International Energy Agency

Secure Sustainable Together

Energy Policies of IEA Countries

Poland

2016 Review

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INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 29 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
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TABLE OF CONTENTS

1. EXECUTIVE SUMMARY AND KEY RECOMMENDATIONS 9

Executive summary 9
Key recommendations 13

PART I POLICY ANALYSIS 15

2. GENERAL ENERGY POLICY 17

Country overview 17
Supply and demand 18
Institutions 23
Key policies 23
Taxation 26
Energy security 27
Local air quality 29
Assessment 29

3. ENERGY AND THE ENVIRONMENT 33

Greenhouse gas emissions overview 33
Energy-related CO_2 emissions 34
Institutions 38
Policies and measures 38
Local air quality 43
Assessment 43

4. ENERGY EFFICIENCY 47

Overview 47
Energy use in industry 49
Residential and commercial 52
Transport 54
Special focus: Electrification of the Polish transport sector 56
District heating 61
Assessment 65

PART II SECTOR ANALYSIS 71

5. ELECTRICITY 73

Overview 73
Supply and demand 74
Institutions and regulatory framework 77
Market structure 77
Transmission and distribution 79
Wholesale market 84
Security of supply 85
Retail market and prices 88
Assessment 90

6. RENEWABLE ENERGY 95

Overview 95
Supply and demand 96
Policy framework 99
Domestic policies and measures 101
Assessment 108
Recommendations 110

7. NUCLEAR ENERGY 113

Overview 113
Nuclear policy 113
Institutions 114
Recent and anticipated policy developments 115
Regulatory framework 117
Assessment 118

8. COAL 121

Overview 121
Supply and demand 122
Structure of the coal sector 127
Clean coal technologies 133
Coal mine methane 134
Local air quality 134
Assessment 135

9. NATURAL GAS 139

Overview 139
Supply and demand 140
Natural gas transit 142
Institutions 142

Industry structure 143
Wholesale market 149
Emergency response policy 149
Prices and taxes 151
Assessment 153

10. OIL 157

Overview 157
Supply and demand 158
Exploration and production 161
Infrastructure 162
Market structure 165
Oil use in road transport sector 167
Emergency preparedness 170
Prices and taxes 173
Assessment 175

PART III ENERGY TECHNOLOGY 179

11. ENERGY TECHNOLOGY RESEARCH, DEVELOPMENT AND DEMONSTRATION 181

Overview 181
Institutions 182
Programmes 183
Public funding 185
International collaboration 187
Assessment 188

PART III ANNEXES 191

ANNEX A: Organisation of the review 193
ANNEX B: Energy balances and key statistical data 197
ANNEX C: International Energy Agency “Shared Goals” 203
ANNEX D: Glossary and list of abbreviations 205

LIST OF FIGURES, TABLES AND BOXES

FIGURES

2.1 Map of Poland 16
2.2 GDP in Poland, 2008-15 18
2.3 Overview of energy production, TPES and TFC in 2014 19
2.4 TPES, 1973-2015 20
2.5 Breakdown of TPES in IEA member countries, 2015 20
2.6 Energy production by source, 1973-2015 21
2.7 Import dependency (net imports as share of TPES) by fuel, 1973-2015 21
2.8 TFC by sector, 1973-2014 22
2.9 Fuel share of TFC by sector, 2014 22
3.1 GHG emissions by emission source (gas), 1990 and 2014 33
3.2 GHG emissions by emission source (sector), 1990 and 2014 34
3.3 CO_2 emissions by sector, 1973-2014 35
3.4 CO_2 emissions by fuel, 1973-2014 35
3.5 Energy-related CO_2 emissions per unit of GDP in Poland and in other selected IEA member countries, 1973-2014 36
3.6 CO_2 emissions and main drivers in Poland, 1990-2014 36
3.7 CO_2 emissions per kWh heat and power in Poland and in other selected IEA member countries, 1973-2014 37
4.1 TPES per capita in IEA member countries, 2015 48
4.2 TPES per GDP in IEA member countries, 2015 48
4.3 Energy intensity in Poland and in other selected IEA member countries, 1973-2015 48
4.4 TFC in the industry sector (including non-energy use) by source, 1973-2014 49
4.5 Industry TFC broken down by industry sector (energy use only), 2014 50
4.6 Energy intensities in Poland in selected industries, 2003 (index) and 2013 50
4.7 TFC in the residential and commercial sectors by source, 1973-2014 52
4.8 TFC in the residential and commercial sectors (separate) by source, 2014 53
4.9 Energy intensity in the residential sector, 1990-2013 (1990 index) 53
4.10 TFC in the transport sector by source, 1973-2014 55
4.11 Age of the car fleet in European countries, 2012 56
4.12 Global EV fleet (battery EVs and plug-in hybrid EVs) per country, 2005-15 57
4.13 Summary of policies to support EV market development 58
4.14 Number of publicly accessible EV charging stations per country, 2005-15 60
4.15 Number of publicly accessible charging points per EV per country, 2015 60
4.16 Heat consumption, 1973-2014 62
4.17 Heat production by fuel, 1973-2015 63
4.18 Heat production forecast by fuel, 2015-25 63
4.19 District-heating customer segments, 2012 64
5.1 Electricity generation by source and consumption by sector in Poland 73
5.2 Electricity generation by source in IEA member countries, 2015 74
5.3 Electricity generation by source in Poland, 1973-2015 75
5.4 Net electricity imports to and exports from Poland, by country, 1990-2014 76
5.5 Electricity consumption by sector, 1973-2014 77

5.6 Map of the Polish electricity system 81
5.7 Trading on the TGE, 2010-15 84
5.8 Unplanned SAIDI, length of outages, selected countries 88
5.9 Electricity prices in IEA member countries, 2015 89
5.10 Electricity prices in Poland and in other selected IEA member countries, 1980-2015 90
6.1 Renewables share of TPES, electricity generation and TFC, 1975-2015 95
6.2 Renewable energy as a percentage of TPES, 1973-2014 96
6.3 Renewable energy as a percentage of TPES in Poland and IEA member countries, 2015 97
6.4 Renewable energy as a percentage of electricity generation, 1973-2014 97
6.5 Electricity generation from renewable sources as a percentage of all generation in Poland and IEA member countries, 2015 98
6.6 Supply and consumption of biofuels and waste, 2014 99
6.7 Deployment of electricity from renewable energy sources in Poland, 2005 to 2015 100
F7.1 Nuclear power plants close to Polish border (up to 300 km) 114
7.2 Timeline of major legal framework actions related to the nuclear programme in Poland 117
8.1 Coal share in different energy supplies in Poland, 1975-2015 121
8.2 Coal supply by source and inland consumption, 1973-2015 122
8.3 Hard coal net imports by country of origin, 1990-2015 123
8.4 Coal consumption by sector, 1973-2014 124
8.5 Heat and power generation from coal, 1973-2014 125
8.6 Map of coal reserves in Poland 126
8.7 State ownership in the coal sector 128
8.8 European thermal coal price development in five years, 2011-16 132
9.1 Natural gas share in different energy supplies in Poland, 1975-2015. 139
.2 Natural gas supply by source and inland consumption, 1973-2015. 140
9.3 Natural gas imports by country of origin, 1990-2015 141
9.4 Natural gas consumption by sector, 1973-2014 142
9.5 Map of natural gas infrastructure in Poland 146
9.6 Trading volumes at the TGE in 2015 149
9.7 Natural gas prices in IEA member countries, 2015 152
9.8 Gas prices in Poland and in selected IEA member countries, 1980-2015 153
10.1 Oil share in different energy supplies in Poland, 1975-2015 157
10.2 Crude oil net imports by country of origin, 1990-2015 159
10.3 Oil consumption by sector, 1973-2014 160
10.4 Oil consumption in the transport sector, 1990-2014 (indexed 1990) 160
10.5 Oil consumption by product, 2015 161
10.6 Vehicle fleet of passenger cars (left) and lorries (right) by fuel type, 2012 161
10.7 Poland's refinery output, 2015 162
10.8 Map of Poland's oil infrastructure 163
10.9 Number of service stations in Poland (2007 to 2015) 166
10.10 Number of road vehicles in Poland, 2007 to 2014 168
10.11 Share of fuels for transportation in total oil consumption 168
10.12 Poland's oil stocks and compliance with the IEA 90-day stockholding obligation (June 2006 to June 2016) 171
10.13 Fuel prices in IEA member countries, third quarter, 2015 174
10.14 Differences between diesel and gasoline prices in Poland, 2007 to 2015 175

11.1 Energy RD&D budget compared to GDP (nominal) in Poland, 2010-15 181
11.2 Government energy RD&D spending by category, 2009-15.....186
11.3 Government energy RD&D spending as a ratio of GDP in IEA member countries, 2015186
11.4 Government energy RD&D spending, 2015.....187

TABLES

2.1 Taxes on energy consumption in Poland 27
3.1 Number of allowances to be allocated for free to power plants in Poland by year 40
3.2 EU ESD emission caps for Poland 2013-20 ($MtCO_2$-eq) 40
4.1 Summary of strengths, weaknesses, opportunities and threats for EV market development.....57
5.1 Breakdown of Polish power generation sector by fuel type, 2010-15.....78
5.2 State of competition in the electricity generation sector in Poland, 2013-15.....79
6.1 Renewable electricity generating capacity, 1990-2014 (MW).....98
6.2 National overall target for the share of energy from renewable sources in gross final consumption of energy in 2005 and 2020 100
6.3 Sector shares and total shares of energy from renewable sources in 2013 and 2013 ...100
6.4 Policies and measures to support renewable energy in Poland 101
6.5 Disputes concerning refusals to connect renewable energy sources to the electricity grid in 2014 106
9.1 Technical capacity of Polish natural gas entry points (as of 1 January 2015) 144
9.2 Natural gas storage facilities in Poland 145
10.1 Sources of crude oil imports to Polish refineries, 2015 158
10.2 Excise tax and fuel surcharge, as of 31 March 2016 173

BOXES

5.1 Loop flows in Central Europe 82
5.2 Generation emergency in August 2015.....87
10.1 LPG use in Poland.....167
10.2 Poland's oil market and and the shadow economy.....169

1. EXECUTIVE SUMMARY AND KEY RECOMMENDATIONS

EXECUTIVE SUMMARY

During the period since the last International Energy Agency (IEA) in-depth review (IDR) in 2011, Poland has continued to make progress in the development and implementation of energy policy. Some key policy recommendations contained in the last IDR, most notably the need to enhance energy security and strengthen energy efficiency, have been implemented. The government is revising and updating its energy strategy to take into account, among other things, recent decisions made on European Union (EU) climate and energy policy. The IEA understands that the government will publish its revised energy strategy in 2017. Meanwhile, energy remains high on the policy agenda of the government, evidenced by the fact that it established a new Ministry of Energy to oversee the development of policy in the sector. The IEA strongly encourages Poland to conclude, without delay, the process of finalising the long-term energy strategy to 2050. This process must also include transparent and open consultation with all industry stakeholders and consumers.

TRANSFORMING THE ENERGY SYSTEM

Market liberalisation, declining international energy prices, decarbonisation and rapid technological change are driving the transformation of electricity sectors across many IEA countries. Poland is less supportive of this "energy system transformation" and foresees fossil fuels as a fundamental element of its energy system over the long term. Nonetheless, the government has placed a strong emphasis on reducing greenhouse gas (GHG) emissions and air pollution, increasing energy efficiency, meeting its renewable energy targets, decarbonising its transport system and introducing nuclear power.

GHG emissions per gross domestic product (GDP) and carbon intensity in Poland are among the highest in IEA Europe member countries. While Poland has been relatively successful in reducing GHG emissions, mostly the result of structural changes in the economy, the country faces more challenging emissions reduction targets in the future. A new target in the sectors not covered by the European Union Emissions Trading Scheme (EU ETS) will be difficult to meet, notably in the transport sector, which is the fastest growing source of GHG emissions in Poland.

In the power sector, many coal-fired power plants are old, inefficient and polluting: 62% of coal capacity is over 30 years old and 13% is between 26 and 30 years old. The replacement of these plants represents an economic challenge for the sector, but at the same time offers a good opportunity to reduce the air pollution and carbon footprint from power generation. World-class power plants can reduce carbon dioxide (CO_2) emissions by over 20% from the existing fleet, while air pollutant emissions can be reduced by 90% or even higher. Progress has been made in this regard, and hard coal plants under construction offer much higher efficiencies. Working with ultra-supercritical technology and modern pollutant abatement equipment will reduce local air pollution.

The strategy of the government is to replace existing, low-efficiency generation units with new high-efficiency plants. This will result in decreased emissions of pollutants while strengthening energy security.

Local air pollution is one of the largest environmental health risks in Poland today. Household heating is a major source of local air pollution in the country, and emissions from this sector are difficult, if not impossible, to regulate. The European Environment Agency estimates that household heating produces approximately 40% of particulate matter emissions. The key factors are ageing and low efficiency of combustion in heating units and, to a lesser extent, the behaviour of household consumers. The government has offered financial support and incentives for the replacement of old boilers with cleaner, more efficient boilers alongside financial support for people to install domestic insulation. The government should examine and adapt present incentives in the sector to ensure the measures provide less well-off households with the means to switch away from coal or waste use towards cleaner solutions such as electricity, natural gas or district heating.

Poland has the fifth-lowest total primary energy supply (TPES) per capita among IEA member countries. The country made large energy intensity improvements over the past two decades, but it remains above the IEA Europe average. The industry sector is the largest energy consuming sector, and policy measures such as the white certificate scheme have incentivised industry to improve energy intensity. The extension of the scheme can allow for further efficiency improvements. New building standards based on the EU Energy Performance of Buildings Directive provide clear direction for energy efficiency in the residential sector. The requirements are ambitious for new buildings, but much of the existing stock of buildings in Poland needs refurbishment and funding mechanisms need to be identified. Retrofit obligations for inefficient heating systems in existing buildings could help to deliver major energy savings by utilising measures with shorter payback periods.

Poland has one of the largest district heating (DH) systems in Europe. With over one-third of heat produced in pure heat plants, there is large potential for increasing high-efficiency combined heat and power (CHP) production, especially when replacing old or small heating plants. The district-heating market is dispersed, with hundreds of small suppliers. Connecting these small systems to larger DH networks can enable benefits from economies of scale and a more efficient utilisation of larger and cleaner CHP plants. The industry estimates that 35% of Polish DH networks are in need of reinvestment. The current regulatory system is perceived as problematic by market participants and requires revision to attract much-needed investments.

Achieving long-term GHG emissions reductions will require measures to mitigate the growing emissions from the transport sector. Implementing measures aimed at reducing emissions and improving energy efficiency in the transport sector is a priority for Poland. New programmes such as the e-mobility programme and greater use of natural gas-powered vehicles have the potential to reduce emissions from the transport sector, provided that the electricity sector also reduces emissions.

Poland has set a very ambitious goal of one million electric vehicles (EVs) by 2025, alongside a comprehensive network of charging infrastructure. Poland plans to build over 7 000 publicly accessible charging points by 2020. The country has also adopted similarly ambitious plans for compressed natural gas (CNG) vehicles and fuelling infrastructure. The EV market in Poland will not grow significantly without policy support

measures. Large purchase subsidies correlate well with EV market growth, but tax deductions and subsidies can lead to large loss of fiscal revenue. A market-based system, such as a bonus-malus system, may offer a means to limit the loss of fiscal revenues for government and offer car buyers a means to share the costs of EV support.

Poland has achieved significant progress in the deployment of renewable energy sources and its share in TPES increased from 5% in 2004 to 10.4% in 2014, slightly exceeding the average for IEA countries. This progress was underpinned by the establishment of several support measures, both regulatory and financial. The main regulatory measure was a quota system obliging suppliers of electricity to purchase power generated from renewables through a system of certificates of origin.

Nonetheless, despite the progress of the past decade, the future of renewable energy in Poland looks uncertain. With the adoption of a Renewable Energy Act in 2015, Poland overhauled its regulatory framework for renewable energy, moving away from a quota-based system to one built around an auction process. Late amendments to the legislation introduced a number of changes in the sector which could impact the future growth of renewable energy. The main driver behind these legislative changes appears to be the adjustment of costs of the support system to the costs of the technology. Alongside these changes, Poland also adopted separate legislation amending the framework for developing onshore wind projects, which may halt further deployment of wind power in Poland. It also makes Poland a less attractive place to invest in wind power and will damage the profitably of existing investments.

STRENGTHENING ENERGY SECURITY

Securing the country's long-term energy supply is a priority for the government. Poland's strategic approach is that the use of hard coal and lignite is the cornerstone of the energy system. In 2015, coal provided over 50% of primary energy supply, the second-largest share among Organisation for Economic Co-operation and Development (OECD) countries and 81% of total electricity generation. Mining directly employs almost 100 000 people, and around three times this number in indirect employment. Any measure affecting the sector therefore has a large social and regional impact, and as a result is politically sensitive. The new energy strategy must determine if coal is going to sustain the Polish economy over the longer term or if it is to be a burden for the country.

Although important improvements have been made to modernise the Polish energy infrastructure, significant investments are still needed to ensure a sustainable supply of energy, reduce the share of carbon-intensive plants and increase the exploitation of renewable energy sources. Poland needs to step up its efforts and extend the development of the electricity transmission grid. Closer integration of the country with neighbouring markets is essential to strengthen electricity security and further integration of electricity markets in the region. Cross-border interconnections represent only 7% of installed generation capacity at present, and further investments are necessary in order to reach the EU target of at least 10% by 2020.[1]

1. The European Council of October 2014 called for all EU member states to achieve interconnection of at least 10% of their installed electricity production capacity by 2020. This means that each member state should have in place electricity cables that allow at least 10% of the electricity it produces to be transported across its borders. The target for 2030 is 15%.

Over the next 20 years, Polskie Sieci Elektroenergetyczne (PSE), the transmission system operator, has projected that between 16 gigawatts (GW) and 23 GW of capacity will be taken out of the market, and less than 10 GW of new capacity, including nuclear, is planned, creating longer-term adequacy concerns. Over the shorter term, the electricity system also faces risks. For example, in August 2015, Poland experienced power shortages after prolonged warm weather, which resulted in power restrictions. In response, Poland is debating the introduction of a capacity market. Similar arrangements are being discussed in other large markets such as the United Kingdom and Germany. While capacity mechanisms can secure electricity supply, great care has to be taken in their design and implementation to ensure they do not distort competition, interfere with cross-border electricity flows or result in higher electricity prices for end users.

Poland does not have any nuclear generating capacity at present. The government has determined that nuclear power will also play a significant role in its future supply as it seeks to increase its energy security and decrease its carbon footprint. The Polish Nuclear Power Programme, which was approved in 2014, foresees two nuclear power plants with 6 000 megawatts (MW) of capacity, with the first one (3 000 MW) commissioned in 2022, which represents approximately 8% of present generating capacity. (In the first quarter of 2017, however, a major update of the programme schedule is expected.) Both the government and nuclear industry have made significant efforts to acquire and develop knowledgeable and skilled personnel to oversee and execute the nuclear power programme. There is a need for all stakeholders to work together and develop a cadre of employees and technically qualified personnel such as nuclear, mechanical and electrical engineers and technicians with nuclear power operation or regulatory experience.

The Polish government has made significant achievements in the natural gas sector since 2011. Its achievements include unbundling of the sector, the establishment of an independent system operator and the introduction of measures to increase liquidity on the wholesale gas market. The opening of the Świnoujście liquefied natural gas (LNG) terminal, which can satisfy more than a quarter of demand, represented a large step towards supply diversification. Nonetheless, there is more Poland can do to deliver a fully competitive natural gas market. Despite the success of the government and Energy Regulatory Office (ERO) in introducing competition at retail level in the natural gas market, there remain concerns regarding the completion of the process and Poland is one of the few IEA Europe countries to maintain regulated prices for household customers. Legislative works are, however, in progress regarding deregulation of gas prices on the retail markets. Similar concerns abound in the electricity retail market. The ERO and Ministry of Energy should work together to end price regulation in both sectors and reduce the dominant position of the state-owned incumbents. Social policy should include protection measures for vulnerable customers and less-well-off consumers.

Oil remains the second-largest energy source in Poland, representing 24% of the country's TPES in 2015. The country produces small quantities of oil, but almost all crude oil is imported. The Russian Federation is Poland's single largest source of crude oil imports through the Druzhba pipeline and the Naftoport oil terminal in Gdańsk. The government is seeking to diversify supply sources and large investments: the Brody-Adamowo pipeline and expansion of the Pomeranian pipeline have been proposed in order to develop a versatile system for pipeline transportation. Completion of both of these projects will make a substantial contribution to energy security.

A serious concern in the oil sector is the so-called "grey fuel market" (fuels for which no value-added tax (VAT) or excise duties are paid), notably in the diesel market, but to a lesser extent in gasoline and liquefied petroleum gas markets. According to estimates, 18% to 24% of the diesel market can be assumed to be "grey". This results in a substantial revenue loss to Polish taxpayers of between Polish zloty (PLN) 8 billion and PLN 10 billion.[2] This not only results in unfair competition, but also in fuel insecurity, as these supplies are mostly imported and not accounted for in the import balance. As a consequence, these supplies are not incorporated in the calculation for the national emergency reserves. This would entail that if 10% of total fuels are not accounted for, the country as a whole would hold some nine days less of emergency stocks than otherwise would be required. The government has begun to make progress in tackling the problem, and since July 2016 the situation has improved and the scale of the "grey fuel market" has decreased as a result of legislative changes in the law introduced by parliament.

Energy research and development is an important policy instrument to meet national energy policy objectives. The development of a new energy strategy presents an opportunity for the research and innovation sector to seek a great role. The strategy should include proposals to increase funding for the sector and introduce measures to commercialise domestic research activities. The IEA also welcomed the establishment of the Innovativeness Council in January 2016. This body is responsible for co-ordinating the innovation policy of the country and defining national innovation priorities where the Polish economy has the greatest potential. While energy may be one of the key sectors identified, this cannot be guaranteed, and participation in the Council should be broadened to include the Ministry of Energy.

KEY RECOMMENDATIONS

The government of Poland should:

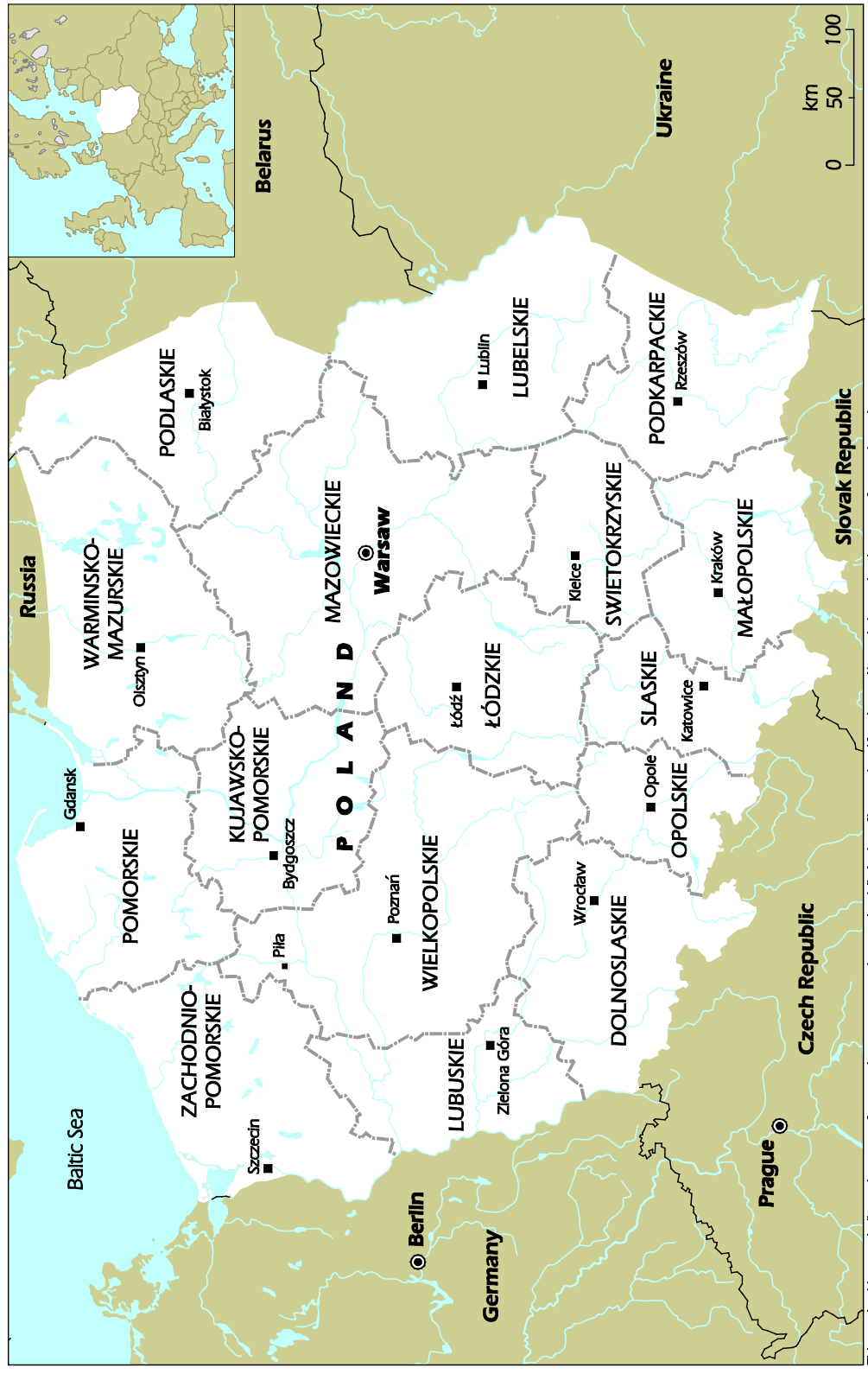
- *Conclude, without delay, the process of finalising its long-term energy strategy alongside action plans and road maps for policy implementation. This process must include transparent and open consultation with all industry stakeholders and consumers.*
- *Ensure the new energy strategy places a strong emphasis on the long-term transformation of the energy sector, including greater investment in energy efficiency, measures to reduce emissions from the non-traded sector, cleaner domestic heating and power sectors, reform of the district-heating sector and expansion of renewable energy.*
- *Establish a clear vision for the coal sector, consistent with the new long-term energy strategy, based on a fair assessment of costs, transparent accountability, elimination of cross subsidies between power producers and coal mines, and provide the private sector with opportunities to develop and compete in the market.*

2. This equals between EUR 1.8 billion and EUR 2.2 billion at an exchange rate of PLN 3.769. Source: https://data.oecd.org/conversion/exchange-rates.htm (accessed 1 November 2016).

- *Introduce measures to secure the short- and long-term security of the electricity system.*
  - *This includes ensuring that the wholesale market is able to provide clear investment signals to new generation and incentives for new interconnections.*
  - *In the short term, the development and implementation of a market-based capacity mechanism that ensures competition between all generation technologies, best use of cross-border resources and demand-side participation.*

PART I
POLICY ANALYSIS

Figure 2.1 Map of Poland



2. GENERAL ENERGY POLICY

Key data (2015 estimated)

TPES: 94.6 Mtoe (coal 50.8%, oil 24.5%, natural gas 14.6%, biofuels and waste 8.9%, wind 1%, hydro 0.2%), +2.7% since 2005

TPES per capita: 2.5 toe (IEA average: 4.5 toe)

TPES per GDP: 0.10 toe/USD 1 000 PPP (IEA average: 0.11 toe/USD 1 000 PPP)

Energy production: 67.6 Mtoe (coal 79.4%, biofuels and waste 12.1%, hydro 0.2%, natural gas 5.4%, oil 1.4%, wind 1.4%), -13.7% since 2005

Electricity generation: 164.2 TWh (coal 80.9%, wind 6.6%, biofuels and waste 6.1%, natural gas 3.8%, oil 1.3%, hydro 1.1%), +5.7% since 2005

Power generation per capita: 4.3 MWh (IEA average: 9.9 MWh)

TFC (2014): 65.3 Mtoe (industry 29.9%, residential 29%, transport 24%, commercial 17.1%)

Currency: USD 1 = PLN 3.7702; or EUR 1 = PLN 4.1821 (2015)

COUNTRY OVERVIEW

Poland is a Central European country on the Baltic Sea, bordered by Germany, the Czech and Slovak republics, Ukraine, Belarus, Lithuania and the Russian Kaliningrad Oblast exclave. With a total area of 312 679 square kilometres, Poland is the ninth-largest country in Europe. In 2014, its population was estimated at 38 million, making it, after Spain, the sixth most populous member state of the European Union and accounting for nearly one-tenth of the European Union's population.

Poland is a democracy with a president as head of state, and the government represented by the Council of Ministers, led by a prime minister. Polish voters elect a bicameral parliament consisting of a 460-member lower house (*Sejm*) and a 100-member senate (*Senat*). The most recent elections were in 2015: the presidential election in May and the parliamentary election in October. The next elections are expected in 2019. In the 2015 parliamentary election, the Law and Justice Party (PiS), a right-wing grouping based on a law-and-order platform, won 37.6% of the vote, with the incumbent Civic Platform second at 24.1%. As a result, Ms Beata Szydło succeeded Ms Ewa Kopacz as prime minister and formed a one-party cabinet. In the presidential election, PiS candidate Mr. Andrzej Duda narrowly defeated incumbent Bronisław Komorowski, who ran as an independent with the endorsement of the Civic Platform.

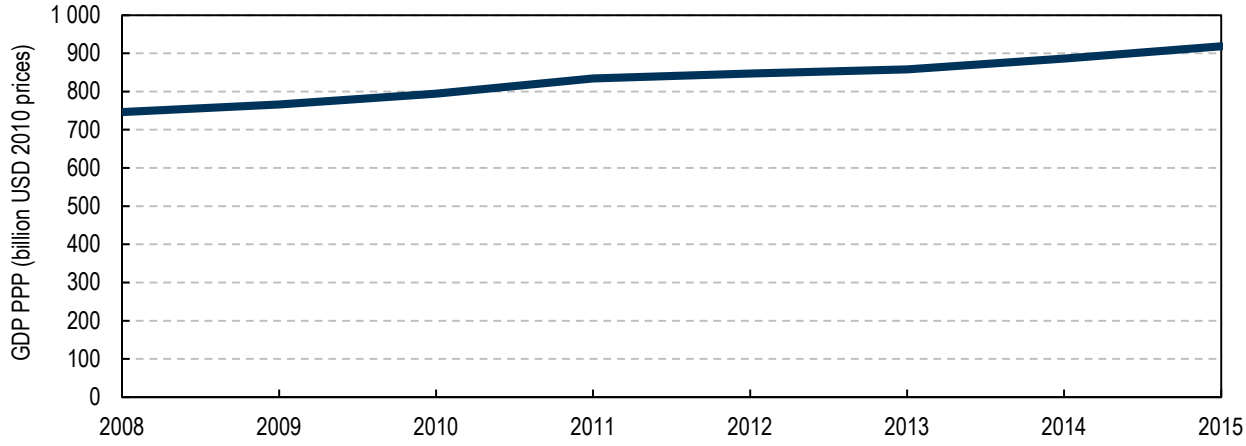
Poland is administratively divided into *voivodeships* (provinces); the *voivodeships* are subdivided into *powiats* (analogous to counties), and these are further divided into *gminas* (also known as communes or municipalities). Major cities normally have the status of both *gmina* and *powiat*. Poland currently has 16 *voivodeships*, 379 *powiats* (including 65 cities with *powiat* status) and 2 478 *gminas*.

ECONOMY

Remarkably resilient to the 2009 world economic and financial crisis, Poland has continued to grow strongly to catch up with other Organisation for Economic Co-operation and Development (OECD) countries in terms of gross domestic product (GDP) per capita (OECD, 2016). After a modest slowdown in 2009, the economy enjoyed a strong upswing in 2010-11, followed by more moderate but still solid growth in 2012-13. Real GDP has increased by almost one-fifth since 2008, which is unparalleled in the European Union. Economic activity accelerated in 2014 as private consumption and investment replaced external trade as the main growth engine. GDP growth is expected to be robust in the near term (EC, 2015).

Poland's investment has been relatively low compared to countries with similar per capita income. Public investment has been heavily supported by EU funds and Poland has significantly upgraded its infrastructure networks over the past decade (EC, 2015). The main environmental problem in Poland is poor air quality, reflected by high levels of urban air pollution. It is related to the dependence on old and sometimes inefficient household heating infrastructure based on low-quality coal, and heavy reliance on aged car fleet. Investment in low-emissions infrastructure and skills is essential to sustain a continued improvement in living standards, environmental quality and well-being (OECD, 2016).

Figure 2.2 GDP in Poland, 2008-15



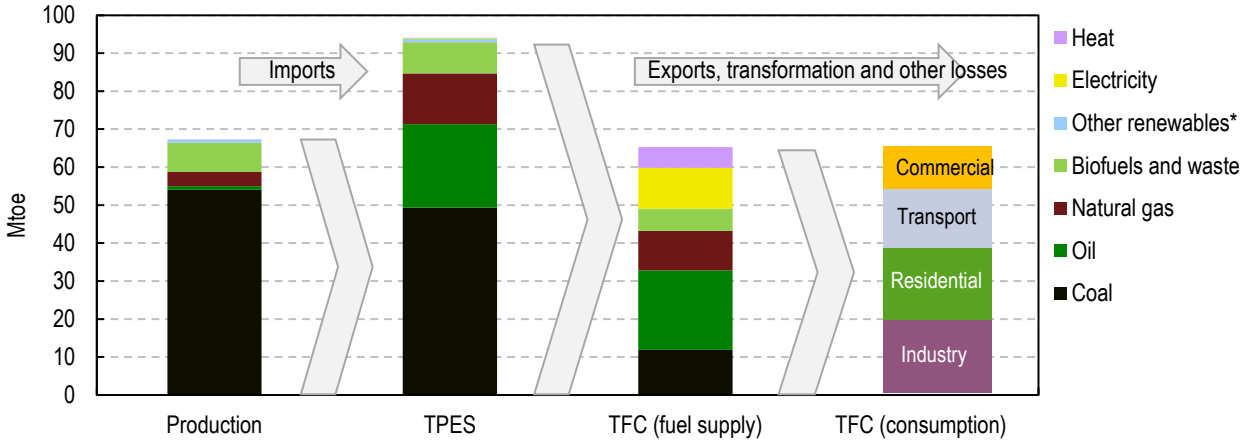
Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

SUPPLY AND DEMAND

Poland looks to coal for its energy supply. It makes up 79% of energy production and 51% of total primary energy supply (TPES). The majority of the coal (71%) is used for heat and power generation, and coal provides 81% of the electricity and 86% of the heat produced in Poland.

Both oil and natural gas have increased their share of TPES in recent decades. Oil is the second-largest source of energy with 24% of TPES, and the biggest in terms of total final consumption (TFC) with 32%. Domestic oil production is small and Poland is dependent on imports. Natural gas is the third-largest source of energy with a 15% share of TPES, of which one-third is produced domestically and the rest is imported.

Figure 2.3 Overview of energy production, TPES and TFC in 2014



* Other renewables constitutes small shares of wind, hydro, solar and geothermal.

Note: Mtoe = million tonnes of oil-equivalent.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Electricity generation is also dominated by coal, but with increasing renewable capacity from biomass and waste alongside wind power. Renewable energy sources provide 10% of TPES and 13% of electricity generation. Poland has no nuclear power, but is planning two reactors with a total combined capacity of 6 gigawatt electrical (GW_e).

The industry and residential sectors are the largest energy consumers in Poland, with close to one-third of TFC each, followed by the transport and commercial sectors.

SUPPLY

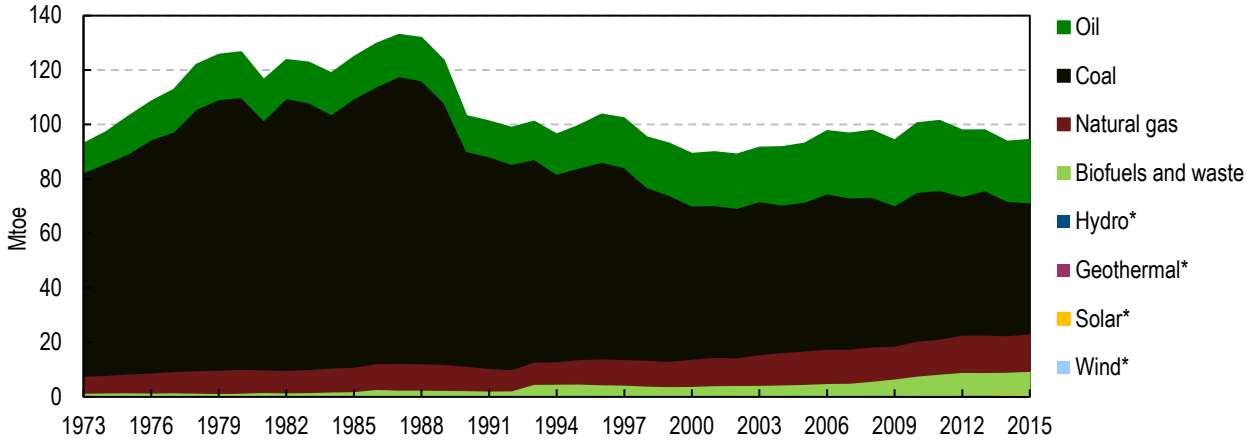
TPES fell sharply after the fall of the Soviet Union, from 133 Mtoe in 1987 to 103 Mtoe in 1990. Since then, TPES has been relatively stable at between 90 Mtoe and 101 Mtoe per year, with a recent peak of 101 Mtoe in 2011 before falling to 95 Mtoe in 2015 (Figure 2.4).

Poland has the largest share of coal in TPES among International Energy Agency (IEA) countries (not counting oil shale in Estonia) and the sixth-largest share of fossil fuels (Figure 2.5). Nonetheless, the country has started a slow transition from coal towards more oil, gas and renewables.

The largest renewable energy source is biofuels and waste, which makes up 88% of renewables in the energy supply and a 9% share of TPES. Wind power is the second-largest source of renewable energy with a small yet growing share of TPES.

Coal production has more than halved from its 1978 peak of 128 Mtoe to 54 Mtoe in 2015. In the last decade, greater production of biofuels and waste has partially compensated for lower coal production, but total energy production has declined 14% since 2005 (Figure 2.6).

Figure 2.4 TPES, 1973-2015

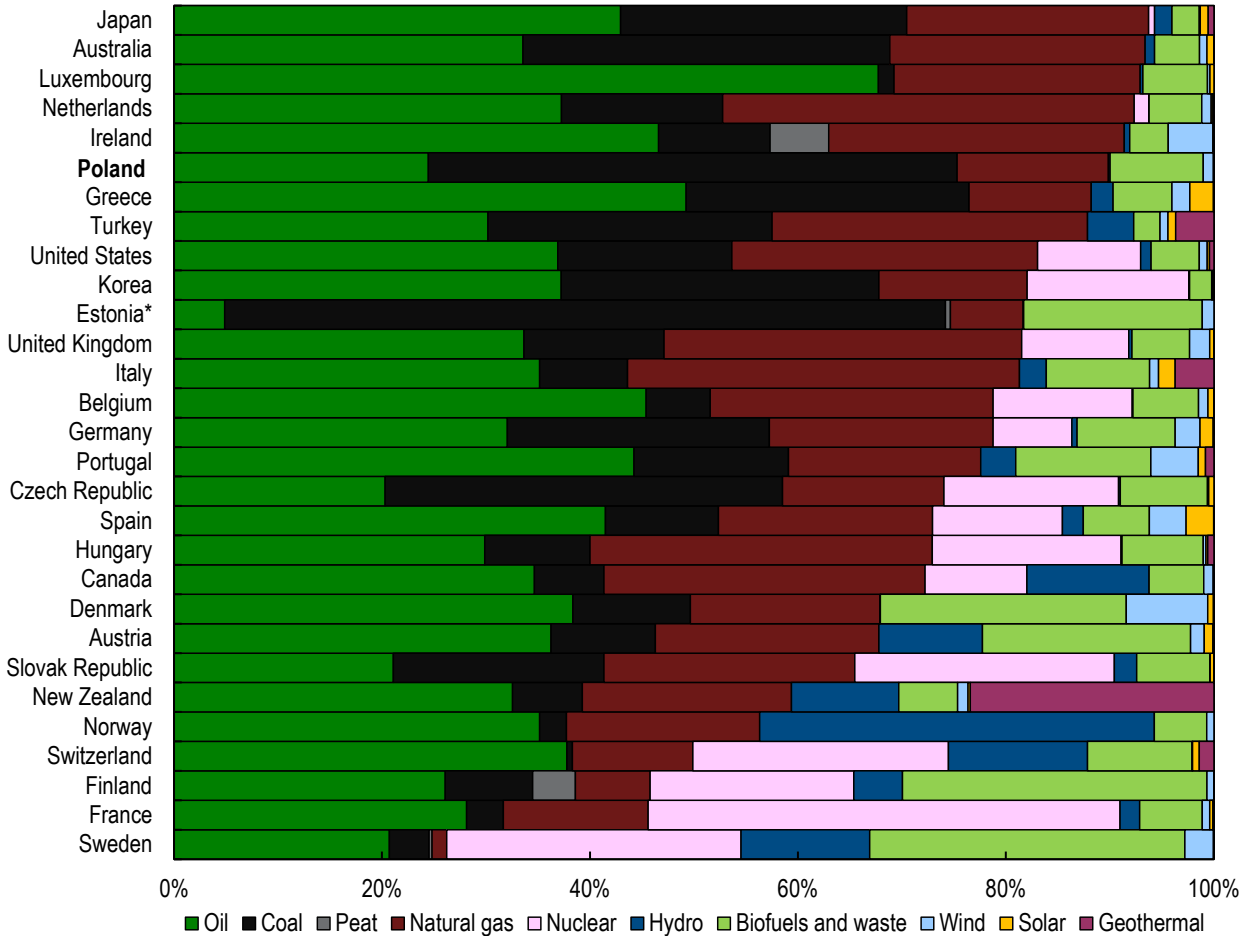


* Negligible.

Note: Data are estimated for 2015.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Figure 2.5 Breakdown of TPES in IEA member countries, 2015



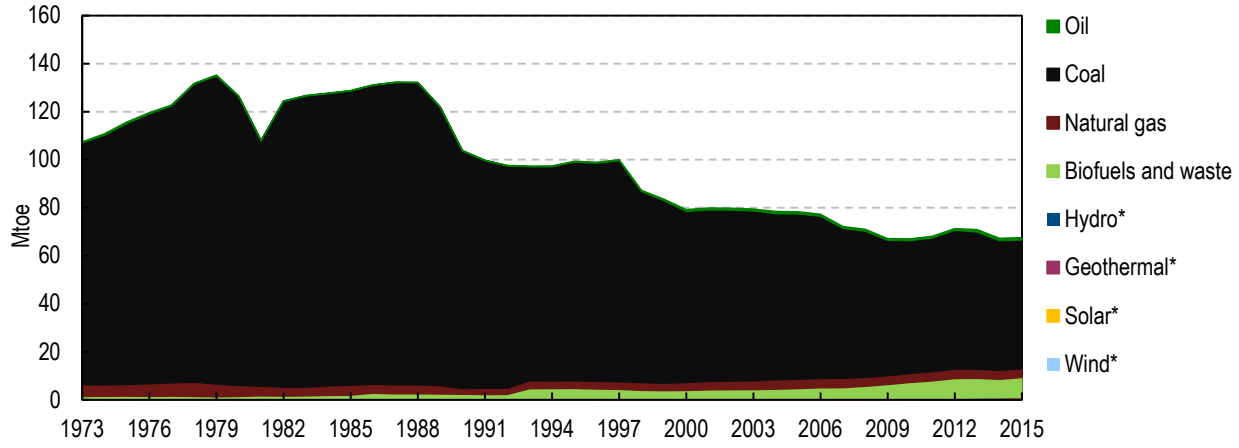
* Estonia's coal represents oil shale.

Note: Data are estimated.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Declining energy production, in combination with relatively stable TPES levels, makes Poland less self-sufficient in energy terms and more dependent on imports. From being a net energy exporter in 1995, Poland's import dependency increased to 30% in 2015 (Figure 2.7). Domestic coal production meets total demand for coal, while import dependency is high for oil (100%) and natural gas (66%). Crude oil imports made up more than half of total imports in 2015, and natural gas made up one-fifth of total imports.

