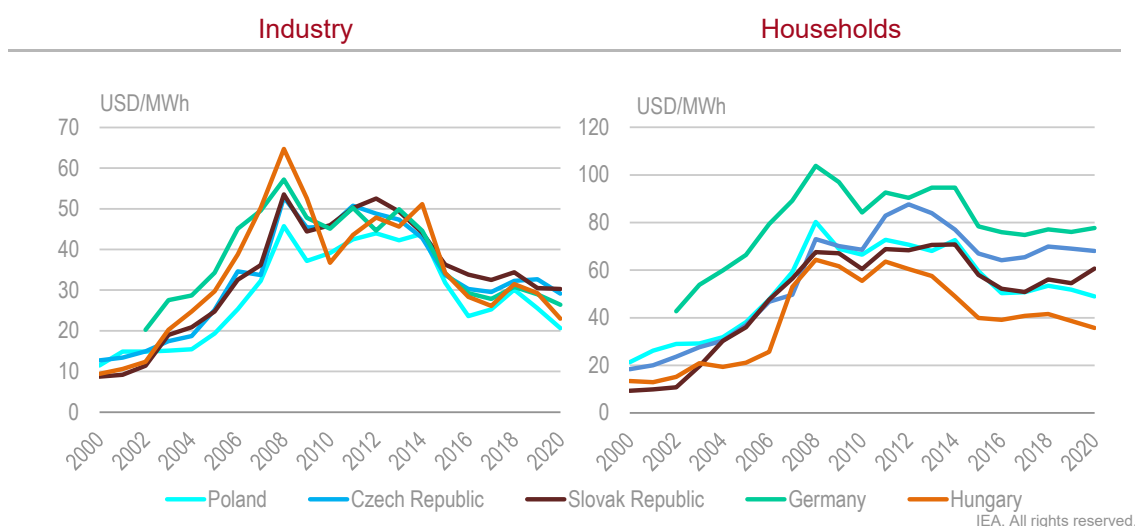
The HHI for the retail gas market was 9 372, indicating a very concentrated market (10 000 is the maximum HHI value and indicates a single supplier). In addition to high market concentration, Poland has one of the lowest household switching rates in the EU, with less than 1% of consumers switching suppliers. Due to impacts of the pandemic, the switching rate was just 0.4% in 2020 (down from around 0.9% in 2019). The switching rate for non-household consumers is higher, but is still one of the lowest in the EU and had declined in recent years from around 18% in 2018 to around 7% in 2019 (ACER, 2021).

Retail prices and taxation

Retail natural gas prices in Poland are composed of wholesale gas costs, network tariffs, an excise duty and other taxes, including 23% VAT. VAT is refunded for commercial use of gas. Gas used for household heating is exempted from the excise duty in most cases. Gas used for electricity generation and for industrial processes is exempt from the excise duty. CNG and LNG used for transportation is exempt from the excise duty, but subject to a road tax.

In 2020, Poland's average natural gas price for industry was 20.6 USD/MWh with a low tax rate of 1%. This was the fourth-lowest price among IEA member countries, which had an average industry price of 29.1 USD/MWh with average tax rate of 11%. In 2020, Poland's average household gas price was 49.0 USD/MWh with a 19% tax rate. This was the seventh lowest among IEA countries, which had an average household price of 71.3 USD/MWh with an average tax rate of 22%. Poland's industry gas prices followed a similar trend to prices in neighbouring countries, with an overall decline from 2012 to 2020 (Figure 9.5). Poland's household gas price was relatively stable from 2008 to 2015, when there was a notable drop in line with the trends seen in neighbouring countries. Poland's household prices have been relatively stable since 2016.

The government took several measures to reduce the impact of the sharp increase in energy prices seen across Europe in 2021. In November 2021, a package of measures with a total budget of EUR 1.1 billion was passed. It included an energy voucher (cash payment through the social aid system) and a separate monthly cash payment (up to EUR 300 per year, with broad eligibility covering 5.2 million households). In addition, from January 2022 to March 2022, the VAT was lowered from 23% to 8% for gas, and taxes were also reduced on transportation fuels, electricity and district heating (see Chapter 2). Parliament is considering a new act that aims to freeze prices for households and essential social entities, with reimbursements provided to gas suppliers to limit market disruptions.

Figure 9.5 Natural gas prices for industry and households in Poland, 2000-2020

Note: Data are unavailable for Germany for 2000 and 2001.

Source: IEA (2022b).

Gas policy

Poland's energy policy gives natural gas an important role in reducing coal demand, especially for heating and electricity. The government also sees gas-fired generation as a key option for the integration of variable generation from wind and solar PV. To support an increased role for gas, there are ongoing works and future plans to notably expand gas infrastructure. Increased gas demand would need to be met mainly with higher imports and there are active and planned projects to expand LNG and pipeline import capacity to secure access to the needed diversification of supply sources, routes and suppliers. The government is also looking to maintain the existing level of domestic production.

Poland's energy policy documents refer to natural gas as a transition fuel and define a clear role for gas in decreasing coal demand. There is less clarity on the long-term decarbonisation of the gas supply, or reduction of gas demand in line with climate goals, with the EPP2040 showing high levels of gas demand continuing through 2040 and 2050.

The government has set goals to increase the production of biomethane, with a preference to use biomethane primarily for public and heavy transport to help meet EU requirements for advanced biofuels (see Chapter 5). The EPP2040 indicates that biomethane production will reach around 2 bcm by 2030 (equal to around 10% of 2020 gas demand). However, analysis from the EC indicates that Poland has the fourth-highest technical potential for biomethane production in the EU, around 9 bcm per year, equal to about 43% of Poland's 2020 gas demand (EC, 2020).

Poland's Hydrogen Strategy, adopted in November 2021, indicates that low-carbon hydrogen is a key option for hard-to-decarbonise sectors and sets goals for the natural gas network to be capable of handling a 10% blend of hydrogen by 2030, and for at least 50 MW of low-carbon hydrogen production capacity by 2025 and 2 GW of electrolyzers and low-carbon production capacity by 2030 (see Chapter 2).

Poland has programmes that provide support for gas-fired heating and electricity generation. The main programme supporting the transition away from individual coal-fired heating is the Clean Air Programme, which provides grants for owners of single-family

residential buildings to upgrade heating systems. Subsidies are provided for a range of technologies, but most have gone to gas boilers. As of November 2021, the Clean Air Programme had received around 340 000 applications for subsidies to upgrade heating systems, with the majority (45%) for gas boilers, followed by biomass boilers (20%), coal boilers (16%), air-source heat pumps (14%), ground-source heat pumps (3%), electric heating (2%), district heating (0.3%) and oil boilers (0.1%) (see Chapter 4).

The Act on the Promotion of Electricity from High-Efficiency Cogeneration introduced a new support scheme for co-generation in 2019. This scheme awards premiums under different rules depending on capacity and whether the plant is new, modernised or existing. Before a co-generation plant can receive support, it needs to be authorised by the ERO. Support is only available to plants with CO₂ emissions not exceeding 450 kg/MWh of energy (heat and electricity). This excludes coal and oil-fired co-generation and requires high efficiency from gas-fired generation (see Chapter 8).

Gas security

Poland's security of gas supply is regulated by the Energy Law and the Act on Stocks and is subject to EU Regulation 2017/1938 on the measures to safeguard the security of gas supply. The Energy Law obligates gas system operators to maintain the ability of equipment, installations and networks to provide gas in a continuous and reliable manner to ensure the security of gas supply, in particular to maintain supplies to protected customers. The Energy Law requires the ERO to control gas entities' compliance with this obligation, including monitoring the connections between the TSO and DSOs and the flow of information between them.

The Energy Law also specifies the emergency gas seller, which is responsible for providing gas to consumers if an emergency prevents a consumer's regular supplier from doing so. The law indicates that PGNiG OD is the emergency seller to consumers. The emergency seller settles accounts with household consumers in accordance with tariffs approved by the ERO. Business consumers are billed according to the current pricing of PGNiG OD. Under the Act on Stocks, energy companies are obliged to have procedures in place to deal with disruptions in the gas supply and an unpredictable increase in natural gas consumption by customers. The procedures must define the manner of providing additional gas supply and how to reduce gas demand in accordance with contracts suppliers have with their consumers.

In 2017, the Act on Stocks was amended to create a requirement for all sellers and end users importing natural gas to maintain mandatory reserves of natural gas for use during emergencies. The law allows for the required volume to be held outside Poland, but the importer must book cross-border transmission capacity ensuring delivery during an emergency. The act requires a stock level equal to at least 30 days of the average daily imports based on imports in the year starting from 31 March of the year proceeding the year of obligation. The ERO verifies the volume of mandatory stocks and sanctions irregularities.

In November 2019, the EC issued a legal opinion on Poland's requirement for gas importers to book cross-border transmission for storage capacity, raising concerns that this regulations might be non-compliant with some EU regulations on security of gas supply (EC, 2019). Poland responded in early 2020 noting that the requirement was necessary to guarantee access to gas stocks because Poland is still working to diversify gas supply and

that a history of supply disruption makes storage key for security. The EC accepted Poland's response and indicated that as long as diversification efforts are ongoing, it is suspending the challenge. The EU is in the process of revising EU gas market legislation in response to the price spikes and supply issues that occurred in 2021.

Poland's gas demand is strongly correlated with seasonal heating demand and gas stocks play a key role in covering this demand. Peak gas demand in 2020 occurred on 2 December and was 72.6 mcm/day (compared to an average demand of 45 mcm/day and the lowest demand of 29 mcm/day). Peak gas demand in 2019 occurred in January and was 74.2 mcm/day (compared to an average demand of 43 mcm/day and the lowest demand of 26 mcm/day). To ensure that peak demand can be met, underground storage is normally filled close to capacity before the start of the winter gas season. At the start of the 2020/21 gas winter season (1 October 2020), underground gas storage facilities were 98.2% full (3.15 bcm). On 30 December 2020, after peak demand, underground gas storage facilities were 74.3% full (2.33 bcm). At the end of the 2020/21 winter season (31 March 2021), gas storage facilities were 38.3% full (1.23 bcm). At the beginning of the 2021/22 heating season, underground gas storage facilities were 98.8% full.

The Regulation of the Council of Ministers of 17 February 2021 on the method and procedure for introducing restrictions on the consumption of natural gas aims to adapt existing gas emergency procedures to EU requirements and current market conditions. It introduced changes, including defining protected consumers as households; entities providing social services such as clinics, hospitals and schools; and small and medium-sized companies. In 2019, these protected consumers accounted for 33% of Poland's gas demand. The regulation defines which protected consumers are not subject to any gas restrictions, which are subject to restrictions only in very severe restrictions, and which are subject to restrictions for only part of the gas demand. The regulation allows emergency gas restrictions to all consumers not qualified as protected consumers with an obligation to announce restrictions to the public ten hours in advance.

The key documents relevant to Poland's policy on gas emergencies are the National Risk Assessment for Security of Natural Gas Supply, the Preventive Action Plan and the Emergency Action Plan. EU regulations require that all three of these plans be updated at least every four years. The National Risk Assessment assesses all relevant risks affecting the security of gas supply. The most recent assessment was completed in 2019 and indicated that under the N-1 condition resulting from the loss of the largest component of gas supply infrastructure, remaining supply infrastructure would allow Poland to cover 118% of expected demand. The Preventive Action Plan defines investments that are of importance for maintaining the security of gas supply. Energy companies in the gas sector must submit quarterly reports to the Minister of Climate and Environment on the implementation of the investments indicated in the plan.

The Emergency Action Plan defines the measures and procedures to reduce or stop natural gas supply disruptions in crisis situations. The most recent plan was adopted in 2019 and indicates that in an emergency, the government relies first on market-based instruments to address supply disruptions. The plan also defines non-market measures that can be taken if market-based measures are insufficient to maintain supply (especially for protected consumers). These include the release of mandatory stocks and restrictions on gas demand.

Assessment

Poland's energy policy sees a major role for natural gas as a transition fuel supporting the long-term goal for a zero-emission energy system. There is a focus on deploying gas infrastructure and gas-fired generation to support energy security, diversify gas supply, and gradually reduce coal-fired generation and heating. Poland's natural gas demand is already increasing in line with the reduced use of coal. From 2010 to 2020, Poland's gas demand steadily increased from 17.2 bcm to 21.3 bcm, driven mainly by higher demand from industry and co-generation. Demand for natural gas is predicted to increase significantly to 27.4-31.6 bcm by 2030.

Poland is conducting and planning major investments for an increased role for gas across the energy system, with the government estimating investment needs at more than EUR 40 billion from 2021 to 2040. Most of this investment is expected to come from large state-owned companies. Major projects include plans to expand gas-fired generation capacity from 3.1 GW up to 9 GW from 2020 to 2030 (with 2.6 GW already under construction) and adding around 2 000 km of new transmission pipelines by 2025 and around 13 000 km of new distributions pipelines by 2030. Smaller projects support the increase of fuelling infrastructure for LNG and CNG powered vehicles.