Figure 2.6 Energy production by source, 1973-2015

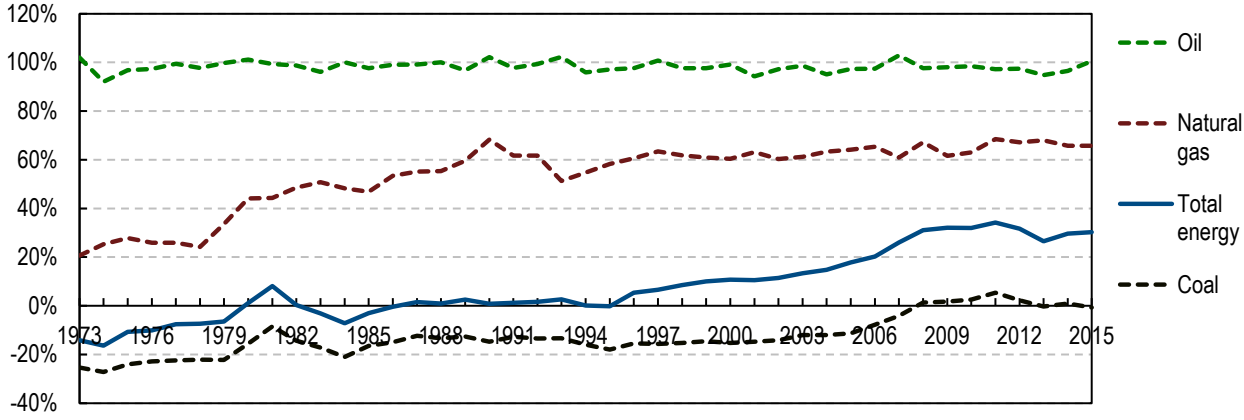


* Negligible.

Note: Data are estimated for 2015.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Figure 2.7 Import dependency (net imports as share of TPES) by fuel, 1973-2015



Sources: IEA (2016b), *Coal information 2016*, www.iea.org/statistics/; IEA (2016c), *Oil information 2016*, www.iea.org/statistics/; IEA (2016d), *Natural Gas Information 2016*, www.iea.org/statistics/.

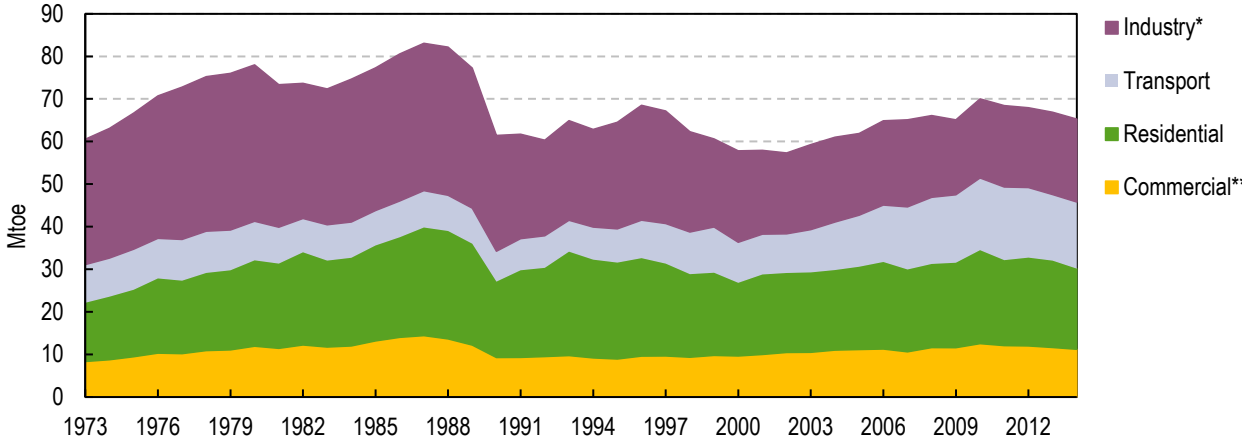
DEMAND

Industry is the largest energy consuming sector, accounting for 19.5 Mtoe or 30% of TFC in 2014. After falling from a share of 50% to 40% of TFC in the 1970s and 1980s, consumption in the sector has stabilised in the past decade (Figure 2.8). Natural gas is the largest source of energy, followed by electricity, coal and oil (Figure 2.8).

The residential sector is the second-largest energy consumer, accounting for 29% of TFC. Energy consumption in the sector increased from 19 Mtoe in 2004 to a peak of 22 Mtoe in 2010, but has since declined to 19 Mtoe in 2014. Coal is the largest energy source in the residential sector, accounting for one-third of total consumption, followed by heat. Poland has one of the largest district-heating markets in Europe, providing one-fifth of TFC in the residential sector.

The transport sector accounts for 24% of TFC and is growing: it increased by 39% from 2004 to 2014. The sector consumes mostly oil, but the use of biofuels has increased rapidly in the last decade, albeit from very low levels. The commercial sector accounted for 11.2 Mtoe in 2014, an increase of 1.8% compared to 2004. Electricity is the largest energy source in the commercial sector accounting for over a third of total consumption.

Figure 2.8 TFC by sector, 1973-2014

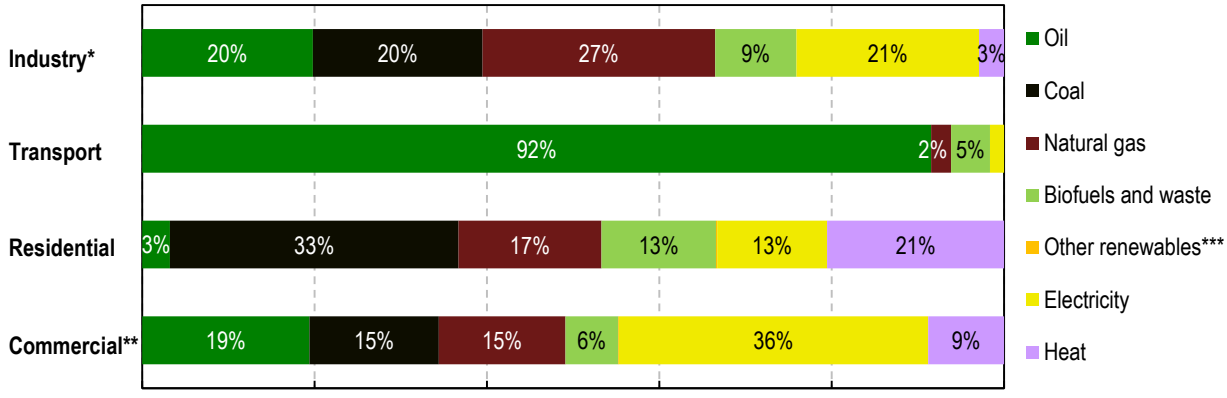


* *Industry* includes non-energy use.

** *Commercial* includes commercial and public services, agriculture, fishing and forestry.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Figure 2.9 Fuel share of TFC by sector, 2014



* Industry includes non-energy use.

** Commercial includes commercial and public services, agriculture, fishing and forestry.

*** Other renewables constitutes small shares of wind, hydro, solar and geothermal.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

INSTITUTIONS

The newly created Ministry of Energy is the lead ministry for energy policy. It sets out the legal framework for the sector and is responsible for the development and implementation of energy policy, including energy security. The Ministry of Energy also represents the government as the asset owner in relation to a number of energy companies fully or partly owned by the state. The Ministry of Environment is responsible for environmental elements of the energy sector, including carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions, and the approval of licences for exploration and extraction of raw materials.

The Ministry of Treasury performs ownership supervision and manages the portfolio of energy companies with Treasury shareholding. The Minister of Treasury acts, in a number of cases, as a body granting state aid to the energy sector most notably coal. The Ministry of Development is responsible for the preparation and implementation of the national development strategy, which includes land zoning and the management of EU assistance funds.

In November 2014, the Polish government established a Plenipotentiary for the Restructuring of the Polish Mining Sector and charged it with responsibility for the preparation and implementation of restructuring of the coal mining industry. The Government's Commissioner (or Plenipotentiary) for Strategic Energy Infrastructure, part of the prime minister's office, is responsible for corporate supervision of transmission system operators in electricity, gas and oil sectors.

The Energy Regulatory Authority is the key agency responsible for economic regulation in the energy sector as well as promotion of competition in energy markets. It is also responsible for granting licences for production, storage and transmission of fuels, and the transportation and storage of natural gas and electricity. The Office of Competition and Consumer Protection is responsible for shaping antitrust policy and consumer protection policy. It co-operates closely with the Energy Regulatory Authority on matters of common interest.

The National Atomic Energy Agency (NAEA) is a central agency with regard to nuclear safety and radiological protection.

KEY POLICIES

POLICY OBJECTIVES

Polish energy policy is driven to a very large extent by EU directives and requirements. In particular, Poland is required to liberalise its gas and electricity markets in line with the EU directives. Also, as part of the EU 20/20/20 goals, the following targets have been established for Poland for 2020:

- Limit GHG emissions in the sectors not covered by the EU Emissions Trading Scheme (EU ETS) to 14% above 2005 levels (binding).
- Reduce energy consumption by 20% of the projected 2020 levels (non-binding).
- Increase the share of renewable energy to 15% of gross final energy consumption, including an increase in the use of renewables in transport to 10% (binding).

Another driving force for Poland's energy policy is reducing the country's dependence on Russia for energy imports. In 2015, 88% of oil imports and 72% of natural gas imports came from Russia. Energy security is a dominant feature of Polish energy policy and the country is working to reduce its dependence on Russia and diversify its energy sources and supply routes. Furthermore, the country places a focus on maximising the use of existing domestic energy resources.

An important element of energy security policy is fuel and technology diversification. While the government expects coal to remain the main fuel in the medium term, it also seeks to support the development of cleaner technologies and the production of liquid and gaseous fuels from coal. It is also expanding storage capacity for oil and supporting Polish companies that perform oil exploration in the Baltic Sea and elsewhere. While the country has no nuclear power capacity, it has chosen to build at least two nuclear power plants (3 GW_e each) as a means to strengthen energy security, diversify fuel sources, and promote clean energy technologies.

The start-up of the Polish liquefied natural gas (LNG) terminal in 2016 marked another important step towards further diversification of gas supplies. The facility is designed to have regasification capacity of 5 billion cubic metres (bcm) per year, roughly equal to one-third of the country's annual gas consumption. Conversely, Poland stresses the need for diversification of sources of gas and has strongly opposed increasing dependence of the European Union, in particular in Central and Eastern Europe, on one dominant supplier, i.e. Russia. Poland strongly disagrees with projects for new transport routes such as Nord Stream 2 for natural gas, which increases dependence of the European Union on one source and can, in Poland's opinion, be destructive to competition between suppliers to European gas markets.

There are two key strategic documents which outline its policy in the energy sector: the 2009 Energy Policy of Poland until 2030 (EPP 2030) and the Strategy for Energy Security and Environment (2014). A draft of the new Energy Policy of Poland until 2050, which reflected recent decisions made on EU 2030 climate policy, was presented for public consultation in September 2015. Following a change of government later in the year, however, the document was withdrawn and is being revised by the Ministry of Energy. The new strategy is expected to be published sometime in 2017.

EPP 2030

On 10 November 2009, the Council of Ministers adopted a new energy policy document, EPP 2030. The document was prepared by the then Ministry of Economy and it outlined a long-term strategy for the entire Polish energy sector as well as fuel and energy demand forecasts. It also outlined a comprehensive programme of policies and measures to be implemented by 2012.

EPP 2030 addressed the most important challenges facing the Polish energy sector both from short- and long-term perspectives. The measures outlined in the strategy were designed to offer solutions to these challenges, and their implementation was expected to satisfy the growing demand for energy, to develop generation and transmission infrastructure and to reduce dependence on external supplies of natural gas and crude oil as well as fulfil international obligations relating to environmental protection.

The fundamental aims of EPP 2030 were:

- to improve energy efficiency
- to enhance security of fuel and energy supplies
- to diversify electricity generation by introducing nuclear energy
- to develop renewable energy sources, including biofuels
- to develop competitive fuel and energy markets
- to reduce the environmental impact of the energy sector.

The document established a number of measures addressing energy demand, including national energy efficiency targets, energy efficiency performance certificates for buildings, minimum standards for power-consuming products, investments in energy saving, and demand-side management techniques.

It also established that energy supply should consist of a mix of co-generation, renewables, grid modernisation and nuclear energy. To this end, EPP 2030 established quantifiable targets, for example: increase the percentage of renewable energy sources to 15% by 2020 and to 20% by 2030; boost the share of biofuels in the transportation fuels market to 10%; and build at least one biogas agricultural plant in each *gmina* (commune) by 2020. As a result, the government established differential fuel taxes in a way that promotes alternative fuels.

Strategy for Energy Security and Environment

Published in 2014, the Strategy for Energy Security and Environment (ESE) identified the key reforms and necessary steps for cleaner energy and to safeguard the security of energy supply up to 2020.

The key objectives of the strategy include sustainable management of the environment by means of measures such as water management, preservation of biodiversity and effective management of mineral resources. The policy attempts to ensure energy supply through measures such as better use of domestic energy resources, improved energy efficiency and modernisation of the power industry. The policy document also called for measures to improve the environment through reduction in air pollution, particularly lead, cadmium and particulate matter, cuts in industrial sector water use and better waste management. The government will also work towards carbon capture and storage solutions and gasification of coal, which is expected to remain the nation's main source of energy (GRI, 2014).

Polish National Strategy for Adaptation to Climate Change

The Polish National Strategy for Adaptation to Climate Change (NAS 2020) was published by the Ministry of Environment in October 2013. NAS 2020 sets out the objectives and directions of adaptation actions to be taken in the most vulnerable sectors and areas within the period to 2020: water management, agriculture, forestry, biodiversity and protected areas, health, energy, building industry, transport, mountain areas, coastal zone, spatial development and urban areas. The report highlights the risk to energy infrastructure posed by extreme climatic conditions such as more frequent storms, lower rainfall, less surface water and changing wind patterns. NAS 2020 sets out a series of adaptation actions to be taken by the sector and identifies the major responsible institutions.

National Transport Development Strategy to 2020

The National Transport Development Strategy to 2020 (with perspectives to 2030) is the first strategy for the transport sector adopted in Poland. This document, published in 2013, aims to ensure co-ordination between all modes of transport and infrastructure projects. It sets the main goals and priorities for the transport sector, including logistics and urban transport. It aims at improving transport accessibility, safety and efficiency, and Poland's international connections. The implementation programme of this Strategy, adopted in 2014, specifies the priorities in the railway, road, maritime and inland waterways sectors to be achieved in 2014-20 to ensure co-ordination between transport modes and infrastructure projects. It also sets criteria for project selection in the use of EU funds (OECD, 2016).

TAXATION

Taxes on energy products contributed 86% of the revenue from environmentally related taxes in 2012, compared with 73% in OECD Europe. The share has remained broadly unchanged since 2005. Most energy excise revenue stems from taxes on gasoline and diesel (88%), followed by electricity (8%), liquefied petroleum gas (LPG) (3%) and heavy fuel oil (1%). After exemptions provided by the EU Energy Taxation Directive (2003/96/EC) expired, excise taxes on coal were introduced in 2012 and on natural gas in 2013. Nonetheless, a wide range of exemptions remains (OECD, 2015). The tax burden on energy, measured as the ratio between energy tax revenue and final energy consumption, increased steadily to 2007 with increased transport fuel taxes.

Fuels in Poland are subjected to value-added tax (VAT) (23%), excise tax and road tax (Table 2.1). Excise tax influences the level of the final fuel price, and contributes to the structure of fuel consumption and changes to consumption patterns in recent years. For example, the difference in excise tax between LPG and gasoline was one of the reasons for the growth of LPG consumption. The privileged tax position of diesel compared to gasoline was also an important factor contributing to higher diesel consumption by privately owned cars. Diesel is taxed at a lower rate than gasoline (as in most other OECD countries) despite the fact that its CO_2 emissions per litre are higher and its combustion emits more local pollutants.

Revenues from environmentally related taxes are somewhat below the OECD average, while revenues from vehicle taxes are well below it. Poland is one of the few OECD countries where passenger vehicle tax rates are not based on environmental criteria. This favours the importation of second-hand vehicles. There are 20 million cars in circulation in Poland and the country's passenger fleet is among the oldest in the European Union. The average age of a car in Poland is 17.5 years, compared to an EU-28 average of 9.65 years (ACEA, 2015).

The effective economy-wide tax rate on CO_2 emissions from energy use is also low, particularly relative to other OECD European economies. Household coal use for heating, often in inefficient systems, is not subject to environmental taxation, even though this is a significant source of urban air pollution. A tax could reinforce the government's subsidy programmes to replace inefficient heating systems in households and its plans to move towards district heating. Relevant examples of tax models that work can be found elsewhere, such as the CO_2 and energy taxes that have been an important element in a broader plan to cut residential-sector emissions by promoting district heating in Sweden (OECD, 2016).

Table 2.1 Taxes on energy consumption in Poland

Energy product	Excise tax	Road tax
Gasoline	PLN 1 540/1 000 litre	PLN 129.41/1 000 litre
Diesel oil for transportation use	PLN 1 171/1000 litre	PLN 288.05/1 000 litre
Diesel oil for heating use	PLN 232/1 000 litre	
Light fuel oil	PLN 232/1 000 litre	
Residential oil	PLN 64/1 000 kg	
LPG	PLN 670/1 000 kg	PLN 159.71/1 000 kg (LPG used for transportation purposes)
Electricity	PLN 20/1 MWh – In 2015, electricity used by energy-intensive industry was partly or fully exempted from excise tax	

Source: Ministry of Energy, IDR submission.

ENERGY SECURITY

OIL

The use of emergency oil stocks is central to Poland's emergency response policy. Until 2014, Poland met its stockholding obligation to the IEA and the European Union by holding 14 days of government stocks and by placing a stockholding obligation on industry for the remainder (compulsory stocks). All liquid fuel producers and importers were obliged to hold 76 days of stock based on their production or imports of crude oil and liquid fuels from the previous calendar year. Following legislative changes in 2014, the role of the government stocks (now agency stocks) is set to increase gradually from 14 to 37 days. Under the direction of the Ministry of Energy, the Material Reserve Agency (MRA) manages the state-owned oil emergency reserves and also monitors the stockholding obligation on industry. Demand restraint is considered as a secondary response measure which could be introduced in a long-lasting and severe crisis.

Russia is Poland's single largest source of crude oil. Crude oil imports from Russia arrive via the Druzhba pipeline and the Naftoport oil terminal in Gdańsk. The government is conscious of the inherent risks of being dependent on limited sources of oil supply, and large investments have been considered to develop a versatile system of pipeline transportation.

The key diversification project being considered is the Brody-Adamowo oil pipeline, which would link the Polish oil transportation system with the Ukrainian Odessa-Brody pipeline, thereby creating a corridor for the transportation of Caspian oil to Europe. The project is on the list of EU Projects of Common Interest (PCI) and is eligible for support from the Connecting Europe Facility. It may also receive direct support from the Polish government. The project has, however, been beset by several delays and is still in the planning phase. Implementation of the project would improve access to other sources and enhance the oil security of the country.

NATURAL GAS

Diversification of supply sources and routes, development of natural gas infrastructure for such diversification, expansion of underground storage capacity and an increase in domestic gas production are the key elements of Poland's gas security policy. Gas traders and importers are obliged to maintain 30 days of compulsory gas stocks in Poland. Security has been strengthened by the construction of a new LNG terminal in Świnoujście, which became fully operational in 2016, bringing additional import capacity of 5 bcm annually.

The Minister of Energy is authorised to decide on the use of compulsory stocks. Gaz-System, the transmission system operator (TSO) for natural gas, is responsible for conducting a withdrawal of compulsory gas stocks, in co-ordination with Gas Storage Poland Sp. z o.o, Poland's natural gas storage system operator (SSO). The maximum withdrawal rate from domestic storage facilities is 43 million cubic metres per day (mcm/d), which is close to the average daily consumption recorded in the 2014-15 winter season.

ELECTRICITY

The country's electricity production is heavily dependent on domestic coal; its share in the total generation mix was 81% in 2015. Natural gas is responsible for just 4% of the country's electricity generation and the Energy Regulatory Office (ERO) has reported that there has been a significant decline in the interest of potential investors in the construction of new gas-fired generating units. Natural gas use has been surpassed by renewable sources, notably wind, which is seen as having the greatest expansion potential and amounted to 6.6% of generation in 2015, up from 2% in 2011. There are no nuclear power plants in Poland, but this is set to change in the mid-term future as the country plans to build its first reactor by 2030 to replace the ageing coal plants.

The country is facing some challenges in maintaining the transmission network because of its age and need for investment, which is reflected in a higher-than-average number of system interruptions. Another major concern is unscheduled loop flows of electricity from Germany, caused by the country's vast variable renewable generation resources and north-south trade flows. At the same time, Poland faces increasing system stress in summer, most recently in August 2015, when Polskie Sieci Elektroenergetyczne (PSE), the TSO, was forced to curtail load to balance the power system. The power sector faces other challenges, too, such as a decreasing capacity margin to meet winter peak demand owing to the ageing power fleet and additional planned plant retirements, as well as the challenge of integrating a rising share of renewable resources in a system dominated by large thermal plants with limited flexibility.

The country's TSO manages generation reserves by contracting "must-run" services and having bilateral agreements with neighbouring TSOs. The Council of Ministers, at the request of the minister of energy, can launch a programme of demand restriction in case of a disruption. The TSO also has contracts for load-shedding services in 2014.

Under its obligation to monitor the security and reliability of network operation, the ERO is required to review actions undertaken by electricity system operators and assesses them in terms of ensuring proper network operation. The ratio of available capacity of domestic power plants to peak capacity demand in the electricity system is evaluated each year. In 2015, there were noticeable drops of capacity reserves of utility power plants and power outages connected with extensive, medium and emergency renovations compared to 2014 (ERO, 2016).

The ERO is also required to monitor new and planned energy infrastructure. Monitoring of investments in generation capacities by the ERO is carried out on the basis of 15-year investment plans of electricity producers, submitted to the President of the ERO every two years by all generators above 50 megawatts (MW). In 2015, the ERO noted that there was 2 600 MW of new capacity to be built by 2020, while 2 900 MW of capacity will be decommissioned in the same period (ERO, 2016).

LOCAL AIR QUALITY

Despite the obligation for EU member states to ensure satisfactory air quality for their citizens, air quality has remained a problem in many places for a number of years. The continuous development of the Polish economy over the last two decades has not resulted in increased emissions and in some cases a systemic reduction has been observed (sulphur dioxide). Nonetheless, and in spite of improvements in air quality, exceedances of limit values for particulate matter (PM) 10, PM2.5, coarse dust and fine particulate matter, and benzo(a)pyrene (BaP) in the winter season, remain a serious problem. Small-scale combustion of coal and biomass and concentrated local pollution (particularly in heating season) are the main factors in these emissions (OECD, 2016).

Exposure to high concentrations of PM10 (coarse dust particles) and PM2.5 (fine particulates) has been linked to a variety of health concerns including asthma, heart problems and premature death in people with heart or lung disease. The daily limit value for PM10 is widely exceeded in Poland, while the target limit for PM2.5 is also regularly exceeded and annual mean concentration values in Poland are the highest in the European Union. Poland's annual mean concentration values of BaP, found in coal tars among other things and a cause of lung cancer, are also the highest in Europe.

ASSESSMENT

In mid-2015, the government of Poland started consultation on a new energy strategy to guide the energy sector to 2050, with the aim of replacing EPP 2030, which was published in 2009. During the consultation period a new government was elected, and it is in the process of revising and updating the draft 2050 strategy. It is doing this with a view to revising the document to take into account recent decisions made on EU 2030 climate policy and the Paris Agreement, and intends to publish its new strategic vision in 2017. Meanwhile, energy remains high on the policy agenda of the new government, as evidenced by the fact that it has established a Ministry of Energy to oversee the development of policy in the sector. Pending the adoption of the new strategy, some draft legislation that was submitted to parliament in 2015 is now on hold, while several other energy laws and regulations that were enacted at the end of 2015 came into force during 2016.

Poland's energy sector is dominated by a slowly decreasing share of (domestic) coal (51% of TPES in 2015). Import dependency of energy stands at 30%, mainly the result of oil imports, and to a lesser extent natural gas. In addition to increasing domestic production, the country is seeking to increase energy security by diversifying its energy imports. Affordable electricity, natural gas and heat for households and industry are also an important priority of energy policy.

The creation of the new Ministry of Energy, a Government Plenipotentiary for Strategic Energy Infrastructure Affairs under the prime minister, and the deliberations on a new energy policy, have highlighted a need for tighter co-ordination within the governmental structure, among the involved ministries and other stakeholders such as the Ministry of Treasury. Energy is the cornerstone of a modern economy and needs a clear allocation of responsibilities, lean institutions and structured exchange of information between all arms of the government administration. These agencies need to be resourced and empowered with the tools to protect and promote competition. Co-ordinating bodies such as joint ministerial steering boards represent an appropriate instrument for supervision as well as for exchange of information, the setup of co-ordinated actions and integrated planning.

The government has demonstrated an effort to shape the country's energy policy framework in accordance with the requirements of the EU directives and domestic needs. It has also successfully implemented several of the key recommendations contained in the previous in-depth review (IDR) published in 2011, most notably in the fields of energy diversification, emissions reductions and lowering energy intensity. The government is also monitoring energy markets closely, and is therefore able to provide comprehensive information on market changes and energy security to sector stakeholders.

The government is faced with several, sometimes conflicting, challenges: the economy is going through a period of robust growth, which needs to be sustained with energy, much of it from coal, without increasing demand. Coal on the one hand brings energy security benefits, but on the other hand it creates climate change and local air pollution challenges on a scale that is rare in Europe. Furthermore, global coal prices have dropped substantially in recent years and this has made large parts of the Polish coal sector uncompetitive. Given the scale of the sector and the large number of jobs dependent on the industry, this has created a major challenge for the industry and government. These circumstances give an inherent push to the government to develop policies to attract investment in other energy sources, such as natural gas and renewable energy sources, but political realities dictate that the coal sector is shielded and only a moderate increase in gas consumption is projected.

Ageing coal-fired generation capacity and widespread solid fuel heating systems in households make a substantial contribution to poor local air quality, notably in urban areas. The leading role of local governments in this context is important: municipalities are in a position of defining binding regulation on air quality, carbon economy plans, emission mitigation plans and spending on energy efficiency, etc., but so far without much success.

The Polish government is developing several ambitious plans for new approaches in energy consumption and electricity generation, such as electro-mobility and nuclear power, both of which can only benefit the energy system over the longer term. The future Polish energy strategy will need to focus on the long-term development of those infrastructure-based technologies, to ensure that investments needed to support their rollout are made on a sound basis.

To assure security in energy supply and greater energy efficiency, a well-functioning energy market is a necessity. Poland made progress in the liberalisation of the electricity and natural gas markets, but there is need for further improvement – notably in market conditions. Greater effort is required in the design of a competitive market and to

establish non-discriminate access to networks and markets and fair conditions for all participants. Unpredictable changes in market rules undermine investor confidence and will scare private investors from the market.

The coal mining sector remains state dominated: only a few privately owned mines remain active in the Polish market. A similar situation is seen in the electricity and oil and gas sectors, where the dominant market players are state-owned. While the transmission and distribution of energy (networks) is deemed a strategic asset of the state, the dominant role of the state in the supply of energy to industry and households needs to be questioned.

In 2015, Poland experienced power constraints partially caused by warm weather and lower availability of water for cooling coal-fired generation plants. Such vulnerabilities in the energy system resulting from changes in climate and environment need careful attention. Furthermore, studies to evaluate the possible expansion of the system and strengthen its resilience should be conducted and acted upon.

Poland has made substantial progress since making a decision in 2009 to pursue nuclear power, which will allow it to add significant additional generation capacity from a non-emitting source while at the same time strengthening its energy security. Poland currently has no nuclear power capacity, but it has chosen to build at least two nuclear power plants (3 GW_e each) to support its energy security, fuel diversification and clean energy technology goals. It has also strengthened the nuclear regulatory body and established an owner and operating entity. These organisations have made considerable progress in preparing to execute their respective responsibilities, including the establishment of processes, the hiring and training of staff and the selection of two sites for further examination. Both the government and nuclear industry have made significant efforts to acquire and develop knowledgeable and skilled personnel to oversee and execute this nuclear power programme.

RECOMMENDATIONS

The government of Poland should:

- *Conclude without delay, the process of finalising a long-term energy strategy to 2050 alongside related action plans and roadmaps for policy implementation. This process must include transparent and open consultation with all industry stakeholders and consumers.*
- *Present a stable and predictable long-term perspective for the development of necessary energy infrastructure such as electricity generation capacity, heat, natural gas and electricity networks and interconnections, in order to attract private and public investors to the energy sector and associated sectors such as transport.*
- *Intensify collaboration efforts with local authorities and communities in order to improve air quality and meet energy efficiency targets.*
- *Ensure stability in the direction of the electricity and natural gas market design. Further effort is needed in designing a competitive market and establishing non-discriminate access to networks and markets, and fair conditions for all participants.*

- *Generate a well-ordered but lean structure of responsibilities and effective participation of legal entities/institutions, and improve co-ordination and information flows between state agencies involved in the energy sector.*
- *Take a long-term perspective on environmental protection and climate action into account when evaluating the effects of potential measures and support mechanisms in renewable energy as well as financial support mechanisms for nuclear power.*
- *Move expediently to determine and announce the timeline, constraints and support mechanisms for the first nuclear units to provide long-term certainty to – and sufficient information for – the licensee to advance with investment decisions, siting examination and selection activities, and technology evaluation and decisions.*

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3. ENERGY AND THE ENVIRONMENT

Key data (2014)

GHG emissions without LULUCF*: 380 $MtCO_2$-eq, -20% since 1990

GHG emissions with LULUCF*: 347.5 $MtCO_2$-eq, -22% since 1990

CO_2 emissions from fuel combustion: 279 $MtCO_2$, -19% since 1990

CO_2 emissions by fuel: coal 69.7%, oil 20.2%, natural gas 9%, other 1%

CO_2 emissions by sector: heat and power generation 53.1%, transport 15.7%, residential 12.3%, manufacturing and construction 10.3%, commercial and other services 6.2%, other energy industries 2.5%

Carbon intensity per GDP: 0.31 tCO_2/USD 1 000 GDP PPP (IEA average 0.26)

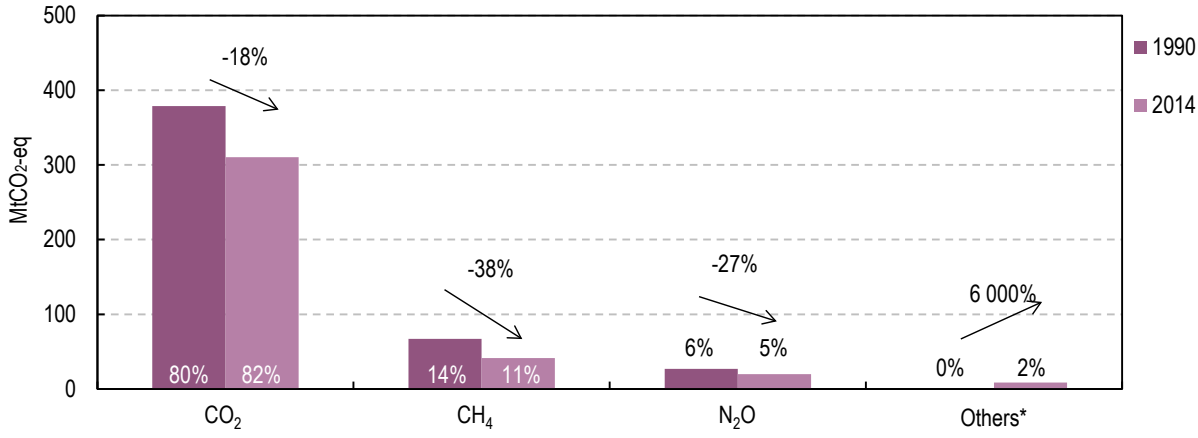
Carbon intensity per population: 7.3 tCO_2/capita (IEA average 10.1)

* Source: KOBiZE (2016).

GREENHOUSE GAS EMISSIONS OVERVIEW

Following the collapse of the Soviet Union, greenhouse gas (GHG) emissions dropped by 20% in just over two years between 1988 and 1990, with emissions falling across all sectors. This rapid drop was followed by a slower decline in emissions, with another reduction by 20% from 1990 to 2014. Carbon dioxide (CO_2) is the largest GHG, contributing to 82% of total emissions in 2014. The main source of CO_2 is fossil fuel combustion in the energy sector (including transport).

Figure 3.1 GHG emissions by emission source (gas), 1990 and 2014

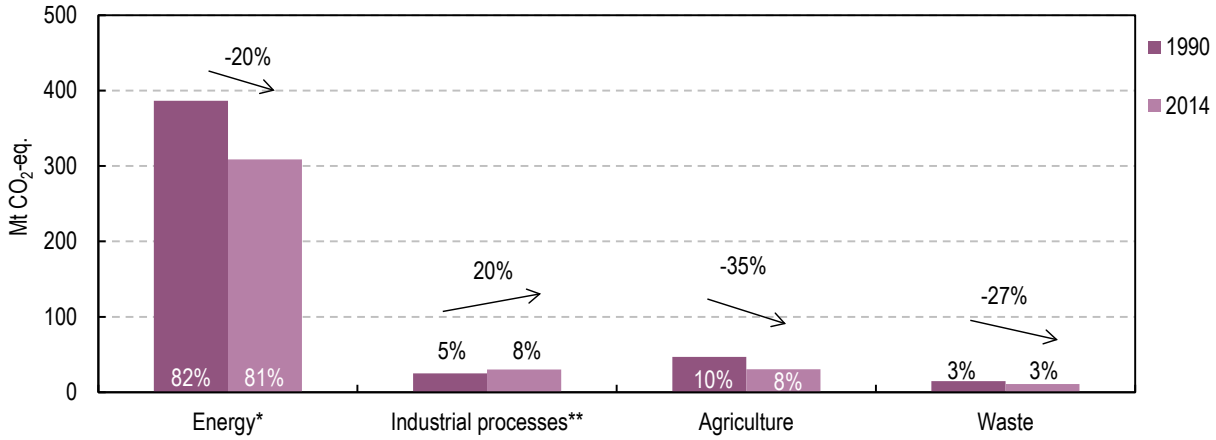


* Other gases are mainly hydrofluorocarbons (HFCs) (measured from 1995), and minor shares of perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

Notes: Numbers in (or above) columns indicate the gas's share of the total GHG emissions. $MtCO_2$ = million tonnes of carbon dioxide; CH_4 = methane; N_2O = nitrous oxide.

Source: KOBiZE (2016), *Poland's National Inventory Report 2016*.

Figure 3.2 GHG emissions by emission source (sector), 1990 and 2014



* Energy includes emissions from transport and manufacturing industries and construction.

** Industrial processes include emissions from processes and product use in different industry sectors (mainly mineral, chemical and metal industries).

Note: Numbers in (or above) columns indicate the sector's share of total GHG emissions.

Source: KOBiZE (National Centre for Emission Management) (2016), *Poland's National Inventory Report 2016, Greenhouse Gas Inventory for 1988-2014, Submission under the UN Framework Convention on Climate Change and its Kyoto Protocol, KOBiZE, Warsaw*

ENERGY-RELATED CO_2 EMISSIONS

Fossil fuel combustion in energy-related processes is a major source of CO_2 emissions. (The following sections concern only CO_2 emissions from fuel combustion, and no emissions from the non-energy-related sectors, or from other GHGs, are shown in Figure 3.2.) Total CO_2 emissions from combustion were 279 $MtCO_2$-eq in 2014, which was a record low for emissions, representing a decline of 6% compared to 2004. Power and heat production accounts for the largest share of energy-related CO_2 emissions. The large share of coal in power production results in a relatively high carbon intensity from the sector. Overall CO_2 emissions per gross domestic product (GDP) have, however, improved significantly over the last three decades.

SOURCES OF EMISSIONS

Power and heat production generated 148.3 $MtCO_2$-eq in 2014, representing over half of total energy-related CO_2 emissions (Figure 3.3). Emissions from power and heat production have declined by 11% from 2004 to 2014, as renewable energy sources and more efficient coal-fired power generation have been introduced into the energy system. The decline in emissions from this sector has partly been offset by increased transport emissions.

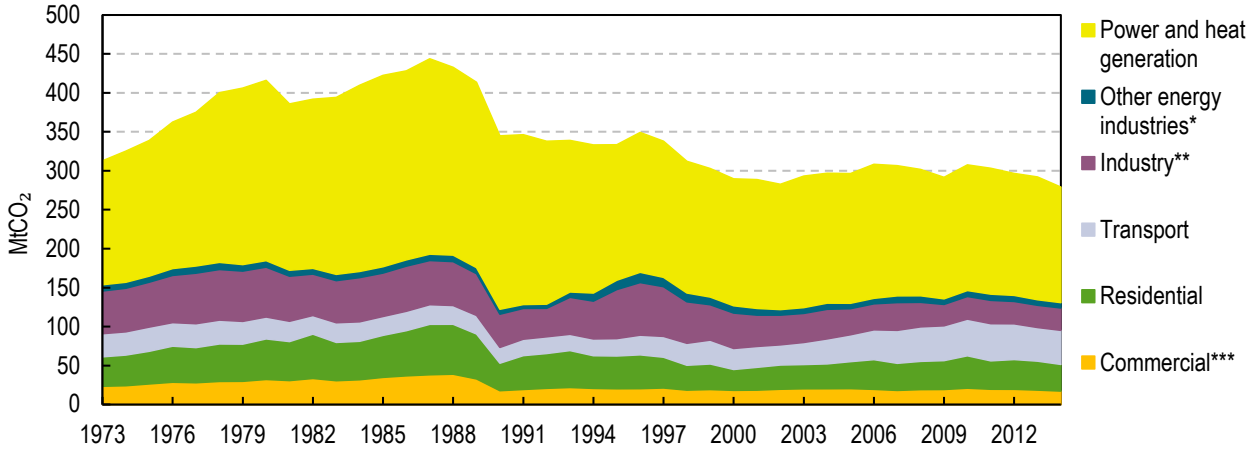
Transport is the second-largest emitting sector, accounting for 43.7 $MtCO_2$-eq in 2014, an increase of 36% compared to 2004. The higher emissions are a direct result of a large growth in energy consumption in the transport sector, which mainly uses oil products, generally the result of greater prosperity.

The residential sector is the third-largest emitter of energy-related CO_2 accounting for 34.2 $MtCO_2$-eq in 2014, a 7% increase compared to 2004. Coal, natural gas and some oil is used in the residential sector, mainly for household heating. Emissions fluctuate annually with weather variations, where cold winters tend to increase demand for energy, resulting in higher emissions. The manufacturing and construction industry

sectors generated 28.7 $MtCO_2$-eq emissions in 2014 accounting for 10% of total emissions. Emissions have fallen steadily from a peak of 67.5 $MtCO_2$-eq in 1996, or 19% of total emissions in that year. In the last decade, industry emissions have fallen by 24%, as a result of a shift from coal towards natural gas and biofuels. The iron and steel industry sector experienced the largest decline in emissions, contributing to 79% of the total reduction from 2004 to 2014.

The commercial sector and other energy industries represent small shares of total emissions and have declined in the last decade. Commercial emissions fell by 15% from 2004 to 17.2 $MtCO_2$-eq in 2014. Other energy industries emitted 6.9 $MtCO_2$-eq in 2014, which was 13% lower than in 2004.

Figure 3.3 CO_2 emissions by sector, 1973-2014



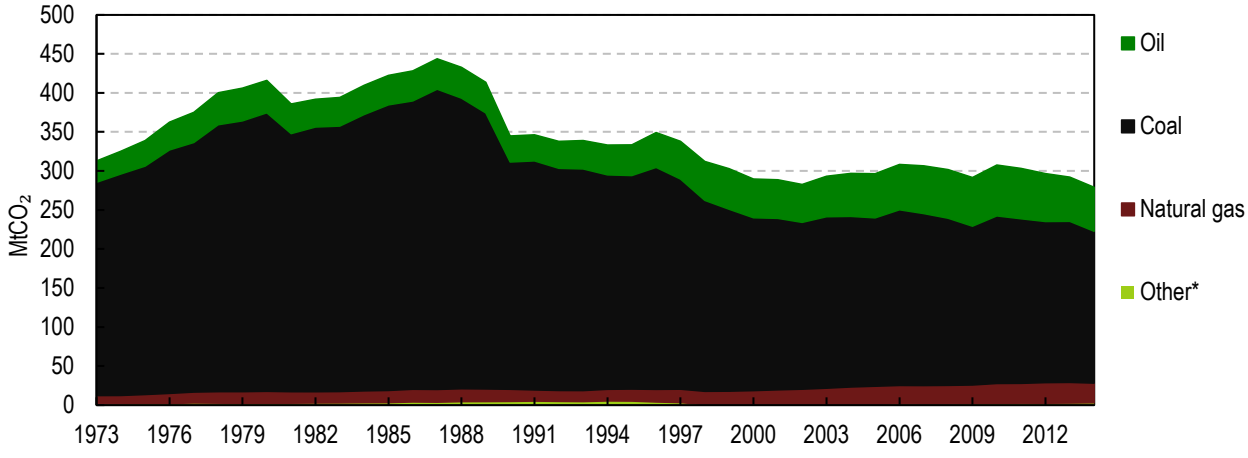
* Other energy industries includes other transformations and energy own-use.

** Industry includes manufacturing industries and construction.

*** Commercial includes commercial and public services, agriculture/forestry and fishing.

Source: IEA (2016a), *CO_2 Emissions from Fuel Combustion 2016*, www.iea.org/statistics/.

Figure 3.4 CO_2 emissions by fuel, 1973-2014



* Negligible.

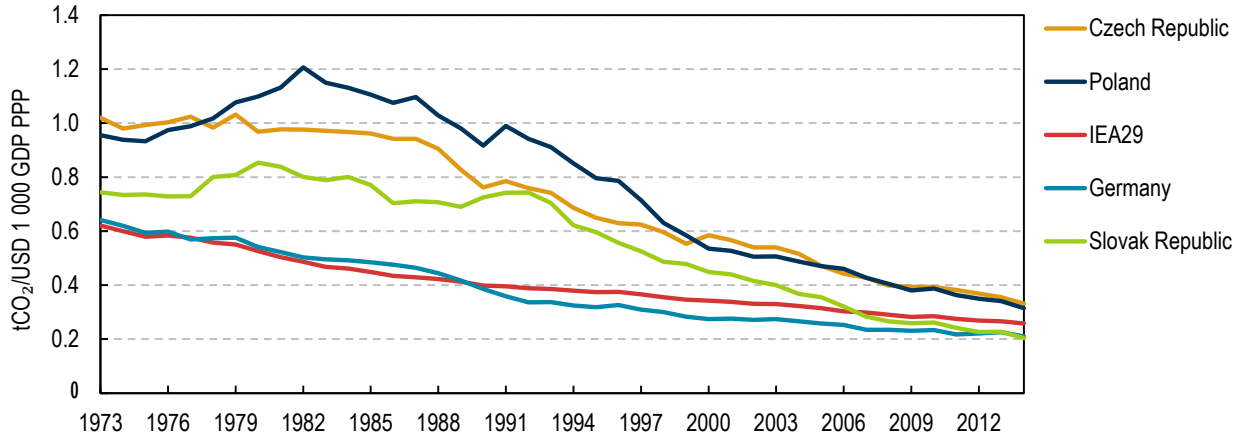
Source: IEA (2016a), *CO_2 Emissions from Fuel Combustion 2016*, www.iea.org/statistics/.

Decreased emissions from the power sector and increased emissions from transport correspond to a shift in fuels that contribute to CO_2 emissions. Emissions from coal, which is used mainly in the power sector, fell by 11% in 2004-14. Over the same period, oil-based emissions increased by 2%. Natural gas contributions to total CO_2 emissions grew by 13% from 2004 to 2014, mainly from increased use in the industry sector.

CARBON INTENSITY

Poland has the seventh-highest energy-related carbon emissions per GDP among International Energy Agency (IEA) member countries, and is the third-highest among IEA Europe countries. Carbon intensity has, however, reduced significantly in Poland and is getting close to the levels of neighbouring countries. Carbon emissions per GDP declined by two-thirds from 1990 to 2014 but remain 22% above the IEA average (Figure 3.5).

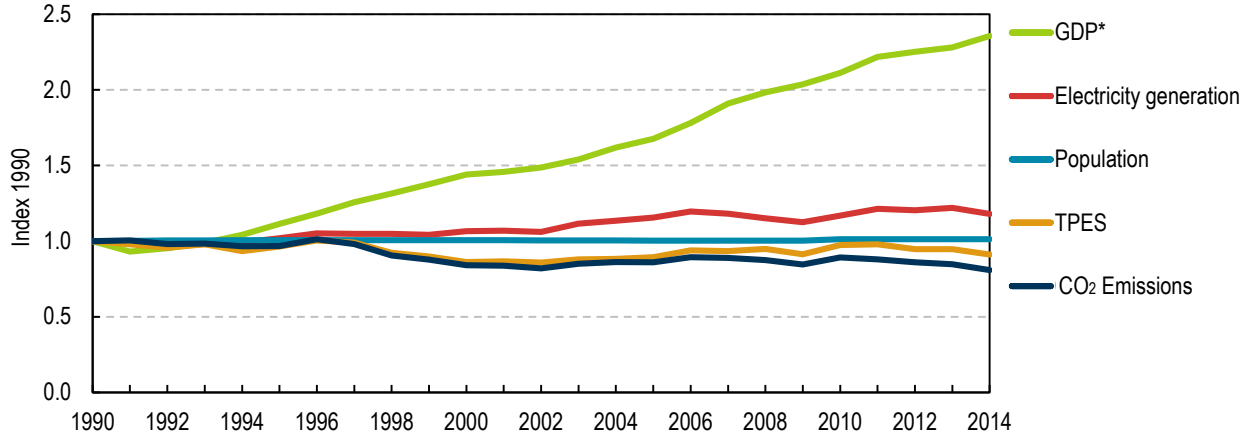
Figure 3.5 Energy-related CO_2 emissions per unit of GDP in Poland and in other selected IEA member countries, 1973-2014



Notes: tCO_2 = tonnes of carbon dioxide; PPP = purchasing power parity.

Source: IEA (2016a), *CO_2 Emissions from Fuel Combustion 2016*, www.iea.org/statistics/.

Figure 3.6 CO_2 emissions and main drivers in Poland, 1990-2014



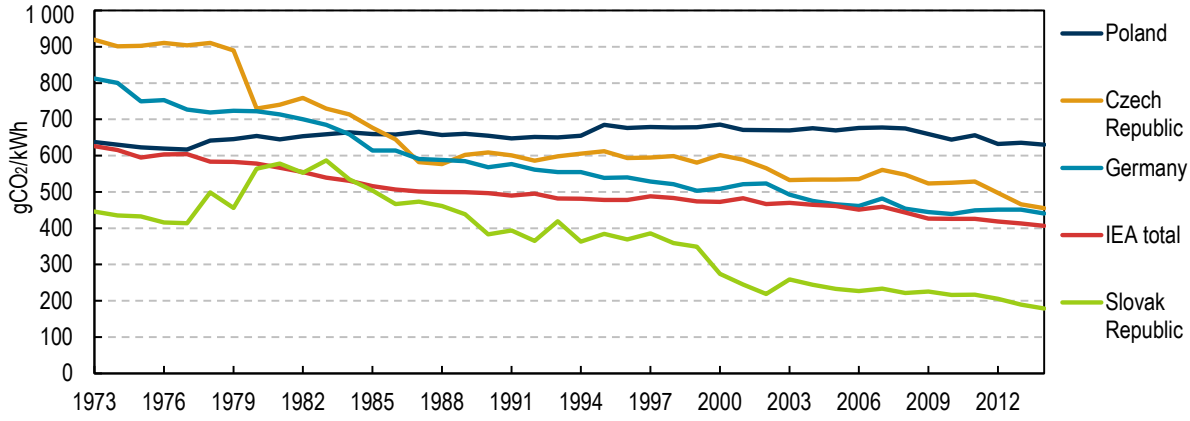
* Real GDP in 2010 prices and PPP.

Source: IEA (2016a), *CO_2 Emissions from Fuel Combustion 2016*, www.iea.org/statistics/.

The decline in CO_2 emissions during periods of strong economic growth indicates that Poland has managed to decouple GDP growth from carbon emissions. Drivers of CO_2 emissions are the overall supply and demand of energy as well as power production (Figure 3.6).

Poland's heat and power sector is carbon-intense compared to other IEA countries, because of its strong reliance on coal. Nonetheless, its carbon intensity fell by 7% in the 2004-14 period as a result of more electricity production from renewable energy sources (mainly biofuels and wind power). Other countries have, however, made greater reductions in CO_2 emissions from the power sector. IEA countries in total reduced the power sector carbon intensity by 13% in 2004-14, and emit 36% less CO_2 per kilowatt hour (kWh) than Poland (Figure 3.7). This implies significant room for improvements in Poland.

Figure 3.7 CO_2 emissions per kWh heat and power in Poland and in other selected IEA member countries, 1973-2014



Note: gCO_2/kWh = grammes of carbon dioxide per kilowatt hour.

Source: IEA (2016a), *CO_2 Emissions from Fuel Combustion 2016*, www.iea.org/statistics/.

PROJECTED EMISSIONS

Poland's projected total emissions in 2030 are 358.8 $MtCO_2$-eq, which is 38% lower than emissions in 1988 and 9.1% lower than those in 2013 (Government of Poland, 2015). The largest fall in emissions by 2030 is projected for CO_2, while emissions of methane (CH_4), nitrous oxide (N_2O) and fluorinated gases are expected to gradually increase as a result of increased agricultural activity. CO_2 retains the largest share in the projected national GHG emissions, as it accounts for almost 82% of emissions in 2015 and is projected to account for 78% in 2030. The main source of CO_2 emissions will continue to be fuel combustion at stationary sources. The share of methane will grow from about 11% of the national emissions in 2015 to 12% in 2030, while the share of nitrous oxide will increase from 5% to 6%. The other emissions are those of fluorinated gases, whose share of total emissions will increase from 2% to 3% in the period 2015−30 (Government of Poland, 2015).

INSTITUTIONS

The Minister of the Environment is responsible for the implementation of the tasks ensuing from the United Nations Framework Convention on Climate Change (UNFCCC). It also approves the programme of the State Environmental Monitoring System, which is co-ordinated, pursuant to the Act on the Inspectorate for Environmental Protection, by the Chief Inspector for Environmental Protection. The Minster of the Environment also oversees the following institutions:

- The Institute of Environmental Protection (National Research Institute [IOŚ-PIB]), which includes the Climate Protection Laboratory and the National Centre for Emissions Management, plays the role of the national co-ordinator for the European Union Emissions Trading Scheme (EU ETS) and reports on local air pollution.
- The Forest Research Institute (IBL) carries out research on matters related to CO_2 removals in land use, land use change and forestry (LULUCF).
- The Institute of Meteorology and Waste Management (National Research Institute [IMGW-PIB]) carries out systematic climate change observations and its organisation also includes the National Focal Point for the Intergovernmental Panel on Climate Change.

At national level, other ministries make policy decisions that impact on the overall climate protection framework. These include the Ministry for Energy, which is responsible for energy policy and the Ministry for Development, which is responsible for industry, as well as for international economic co-operation, and for the co-ordination and management of the resources obtained from EU Funds. The Ministry for Agriculture and Rural Development is responsible for the implementation of government policy in the agricultural sector and rural areas and the Ministry for Infrastructure and Construction is responsible for policy in the transport and construction sectors.

The Central Statistical Office (GUS) prepares aggregated data on the emissions of GHGs and other air pollutants, statistical data on energy, production and fuel consumption, other statistical data related to the Climate Convention and data concerning the production, imports and exports of substances that deplete the ozone layer.

The National Fund for Environmental Protection and Water Management, together with the *Voivodeship* funds, make up the system for financing environmental protection in Poland. The National Fund is a source of funding for environmental projects at the higher-than-regional level, including the measures to reduce emissions.

POLICIES AND MEASURES

EUROPEAN UNION TARGETS AND POLICIES

The emissions reduction targets for 2013-20 were adopted at EU level. As a member state of the European Union, together with other member countries, Poland made joint reduction commitments in order to achieve a 20% emission reduction by 2020 with respect to 1990. As part of the joint commitments, the European Union undertook to reduce its emissions in the sectors covered by the EU ETS by 21% with respect to their levels in 2005.

In the sectors not covered by the EU ETS, in accordance with Effort Sharing Decision 406/2009/EC1 (ESD), Poland may increase its emissions by 14% with respect to 2005. Table 3.1 below shows the allocations for Poland in the sectors not covered by the EU ETS.

EU ETS

The EU ETS is a mandatory cap-and-trade system covering CO_2 emissions from energy-intensive industry. It was launched in 2005 and its first commitment period ran until the end of 2007. The second phase covered the period 2008-12. Installations under the EU ETS can meet their obligations either by reducing emissions on their own, or by purchasing allowances from other installations covered by the scheme, or by purchasing credits under the Kyoto Protocol's flexible mechanisms (joint implementation or the clean development mechanism) up to an established limit.

From 2005 to 2012, emission allowances were allocated to the facilities on the basis of a national allocation plan (NAP). The NAP was prepared by each national government following criteria set out in the ETS Directive (2003/87/EC, later amended by 2009/29/EC) and approved by the European Commission. More than 95% of the allowances in the European Union were allocated to the companies free of charge. Over-allocation of allowances as well as a decline in economic activity led to a large surplus of allowances, a steep decline in their prices and a need to reform the ETS.

The third phase of the EU ETS runs from 2013 to 2020. It is significantly different from previous phases. NAPs are no longer required and a single EU-wide ETS cap is introduced. The cap is reduced by 1.74% per year from 2010 onwards, resulting in a total reduction of 21% by 2020 below the 2005 levels. More than 40% of allowances will be auctioned and electricity generation will no longer receive free allowances. For the sectors where allowances will still be given away for free, such as manufacturing industry and heat sectors, harmonised allocation rules apply, based on EU-wide benchmarks of emissions performance. A separate cap applies to the aviation sector. From 2021 to 2030, the number of allowances will be reduced by 2.2% per year, and a market stability reserve of allowances is expected to be introduced from 2019.

From 2013, the allocation of free emission allowances was restricted to installations which did not generate electricity, excluding the so-called derogation (under Article 10c of Directive 2003/87/EC). Poland meets the criteria defined as the dependence of electricity generation on one type of fossil fuel to an extent exceeding 30% and the GDP level per capita of less than 50% of the average GDP in the European Union. The total number of emission allowances until 2020 which Poland will be able to allocate under the derogation is about 404.65 million EU emission unit allowances (EUAs).[1] The maximum allocation of free allowances to be allocated over seven years will be gradually phased out to none in 2020.

The implementation of the derogation required the adoption of the National Investment Plan (NIP). In Poland's case, the NIP covers primarily investments in new electricity generators and the modernisation of old generators. Furthermore, the NIP results in limiting energy price increases which could otherwise occur in the absence of the derogation.

1. One allowance (EUA) equals 1 tonne of CO_2 or its equivalent.

Table 3.1 Number of allowances to be allocated for free to power plants in Poland by year

2013	2014	2015	2016	2017	2018	2019	2020	Total
78.817	72.259	66.701	60.031	52.249	43.355	32.329	0	404.65

Source: European Commission (EC) (2016), http://europa.eu/rapid/press-release_MEMO-12-561_en.htm?locale=en (accessed 1 October 2016).

THE EU EFFORT SHARING DECISION

Allowed GHG levels for the sectors which are not covered by the EU ETS were established in EC Decision 2013/162/EU of 26 March 2013. On 31 October 2013, the European Union then published an implementing decision setting out final adjusted annual limits for EU member states' emissions from sectors not covered by the EU ETS.

Under the Effort Sharing Decision (ESD), countries with a low GDP per capita are allowed to emit more than they did in 2005 because their relatively higher economic growth will probably be accompanied by increased emissions in sectors such as transport. The emissions reduction required in EU member countries where GDP per capita is below the EU average is therefore correspondingly lower (i.e. less than 10% below 2005 levels). Less wealthy member states will be allowed to increase their emissions in the non-ETS sectors by up to 20% above 2005 levels. These targets do, however, represent a cap on their emissions and will still require a reduction effort. In the case of Poland, it will be allowed to increase its GHG emissions levels in the non-ETS sectors by 14% in 2020 compared to 2005, a target that seems unambitious.

Table 3.2 EU ESD emission caps for Poland 2013-20 ($MtCO_2$-eq)

2013	2014	2015	2016	2017	2018	2019	2020
193.642	194.885	196.128	197.371	198.614	199.856	201.099	202.342

Source: Government of Poland (2015), *Second Biennial Report to the Conference of the Parties of the United Nations Framework Convention on Climate Change 2015.*

Generally, it is up to each EU member state to define and implement its own policies and measures to reduce emissions from the non-ETS sectors. Nonetheless, a number of EU-level measures taken in areas such as energy efficiency standards, limits on CO_2 emissions from cars and vans, and waste management will also contribute to emission reductions in these sectors.

THE NATIONAL GREEN INVESTMENT SCHEME

The Green Investment Scheme (GIS) derives from the EU ETS mechanism. The objective of the GIS is to generate and strengthen the environment-friendly effect of the sales of surplus Assigned Amount Units (AAUs). It is a mechanism to sell AAUs to countries or entities (authorised by these countries) which need the units to achieve their reduction target under the Kyoto Protocol. The legal framework for the GIS Scheme was adopted by the Act of 17 July 2009 on the System to Manage the Emissions of Greenhouse Gas Emissions and Other Substances. This Act regulates the principles of the functioning of the GIS, including its organisation and the selection of projects. In turn, the Regulation of the Council of Ministers of 20 October 2009 on the types of programmes and projects designated for implementation within the framework of the GIS (Official Journal of the

Laws, No. 187, Item 1445) defines the types of programmes and projects designated for implementation within the framework of the GIS. They are projects designed to avoid or reduce GHG emissions and those involving CO_2 removals and sequestration, the measures to adapt to climate change and other measures to protect the air. Each time the choice of specific areas is negotiated with the buyer. To date, the Minister of the Environment has signed 11 agreements on the sales of AAUs for the total value of more than EUR 195 million.

INTERNATIONAL FLEXIBILITY MECHANISMS

In the first Kyoto commitment period (2008-12), Poland hosted 38 Joint Implementation (JI) projects. All together, these projects achieved verified emission reductions of 21.1 Mt CO_2-eq during 2008-12. Post-2012 reductions have not been verified.

Participants in the EU ETS in Poland used 95.6 million of international credits (certified emission reduction or CER/ emissions reduction unit or ERU) towards fulfilling part of their obligations in phase two (2008-12).[2] On average, Poland used 9.3% of Kyoto units in 2008-12 (and the international credit entitlement for participants is 11% for the period). Unused entitlements have been transferred to the third phase of the EU ETS (2013-20) and can be used by participants of the scheme towards fulfilling part of their obligations until 2020.

As regards quantity of units in the retirement account, the quantity of Kyoto Protocol units from flexible mechanisms in Poland's retirement account at the end of the true-up period is -2 061 462 ERU and -28 840 820 CER.

DOMESTIC POLICIES AND MEASURES

The principal domestic policy tools to reduce GHG emissions are measures to encourage energy efficiency improvements, the development of renewable energy sources and the modernisation of the electricity generation sector, including the pursuit of nuclear power. The government has also introduced measures to improve the energy efficiency of the agricultural sector, support the use of coalbed methane to produce electricity and heat and to reduce methane emissions from fuel production and distribution processes.

Funds to support financing environment-friendly measures are also available from the National Fund and Voivodship Funds for Environmental Protection and Water Management alongside EU Funds and the Norwegian Fund.

The targets for the share of energy from renewable sources in the transport sector, the electricity sector and the heating and cooling sector in 2020 were adopted on 7 December 2010 in the National Action Plan on Energy from Renewable Sources, which was subsequently updated with "A Complement to the National Action Plan on Energy from Renewable Sources", adopted by the Council of Ministers on 2 December 2011 (see Chapter 6).

The National Action Plan for Energy Efficiency for Poland 2014 was prepared pursuant to the Act of 15 April 2011 on Energy Efficiency and adopted in October 2014. The plan sets out the adopted and planned measures to improve energy efficiency in the individual

2. An ERU is equal to one tonne of CO_2 and is generated by a joint implementation project. A CER is equal to one tonne of CO_2 and generated from a clean development mechanism project activity.

sectors which are necessary to achieve in 2016 final energy savings representing at least 9% of the average national final energy consumption in 2001–05. Moreover, it indicates the measures designed to achieve 20% savings in primary energy consumption in the European Union by 2020.

To reduce emissions from the transport sector, the Council of Ministers adopted the Transport Development Strategy until 2020 (with an Outlook until 2030). This is a planning document, indicating the objectives and directions of measures in the area of transport. The main goal of this strategy is to enhance regional accessibility and to improve the safety and efficiency of the transport sector by creating a consistent, sustainable and user-friendly transport system at the local, national, European and global levels. One of the key objectives of the strategy is to limit the adverse impact of transport use on the environment. The government has also adopted a Long-Term Rail Investment Programme until 2015 with an Outlook until 2020 and a National Plan for the Implementation of the European Rail Traffic Management System in Poland.

Poland is likely to adopt ambitious targets for future electric vehicle (EV) deployment, with a target of 50 000 EVs on the road by 2020 and one million by 2025 (see Chapter 4). Poland, however, is one of few countries in the European Union without any incentives for EV investments, but legislation to support an electro-mobility programme is being prepared at present. EVs will contribute to improved local air quality, but not so much to CO_2 emissions reduction as long as electricity is mostly stemming from coal-fired power generation.

Strategy for Energy Security and Environment

Published in 2014, the Strategy for Energy Security and Environment (ESE) is one of nine integrated government development strategies. It identifies the key reforms and necessary steps for cleaner energy and to safeguard the security of energy supply up to 2020. The key objectives of the strategy include sustainable management of the environment by means of measures such as water management, preservation of biodiversity and effective management of mineral resources. The policy attempts to ensure energy supply through measures such as better use of domestic energy resources, improved energy efficiency and modernisation of the power industry. The policy document also called for measures to improve the environment through reduction in air pollution, particularly lead, cadmium and particulate matter, cuts in industrial sector water use and better waste management. The government will also work towards carbon capture and storage solutions and gasification of coal, which is expected to remain the nation's main source of energy (GRI, 2014).

Adaptation to climate change

Poland published its National Strategy for Adaptation to Climate Change (NAS 2020) in October 2013. It has been prepared with a view to ensuring that the country can maintain the conditions of stable socio-economic development in the face of risks posed by climate change. It also takes into account the positive impact which adaptation actions may have not only on the environment but also on economic growth. NAS 2020 sets out the objectives and directions of adaptation actions to be taken in the most vulnerable sectors and areas within the period to 2020: water management, agriculture, forestry, biodiversity and protected areas, health, energy, building industry, transport, mountain areas, coastal zones, spatial development and urban areas. The report

highlights the risk to energy infrastructure posed by extreme climatic conditions such as more frequent storms, lower rainfall, less surface water and changing wind patterns. NAS 2020 sets out a series of adaptation actions to be taken by the sector and identifies the responsible institutions.

LOCAL AIR QUALITY

Despite the obligation for EU member states to ensure satisfactory air quality for their citizens, local air quality has remained a problem in many parts of Poland for a number of years. The continuous development of the economy over the last two decades has not led to increased emissions, although in some cases a systemic reduction has been observed (sulphur dioxide). Nonetheless, and in spite of improvements of air quality, exceedances of limit values for particulate matter (PM) 10, PM2.5 and benzo(a)pyrene (BaP) in the winter season remain a serious problem. Small-scale (household) combustion of coal, waste, and biomass and concentrated local pollution (particularly in the heating season) are the main factors in these emissions (OECD, 2016).

Exposure to high concentrations of PM10 (coarse dust particles) and PM2.5 (fine particulates) have been linked to a variety of health concerns including asthma, heart problems and premature death of people with heart or lung disease. The daily limit value for PM10 is widely exceeded in Poland while the target limit for PM2.5 is also regularly exceeded and annual mean concentration values in Poland are the highest in the European Union. Poland's annual mean concentration values of BaP, found in coal tars among other things and a cause of lung cancer, are also the highest in Europe.

To improve local air quality, the government is implementing a two-phase air quality programme between 2013 and 2018. The first phase includes the development of air protection programmes and short-term action plans while the second phase includes measures to eliminate local emissions by supporting energy efficiency improvements and the development of distributed renewable energy sources. Resources from the National Fund and Voivodship Funds for Environmental Protection and Water Management are being used to co-finance the development of air protection programmes in the zones where there are significant exceedances of the limits and target concentrations of PM2.5, PM10 and CO_2. The purpose of these programmes is to reduce pollutant emissions and the exposure of the local population to the impacts of these pollutants. The programme also aims to eliminate local emissions, to improve energy efficiency and to develop distributed renewable energy systems (RES).

ASSESSMENT

Poland is the tenth-largest emitter of GHG in the Organisation for Economic Co-operation and Development (OECD) and the fifth-largest in the European Union. Measured by emissions per capita, Poland has the sixteenth-highest emissions in the OECD and the ninth-highest in the European Union. Emission intensity in Poland has decreased steadily since 1990. GHG emissions per GDP in Poland, however, remain the fourth-highest in the OECD and third-highest in the European Union (2012).

In 2014, CO_2 emissions constituted 81.7% of Poland's total GHG emissions and 91.8% of CO_2 emissions was coming from fuel combustion. Methane (CH_4) emissions represented 10.9% of total GHG emissions, with 33.7% coming from agriculture and 44.5% from

energy, mainly fugitive emissions from fuels. As an EU member state, Poland has committed to contributing to the EU reduction target under the climate and energy framework of 20% emissions reductions in 2020 compared to 1990. As part of this commitment, the European Union has a reduction target in the sectors not covered by the EU ETS of 10% in 2020 compared to 1990. Under the ESD, Poland must limit emissions in 2020 from sectors outside the EU ETS to 14% above 2005 levels while complying with yearly caps. Poland is currently below the emission cap under the ESD and is expected to easily fulfil the overall target for 2020.

In the third trading period of the EU ETS (2013-20), significant changes were introduced to the principles of the allocation of allowances. A single EU-wide cap on emissions was introduced, replacing the previous system of national caps. Furthermore, auctioning became the default method for the allocations of allowances, replacing free allocation, and harmonised rules now apply for allowances allocated for free. For sectors within the EU ETS, the European Union has a common reduction target of 21% in 2020 compared to 2005. As a result of the common EU-wide cap, Poland does not have a national reduction target within the EU ETS.

From 2013, free allocation of allowances is restricted to installations not generating electricity. As an exemption from this, the derogation under Article 10c of the ETS Directive (2003/87/EC) allows for transitional free allocation to electricity production in certain member states. Poland meets the criteria for this derogation. The total number of emission allowances which Poland will be able to allocate under the derogation is about 404.65 million EUAs.

Poland's reduction target under the Kyoto Protocol (KP) for 2008-12 was 6% compared to the base year of 1988. The target under the KP was significantly overachieved based on domestic measures, not only because of efficiency improvements in industry, but also as the result of structural changes in the economy during the early 1990s. This has resulted in a large decrease in overall emissions from 1990 until 2002, but since then emissions have increased slightly.

Climate policy and emission reduction targets in Poland are almost exclusively driven by EU policy and targets. As a result, since the reduction targets for 2020 are foreseen to be met with existing measures in place, no additional measures are prepared either for the time until 2020 or thereafter. Continued improvement in energy efficiency, however, is generally treated as a priority in Poland with the goal of maintaining a zero-energy economic growth and consistent reduction of the energy intensity of the Polish economy towards the level of the EU-15.

Poland has also prepared and adopted a climate adaptation strategy (NAS 2020) and a strategy for energy security and environment (ESE). The government has wisely committed to adaptation actions to be taken in the most vulnerable sectors and areas by 2020 in order to avoid costs resulting from adaptation inaction, and to reduce social and economic risks associated with climate change. An implementation system has been proposed, by identifying responsible entities and indicators for monitoring and evaluation of the achievement of the objectives. The main goal of ESE is to ensure a high quality of life for present and future generations, taking into account the protection of the environment, and to create the conditions for the sustainable development of a modern energy sector. The key goals of ESE are to limit local air pollution and reform the water management system.

Household heating is a major source of local air pollution in the country, and emissions from this sector are difficult, if not impossible, to regulate. The European Environment Agency estimates that household heating produces approximately 40% of particulate matter emissions. The key factors are ageing and low efficiency of combustion in heating units, and to a lesser extent, the behaviour of household consumers. The government has offered financial support and incentives for the replacement of old boilers with cleaner, more efficient boilers alongside financial support for people to install domestic insulation. The government should examine and adapt if necessary present incentives in the household space-heating sector to ensure the mechanism provides less-well-off householders with the means to switch away from coal or waste use towards cleaner solutions such as electricity, natural gas or district heating.

Following the agreement in the European Council on the energy and climate framework for 2030, including an overall GHG reduction target of 40% in 2030 compared to 1990, Poland will likely face more challenging reduction targets in the future. A new target in the sectors not covered by the EU ETS may prove to be challenging as emissions in these sectors are expected to remain constant or even increase towards 2030. This is true for the transportation sector, which is the fastest growing source of GHG emissions in Poland. Achieving long-term GHG emission targets will require firm measures to mitigate the growing emissions from the transport sector.

Continued economic growth and the related greater affluence of society, as well as the continued process of the socio-economic convergence with the European Union, has caused the mobility level in Poland to come closer to the average level in the European Union; therefore, it is forecast that the demand for transport will grow significantly in both the medium and long term (in 2030, the volume of transport will grow by more than 60% compared with 2010) (Government of Poland, 2015). Implementing measures aimed at reducing emissions and improving energy efficiency in road transportation should be a priority for Poland. New programmes such as the recently proposed e-mobility programme and greater use of natural gas-powered vehicles have the potential to reduce emissions from the transport sector, provided that the electricity sector itself reduces emissions as well. Poland is also actively implementing other policies to reduce emissions from the transport sector, including investment in rail networks, reducing emissions from air transport, inland navigation and maritime shipping. All of these policy packages and action plans should be integrated into the development of the long-term energy strategy to 2050.

Coal is the dominant source of emissions in Poland. Projections show that coal is expected to continue to play a large role in Poland's energy mix in the long term. This necessitates that measures aimed at reducing emissions from the energy sector are developed and supported in order for Poland to be able to achieve a low-emission economy. Energy supply should be diversified, including introduction of nuclear power, increasing the shares of renewable energy and natural gas. In regards to the future role of coal, technologies with carbon capture and storage (CCS) and carbon capture and utilisation (CCU) should be pursued further in order for Poland to ensure a high degree of energy security through reliance on coal while focusing on mitigation of climate change. As part of this, Poland should ensure that the relevant legislation is ready for full implementation of CCS and CCU.

RECOMMENDATIONS

The government of Poland should:

- *Formulate and integrate a long-term climate policy as part of its overall energy strategy framework for 2050 in order to provide a stable framework to ensure investment security for nuclear power, renewable energy, other low-emissions technologies and energy efficiency measures. The climate policy should prepare Poland for more stringent emissions targets stemming from the Paris Agreement and beyond and also address local air quality problems prevalent today.*
- *Implement the actions set out in the National Strategy for Adaptation to Climate Change and the Strategy for Energy Security and Environment in order to reduce the social and economic risks associated with climate change by 2020.*
- *Ensure that the goals and targets for the transport sector already established in the packages for electro-mobility, road, rail, maritime and aviation are integrated into the long-term energy strategy to 2050.*
- *Maintain investment and research activities in carbon capture storage and utilisation (CCS&U) technologies and review all relevant legislation with a view to removing any obstacles to the future deployment of CCS and CCU.*

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4. ENERGY EFFICIENCY

Key data (2015 estimated)

Energy supply per capita: 2.5 toe (IEA average: 4.5), +1.7% since 2005.

Energy intensity: 0.1 toe/USD 1 000 PPP (IEA average: 0.11), -29.5% since 2005.

TFC (2014): 65.3 Mtoe (oil 32.1%, coal 18.2%, electricity 16.6%, natural gas 15.9%, biofuels and waste 8.8%, heat 8.3%), +7% since 2004.

Consumption by sector (2014): Industry 29.9%, Residential 29%, Transport 24%, Commercial 17.2%.

OVERVIEW

Total final consumption (TFC) has increased in the last decade, but dropped by 6% in 2014 compared to a recent peak in 2010. The trend for energy consumption varies for the different sectors, but overall energy intensity is declining. The industry sector is the largest energy consumer in Poland, followed by the residential, transport and commercial sectors. A national action plan and sector-specific programmes are in place to promote further energy efficiency measures. This chapter presents a general overview of energy efficiency in Poland, followed by assessments sector by sector, including a separate section on electric vehicles (EVs).

ENERGY INTENSITY

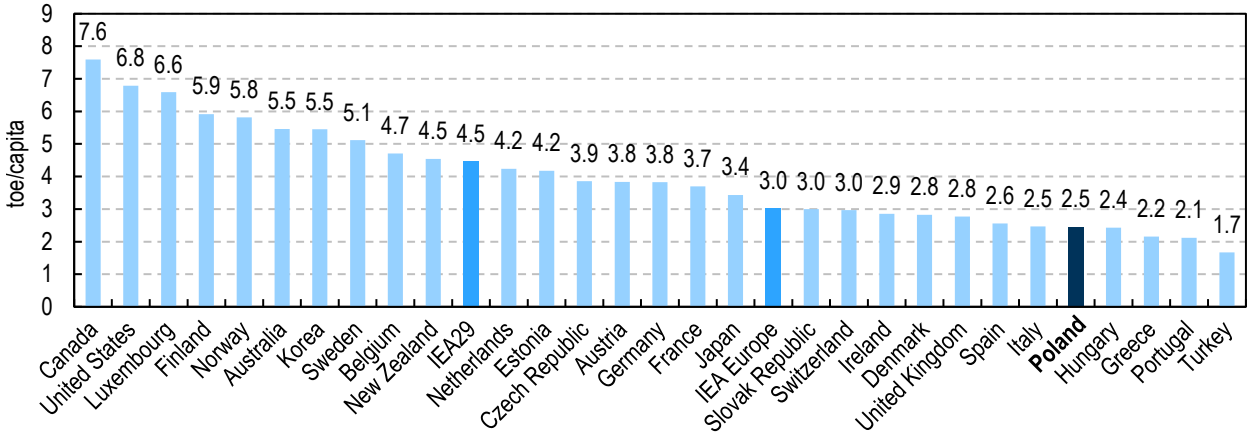
Poland has the fifth-lowest total primary energy supply (TPES) per capita among International Energy Agency (IEA) member countries. With TPES of 94.6 million tonnes of oil-equivalent (Mtoe) and a population of 38.5 million in 2015, Poland consumed 2.5 tonnes of oil equivalent (toe) per capita, which was 45% below the IEA average (Figure 4.1).

Energy intensity in terms of energy consumption per unit of economic output places Poland in the middle of the scale with 103 toe/USD million in 2015. This was 9% below the IEA average but 16% above the IEA Europe average (Figure 4.2).[1]

Poland has made large energy intensity improvements since 1982 when TPES per gross domestic product (GDP) peaked at 381 toe/USD million, close to four times as high as in 2015. In 2009, energy intensity was below the IEA average for the first time. The downward trend for energy intensity has continued at a steady but slower pace in recent years, with a 29% decline in the ten years from 2005 to 2015 (Figure 4.3). Poland's energy intensity was 16% higher than Germany's and the IEA Europe average in 2015, but 6% lower than the Slovak Republic and 23% lower than the Czech Republic.

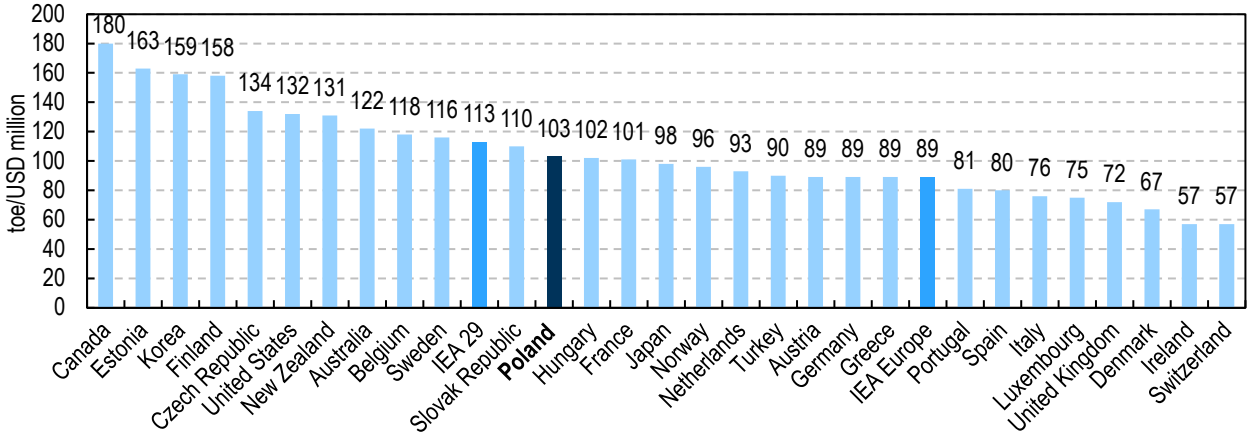
1. The main reason for the difference between the IEA total and IEA Europe is that the United States has a relatively high level of energy consumption per unit of economic output, and a GDP that made up 36% of the total GDP in all IEA countries in 2015.

Figure 4.1 TPES per capita in IEA member countries, 2015



Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

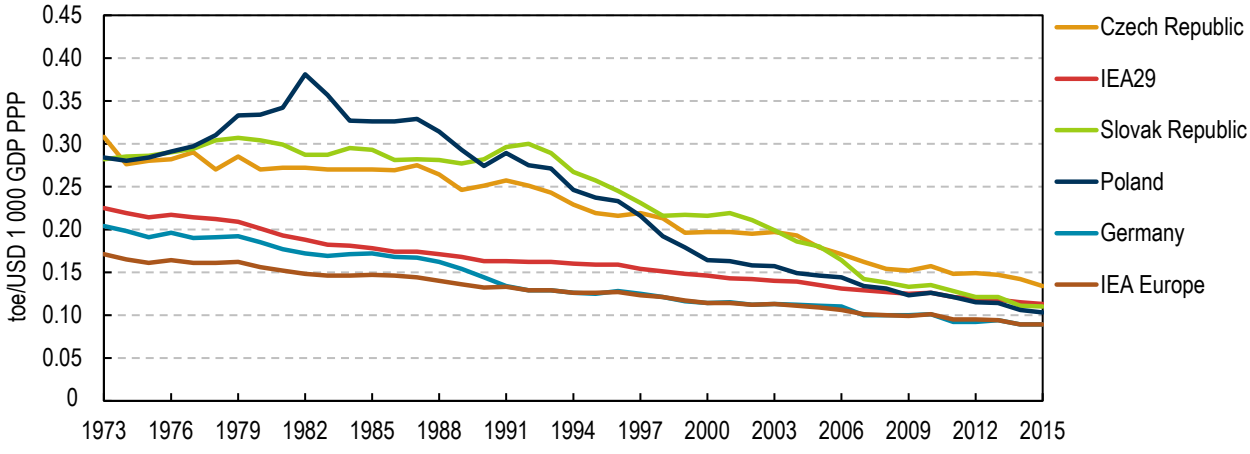
Figure 4.2 TPES per GDP in IEA member countries, 2015



Note: GDP in real numbers for USD per purchasing power parity (PPP), in 2010 values.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Figure 4.3 Energy intensity in Poland and in other selected IEA member countries, 1973-2015



Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

EU POLICY FRAMEWORK

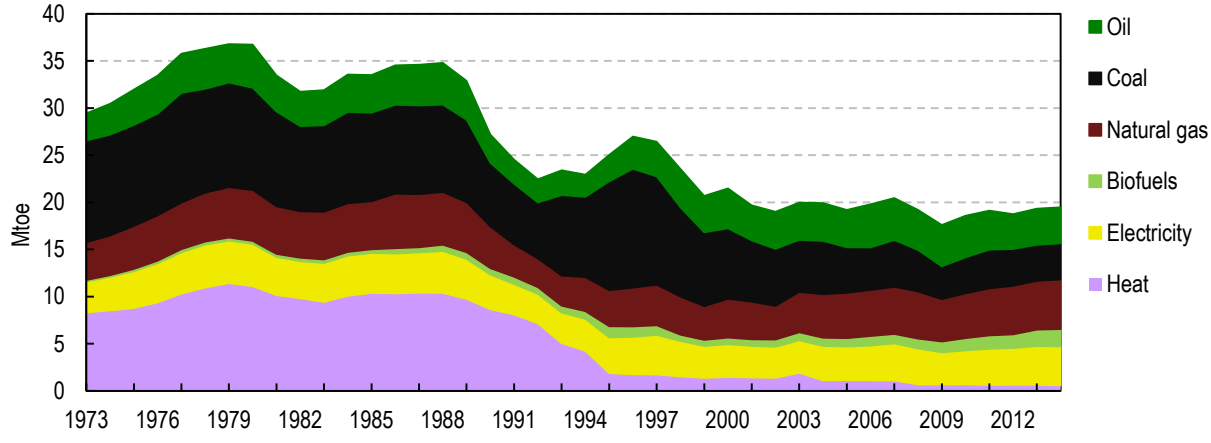
The 2012 EU Energy Efficiency Directive (EED) (2012/27/EU) provides a framework for national policy in EU member countries. It established a set of binding measures to help the European Union reach its 20% energy efficiency target by 2020. Under the Directive, all EU countries are required to use energy more efficiently at all stages of the energy chain, from its production to its final consumption. Poland has implemented the main requirements of the EED by means of the adoption of the Energy Efficiency Act (EEA), which was updated on 20 May 2016. These requirements include an energy efficiency saving scheme for energy utilities and other measures resulting in 1.5% annual savings from 2014 to 2020. Poland's most important policy measure for reaching its efficiency improvement targets is the white certificate scheme (WCS), launched in 2013. The Minister of Energy is responsible for the implementation of the EEA, taking over from the Minister of Economic Affairs (CAEED, 2016).

In accordance with the EED (Article 24), member States are required to submit National Energy Efficiency Action Plans (NEEAP) every third year, including targets for energy savings and information on energy efficiency measures. In the NEEAP, the government determined targets for Poland to reduce primary and final energy consumption in the period 2010-20. The target for end-use energy consumption in 2020 is 71.6 Mtoe compared to 65.3 Mtoe in 2014. This leaves room for a significant increase in TFC until 2020. The target for primary energy consumption is 96.4 Mtoe, compared to 94.6 Mtoe in 2015. This target requires that TPES is kept from increasing (NEEAP, 2014; IEA, 2016a). The overall goal is to achieve economic development without increasing primary energy consumption. This has been achieved historically as TPES has fallen despite rapid growth in GDP (see Chapter 3).

ENERGY USE IN INDUSTRY

The industry sector was the largest energy consuming sector in 2014. Following transformation of the sector in the 1980s and 1990s, which led to a large decline in energy use, energy consumption has been stable in the last decade. New policy programmes, such as the WCS, have been implemented in recent years to increase efficiency in the sector.

Figure 4.4 TFC in the industry sector (including non-energy use) by source, 1973-2014



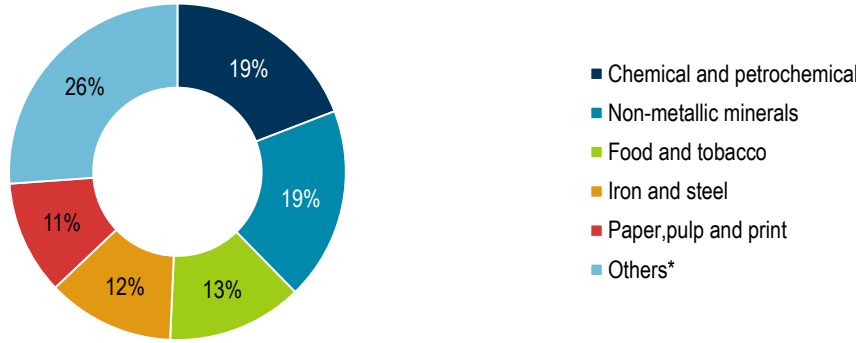
Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

ENERGY CONSUMPTION AND INTENSITY

The industry sector consumed 19.5 Mtoe of energy in 2014, a decline of 2% since 2004 (Figure 4.4). Natural gas provided 27% of the fuels consumed in 2014, followed by electricity (21%), oil (20%), coal (20%), biofuels (9%) and heat (3%).[2] Biofuels have more than doubled since 2004, while the use of coal has decreased by one-third. Electricity and natural gas increased by 13% and 14% respectively over the same period. Energy from oil use in industries more than halved, but increased consumption in non-energy use compensated for this decline, resulting in stable oil consumption (IEA, 2016a).[3]

The main consuming industries are the chemical and petrochemical, non-metallic minerals, and food and tobacco industries. These sectors represent over half of total industry consumption (Figure 4.5). Energy efficiency in terms of energy use per unit of economic output has improved across all major industry sectors. The two largest sectors, chemical and petrochemical, and non-metallic minerals, both more than halved their energy intensity from 2003 to 2013 (Figure 4.6).

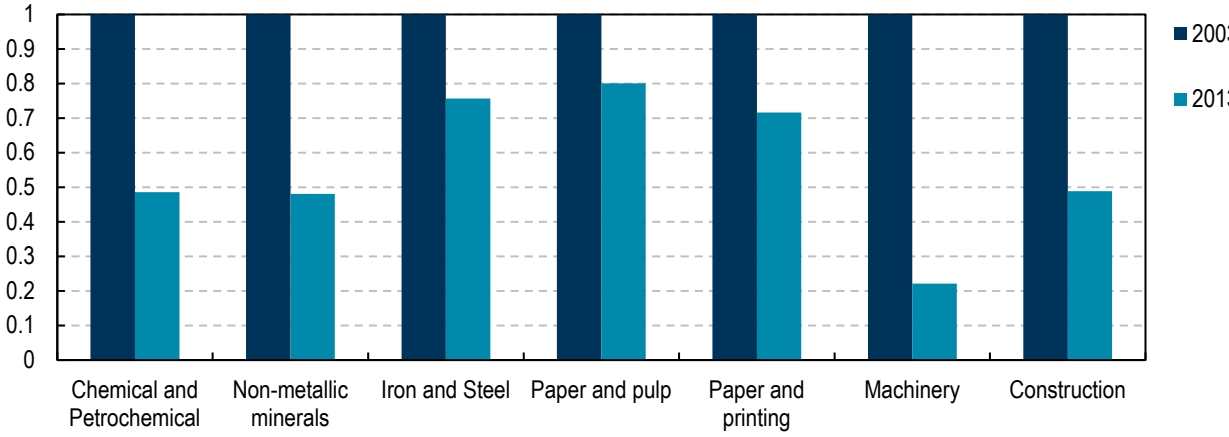
Figure 4.5 Industry TFC broken down by industry sector (energy use only), 2014



*Others includes wood and wood products, machinery, non-ferrous metals, transport equipment, mining and quarrying, construction and textiles.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Figure 4.6 Energy intensities in Poland in selected industries, 2003 (index) and 2013



Source: IEA (2016b), *Energy Efficiency Indicators 2016* (database), www.iea.org/statistics/.

2. This included fuels used in industry for non-energy purposes.

3. Non-energy use refers to fuel (here oil) used as raw material in industrial processes.

POLICIES AND MEASURES

Important energy efficiency policy measures that mainly affect the industry sector are the WCS and energy audits requirement.

White certificate scheme

The WCS was launched in 2013 as a support mechanism for measures aimed at improving the energy efficiency of the economy, such as modernisation of industrial devices and installations as well as energy recovery. Energy companies selling electricity, heat, or natural gas to end users are obliged to obtain a specific value of energy efficiency certificates (white certificates, WCs) and submit them to the President of the Energy Regulatory Office for redemption. WCs can be obtained either through performing approved energy efficiency measures that earn WCs or through trading on the commodity exchange market (CAEED, 2016). In the past there was an option to pay a substitution fee instead of obtaining the certificates, but this no longer exists. The WC mechanism was initially scheduled to run for the period 2013-16, but following a revision to the scheme, it was decided to prolong it until 2020.

WCs in the first period were allocated in an annual tendering process. A total of 5.6 Mtoe in primary energy savings were awarded in four initial tenders, and a fifth and last tender was announced in September 2016. In the 2016 EEA, the system was modified to increase the scheme's flexibility. The tender application procedure was considered complicated, with a short time frame from announcement to submission, followed by a long evaluation procedure. Certificates are now issued by the President of the Energy Regulatory Office upon application on a continuous basis, in a system that is intended to be more efficient than the previous auctioning mechanism. Further changes include a phase-out of the possibility to pay the substitution fee as well as a shift from primary energy to final energy when determining the value of certificates. Installations covered by the EU Emissions Trading Scheme (EU ETS) are now also being included in the scheme (KAPE, 2016).

Energy audits

The EU EED requires large companies to perform energy audits to identify economically feasible investments for improving energy efficiency.[4] EU member states are also advised to develop programmes to encourage small- and medium-sized enterprises to undergo energy audits. An energy audit support programme was operated in 2011-14 by the National Fund for Environmental Protection and Water Management, as a support mechanism for energy efficiency in large enterprises. The programme financed the preparation of 85 energy audits in large companies. With the new EEA of 2016 ensuring full implementation of the EED requirements, including mandatory energy audits in large enterprises, the programme has been suspended.

Energy audits are generally performed by an energy service company (ESCO). An ESCO is a company that offers energy services which may include implementing energy efficiency projects (and also renewable energy projects), often on a turn-key basis. There are approximately 30 companies offering ESCO services in Poland. The ESCO market has

4. Large companies are here defined as companies that employ over 250 people or have an annual turnover exceeding EUR 50 million and an annual balance sheet total exceeding EUR 43 million.

significant potential but it remains at an early stage in its development. An Energy Performance Contract (EPC) is a contractual arrangement between the beneficiary and the ESCO, verified and monitored during the entire term of the contract, where investment in an energy saving measure is paid for in relation to a contractually agreed level of energy efficiency improvement or other agreed energy performance criteria, such as financial savings. Greater use of energy performance contracting in Poland could support the development of a strong ESCO sector and in turn greater energy savings in the industry sector. Standardised energy performance contracting, where the ESCO assumes the performance risk for the project, could be one way to boost the sector in Poland.