Poland is also conducting major projects to increase gas supply, with a focus on diversifying sources and routes to end reliance on imports from Russia. These include expanding pipeline interconnections, including through the new Baltic Pipe and LNG capacity (aiming to double import capacity by 2030). The government is also looking to maintain the level of domestic production. However, domestic production has been slowly declining and even with expanding investments, most new gas demand will need to be covered by increased imports.

Poland's policy to expand the use of gas to reduce coal demand will likely deliver notable GHG emissions reductions and greatly reduce health risks from local air pollution. However, the large expansion of gas foreseen under current policy also creates notable risks, including for stranded assets, higher energy import dependency, higher exposure to price volatility (especially for vulnerable consumers and energy-intensive industry) and could be only a temporarily solution to reduce GHG emissions that is not in line with EU carbon neutrality goals. Poland should thoroughly analyse the full range of risks associated with the large investments in gas infrastructure and examine how limited investment capital could be more effectively directed to decarbonising electricity generation, electrification of demand, energy efficiency and scaling up the production of low-carbon gases, including biomethane and low-carbon hydrogen.

Renewable generation coupled with energy storage at both utility and distributed scale could provide an alternative to increased gas-fired generation in many cases. Refurbishing existing coal-fired district heating to run on natural gas is likely a good option, especially where it can be achieved with minimal investment in gas networks. However, the government's long-term development plans need to include a clear pathway to achieving zero-emission district heating, for example through large-scale heat pumps, solar thermal and renewable gases. Poland's planned deployment of nuclear power also presents a notable opportunity to support zero-emission district heating.

The planned large growth of gas boilers to heat individual homes, which requires an expensive distribution network expansion, can be largely avoided by connecting more homes to district heating and increasing the deployment of heat pumps. Better thermal insulation is also strongly needed to ensure the correct sizing and efficient use of all heating systems.

There is also a need for greater efforts to decarbonise the gas supply through the increased use of biomethane and the development of a market for renewable and low-carbon hydrogen. Biomethane is particularly useful as it is directly compatible with existing co-generation plants, gas networks and gas storage facilities. Biomethane offers additional value by creating economic value from waste streams (e.g. from agriculture, agro-food industry, animal waste or biodegradable municipal waste). The EPP2040 estimates that biomethane production could reach approximately 2 bcm by 2030; however, Poland's technical biomethane production has been estimated by the European Commission at up to 9 bcm and remains largely untapped. Poland is working to introduce a regulation enabling the injection of biomethane into the gas grid. The government should take stronger steps to encourage growth in biomethane production and use.

Efficient and competitive markets for renewable and low-carbon gases (including biomethane and hydrogen) are also needed for these gases to play a significant role in decarbonising gas supply. The government should foster the development of these markets, taking into account lessons learnt from the liberalisation of the gas and electricity sectors in EU member states and other countries. The development of renewable gases would also be assisted by more integrated planning of electricity and gas networks, non-discriminatory third-party access to gas networks (including storage), and access to the wholesale gas market. The government should also closely monitor progress on the goals set in the Polish Hydrogen Strategy.

Poland is still in the process of developing a liberalised natural gas market. Household gas prices are still subject to tariffs approved by the ERO until the end of 2023. The state-owned PGNiG Capital Group dominates Poland's gas sector, controlling most domestic production, most imports, all gas storage, and in 2020 accounted for 91% of the wholesale market and 86% of the retail market. According to the ERO's annual report, a key reason for the growing dominance of PGNiG on the Polish market is the introduction of a mandatory storage obligation, including for companies that do not supply protected consumers or that import gas solely for their own use.

The dominant position of the PGNiG Capital Group throughout the gas market value chain and the storage obligation for all suppliers are barriers for increased competition, and the planned revision of this framework will facilitate the growth of competition.

Recommendations

The government of Poland should:

- ❑ Avoid long-term lock-in of natural gas in the energy mix and financing assets that may become stranded. The expansion of gas infrastructure (including generation, transmission and distribution, and heat production) should therefore be future-proof, enabling the use of renewable and low-carbon gases (including hydrogen), when available on the market.
- ❑ Support investments in the production of renewable and low-carbon gases, including biomethane and hydrogen. The gradual phase-out of natural gas from the energy mix should be streamlined through credible plans or commitments to increase the use of renewable and low-carbon gases, especially in electricity generation, energy storage and heat production, to give investors a clear perspective.
- ❑ Foster the development of competition on emerging renewable and low-carbon gas markets (including biomethane and hydrogen) and take into account the lessons learnt from the liberalisation of the gas and electricity sectors in EU member states and other countries.
- ❑ Consider full ownership unbundling of gas storage facilities. This would improve market conditions by creating a level playing field for all market participants.
- ❑ Support competition on the wholesale and retail market segments by lowering the barriers for new entrants, removing regulatory barriers on storage and actively promoting consumer choice by providing for objective and up-to-date price comparison tools.

References

ACER (European Union Agency for the Cooperation of Energy Regulators) (2021), ACER Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2020,

https://extranet.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/ACER%20Market%20Monitoring%20Report%202020%20%E2%80%93%20Energy%20Retail%20and%20Consumer%20%20Protection%20Volume.pdf

EC (European Commission) (2020), Impact of the Use of the Biomethane and Hydrogen Potential on Trans-European Infrastructure, https://energy.ec.europa.eu/impact-use-biomethane-and-hydrogen-potential-trans-european-infrastructure_en

EC (2019), November infringements package – Commission takes further steps to ensure member states respect EU energy rules (web page), https://ec.europa.eu/info/news/november-infringements-package-commission-takes-further-steps-ensure-member-states-respect-eu-energy-rules-2019-nov-27_en

ICIS (Independent Commodity Intelligence Service) (2019), Polish TSO to auction Yamal pipe capacity as transit deal ends (web page), <https://www.icis.com/explore/resources/news/2019/06/04/10374390/polish-tso-to-auction-yamal-pipe-capacity-as-transit-deal-ends>

IEA (International Energy Agency) (2022a), Natural Gas Information (database) <https://www.iea.org/data-and-statistics/data-product/natural-gas-information> (accessed on 9 March 2022)

IEA (2022b), Energy Prices (database), <https://www.iea.org/data-and-statistics/data-product/energy-prices> (accessed on 9 March 2022)

PGNiG (2022), Declaration of will to terminate Yamal contract effective (web page), <https://en.pgnig.pl/news/-/news-list/id/declaration-of-will-to-terminate-yamal-contract-effective-december-31-2022/newsGroupId/1910852?changeYear=2019¤tPage=1>

URE (Energy Regulatory Office) (2021), Characteristics of the gaseous fuels market (web page), <https://www.ure.gov.pl/pl/paliwa-gazowe/charakterystyka-rynku/9662,2020.html>

10. Oil

Key data (2020)

Domestic crude oil production: 19.6 kb/d in 2019, +42% since 2010; 18.8 kb/d in 2020

Net imports of crude oil: 541 kb/d in 2019, +16% since 2010, 503 kb/d in 2020

Domestic oil products production: 599 kb/d in 2019, +22% since 2010, 568 kb/d in 2020

Net oil products imports: 94 kb/d in 2019, +46% since 2010, 85 kb/d in 2020

Share of oil: 26% of TES, 1% in electricity generation and 2% in domestic energy production, 37% of TFC (2020)

Oil demand by sector: 675 kb/d in 2019, 631 kb/d in 2020 (domestic transport 72%, industry including non-energy consumption 22%, buildings 4%, international bunkering 2%, energy sector including power generation less than 1%)

Overview

Oil plays a key and growing role in Poland's energy sector. Oil covers most of Poland's transport energy demand (92% in 2020) and a notable share of industry energy demand (27%). Because of the historic reliance on domestic coal for building heating (especially in the residential sector), oil covers a small share of building energy demand (4% in 2020). The Covid-19 pandemic caused oil demand to drop by 6% in 2020, reaching a five-year minimum and halting an upwards trend. From 2010 to 2020, the share of energy demand covered by oil increased from 33% to 37%, driven by strong growth in transport oil demand, while oil demand in all other sectors declined.

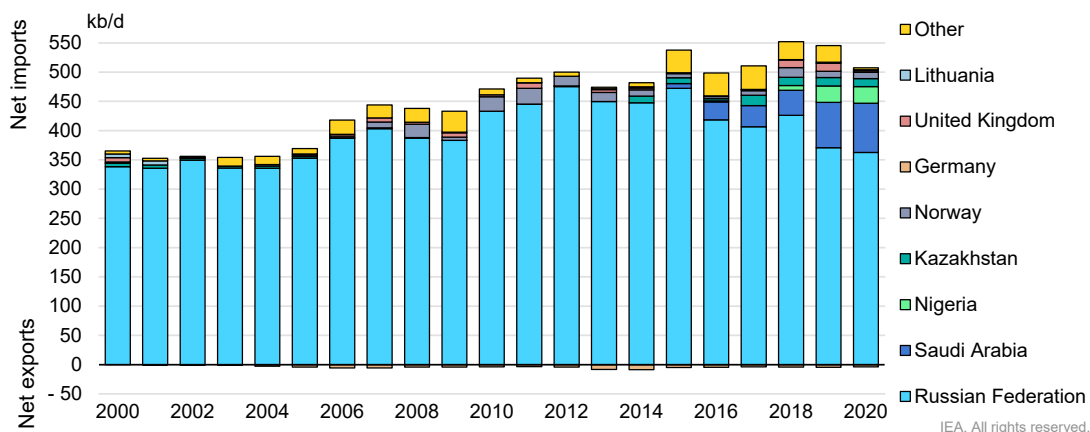
Poland's energy policy places a clear priority on investing in oil infrastructure to ensure oil security and reduce reliance on imports from Russia. Poland aims to reduce oil demand in line with energy transition goals and climate targets. There is an emphasis on electrification of road transport, which accounts for the largest share of oil demand (72% in 2020).

Crude oil trade

Most of Poland's crude oil trade consists of imports to supply its domestic refineries and petrochemical industry. From 2010 to 2020, Poland's crude oil supply increased from 547 thousand barrels per day (kb/d) to 616 kb/d. Imports account for most of the crude oil supply (98% in 2020) and come mainly from Russia (Figure 10.1). Crude oil imports are delivered via the Druzhba pipeline (connected to production in Kazakhstan and Russia) and via international shipping at the Naftoport oil terminal in Gdańsk. Thanks to significant

expansion of oil port infrastructure since 2014, crude oil delivered via ship rose from 35% to 42% of imports from 2015 to 2020, while the share of imports from Russia dropped from 89% to 70%. Poland has a small production of crude oil, which increased from 13.9 kb/d to 18.9 kb/d from 2010 to 2020. Most of Poland's domestic crude production is delivered to refineries or storage sites in Poland. Poland also exports a small amount of crude oil to Germany (4.0 kb/d in 2020).

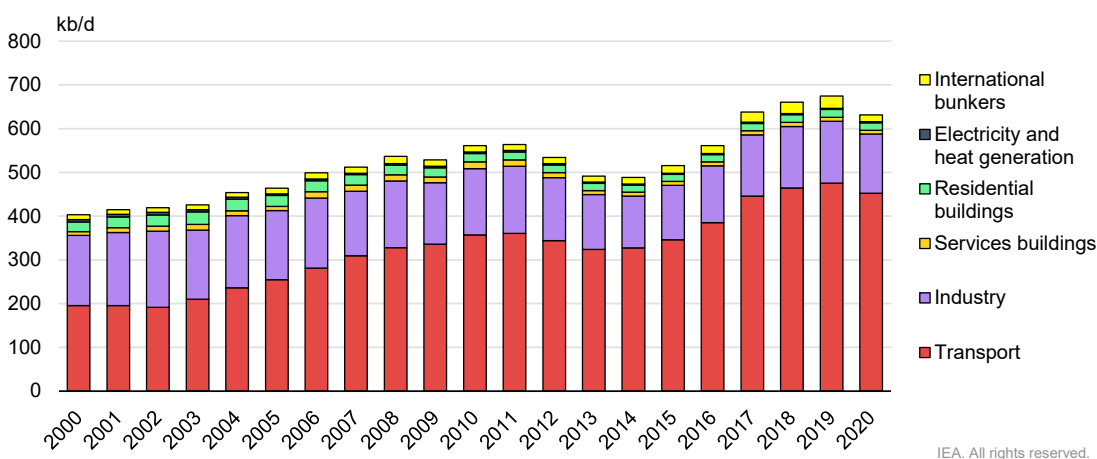
Figure 10.1 Poland's crude oil, trade by country, 2000-2020



Oil products demand, production and trade

Most of Poland's demand for oil products comes from the transport sector (72% in 2020), mainly from road freight transport (42%) and road passenger transport (30%), followed by industry (22%), international bunkers (5%), residential buildings (3%), service sector buildings (1%) and electricity generation (less than 1%) (Figure 10.2).