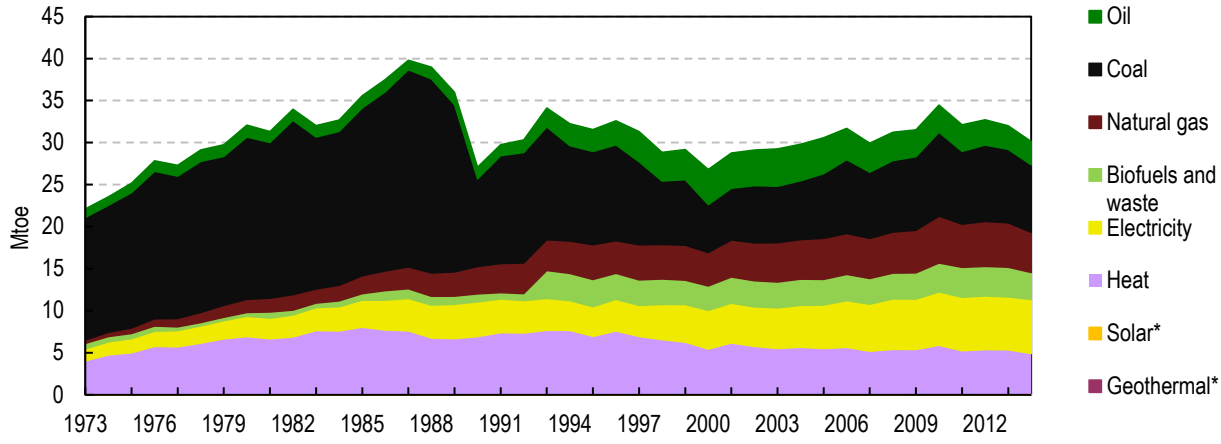
RESIDENTIAL AND COMMERCIAL

Residential and commercial energy consumption has increased at a similar rate to the transport sector, but the fuel mix is more similar to the industry sector. New EU directives and national policy focus on energy efficiency in buildings.

ENERGY CONSUMPTION AND INTENSITY

The residential and commercial sectors together consumed 30.1 Mtoe in 2014, a 1.1% increase from 2004. Of this, 63% was consumed in the residential sector and 37% in the commercial and service sectors. Energy consumption for the heating of buildings is affected by the outdoor temperature, which leads to annual variations based on weather and climate factors. Disregarding these annual variations, energy consumption is stable in both the residential sector (increased by 0.7% in 2004-14) and the commercial sector (increased by 1.8%).

Figure 4.7 TFC in the residential and commercial sectors by source, 1973-2014



*Negligible.

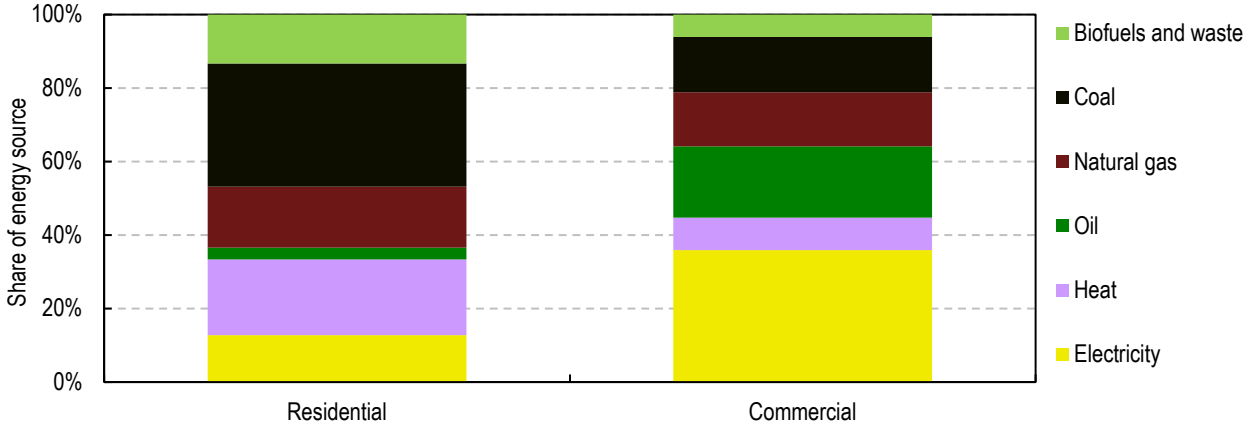
Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Coal is the largest source of energy, accounting for 27% of total consumption in the residential and commercial sectors. Although coal consumption is significantly lower than record levels in the 1980s, it has increased by 15% since 2004. The second-largest energy source is electricity, which accounted for 21% of total consumption in 2014, a 29% increase in ten years. The increase in coal and electricity has been compensated by

a decrease in oil consumption, with a 36% reduction in 2004-14, and heat, which declined by 14% over the same period. The overall trend is similar for the residential and commercial sectors, but the energy mix differs considerably (Figure 4.8).

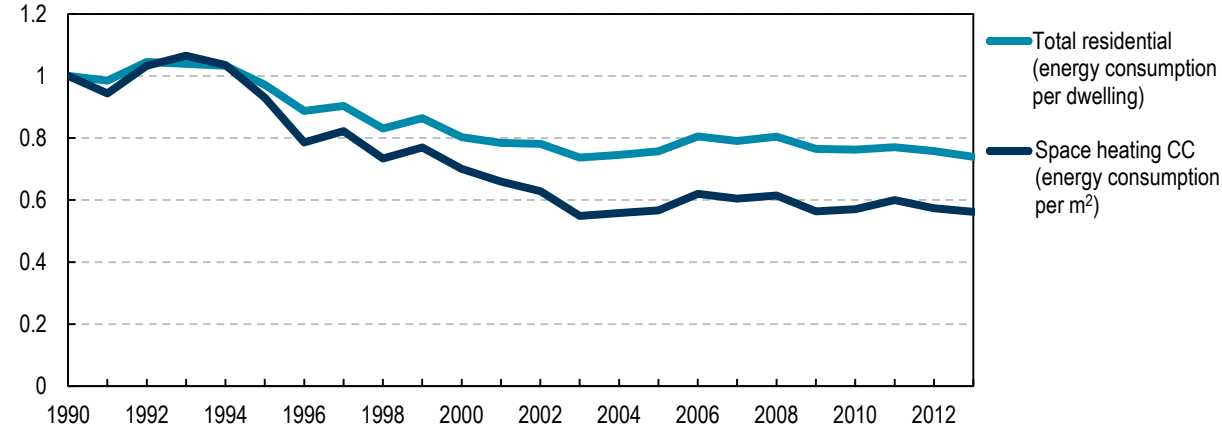
Significant improvements have been made in the energy intensity of the residential sector in the past 25 years. Energy used per square metre for heating declined by 44% between 1990 and 2013 (Figure 4.9).

Figure 4.8 TFC in the residential and commercial sectors (separate) by source, 2014



Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Figure 4.9 Energy intensity in the residential sector, 1990-2013 (1990 index)



Note: CC = Climate Corrected.

Source: IEA (2016b), *Energy Efficiency Indicators (database) 2016*, www.iea.org/statistics/.

POLICIES AND MEASURES

The National Fund for Environmental Protection and Water Management (the Fund or NFEPWM) provides large-scale funding for the implementation of energy efficiency measures, both in public buildings as well as multi-family residential buildings. From EU sources managed by the Fund, almost EUR 166 million has been allocated to the public buildings sector (in the form of grants) and EUR 225.5 million has been allocated to the residential sector in the form of repayable assistance and grants. The level of support

available depends on the achieved energy savings and building's energy class, and thus the scheme strongly promotes more ambitious projects. The Fund is also revising and updating its own programme for low-energy houses and thermo-refurbishment of privately owned single-family houses. The purpose of this revision is better adaptation to local needs and conditions and more efficient distribution of founding at the regional level.

In addition, NFEPWM offers, funded from its own resources, a programme dedicated to support for energy efficiency projects in buildings which are not covered by the financing available from EU Funds, e.g. historical buildings, healthcare facilities and dormitories (budget EUR 125 million). Moreover, the Fund provides not only financing, but more comprehensive and complementary support, offering a nationwide energy advisory scheme, which provides necessary skills and knowledge at the regional and local level.

The Energy Performance of Buildings Directive (2010/31/EU) requires all new buildings to be nearly zero-energy buildings by 31 December 2020. New public buildings must be nearly zero-energy buildings by 2018. Poland has identified the Nearly Zero-Energy Building Standard, which is set out in Article 9 of the Directive. The Directive further requires that energy performance certificates be included in all advertisements for the sale or rental of buildings. Poland has an energy performance certificates scheme in place, with the aim to provide building owners and users with reliable information regarding the estimated or measured energy consumption, the energy-related conditions and renovation potential.

The Ecodesign Directive (2009/125/EU) has also been implemented in Poland. The Directive provides requirements that energy-related products covered by implementing measures must fulfil in order to be placed on the market or put into service. There are 27 implementing regulations which cover different energy-related products. Regulations are directly applicable from the date of their entry into force.

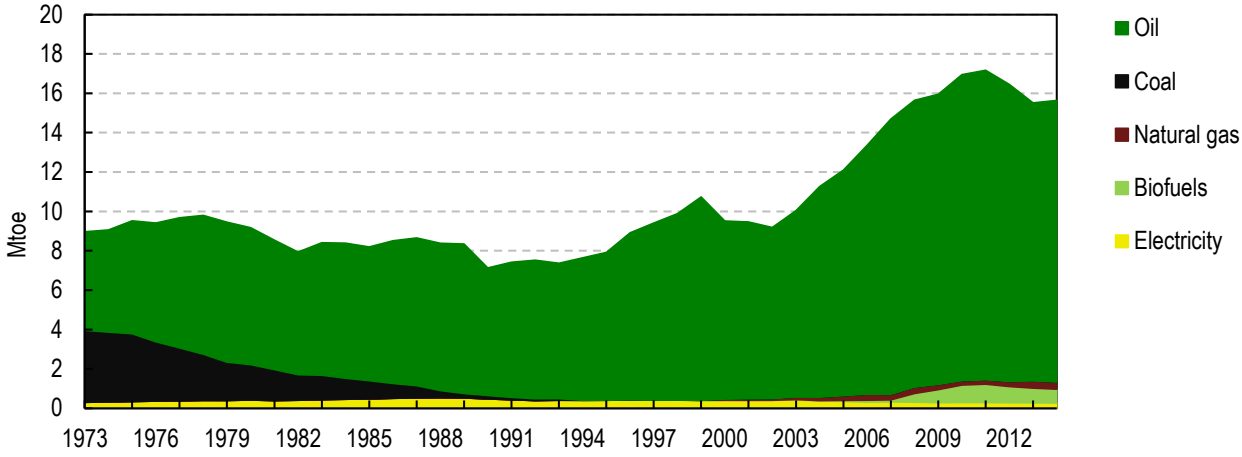
TRANSPORT

Transport is the only sector that has significantly increased its energy consumption in the last decade. With greater transport activity likely, a shift in transport fuels and technologies is needed to avoid greater levels of energy consumption and emissions. Electro-mobility is one of the major ongoing shifts in the transport sector worldwide. This has been identified as a new area of priority for Poland, and legislation to support it is currently being prepared. It is described in more detail in a separate section below.

Energy consumption in the domestic transport sector was 15.6 Mtoe in 2014, equal to about a quarter of TFC.[5] Increased transport activity has led to a 39% growth in energy consumption from 2004 to 2014. Although energy consumption has declined in recent years from a peak of 17.1 Mtoe in 2011, transport activity is projected to continue to increase beyond 2030. Oil constitutes 91.5% of total energy consumed in the transport sector. The remainder is a combination of biofuels (4.5%), natural gas (2.3%) and electricity (1.7%). Biofuels were introduced in the transport sector in 2003 and grew rapidly until 2011, but have since declined. Natural gas is the only transport fuel that has increased between 2011 and 2014, but its use remains at very low levels.

5. Excluding international marine bunkers and international aviation bunkers (which are included in Eurostat data).

Figure 4.10 TFC in the transport sector by source, 1973-2014



Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

POLICIES AND MEASURES

During the 2014-20 programming period, the European Structural and Investment Funds will support 11 objectives, among them the shift towards a low-carbon economy in all sectors. Many of the interventions in Poland will be aimed at reducing GHG emissions generated by transport use in urban areas. Investment in urban transport will be focused on infrastructure, public transport and non-motorised transport, rail rolling stock (including the infrastructure to support it, e.g. installations for the distribution of energy), interchanges including "park and ride" or "park and bike" and intelligent transport systems (e.g. aimed at the improvement of conditions for public or non-motorised transport). The funds are transferred through national and regional operational programmes.

Another objective is the promotion of sustainable transport and removal of bottlenecks in key network infrastructure. The Operational Programme "Infrastructure and Environment 2014-2020" channels EU funds towards transport infrastructure projects to improve road and multimodal transport, and increase transport availability of the urban centres. The General Directorate for National Roads and Motorways is a main beneficiary body of the programme, with 56 approved projects.

Poland's National Fund for Environmental Protection and Water Management has established development programmes with the objective of improving natural resource management. One of these programmes, GAZELA BIS, is focused on energy-efficient and low-emission urban public transport systems. The programme has a total funding of PLN 300 million (about EUR 68 million) in 2015-20, directed at the development of low-emission public transport in cities (EIO, 2016). Funded projects can include new low-carbon fuel vehicles, modernisation or construction of bicycle paths and bus lanes, and implementation of urban transport management systems (NEEAP, 2014).

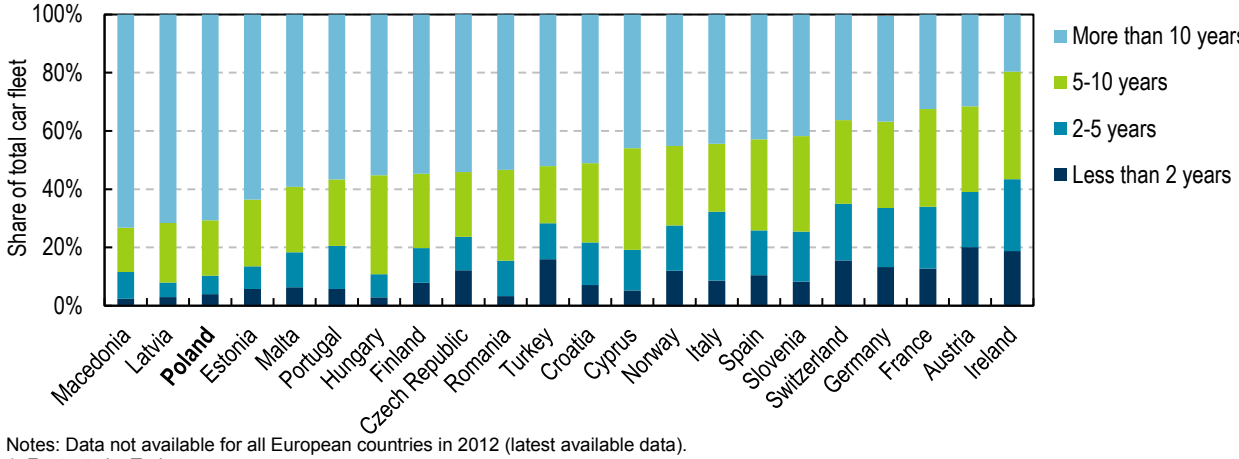
The Electromobility Development Plan constitutes an important new policy strategy for energy efficiency in the transport sector. This is further described below in the "Electrification of the Transport Sector" section of this chapter.

To reduce energy use and GHG emissions from the transport sector, the Council of Ministers adopted the Transport Development Strategy by 2020 (with perspective to

2030). This is a planning document, indicating the objectives and directions of measures in the area of transport. The main goal of this strategy is to enhance regional accessibility and to improve the safety and efficiency of the transport sector by creating a consistent, sustainable and user-friendly transport system at local, national, European and global levels. One of the key objectives of the strategy is to limit the adverse impact of transport use on the environment. The government has also adopted a Long-Term Rail Investment Programme until 2015 with an Outlook until 2020 and a National Plan for the Implementation of the European Rail Traffic Management System in Poland. Other policy packages are targeting reduced energy use in aviation and maritime transport.

The age of the vehicle fleet is also a concern for energy efficiency in Poland's transport sector. Cars older than ten years represented 71% of the total passenger car fleet in Poland in 2012, which was among the highest shares in Europe (Figure 4.11).

Figure 4.11 Age of the car fleet in European countries, 2012



Notes: Data not available for all European countries in 2012 (latest available data).
1. Footnote by Turkey
The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of United Nations, Turkey shall preserve its position concerning the "Cyprus issue".
2. Footnote by all the European Union Member States of the OECD and the European Union
The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

Source: Eurostat (2016), *Passenger Cars, by Age* (database), http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=road_eqs_carage&lang=en.

SPECIAL FOCUS: ELECTRIFICATION OF THE POLISH TRANSPORT SECTOR

Progress in battery technology and stronger support mechanisms have enabled a rapid growth in EVs in recent years, with different policy approaches resulting in large variations worldwide. Political support has been necessary for EV markets to grow, including incentives to invest in both cars and infrastructure. The share of EVs in the Polish car fleet is very low today, but the government has adopted ambitious targets for future EV deployment, with a target of 50 000 EVs on the road by 2020 and one million by 2025. This section provides an overview of global EV development, followed by an assessment for Poland.

BENEFITS AND CHALLENGES FOR EVS

The transport sector is a major energy consumer and a main emitter of greenhouse gas (GHG) emissions globally. EVs are more energy efficient than internal combustion engine

vehicles (ICVs) and enable low-carbon emissions if the electricity is supplied by nuclear or renewable energy sources. Furthermore, EVs can reduce local air pollution and noise levels in urban areas. For oil-importing countries with high reliance on fossil fuels in the transport sector, EV use can also strengthen energy security.

Despite the potential benefits of EVs, market development has been slow. Important barriers to EV market growth are high capital costs, limited driving range, lack of charging infrastructure and lack of consumer confidence in the technology (IEA, 2016c). Continued improvements in battery technology can increase competitiveness, but support policies are nevertheless needed for EVs to become a more attractive option.

Large-scale EV implementation will have an impact on the electricity grid. If many EVs are charged at the same time, especially in fast chargers, peak demand will increase and cause stress on the grid. On the other hand, if EV charging is managed well at system level, there is an opportunity for improving grid balance.

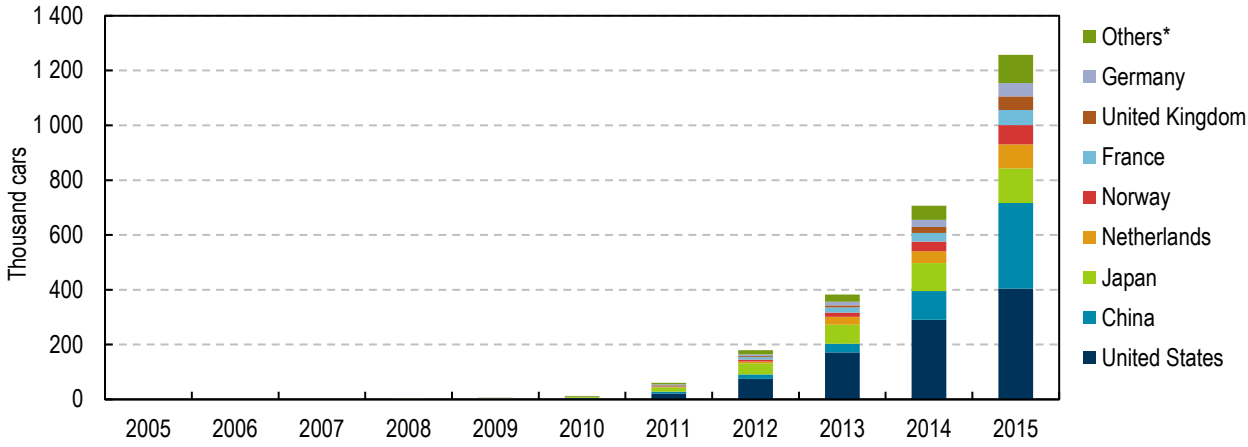
Table 4.1 Summary of strengths, weaknesses, opportunities and threats for EV market development

Strengths	**Weaknesses**
Energy efficient	High investment cost
Improved local air quality and noise levels	Limited driving range
Lower GHG emissions (depending on electricity mix)	Long charging time
Opportunities	**Threats**
Increased energy security	Lack of infrastructure and consumer confidence
Smart charging and grid balancing	Can cause stress on power grid

EV MARKET DEVELOPMENT

The global EV car fleet has grown rapidly in the last five years, with a hundredfold increase from 12 500 passenger vehicles in 2010 to 1.26 million in 2015 (Figure 4.12).

Figure 4.12 Global EV fleet (battery EVs and plug-in hybrid EVs) per country, 2005-15



*Others include Canada, Sweden, Italy, India, Spain, Korea and Portugal with more than 2 000 EVs, and another 25 countries with smaller shares.

Source: IEA (2016c), *Global EV Outlook 2016*, OECD/IEA, Paris.

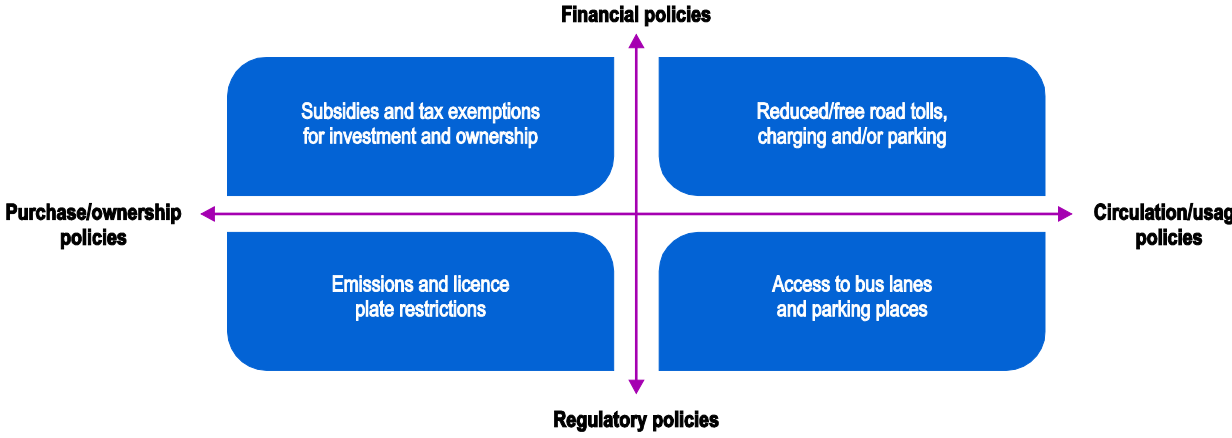
The United States had the largest number of EVs, with 404 000 in 2015, followed by China, which tripled its EV fleet in one year to 312 000. Norway had the fifth-largest EV fleet with 71 000 cars, and by far the highest share of EVs per capita.

Policy instruments

Support for EV market development can be divided into regulatory measures and financial incentives. Policies can also be divided into support for purchasing (and owning) the EV, or incentives directed at the circulation (period of using of the EV). Many countries also set targets for the EV stock or sales shares.

Tail-pipe emission and fuel economy standards, such as the Euro 6 classification in Europe, are regulatory measures used by most countries. In China, many cities have restrictions on licences for owning cars, where EVs can benefit from exceptions. Other regulatory support instruments are waivers on access restrictions, providing EV drivers access to bus lanes or specific parking spaces.

Figure 4.13 Summary of policies to support EV market development



Financial incentives can be direct investment subsidies (e.g. value-added tax [VAT] exemptions) or incentives to lower the cost of owning the car, such as exemptions from annual vehicle/circulation taxes. Tax exemptions can target EVs directly or be based on emission standards, enabling other low-carbon vehicle technologies to utilise the tax reduction as well.

Support mechanisms can be government financed through tax reductions and direct investment support, or based on market incentives. Bonus-malus is an example of a market-based system, where large emitters pay higher fees and low emitters get refunds. There are also financial policies supporting EV circulation through reduced fees for road tolls, parking or charging the EV.

National EV policy examples

Norway has adopted a comprehensive EV support system, including both financial and non-financial incentives. EV purchases are supported through a tax exemption from VAT and registration tax up to around USD 12 000. Other incentives include discounts on road tolls and access to bus lanes. The support system has been successful in terms of market growth. EVs constituted 23% of all new cars sold in Norway in 2015, significantly

higher than in any other country. As one of the world's richest countries, Norway has been well positioned to implement large financial EV purchase-support schemes. Norway had a target of 50 000 EVs in the car fleet in 2018, which was achieved and surpassed by over 40% in 2015. The VAT exemption is only valid for BEVs and not for PHEVs. This has contributed to a dominance of BEVs that constitute over three-quarters of Norway's EVs (IEA, 2016c).

The Netherlands had the second-largest EV market share with 9.7% in 2015. Instead of a stock target, the Netherlands has set a target of 50% EVs of total car sales in 2025. EVs are exempt from the registration tax (BPM) as well as from the annual road tax based on CO_2 emission levels. The system provides tax breaks based on low (not zero) CO_2 emission vehicles, which has given a stronger incentive for PHEVs compared to BEVs. PHEVs represented 94% of total EVs in the Netherlands in 2015, which is the highest share of all major EV countries. (IEA, 2016c)

Sweden had the third-largest market share of EVs with 2.4% in 2015. It has no set target for the size of the EV stock, but a political ambition of having a carbon-neutral vehicle fleet in 2030. The Swedish government provides an investment incentive of around USD 4 400 and a five-year exemption from vehicle tax for cars emitting less than 50 grammes of carbon dioxide per kilometre (gCO_2/km). Similar to the Netherlands, Sweden's EV stock is dominated by PHEVs, representing two-thirds of the total EV fleet in 2015 (IEA, 2016c). A bonus-malus system has been suggested to replace existing incentives by providing a bonus up to around USD 6 200 for vehicles with zero tail-pipe emissions and at the same time increasing the malus through the CO_2 component in the vehicle tax (SOU, 2016). A similar bonus-malus system has been in place in France since 2013, with a maximum purchase bonus of USD 6 300 (IEA, 2016c).

INFRASTRUCTURE DEVELOPMENT

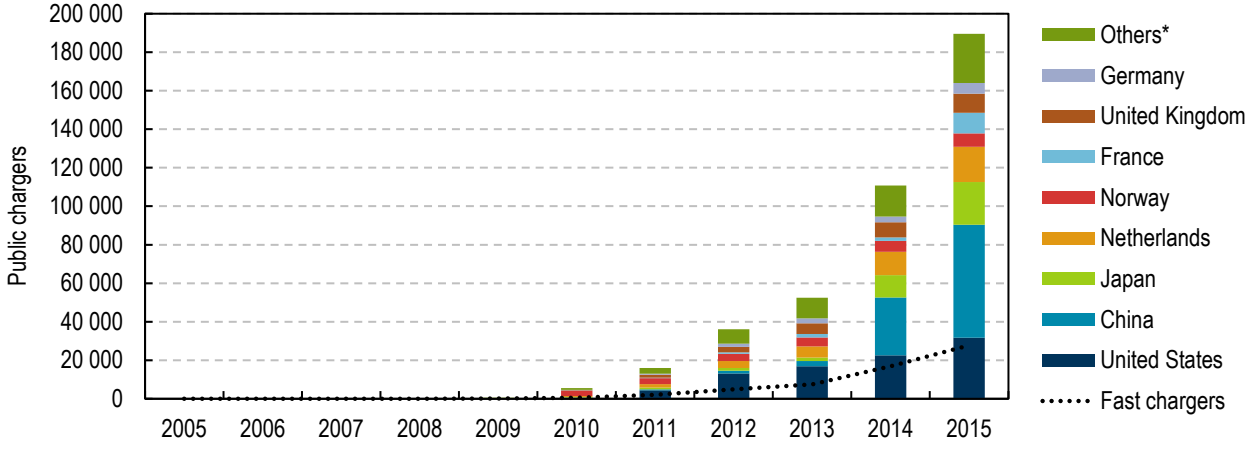
Charging an EV differs from filling gasoline or diesel in an ICV, both in terms of availability and speed. While the ICV driver needs a service station to fill the tank, EV owners can charge their cars while parked at home or at work. On the other hand, while the ICV can be filled in a few minutes, charging an EV can take anything from half an hour to half a day, depending on the size of the battery and the charging speed. EV supply equipment (EVSE) can be divided into private charging equipment for charging at home or at the office, and public charging stations. The charging speed varies with the size (capacity) of the charger, from small home chargers with power levels of a few kilowatts (kW), to public chargers for fast charging of around 50 kW.

In 2015, there were in total 1.45 million charging points for EVs globally, of which 190 000 (13%) were public chargers (IEA, 2016c). The number of public charging points has grown in a similar way as the increase in EVs, with a 71% increase from 2014 to 2015 (Figure 4.14). China has the most public chargers, accounting for almost one-third of the world total. The Chinese EVSE development has been very rapid in the last two years, aiming at a national target of 0.5 million public EV chargers in 2020. France has also rapidly increased EVSE deployment. It has a comprehensive support system for investments in both private and public chargers and the number of public chargers grew almost six-fold in 2015. The country has a target of seven million charging points by 2030 (IEA, 2016c).

The growth in the global EV stock and the number of charging stations in a country indicates a correlation between EV growth and EVSE development. Charging

infrastructure is necessary to increase people's confidence in EVs, and governments need to support investments in chargers to enable strong EV growth. Nevertheless, the number of public chargers per EV varies for different countries. Norway, with the highest market share of EVs, has 100 public chargers per 1 000 EVs, while the Netherlands has over twice as many (Figure 4.15). The Netherlands' government supports charging infrastructure investment through direct investment support for public chargers and a tax deduction for investment in private chargers. The type of chargers being installed correlates to the type of EVs in the country. Norway, with a high share of BEVs, has a higher share of fast chargers installed (10% of total public chargers) while the Netherlands, dominated by PHEVs, has a low share of fast chargers (2.5% of the total) (IEA, 2016c).

Figure 4.14 Number of publicly accessible EV charging stations per country, 2005-15

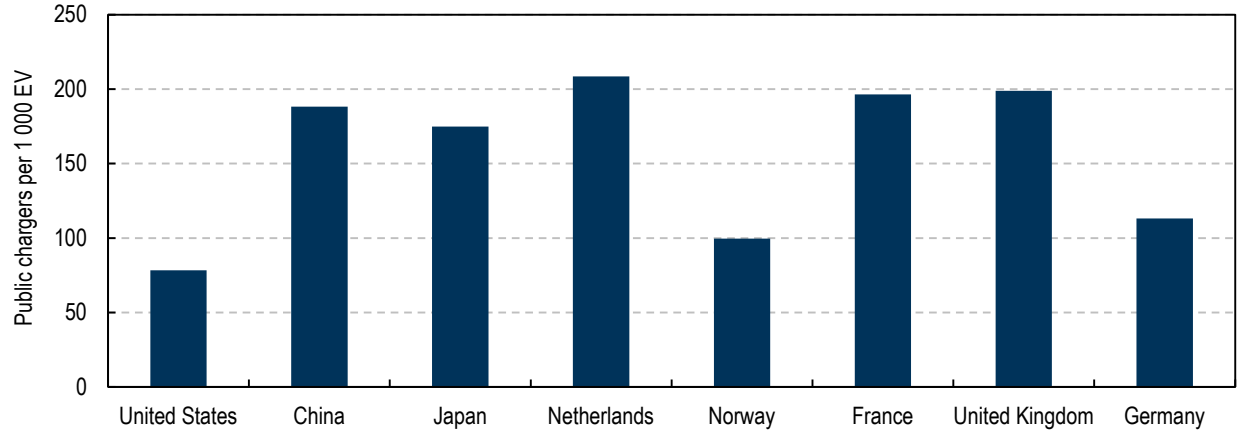


*Others include Canada, Italy, Korea Portugal, Spain and Sweden with more than 1 000 chargers, and another 26 countries with smaller shares.

Note: Both slow chargers and fast chargers are included in the columns (line showing number of fast chargers).

Source: IEA (2016c), *Global EV Outlook 2016*, OECD/IEA, Paris.

Figure 4.15 Number of publicly accessible charging points per EV per country, 2015



Source: IEA (2016c), *Global EV Outlook 2016*, OECD/IEA, Paris.

EV DEVELOPMENT IN POLAND

Poland has a very small share of EVs in the car fleet. Out of 19 million passenger cars, the number of EVs was 519 in 2015, and the market share for EVs was only 0.07% of cars sold in 2015 (EAFO, 2016). There were over 700 EVs by the end of 2016. Poland is one of few countries in the European Union without any incentives for EV investments. The government is, however, showing interest in electrifying the transport sector. Motivation for EV development in Poland is to tackle local air pollution and to reduce import dependency of oil. Poland imports 96% of its total oil consumption, and 88% of oil imports are from Russia (IEA, 2016a). The energy security element of EV development is therefore relevant for Poland. It should be noted that coal power accounts for 81% of Poland's electricity supply, making the electricity system carbon-intensive. EVs might improve local air quality, but the impact on GHG emissions is less clear. As a step to electrifying the transport sector, the government has proposed an Electromobility Development Plan (EDP). The EDP sets targets of 50 000 EVs and 2 000 electric buses in Poland by 2020 (PZPM, 2016). In 2025, the target is one million EVs. The initial focus is on urban areas with high population density. Poland is proposing a number of policy instruments for creating a national framework to support EV development (PZPM, 2016):

- new legislation defining rules of EV charging service sales markets and rules on consumer information about refuelling possibilities
- taxation changes, e.g. to the excise tax
- establishing of low-emission zones in the cities
- establishing of additional car registration fees depending on emission levels of harmful compounds, with tax exemption for EVs
- mandatory electric power installation in newly built public utility buildings and multi-family residential buildings to allow future installation of EV charging points.

The EU Directive on the Deployment of Alternative Fuels Infrastructure (2014/94/EU) requires EU member countries to adopt a national policy framework for alternative fuels infrastructure development. This includes setting a target for an appropriate number of public charging points by November 2016, and ensuring that it is achieved by 31 December 2020. In comparison with the low number of EVs, Poland has a high share of infrastructure with 306 public chargers, of which 16 are fast chargers (EAFO, 2016). In the EDP, a target of 7 000 publicly accessible charging stations is set for 2020. Besides growing the EV and EVSE stock, the EDP also aims to create a manufacturing industry for electric cars and buses.

DISTRICT HEATING

Poland has one of the largest district-heating (DH) markets in Europe, with over 200 petajoules (PJ) of heat reaching approximately half of the population. Coal is the dominant fuel in heat production, and the residential sector is the largest consumer of heat. Although a large share of heat is produced in energy-efficient combined heat and power (CHP) plants, there are many small DH systems being supplied by inefficient heat boilers that could be converted to CHP technology.

DEMAND AND SUPPLY

Heat consumption

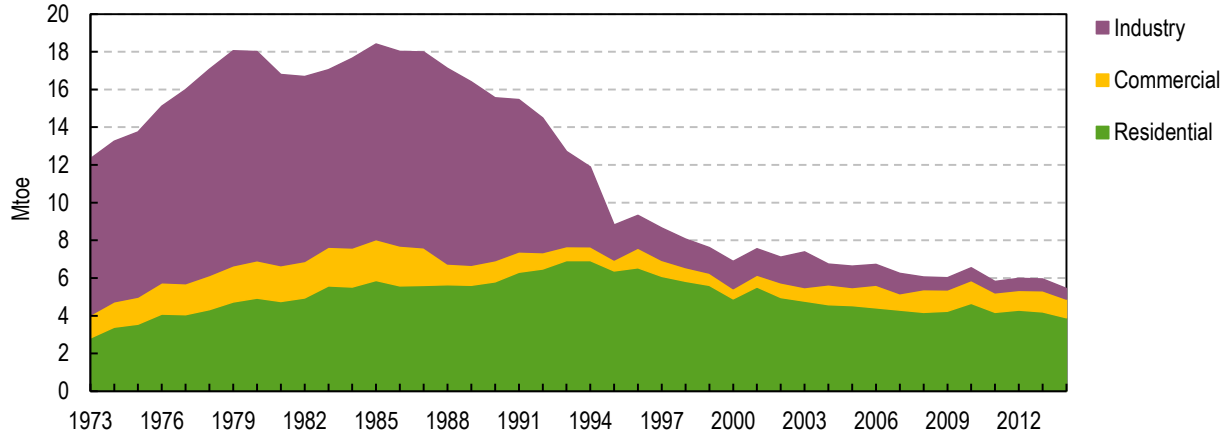
Poland's heat consumption was 5.4 Mtoe in 2015. Heat consumption has been slowly declining in the last 25 years, following a rapid reduction in the industry sector in the late 1980s. Total consumption fell by 19% from 2004 to 2014 (IEA, 2016a). The residential sector is the largest consumer, accounting for 71% of total heat consumption. Residential heat demand has been declining in the last two decades, with a 15% reduction from 2004 to 2014, largely a result of energy efficiency measures in buildings. Heat consumption is correlated with ambient temperatures: for example, the relatively cold winter in 2010 led to increased heat demand in households. The commercial sector accounted for 18% of total heat consumption in 2014. Demand has been stable around 1 Mtoe per year in the last decade, with a 7% decline from 2004 to 2014. Heat demand in the industry sector has experienced the greatest decline, with a 48% drop in heat demand from 2004 to 2014. The chemical and petrochemical sector is the largest heat consuming industry, accounting for 14% of total heat demand in 2014, and heat consumption is spread evenly across most industry sectors.

Supply

Total heat production was 279 PJ in 2015, of which around two-thirds were from CHP plants. The share of CHP heat in total heat supply has been stable at around 60% to 65% in the last decade (IEA, 2016a). Electricity generation from CHP plants accounts for 14% of total production, and Poland aims to double this share by 2030. The fuel mix in heat production is similar to the fuels used in electricity generation (Figure 4.17).

Coal and coal products account for 86% of total heat production, a reduction from 91% in 2005. Natural gas has increased its share of heat production from 6% to 7%, while oil has declined from 2% to 1% from 2005 to 2015. The share of biofuels and waste has increased from 1% in 2005 to 5% in 2015. Waste incineration has a small share of total heat generation, but is expected to increase in the future.

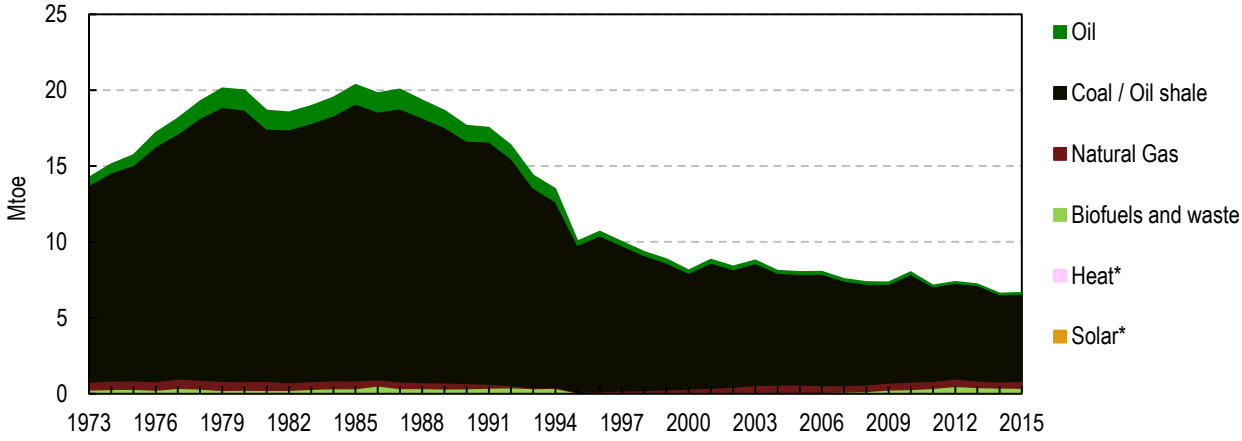
Figure 4.16 Heat consumption, 1973-2014



Note: Heat in TFC.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Figure 4.17 Heat production by fuel, 1973-2015



* Negligible.

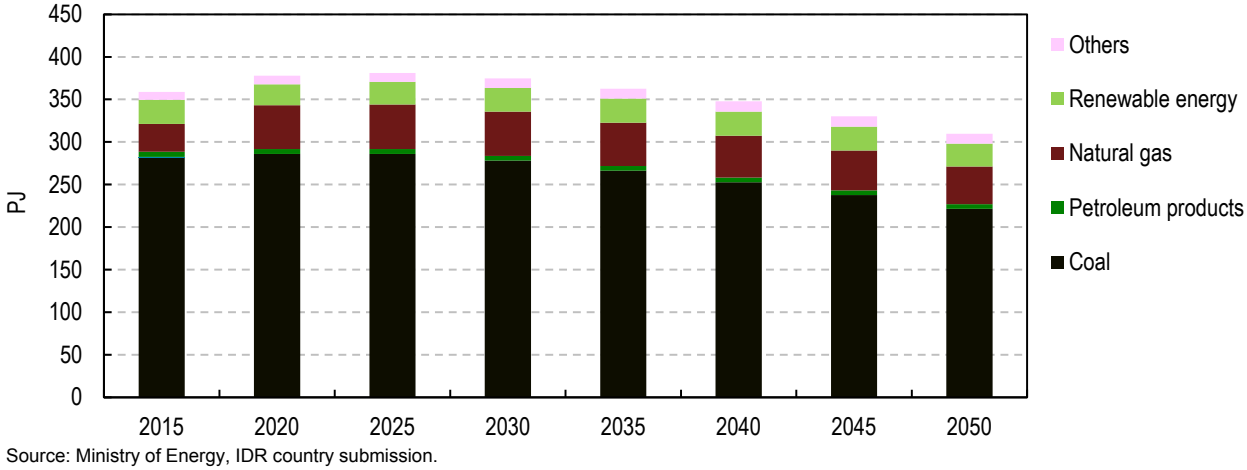
Note: Coal includes coal-related gases (coke oven gas, blast furnace gas and other recovered gases).

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Heat consumption is forecast to increase by 7% in 2025 compared to 2015, followed by a decline of 19% until 2050 (Figure 4.18). Coal will remain the main fuel in the DH production mix, although its share is decreasing and partly being replaced by natural gas.

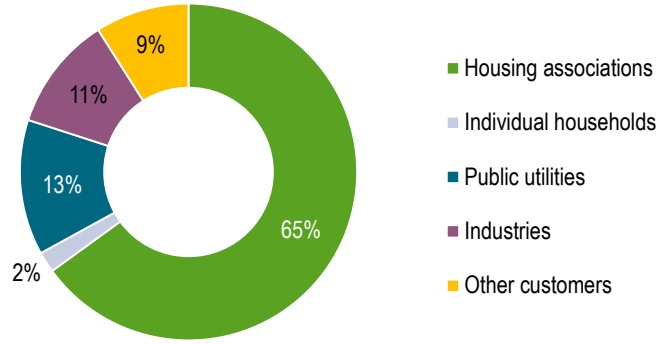
There are over 300 DH systems in Poland with a total capacity of 56 gigawatts (GW). District-heating networks span a total distance of 20 000 km and reach approximately half of the Polish population (Euroheat, 2015). Housing associations, condominiums and communal flats account for two-thirds of the total DH customer base, while individual households make up a minor share (Figure 4.19).

Figure 4.18 Heat production forecast by fuel, 2015-25



Source: Ministry of Energy, IDR country submission.

Figure 4.19 District-heating customer segments, 2012



Source: Chamber of Commerce Polish District Heating (2012), *Polish District Heating*, http://innoheat.eu/wp-content/uploads/2012/04/Polish-district-heating_ENG.pdf (accessed 1 October 2016).

POLICIES AND REGULATION

The Polish DH market is regulated through the President of the Energy Regulatory Office (ERO). The ERO president grants licences for DH sales and approves heat tariffs set by the energy companies. Tariffs must be set in accordance with the principles laid out in the Energy Law (Act of 10 April 1997), which allows for a reasonable return of capital for the business while protecting the customers against unjustified price levels.

The use of efficient production and use of energy is regulated in the EU EED. Article 14.5 in the EED prescribes that a cost benefit analysis (CBA) should be done for power plants when new plants over 20 megawatts (MW) are built or refurbished by more than 50% in order to assess if the power plant can be converted into a CHP plant. The NFEPWM (or the Fund) includes many measures to support development of a low-emissions economy, including programmes supporting the development of renewable and efficient energy sources (including district heating) or decreasing the impact of the industrial sector on the environment. A part of its Improving Air Quality priority programme, with a budget of EUR 125 million, provides preferential loans and equity for development of geothermal energy sources. More than EUR 610 million of EU resources under the Infrastructure and Environment Operational Programme (being in the Fund) can be designated for construction of new – or modernisation of existing – CHP plants, as well as investments in modernisation and development of DH networks. In addition, state-funded loans are provided through the Support for a Low-Emission Economy Programme for investments in local DH projects necessary to achieve high-efficiency requirements in line with the EU EED (EUR 250 million), and necessary state co-financing for EU-supported projects (EUR 125 million).

The Support for a Low-Emission Economy Programme provides businesses with access to preferential loans for projects related to the optimisation of raw material use and the reduction of GHG emissions (EUR 250 million). In addition, EUR 150 million in the form of repayable assistance is available for energy efficiency measures in the corporate sector, from the EU resources managed by the Fund.