Figure 10.2 Oil products demand by sector in Poland, 2000-2020



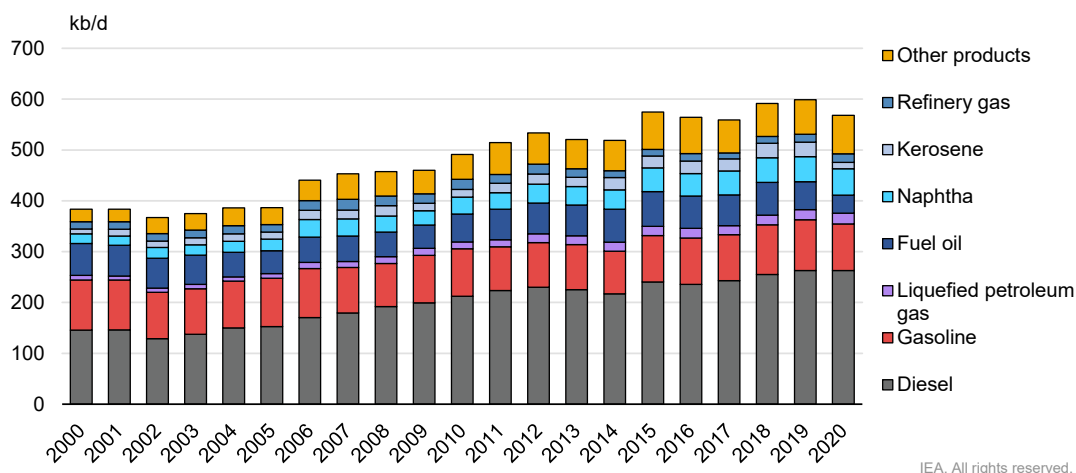
From 2010 to 2020, Poland's oil products demand experienced overall growth from 561 kb/d to 631 kb/d, driven by higher demand from the transport sector (357 kb/d to 452 kb/d), while demand in all other sectors declined: industry (129 kb/d to 119 kb/d), buildings (35 kb/d to 25 kb/d), and electricity and heat generation (3.4 kb/d to 2.6 kb/d). Poland's transport sector is notable for the high share of vehicles fuelled with LPG, which accounted for 15% of the passenger car fleet and 74% of LPG demand in 2020.

The notable drop and rebound in transport oil products demand from 2010 to 2015 does not accurately reflect actual transport energy demand, but was driven by grey market sales of illegally imported transportation fuels, mainly diesel. Poland's oil market association estimates that grey market sales could have accounted for up to 20% of total fuel sales from 2011 to 2015 (POPiHN, 2015). Legislative and enforcement actions taken in 2016 helped to significantly reduce grey market sales, which is reflected in the notable demand increases seen in 2016 and 2017.

The Covid-19 pandemic notably affected transportation fuel demand. Total oil demand decreased by 5% in 2020 with respect to 2019. Gasoline demand was especially hit by the pandemic, dropping to minimum levels in April 2020, to reach 2019 demand levels again in June 2020. Compared to 2019, gasoline demand in 2020 decreased by 6.1% and diesel demand by 1.8%. In the first half of 2021, diesel demand increased by 3% compared to 2019.

From 2010 to 2020, Poland's oil products production increased from 491 kb/d to 568 kb/d, with most of this increase coming from higher production of diesel (212 kb/d to 263 kb/d), with smaller production increases for gasoline, LPG (13 kb/d to 21 kb/d), naphtha (33 kb/d to 52 kb/d) and kerosene (Figure 10.3).

Figure 10.3 Oil products production by type in Poland, 2000-2020



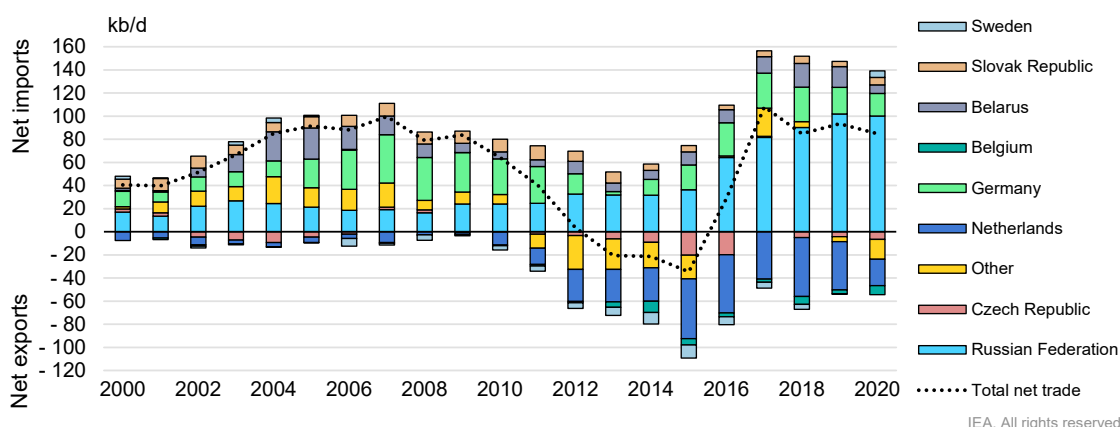
Source: IEA (2022).

Domestic production is sufficient to cover most oil products demand and supports a notable level of exports; however, imports are still needed, mainly for road transportation fuels. In 2020, imports covered 8% of gasoline demand, 28% of diesel demand and 82% of LPG demand. Poland has been a net importer of oil products for most of the past two decades (Figure 10.4).

The strong shift in net trade from imports to exports from 2010 to 2015 was mainly a result of Polish refineries seeking export markets for transportation fuels because grey market sales took such a large share of the domestic market. Measures taken in 2016 to address grey market sales drove a strong shift back to net imports. Since peaking at 108 kb/d in 2017, net imports declined to 85 kb/d in 2020, but are still at historically high levels.

Russia is the main source of oil products imports and reliance on Russian imports has been increasing. In 2020, Russia accounted for 54% of total imports, followed by Germany (17%). The Netherlands has been the main destination for Poland's oil product exports over the last decade.

Figure 10.4 Poland's oil products net trade by country, 2000-2020



Source: IEA (2022).

Infrastructure

Poland's oil infrastructure includes one major oil port, two large refineries, two main crude oil pipelines, four main oil products pipelines, and notable storage capacity for crude oil and oil products (Figure 10.5).

Figure 10.5 Poland's oil infrastructure, 2020



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Refining

Poland has two major refineries with a total capacity of 556 kb/d of crude oil in 2020. The largest refinery (343 kb/d) is located at Płock in central Poland and owned by PKN ORLEN. The other (213 kb/d) is located in Gdańsk near the Baltic Sea and owned by LOTOS. In 2019, a EUR 600 million project increased the production capacity of the Gdańsk refinery by around 20 kb/d, mainly for diesel and jet fuel. In 2021, PKN ORLEN started a EUR 2 billion project to expand the Olefins Complex in Płock as a key project under the strategic Petrochemical Development Programme and the largest petrochemical investment in Europe over the last 20 years. The investment is scheduled to be completed in the first quarter of 2024, with production starting in early 2025. In recent years, both the Płock and Gdańsk refineries have been operating at close to full capacity. There are also four small refineries in southern Poland used mainly as storage depots and to produce asphalt. In 2020, these refineries processed only 5.5 kb/d of crude.

Ports

The Naftoport oil terminal, located in Gdańsk, is Poland's only major oil port. It supports crude oil imports and oil products imports and exports. In 2020, the port capacity was 847 kb/d of crude oil and oil products, while around 239 kb/d of crude oil and 31 kb/d of oil products were shipped through the port. The port can receive very large crude carriers with a maximum dead weight of 2.3 million barrels (mb) and is connected by pipelines to tanks for crude oil and oil product tanks at the Gdańsk refinery. PERN is the majority owner of the Naftoport oil terminal; other shareholders are PKN ORLEN, LOTOS Port Północny, J&S Service and Investment, and the State Treasury. From 2016 to 2020, PERN made notable investments to expand the port's capacity for receiving and storing oil, including 5 mb of new tank capacity for different crude grades.

Pipelines

Poland has two major pipelines for importing and transporting crude oil. The Druzhba pipeline is a key source of oil imports from Kazakhstan and Russia to Poland and several other EU countries. Within Poland, the Druzhba pipeline consists of an east section (1 000 kb/d of capacity) running from the Belarussian border to the Płock refinery and a west section (540 kb/d of capacity) running from the Płock refinery to the Schwedt refinery in Germany. The Druzhba pipeline also transports crude oil from Poland's onshore oil fields and is connected to several of the largest crude oil storage facilities.

Poland's other major crude oil pipeline is the Pomeranian pipeline (550 kb/d of capacity), which transports crude oil arriving at the Naftoport oil terminal to the refinery in Płock. The Pomeranian pipeline is also used to deliver crude oil supplied via the Druzhba pipeline to the refinery in Gdańsk. The connection between the two pipelines is located close to the refinery in Płock. A project adding a second line to the Pomeranian pipeline is under consideration, with a final investment decision expected in 2022. If completed, it would expand total capacity to 1 100 kb/d and allow crude oil to be pumped in two directions simultaneously.

Poland's oil products pipeline network consists of four main lines connecting the Płock refinery to regional storage depots. Three of these lines (owned by PERN) run to Nowa Wieś Wielka (46 kb/d), to the Warsaw area (21 kb/d) and to Koluszki (80 kb/d) with an extension to Boronów (24 kb/d). The fourth pipeline (75 kb/d; owned by PKN ORLEN) runs to depots in south-west Poland. PERN is working to increase the capacity of the pipeline running to Boronów and to build a new pipeline from Boronów to Trzebinia (30 kb/d). The project is expected to be completed by the end of 2022.

Storage

In 2020, Poland had around 55 mb of crude oil storage and around 33 mb of oil products storage. There are two crude oil tank farms located along the Druzhba pipeline, one near the eastern border of Poland in Adamowo (5 mb) and one near Płock (9.2 mb). Two crude oil tank farms and tanks in refinery in Gdańsk with a combined capacity of 15 mb are located near the Naftoport terminal and refinery in Gdańsk. Crude oil is also stored in seven underground salt caverns (26.4 mb) that are connected to the west section of the Druzhba pipeline at a site owned by IKS Solino, a subsidiary of PKN ORLEN. This site also has 11.3 mb of oil products storage capacity in three salt caverns connected by pipeline to the Płock refinery. Additional oil products storage capacity (13.5 mb) is spread across Poland at 19 storage depots owned by PERN. The five largest ones are

connected by pipeline to the Płock refinery. PERN has plans to add 1.2 mb of oil products storage capacity at existing depots.

Market structure

Poland's markets for crude oil and oil products are fully liberalised with prices set by market forces. However, there is a high level of market concentration and limited competition at the wholesale and retail levels. State-controlled companies own all domestic oil production and refining capacity in Poland and account for most of the wholesale oil products supply (almost 75% in 2020).

PKN ORLEN is active in oil refining and oil product sales in Poland, the Czech Republic, Germany, the Baltic states and Ukraine. The State Treasury holds a golden share that gives it full control of PKN ORLEN, which owns Poland's largest refinery (Płock) and is the largest wholesale and retail supplier of oil products in Poland. IKS Solino (a subsidiary of PKN ORLEN) owns the largest single crude oil and oil products storage facility (ten salt caverns in Western Poland). LOTOS is also a vertically integrated oil company active in production, refining and oil product sales in Poland. Poland's State Treasury holds a controlling share of LOTOS (53.19% in 2020). LOTOS Petrobaltic is the only Polish company producing oil and gas in the Baltic Sea and is the second-largest producer of crude oil in Poland (24% of production in 2020). LOTOS owns Poland's second-largest refinery (Gdańsk) and is the second-largest wholesale and retail supplier of oil products.

PGNiG is a Polish state-controlled (72%) oil and natural gas company, active in the exploration and production of gas and crude oil, gas import, storage and distribution, and sales of gas and crude oil. PGNiG is the dominant producer of crude oil in Poland (76% of production in 2020) and the only company active in onshore production.

PERN is a 100% state-owned company responsible for oil transportation in Poland. It operates most pipeline infrastructures for the transport of crude oil and oil products and owns just under 50% of Poland's crude oil storage and just over 50% of oil products storage.

In 2018, the State Treasury decided to merge LOTOS and PKN ORLEN. The merger received antitrust approval from the EC on numerous conditions, including the requirement that LOTOS would sell significant assets to third parties (30% of the Gdańsk refinery, 80% of its fuel stations, several fuel depots, and some subsidiaries in the field on infrastructure and logistics). The merger is expected to be completed by mid-2022. In 2021, the State Treasury decided to examine the creation of a holding company that will also merge PGNiG into PKN ORLEN. The government aims to finalise this process by the end of 2022 (this requires approval from the EC and Poland's Office of Competition and Consumer Protection). The State Treasury plans to hold a 50% stake in the holding company, which would control the majority of the oil and gas value chains in Poland.

Crude oil market

Poland's two refining companies (PKN ORLEN and LOTOS) purchase most of their crude oil supply via long-term contracts with the Russian oil company Rosneft, with these imports delivered via the Druzhba pipeline and the Naftoport. Russia is still the dominant crude supplier, but its share of supply has been decreasing (from 95% to 70% between 2010 and 2020), with an increasing share of crude oil supply coming from contracts with a variety of global traders (mainly Saudi Arabia and Nigeria).

Reducing dependence on Russian imports has been supported by a variety of activities aimed at diversifying crude oil supplies, including investment at the Naftoport oil terminal (e.g. to allow handling and storage of different grades of crude oil). The share of crude oil supply covered by Poland's two domestic producers (PGNiG and LOTOS Petrobaltic) has been stable in recent years, at 4% in 2020.

Oil products market

Poland's wholesale market for oil products is highly concentrated. In 2020, PKN ORLEN accounted for 53.3% of fuel sales and LOTOS for 20.5%. BP is the only other company with a notable market share (7.5%). In 2020, there were 9 154 fuel stations in Poland selling at least one type of fuel (250 less than in 2019): 6 436 offered diesel, gasoline and LPG; 1 445 offered diesel and gasoline; 932 offered only LPG; and 300 offered only diesel. Most stations (5 705, 62%) are run by small regional chains and independent distributors. PKN ORLEN is the largest single controller of retail stations (1 811, 20%), with 1 380 owned and 431 franchised, followed by Shell (375, 4%), BP (363, 4%), LOTOS (324, 3.5%), CircleK (276, 3%), hypermarkets (184, 2%) and Amic (116, 1%). LPG companies (not owned by PKN ORLEN or LOTOS) account for most retail LPG sales.

Prices and taxation

Retail oil product prices in Poland are composed of wholesale prices, distribution margins, VAT (23%) and additional taxes depending on the type of fuel (Table 10.1). The proceeds of the road tax go to the National Road Fund (80%) and the Rail Fund (20%) for construction and maintenance. The emission tax (introduced in 2019) is paid by fuel producers and importers, with 95% of the proceeds going to the National Fund for Environmental Protection and Water Management, which co-finances a variety of energy transition programmes, including those for EVs and alternative fuels. The remaining 5% goes towards expanding local bus routes. A stockholding fee is levied on all oil products and crude oil and funds the purchase and maintenance of government-owned oil stocks that are used in supply emergencies.

Table 10.1 Oil product taxes in Poland, 2020

Oil product taxation	EUR per	Excise duty	Road tax	Emission tax	Stockholding fee (EUR/GJ)*	Total (EUR/GJ)*
Transportation fuels						
- Gasoline (regardless of share of biofuels)	1 000 L	333	36.3	17.6	0.55	12.11
- Diesel (regardless of share of biofuels)		252	74.5	17.6	0.55	10.17
- LPG	1 000 kg	142	43.6		0.22	4.25
Heating fuels						
- Diesel	1 000 L	51			0.55	1.98
- Light fuel oil		51			0.55	1.98
- Heavy fuel oil	1 000 kg	14.1			0.55	0.89
LPG	Gigajoule	0.28			0.22	0.48

* Estimated equivalent based on the following energy densities: gasoline 33.5 MJ/L, diesel 35.8 MJ/L, LPG 46 MJ/kg, CNG 38.5 MJ/kg, LNG 53.5 MJ/kg, light fuel oil 36 MJ/L, heavy fuel oil 41 MJ/kg.

Poland provides some tax exemptions and reductions for certain uses of oil products. There is refund of 0.22 EUR/L for diesel used for agriculture, with an upper limit based on the hectares of agricultural land or number of animals. Fuel used for domestic and international commercial aviation and shipping is exempted from taxation. The excise duty for diesel used for heating is significantly lower than for diesel used for transport. LPG used for heating is exempt from the excise duty. The stockholding fee is not charged on crude or oil products exports, oil products used in refining, marine bunkers, oil products refined from domestic crude or biofuels.

In the first quarter of 2021, Poland's price for automotive diesel was the eighth lowest among IEA member countries (1.29 USD/L), with a tax rate of 49%, compared to the IEA average of 1.38 USD/L and a tax rate of 49%. Poland's price for premium unleaded gasoline (95 RON) was the fifth lowest among IEA member countries, at 1.29 USD/L, with a tax rate of 53%, compared to the IEA average of 1.53 USD/L and a tax rate of 56%. For light fuel oil, Poland's price was the eighth highest among IEA member countries, at 0.85 USD/L and a 26% tax rate, compared to the IEA average of 0.91 USD/L and a tax rate of 33%. Domestic prices for crude oil and oil product prices are significantly affected by any changes in the exchange rate between the Polish zloty and the US dollar.

Oil policy

Poland's energy policy focuses on maintaining security of oil supply and defines a range of measures to reduce oil demand in line with energy transition goals and climate targets. The key documents defining Poland's plans for the oil sector are the Policy for Logistics Infrastructure in the Oil Sector (adopted in 2017) and the EPP2040, adopted in 2021. The main policy document for Poland's transport sector is the Strategy for Sustainable Transport Development to 2030, adopted in 2019.

Poland has developed numerous measures to reduce oil demand, especially in the transport sector (see Chapters 4 and 5). There is a strong focus on electrification of road transport (private vehicles, public transport and government fleets), which is supported through subsidies for EVs, investments in EV charging and other measures. There is also support for increased use of vehicles fuelled by CNG, LNG and hydrogen. The Strategy for Sustainable Transport Development to 2030 includes measures to shift passenger and freight transport from roads to rail and waterways, electrify road transport, improve public transport, promote walking and bicycling, implement low-emission zones, and minimise the negative impact of air transport on the environment.

Poland has a mandate for blending biofuels into diesel and gasoline used for transport, with the required share by energy content set at 8.8% in 2021 and increasing to 9.1% in 2024. The government is working with the oil industry to examine options for transitioning to the production of low- and zero-carbon fuels, including advanced biofuels, hydrogen and synthetic fuels.

Poland's energy policy places a strong emphasis on ensuring oil security, in particular reducing reliance on imports from Russia. Poland has undertaken or is planning investments in port, pipeline and storage infrastructures to allow a higher share of crude supply to be delivered via international shipping at the Naftoport and transported to Polish refineries, and to increase security of oil products supply. The EPP2040 defines the second line of the Pomeranian pipeline as a strategic project and notes the government's

endorsement of other recently completed and planned projects for diversifying supply and increasing security of delivering oil products. The EPP2040 notes that the government is analysing the extension of the Central Europe Pipeline System (CEPS) to Poland and other Baltic states. The CEPS is Europe's largest oil products pipeline network covering Belgium, France, Germany and the Netherlands. It is operated by the North Atlantic Treaty Organization (NATO) and serves primarily to ensure delivery of fuels to NATO military bases, but is used extensively for delivering commercial fuels.

Poland has taken steps to improve the forecast of oil demand. The first forecast of national demand for crude oil, oil products and oil storage was prepared in 2019. It covers ten years and is to be updated every two years. The goal of the forecast is to provide the domestic oil sector with an appropriate basis for investment decisions. To support oil security and limit oil imports, the government supports the exploration for domestic crude oil deposits to replace supply from depleted fields.

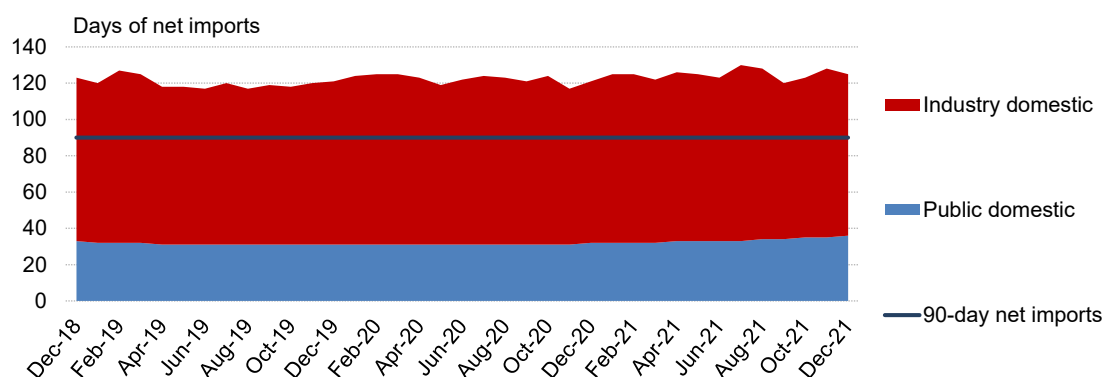
Poland has undertaken measures to address grey market sales of transportation fuels. In 2016, the government adjusted the process for collecting the VAT on liquid fuels to increase transparency and tracking of sales, and strengthened the ERO's control over transport fuel markets, including the power to revoke fuel-trading licences. In 2017, the government established a system to monitor road and rail transport of sensitive commodities (including fuels). In 2019, additional changes were made to increase the transparency of VAT collection of transport fuels.

The government is developing an online platform for reporting fuel sales by retailers, integrating fuel market data (currently collected by several institutions) and exchange of information between authorities supervising the transportation fuel market. The system is planned to be launched in 2023 based on data transferred to the ERO and the Governmental Strategic Reserves Agency (RARS) and data from the Ministry for Energy and the Ministry for Finance. In the following years, the system will be expanded with new data sets and to allow other authorities access to the data.

Emergency response policy

Poland maintains stocks of crude oil and oil products to ensure adequate supplies during emergency situations and to meet IEA and EU stockholding obligations. The Act on Stocks sets a 90-day stockholding obligation (based on net imports), which is divided between 57 days of compulsory stock held by industry and agency stocks held by RARS, which must cover at least the difference required to have 90 days. The Intervention Stocks Fund, financed by stockholding fees paid by oil sector companies, supports the RARS in purchasing and maintaining agency stocks. The RARS does not own oil storage capacity, but holds public stocks at industry facilities. Oil sector companies are required to hold private stocks at their own cost. The RARS is responsible for monitoring private stocks. Stocks supporting emergency response may be generally commingled with commercial stocks that support normal industry operations.

Poland has consistently held stocks above the 90-day obligation. At the end of December 2021, Poland held 125 days of stocks (Figure 10.6). All of Poland's stocks are held domestically, mostly by industry. In December 2021, industry stocks accounted for 73% of total stocks and public stocks for 27%.

Figure 10.6 Emergency oil stocks by type in Poland, December 2021

IEA. All rights reserved.

Source: IEA (2021).

The Act on Stocks defines emergency response mechanisms to address both domestic and international supply disruptions. In both cases, the Minister of Climate and Environment is responsible for evaluating the situation and determining the appropriate level of response and the measures to be taken. Possible measures are defined in a handbook, which indicates that the first response is the release of compulsory stocks, followed by the release of agency stocks and, as a last resort, demand restriction measures. Poland conducts emergency response exercises with stakeholders, including exercises run by the National Security Bureau with dedicated oil disruption scenarios, to test emergency capabilities.

The composition of stocks released in an emergency and the legal instrument used (government decision or ministerial regulation), depends on the nature of the disruption (crude oil or oil products; regional, national or international response). The act does not limit the use of oil demand restraint measures, but requires that they be introduced by a regulation of the Council of Ministers at the request of the Minister of Climate and Environment, and that the public be informed through radio and television broadcasts. The Department of Oil and Transportation Fuels within the Ministry of Climate and Environment monitors the effects of any actions taken.

Poland's oil emergency response system has proven effective at addressing major supply disruptions. In April 2019, more than 1 million tonnes of contaminated crude oil destined for refineries in Poland and Germany was pumped into the Druzhba pipeline. The extremely high concentrations of organic chlorides detected in the oil would have resulted in major damage and safety concerns at refineries. In response, PERN stopped all transmission via the Druzhba pipeline, Poland's main source of crude oil supply. A large effort was required to remove the contaminated crude oil and to clean affected sections of the pipeline; imports via the Druzhba pipeline were not possible for 46 days.

Poland's refineries coped with the crisis thanks to the immediate release of crude stocks, increased crude imports through the Naftoport and higher use of the Pomeranian pipeline. Stocks released to address the crisis totalled 8.1 mb (11% of stocks). Over the period, supplies by sea with the support of stock releases ensured security of supply, with no interruptions in fuel supplies to consumers. The contaminated crude was blended with good quality crude to allow it to be used, with the last contaminated crude processed in July 2021.