In order to incentivise the development of CHP, a certificate support scheme started in 2000. The scheme is comprised of a range of certificates in different colours depending on size, fuel and efficiency, and will fetch anywhere between PLN 10 per megawatt hour (MWh) and PLN 99 per MWh. The certificate scheme has been amended several times since the start and it will be abandoned entirely in 2018. A new system for supporting CHP has been discussed, but there is currently no such proposal.

ASSESSMENT

INDUSTRY

Energy efficiency has improved in all the main industry sectors in recent years. This is partially a result of the WCS, incentivising industries to improve their energy intensity compared to the average competitor. The extension of the scheme can allow for further efficiency improvements, which is necessary to achieve decreased energy consumption in a growing economy. Industries are also shifting fuels from coal and oil towards natural gas and electricity. This can lead to both improved energy efficiency and lower GHG emissions. Energy audits in enterprises can be a useful tool to identify economically feasible investments to improve energy efficiency. The audits should be carried out by an independent entity with the professional knowledge and experience in executing these types of reviews. An energy audit can be the starting point of an integrated energy roadmap, and assistance during the process can increase the implementation rate.

RESIDENTIAL AND COMMERCIAL

Coal used for household heating makes up one-third of total energy consumption in the residential sector, and it has increased in the last decade, while more energy-efficient heating methods, such as district heating, decreased. New building standards based on the Energy Performance of Buildings Directive provide clear direction for energy efficiency in the residential sector. The requirements are ambitious for new buildings and buildings undergoing reconstruction, but the existing stock of buildings needs to be addressed and funding mechanisms need to be intensified. Retrofit obligations for inefficient heating systems in existing buildings could help to deliver major energy savings and reduce air pollution by utilising measures with shorter payback periods.

The Eco-design Directive provides harmonised standards for energy-related products in the European Union and aims at achieving energy savings through better product design. Poland has implemented the Directive and specific EU regulations for many new products. Effective enforcement of these regulations will improve energy savings effects, but monitoring and enforcement of the regulations in Poland is hitherto insufficient.

The rollout of smart meters enables detailed energy consumption data to be provided also to small consumers. With smart metering, consumers can adapt their energy usage to different energy prices throughout the day, thereby saving money on their energy bills by moving consumption to lower price periods. Smart meters are basic constituents of an intelligent grid, and when connected with electricity-based heating systems, such as heat pumps, they enable interaction between energy systems. Poland can evaluate and draw conclusions from the smart meter rollout pilot projects, to further realise smart grid implementation.

TRANSPORT

Final energy demand is projected to increase by 2050 as a result of growth in transport activity. To decrease CO_2 emissions and dependence on imported energy it is essential to cut down oil use in the transport sector. Greater access to clean public transport, traffic management systems and the use of electro-mobility are possibilities to increase energy efficiency in the transport sector. Electro-mobility requires a special infrastructure, which is being considered in the new Electro-mobility Development Plan.

A large portion of the car fleet is more than ten years old and was built with lower energy efficiency and emission standards. Increasing the share of modern cars with lower fuel consumption and emissions would help to improve the energy efficiency of the transport sector. Scrappage schemes can be used to encourage owners of old and inefficient cars to dispose of them or replace them with modern vehicles.

Poland's electro-mobility target of 50 000 EVs in 2020 and one million in 2025 is very ambitious. From the 700 EVs in 2016, the growth rate would have to be 150% per year until 2020 and then 80% per year until 2025. With this development trajectory, EVs could have a majority of the market share for new cars in Poland by 2025.

The EV market will not grow significantly without policy measures. Large financial purchase subsidies correlate well with EV market growth, but tax deductions and subsidies can lead to large loss of fiscal revenue if many start using the benefits. A market-based system, such as a bonus-malus system, can be a way to limit the loss of fiscal revenues for the government and have car buyers share the cost for EV support. Other policy options, such as access to free charging and parking spaces, tend to be less expensive. Non-financial instruments, such as improved access to bus lanes and parking, can make good complements to financial incentives. Its effectiveness to incentivise EV growth is less established, but can work well in certain contexts. A case study from Stockholm indicates that access to free parking can be a stronger incentive for EV purchase than existing financial support (KTH, 2016). One concern surrounding the use of these instruments is the risk of increasing the total number of cars and therefore road congestion if EV travel becomes too convenient compared to alternative means of transport. This will have to be monitored and the incentives adjusted accordingly.

Infrastructure investments are also required to enable large-scale EV growth. There is a clear correlation between EVs and EVSEs, but it is not certain if EVs incentivise the construction of charging stations or the opposite (IEA, 2016c; Mersky et al., 2016). Poland has set an EVSE development target of 7 000 public charging stations to match their target of 50 000 EVs in 2020. This ratio of 140 chargers per 1 000 EVs would be comparable to other main EV countries (Figure 4.14). Besides mandatory electrical power installation in newly built public utility buildings and newly built multi-family residential buildings, which will allow future installation of EV charging points, investment incentives for installing charging points in homes or public spaces are another option to consider. Fast chargers along large motorways and other strategic routes are required to spread the use of EVs outside of urban areas. This technology is more expensive and the business case for investing in fast chargers is less attractive than slow chargers in cities. Fast chargers are therefore more dependent on state investments and incentives.

An increased amount of EVs in the transport sector will affect the electricity grid. If not managed properly, EV charging (especially fast charging) can lead to increased peak power demand and grid balancing issues. Through efficient integration in the energy system, EVs can on the other hand provide grid services such as demand-side management, energy storage and back-up power. This calls for industry collaboration between grid operators, electricity suppliers, EVSE infrastructure operators and other actors involved. Distribution system operators (DSOs) are potentially well placed to co-ordinate such collaboration and enable a smooth integration of EVs in the energy system. An example of such collaboration is the ElaadNL initiative in the Netherlands, owned by the Dutch DSOs. ElaadNL is a knowledge and innovation centre for smart

charging infrastructure that co-ordinates connection of public charging systems to the electricity grid (ElaadNL, 2016).

Poland is dependent on oil imports, making energy security a main motive for supporting EV market development. Improved local air quality is another motive. Reliance on coal in power production reduces the potential to also cut GHG emissions by electrification of the transport sector. Poland needs to continue the transformation towards renewable energy in power production to benefit from all positive aspects of EVs. The planned nuclear power programme could provide low-carbon electricity production that enables GHG emission reductions through EV development.

DISTRICT HEATING

CHP accounts for almost two-thirds of DH and 14% of the electricity produced. This is around the same level as when the last IEA Review took place. The ambition to double the CHP share in electricity by 2030 will, however, require increased incentives, followed by investments, in order to materialise. The CHP certificate system is very important for investments in CHP and the close-down will negatively affect both CHP and DH.

With over one-third of heat produced in pure heat plants, there is large potential for increasing high-efficiency CHP production, especially when replacing old or small heating plants. Almost 75% of Polish coal-fired power plants are over 25 years old and 62% are over 30 years old. This presents an opportunity to replace old plants with CHP plants while simultaneously complying with cost-benefit analysis requirements in the EED.

The DH market is dispersed, with hundreds of small suppliers. Small heating plants under 5 MW do not require a licence to operate and are not visible in the statistics. Nevertheless, they provide a large potential for creating more efficient DH systems. Connecting small systems to larger DH networks can enable benefits from economies of scale and a more efficient utilisation of larger and cleaner CHP plants.

The price regulation in the 1997 Energy Law can negatively affect adequate profits and therefore investments in DH production and networks, including co-generation. An estimated 35% of Polish DH networks are in need of reinvestment. The current system for regulating the natural monopoly market is seen as problematic by DH market actors.

RECOMMENDATIONS

Industry

- ☐ *Monitor the outcome of the revised WCS to ensure efficiency in the application process and include cost effectiveness in the evaluation of energy efficiency measures.*
- ☐ *Energy savings could be achieved through greater use of ESCOs, which need to be supported by dedicated measures such as standard contracts.*

Residential and commercial

- ☐ *Develop a long-term strategy for existing buildings in accordance with the EU strategy for heating and cooling and Article 4 of the EED (energy efficiency strategy for buildings). This strategy should be connected with communal activities and contain renovation roadmaps. These can be embedded in local energy plans.*

- *Channel EU structural funds, or other suitable financing sources, towards the introduction of a long-term funding programme for support (loans and grants) of energy efficiency measures in residential, communal and social housing and redesign the national tax system to allow for reimbursement of some investment costs spent on energy efficiency of privately owned buildings.*
- *Prepare a coherent system for monitoring energy consumption and energy savings in all relevant sectors and improve the database and the energy statistics on local level, especially in the buildings sector.*
- *Extra points in the white certificates should be awarded for investments in the housing sector and energy-poor households.*

Transport and electro-mobility

- *Develop a policy package to enable reaching the very ambitious EV targets of the EDP. Market-based mechanisms (e.g. bonus-malus) and a combination of financial and non-financial incentives should be considered to lower the costs.*
- *Develop investment incentives for EVSEs (private and/or public charging station) in parallel to EV support. Identify strategic locations for fast chargers and consider specific investment incentives or state investments for fast charging infrastructure.*
- *Plan for efficient integration of EVs in the power grid, e.g. through facilitating a forum for discussion together with DSOs, utilities and other stakeholders.*

District heating

- *Introduce a stable market-based support scheme for high-efficient CHP investments in bio, waste and gas, to stimulate replacing small heat boilers and ageing thermal plants with new modern plants for high-efficiency co-generation in line with the EED.*
- *Replace the current tariff approval of the ERO with a mechanism that allows for higher profit margins to incentivise investments in CHP and network reinvestments.*

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PART II
SECTOR ANALYSIS

5. ELECTRICITY

Key data (2015 estimated)

Total electricity generation: 164 TWh, +5.7% since 2005

Electricity generation mix: coal 80.9%, wind 6.6%, biofuels and waste 6.1%, natural gas 3.8%, oil 1.3%, hydro 1.1%, solar <0.1%

Installed capacity (2015): 37.3 GW

Peak load (2015): 24.8 GW

Electricity consumption (2014): industry 35.3%, commercial and other services 34.3%, residential 20.6%, other energy 7.7%, transport 2.2%

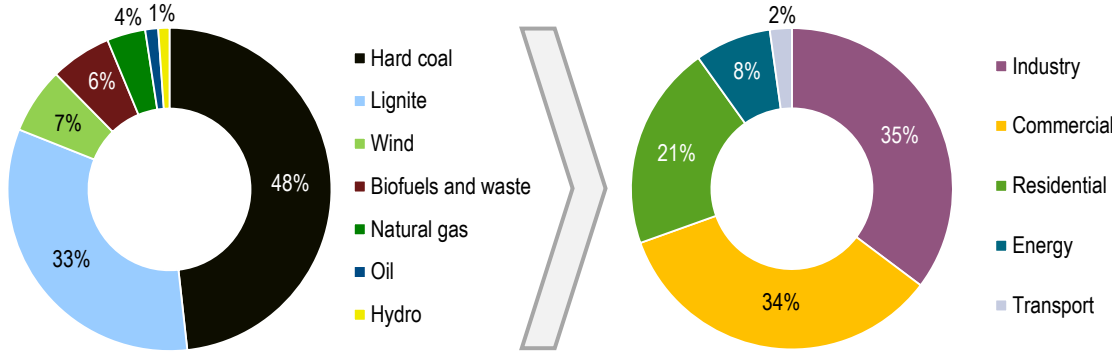
OVERVIEW

Electricity production in Poland is dominated by coal, which is the source of 81% of total generation. Hard coal made up 60% of the coal used for electricity generation in 2015, and the remaining 40% was lignite.

Poland has historically been a net exporter of electricity, but increased imports, mainly from Germany, resulted in Poland becoming a net importer in 2014.

The industry and commercial sectors are the largest electricity consuming sectors, accounting for over one-third of total consumption each.

Figure 5.1 Electricity generation by source and consumption by sector in Poland



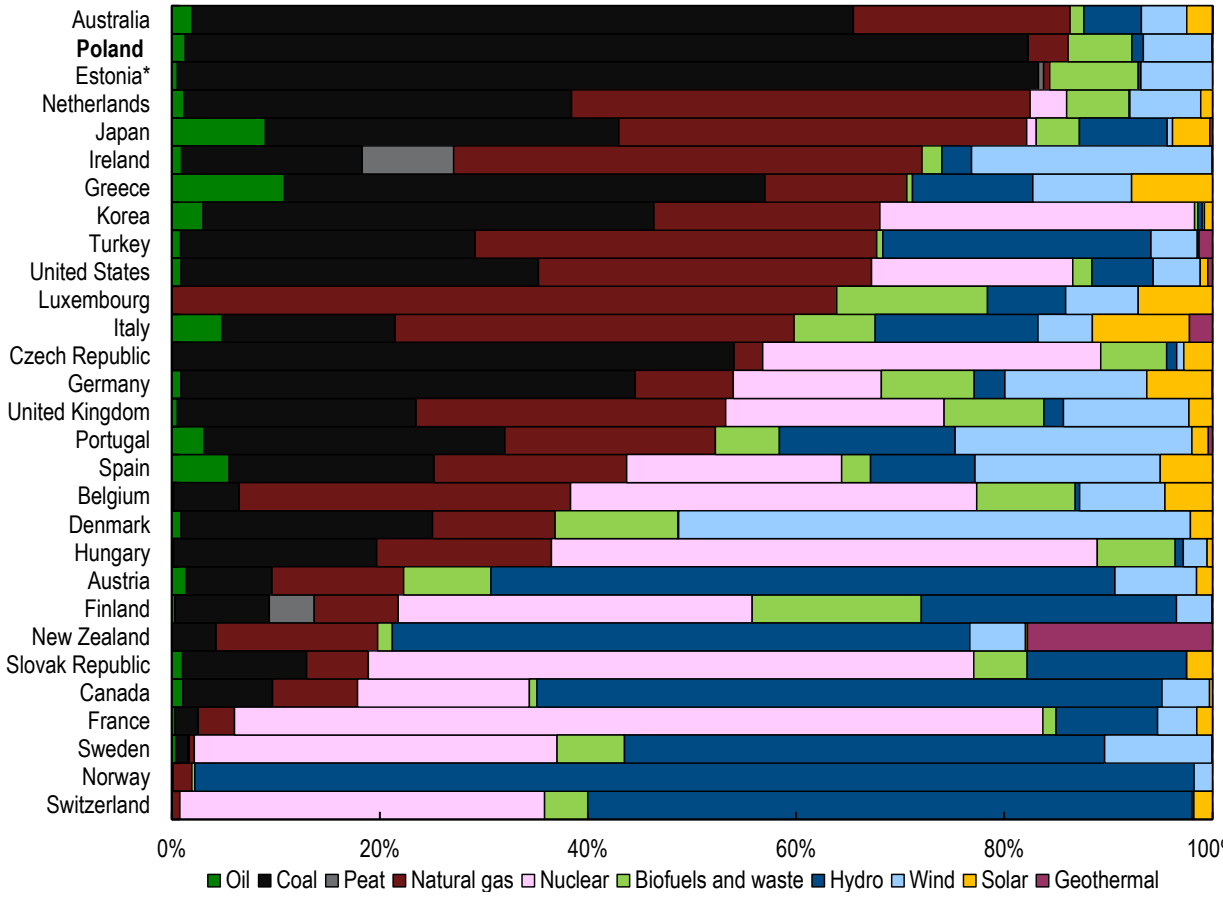
Sources: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/; IEA (2016b), *Electricity Information 2016*, www.iea.org/statistics/.

SUPPLY AND DEMAND

ELECTRICITY GENERATION

Poland has the highest share of coal in electricity generation of all the International Energy Agency (IEA) countries (excluding the oil shale in Estonia). Furthermore, Poland has the second-largest share of fossil fuels in electricity generation after Australia. Despite a rapid growth in renewables in recent years, Poland has still the sixth-lowest share of renewables in electricity generation among IEA member countries (Figure 5.2).

Figure 5.2 Electricity generation by source in IEA member countries, 2015



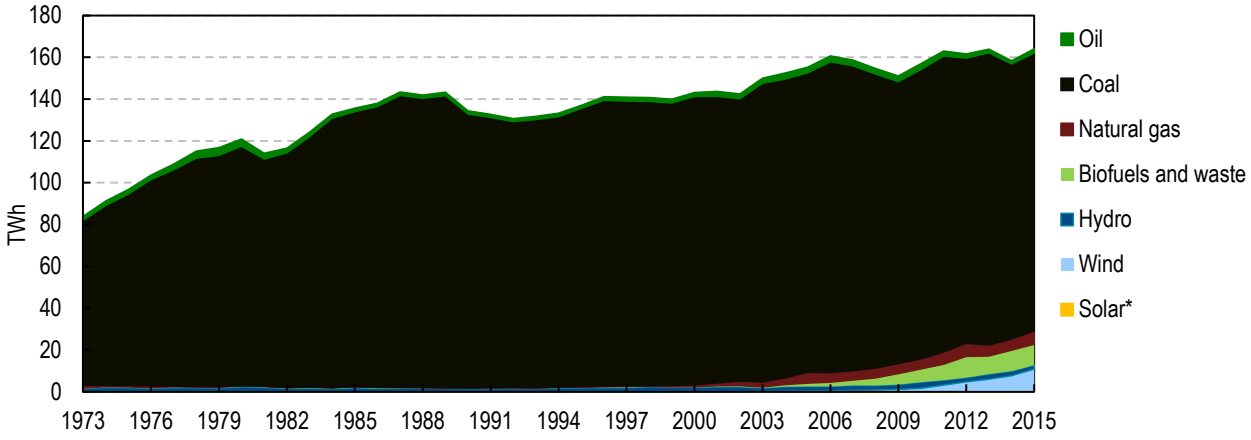
* Estonia's coal represents oil shale.

Note: Data are estimated.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Nonetheless, the share of coal power has declined from 97% in 1995, and 92% in 2005 to 81% in 2015. The electricity generated from coal has dropped by 7% in ten years, from 143 terawatt hours (TWh) in 2005 to 133 TWh in 2015. This decline in coal power has been compensated by a rapid increase in renewable electricity generation, which contributed to 14% of the total generation in 2015 (compared to 3% in 2005). The growth in renewables has contributed to an overall upward trend for total electricity generation, which increased by 6% from 2005 to 2015 (Figure 5.3).

Figure 5.3 Electricity generation by source in Poland, 1973-2015



* Negligible.

Note: Data are estimated for 2015.

Source: IEA (2016a), Energy *Balances of OECD Countries 2016*, www.iea.org/statistics/.

In the past, hydro power was the main source of renewable electricity in Poland, but output has shifted towards wind and biofuels (including a small share of waste). Biofuels have grown fivefold since 2005 to total electricity generation output of 10 TWh in 2015, while wind has increased from 0.1 TWh to 11 TWh over the same period (Figure 5.3). Electricity output from biofuels has stabilised at around 10 TWh in the last four years, while wind power has continued to increase and grew by 41% in 2015 compared to the previous year.

Poland has no nuclear power, but in 2014 a decision was made to build at least two reactors with a combined total capacity of 6 gigawatts electric (GW_e). It was approved by the Polish Nuclear Power Programme as a matter of energy security, fuel diversification, and promotion of clean energy technologies. A final investment decision has not yet been made.

IMPORTS AND EXPORTS

Poland has historically been a net exporter of electricity, mainly to the neighbouring countries of the Czech Republic (with a share of 66% of total exports in 2015) and the Slovak Republic (33%). Most imports come from Germany (with a 74% share of total imports in 2015) and Sweden (24%) (Figure 5.4).

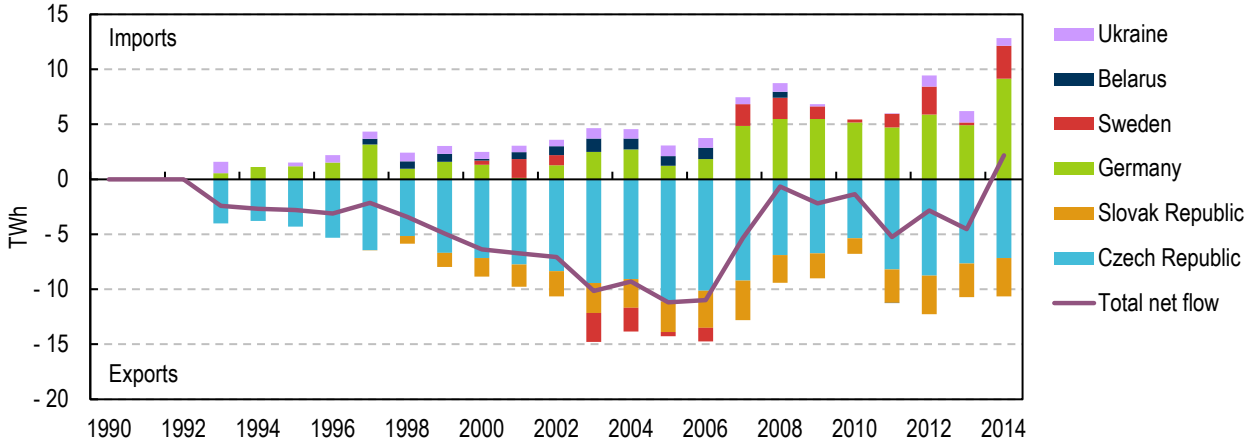
The export and import directions show, however, physical flows of electricity. The huge flow from Germany through Poland to the Czech Republic and Slovakia is not a commercial flow but a loop flow. These large flows require the Polish transmission system operator (TSO) to take costly remedial actions such as re-dispatching. Both Germany and Sweden have increased their shares of variable renewable energy, which leads to excess capacity of cheap electricity available at times of ample sunshine and wind. As a consequence, inflows from these countries have increased.

Most of the imports from Germany are unscheduled flows of electricity known as loop flows, caused by congestion in the power grid outside Poland at times of large production of variable renewable electricity. This is typically a flow of electricity from wind power in the north of Germany that is transported to industries in the south of

Germany and to Austria. Lack of transmission capacity within Germany and an existing common bidding zone with Austria forces the electricity to take routes through neighbouring countries. Such unscheduled loop flows make up both parts of Poland's imports from Germany and exports to the Czech Republic, and cause stress to the Polish power grid.

Since early 2015, new imports and exports of electricity from the Nordic market arrived via the 500-megawatt (MW) LitPol Link between Poland and Lithuania. The flow is mostly from Lithuania to Poland.

Figure 5.4 Net electricity imports to and exports from Poland, by country, 1990-2014



Note: Electricity trading in Poland began in 1993.

Source: IEA (2016b), *Electricity Information 2016*, www.iea.org/statistics/.

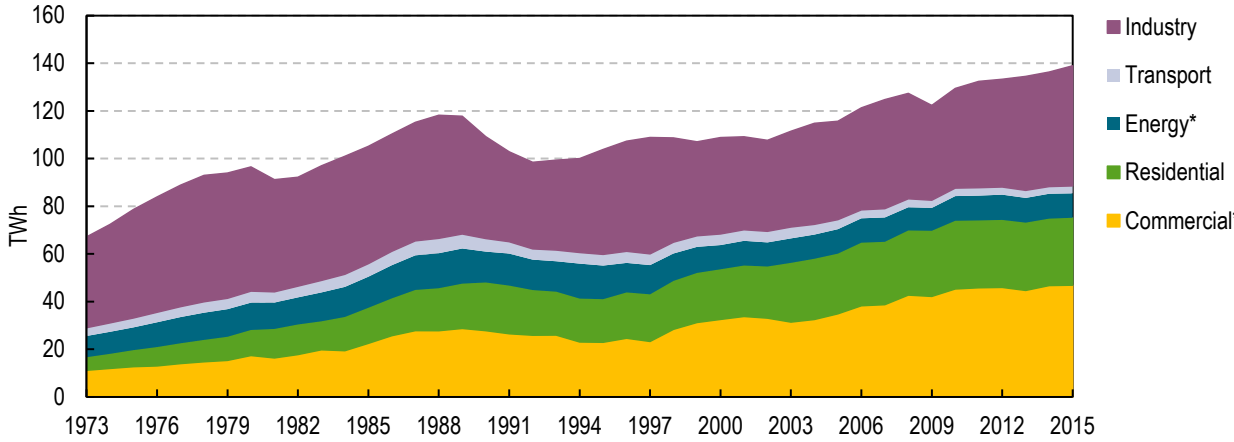
ELECTRICITY CONSUMPTION

The industry sector is the largest electricity consuming sector, accounting for over 35% of total consumption in 2014. Electricity consumption in the industry sector has increased by 13% from 2004 to 2014, and reached a level of 48 TWh. Despite the increase, the consumption is lower than in the peak year 1978 when the industry sector consumed 53 TWh, corresponding to 57% of the electricity in Poland.

Electricity consumption in the commercial sector (including commercial and public services, agriculture, fishing and forestry) has grown rapidly in recent years, with an increase of 44% from 2004 to 2014. The residential sector has also grown steadily, with a 10% increase over the last decade. Since a peak in 2010 the consumption has stabilised at around 28 TWh.

The smallest shares of electricity consumption are in the transport and energy sectors. There are no signs of an electrification trend in the transport sector in Poland. Electricity consumption in transport has been declining steadily since a peak in 1988, and decreased by 30% from 2004 to 2014. The use of electricity in the energy sector has been stable around 10 TWh in the last decade.

Figure 5.5 Electricity consumption by sector, 1973-2014



* *Energy* includes energy own-use and the transformation sector.

** *Commercial* includes commercial and public services, agriculture, fishing and forestry.

Source: IEA (2016b), *Electricity Information 2016*, www.iea.org/statistics/.

INSTITUTIONS AND REGULATORY FRAMEWORK

The Ministry for Energy is responsible for the development and implementation of electricity policy in Poland. This includes the operation of the electricity market, the development of electricity infrastructure, and international co-operation in the sector. The Government Commissioner for Strategic Energy Infrastructure is responsible for corporate supervision of TSOs in electricity, gas sectors.

The independent Energy Regulatory Office (ERO) regulates the activities of participants in the natural gas and electricity markets with the aim of balancing the interests of the market and customers. The duties and competences of the ERO are strictly linked to state energy policy. The Office of Competition and Consumer Protection is also active in the electricity sector. The President of the Office is responsible for shaping the antitrust policy and consumer protection policy. Since 2004, for example, the Office of Competition and Consumer Protection provided its opinion on state aid schemes and individual state aid decisions before their notification to the European Commission.

MARKET STRUCTURE

The electricity sector in Poland is dominated by state-owned companies. The current structure of the Polish electricity market has its roots in the Act on Energy in 1997. Following the implementation of this act, four large companies, PGE Polska Grupa Energetyczna S.A. (the PGE Group), TAURON Polska Energia S.A.(the TAURON Group), Enea S.A. (the Enea Group) and ENERGA S.A. (the ENERGA Group), were created by the state from the previous incumbent.

- The PGE Group is now the largest player in the Polish electricity market. It is active in electricity generation, including nuclear, transmission, distribution and retail markets. The company also owns a number of lignite mines. The State Treasury owns 57.39% of the company while the remaining shares in the business are traded on the Warsaw Stock Exchange. PGE owns 12.77 GW of installed capacity and sold 55.58 TWh of electricity in 2015.

- The TAURON Group, which is 30.06% owned by the State Treasury, is active in coal mining, generation, distribution and the sale of electricity and heat. It supplied over 49 TWh of electricity to over 5.4 million customers in 2014, which made it the largest distributor of electricity in Poland. It is also the second-largest electricity generator and supplier in the country as well as a significant heat retailer. The company controls approximately 29% of Polish hard coal resources.
- The Enea Group produces, distributes and retails electricity. It also owns the Lubelski Węgiel Bogdanka Spółka Akcyjna coal mine. It owns 3.3 gigawatts (GW) of capacity and produced 13.1 TWh of electricity in 2015. The State Treasury owns 51.5% of the business.
- The ENERGA Group owns 1.4 GW of electrical capacity, of which 0.56 GW is renewable energy sources. Its business includes the generation, distribution and sale of electricity and heat. The State Treasury owns 51.52% of the business.

GENERATION

In the generation sector, installed capacity was 38 121 MW in 2014, a decrease of approximately 285 MW (0.7%) compared to 2013. Hard coal dominates the fuel mix, followed by lignite and natural gas. Generation is based on conventional fuels, i.e. largely hard coal and lignite, while the growth of shares of wind and other renewable energy sources is continuing.

Table 5.1 Breakdown of Polish power generation sector by fuel type, 2010-15

Installed capacity	Unit	2010	2013	2014	2015
Installed capacity at the end of the year Out of which power plants and CHP:	MW	32 571	32 783	32 924	32 764
Hard coal	MW	22 046	21 039	21 313	20 802
Lignite	MW	8 796	9 421	9 221	9 243
Natural gas	MW	1 085	1 132	1 222	1 248
Biomass and biogas	MW	68	569	624	839
Others	MW	576	622	544	632

Note: CHP = combined heat and power.

Source: Ministry of Energy, Poland IDR submission.

The largest share in the generation market was held by PGE. The share of PGE in the generation sector in 2014 was 38%. Other significant players include TAURON Group (11%), ENEA (9%), EDF group (9%), PAK (7%), GDF Suez (6%) and ENERGA (3.3%). The EDF Poland plant in Rybnik is one of the largest baseload power plants in the country, generating approximately 7% of energy generated in Poland. EDF also supplies approximately 15% of the heat distributed in the country.

The market share index of three biggest entities, calculated on the basis of the volume of energy fed into the grid (including volume of energy supplied by generators directly to end-users), in 2015 was 57.4%. Compared to the previous year, this index dropped very slightly, i.e. by 0.3%. A similar tendency may be observed in the case of the other index –

the share of three biggest generators in installed capacities: this share decreased in 2015 by 1.4% compared to 2014.

The three largest generators (PGE, TAURON and Enea) held a little more than half of installed capacities and were responsible for less than 60% of electricity generation in the country.

The changes in concentration levels are mainly caused by the growth of electricity generated from renewable energy sources, most notably wind. In 2015, the concentration index decline was also a result of the change in cross-border trade balance from exports to imports, which is connected with the decrease in electricity generation in conventional sources, compared to the previous year (ERO, 2015).

Table 5.2 State of competition in the electricity generation sector in Poland, 2013-15

Year	Number of entities with at least 5% share in installed capacity	Number of entities with at least 5% share in the volume of energy fed into the grid	Share of three largest entities in installed capacity [%]	Share of three largest entities in the volume of energy fed into the grid [%]	HHI Index[1]	
					Installed capacity	Volume of energy fed into the grid
2013	5	6	55.1	62.5	1 520.5	1 995.5
2014	5	6	53.6	57.7	1 441	1 823.1
2015	5	6	52.2	57.4	1 366	1 762.9

Source: ERO (2015), *National Report of the President of the Energy Regulatory Office in Poland 2015*.

TRANSMISSION AND DISTRIBUTION

TRANSMISSION

On 31 December 2015, the Polish electricity transmission network was made up of 14 069 kilometres (km) of power lines (750 kilovolts [kV]: 114 km; 400 kV: 5 984 km and 220 kV: 7 971 km), 106 extra-high voltage (EHV) substations and a 254-km, 450-kV under-sea DC connection between Poland and Sweden (127 km of which belongs to Polish TSO). The transmission network is interconnected, via cross-border lines, with transmission networks of neighbouring countries thus enabling a synchronous operation with the interconnected power systems of the rest of continental Europe.

Polskie Sieci Elektroenergetyczne S.A. (PSE), whose only shareholder is the government, via the Government Plenipotentiary for Strategic Energy Infrastructure, owns and operates the electricity transmission system. It is the exclusive holder of the electricity transmission licence under the Energy Act. On 10 October 2013, PSE S.A. applied to the President of ERO for a certification of independence of electricity TSO, i.e. a certificate of meeting the criteria of independence, which was approved on 6 June 2014. The certification of independence granted by the President of ERO designated PSE as the TSO in Poland until 31 December 2030.

1. A Herfindahl-Hirschman Index (HHI) of less than 1 000 represents a relatively unconcentrated market while an HHI between 1 000 and 1 800 represents a moderately concentrated market. Markets having an HHI greater than 1 800 are considered to be highly concentrated.

Network access

Terms of access to the transmission system and use of system tariffs are approved by the TSO, according to the rules defined in the Energy Law Act and the Regulation of the Minister of Energy on detailed tariff regulation. The network companies are required to submit tariffs to the ERO for approval.

Ancillary services

Ancillary services refer to a range of functions which TSOs contract in order to guarantee system security. In 2015, PSE entered into nine agreements for the provision of ancillary services, 11 agreements for the provision of reliability-must-run (RMR) services, two agreements for the provision of ancillary services involving the power system recovery services, and an agreement for the provision of interruptible load services (reduction of demand on instructions from the TSO) for 35 MW.

Market coupling

Capacity Allocation and Congestion Management (CACM) mechanisms set out the methods for allocating capacity in day-ahead and intraday timescales and outline the way in which capacity will be calculated across different zones.

Demand-side management

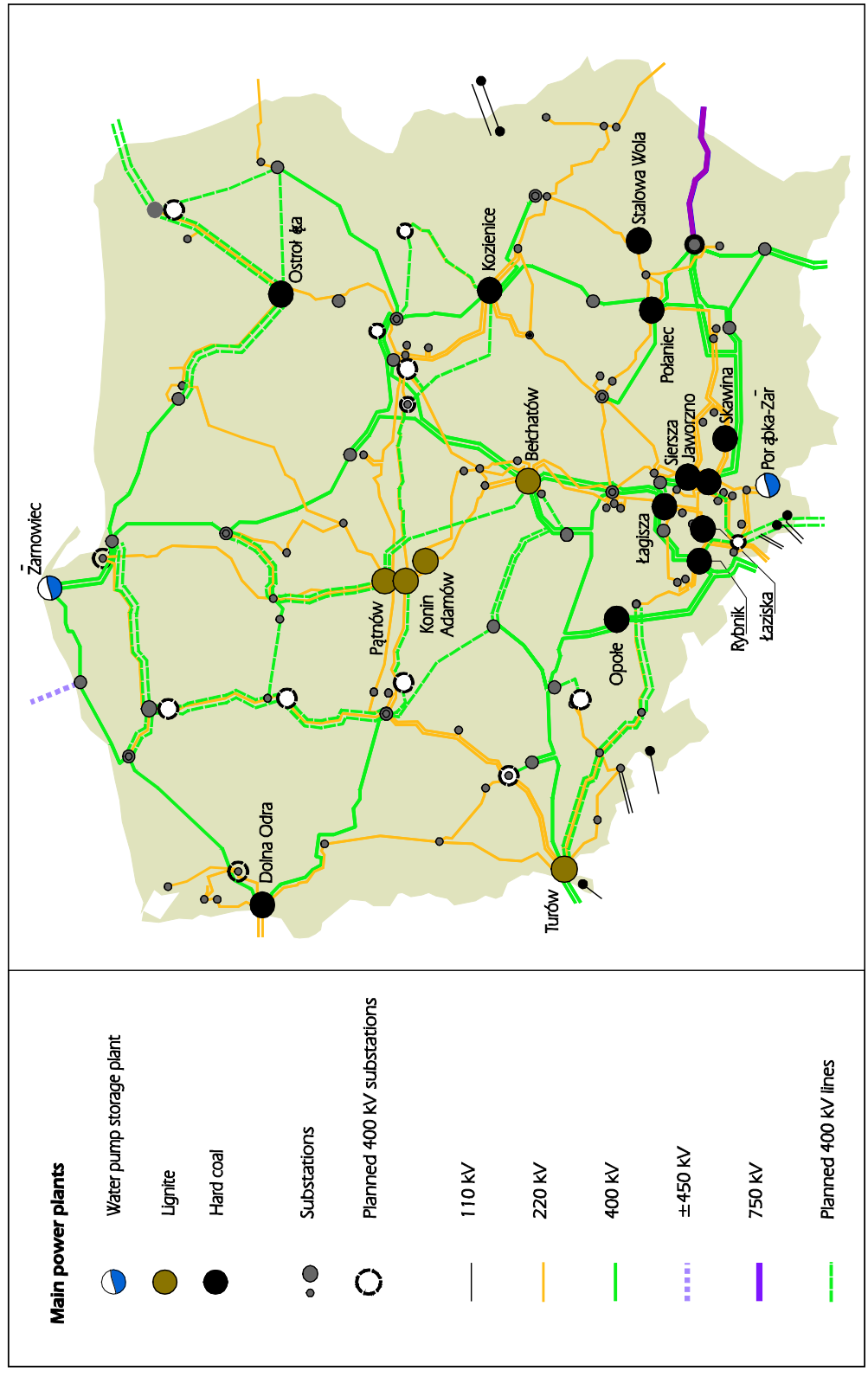
The TSO acquired, via procurement processes, interruptible contracts with industrial customers and demand aggregators approximately 200 MW of demand or less than 2% of peak demand. Large energy users also have the possibility of participating in balancing markets and provide a demand-response service, but there has been little market interest to date. There is no real-time pricing on retail markets, but some distribution system operators (DSOs) and retailers offer time-of-use tariffs/prices for customers; however, the structures of these tariffs are not attractive. Studies have demonstrated that Poland has more than 2 GW of demand-response potential, or enough to meet about 7.5% of peak load (SIA, 2015).

Cross-border transmission

The transmission network is connected with Sweden, Germany, the Czech Republic, Slovakia, Lithuania, Ukraine and Belarus. A new 500-MW (400-kV) equipped with back-to-back station in Alytus (LT) Poland-Lithuania electricity interconnection, known as LitPol Link, was completed in December 2015. The expected final capacity after implementation of the second phase in 2020 is 1 000 MW. A decision on this investment has not yet been taken by the TSOs. Currently, under the Baltic Energy Market Interconnection Plan (BEMIP), regional initiative works are carried out on several options of integration of the power system of Lithuania and other Baltic States into the synchronous grids of the European Union (continental Europe, Nordic or island operation of three Baltic States).

Optimisation of the use of available transmission capacities on many of the interconnections is not possible owing to the presence of unplanned power flows (loop flows) that occur in the Polish system from commercial transactions between Germany and Austria. These transits have a crucial impact on the import and export capacities of the Polish electricity system. Every 100 MW of unplanned power flows reduces available interconnector capacity by 200 MW.

Figure 5.6 Map of the Polish electricity system



Source: Ministry of Energy.

Box 5.1 Loop flows in Central Europe

Power loop flows, from Germany through its neighbours, appear to be causing significant difficulties in Central Europe, especially in Poland and the Czech Republic. These loop flows occur when Germany has insufficient grid infrastructure to connect production locations with demand centres, for example from wind, and the power is diverted through neighbouring countries' grids and then back into a different part of Germany. Such loop flows have become more common since Germany developed large amounts of wind power in its northern Länder, but did not develop the grid infrastructure to transfer the output south to where much of the demand is located. This difficulty has been amplified by the shutdown of eight nuclear plants in 2011.

In its Ten-Year Network Development Plan for Electricity (TYNDP), the European Network of Transmission System Operators for Electricity (ENTSO-E) identified major flows in the south-east and south-central regions, including loop flows in the north-south direction, among the problems driving the need for significant investments in Central Europe.

To support the development of an integrated EU energy market, the European Commission has drawn up a list of 248 projects of common interest (PCIs). These projects may benefit from accelerated licensing procedures, improved regulatory conditions, and access to financial support totalling EUR 5.85 billion from the Connecting Europe Facility (CEF) between 2014 and 2020.

Three electricity PCIs are being developed in Poland. The aim of two of these projects is to increase capacity at Poland's border with Germany (GerPol Power Bridge project and GerPol Improvements project) and contribute to addressing the problems caused by loop power flows in the region (EC, 2014).

In 2015, PSE provided transmission capacity over the interconnections with Germany, the Czech Republic and Slovakia through co-ordinated annual, monthly and daily auctions and through the intraday mechanism. The Joint Allocation Office (JAO), a joint service company of 20 TSOs from 17 countries, is responsible for allocating long-term cross-border transmission capacity in the region. The Polish connection with Sweden (SvK) and Lithuania (LitPol link) is operated by the Polish Power Exchange by means of day-ahead market coupling. The TSO is responsible for operating the connections with Ukraine. Data regarding availability are published by the TSO.

In the second half of 2016, the volume of loop flows was limited thanks to installation of a phase shifting transformer (PST) at the Mikulowa substation (PL) and switching off the Krajnik–Vierraden line. The second PST in Vierraden (DE) is delayed by two to three years as well as an internal line in Germany.

DISTRIBUTION

Electricity distribution is performed by 169 DSOs who supply electricity to around 16.8 million customers. This number includes five entities directly connected to the transmission grid who legally unbundled from former distribution companies and 164 DSOs, which are not obliged to be legally separated. Four of the five legally unbundled DSOs operate within vertically integrated energy companies.

The ownership supervision over these groups is, in principle, exercised by the Minister of Energy. Only one DSO is owned by a company whose shareholders are not connected with the government.

A concession regime is in place for DSOs, most of which are issued for ten-year periods. Concessions are granted to those who hold rights to distribution assets (ownership, leasing, other) (EC, 2015). Tariffs are set by the DSO and are approved by the ERO. No cross-subsidies of distribution costs are applied, and tariffs are composed of a fixed and a variable cost element. Connection fees are calculated on the basis of expenditures incurred only in relation to building the connection (shallow costs). Every three years, each DSO, with the exception of the smaller DSOs, is required to prepare and publish a development plan for the next five years

Distributed and variable renewable power integration

The Baltic Sea region holds strong wind energy potential and, according to the European Wind Power Association, could expand to as much as 15 GW by 2030, while onshore wind could grow by another 30 GW to 45 GW. Poland, previously considered a wind conservative, has installed more than 5.1 GW onshore wind capacity. Despite recent changes to the law that could have the effect of limiting wind power developments, another 10 GW onshore and up to 6 GW of offshore wind in the Baltic Sea are ambitiously projected by 2030. High penetrations of wind power in the future will require the TSO to deploy variable renewable energy (VRE) in a system-friendly way and use demand response and interconnection to balance VRE. This will require Poland to have more peaking technologies and combined-cycle gas turbines (CCGTs) in the long run.

Integrating variable resources, notably wind, can be a challenge in Poland, especially at night when load on the system is low. As more wind comes into the system, net demand may drop to very low levels. This means that the level of inflexible coal-fired capacity required to cover net demand will be variable, and sometimes very low. In Poland, a combination of network constraints and technical limits of coal-fired plants restricts the ability to ramp down or shut off plants when they are not needed. A substantial portion of coal capacity in Poland cannot be shut off at night, as it would not be able to ramp up to meet the next day's demands. Moreover, many plants must operate at greater than 50% capacity (40% for supercritical units), which translates to approximately 10 GW of power. It will be important to address the operational limitations of coal plants on the Polish system because of the current dominance of the power fleet by large coal and lignite plants. Poland may need to look at ways to make coal-fired power and combined heat and power (CHP) more flexible, for example by using electric boilers (FEA, 2015).

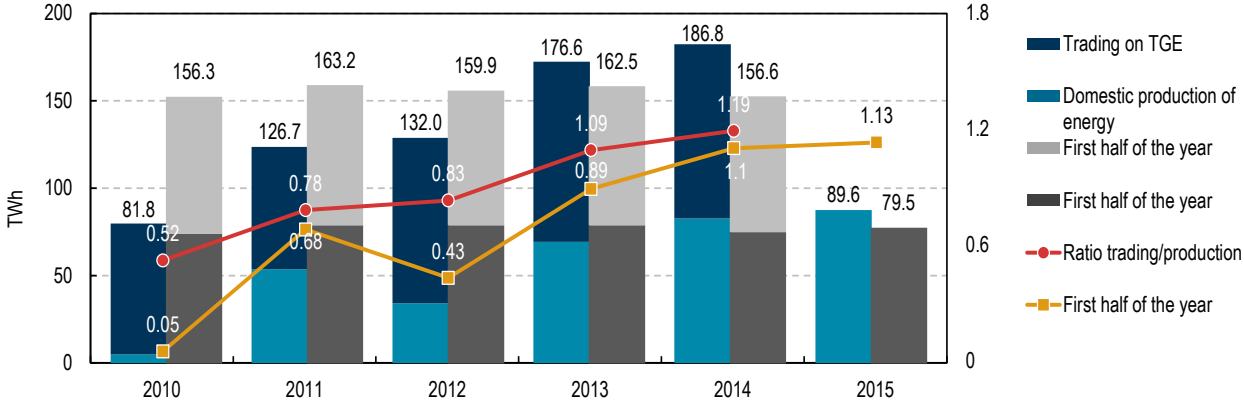
Smart grids

A smart grid is an electricity network that uses digital and other advanced technologies to monitor, manage and balance the transport of electricity from all generation sources to meet the varying electricity demands of end users. Smart grids include electricity networks (transmission and distribution systems) and interfaces with generation, storage and end users (IEA, 2011). The government is preparing a draft law to introduce smart metering as a basis for a future smart grid.

WHOLESALE MARKET

The sale and purchase of electricity on the Polish market is performed mainly through the power exchange managed by Towarowa Giełda Energii (TGE) S.A. (Polish Power Exchange, POLPX). In 2014, POLPX offered the following markets: Intraday Market (IDM), Day-Ahead Market (DAM) and Commodity Forward Instruments Market with Physical Delivery (CFIM). Sales of electricity were also conducted in the auction system. The largest volume of trade was conducted on the CFIM. The total volume of transactions concluded in 2014 on all the POLPX's electricity markets was 186.7 TWh, which was 5% more than the 2013 volume, which was 176.6 TWh.