Assessment

Oil plays a major role in Poland's energy system, covering most transport energy demand and around a quarter of industry energy demand. Demand for oil has been increasingly driven by a strong growth in road transport oil demand, while oil demand has declined in other sectors. Poland has a small domestic crude oil production, but is reliant on crude oil imports, mainly from Russia.

Poland has developed measures to reduce oil demand, especially in the transport sector. These include targets and financial support for EVs and charging infrastructure, and measures to increase the use of natural gas-powered vehicles. There are also goals for a modal shift away from private cars to public transportation and active mobility. However, the EPP2040 estimates only small reductions in Poland's oil demand, with crude oil demand peaking at 547 kb/d in 2020, declining slightly to 538 kb/d in 2030 and remaining at this level through 2040, and oil products demand peaking in 2020 at 627 kb/d, slightly declining to 624 kb/d in 2030 and to 613 kb/d in 2040.

A separate study prepared for the government estimated that demand for gasoline will increase from 93 kb/d to 105 kb/d from 2020 to 2026 and remain at that level through 2030, while demand for diesel is estimated to increase from 371 kb/d to 408 kb/d from 2020 to 2026 and remain at that level through 2030. In 2020, oil demand decreased by 5% due to the Covid-19 pandemic. However, after dropping in April 2020, oil demand started to recover quickly, and at the end of the year was higher than initial government estimates. Demand continued to increase in 2021.

Poland should quickly elaborate a robust policy to reduce oil demand across the entire economy. The government is encouraged to examine the effectiveness of current policies and determine what adjustments are needed to support sustained reductions in oil demand that are in line with its energy transition goals and climate targets. The current approach to increasing EV adoptions looks promising, but Poland is in the very early stages of developing an EV fleet and needs to closely monitor the effectiveness of measures pushing for EVs. From 2012 to 2020, the number of registered EVs grew from just 66 to almost 12 500, but this still represents just 0.05% of the total passenger car fleet, compared to the EU average of 0.9%. More aggressive targets for electrification of government fleets and company cars could help to accelerate the development of an EV market. The policy on modal shift is less clear and lacks a comprehensive approach that addresses the need for behavioural changes.

Poland is making significant infrastructure investments to increase oil security, with a focus on diversification away from reliance on imports from Russia. This has included expanding receiving and storage capacity and the ability to handle a wider range of crude grades at Naftoport. There have also been investments to allow Poland's refineries, originally designed to process heavier Russian crudes, to process a wider range of crude grades. As a result of these efforts, supplies have become more diversified and from 2015 to 2020, the share of crude imports from Russia dropped from 89% to 70%.

Poland is planning further investments to increase and diversify oil supply, including adding a second line to the Pomeranian pipeline and expanding oil pipeline and storage capacity. While new large investment projects may increase oil security, they need to be carefully planned and thoroughly assessed, as they present risks of stranded assets given the need to reduce oil demand in line with climate targets. The government should also consider

how limited investment capital could be directed to projects that support both energy security and energy transition. For example, investment in EV charging stations would help to reduce oil imports and emissions.

Poland's markets for crude oil and oil products are fully liberalised, with prices set by market forces. However, there is a high level of concentration and limited competition at the wholesale and retail levels, and the Polish state owns or controls companies that account for almost all of the refining sector in Poland. Two incumbent companies (PKN ORLEN and LOTOS) have dominant market positions. In 2020, PKN ORLEN accounted for 53.2% of wholesale fuel sales and LOTOS for 20.5%.

The government is planning to merge both LOTOS and PGNiG into PKN ORLEN to create a large vertically integrated energy company. The merger of LOTOS into PKN ORLEN has been approved by the EC, with requirements for LOTOS to sell notable assets to third parties, and is expected to be complete in mid-2022. The merger of PGNiG into PKN ORLEN is being planned and still requires approval from the EC and Poland's Office of Competition and Consumer Protection. The government aims to complete the second merger by the end of 2022, with the State Treasury planning to hold a 50% stake in PKN ORLEN after all the mergers have been made. The resulting company would control the majority of the oil and gas value chains in Poland. While this merger presents opportunities for increased efficiency and an improved market position for PKN ORLEN at a European level, it also presents notable risks of further increasing market concentration and reducing competition. The government should thoroughly evaluate the merger's impact on competition and more broadly should evaluate what measures can be taken to increase market competition.

To date, the most effective measure in reducing road transport oil demand in Poland has been a biofuels blending mandate that obligates fuel producers and importers to have certain share of biofuels by energy content in total fuel sales (8.8% in 2021, increasing to 9.1% in 2024). Poland relies on first-generation biofuels in achieving the targets, with very little use of advanced biofuels. EU regulations require increased use of advanced biofuels and place limits on use of first-generation biofuels. Biofuels covered only 4% of Poland's transport demand in 2020, one of the lowest among IEA countries.

Additional efforts are needed to ensure that biofuels can play an important role in reducing transport oil demand. The government should be more aggressive at increasing the mandated share of biofuels (with a focus on advanced biofuels) and at introducing retail fuel products with higher shares of biofuels. Biofuels are taxed at the same rate as fossil transportation fuels, and most biofuels are currently more expensive than fossil transportation fuels. Taxation of biofuels should be eliminated, as this would reduce the cost impact of higher biofuel blending mandates and support the introduction of retail products with higher shares of biofuels. The government should also continue to work with industry to increase domestic biofuels production, especially of advanced biofuels, to support economic development and give a clear role for the industry to support the energy transition.

Poland's transport sector is notable for the high share of LPG fuelled vehicles. In 2020, LPG fuelled vehicles accounted for 15% of the passenger car fleet and 74% of LPG demand. Domestic refineries cover only 18% of Poland's total LPG demand, with most demand covered by imports from Russia. LPG is given favourable tax treatment, making

it a low-cost transportation fuel. The government should ensure that measures supporting electrification of road transport are also effective at transitioning consumers away from LPG vehicles.

Poland has effectively tackled the issue of grey market fuel sales through strong legislative and enforcement actions taken from 2016 to 2019. In 2017, there were significantly higher revenues related to fuel sales (VAT, excise duty and others fees). In 2017, Poland's two refiners also registered a 20% increase in domestic fuel sales, close to the estimated share of sales going to the grey market (15-25% annually over the period 2010-16). The government is developing an online platform to improve the reporting and transparency of fuel sales data. The system is planned to be launched in 2023. The IEA commends Poland's success in reducing grey market sales and encourages the government to remain vigilant.

Poland's oil emergency response system has proven effective at addressing major supply disruptions. The 2019 emergency resulting from contaminated crude oil in the Druzhba pipeline was quickly and effectively addressed by releasing stocks and increasing imports arriving via ship. Poland also conducts emergency response exercises to increase preparedness. However, the government should consider how changing oil markets and the transition to a low-carbon energy system will influence oil security and adapt its emergency response plans and exercises accordingly.

Recommendations

The government of Poland should:

- ❑ Develop a comprehensive oil and transport policy that clearly supports reductions in oil demand across all sectors in line with energy transition goals and climate targets.
- ❑ Incentivise greater use of biofuels, especially advanced biofuels, to decrease fossil fuel demand and work with industry to increase domestic biofuels production. End taxation of biofuels to support the goal of greening the transport sector.
- ❑ Reconsider the need for large investments in the oil sector, taking into account the risk of stranded assets and the need to direct limited capital to investments supporting Poland's energy transition.

References

IEA (International Energy Agency) (2022), Oil Information (database), <https://www.iea.org/data-and-statistics/data-product/oil-information> (accessed on 9 March 2022)

IEA (2021), Monthly Oil Data Service (database), www.iea.org/statistics

POPIHN (Polish Organization of Oil Industry and Trade) (2015), Oil Industry and Trade, <https://popihn.pl/wp-content/uploads/2021/05/Raport-za-2014-rok-wersja-angielska.pdf>

11. Nuclear

Overview

Poland has no commercial nuclear power plant in operation. However, the introduction of nuclear power is a key component of the EPP2040. The Polish Nuclear Power Programme (PNPP), adopted in 2014 and updated in 2020, defines the measures and timeline for implementing nuclear energy in Poland and ensuring safe operations, decommissioning and waste storage. Poland aims for the first reactor with a capacity of 1-1.6 GW to be in operation by 2033 and for six reactors with a total capacity of 6-9 GW to be in operation by 2043. The government estimates that by 2040, nuclear energy could account for up to 16% of generation.

To meet its objectives on nuclear, Poland needs to achieve important milestones in the coming years, such as site selection, choice of the strategic co-investor and reactor technology, as well as the definition of the associated financing mechanism and contractual arrangements. The private sector expressed its interest in small modular reactors, which could complement the government's strategy to decarbonise hard-to-abate sectors in the long term.

Nuclear power policy

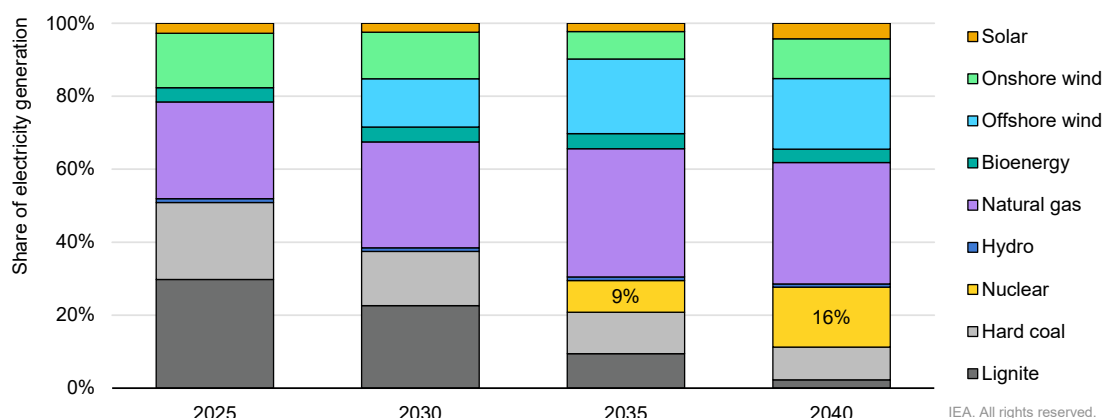
Although Poland has no commercial nuclear reactor in operation, subsequent Polish governments have considered nuclear power. In the 1980s, Poland initiated the construction of nuclear units but abandoned the projects after a ministerial council decision in 1990. Since 1974, the National Centre for Nuclear Research operates the multi-purpose research reactor Maria. This organisation also ran the research reactor Ewa for more than 35 years, which was decommissioned in 1995. As a result, Poland has developed domestic capabilities in the planning, regulation and operation of nuclear facilities, as well as in radioactive waste management. The plans to include nuclear power in the Polish electricity mix were revisited in 2009 as part of the 2030 Energy Strategy, and incorporated in the EPP2040. The EPP2040 outlines the construction of new nuclear power plants as a central aspect of Poland's plans to reduce coal-fired generation and decarbonise electricity generation.

The role of nuclear power beyond 2030

Energy security is a key priority for the Polish government. The decarbonisation strategy laid out in the EPP2040 thus consists of developing a diversified electricity mix with gas, offshore wind and nuclear power providing nearly 70% of electricity generation by 2040. Around 8-11 GW of offshore wind is expected to be operational by 2030, followed by 6-9 GW of nuclear power by 2040. In cumulative terms, these two

technologies will capture 70% of the total planned public investment in low-emitting sources in Poland for the next 20 years, approximately USD 30 billion each. The diversification of the electricity sources will allow Poland to take advantage of the complementary benefits of each technology to progressively abandon coal generation while minimising security of supply risks (Figure 11.1).

Figure 11.1 Projected share of nuclear power generation in Poland, 2025-2040



Source: Poland, Ministry of Climate and Environment, 2021.

Deployment of offshore wind, onshore wind and solar PV will reduce the share of coal-fired generation. Natural gas is set to become the main source of flexibility in the system to back up the increase of variable renewables generation. Some CO₂ emissions reductions will be achieved through coal-to-gas fuel switching too. Nuclear power generation is expected to play an increasing role beyond 2030, accounting for 16% of electricity generation by 2040. The amount of low-carbon and firm electricity coming from nuclear will further reduce the share of coal-fired generation, while contributing to the stability of the electricity system. As a result, the share of coal in electricity generation should shrink to 11% by 2040, from 68.5% in 2020. As a result, total carbon emissions of the power sector could fall more than 65% over the same period.

The Polish government has expressed concerns about retail electricity prices and energy poverty. The total costs analysis provided in the EPP2040 and further developed in the PNPP illustrates how nuclear new builds could lower total costs of the electricity system by keeping variable renewables integration costs in check, thanks to the availability of dispatchable power on demand. Large nuclear units also fit with the existing Polish electricity grid infrastructures, built around GW-scale generation plants, therefore reducing grid reinforcement needs. In addition, once built, nuclear reactors have low and predictable operational costs, which can be positive for households' electricity bills over the long term. If not adequately managed, the high financing costs of nuclear new builds can reduce these benefits. With the development of nuclear power, the Polish government also expects to reduce air pollution and to boost local economies to ensure a just transition, especially in those regions highly reliant on coal activities.

Coal also dominates residential heating and industrial applications in Poland. As a source of low-carbon heat, nuclear power could potentially play a role in decarbonising these sectors, as well as in the production of low-carbon hydrogen.

Main institutions

The Ministry of Climate and Environment is responsible for nuclear power policy and strategy in Poland. Through the Nuclear Energy Department – serving the role of Nuclear Energy Programme Implementing Organisation – the ministry evaluates and develops the necessary infrastructures and legal and organisational measures for the implementation of the PNPP. These activities are carried out in co-ordination with other relevant stakeholders, including other government agencies (e.g. the Office for Strategic Energy Infrastructure) and technical support organisations (e.g. the National Centre for Nuclear Research). Since April 2021, the government is the full owner of Polish Nuclear Power Plants (PEJ), the project company in charge of the nuclear programme. The ministry also aims to ensure a correct regulatory framework for the safe and effective operation of nuclear power facilities and long-term management of radioactive waste.

The National Atomic Energy Agency (PAA) is an independent agency in charge supervising and regulating nuclear facilities in Poland. These include the Maria and Ewa research reactors, the latter being decommissioned. The PAA also oversees activities involving radioactive sources, granting permits, and taking decisions related to nuclear safety and radiological protection. With regards to the PNPP, the Polish safety authority formulates the necessary safety and radiological protection requirements and verifies compliance with these standards at all stages of the life cycle of the nuclear facilities, from environmental and location assessments through to design, construction, commissioning, operation and decommissioning.

The Radioactive Waste Management Plant (ZUOP) is a state-owned company in charge of collecting radioactive waste from producers and its safe management. The waste comes from the research nuclear reactors and from other sectors such as radioisotopes in medicine. In the future, ZUOP will also manage the radioactive waste from the operation of commercial nuclear power plants.

Recent progress in the new nuclear build programme

Since the confirmation of nuclear power potential in Poland in 2009, one of the main achievements has been the definition and adoption of the PNPP. This strategic document frames nuclear policy in Poland and provides a clear rationale as well as objectives, tasks and milestones for the implementation of nuclear power in the country. The programme was initially approved by the Council of Ministers and published in 2014, after extensive public and cross-border consultations with neighbouring countries. A revised version of the PNPP that takes into account the new EPP2040 strategy and recent developments in the nuclear field was approved in October 2020.

The current PNPP aims to commission six nuclear units, representing a total capacity of 6-9 GW, with the first unit (1-1.6 GW) coming online by 2033 and the remaining units being commissioned every two to three years until 2043. The programme foresees the construction of two nuclear power plants, with three units each, to be put in operation between 2033 and 2037 (NPP1) and 2039-43 (NPP2). The detailed schedule is provided in Table 11.1. Important decisions such as the site selection as well as the choice of the co-investor and the reactor technology are expected to be taken in 2022, with construction of the first unit to start in 2026.

Table 11.1 Implementation schedule of the Polish Nuclear Power Programme

Year	Milestone
2022	Selection of technology for NPP1 and NPP2
2022	Obtaining an environmental and siting decision for NPP1
2022	Signing an agreement with the technology vendor and the EPC contractor
2026	Obtaining a construction permit and start of the construction of NPP1
2032	Obtaining a construction permit and start of the construction of NPP2
2033	The issuance of an operating licence by the National Atomic Energy Agency and the commissioning of the first reactor of NPP1
2033-43 (every 2 years)	The issuance of an operating licence and the commissioning of two more reactors at NPP1 and three reactors at NPP2

According to the PNPP, over the years, the government has considered more than 27 sites for the construction of new nuclear reactors. The final choice will be the result of a multi-criteria analysis that features environmental, technological, economic and social factors. The best possible sites are on the coast and at existing large-scale coal plants. As of 2021, the coastal sites of Lubiatowo-Kopalino and Żarnowiec are the preferred options and the associated environmental impact assessments, as well as seismic monitoring, are already being conducted (WNN, 2017).

The PNPP also sets priority tasks for the government, including the development of human resources and specific infrastructures (e.g. road and rail transport and power system upgrades), supporting the national industry, strengthening regulatory capabilities and building a communication strategy. In parallel, the Polish government is working to improve the legal provisions necessary to undertake nuclear investments in the country. The objective is to facilitate and accelerate the development of nuclear projects through a streamlined licensing and permitting process for each development stage. Among other measures, the Polish government is exploring the possibility of conducting parallel administrative proceedings and of introducing legal instruments facilitating data exchange between relevant stakeholders.

Peer reviews from the International Atomic Energy Agency (IAEA) confirm that Poland has made important progress in preparing its physical and regulatory infrastructure to license, build and operate new nuclear reactors. The Integrated Nuclear Infrastructure Review conducted by the IAEA in 2016 confirms that Poland effectively engaged with the recommendations of the previous review conducted three years prior (IAEA, 2016a). A new Integrated Nuclear Infrastructure Review meeting is expected to take place in the first half of 2023 to evaluate the Polish authorities' capacity to negotiate contracts and move towards the construction phase. Additional IAEA reviews were performed between 2016 and 2017 to assess Polish nuclear regulations (Integrated Regulatory Review Service) and the physical protection of existing infrastructures (International Physical Protection Advisory Service), all with positive outcomes (IAEA, 2016b). The next follow-up reviews in these fields are planned for 2023-24. The PAA has also increased its international outreach, signing bilateral agreements with Finland and Hungary in 2017. The Polish

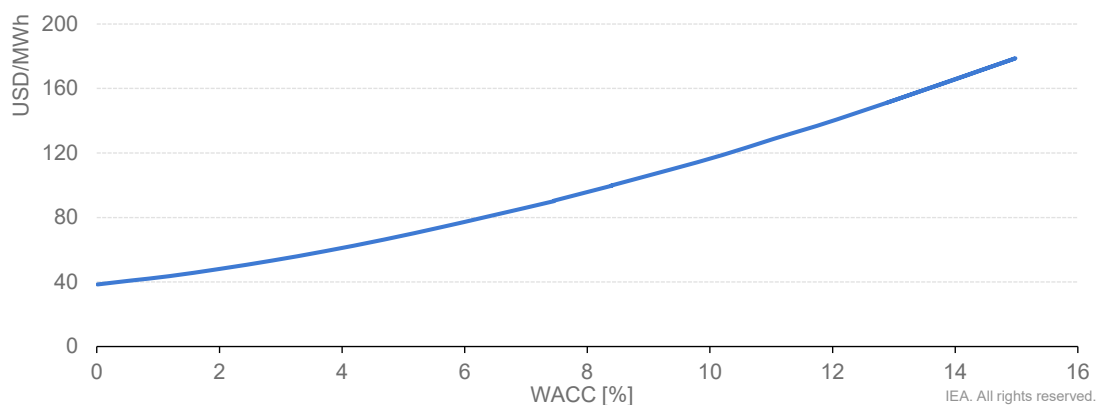
regulator has signed 19 bilateral agreements with leading nuclear regulatory authorities across the world to co-operate and exchange information with regard to nuclear safety and radiation protection.

The Polish government is actively working to create the political and industrial conditions necessary for the success of the PNPP. Enabling its economic feasibility (via the definition of a robust financial model) and securing the growing workforce needs are two key and short-term priorities. At the same time, the development of nuclear power is not possible without long-term political stability and public acceptance. Nuclear power has historically benefited from high levels of public acceptance and support across the main political parties in Poland. Nevertheless, building and keeping political consensus as the PNPP progresses remains one of the most important tasks for the Polish government, and efforts on this front are expected to intensify in the coming years.

The PNPP financing model

The design of robust and predictable market and financing frameworks is a key lever to increase the competitiveness of new nuclear projects. Such arrangements have a direct impact on the cost of capital, which heavily influences the generation costs of capital-intensive projects, and therefore determines the final price paid by consumers. In Poland, shifting the cost of capital from 9% to 5% would lead to a 40% reduction of generation costs and help deliver nuclear projects below 80 USD/MWh (Figure 11.2). There is no “one-fits-all” solution for financing nuclear projects, but governments are uniquely placed to influence risk and have at their disposal proven mechanisms to secure access to cheap capital for nuclear projects.

Figure 11.2 Total levelised cost of electricity of nuclear power in Poland as a function of the cost of capital



Note: WAAC = weighted average cost of capital.

Source: Poland, Ministry of Climate, 2020.

Poland has been working on its financial model for new reactors since the publication of the first version of the PNPP back in 2014. This model relies on three main components: 1) the ownership of the project; 2) the choice of the co-investor; and 3) the financial mechanism, including specific market regulations. By leveraging these three components, the Polish government expects to adequately allocate and mitigate policy, construction and market risks and find the right compromise between the project's profitability and the consumers' interest.

In terms of ownership, the Polish financing model is quite advanced. The selected approach consists of the creation of a special purpose vehicle (SPV) shared with the co-investor, who will own up to 49% of the project company. The Polish government will hold the remaining stake, thereby keeping control of the decision-making process and investment choices. By being the main shareholder, the government also expects to reduce policy risks significantly. The SPV PGE EJ 1 was set up in 2010 with the state-owned company utility PGE being the sole owner. In 2014, PGE sold 30% of its stakes to two other Polish utilities (Enea and TAURON) and a copper mining company – KGHM Polska Miedź, which agreed to take an equal share in the acquisition. In April 2021, the State Treasury reached an agreement with a consortium to take full control of PGE EJ 1, for a total value of USD 125 million. This is a major step before the selection of the co-investor. The government plans to invest up to USD 20 billion over 20 years through PGE EJ 1.

The selection of the co-investor is another critical milestone in the development of nuclear power in Poland. The co-investor may be a country willing to create a long-term strategic partnership and with strong links with the technology vendor. The offer should cover the reactor design, a financial proposition for taking up to a 49% stake in the project company as well as the engineering, procurement and construction arrangements for the six nuclear units. With this integrated contracting approach and the choice of an experienced partner, the government expects to keep the construction risks to a minimum. This could also increase the credibility of the project and help attract funding from other national and international institutions. As of 2021, Poland was in discussions with three major technology providers: Westinghouse (United States), EDF (France) and KHNP (Korea). In March 2021, Poland ratified an intergovernmental nuclear co-operation agreement with the United States, under which Westinghouse and Bechtel would submit within 18 months their tenders to build the plants. EDF submitted a preliminary, non-binding offer in October 2021 as well. KHNP has set up an expert group to prepare an offer for nuclear new build by the first quarter of 2022 (Kraev, 2021).

In addition, the PNPP sets out various conditions that should contribute to further lowering construction risks and costs, as more units are being built. First, Poland will rely on a mature, GW-scale pressurised water reactor design. Pressurised water reactors represent more than 80% of the reactors being built worldwide. All three potential co-investors have recent experience in building their own pressurised water reactor design and will benefit from lessons learnt and established industrial capabilities. The choice of this technology could also facilitate future export opportunities for the Polish industry. Second, Poland has decided to deploy only one reactor design for its nuclear programme, to enhance series and multi-unit effects and enable the adoption of a standardisation strategy. For instance, the Barakah Project in the United Arab Emirates has been able to reduce the construction costs of the fourth unit by up to 60% thanks to the multi-unit effect on the same site.

Lastly, different support and financing schemes are being considered to further mitigate market and construction risks. For example, the PNPP mentions long-term purchase agreements, contract-for-difference, regulated asset base and the Finish Mankala model as potential options. The government preliminarily assessed the contract-for-difference mechanism in 2015 and concluded that it could result in unacceptable costs for consumers.

Education, training and human capabilities

Poland offers the possibility for students to undertake a higher education and research career in nuclear power in domains such as nuclear physics, engineering, radioprotection and nuclear medicine. Current programmes are accessible in top universities across the country (e.g. Warsaw University of Technology and Wrocław University of Science and Technologies) in partnership with national nuclear research centres and key international industrial players. Training in nuclear installations is part of existing programmes, either in national research facilities (e.g. the Maria research reactor) or abroad. The government periodically reviews nuclear training programmes to ensure that their content is aligned with the human resource needs set out in the PNPP.

At the regulatory level, the implementation of the nuclear programme will also require strengthening regulatory competencies and associated human resources. The PNPP includes specific provisions to reinforce the PAA's capabilities, in particular in the field of surveillance and inspection of nuclear facilities. By 2023, the PAA should employ 110 specialists dedicated to licensing and oversight of nuclear power plants. This represents almost a fourfold increase from today's workforce levels. In 2015, an on-the-job training programme was also established. The PAA leverages its different bilateral agreements to train specialists by performing actual inspections and safety analyses in reactors in operation and/or under construction worldwide.