Figure 5.7 Trading on the TGE, 2010-15



Source: TGE (2015), *Towarowa Giełda Energii: At the Heart of Central European Power and Gas Trading*.

Electricity trading on the TGE market has been steadily growing since 2010. Liberalisation of the wholesale and retail markets was supported by the obligation imposed on electricity generators to sell at least 15% of the electricity generated in the form of a public sale, i.e. on commodity exchanges or on organised markets in accordance with relevant regulations.

A record high trading volume of 186.7 TWh in 2014 accounted for over 119% of electricity production and more than 138% of consumption in Poland (TGE, 2015). In February 2015, the Financial Supervision Authority granted TGE a licence to operate a financial market, which allowed TGE to offer market participants new products for hedging risk in the electricity market and match products available on markets elsewhere.

REMIT

On 28 December 2011, the EU Regulation on Wholesale Energy Market Integrity and Transparency (REMIT) entered into force.[2] Under this regulation, several new obligations were imposed on national regulatory authorities (and the European Agency for the Cooperation of Energy Regulators [ACER]) regarding wholesale energy market monitoring and the detection of market manipulation or gaming. Every market

2. The REMIT is intended to promote transparency in wholesale market price formation and to detect and deter abusive behaviour.

participant, prior to concluding the first contract which falls under notification obligation, is required to register itself in the market participant register established and kept by the national regulatory authority. In Poland, the respective regulations have been introduced in the amendment of the Energy Law Act of 11 September 2015.

Capacity allocation and market coupling

Under market coupling, electricity prices are computed simultaneously for different nationally organised electricity market platforms (or power exchanges), while taking into account cross-border transmission capacity. DAM coupling now links the Nordpool area, Great Britain, central Western Europe, the Iberian Peninsula and Italy. The same algorithm is used to clear markets simultaneously, to ensure that electricity always flows from the lower price zone to the higher price zone (IEA, 2016c).

On the interconnection between Poland and Sweden, which links the operational areas of PSE and Affärsverket Svenska Kraftnat, the TSO of Sweden, transmission capacity allocation is carried out under implicit auctions within the market coupling mechanism. The auctions are performed by the power exchanges, i.e. Towarowa Giełda Energii S.A. (POLPX) and Nordpool Spot. Transmission capacities, together with electricity, are offered in auctions. The TSOs of Poland and Sweden make the capacity available, and accept and nominate the schedules notified by power exchanges, ensuring allocated amounts.

The rules of transmission capacity allocation on the Poland-Sweden interconnection, as well as the associated financial settlements, are determined in the Market Coupling Agreement, signed by POLPX and Nordpool Spot, and the TSOs of Poland and Sweden, PSE and Affärsverket Svenska Kraftnät. The maximum offered transmission capacities amounted to 300 MW for exports from Poland and 600 MW for imports to Poland. On the Poland-Ukraine interconnection, allocation of transmission capacity is carried out under unilateral monthly explicit auctions

SECURITY OF SUPPLY

The Energy Law of 10 April 1997 sets out legal definitions of energy security, security of electricity supply, security of the electricity grid and threats to the security of supply. It also stipulates the key tools for dealing with long-term security of electricity supply: increasing the diversification of resources, development of renewable energy sources, building of new power generating capacity, enforcing competitiveness in the energy market and expansion of the network infrastructure.

The law also sets out tools for dealing with supply disruptions and tasks the TSO to:

- Issue instructions to generators on starting, shut-down, changes of load or disconnection from the grid of the centrally disposed of generation units.
- Carry out intervention purchases of power.
- Issue instructions to DSOs on starting, shut-down, changes of load or disconnection from the grid in the area of its operation of such a generation unit connected to the distribution grid, which is not centrally dispatched.

- Issue instructions to DSOs to reduce the amount of electricity consumed by final customers connected to the distribution grid in the area of its operation or to interrupt power supply to final customers connected to the distribution grid in this area.
- Having exhausted all possible efforts to meet demand for electricity, instruct final customers directly connected to the transmission grid to reduce load or to disconnect from the grid, in accordance with the load reduction plan.
- Reduce the volume of intersystem transmission capacity.

Each year, a scheme for introduction of restrictions in power supply and off-take, from 1 September of the given year to 31 August of the next year, has to be presented by the TSO to the ERO for regulatory approval. These restrictions in the supply and consumption of electricity consist of limiting the maximum electricity consumption used and a restriction of the daily electricity consumption of these consumers whose contractual capacity is higher than 300 kW.

EMERGENCY RESOURCES, GENERATION RESERVES

To ensure adequacy of supply, the TSO arranges control services for centrally dispatched generation units, and is responsible for contracting "must-run" services with non-centrally dispatched generators and supporting power from hydro units of a total of 1 704 MW, as well as 830 MW of cold (non-spinning) reserves.

Bilateral agreements with neighbouring TSOs ensure an estimated additional 300 MW of supporting power that can be used for recovery of the system to normal state. The TSO monitors the level of coal stocks in centrally dispatched generating units; the threshold for alarm is 20 days. The TSO also elaborates a daily report with aggregated data from generators for the ERO and Ministry of Energy.

DEMAND-SIDE POLICIES

In 2014, PSE contracted load-shedding services in a total volume of 147 MW (in interruptible contracts).

In a risk of disruption, the Council of Ministers (at the request of the Minister of Economy) has the power of introducing limitations in power supply and consumption. The TSO has the same power, but limited to 72 hours. In "emergency mode," disconnections of customers should be executed within one hour from the time of the order by shutting down the lines and medium-voltage stations.

EMERGENCY MANAGEMENT AND RESTORATION

A restoration plan based both on bottom-up and top-down is prepared by the TSO. The TSO, in co-operation with DSOs and power plants, annually runs at least one black-start test – supplying large thermal units from the black-started one. The capability of black-start of a unit is tested twice a year in accordance with the agreement signed between the TSO and the respective power plant owner. Thermal units larger than 100 MW have an obligation to test, on a regular basis, their capability for island operation.

Box 5.2 Generation emergency in August 2015

On 10 August 2015, net generating capacity on the system was 38.7 GW. Furthermore, for a number of reasons, only about 65% of this capacity was reliably available. The combined output of available plants was even lower. Reasons for unavailable capacity included:

- approximately 40% of CHP plants were offline for the season
- capacity factor of wind was approximately 5%
- scheduled modernisation and renovations
- operational restrictions owing to high air and water temperatures and a low water table
- emergency shutdown of the largest unit at Bełchatów power plant (the largest in Poland).

Demand exceeded available capacity on the system by 883 MW in the morning and 571 MW in the evening. Additional operational reserves of 18% of load were expected to be available to the system; however, as the reserves are composed of the spinning reserves of thermal plants in the system, they were largely unavailable owing to the same weather-related restrictions that affected the wider fleet (FEA, 2015). Network congestion further restricted the flow of power. Poland had limited available interconnection capacity and demand-response resources on which to rely. In combination, these restrictions led to forced curtailments to 1 600 commercial customers – the first such event in 30 years. In response, PSE utilised all measures available, including among others:

- activated all available generating units (including the generating units not directly dispatched by TSO)
- postponed, in consultation with the generators, all planned overhauls
- ordered the activation of the contracted load reduction mechanisms
- ordered, to the maximum possible extent, the supply of emergency power from neighbouring TSOs (notably from the Czech and Slovak republics).

At the same time, a large-scale multilateral re-dispatching was implemented to keep flows on the German – Polish border at a secure level, as this border was heavily congested as a result of unscheduled power flows (loop and transit). This meant that it was impossible to import more supportive power on the synchronous profile (Germany, Czech Republic, Slovak Republic) than limited amounts from southern neighbours.

Despite the measures taken by the TSO, it was decided to implement a plan to limit power supply to industrial consumers (consumers with contracted capacity above 300 kW). During the night, generation capacity outages increased further and reached about 20% of planned power demand for the morning peak on 10 August (22 200 MW). Therefore, on Monday morning further controls were announced. By implementing further limitations, the stable operation of the power system was maintained and emergency uncontrolled disconnections of customers were avoided. By the end of the month the system returned to normal operating conditions.

Source: PSE (2016), www.pse.pl/index.php?dzid=32&did=2516&lang_id=2 (accessed 1 November 2016).

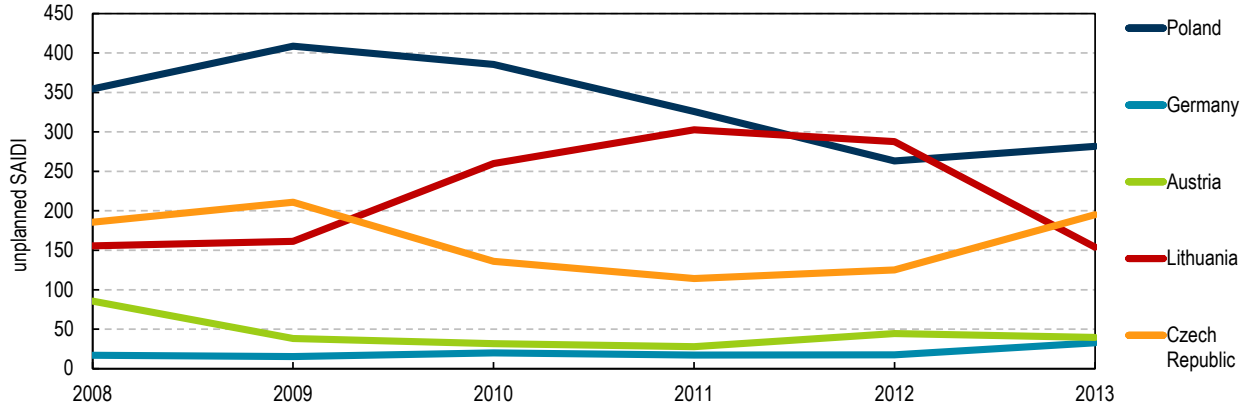
TRANSMISSION SYSTEM OPERATOR SECURITY CO-OPERATION

The Transmission System Operator Security Co-operation (TSC) is a group of central European TSOs, established in 2008 with a goal to increase the security of operation of the regional interconnected power systems in face of increasing variable renewable generation (wind) and growing cross-border transmissions. TSC has developed an online data sharing platform to share operational forecast data. Member TSOs, including Poland's PSE, have signed an Agreement on Multilateral Remedial Actions which relies on co-ordinated changes in production output that can be activated on the request of one or more TSOs.

POWER SYSTEM SECURITY PERFORMANCE

The figure below illustrates the System Average Interruption Duration Index (SAIDI) for each year from 2008 to 2013, when all interruptions (originating from all voltage levels) are taken into account, including planned interruptions and unplanned interruptions with exceptional events. Poland's performance in this metric has been improving since 2009 with the exception of a slight dip in performance in 2013.

Figure 5.8 Unplanned SAIDI, length of outages, selected countries



Source: CEER (2015), *CEER Benchmarking Report 5.2 on the Continuity of Electricity Supply Data Update*.

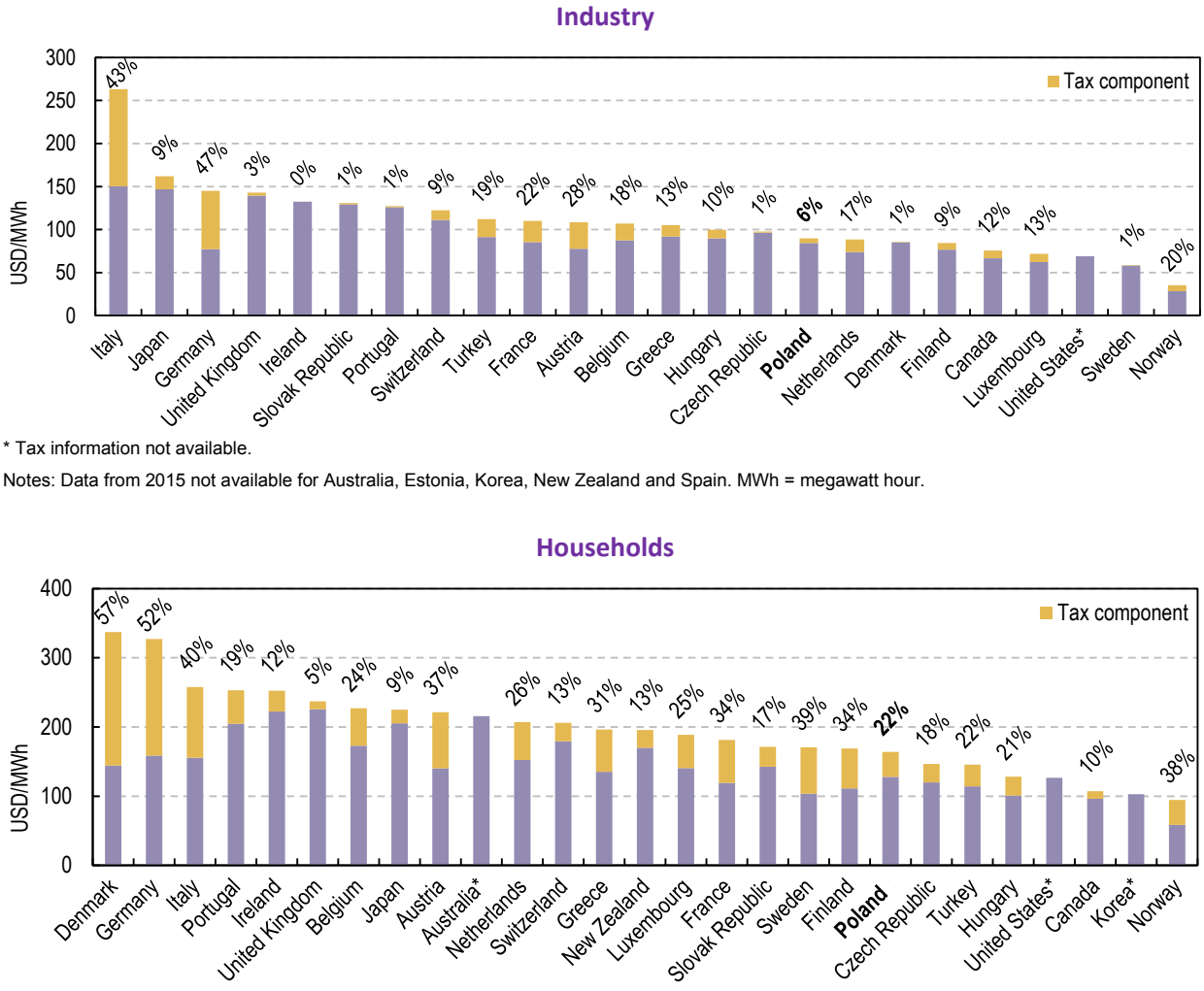
RETAIL MARKET AND PRICES

PRICES

According to IEA data, electricity prices for households and industry in Poland are among the lowest in Organisation for Economic Co-operation and Development (OECD) Europe. This is also reflected in Eurostat data: retail prices for electricity for household consumers in Poland (EUR 0.1105/kWh excluding taxes and levies or 0.1418/kWh including taxes and levies) are well below the EU-28 average (EUR 0.1419/kWh excluding taxes and levies, EUR 0.2105/kWh including taxes and levies).[3]

3. Eurostat, electricity prices for domestic consumers - bi-annual data (from 2007 onwards) – Band DC 2 500 kWh < consumption < 5 000 kWh, (second semester 2015).

Figure 5.9 Electricity prices in IEA member countries, 2015



* Tax information not available.

Notes: Data from 2015 not available for Australia, Estonia, Korea, New Zealand and Spain. MWh = megawatt hour.

* Tax information not available.

Note: Data not available for Estonia and Spain.

Source: IEA (2016d), *Energy Prices and Taxes 2016*, Q3, www.iea.org/statistics/.

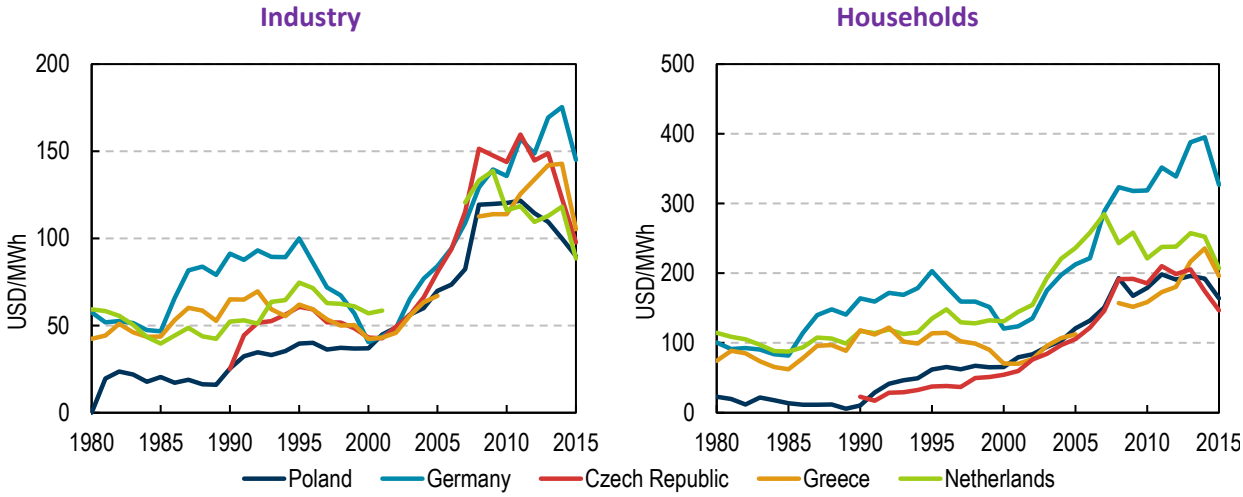
Prices for industrial users (EUR 0.0813/kWh excluding taxes and levies or 0.1059/kWh including taxes and levies) are also less than the EU-28 average (EUR 0.0879/kWh excluding taxes and levies or 0.1474/kWh including taxes and levies).[4]

Unlike many other European countries, Poland continues to regulate retail electricity prices for households, and the approval of electricity prices by the president of the ERO remains in place for households. The president of the ERO still maintains the obligation to submit for approval, on an annual basis, electricity tariffs for consumers classified in the G tariff group (householders) who have not decided to switch supplier connected to the grid of a DSO. Electricity prices for these consumers are included in the tariffs of the

4. Eurostat, electricity prices for industrial consumers - bi-annual data (from 2007 onwards) - Band IC 500 MWh < Consumption < 2 000 MWh (second semester 2015).

suppliers (known as trading companies in Poland), approved by the president of the ERO and published in the Branch Bulletin of the Energy Regulatory Office. Electricity prices for other groups of consumers are set by the market.

Figure 5.10 Electricity prices in Poland and in other selected IEA member countries, 1980-2015



Note: Data not available for the Czech Republic 1980-89, the Netherlands 2002-06 (Industry) and Greece 2006-07 (Household).

Source: IEA (2016c), *Energy Prices and Taxes 2016*, www.iea.org/statistics/.

In its 2015 Market Monitoring Report, ACER highlighted significant entry/exit activity in the household markets sector of the electricity market, but also highlighted unethical supplier sales practices in some countries including Poland, where customers' switching under pressure has been reported. This has created bad publicity for some alternative suppliers and undermined trust in the market, and thus discouraged consumers from switching. Poland has introduced some measures to combat these claims, such as a 21-day cooling off period guaranteed by the Polish Energy Law, during which a consumer may reverse the switch without any consequences (ACER/CEER, 2015). In September 2015, ACER published a study of competitiveness of retail electricity and gas markets in EU member states and Norway. The outcome of the study ranked Poland the seventeenth most competitive electricity retail market among the 24 countries studied (IPA, 2015).

ASSESSMENT

In 2015, total power generation was 164 TWh with most (81%) coming from fossil fuels, principally coal and lignite, along with small volumes of natural gas and oil. Renewables, including biofuels and waste, accounted for 13.8% of electricity production in the same year. Poland maintained traditional exports of electricity, mainly to the Czech Republic and Slovakia, but these were offset by higher imports, often unplanned imports from Germany, but also from Sweden.

Although important improvements have been made to modernise Polish energy infrastructure, significant investments are still needed to ensure a sustainable supply of energy, reduce the share of carbon-intensive plants and increase the exploitation of

renewable energy sources. Poland needs to step up its efforts and extend the development of the electricity transmission grid. At present, it is one of the least connected EU member states in terms of electricity infrastructure. Closer integration of the country with neighbouring markets is essential to strengthen electricity security and further integration of electricity markets in the region.

Cross-border interconnections represent only 7% of installed generation capacity at present, taking into account unscheduled flows, and further investments are necessary in order to reach the EU target of 10% by 2020.[5] The Baltic Energy Market Interconnection Plan plays a key role in this regard. Furthermore, an important priority in the ENTSOE Continental Central Eastern Europe (CEE) integration initiative is strengthening the transmission network in CEE between Germany, the Czech Republic, Slovakia and Poland. The driver for investments in this region is to decrease price-differences between Poland and the neighbouring countries, as well as the need to increase security of supply. ENTSOE analysis indicates that the optimal level of interconnection in this region ranges from 2.5 GW to 4.5 GW. Compared to present and planned investments, this shows potential for further projects.

In December 2015, a new 500 MW electricity interconnector with Lithuania (LitPolLink) became operational and work to restart an existing 750 kV line between Poland and Ukraine is underway, but work on further electricity interconnectors with Germany is not progressing as fast as planned because of unsolved existing flow questions. Conversely, on the interconnection line between Poland and Sweden and Poland and Lithuania, electricity is flowing freely and transmission capacity allocation is carried out under implicit auctions within a market coupling mechanism.

Furthermore, obstacles in cross-border exchange of electricity should be eliminated and the problems resulting from unscheduled (or loop) flows properly addressed. The geographical imbalance between generation and consumption within Germany does not allow electricity to flow through the German-Austrian border as scheduled, and instead power flows via Poland, the Czech Republic, Slovakia and Hungary. The situation is made worse by the fact that much of this power comes from renewable sources and cannot be adequately planned. Power flow control devices became operational on Poland's border with Germany at Mikułowa, but there are delays in the construction of a phase shifter on the German side in Vierraden. Greater exchange of data between TSOs and forecasts of VRE on the day of operation would already help. The IEA understands that grid investments such as new transformers are not a permanent solution to grid stability problems in the region, for which the most cost-effective long-term solution is more grid capacity.

The electricity TSO, PSE S.A, was certified as an ownership unbundled TSO in June 2014 following adoption of rules on certification of independent system operators in 2013. There were 169 electricity DSOs at the end of 2014, but only five serve more than 100 000 customers. Each of these five companies is legally unbundled and only one of them is controlled by shareholders unconnected with the Polish State Treasury. The Polish wholesale power generation market still remains concentrated, with five main

5. The European Council of October 2014 called for all EU member states to achieve interconnection of at least 10% of their installed electricity production capacity by 2020. This means that each Member State should have in place electricity cables that allow at least 10% of the electricity that is produced by their power plants to be transported across its borders to its neighbouring countries. The target for 2030 is 15%.

operators – PGE, TAURON, EDF, ENEA and PAK – accounting for 74% of production. Despite the large presence of many state-owned entities, recent data published by the energy regulator, the ERO, indicates that the market can no longer be considered highly concentrated. An effective measure in stimulating competition in the wholesale market has been the obligation imposed on generators by the ERO to sell electricity through the power exchange. According to the TGE, the market operator, the volume of electricity traded on the POLPX was 186.7 TWh in 2014. The average price of EUR 44/MWh was converging towards average prices on other large markets.

Poland has significant untapped demand-response potential. Experience elsewhere has demonstrated that demand response has the ability to cover 10% or more of peak needs, and often outperforms supply-side resources in terms of reliable delivery. Recent analysis has suggested that Poland can meet approximately 7.5% of its peak needs with demand response, highlighting the fact that demand response is a significantly under-utilised resource in Poland (SIA, 2015). Demand response can help meet summer peaks, and it can also support the system in winter when demand is higher. Large industrial customers have emphasised the importance of planned load shifting as demand response to prevent the unplanned curtailments imposed on them in August 2015. Demand-side resources can further help integrate renewables by ramping down, but also ramping up activity in response to fluctuations in output from variable renewable resources. The latter feature is particularly useful in Poland, where increasing load on the system at night can help address challenges to integration of wind (FEA, 2015).

Despite significant emission reductions realised over the last two decades, Poland is reluctant to support ambitious EU climate policy targets beyond 2020. This position seems to arise from concerns about energy security and its heavy reliance on coal, of which it has the biggest reserves in the European Union and which is instrumental for electricity generation. The domestic electricity generation fleet is old and heavily reliant on coal.

Over the next 20 years, the TSO has projected that between 16 GW and 23 GW of capacity will be taken out of the market and less than 10 GW of new capacity, including nuclear, is planned. In 2025, the capacity shortfall will be at least 3.5 GW (PSE, 2015). Over the shorter term, the electricity market faces risks. For example, in August 2015, Poland experienced power shortages after prolonged warm weather and low water levels in rivers used to cool coal-fired plants, which resulted in power consumption restrictions. In the absence of substantial new power capacity and interconnection constraints in the short term, Poland has considered the introduction of some form of capacity mechanism to secure the energy system. Similar arrangements are being discussed in other large markets such as the United Kingdom and Germany. While capacity mechanisms can secure electricity supply, great care has to be taken in their design and implementation to ensure they do not distort competition, interfere with cross-border electricity flows or result in higher electricity prices for end users.

Poland continues to regulate retail electricity prices for households. In 2015, the regulation of electricity prices for households applied to all consumers who did not choose to switch to the free market. Similar to the wholesale market, the incumbent retains a large market share and the level of customer switching remains very low at 0.7% of domestic households. While the ERO has developed a number of tools to promote customer switching and protect customers, much more must be done to stimulate a competitive retail market.

RECOMMENDATIONS

The government of Poland should:

- ☐ *Take steps to secure the short- and long-term security of the electricity system.*
  - *This includes ensuring that the wholesale market is able to provide clear investment signals to new generation.*
  - *In the short term, the government must facilitate the implementation of a market-based mechanism that ensures competition between all generation technologies, best use of cross-border resources and demand-side participation.*
- ☐ *Work with its partner countries to eliminate unscheduled cross-border electricity flows.*
- ☐ *Ensure that the regulatory bodies that have responsibility for oversight of energy markets are adequately resourced and have the necessary legal tools to address market problems, protect consumers and promote competition.*
- ☐ *Develop a clear and transparent programme for the implementation of full retail market liberalisation by the end of 2017 including the elimination of regulated tariffs. Social policy should include protection measures for vulnerable customers and less-well-off consumers.*

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6. RENEWABLE ENERGY

Key data (2015 estimated)

Total supply: 9.6 Mtoe (10.1% of TPES) and 22.7 TWh (13.8% of electricity generation). IEA average: 9.9% of TPES and 23.6% of electricity generation

Biofuels and waste: 8.5 Mtoe[1] (8.9% of TPES) and 10 TWh (6.1% of electricity generation)

Wind: 0.9 Mtoe (1% of TPES) and 10.8 TWh (6.6% of electricity generation)

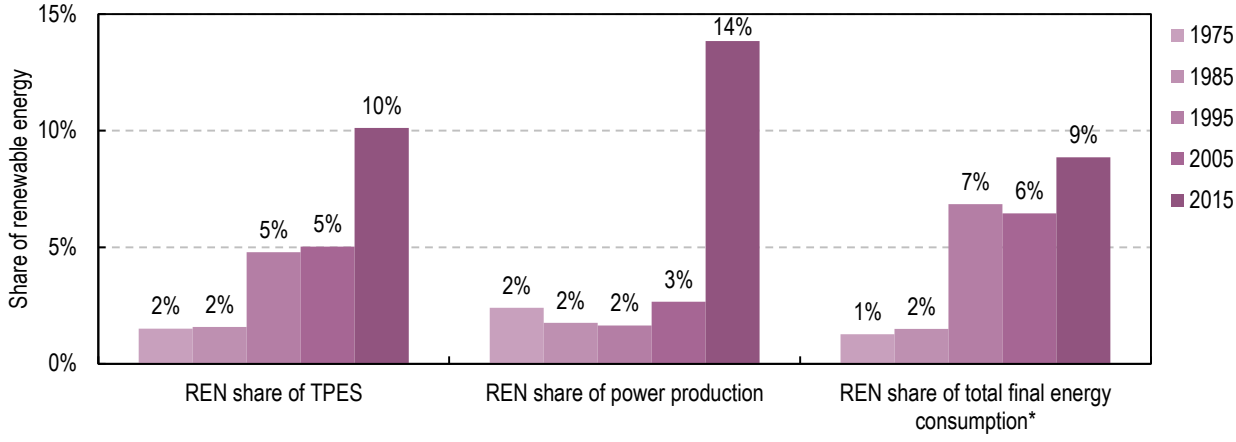
Hydro: 0.2 Mtoe (0.2% of TPES) and 1.8 TWh (1.1% of electricity generation)

Solar: 0.02 Mtoe (0.03% of TPES) and 0.1 TWh (0.04% of electricity generation)

OVERVIEW

Poland has achieved significant progress in the deployment of renewable energy sources in recent years. The share of renewables in total primary energy supply (TPES) doubled from 5% in 2005 to 10% in 2015, exceeding slightly the average for International Energy Agency (IEA) countries. Biofuels and waste is the main renewable energy in terms of TPES and total final consumption (TFC) in Poland. Recent growth has, however, been strongest in wind power, which became the largest renewable energy source in electricity production with 6.6% of total generation in 2015.

Figure 6.1 Renewables share of TPES, electricity generation and TFC, 1975-2015



*Latest consumption data are from 2014.

Note: 2015 values are estimates.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

1. Biofuels and waste includes 0.5 Mtoe (6% of total supply) non-renewable waste from industry and municipalities.

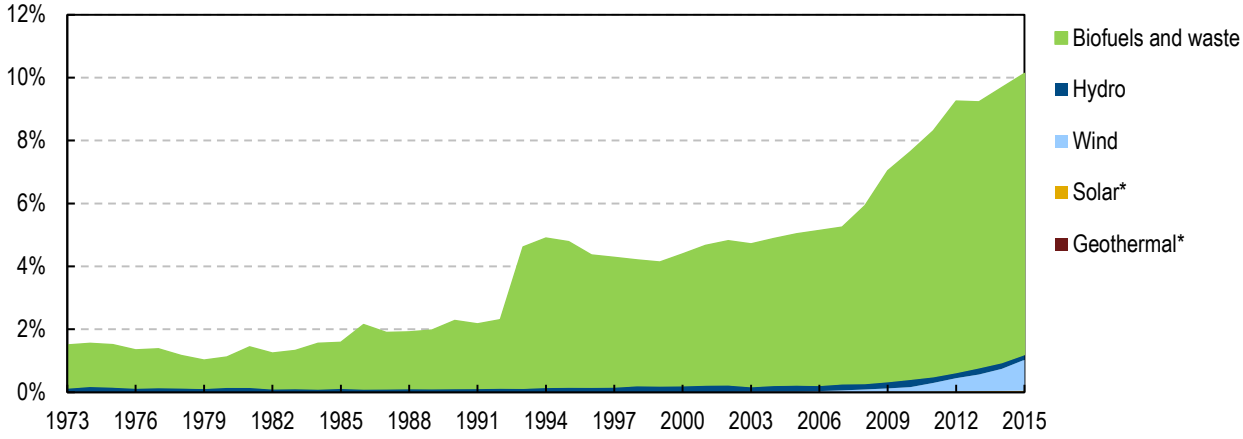
The EU Renewable Energy Directive mandated Poland to increase its overall renewable energy consumption to 15% by 2020. The overall target is split between the electricity target (19%), heat and cooling target (17%), and transport target (10%). The greatest efforts in the coming years will be concentrated in the transport and power generation sectors.

SUPPLY AND DEMAND

RENEWABLE ENERGY IN TPES

From an almost complete dominance of coal in the energy supply, Poland's share of renewables has increased significantly since the early 1990s. Biofuels and waste is the biggest source of renewable energy, with 8.5 million tonnes of oil-equivalent (Mtoe) of TPES in 2015, which corresponds to a 91% increase since 2005. The growth in biofuels was particularly strong in the five years from 2007 to 2012, representing an increase of 76%. Since 2012, the level of biofuels and waste in Poland's TPES has been stable. The biggest increase of renewable energy supply in recent years has been wind energy, contributing 0.93 Mtoe in 2015. Wind makes up only 1% of TPES, but represents a larger share in terms of electricity generation. Hydro power is the third-largest renewable, with a production that is stable around 0.2 Mtoe. There is also a small, yet growing, share of solar energy accounting for 0.02 Mtoe in 2015.

Figure 6.2 Renewable energy as a percentage of TPES, 1973-2014



*Negligible.

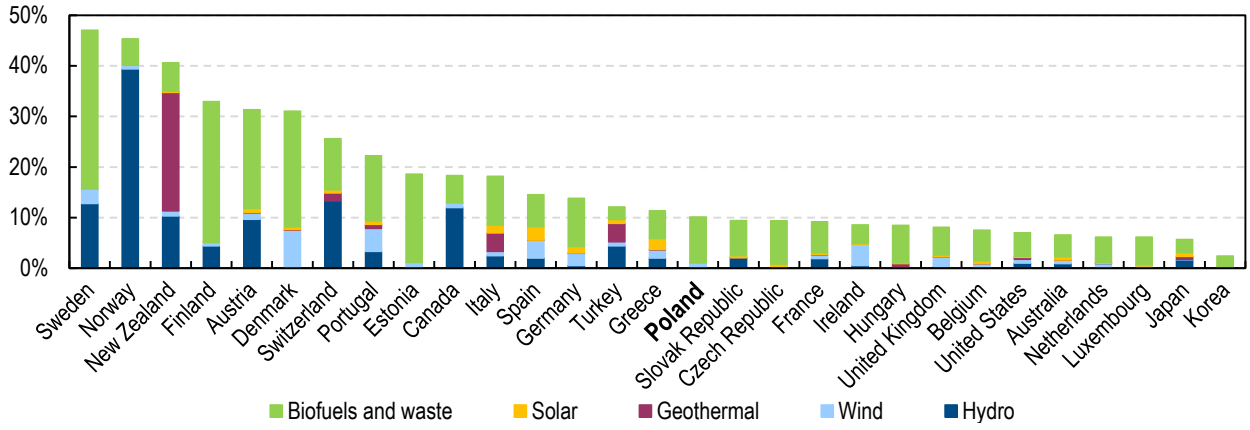
Note: Biofuels and waste includes shares of non-renewable waste (approximately 6% of total energy in the biofuels and waste category).

Source: IEA (2016a), *Energy Balances of OECD Countries2016*, www.iea.org/statistics/.

Poland's share of renewables in TPES is just above the IEA average of 9.5%.[2] The share of biofuels and waste is the 10th highest and the share of wind is 12th highest, while the shares of hydro and solar are among the lowest in the IEA. Compared to other IEA Europe member countries, however, Poland has a lower than average share of renewables in TPES (compared to 14% in IEA Europe).

2. Average in terms of total renewable energy divided by total primary energy supply in IEA-29.

Figure 6.3 Renewable energy as a percentage of TPES in Poland and IEA member countries, 2015



Note: Biofuels and waste may include shares of non-renewable waste.

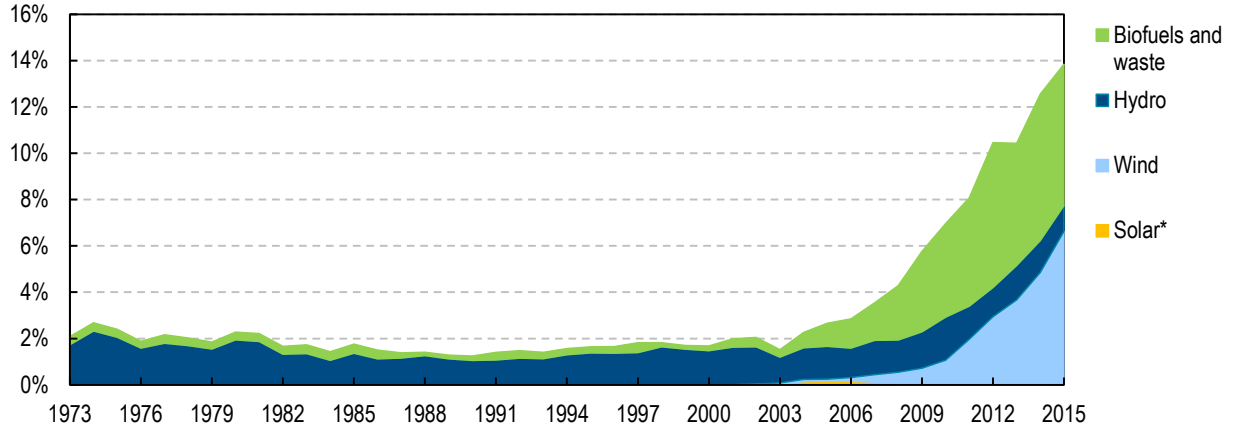
Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

ELECTRICITY FROM RENEWABLE ENERGY

Historically, renewable power generation was dominated by hydro power until electricity production from biofuels and waste grew and became the largest source in 2007. Biofuels and waste continued to grow until 2012 and has since been stable at around 10 terawatt hours (TWh) per year, representing around 6% of total electricity generation, largely for co-firing.

In recent years there has been another shift in renewable power production, as a result of the rapid expansion of wind energy. Wind power increased by 550% from 2010 to 2015, albeit from only 300 megawatts (MW) in 2010, reaching 11 TWh or 7% of total electricity generation.

Figure 6.4 Renewable energy as a percentage of electricity generation, 1973-2014



*Negligible.

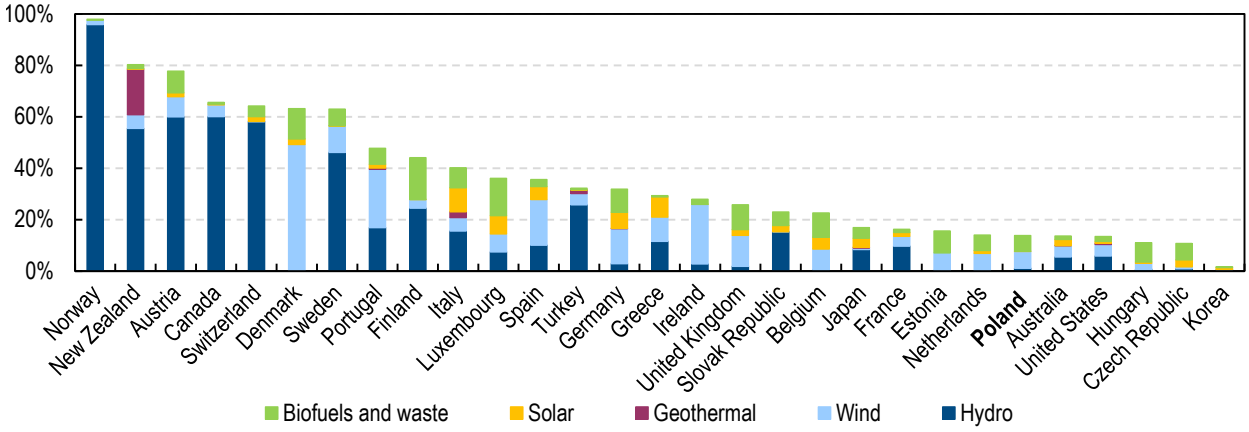
Note: Biofuels and waste in electricity production includes minor shares of non-renewable municipal waste.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Poland has the sixth-lowest share of renewables in electricity generation among IEA member countries. This is a result of especially low shares of hydro and solar power in

Poland, while wind and biofuel shares are on median levels among IEA countries. Hydro power decreased by 17% from 2005 to 2015, to 1.8 TWh or 1% of total electricity generation. The number of solar photovoltaic installations in Poland is increasing, but their electricity output remains very modest at 0.1 TWh in 2015.

Figure 6.5 Electricity generation from renewable sources as a percentage of all generation in Poland and IEA member countries, 2015



Note: Biofuels and waste may include shares of non-renewable waste.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Table 6.1 Renewable electricity generating capacity, 1990-2014 (MW)

Technology	1990	2000	2004	2008	2009	2010	2011	2012	2013	2014
Hydro	1 888	2 183	2 282	2 335	2 338	2 342	2 346	2 351	2 355	2 364
Pumped storage	1 205	1 366	1 406	1 406	1 406	1 406	1 406	1 406	1 406	1 406
Solar PV	0	0	0	0	0	0	1	1	2	27
Wind	0	4	40	526	709	1 108	1 800	2 564	3 429	3 836
Industrial waste	0	3	3	3	3	3	3	3	3	3
Solid biofuels	0	0	24	40	42	53	175	455	582	629
Biogases	0	9	24	52	68	81	102	128	153	187
Total capacity	**1 888**	**2 199**	**2 373**	**2 956**	**3 160**	**3 587**	**4 427**	**5 502**	**6 524**	**7 046**

Source: IEA (2016b), *Renewables Information*, www.iea.org/statistics/.

BIOFUELS AND WASTE

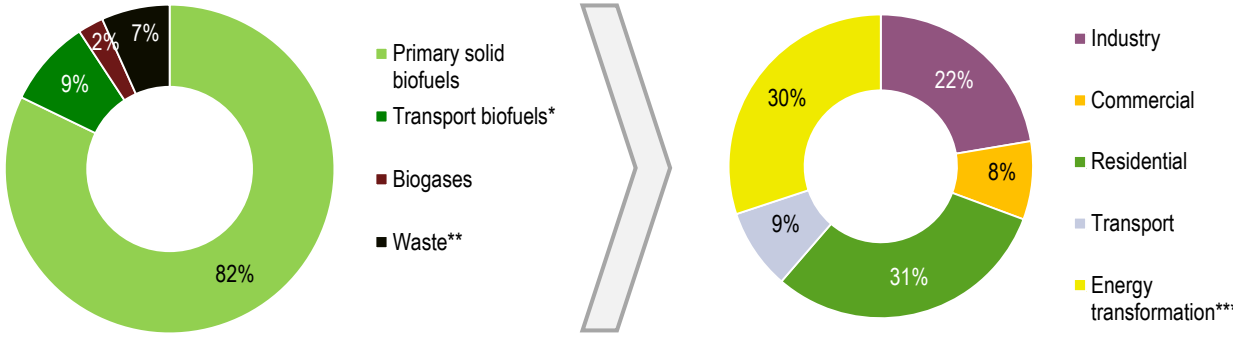
Biofuels and waste is the largest renewable energy source in Poland. The biggest part is primary solid biofuels, mainly used in heat and power plants or consumed directly in the residential or industrial sectors. Solid biofuels are also traded, and Poland was a net importer of 0.52 Mtoe in 2015. This equals 8% of the total supply of solid biofuels.

Waste and biogases are also used for heat and power production. Industrial waste makes up 74% of total waste with the rest being municipal waste, of which one-quarter

is renewable waste fractions.[3] Waste is mainly used as fuel in industries, while biogases are used mostly in combined heat and power (CHP) plants.

The remaining share of biofuels (0.7 Mtoe) is used in transport. These transport fuels consist of 81% biodiesel and 19% biogasoline. Biofuels made up 5% of total energy consumption in the transport sector in 2014.

Figure 6.6 Supply and consumption of biofuels and waste, 2014



*Biofuels is made up of biogases, biogasoline and biodiesel.

**Waste is made up of industrial waste, renewable municipal waste and non-renewable municipal waste.

***Energy transformation is heat and power production (mainly in CHP plants).

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

POLICY FRAMEWORK

NATIONAL PLANS

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources lays down a 20% target for the overall share of energy from renewable sources and a 10% target for energy from renewable sources in transport for the European Union as a whole. Pursuant to this Directive, only the overall 2020 targets are mandatory for the Poland, i.e. a mandatory target of a 15% share of energy from renewable sources in gross final energy consumption by Poland by 2020. This includes the mandatory target of a 10% share of energy from renewable sources in all kinds of transport in gross final energy consumption by 2020.

The first National Renewable Energy Action Plan (NREAP) for Poland was submitted to the European Commission in 2010. The plan projected a target of a 15% share of energy from renewable sources in gross final energy consumption, 17% in electricity, a 17% share of energy from renewable sources in heating and cooling and a 10% share of energy from renewable sources in transport in gross final energy consumption by 2020.

3. Industrial waste is included in the data, but not considered as a renewable energy source.

Table 6.2 National overall target for the share of energy from renewable sources in gross final consumption of energy in 2005 and 2020

A. Share of energy from renewable sources in gross final consumption of energy in 2005 (%)	7.2
B. Target of energy from renewable sources in gross final consumption of energy in 2020 (%)	15
C. Expected total adjusted energy consumption in 2020 ((ktoe)	69 203
D. Expected amount of energy from renewable sources corresponding to the 2020 target (calculated as B × C) (ktoe)	10 387

Note: ktoe = kilotonnes of oil-equivalent.

Source: Ministry of Energy (2009), *Energy Policy of Poland until 2030*.