The local industry has also shown significant interest in participating in the construction of nuclear projects. The Polish industry is already involved in 80% of new build projects at the European level. The PNPP sets ambitious localisation plans with the Polish industry expected to capture at least 40% of the value of nuclear projects (mainly civil works and balance of plant components) during the construction of the first unit. Some of the potential co-investors are proposing in their offers plans to engage with the local industry to maximise their participation in future nuclear projects. The government is also working to update the Nuclear Human Resources Development Programme, to co-ordinate staffing needs across the parties taking part in the PNPP, as well as to anticipate future supply chain qualification needs.

Radioactive waste management

Poland's radioactive waste management strategy is framed by the National Plan for Handling Radioactive Waste and Spent Nuclear Fuel. This document covers the objectives, main tasks, infrastructure development, research activities, inventories and financial arrangements necessary to safely manage and dispose all types of radioactive waste. A first version of the plan was approved by the Council of Ministers in 2015, and updated in 2020 to make it consistent with the PNPP. According to the Atomic Law, this plan has to be reviewed every four years.

The operation of commercial nuclear reactors will increase waste management needs significantly. In the short to medium term, high-level radioactive waste in the form of spent nuclear fuel should not raise any concerns since the pools at the reactor sites have been designed to safely cool and store several decades of production of spent fuel. On the other hand, the high volumes of low- and intermediate-level radioactive waste that will be generated will require new specific storage facilities. ZUOP has been operating the National Radioactive Waste Repository in Rózan for more than 60 years. This facility will reach full capacity in the coming decade. The government is working on identifying potential locations for a new intermediate radioactive waste storage facility, as stipulated in the Waste Management Plan. This plan, however, does not indicate any specific schedule for the commissioning of such a facility.

For the long-term management of high-level radioactive waste, the national plan indicates that a deep geological repository (DGR) facility should start operation before the decommissioning of the first unit. Some preliminary DGR studies were performed between 1980 and 1990 and a knowledge base has been accrued on geological conditions and potential configurations of the future DGR facility in Poland. Prior to the DGR construction, a special underground research laboratory will operate for around 15 years to verify the suitability of the site's geological conditions. The government has not provided a binding deadline for the commissioning of the DGR.

A special act supplementing the Atomic Law provides for the funding mechanisms of the decommissioning and long-term radioactive waste management activities. It consists of a dedicated special fund, financed by a fee levied from each MWh of electricity sold by the nuclear operator. The fund is established by the entity holding the operating licence of the nuclear power plant. Currently, the fee is fixed at USD 4.3/MWh, but could be subject to revisions based on the latest information available on the costs of nuclear back-end activities.

Small modular reactors and other advanced nuclear technologies

The Polish private sector is looking at small nuclear reactors (SMRs) with increasing interest. A number of companies from the chemical, petrochemical and mining sectors have signed collaboration agreements with some vendors to evaluate how SMRs could help decarbonise their energy needs in the long term. Discussions are the most advanced with the chemical sector, with potential investment agreements already being explored (Dalton, 2021).

In terms of advanced reactors, Poland is working on the research and development of domestic high-temperature reactor (HTR) technology. This technology can produce heat between 550°C and 750°C and eventually reach 1 000°C with technical progress in advanced materials. Some HTRs have already been operated in the past in Germany and the United States, and China recently commissioned a 250-megawatt electrical (MW_e) unit: the HTR-PM. The main purpose of the Polish efforts is to develop a technology capable of decarbonising long-term heating needs for industry sectors, also covering residential areas. Today, these sectors primarily rely on fossil fuels, with coal for instance covering up to 70% of energy needs for district heating. Furthermore, the 13 largest chemical plants in Poland require around 6.5 GW of heat at 400-550°C, a temperature range that can be achieved with HTRs. In 2016, a government-appointed committee

elaborated a general framework for the deployment of HTRs in Poland. Results were published and accepted by the government in 2018. The next steps include the design and construction of a pilot project to deliver 200-350 MW of heat to an industrial facility, tentatively by 2030, depending on the availability of funding.

The Polish government welcomes the private sector's interests in SMRs, which is seen as complementary to the state's plans of deploying large reactors. The decarbonisation and electrification of the Polish energy sector provides enough demand for both nuclear technologies. Large reactors are a priority given their higher maturity and economic efficiency to replace large amounts of coal-based electricity generation. Beyond 2030, Poland will have to decommission a significant amount of coal capacity serving district heating and industrial applications. The possibility to retrofit existing coal sites with SMRs – especially those units under 20 years of operation or that have been modernised recently – also reduces the risk of stranded assets.

Assessment

Nuclear is expected to be one of the key pillars of the Polish electricity system by 2040, along with renewables and gas. Variable renewables are developing fast in Poland, with government plans of installing up to 8-11 GW of offshore wind by 2030. At the same time, rising carbon prices could also accelerate the coal phase-out and limit the recourse to gas. With the first units coming online by 2033, nuclear power will operate in a system with higher shares of variable renewables and potentially less dispatchable fossil fuel-fired generators. Such conditions will require a comprehensive integration of nuclear policies with other EPP2040 energy pillars and government agencies to adequately assess the role of nuclear power in the future Polish energy system as a whole.

Poland has been making steady progress since 2009 in developing its infrastructure and human capacities to build nuclear power plants. This is reflected in the IAEA's Integrated Nuclear Infrastructure Review and Integrated Regulatory Review Service review carried out over the last years. The ministry responsible for nuclear power implementation identifies, however, five short-term challenges that need to be addressed by the relevant government agencies for implementing the programme: 1) stable political support (across changes of government and mandates); 2) site selection and adaptation of the legal framework for nuclear investments; 3) financing and funding; 4) capacity building, including human resources; and 5) maintaining public acceptance at current levels.

The Polish nuclear programme has benefited from stable political support over the last 11 years. This has been possible thanks to a consensus across different political parties on the need for nuclear power in Poland. Such political long-term stability will be key for investors and industrial and workforce development, especially as Poland moves closer to the construction of nuclear reactors. Any political shift in nuclear policy would be detrimental at this stage, as it would delay the country's nuclear programme and endanger the achievement of the long-term energy policy objectives set by the EPP2040.

The main locations for nuclear new build considered by the Polish government and the investor are in the north (Lubiatowo-Kopalino and Żarnowiec). In December 2021, the investor announced that Lubiatowo-Kopalino is the preferred location for the first plant. The Polish government is also considering other options located in the central part of Poland (around Bełchatów or Konin-Pątnów). The north is an attractive location in terms

of public support and site-cooling solutions. Potential grid development could be optimised with grid investment for offshore wind and ongoing upgrades in the Baltic region. Other locations indicated include existing coal plants, which could limit grid upgrades and the economic impact for local communities. The environmental impact assessment in the pre-selected sites is ongoing and a final decision should be taken by 2022.

The Polish government is also preparing the necessary legal changes to ensure that the existing regulations do not hinder nuclear development plans. The new legal framework under development would facilitate the licensing process for nuclear power plants, in particular by allowing multiple levels of regulatory approvals to be addressed in parallel. In addition, it would extend some functions of the PAA in the field of environmental impact assessment of the planned nuclear power plants. These changes are consistent with best practice in major nuclear countries.

Access to affordable financing is key to reducing the costs of the PNPP for final consumers. Upfront investment needs are estimated around EUR 30-35 billion. The current financing model foresees the creation of an SPV co-owned by the government (51% or more) and a strategic investor (up to 49%), the latter with strong links to the technology provider and key suppliers. How much of the project would be financed by debt has not yet been specified and potential co-investors will be largely contingent on the choice of nuclear technology. Currently, the Polish government has full ownership of the project company and is in discussion with three major technology providers: Westinghouse (United States), EDF (France) and KHNP (Korea). The potential vendors shall provide an offer covering the technology choice, financing scheme, proposed engineering-procurement and construction frameworks until mid-2022. Uncertainties remain on how the financing and funding will take place. A final decision is expected in the second half of 2022.

As part of the financing model definition, market support mechanisms will be needed to overcome long-term market challenges. The potential options being evaluated by the Polish government should find the right balance between protecting consumers' interest, ensuring plant profitability and providing economic incentives to keep costs under control. It is likely that the selected mechanism will be subject to approval according to the EU state-aid rules.

Local industry involvement is expected to be around 40% of the value of the first units, and up to 70% of the value of the following ones, enabled by the high-skilled Polish industry already involved in recent nuclear projects in Europe. Engaging with domestic suppliers is also an opportunity to support the local economy, especially in light of a coal phase-out. In close collaboration with the future technology provider, the Polish government should develop a robust localisation approach, while embracing the benefits of relying on more experienced foreign suppliers for the most critical phases of the project. The delivery of nuclear components by Polish industry would also require the adoption of nuclear codes and standards that the government is planning to support.

Workforce needs will surge at all levels as the PNPP gets closer to the construction phase. A fourfold increase in the number of the PAA's staff assigned to tasks associated with nuclear power development is expected by 2023. At the government level, the project company should develop a robust governance framework and project owner's skillset in collaboration with the co-investor. The education and training infrastructure should be ready to support similar trends at the construction level. In 2016, a first draft of the Nuclear Human Resources Development Programme was developed to guide workforce

development endeavours associated with the PNPP. The final plan is expected to be approved by 2023.

The latest public opinion poll conducted by the Ministry of Climate and Environment in November 2021 found that 74% of the population supports the construction of nuclear power plants in Poland. This is the highest figure since 2012. Local support for the construction of nuclear power plants in potential locations is consistently high. The survey conducted in 2019, among municipalities located in potential sites in the Pomerania Region, revealed 71% support for nuclear new build.

Recent studies conducted by the National Centre for Nuclear Research and funded by the government propose examining the deployment of HTRs as a long-term technology option for using the low-carbon nuclear heat for hard-to-abate industrial heat applications. More recently, private companies in Poland have also expressed an interest in adopting SMRs as a long-term solution to decarbonising energy needs. Considered development of HTRs and SMRs (light-water technology and/or advanced concepts) is complementary to the existing PNPP strategy and could foster the decarbonisation of hard-to-abate sectors, such as industrial applications and district heating and the production of low-carbon hydrogen after 2040. SMR initiatives, however, are taking place outside of the PNPP and cannot benefit from the current long-term policy framework.

Recommendations

The government of Poland should:

- ❑ Ensure nuclear energy policy is well integrated with other energy policy pillars, in particular when it comes to nuclear power integration with offshore wind and long-term electricity grid development plans. Given the ambitious timelines and targets, implementation of the nuclear programme will benefit from higher levels of collaboration, co-ordination and involvement across all government agencies.
- ❑ Develop a comprehensive plan for financing the execution of the Polish Nuclear Power Programme in parallel with the nuclear technology selection.
- ❑ Strengthen nuclear capabilities at all levels, anticipating the need to rapidly increase regulatory readiness as the Polish Nuclear Power Programme progresses. Continue to develop bilateral and multilateral collaborations and peer reviews in this field.
- ❑ Progress on nuclear site selection with an emphasis on community engagement. Site preparation could advance in parallel with technology selection based on shortlisted nuclear reactor designs.
- ❑ Develop an integrated approach for the deployment of innovative nuclear technologies to contribute to climate and energy security objectives. In particular, evaluate the potential of small modular reactors and high-temperature reactors for industrial heat applications and district heating where gigawatt-scale nuclear may not be suitable. Such a programme would further benefit from international collaboration, in particular with neighbouring European countries and international nuclear technology supplier countries.

References

Dalton, D. (2021), Poland/state energy company PKN ORLEN “in negotiation” to invest in SMR deployment (web page), NUCNET, <https://www.nucnet.org/news/state-energy-company-pkn-orken-in-negotiations-to-invest-in-smr-deployment-10-1-2021>

IAEA (International Atomic Energy Agency) (2016a), Poland progresses in developing infrastructure for its nuclear power programme, IAEA Review Concludes (web page), <https://www.iaea.org/newscenter/news/poland-progresses-in-developing-infrastructure-for-its-nuclear-power-programme-iaea-review-concludes>

IAEA (2016b), IAEA completes nuclear security review mission in Poland (web page), <https://www.iaea.org/newscenter/pressreleases/iaea-completes-nuclear-security-review-mission-in-poland>

Kraev, K. (2021), Poland/South Korea sets up expert group to prepare nuclear new-build offer (web page), NUCNET, <https://www.nucnet.org/news/south-korea-sets-up-expert-group-to-prepare-nuclear-new-build-offer-10-4-2021>

WNN (World Nuclear News) (2017), Poland starts environmental survey for first reactors (web page), <https://www.world-nuclear-news.org/NN-Poland-starts-environmental-survey-for-first-reactors-07041701.html>

ANNEX A: Review team and supporting stakeholders

Review criteria

The Shared Goals, adopted by the IEA Ministers at their 4 June 1993 meeting in Paris, provide the evaluation criteria for the in-depth reviews. [The IEA Shared Goals are available on line.](#)

Review team and preparation of the report

The IEA's in-depth review visit of Poland took place virtually from 20 September to 1 October 2021. The review team met with government officials, energy suppliers, market participants, interest groups, consumer associations, research institutions and other stakeholders. This report was drafted based on information obtained in these meetings, the review team's assessment of Poland's energy policy, the government's response to the IEA energy policy questionnaire, and subsequent research by the IEA. The members of the team were:

IEA member countries

Ms. Emina Pasic, Sweden (team leader)
 Mr. Frans Duijnhouwer, Netherlands
 Mr. Asbjørn Zachariassen Hegelund, Denmark
 Ms. Ágnes Gerse, Hungary
 Mr. Luca Castiglioni, Switzerland
 Mr. Refik Tiryaki, Turkey
 Ms. Miroslava Vittekova, Slovak Republic
 Mr. Scott Smouse, United States

European Union

Ms. Szymon Polak

Nuclear Energy Agency

Ms. Diane Cameron
 Mr. Antonio Vaya Soler

International Energy Agency

Mr. Aad van Bohemen
 Mr. Kiyomi Hyoe
 Mr. Peter Journeay-Kaler

The team is grateful for the co-operation and assistance of the many people who supported the review. Thanks to their hospitality, openness and willingness to share information, the visit was highly informative, productive and enjoyable. The team expresses its gratitude to Minister Piotr Naimski, Secretary of State, Government Plenipotentiary for Strategic Energy Infrastructure, whose comments helped frame all the discussions during the review. The team also extends a special thanks to Ms. Ewa Chmura-Golonka and Mr. Ernest Makowski for their tireless efforts in co-ordinating the in-depth review and emergency response parts of the review visit, prompt responses to the team's many requests, and patience throughout the weeks leading up to and during the review.

The review was prepared under the guidance of Mr. Aad van Bohemen, Head of the Energy Policy and Security Division, IEA. Mr. Peter Journeay-Kaler managed the review and is the author of the report. Ms. Kiyomi Hyoe co-ordinated the emergency response component of the review and contributed to the chapters on oil, natural gas and electricity. Mr. Alessio Scanziani wrote the chapter on energy efficiency. Mr. Antonio Vaya Soler wrote the chapter on nuclear energy. Mr. Alessio Scanziani, Ms. Clémence Lizé, Ms. Eunjin Choe, Ms. Myriam Badri, Ms. Elisa Hittner and Ms. Jiyul Shin prepared and drafted the sections relating to energy data contained in each chapter. Helpful comments, chapter reviews and updates were provided by the following IEA staff: Mr. David Fischer, Ms. Sara Moarif, Mr. Fabian Voswinkel, Mr. Kevin Lane, Mr. Piotr Bojek, Mr. Simon Bennet, Mr. Jacques Warichet, Mr. Carlos Fernandez Alvarez, Mr. Gergely Molnar, Ms. Toril Bosoni and Mr. Milosz Karpinski.

Special thanks to the IEA secretariat with regard to the data, publication and editing. Ms. Astrid Dumond, Ms. Isabelle Nonain-Semelin and Ms. Taline Shahinian managed the layout and publication. Ms. Roberta Quadrelli, Mr. Steve Gervais, Mr. Arnau Risquez Martin and Ms. Laura Marí Martínez provided support on statistics. Ms. Therese Walsh managed the editing process. Mr. Jad Mouawad and Mr. Jethro Mullen supported the press launch. Ms. Jennifer Allain was the editor.

Meetings held with the following organisations

AGH University of Science and Technology
 Association of Renewable Energy (SEO)
 Chamber of the Natural Gas Industry (IGG)
 Chancellery of the Prime Minister
 Climate Coalition
 Consumers Federation (FK)
 Electric Vehicles Promotion Fundation (FPPE)
 Enea Operator
 Energa Operator S.A. (PKN ORLEN)
 Energy Forum
 Energy Market Agency (ARE)
 Energy Regulatory Office (URE)
 Gas Storage Poland
 Gas System S.A. (TSO)
 GK PGE S.A.

Governmental Agency for Strategic Reserves (RARS)
 Green Economy Institute (IZG)
 Greenpeace Polska
 Industrial Development Agency (ARP) Katowice branch
 innogy STOEN Operator
 Instrat Foundation
 Krajowy Ośrodek Wsparcia Rolnictwa (biofuels)
 LOTOS Group S.A.
 Lubelski Coal "BOGDANKA" S.A.
 Ministry of Agriculture and Rural Development
 Ministry of Climate and Environment
 Ministry of Economic Development and Technology
 Ministry of Education and Science
 Ministry of Finance
 Ministry of Infrastructure
 Ministry of State Assets
 National Agricultural Support Center
 National Atomic Energy Agency (PAA)
 National Centre for Emissions Management (KOBiZE)
 National Energy Conservation Agency (NAPE)
 National Fund for Environmental Protection and Water Management (NFOŚiGW)
 National Research Institute (INiG)
 National Secretariat of Mine and Energy Workers Union NSZZ "Solidarity"
 Office of Competition and Consumer Protection
 Permanent Representation of Poland to the OECD
 PGE Dystrybucja
 PGG S.A.
 PGNiG S.A.
 PKN ORLEN
 Polish Alternative Fuels Association (PSPA)
 Polish Association of Solar Energy (PSES)
 Polish Chamber of Liquid Fuels (PIPP)
 Polish District Heating Chamber of Commerce
 Polish Electricity Association (PKEE)
 Polish Foundation for Energy Efficiency FEWE & National Association "Respect for Energy and the Environment" (SAPE)
 Polish Electric Power Industry Association (PSBE)
 Polish LPG Association (POGP)
 Polish National Energy Conservation Agency (KAPE)
 Polish Power Transmission and Distribution Association (PTPiREE)
 Polish Society of Professional Combined Heat and Power Plants (PTEZ)

ANNEXES

Polish Wind Energy Association (PSEW)

Polska Spółka Gazownictwa

PSE S.A.

Statistics Poland

TAURON Distribution S.A.

TAURON Extraction S.A.

Trade Union of Miners in Poland OPZZ

ANNEX B: List of acronyms and abbreviations

In this report, abbreviations and acronyms are substituted for a number of terms used within the International Energy Agency. While these terms generally have been written out on first mention, this glossary provides a quick and central reference for the abbreviations used.

Acronyms and abbreviations

AC	alternating current
CCUS	carbon capture, utilisation, and storage
CEEB	Central Building Emission Register
CNG	compressed natural gas
CSIRE	Central Energy Information Exchange System
DC	direct current
DEID	Directions of Energy Innovation Development
DGR	deep geological repository
DSO	distribution system operator
DSR	demand-side response
EC	European Commission
EEA	European Environment Agency
EED	Energy Efficiency Directive
EEO	Energy Efficiency Obligation
EPC	energy performance certificate
EPP2040	Energy Policy of Poland until 2040
ERO	Energy Regulatory Office
ESD	Effort Sharing Decision
ESR	Effort Sharing Regulation
ETS	Emissions Trading System
EU	European Union
EV	electric vehicle
FEC	final energy consumption
FENIKS	European Funds for Infrastructure, Climate and Environment
GDP	gross domestic product
GHG	greenhouse gas
GIPL	Gas Interconnection Poland-Lithuania
HHI	Herfindahl-Hirschmann Index
HTR	high-temperature reactor
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
LNG	liquefied natural gas

LPG	liquefied petroleum gas
LULUCF	land use, land-use change and forestry
NABE	National Energy Security Agency
NCBR	National Centre for Research and Development
NECP	National Energy and Climate Plan
NSS	national smart specialisations
OECD	Organisation for Economic Co-operation and Development
OGMP	Oil and Gas Methane Partnership
OTF	Organised Trading Facility
PAA	National Atomic Energy Agency
PEC	primary energy consumption
PNPP	Polish Nuclear Power Programme
PSP2050	Raw Materials Policy
PV	photovoltaics
R&D	research and development
RARS	Governmental Strategic Reserves Agency
RD&D	research, development and demonstration
RED	Renewable Energy Directive
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SMR	small nuclear reactor
SPV	special purpose vehicle
SRK	Mine Restructuring Company
SRT2030	Strategy for Sustainable Transport Development to 2030
SUV	sport utility vehicle
TES	total energy supply
TFC	total final consumption
TFEC	total final energy consumption
TSO	transmission system operator
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar (currency)
VAT	value-added tax
ZUOP	Radioactive Waste Management Plant

Units of measure

bcm	billion cubic metres
CO ₂ -eq	carbon dioxide equivalent
g CO ₂ /km	gramme of carbon dioxide per kilometre
GJ	gigajoule

Gt	gigatonne
GW	gigawatt
GWh	gigawatt hour
kb/d	thousand barrels per day
km	kilometre
km ²	square kilometre
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
kWh/m ²	kilowatt hour per square metre
L	litre
m ²	square metre
m ³	cubic metre
mb	million barrels
mcm	million cubic metres
MJ	megajoule
Mt	million tonnes
Mt CO ₂	million tonnes of carbon dioxide
MtCO ₂ -eq	million tonnes of carbon dioxide-equivalent
Mtoe	million tonnes of oil equivalent
MW	megawatt
MW _e	megawatt electrical
MWh	megawatt hour
t CO ₂	tonne of carbon dioxide
toe	tonne of oil equivalent
TJ	terajoule
TWh	terawatt hour

ANNEX C: Statistical notes

Statistical notes

- Unless otherwise noted, all GDP data are in USD 2015 prices and purchasing power parity.
- *Total energy supply (TES)* comprises production + imports – exports – international marine and aviation bunkers ± stock changes. This equals the total supply of energy that is consumed domestically, either in transformation (e.g. power generation and refining) or in final use.
- *Total final consumption (TFC)* is the final consumption of energy (electricity, heat and fuels, such as natural gas and oil products) by end users, not including the transformation sector (e.g. power generation and refining).
- *Total final energy consumption (TFEC)* excludes non-energy use which is counted in TFC. TFEC provides a more accurate assessment of the share of energy demand covered by renewable energy and is better aligned with the European Union's gross final energy consumption metric, which is used to set EU member states' renewable energy targets.
- The primary energy equivalent of nuclear electricity is calculated from the gross generation by assuming a 33% conversion efficiency. The calculation to be carried out is the following: gross electricity generation in TWh $\times 0.086/0.33$ = primary energy equivalent in Mtoe.
- *Bioenergy* refers to solid and liquid biofuels, renewable waste, and biogas and excludes non-renewable waste.
- *Buildings* includes the energy use of the residential sector (residential buildings) and commercial and public service sectors (service sector buildings).
- *Transport* excludes international aviation and navigation.
- *Industry* includes both energy and non-energy use of the industry sector, agriculture, forestry and fishing.
- *Non-energy use* refers to fuels used as raw materials and not used as fuel or transformed into another fuel. This comprises typically raw materials used in the chemical and petrochemical sector.
- *IEA30* is the equivalent of a weighted average of 30 IEA member countries.
- *CO₂ emissions from fuel combustion* have been estimated using the IPCC Tier I Sectorial Approach methodology from the 2006 IPCC Guidelines. Emissions from international marine and aviation bunkers are not included in national totals.

This publication reflects the views of the IEA Secretariat but does not necessarily reflect those of individual IEA member countries. The IEA makes no representation or warranty, express or implied, in respect of the publication's contents (including its completeness or accuracy) and shall not be responsible for any use of, or reliance on, the publication.

Unless otherwise indicated, all material presented in figures and tables is derived from IEA data and analysis.

This publication and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

IEA. All rights reserved.

IEA Publications

International Energy Agency

Website: www.iea.org

Contact information: www.iea.org/about/contact

Typeset in France by IEA - May 2022

Cover design: IEA



Poland 2022

Energy Policy Review

The International Energy Agency (IEA) regularly conducts in-depth peer reviews of the energy policies of its member countries. This process supports energy policy development and encourages the exchange of international best practices and experiences to help drive secure and affordable clean energy transitions.

Poland's energy policy aims to decarbonise its energy supply through expanding renewable energy, introducing nuclear energy, powering transportation through electricity, and increasing energy efficiency across the economy. A central aspect of Poland's energy policy is reducing the reliance on coal, especially for electricity generation and building heating. There is a strong policy focus on energy security and ensuring a just transition that maintains affordable access to energy and protects vulnerable consumers, while promoting economic growth.

Poland has made notable progress on energy transition. It has one of the fastest growing markets for distributed solar PV in Europe, and it has developed a strong programme to drive offshore wind deployment. Poland has also taken important steps to improve energy security, like diversifying energy imports away from Russia. However, the country's energy mix is still dominated by fossil fuels. All sectors have considerable work ahead to meet targets for increasing the share of renewables, lowering energy demand and reducing emissions.

In this report, the IEA provides a range of energy policy recommendations to help Poland smoothly manage the transition to an efficient and flexible low-carbon energy system.