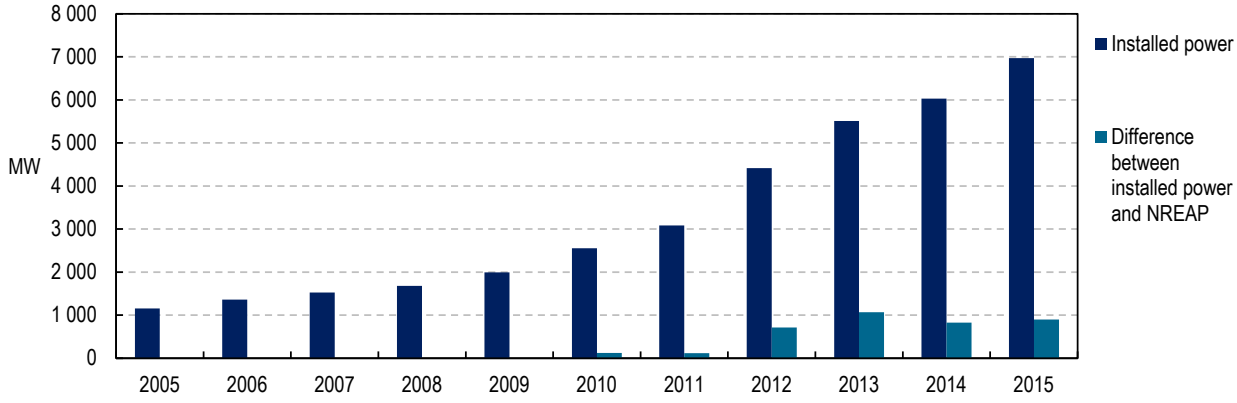
Directive 2009/28/EC also requires each EU member state to submit a report to the European Commission on progress in the promotion and use of energy from renewable sources every two years from December 2011. The obligation was transposed into Polish law by means of Article 127 of the Act of 20 February 2015 on Renewable Energy Sources. The data included in the most recent report is set out in Table 6.3 below.

Table 6.3 Sector shares and total shares of energy from renewable sources in 2013 and 2013

	2013	2014
Electricity	10.73%	12.4%
Heating and cooling	14.07%	13.95%
Transport	6.03%	5.67%
Overall share of renewable energy sources	11.34%	11.45%

Source: Ministry of Energy (2016), "Interim report on progress in the promotion and use of energy from renewable sources in Poland in 2013-14".

Figure 6.7 Deployment of electricity from renewable energy sources in Poland, 2005 to 2015



Source: Ministry of Energy, Poland IDR submission.

DOMESTIC POLICIES AND MEASURES

Poland's Energy Policy to 2030, which is expected to be replaced by a new energy strategy in 2017, was adopted by the Polish government on 10 November 2009 and emphasised support for the sustainable use of renewable energy. It established a 15% renewable in final energy consumption by 2020 target, which included a 10% share of biofuels in the transport sector. The details of these binding renewable energy targets are provided in Poland's NREAP, which was discussed in the previous section. In order to achieve the targets set out in the NREAP, Poland has developed a series of domestic policies and measures, which are summarised in table 6.4 below. There are also a number of pieces of legislation, which provide guidance for the sector.

Table 6.4 Policies and measures to support renewable energy in Poland

Measure	Type of measure	Expected result	Targeted group and/or activity	Existing or planned	Start and end dates of the measure
Facilitating the process of connecting micro-installations to the electricity grid.	Regulatory	Increasing the number of micro-installations.	Micro-generators of renewable energy with an installed capacity of up to 40 kilowatts (kW).	Existing	Since 2013
Making it obligatory to purchase electricity generated from micro-installations.	Financial	Increasing the number of micro-installations.	Micro-generators of renewable energy with an installed capacity of up to 40 kW.	Existing	Since 2013
Providing certification schemes for installers of micro- and small-scale installations and the accreditation of training providers.	Regulatory	Implementing the provisions of Directive 2009/28/EC and improving the quality of installed micro- and small-scale installations and the quality of training provided.	Entities operating in the field of installing micro - and small-scale systems and training providers.	Existing	Since 2013
Establishing procedures to implement joint projects and statistical transfers.	Regulatory	Implementing the provisions of Directive 2009/28/EC. Taking measures to enable energy companies to participate in the joint projects related to renewable energy supply and to carry out statistical transfers of energy from renewable sources.	Energy companies.	Existing	Since 2013
Introducing the possibility of obtaining guarantees of origin for energy from renewable sources.	Regulatory	Implementing the provisions of Directive 2009/28/EC. Providing confirmation of origin for electricity from renewables to final customers.	Energy companies and energy consumers.	Existing	Since 2013

Putting forward recommendations to utilise energy generated from renewable sources in buildings used by the public sector.	Regulatory	Increased deployment of renewable energy.	Public sector entities.	Existing	Since 2013
Taking measures to facilitate the process of installation of heat pumps and photovoltaic devices.	Regulatory /financial	Increased use of biofuels, liquid biofuels or other renewable fuels in the transport sector.	A wide range of market participants.	Existing	Since 2013
Exemption of generators producing electricity from micro-installations and small-scale installations as well as from agricultural biogas and exclusively from bio-liquids from the obligation to obtain a licence in accordance with the provisions of the Energy Law Act.	Regulatory /financial	Increased deployment of renewable energy.	Generators producing electricity in micro-installations, small-scale installations, from agricultural biogas and exclusively from bio-liquids.	Existing	Since 2015
Imposing an obligation on certain suppliers to purchase surplus electricity produced by a generator of electricity from renewable energy systems (RES) in a micro-installation.	Financial	Increased deployment of renewable energy.	Micro-generators of renewable energy with an installed capacity of up to 40 kW.	Existing	Since 2016
Introducing an obligation to purchase electricity from newly built RES installations from a micro-generator of renewable energy of up to 10 kW.	Financial	Increased deployment of renewable energy.	Micro-generators of renewable energy with an installed capacity of up to 10 kW.	Planned	2016

Source: Ministry of Energy (2016), "Interim report on progress in the promotion and use of energy from renewable sources in Poland in 2013-14".

RENEWABLES OBLIGATION

Since 2005, mandatory quotas for utilities and a certificate system have been used to encourage the production and use of renewable energy sources. The Energy Law obliges electricity generators and suppliers that supply electricity to end users to fulfil a specified annual quota of renewable electricity. This volume is confirmed by the amount of green certificates presented to the Energy Regulatory Office (ERO) at the end of the year. These certificates are awarded to the producers of electricity from renewable sources. On 1 July 2016, this quota system was replaced by an auction system for installations with a capacity between 3 kW and 10 kW.

In accordance with the Energy Law, a certificate of origin testifying to the source of electricity generation from a renewable source serves as the evidence of generation. Accordingly, this kind of support is available for all types of renewable sources generating electricity from renewable energy sources. The green certificates are issued by the ERO at the request of generators.

In 2015, certificates of a volume corresponding to 112 TWh of renewable energy, 186 TWh of energy from high-efficiency co-generation units and 75 000 tonnes of oil-equivalent (toe) of energy efficiency improvements were registered on the Certificate of Origin Register operated by TGE (Polish Power Exchange).

Although these mechanisms have been successful in developing wind capacity, the system did not spur investment in new types of technologies as it was more favourable for development of co-firing biomass with coal in existing power plants as a way to comply with the renewable obligation without much additional investment. As a consequence, too many green certificates were issued for biomass co-firing, which weakened their price and made them unattractive to investors in newer technologies. As a result, the renewable energy mix is unbalanced, with biomass accounting for 60% of gross electricity generation from renewable sources in 2012. Should Poland reach its 2020 renewables target with co-firing, this achievement will be short-lived, as old coal plants, which provide the bulk of co-firing, will have to retire after 2020 to comply with EU regulations (OECD, 2012).

Following an amendment to the Energy Act in 2010, certificates of origin for biogas were introduced, known as brown certificates. They certify to the fact of production and, at the same time, introduction to the distribution network of agricultural biogas. In other words, a biogas certificate of origin can be obtained only for agricultural biogas production and introduction to the gas network; in the case when electricity is generated from such biogas, the producer obtains a green certificate and not a brown one.

Certificates are also provided for co-generation but are more complex, in that the support depends on the capacity of the source as well as the fuels used, not all of which are renewable. Purple certificates are available to co-generation units consuming methane released and captured in hard coal mines or with gas obtained from biomass. Red certificates are available for units of 1 MW or more consuming fuels other than natural gas, methane or biogas from biomass. Yellow certificates are available to similar units of less than 1 MW. The system is further complicated by the fact it is possible to obtain several certificates for the generation of electricity from the same unit and the Energy Act has been amended to eliminate the possibility of obtaining support twice.

REFORM OF THE RENEWABLES OBLIGATION

The government first proposed a reform of the renewables support mechanism in 2011. On 20 February 2015, following a legislative process that lasted almost four years, the new Act on Renewable Energy Sources was approved in parliament. On 11 March 2015, the bill was signed into law by the president, and the new legislation was published in the official journal on 8 April 2015. The main goals of the new law were to: fully transpose into domestic law EU Directive 2009/28/WE; reform the renewable energy support system in the country; and provide legislation regulating the development of renewable energies.

The Act was scheduled to enter fully into force on 1 January 2016. On 29 December 2015, however, the government postponed the Act from entering into force in its full form by six months. Within that period of six months, the government amended the Act, notably the provisions for the support system for further deployment of renewable energy in the country.

The new Act provides that Poland will maintain the green certificate system for the existing renewable energy source installations, albeit with some changes to the existing rules.

For new renewable energy installations (i.e. those that start generating electricity no earlier than 1 January 2016), the act introduced the following support instruments:

- a net-metering system based on a rebate in the form of a discount on the electricity bill for residential systems up to 10 kW and commercial systems up to 40 kW; or
- feed-in premiums for larger renewable installations, where both feed-in tariffs and feed-in premiums would be awarded in auctions.

Projects that start electricity production after 1 January 2016 will no longer be eligible for green certificates, and depending on their size may apply for a feed-in tariff or feed-in premium by means of an auction mechanism. Projects in the green certificate system will be allowed to switch from green certificates to feed-in tariffs or feed-in premiums, and participate in auctions, which will be organised separately from the auctions for new projects.

The ERO will oversee the auctions, indicating the required amount of renewable energy required. Auctions will be held by the ERO at least once a year. If volumes set by the Council of Ministers are not exhausted in an auction, the ERO may (but is not obliged to) hold further auctions in that year. The production of renewable electricity should start within 24 months (solar photovoltaic [PV]), 72 months (wind farms) or 48 months (all other sources) from the day on which the auction winners are announced. Auction winners will be chosen based on the outcome of a two-phase process: prequalification and the auction. Separate auctions will be held for installations with installed capacities up to 1 MW and for those installations that are greater than 1 MW.

At least 60 days before the first auction of each calendar year, the Ministry will publish the reference (maximum) prices for 1 megawatt hour (MWh) of renewable electricity produced from each technology. The Ministry claims that reference prices will be determined at a level that will ensure that about 80% of the projects will be profitable. The ministry has estimated that the changes to the support mechanism will reduce the costs of renewables support by half, from PLN 8.9 billion (EUR 2.13 billion) by 2020 to PLN 4.26 billion (EUR 1.02 billion) during the same time period.

Support for micro-generators

Under the new support scheme, electricity distribution companies will be obliged to buy any surplus energy produced by micro-generators with an installed capacity of up to 40 kW for 100% of the average market price in the previous quarter. This obligation will last for a period of 15 years from the commencement of renewable production, but no longer than until 31 December 2035.

Provisions for existing generators

Producers of renewable electricity will be able to choose if they want to continue using the existing support scheme (but only for the 15 years following the commencement of production) or move to the auction-based system. The current support scheme is also going to be changed. The substitution fee will be capped at the 2014 level, i.e. PLN 300.03 or approximately EUR 75 per MWh. The purpose of this change is to stabilise the price of green certificates, which was volatile in the preceding two years.

NEW LEGISLATION IN 2016

In June 2016, two significant pieces of legislation entered into force. First, on 22 June 2016, an Act on Investments in Wind Power Plants (Act on Windfarms) became law, followed on 27 June 2016 by a new bill introducing changes to the Act on Renewable Energy Sources (Amending Act). Both of these acts have been heavily criticised by the renewable energy industry.

The Amending Act significantly modifies the new auction system. On 30 November 2016, the ERO announced the first renewable energy auction. The auction took place on 30 December 2016. The IEA understands that this auction was a "pilot auction" to test how the system will perform (online auction platform and entire auction process). Under the new law, auctions will be divided into groups based on the efficiency of an installation rather than the technology and there will be separate auctions for installations with capacities below and above 1 MW. The auction groups are as follows:

- Installations where the total installed capacity, regardless of the source of origin, exceeds 3 504 MWh/MW per year, equivalent to a 40% load factor, effectively excluding solar PV and onshore wind installations and indirectly favouring baseload renewables such as biomass and hydro.
- Installations using biodegradable waste to generate electricity.
- Installations emitting not more than 100 kilogrammes (kg)/MWh of carbon dioxide (CO_2), with a total installed capacity level exceeding 3 504 MWh/MW per year.
- Auctions for members of an energy cluster.[4]
- Auctions for members of an energy co-operative.
- Installations using exclusively agricultural biogas for electricity generation.
- Other installations.

Further changes will be introduced by means of secondary law:

- The maximum volume and value of electricity generated by renewable installations, which may be sold in auctions.
- The order in which auctions will be held during the year.
- The reference (maximum) price for each type of technology will be determined separately, not later than 30 days before the first auction in 2016.

The Act on Windfarms

The purpose of the Act on Windfarms, which came into force in July 2016, is to determine locations where new wind farms may be located. It establishes the minimum distance required between a wind farm and residential buildings, forests or national parks. The distance is set at ten times the height of a wind turbine (approximately between 1.5 kilometres (km) and 2 km). In addition, the Act sets out a new definition of a wind farm and leads to an increase in the property tax imposed on the owners of the plant.

4. Energy clusters are a new concept based on agreements on generating and balancing the demand for, or trade in, energy from RES, and other sources or fuels within the distribution grid, with a voltage not exceeding 110 kV.

Other measures

The National Fund for Environmental Protection and Water Management grants low-interest loans to support the purchase and installation of renewables.

Producers of electricity from renewable sources are exempt from the tax on the sale and consumption of electricity. The National Fund for Environmental Protection and Water Management (NFEPWM) grants low-interest loans, together with subsidies, to support the purchase and installation of small and micro-renewable installations for the needs of residential single-family or multi-family houses.

The NFEPWM grants low-interest loans to support the purchase and installation of renewables installations (7.1 Priority Programme RES Stork). The duration of the scheme is 2014-20 (4.0 Priority Programme RES Stork). The support is not combinable with other support schemes from the NFEPWM (7.3, No. 2 Priority Programme RES Stork).

GRID ACCESS

Network operators are obliged to enter into agreements with renewable energy generators and the cost of connecting a plant to the grid is borne by the plant operator. Plants that generate electricity from renewable energy sources whose capacity does not exceed 5 MW are subject to reduced connection charges and micro-generators may connect free of charge.

If a network operator refuses to offer a grid connection agreement, it is obliged to inform the ERO, providing the reasons for the refusal. If the refusal results from lack of economic conditions for grid connection, the grid company may agree with an entity requesting grid connection on the level of connection fee. Data on disputes concerning refusals to connect renewables to the electricity grid in 2016 are presented in Table 6.5 below.

The 2016 Act on Renewable Energy Sources requires that grid connection agreements for renewables installations specify deadlines for the first delivery of electricity from renewables installation to the grid. The deadlines cannot fall more than 48 months from the moment that the agreement is signed, with the exception of offshore wind projects, for which this period cannot exceed 72 months. Existing connection contracts will need to be adapted to the new rules and will need to specify time limits not exceeding 48 or 72 months from the date of entry into force of the new act.

Table 6.5 Disputes concerning refusals to connect renewable energy sources to the electricity grid in 2014

Number of applications for dispute settlement	Number of settled cases	Number of decisions stating that there is no legal obligation to conclude network connection agreement	Number of decisions stating that there is legal obligation to conclude network connection agreement	Number of decisions to discontinue the proceeding	Number of administrative settlements
27	30	13	0	14	3

Source: ERO (2016), *National Report of the President of the Energy Regulatory Office in Poland 2016*.

HEATING AND COOLING

There are three subsidy schemes for heat from renewable energy sources. One was launched by a state-owned bank, Bank Gospodarstwa Krajowego, the other two by the NFEPWM. The former and one of the latter support refurbishment work in buildings which, among others, may include the installation of renewable technologies for heat generation in buildings. A second subsidy programme from NFEPWM supports the purchase and installation of solar collectors for water heating in buildings. Co-financing is available in the form of subsidies for up to 45% of the principal of the bank loan used for financing the project. The NFEPWM also grants low-interest loans to support the purchase and installation of renewables installations for heating.

NATIONAL FUND FOR ENVIRONMENTAL PROTECTION AND WATER MANAGEMENT

The NFEPWM, which was established in 1989 as a result of the regime transformation in Poland in co-operation with *voivodeship* funds for environmental protection and water management, is the pillar of the Polish system of financing environmental protection.[5] The basis of the NFEPWM's operation as a state legal person is the Act on Environmental Protection Law.

In 2010, the National Fund initiated the nationwide programme of subsidies to loans for purchase and installation of solar collectors by individual investors, natural persons and housing associations. In 2014-20, the National Fund allocated PLN 800 million of financial support for the construction of small installations, producing energy from renewable sources for self-consumption. In recent years, more than 67 000 households received financial support to install solar collectors. The NFEPWM (with a budget of PLN 300 million) also offers support to families for the construction of energy-saving houses.

TRANSPORT FUELS

In 2015, Poland produced 757 000 million tonnes (Mt) of biodiesel, and 2016 production is projected to increase by 3%. The national indicative target in 2015 and 2016 is set at the same level in both years at 7.1%, and therefore there is no incentive to increase biodiesel production. Biodiesel is produced almost entirely from domestically grown rapeseed supplemented by imports. Almost two-thirds of annual production of rapeseed (2 million Mt) is used for production of biodiesel and one-third for rapeseed oil for human consumption. The value-added tax (VAT) rate for rapeseed used for human consumption is 5% and for production of biodiesel it is 23%.

There is a significant surplus of current domestic production capacity in both biodiesel and bioethanol markets in Poland, and further investments in this area are not expected. Capacity in biodiesel production is currently at around 70%, and in bioethanol production it is below 30%. In 2015, there were ten facilities for biodiesel production with a total production capacity of 970 000 Mt. More recently, the industry has consolidated, leading to a reduction in the number of biodiesel installations and an increase of their production capacity.

5. A *voivodeship* is the highest-level administrative subdivision of Poland, corresponding to what may be called a province in other countries.

In 2015, there was a 30% surplus of production capacity over actual output, and total production exceeded demand by 10%. In Poland, there are 11 bioethanol plants with a total production capacity of 511 000 Mt. In 2015, production of bioethanol amounted to 169 000 Mt or an 18% increase compared to 2014 (USDA, 2016).

ASSESSMENT

Poland achieved significant progress in the deployment of renewable sources in recent years. The share of renewables in TPES increased from 5% in 2005 to 10% in 2015, exceeding slightly the average for IEA countries. Since 2009, the most spectacular increase concerned wind, where the production capacity increased nine-fold, reaching 7% of electricity generation, followed by biofuels and waste with a 6% share and hydro with 1%.

The EU Renewable Energy Directive mandated Poland to increase its overall renewable energy consumption to 15% by 2020. The overall target is split between the electricity target (19%), heating and cooling target (17%) and transport target (10%). To date, Poland appears to be on track to reach its overall target. The share of renewables in gross final consumption for those sectors in 2014 was 12.4% in power generation, 13.95% in heating and cooling, and 5.67% in transport. The biggest efforts will therefore need to be concentrated in the coming years in the transport and power generation sectors.

This progress was underpinned by the establishment of several support measures, both regulatory and financial. Since 2012 the main regulatory measure has been a quota system obliging suppliers of electricity to purchase power generated from renewables through a system of certificates of origin. An oversupply of these certificates resulted in their prices remaining relatively low; nonetheless, this system provided the basis for a relatively fast deployment of renewables, notably onshore wind. Complementing this, financial support mainly in the form of low-interest loans was deployed on a wide scale, notably with the help of co-financing from EU structural funds (from which roughly EUR 760 million were allocated to renewables between 2007-13; the amount expected to be allocated will be slightly higher in the period to 2020).

With the adoption of a Renewable Energy Act in 2015, Poland overhauled its regulatory framework for renewable energy, moving away from a quota-based system (the certificate of origins system also known as green certificates) to one built around an auction process. The Act entered into force in May 2015 with an exclusion of provisions regarding a new support system based on auctions which were to enter into force by 1 January 2016. First, the government delayed the entry into force of the Act in its full form by six months (until 1 July 2016), and subsequently within this period it introduced an amendment. This delay enabled the completion of investments already underway and an increase in renewable energy capacity by approximately 860 MW in the first quarter of 2016. Regulations regarding the new support system entered into force on 1 July 2016. Notably, the Act was substantially amended in June 2016 just before entering into force.

Changes resulting from the 2016 amendments introduced preferential rules of accounting for the smallest installations, together with the cancellation of the investment limit for new micro-installations. Changes in the auction system were also made, directing the system towards support for the technological baskets and growth of

competition between investors operating within the same technological basket. The government argues that new regulations do not limit, but instead promote, renewable energy expansion. For example, it points to the clarification of the accounting rules regarding state aid in the renewables support system, separate legal regulations for agricultural biogas production, introduction and clarification of the regulations concerning auction baskets in the new renewables support system, which are effective after 1 July 2016, simplification of legal terminology and closing loopholes, and the development of renewables clusters and energy co-operatives. New regulations introduce a basket dedicated to other technologies, in particular to wind and photovoltaics, as the government claims that these are technologies characterised by lower stability (less than 3 504 MWh/MW per year).

Alongside these changes, Poland also adopted separate legislation amending the framework for developing onshore wind projects. The new law sets out the conditions and procedures for siting and construction of wind power plants in the vicinity of existing or planned residential development. This distance equates to ten times the height of the turbine, or approximately 1.5 km to 2 km. Previously, Polish law did not dictate the minimum distance of wind farms from residential buildings, something that is regulated in other countries, for example Denmark (four times the height of the turbine), Belgium (350 metres [m] from the turbine), Scotland (2 km), Wales (500 metres), Germany (from 300 m to 1.5 km depending on noise levels), the Netherlands (four times the height of the turbine) and Romania (three times the height of the turbine). The new legislation mandates a large increase in the tax base of wind turbines.

The renewables electricity industry has argued strongly that the new legislation will halt further deployment of wind power in Poland (increase in tax heavy permitting process, and minimum distance from buildings). It also makes Poland a less attractive place to invest in wind power and damages the profitably of existing investments. Conversely, the Polish government argues that the new law clearly defines the conditions relating to the siting of wind turbines and does not aim to discriminate or put a stop to further deployment of onshore wind farms. Furthermore, the government argues that wind farm development in Poland has already achieved its 2020 target.

The main driver behind these legislative changes appears to be the adjustment of costs of the support system to the costs of technology (technological baskets) and ensuring the cheapest and most stable production of energy from renewable sources. New regulations, apart from the support for biomass technologies in the new auction system, allow for competition of technologies of co-firing with technologies that are comparable in terms of costs. The government also argues that the new system will provide for greater financial efficiency. In the view of the government, the amendments to the Act on Renewable Energy Sources will be a stimulus to investors for increasing capacity within the renewables sector. The government is therefore confident that the EU 2020 renewables target will be achieved and the switch from the quota-based system to the auction system was made in accordance with the European Commission's Guidelines on State Aid for Environmental Protection and Energy 2014-20.

According to the government, the quota-based system favoured onshore wind and led to a substantial increase in biomass use for co-firing. Instead, the new system will ensure a more balanced approach. While it is true that wind saw the biggest increase in recent years, it needs to be noted that between 2005 and 2014 public support for that technology was comparable to hydro and lower than support for co-firing. The new

auction system appears to be favouring technological baskets, giving a chance to compete to technologies that are characterised by the same cost of energy production.

The new rules applicable to the installation and operation of new onshore wind farms appear prohibitive, as they will exclude most of the country from the development of such installations and increase significantly the cost of operating them. The Polish wind industry, which was not consulted on these new rules, believes that they will lead to a wave of bankruptcies within the sector. The authorities should therefore consider what rules would allow controlling the impact of wind on the stability of the grid and social aspects while limiting the negative impact on industry.

The lack of clarity surrounding recent legislative changes deters new investments in renewables. It concerns such elements as the duration of the guaranteed contracts (up to 15 years), the size of the auction envelopes, the reference prices for each technology and the modalities for collecting an additional fee that will help to cover the costs of adapting the grid to renewables. While certain provisions need to be flexible and take into account market developments, the government should strive to put forward a stable, transparent and detailed set of rules to improve the investment climate. The government should also, as much as possible, lower the administrative burden of deploying renewables, notably by shortening the time necessary for obtaining conditions for connecting to the grid of small-scale generators.

In mid-2015, the government started a consultation on a new energy strategy to guide the energy sector to 2050, with the aim to replace EPP 2030. During the consultation period, there was a change of government and the new government is revising the draft 2050 strategy with a view to updating it to take into account recent decisions made on EU 2030 climate policy. The government has indicated its intention to publish its long-term strategic vision for the energy sector sometime in 2017. This new long-term strategy should take into consideration the role of renewables within the broader energy policy framework and its role in sectors such as district heating, transport (e.g. e-mobility) and air quality (e.g. heat pumps) post-2020. The stability of such a long-term strategy is important: therefore, the government should seek cross-party support and open public consultation with all sector stakeholders.

RECOMMENDATIONS

The government of Poland should:

- *Put in place a long-term policy for renewable energy development, covering all sectors, as part of the forthcoming strategy for the energy sector.*
- *Increase the clarity of the auctioning conditions and simplify relevant legal provisions.*
- *Ensure a more balanced approach for supporting different sources of renewable energy.*
- *Perform a review on the legal provisions with respect to the development of onshore wind.*

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7. NUCLEAR ENERGY

OVERVIEW

Poland does not have any nuclear generating capacity at present. Nuclear energy, however, plays a prominent role in Poland's energy security and clean energy planning. Under the previous government, the Energy Policy of Poland until 2030 (EPP 2030) laid out plans to develop and deploy nuclear capacity in Poland by the end of 2022. In mid-2015, the government of Poland started consultation on a new energy policy up to 2050, with the aim to replace the EPP 2030. During the consultation period a new government was elected, and this new government is revisiting the draft 2050 strategy and intends to publish its strategic vision later this year. It is anticipated that the new energy strategy will be consistent with the previous policy in its strong support for nuclear generating capacity, including existing activities to establish nuclear generating capacity.

NUCLEAR POLICY

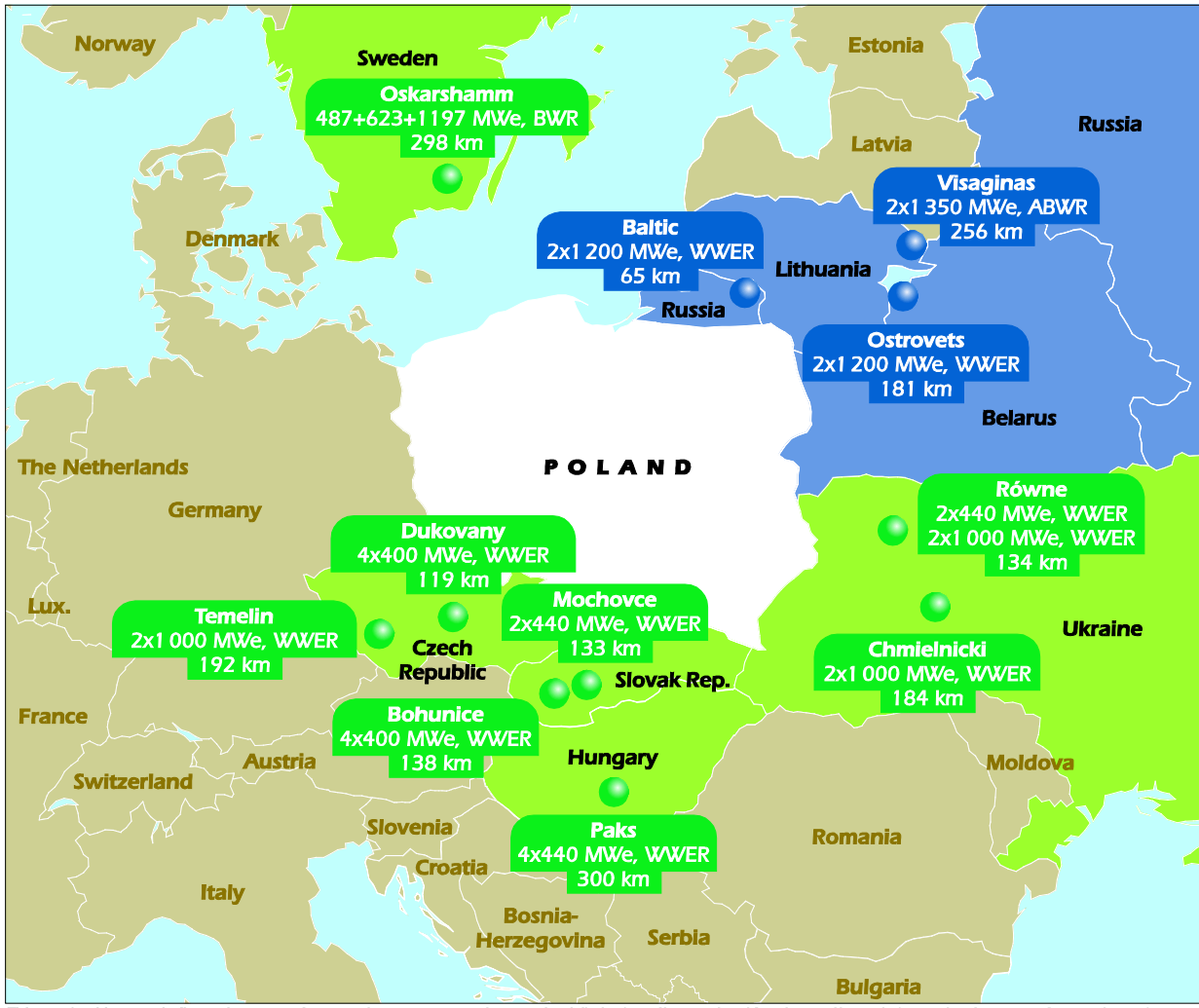
The Polish government has determined that nuclear power will play a significant role in its future energy mix, particularly as it looks to increase its energy security and decrease the carbon intensity of its electricity production. Aside from its coal resources, Poland is heavily dependent on external sources of energy for electricity production. This has increased concerns about diversity of primary fuels and sources of fuels, particularly as Poland projects an increase in electricity demand through 2030 and beyond. In addition, most of the neighbouring countries either have existing nuclear programmes or are actively pursuing nuclear power deployment.

The EPP 2030, which was approved by the Council of Ministers in 2009, envisioned construction of two nuclear power plants (NPPs) of 3 gigawatts electrical capacity (GW_e) each, with the first one online by 2022. Combined, the two NPPs would constitute 16% to 20% of Poland's electrical generation. A Polish Nuclear Power Programme (PNPP) document, adopted by the government and published in January 2014, outlines the objectives, analysis, requirements and milestones to implement the envisaged programme and the status achieved to date against those requirements and milestones.

The projected timeline for bringing the first reactor online has continued to slip from the 2022 date first laid out, but Poland has made significant progress nonetheless since that original projection. Considering the progress to date and the tasks still ahead, operation of the first unit in the 2030 time frame now appears more realistic.

Although Poland does not have any operating power reactors, it does have experience with nuclear energy and technology. It has a nuclear research facility with an operating research reactor and several other nuclear research activities across the country. The reactor is a 30-megawatt thermal (MW_{th}) pool-type reactor used heavily for medical isotope production and nuclear research.

Figure 7.1 Nuclear power plants close to Polish border (up to 300 km)



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.

Note: MW_e = megawatts electrical capacity.

Source: Ministry of Energy, Poland IDR submission.

Construction of four Soviet-designed units (modified VVER-440/213) was under way in the 1980s at the Zarnowiec site, near Gdynia on the Baltic Sea. Construction was halted after the political changes in 1990 and increased opposition to the plant after the Chernobyl accident in 1986. The Zarnowiec site is one of two sites (the other being Lubiatowo-Kopalino) now under active consideration for the first nuclear plant, and both sites are receiving high local support according to Polska Grupa Energetyczna (PGE) opinion polls and stakeholder engagement activities.

INSTITUTIONS

The Ministry of Energy is the government entity responsible for planning and co-ordinating the execution of the nuclear power programme from the state's perspective in Poland, often referred to as the Nuclear Energy Programme Implementing Organisation (NEPIO). This responsibility previously resided in the Ministry of Economy,

whose functions are now divided between the Ministry of Energy and the Ministry of Development. The Ministry of Energy is responsible for developing and updating the government's policy and strategy for the nuclear power programme, co-ordinating the programme within the Polish government and with other governments, and defining and monitoring state actions required for successful completion of the programme.

The National Atomic Energy Agency (PAA) is the government body with principal responsibility for regulating and overseeing the nuclear safety and radiological protection at existing facilities and those envisioned as part of the nuclear power programme. The PAA President, the head of the PAA, is appointed by the prime minister. He operates the PAA under his authority, independently from the other ministries and the industry (e.g. licensees, designers and investors).

The Radioactive Waste Disposal Enterprise (RWDE) is a state-owned public benefit corporation that takes responsibility for collecting radioactive waste from the producers, conditioning it, and disposing of it. The RWDE is the operator of the National Radioactive Waste Repository located in Rozan, 90 kilometres (km) from Warsaw, and will be responsible for disposing of radioactive waste and used nuclear fuel from future nuclear power plants.

Nuclear power investors and operators are the entities responsible for carrying out the design, construction, and eventual operation of the nuclear power reactors and plants. The investors are required to have sufficient finances and human resources to execute these functions, including ensuring safety and planning, budgeting, and collecting funds for decommissioning of the facility and disposal of used nuclear fuel. The Polish government has selected PGE S.A. to be the primary investor and eventual operator of the first nuclear plant in Poland, but it has not made any decisions on potential subsequent plants.

RECENT AND ANTICIPATED POLICY DEVELOPMENTS

Starting in 2009, the government of Poland embarked on a path to establish nuclear power capacity to meet its energy needs and environmental and climate commitments under the European Union. The Council of Ministers took a number of formal steps in that year, starting with the approval of a resolution on 13 January on nuclear power development activities. The resolution was followed in May 2009 by an ordinance that established a Government Commissioner for Nuclear Power in Poland. In August 2009, an additional resolution by the ministers provided a "framework time schedule for nuclear power activities." Finally, the Council of Ministers approved the EPP 2030.

These actions provided the driver to update the legal framework. Two years later, in 2011, an amendment to the Polish Atomic Law was passed that significantly expanded the authority and requirements necessary to underpin the PNPP. The Law, as amended, identifies specific requirements for safety, security and radiological protection. At least 20 subordinate pieces of secondary legislation have been passed to implement the Atomic Law requirements.

The PNPP outlines four stages for the development of its nuclear power programme. In the first phase, which was envisaged to be completed by the end of 2016, the government will select a site and the nuclear technology to be deployed through an open tender process. The second phase involves obtaining all required decisions and approvals to move to construction by the end of 2018, such as completing the design

and obtaining regulatory approvals. The third phase would see the completion of the first reactor unit and start of construction on the second by 2024 (a two-year slip from the date in the EPP 2030). The final phase, stretching to 2030, marks the completion of the first plant of two to three units and the initiation of a second plant, eventually reaching a total of 6 000 megawatts (MW) net by 2035.

Even this revised schedule is bold for a country attempting to establish a new nuclear power programme. While the first phase will not be completed by the end of 2016, as outlined in the PNPP, significant progress has been made and Poland appears to be adhering to the phased process outlined in the policy documents. The Ministry of Energy announced in 2016 that the new schedule will be presented in the first quarter of 2017 and the PNPP will be updated by the end of the same year.

Early in the process, the Polish government decided that this activity would require the investor, or owner/operator, to have access to state financial backing and thus selected PGE S.A. to fill this role. PGE Energia Jadrowa S.A. (PGE EJ) was set up in 2009 to develop nuclear power within the PGE Capital Group. In January 2010, PGE EJ1 was then set up as a limited liability company with 51% equity from PGE EJ S.A. and 49% from PGE S.A. PGE EJ1 is responsible for the investment process, site selection, permitting and then building and operating the first nuclear power plant.

In 2015, PGE suggested the European Commission-accepted "contracts for difference" (CfD) mechanism to provide the needed degree of revenue certainty to the investor, as well as to protect the ratepayers from potential overcompensation. In June 2016, the Minister of Energy suggested that the use of CfDs would result in an unacceptable cost to consumers and that it was investigating other mechanisms to achieve the required certainty for investors. It is also considering splitting the so called "integrated tender" in order to achieve a higher degree of competition among reactor vendors.

PGE S.A. has engaged the communities around the potential plant sites in several ways. In 2013, the utility reduced the number of sites under consideration for the first plant from three to two (Lubiatowo-Kopalino and Zarnowiec). However, the site investigation activities have not started yet.

In October 2016, the government outlined the "plan to develop new nuclear technologies connected to nuclear co-generation and high-temperature reactors". A study by Poland's National Centre for Nuclear Research (NCBJ) concluded the high-temperature reactor (HTR) to be a "promising concept for the next generation of nuclear power plants". This technology is not being actively considered for the first plant but is of longer-term interest to the government.

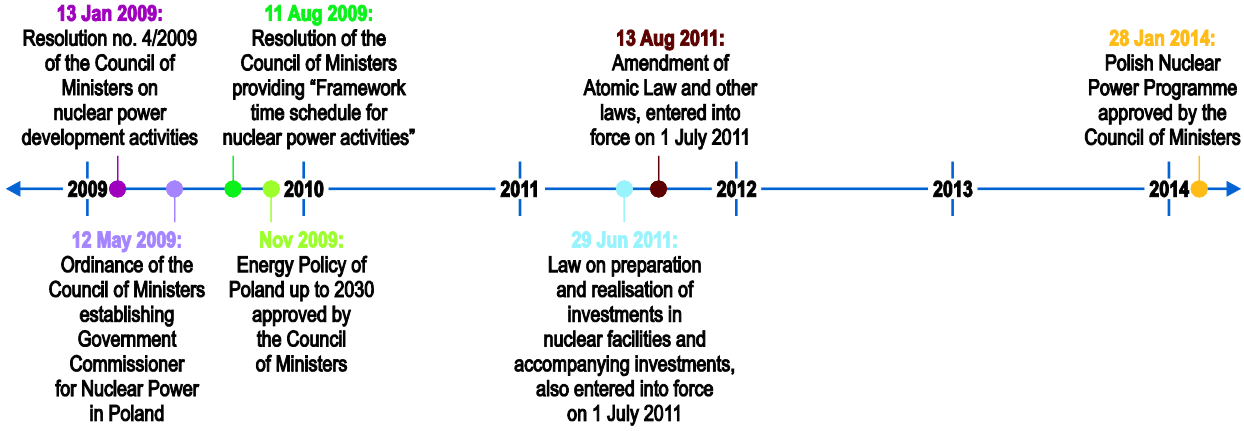
For any industrial activity, it is important to account for the disposition of the by-products that will be generated. In the case of nuclear power, these by-products primarily involve low- and medium-level wastes and the used nuclear fuel. Poland is already accustomed to handling such operations from its existing nuclear research and isotope activities, but the overall volume will increase substantially once nuclear power operations are brought online.

The process to identify a location and develop a new low- and medium-level waste storage facility is underway with stakeholder consultation. A site selection was originally envisioned for 2016, but has since been pushed back to 2017 or 2018. Poland has not yet chosen its final approach to the disposition of used fuel, but is working to site an

underground research laboratory to study the suitability for a permanent repository while also considering the use of an international repository if that becomes a possibility.

The Ministry of Economy produced a Forecast Environmental Impact Assessment in 2010 for implementing the PNPP, and comments from over 300 institutions and organisations were incorporated into a Strategic Environmental Impact Assessment of the Draft PNPP through a formal public consultation process in 2011. A transboundary consultation process was then conducted, in line with the Environmental Impact Assessment (EIA) Act and the Aarhus and Espoo conventions, with the process concluding in May 2013 upon signature by Austria of the relevant minutes of the bilateral talks.

Figure 7.2 Timeline of major legal framework actions related to the nuclear programme in Poland



Source: Ministry of Energy, Poland IDR submission.

REGULATORY FRAMEWORK

The nuclear regulatory body, the National Atomic Energy Agency (NAEA), or Polish National Atomic Energy Agency (PAA), operates under the authority of the Ministry of Environment, and is separate from the programme implementation organisation in the newly formed Ministry of Energy. However, the two organisations have worked to establish the legal framework and staffing necessary to execute their respective roles in the nascent nuclear power programme. The PAA currently regulates the operating Maria research reactor, a decommissioned Ewa research reactor, and two spent fuel storage installations, in addition to all of the other activities using radioactive materials in Poland. PAA has been making adjustments since 2009 to the legal framework and to its own knowledge, skills and processes to implement the new PNPP and feels that both are now in place for it to adequately carry out its duties.

The Ministry of Energy, PGE and PAA have been participating on behalf of Poland in international co-operation and external peer reviews to ensure that they are adequately prepared. Poland hosted the International Atomic Energy Agency (IAEA), who conducted an Integrated Nuclear Infrastructure Review (INIR) and an Integrated Regulatory Review Service mission in 2013. The reviews identified strengths and areas for improvement. The Polish government and PGE have formulated action plans to address the identified areas for improvement and are executing those plans. A follow-up review in June 2016 concluded that all the recommendations from 2013 regarding infrastructure improvements had been implemented, and a Phase 2 INIR is envisaged in 2017.

To address human resource and skills needs, PAA has hired 39 new staff over the past four years and signed numerous co-operation agreements with other countries' nuclear regulatory organisations (NROs). In addition to technical seminars and training, the agreements with other NROs allow PAA to send staff to perform resident assignments in the foreign NRO organisation, working alongside resident inspectors in countries with strong regulatory experience and safety cultures. PAA believes that it has the necessary people and legal framework in place to execute the PNPP as it continues to progress.

ASSESSMENT

Poland has made substantial progress since deciding in 2009 to pursue nuclear power, which will allow it to add significant additional electrical generation capacity from a non-emitting source while at the same time strengthening its energy security. It has strengthened a nuclear regulatory body and also established an owner and operator entity. These organisations have made considerable progress in preparing to execute their respective responsibilities, including the establishment of processes, and hiring and training of staff and the selection of two sites for further characterisation. The legal framework for nuclear power development was established by the nuclear regulatory body and by the Ministry of Economy (now the Ministry of Energy).

The nuclear energy policy-making body, the Nuclear Energy Department, was recently moved from the Ministry of Economy to the newly created Ministry of Energy, which is responsible for policymaking, strategies and law-making co-ordination. The Ministry of Energy is developing a national energy strategy to 2050 and the nuclear programme is understood as being "implemented to the already envisaged extent."

The PNPP approved in 2014 envisages the first nuclear power plant of 3 000 MW of capacity, which represents approximately 8% of their current electrical capacity (and a total of two NPPs with combined capacity of 9 GW). The International Energy Agency (IEA) understands that the timeline set out in this previously approved programme, with a final investment decision in 2017 and first unit operational in 2024 (already a two-year delay from the EPP 2030), is no longer attainable, and a revised schedule is expected soon. The ministry considered that the CfD financial support mechanism proposed in 2015 by the investor (PGE) will result in unacceptably high electricity costs to consumers. Thus, the Ministry is considering alternative financial models.

The public seems favourable towards nuclear energy in general, with strong support of 60% to 80% over the past five years near the two possible sites under consideration for the first reactors. In October 2015, Poland adopted a "National Plan for Radioactive Waste and Nuclear Spent Fuel Management" to ensure that all activities in this field will be conducted in co-ordinated, integrated and transparent manner, with high involvement of local communities.

The government has completed initial examination of options for treating and disposing of future used nuclear fuel from the nuclear power programme and concluded that a number of options exist, but further action on them is premature until it is clearer how many nuclear reactors will ultimately be deployed and whether international disposal is a possible and cost-effective option.

Both the government and nuclear industry have made significant efforts to acquire and develop knowledgeable and skilled personnel to oversee and execute this nuclear power programme. The Ministry of Energy highlighted several nuclear-related research and

commercial activities as evidence of Poland's nuclear experience and readiness to support the nuclear programme. The nuclear regulator (National Atomic Agency or PAA) described many commendable efforts that they are undertaking to provide significant, hands-on training and experience to their staff, including assignments at regulatory bodies in established nuclear power countries gaining real-world experience. Together these provide a base to build upon, but the design, construction, operation and oversight of one or more nuclear power plants will require a considerable build-up once firm decisions are taken that allow industry to make the necessary investments.

It should be noted that Poland has collaborated closely with relevant international organisations, such as IAEA and NEA, since first embarking on its PNPP in order to ensure that national nuclear infrastructure meets all international standards and best practices. In recent years, it has hosted various missions organised by IAEA (e.g. INIR, IPPAS, IRRS), and has put in place action plans to further progress and strengthen its people, systems and practices.

RECOMMENDATIONS

The government of Poland should:

- *Move expediently to determine and announce the timeline, constraints and support mechanisms for the first nuclear units to provide long-term certainty to and sufficient information for the licensee to move forward with investment decisions, siting characterisation and selection activities, and technology evaluation and decisions.*
- *Actively and substantially engage the public and other potentially affected stakeholders on nuclear plans and decisions, particularly during the site characterisation and selection process.*
- *Work co-operatively across the government and industry in an appropriate way, recognising the need for independence between regulator and licensee, to develop a cadre of employees and robust pipeline of technically qualified personnel such as nuclear, mechanical and electrical engineers and technicians with nuclear power operation or regulatory experience.*

8. COAL

Key data (2015 estimated)

Coal production: 135.2 Mt, -15% since 2005

Coal imports and exports: 8.5 Mt imported, 9.4 Mt exported

Share of coal: 50.8% of TPES and 80.9% of electricity generation

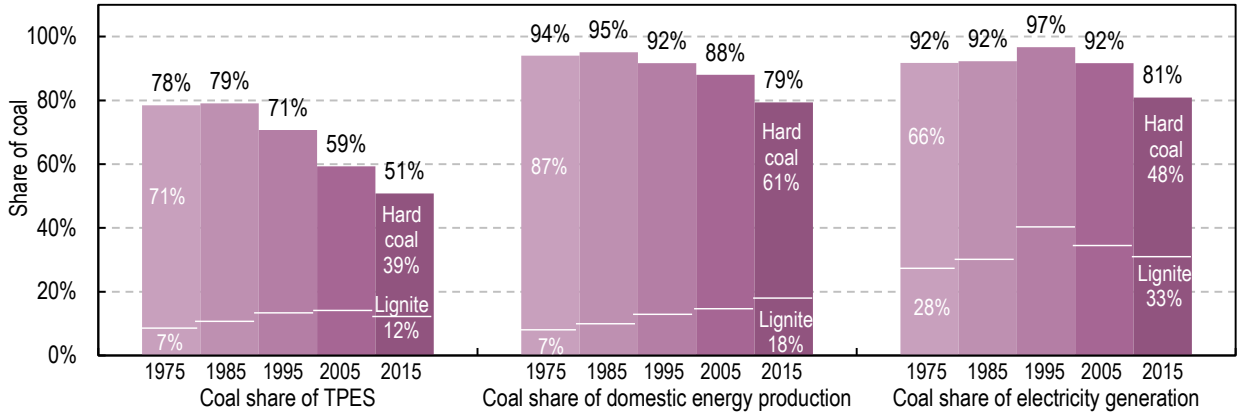
Consumption by sector (2014): 137.4 Mt (heat and power generation 70.7%, residential 12.8%, industry 7.7%, other energy industries 5.5%, commercial and public services, including agriculture and fishing 3.4%)

OVERVIEW

Poland is endowed with extensive coal resources, both hard coal and lignite, which have been exploited for a long time, leading to the development of a large coal mining sector, which employs a skilled workforce of around 100 000 people today. Coal is the cornerstone of the energy supply, the source of 80% of the electricity supply and supplies more than half of primary energy. Coal therefore plays a crucial role for energy security in Poland.

While coal is by far the main source of energy in Poland, total coal supply has been decreasing for three decades. The share of coal in the total primary energy supply has fallen from 79% in 1985 to 51% in 2015. The share of coal in domestic energy production and heat and power generation shows a similar, but slower, rate of decline (Figure 8.1). Most of this coal is produced domestically and the country is self-sufficient in both hard coal and lignite; however, hard coal is also traded on global markets. While coal is mostly used for heat and power generation, it is also an important fuel in the residential and industry sectors.

Figure 8.1 Coal share in different energy supplies in Poland, 1975-2015



Notes: 2015 values are estimates. TPES = total primary energy supply.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

At the same time, Poland needs to reduce greenhouse gas (GHG) emissions in order to comply with its international climate commitments, and this requires not only the use of coal in a more efficient way but also the use of lower-carbon sources. The previous in-depth review (IDR) published in 2011 recommended Poland "establish a vibrant and competitive coal mining industry in private ownership". Between 2011 and 2015, however, coal prices were in continuous decline, driving the Polish hard coal sector into significant financial losses.

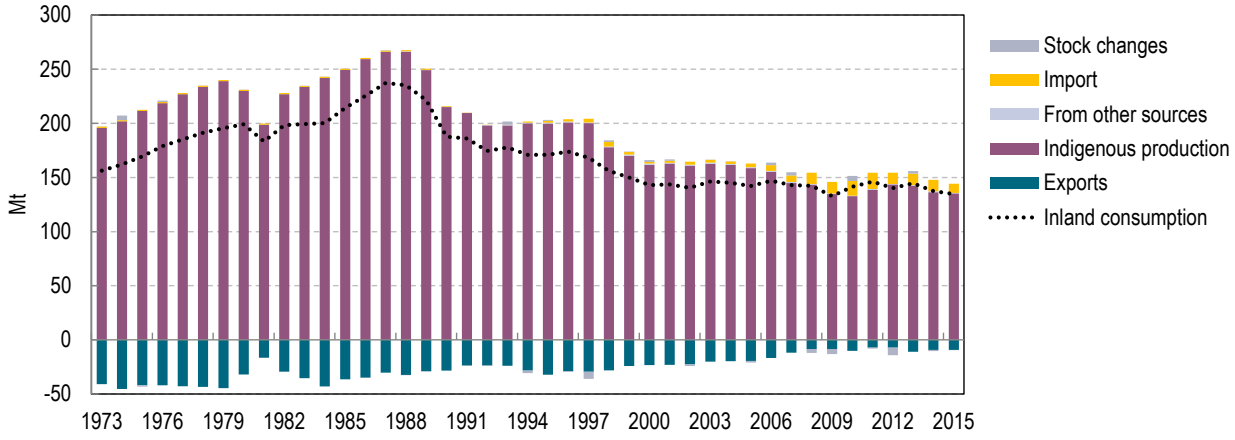
The government has intervened in the sector on a number of occasions, and any collapse of the coal industry could have increased dependence on imported energy. Furthermore, the social and political implications of such a collapse would be significant. Conversely, a subsidised coal sector is not a desirable outcome either. The current challenge, therefore, is the need for harsh reform of the coal sector, including the closure of uncompetitive mines and investment to increase productivity and reduce costs in the remaining profitable mines. This can be done, for example, by reducing over-staffing and improving management of the companies. Whereas the priority of the government is the stabilisation of the sector, the International Energy Agency (IEA) recommendation from 2011 remains relevant and should be the medium-term target for Poland.

SUPPLY AND DEMAND

SUPPLY

Domestic coal production was adequate to satisfy demand for both hard coal and lignite (brown coal) in 2015, complemented by smaller volumes of coal imported and exported (Figure 8.2).

Figure 8.2 Coal supply by source and inland consumption, 1973-2015



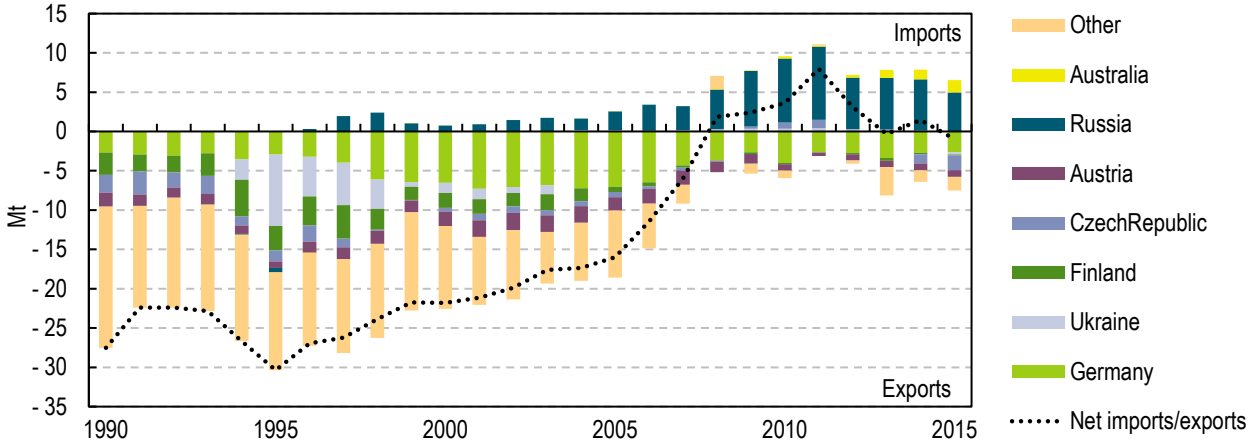
Note: Mt = million tonnes.

Source: IEA (2016b), *Coal Information 2016*, www.iea.org/statistics/.

Historically, Poland was a coal exporter, supplying hard coal to nearby countries. With decreasing domestic production, these exports have declined, and in 2008 Poland was a net importer of coal for the first time. In 2011, net imports reached a record level of 8 Mt, but this has varied year by year and in 2015 Poland was again a net exporter (1 Mt). The majority of coal imports come from Russia (60%) and Australia (19%), while

most exports are to Germany and the Czech Republic (29% each) (Figure 8.3). Most of the coal traded is hard coal, with a share of 97% of imports and 98% of exports. Lignite is mainly consumed at mine-mouth power plants such as Bełchatów (5 520 MW), the largest coal-fired power plant in Europe.

Figure 8.3 Hard coal net imports by country of origin, 1990-2015



Source: IEA (2016b), *Coal Information 2016,* www.iea.org/statistics/.

In 2015, hard coal production in Poland was 72 Mt, unchanged from 2014 production levels. Thermal coal production was 59 Mt (compared with 60 Mt in 2014) and coking coal production was 13 Mt (compared with 12 Mt in 2014). Coal production has been declining consistently since 1987 (193 Mt), although since 2010 (76 Mt) there has been a sort of stabilisation, threatened more recently by low coal prices. There were 70 mines operating in 1987, but only 28 mines were active in 2016. Likewise, the number of employees fell from more than 425 000 in 1987 to less than 100 000 in 2016. By region, 8.5 Mt of coal is produced by LW Bogdanka in the Lublin Coal Basin and the remainder in the Upper Silesian Coal Basin.

In the future, the Lublin Coal Basin has the greatest long-term potential. The most advanced new project is the Jan Karski mine, developed by Prairie Mining, with cash costs below USD 30/tonne (t) in accordance with the feasibility assessment, which would make it a profitable project given the current prices of around USD 84/t.[1]

In 2015, lignite production in Poland was 63 Mt, the second-largest in Europe after Germany (178 Mt), of which 42 Mt were produced in Bełchatów, 9 Mt in Konin, 7 Mt in Turów and 4 Mt in Adamov. There is also a small amount of production in Sieniawa. Lignite production faces many challenges. Adamov is likely to cease production in 2018, and an increase in production is unlikely despite abundant lignite deposits. The potential to increase production in existing mines is limited, and it is very difficult to open a new lignite mine and power plants in a new location because of the difficulties in obtaining public support/acceptance for such new open-cast excavations.

1. Price for steam coal (6 000 kcal/kg) imported in North West Europe as of November 2016 was USD 84/t.

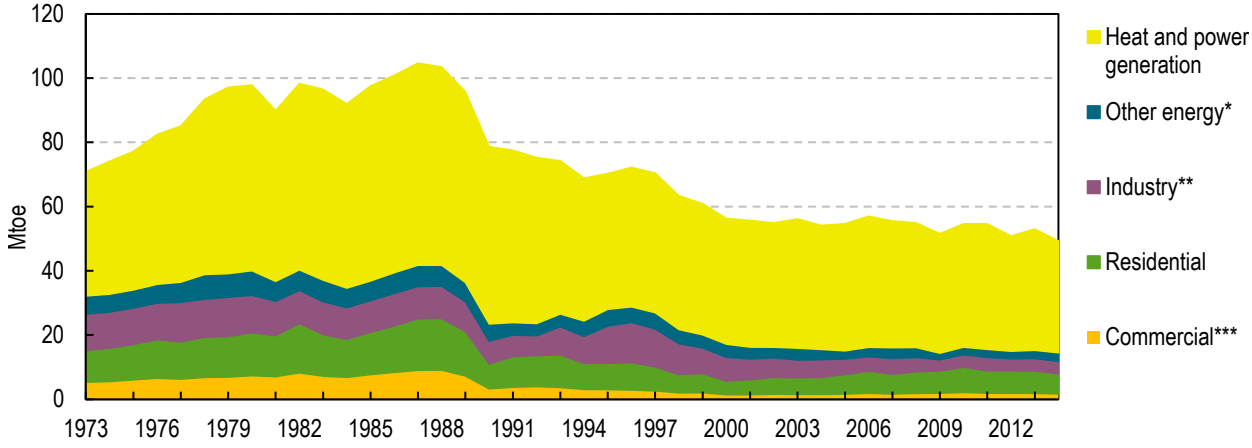
DEMAND

Coal demand fell sharply in the late 1980s from a peak level of 105 million tonnes of oil-equivalent (Mtoe) in 1987, and has more than halved since (Figure 8.4). The reasons for this include falling demand in heat and power generation and in the residential sector, and more efficient electricity production as older plants were decommissioned and replaced by new modern plants. The trend in the last decade has been a slow decline, with annual variations resulting from fluctuations in temperature and economic activity. Demand has fallen by over 30% in the industry sector between 2004 and 2014. Similarly, coal consumption has fallen by 10% in heat and power generation and by 16% in other energy sectors during the same period. The residential and commercial sectors display a different trend, with an 18% increase in residential coal consumption and 12% in commercial use. Nonetheless, both these sectors have experienced a decline from a peak in coal consumption in 2010.

The heat and power sector is the largest coal consumer, accounting for 35 Mtoe in 2014, or 71% of total demand. The residential sector is the second-largest coal consumer with 13% of total consumption, followed by the industry sector with 8%, other energy industries with 5% and the commercial sector with 3%.

Electricity represented two-thirds of the 200 terawatt hours (TWh) generated heat and power from coal in 2015, with heat accounting for the remaining third. These ratios have shifted since the 1970s when two-thirds of production was heat. This change reflects growing electricity demand, mainly in the residential and commercial sectors, and a decreasing heat demand in the industry sector (Figure 8.5).

Figure 8.4 Coal consumption by sector, 1973-2014



*Other energy includes coke ovens, other refining and energy own use.

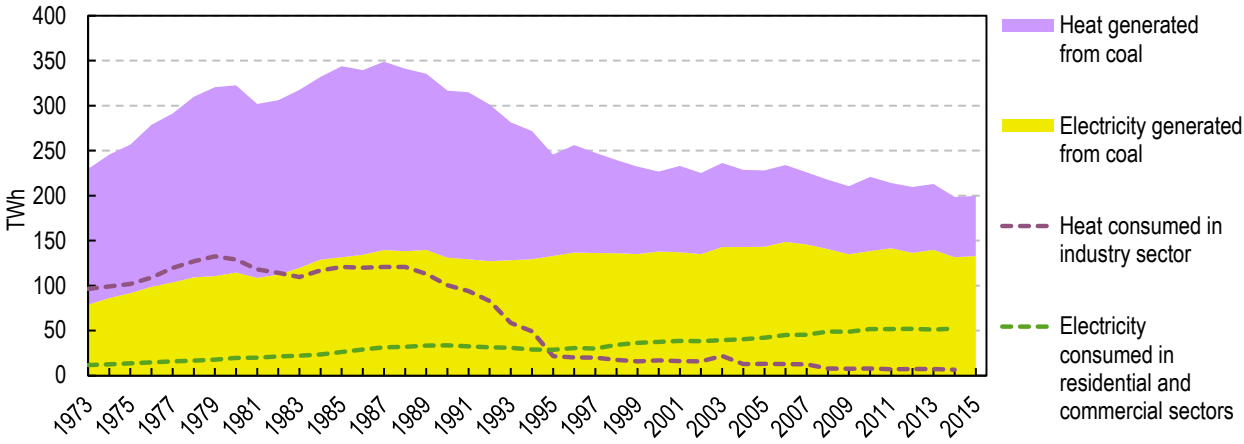
**Industry includes non-energy use.

***Commercial includes commercial and public services, agriculture/forestry and fishing.

Note: TPES by consuming sector.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Figure 8.5 Heat and power generation from coal, 1973-2014



Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Poland is the second-largest coal consumer in Europe after Germany. In 2015, consumption was 58.3 Mt of thermal (hard) coal (from 61 Mt in 2014), 13.4 Mt of coking coal (12.6 Mt in 2014) and 63 Mt of lignite (63.8 Mt in 2014).

Almost two-thirds of hard coal in Poland is consumed to generate electricity. Hard coal is the largest source of electricity in Poland (77 TWh in 2015, or 47% of electricity production), and hard coal generation capacity is 20 291 MW, roughly half of the Polish generation capacity. Industry is the second-largest consumer, including the building sector and coke ovens, where most of the coking coal is used to produce coke, destined for steel production and export.

The small-consumers sector, including households (around 10 Mt), agriculture (1.5 Mt) and others (0.9 Mt) has a considerable impact on the Polish market. Notably, the share of coal consumption in this sector is bigger in Poland than in China. The distributed consumption of coal for use in small boilers, without any emission abatement equipment, is a major contributor to local air pollution, a critical issue in several cities and regions in Poland.

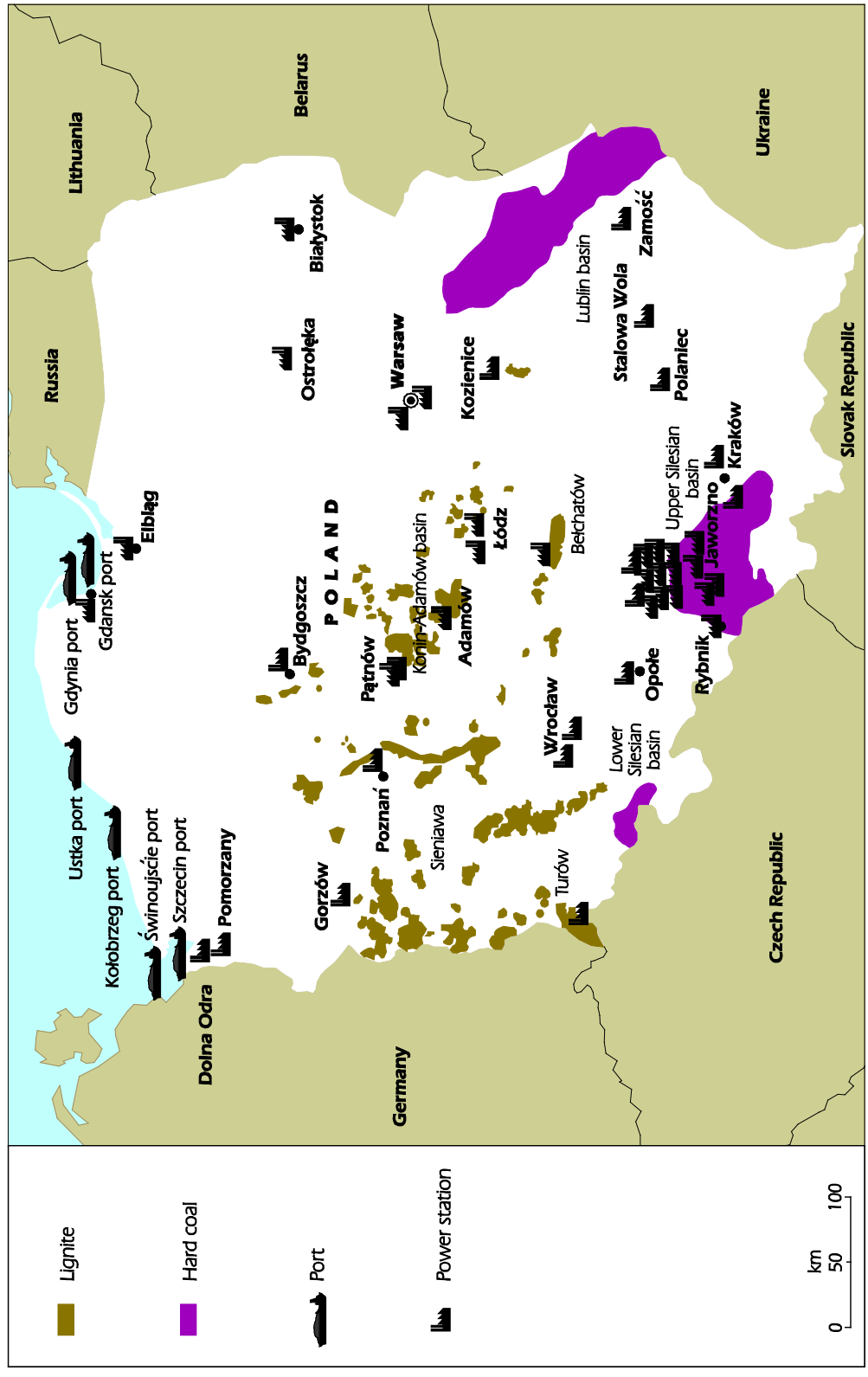
Most lignite is consumed in power plants near the mine mouth, with smaller amounts sold for other purposes. In 2015, lignite power plants generated 53 TWh, or 32% of Polish electricity generation. The generation capacity of lignite power plants accounts for 9 220 MW, roughly one-third of the electricity generation capacity in Poland.

RESERVES

Poland is endowed with large coal resources. According to the Polish Mining Institute, the country's anticipated economic recoverable resources of hard coal are 51.9 gigatonnes (Gt), of which around three-quarters are thermal coal and one-quarter are coking coal.

Hard coal reserves are mainly located in Upper Silesia and in the Lublin basin. The Lower Silesian Coal Basin, which has historical significance, contains a small amount of coal. The Upper Silesian Coal Basin, which holds around 80% of hard coal reserves, is where most of the mines are located. The Lublin Coal Basin, which holds around 20% of reserves is the location of one active mine.

Figure 8.6 Map of coal reserves in Poland



Lignite reserves have been evaluated at 23.5 Gt, i.e. more than 300 years of production at current utilisation rates. Lignite reserves in operating mines, however, are 1.4 Gt, or 22 years of production at current utilisation rates. Lignite reserves are located in central and western Poland, with five active mines in Bełchatów, Adamov, Konin, Turów and Sieniawa.

COAL TRADE

With 9 Mt of hard coal exports in 2015, Poland is the largest exporter in Organisation for Economic Co-operation and Development (OECD) Europe, despite the dramatic drop from historical levels (30 Mt per year in the 1990s). Three-quarters of exports are thermal coal and one-quarter is coking coal. Exports go to neighbours such as Germany, Austria and the Czech Republic, although further destinations such as Morocco, Ukraine and Turkey are also consumers of Polish coal. Poland is also an importer of coal. In 2015, imports were 8.2 Mt, mostly thermal coal from Russia, with smaller amounts of coking coal from Australia or the Czech Republic. The reasons for the existence of imports and exports at the same time are a combination of quality, seasonality and geography.

Poland is a significant exporter of coke-oven coke (6.7 Mt in 2014), mainly to neighbours in Europe such as Germany.[2] Given that roughly 1.5 t of coking coal is needed to produce 1 t of coke, this means that 10% to 15% of hard coal consumption in Poland is used to produce coke for the international markets.

STRUCTURE OF THE COAL SECTOR

INSTITUTIONS

The Ministry of Energy is responsible for policy making in the coal sector and for the supervision of state-owned mining companies. It is also responsible for oversight of coal-related research and development and supporting new coal technologies. The Ministry of Energy is working on a programme for the reform of the mining industry in Poland. The purpose of this reform is the creation of a modern coal sector. The Ministry of Environment is responsible for mining concessions and regulations relating to air quality and climate protection. The Ministry of Development is responsible for the promotion of mining technologies. The Ministry of State Treasury performs ownership supervision and manages the portfolio of coal companies with State Treasury shareholding and the efficient use of state-owned assets. The Minister of State Treasury also acts, in a number of cases, as a body granting state aid to the industry.

In November 2014, the Polish government appointed the Plenipotentiary for the Restructuring of Polish Mining Sector, with responsibility for the preparation and implementation of restructuring coal mining. The Plenipotentiary is responsible for measures aimed at restructuring the sector and raising funds for its operation. The laws relating to coal mining were amended at the end of 2015, allowing for the introduction of provisions to facilitate the restructuring process as well as support for the elimination of redundant assets, social protection for miners and restructuring of employment.

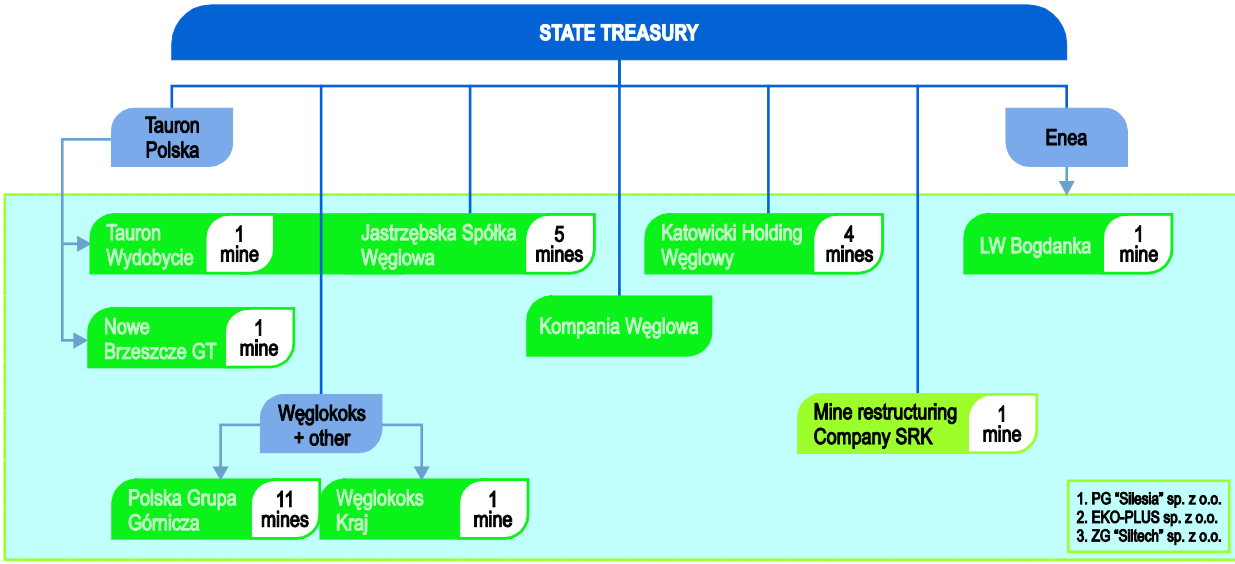
2. Coke-oven coke is the solid product obtained from the carbonisation of coal, principally coking coal, at high temperature. It is low in moisture content and volatile matter.

INDUSTRY STRUCTURE

The coal sector in Poland is mostly state-owned, with the exception of three small privately owned producers in Silesia. The most notable recent development has been the liquidation of Kompania Węglowa and the acquisition of its assets by other players, mainly through the creation of a new company, Polska Grupa Górnicza. The privatisation process was stopped, and a privately owned company, LW Bogdanka, was recently incorporated into the public sector through the purchase of 66% of the company by GK Enea, an energy utility which is 51% owned by the Ministry of State Treasury.

According to current legal status, the State Treasury owner's rights to the coal companies belong to the Minister of Energy (they previously belonged to the Minister of Economy); the secondary institution that has owner's rights over coal companies is the Minister of State Treasury. Grants to SRK S.A. (the mines restructuring company) were sourced from the government budget by the Minister of the Economy and afterwards by the Minister of Energy. Both the Minister of Economy and the Minister of Energy are State Treasury representatives, which is the owner of SRK S.A. and the remaining mines that are also being transferred to SRK S.A.

Figure 8.7 State ownership in the coal sector



Other: PGE GIEK S. A., Energ S. A., PGNiG Termika S. A., TF Silesia, Fundusz Inwestycji Polskich Przedsiębiorstw

Source: Ministry of Energy, Poland IDR submission.

Spółka Restrukturyzacji Kopalń S.A.

Spółka Restrukturyzacji Kopalń S.A. (SRK) is a state-owned company created in 2000 to execute the Program for Reform of the Hard Coal Sector in Poland 1998-2002. The programme dictates that when a decision is made to close a state-owned mine, it is transferred to SRK, which then manages the assets of these mines. At the same time, SRK secures other mines remaining in operation from danger of water, gas release and fire, and creates new jobs. In 2016, SRK controlled over 30 mines, which have been transferred to its ownership in recent years.

SRK is structured in three parts:

- the Central Plant of Mines Dewatering, (CZOK, 670 employees), which is responsible for dewatering of decommissioned coal mines to protect operating neighbouring mines against flooding hazards during and after mine closure.
- the Hard Coal Mines in Total Liquidation (KWK, 74 employees), which is responsible for the administration and sale of the assets from closed mines, land reclamation and remediation of damage resulting from mining.
- the Administration of Housing Resources (AZM, 87 employees), which is responsible for administration and maintenance of the housing resources acquired from closed coal mines.

During 2015-16, SRK acquired seven mines to be closed: Brzeszcze-Wschod, Centrum, Kazimierz-Juliusz, Myslowice, Boze Dary, Rozbark V and Anna. In addition, SRK provides benefits to workers leaving the sector, including severance payments. SRK is loss-making by definition, as income from asset sales cannot offset the expenses incurred in the reclamation, dewatering, worker benefits, etc. The State Treasury provides the funds required to operate, which are considered state aids (see section on State Aids). As a result of the government's strategy to rescue the sector, SRK acquired the Makoszowy mine from Kompania Węglowa; therefore, SRK is now also a coal producer.

The Ministry of Energy issues grants to the SRK S.A. for funding the specific activities that are specified in the Functioning of Coal Mining Law (liquidation of mines, activities performed during and after mine liquidation, including dewatering the liquidated and abandoned mines, provision of social benefits for employees, etc.). Resources for the grant are provided from the following public sector institutions:

- The National Funds of Environmental Protection and Water Management (NFEPWM) provide grants for reclamation of post-mining areas.
- The National Fund for Rehabilitation of Disabled People (PFRON) allows an exemption for contribution to its fund that all other employers are required to make.
- The Social Insurance Institution (ZUS) allowed the division of outstanding payments from SKR and Kompania Węglowa to ZUS into installments.

As such, there are good reasons to justify the existence of SRK. It gives transparency to the public sector, as the accountability of the state aid received is simpler. Also, as a company whose only mission is to centralise the works to comply with post-closure obligations, it has gained specialisation and, therefore, efficiency. The private sector, however, should have similar opportunities to transfer its liabilities to SRK. Otherwise, private players cannot compete with the public producers in a fair way.

Polska Grupa Górnicza (PGG), which employs 32 000 people, was established in April 2016 as a result of the process of restructuring the hard coal mining sector and the liquidation of Kompania Węglowa (KW). PGG consists of 11 mines and four auxiliary plants, all in the Silesian province. It is the largest producer of hard coal in the European Union, and in 2016 the mining capacity of the company mines was approximately 27 Mt of coal. The organisational restructuring by merging the companies in terms of technology and organisation resulted in the following combined mines starting operations on 1 July 2016:

- KWK Ruda (Ruch Bielszowice, Ruch Pokój, Ruch Halemba)
- KWK ROW (Ruch Chwałowice, Ruch Jankowice, Ruch Marcel, Ruch Rydułtowy)
- KWK Piast-Ziemowit (Ruch Piast and Ruch Ziemowit).

PGG benefited from a PLN 1.5 billion cash injection from PGE S.A., ENERGA S.A. and PGNiG S.A. and five banks, including units of Banco Santander S.A. and BNP Paribas S.A., also signed an agreement to give the new company financing options.[3]

Jastrzebska Spolka Węglowa (JSW), controlled and partially owned by the Ministry of State Treasury, which owns 55% of shares, produced over 16.3 Mt of coal in 2015, of which 8.1 Mt were hard coking coal and 3.1 Mt semi-soft coking coal, which makes JSW the largest coking coal producer in Europe, with the remainder destined for the power sector. Around half of the production is exported, mainly to neighbouring countries. Staff is 23 000 employees operating five coal mines in Upper Silesia: Borynia-Zofiowka-Jastrzebie, Budryk, Krupinski, Pniowek and Knurow-Szczyglowice.

Other publicly owned players

Katowicki Holding Węglowy (KHW), which is 100% owned by the Ministry of State Treasury, owns four mines: Murcki-Staszic, Myslowice-Wesola, Wieczorek, and Wujek (Kazimierz-Juliusz was transferred to SRK in 2014). KHW has over 14 000 employees (as of 31 December 2015).

The TAURON Group, which is partially owned by the Ministry of State Treasury (30%), is the owner of TAURON Wydowizye, a hard coal producer in the Upper Silesia region at mines located in Sobieski and Janina (5 Mt in 2015). Three-quarters of production is used by the group itself for power generation, and the rest is sold to third parties. The company plans to start a new shaft in the Sobieski mine to be operational by 2023, to gain closer access to the operating longwall, as well as construction of a new level in Janina mine, as depth has increased over the years. In 2016, the TAURON Group acquired the Brzeszcze mine from Kompania Węglowa.

Enea Group, an integrated energy company which is 51.5% owned by the Ministry of State Treasury, holds 66% of shares in LW Bogdanka, understood to be the most productive hard coal mine in Poland, with a production of 8.5 Mt and capacity over 10 million tonnes per annum (Mtpa). Bogdanka is the only mine operating in the Lublin Basin, where, given the good geological conditions of the deposits and high quality of coal, Bogdanka is applying for new licences to mine in Ostrów and Orzechów.

Weglokoks Kraj, a subsidiary of Weglokoks (a coal trading company 100% owned by the State Treasury), acquired Bobrek-Piekary mine from Kompania Weglowa in May 2015.

The procedure for the takeover of the Bobrek, Makoszowy and Brzeszcze mines was specified in an agreement signed with trade union representatives on 17 January 2015. The agreement stated that Makoszowy and Brzeszcze mines were to be transferred to SRK.

The sale of Piekary mine to Węglokoks Kraj was not included in the agreement. Węglokoks Kraj has expressed an interest in acquiring the Piekary mine for some time (as part of the capital strategy of the WĘGLOKOKS Group). The Piekary mine was desirable for their business, as the company already owned a processing plant at nearby Julian. At the same time, as a result of limited coal production at Piekary, the company

3. Banks, including commercial banks, were engaged in co-operation with PGG for their own business reasons. These banks did not invest new funds – their co-operation was based on taking over new bonds issued by the Polish Mining Group, in return for bonds that came from the bond programme from KW S.A. (Kopalnia Węglowa) that has been terminated.

decided to acquire KWK Bobrek mine as well. The mines are in the same vicinity of Bytom Basin and they have similar physicochemical characteristics, which is important for Węglokoks Kraj clients.

The privately owned mining sector

Following the acquisition of LW Bogdanka by the Enea Group, there are only three private hard coal producers remaining in Poland: PG Silesia, Siltech and Eko-Plus, all three located in Upper Silesia.

PG Silesia, owned by the Czech Group EPH, acquired Silesia mine from Kompania Węglowa in 2010. Since then, more than PLN 1 billion has been invested to modernise the mine. Over 1 500 employees (1 650 as of 31 December 2015) produced 1 Mt (3 Mt of raw coal) in 2015 in two longwalls. Siltech was the first privately owned coal producer in Poland, starting operations in 2002. It has an annual production is around 300 000 t. Eko-Plus produces around 150 000 t per year since 2010 in the Bytom mine, employing around 300 people. Production is mostly sold to local and industrial producers in the area.

LIGNITE

Polish lignite production stood at 63.1 Mt in 2015, slightly less than the 63.7 Mt produced in 2014. Lignite is mined in four sites in Poland, linked to mine-mouth power plants: the leading producer is PGE Bełchatów, with over 42 Mt per year. Other producers include PGE Turów, PAK Konin and PAK Adamów. There is a fifth site, Sieniawa, which produces small volumes that are sold nearby. The sector employs over 9 500 people (2015 data), a significant decline from over 27 000 in 1991 or 16 000 in 2010. Lignite-fired power generation supplied 53.2 TWh, covering about 33% of the Polish electricity market

GOVERNMENT POLICIES AND RESTRUCTURING OF THE SECTOR

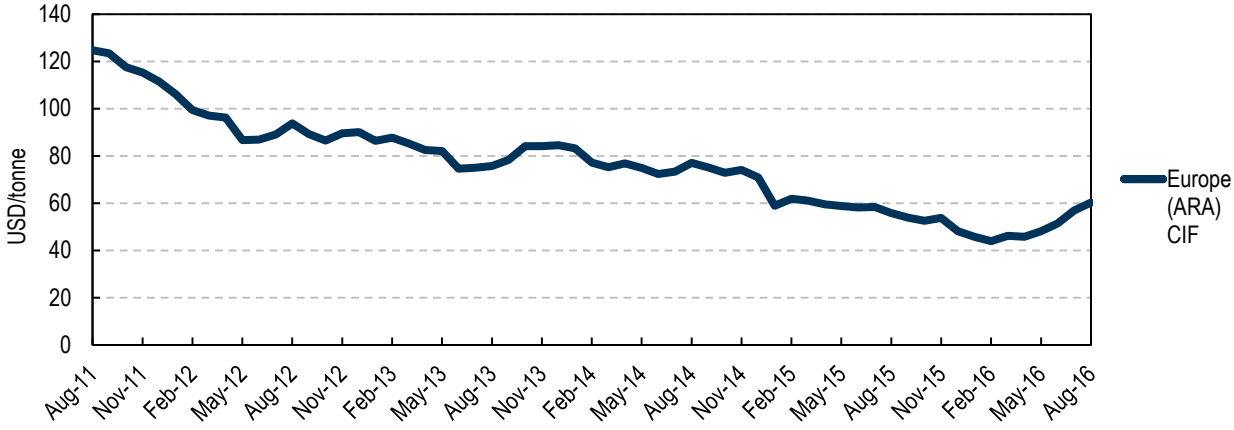
The productivity of hard coal mines in Poland is low, much lower than of competitors such as Indonesia, Australia, Russia, Colombia or South Africa. Geological conditions are the main reason, and the mining depth is increasing in Polish mines, from an average depth of 510 metres (m) in 1989 to 750 m in 2015 and as deep as 1050 m in some mines. Restructuring of the industry has traditionally been a challenge, with strong opposition from trade unions in order to protect jobs in the sector.

The initial plans of the Polish government to restructure the sector did not include aid to support coal production losses, only to cover exceptional costs. The sudden unprofitability of most of the Polish coal sector, however, made the government change its view.

Since the last IDR, coal prices have fallen to levels unexpected back in 2011 (Figure 8.8) and recent low prices have put the entire Polish coal industry on the edge of viability. European coal prices have fallen significantly in the last five years, with a 53% decline in annual prices from USD 121.48/t in 2011 to USD 56.64 /t in 2015. In recent months, prices have picked up somewhat from the negative trend. The monthly price in November 2016 was USD 84/t, representing an increase of 40% compared to August 2015. Most Polish mines had been operating at a loss and this forced the government to act in order to rescue the sector. In June 2014, the Ministry of Economy started the Coal

Mining Sector Development Program 2016-2020, which was cancelled in September 2014 following disagreements between unions and government. In November 2014, the government established the Plenipotentiary for the Restructuring of Polish Mining Sector, charged with responsibility to design and implement the restructuring of the Polish coal sector.

Figure 8.8 European thermal coal price development in five years, 2011-16



Note: European thermal coal prices, as indicated by the Amsterdam Rotterdam Antwerp (ARA) cost, insurance and freight (CIF) price index.
Source: IHS Energy (2016), Coal McCloskey Price and Statistical Data, https://connect.ihs.com/industry/coal (accessed 1 December 2016).

Once it was decided in April 2016 that Kompania Węglowa (KW) had to be liquidated, the key concern became how to guarantee the economic feasibility of the sector, especially of the mines of KW. The process has been patchy and not always transparent. Different agents from the state-owned sector have assumed part of the assets of former KW, aimed at being profitable in the short term, which requires significant investments. The accumulated losses of KW have been assumed by the Ministry of Treasury, a constituent of state aid. In a further state intervention, the Material Reserves Agency bought 8 Mt of coal from state-owned producers on 30 December 2015, in an operation with the sole intention to provide some publicly owned mines with cash before closing their yearly books.

According to the government, subsidies to cover exceptional costs accounted for PLN 1.6 billion during 2011-14. State support has been provided by the Ministry of Economy, the National Fund for Environmental Protection and Water Management, the National Fund for the Rehabilitation of the Disabled and the Polish Social Insurance Institution. These aids are mostly directed to after-closure actions and to pay benefits to miners affected by the restructuring, and followed the European rules on state subsidies to the coal industry.

A new law establishes measures to buffer the social effect of the restructuring, including four years' leave for underground miners who are no more than four years from retirement (three years in the case of workers in processing plants) and one year of salary for miners resigning by the end of 2015. These compensation packages will be paid by SRK.

CLEAN COAL TECHNOLOGIES

COAL POWER GENERATION

Polish coal power plants are generally inefficient and polluting: 62% of coal capacity is over 30 years old, and 13% is between 26 and 30 years old. The replacement of these plants represents an economic challenge for the sector, but at the same time offers a good opportunity to reduce the air pollution and carbon footprint. Replacement of the existing old fleet of plants with world-class power plants can reduce carbon dioxide (CO_2) emissions by over 20% compared to the existing fleet, while air pollutant emissions can be reduced by over 90%.

Poland is responding to this challenge. The self-financed Lagisza Power Plant (460 megawatts [MW]), the first supercritical circulating fluidised bed (CFB) in the world, was commissioned in 2009, with a net efficiency over 43%. The Bełchatów power plant unit 13 (858 MW), Part financed by the European Investment Bank, was commissioned in 2011 using supercritical technology. Emission levels from this unit are 93 milligrammes per normal cubic metre (mg/Nm^3) (SO_2), 195 mg/Nm^3 (NO_x) and 3 mg/Nm^3 (PM), and net efficiency based on lower heating value (LHV) is 41%. For new plants, Poland has embraced ultra-supercritical technology. As much as 4 235 MW of new ultra-supercritical coal power plants are under construction in four different sites: Opole units 5 and 6 (2 x 900 MW), Kozienice unit 11 (1 075 MW), and Jaworzno (910 MW), with efficiencies over 45% on LHV basis working with hard coal; and Turów (450 MW), using lignite at around 42% efficiency.

CARBON CAPTURE AND STORAGE

Carbon capture and storage (CCS) technologies in Poland have not progressed since the 2011 IDR. CCS-related activities have been focused on research and development (R&D) activities and a demonstration project in Belchatów, now abandoned. Conversely, legislation adopted is not supportive of CCS.

Belchatów, the largest coal power plant in Europe, was also earmarked to be one of the flagship CCS projects in Europe. Designed to use local lignite and to capture up to 1.8 Mtpa of CO_2 through post-combustion amines absorption, the CO_2 would be transported by pipeline around 140 km and injected into onshore deep saline aquifers. The project was awarded EUR 180 million from the European Commission in 2009 as part of the European Energy Programme for Recovery. Belchatów applied for funding under the EU New Entrants' Reserve (NER) 300 programme for innovative low-carbon energy demonstration projects and was placed in second place in the list of potentially funded CCS projects. It did not meet the criteria to receive NER funds, however, as they required the developer to meet 50% of the costs of the project. In 2013, Polska Grupa Energetyczna (PGE) announced the cancellation of the Belchatów project, as the company could not secure financing.

Regarding R&D activities on CCS, Poland established a programme called New Technologies for Energy Generation, funded by the National Centre for Research and Development and the large Polish energy companies. As a result of this programme, active from 2010 to 2015, two pilot capture plants were built: one based on CO_2 adsorption using membranes and the other one based on chemical absorption using amines. These pilot plants have been tested in Lagisza and Jaworno power plants. There

has been also some research conducted in geological characterisation of potential CCS storage sites and the possible use of CO_2 in enhanced oil recovery.

In October 2013, Poland implemented the European Union's CCS Directive through amendment of the Polish Geological and Mining Law.[4] The approach is very restrictive, as it establishes only one storage site, the Baltic Sea. This is disappointing, as the main sources of CO_2 in Poland are located in the centre and, especially, in the south of Poland.

COAL MINE METHANE

Coal production releases methane trapped in the coal seams.[5] Given the higher greenhouse effect of methane compared with CO_2, it is important to reduce methane emissions from coal mines in order to fight climate change. Good progress has been made in the area of methane capture. Since 11 March 2010, there has been a support mechanism for electricity produced from coal mine methane (CMM), but only in high-efficiency co-generation for combined production of heat and electricity (the so-called violet certificates). Conversely, there are no incentives in place for the use of methane for heat.

According to the Polish Geological National Research Institute, the measured volume of methane in Polish mines was 933 million cubic metres (mcm). Of this, 197 mcm, or 21% of the methane measured, has been captured and used, and 594 mcm (64%) of the methane measured was not captured. Furthermore, 142 mcm of methane that was captured was unused. The unmeasured methane, i.e. coming from non-methane or low-methane underground mines, plus open-pit production, represents between 5% and 10% of measured methane. It may be necessary, therefore, to offer greater incentives to stimulate recovery and use of CMM, with a double benefit of using a valuable product and reducing GHG emissions.

LOCAL AIR QUALITY

The share of coal consumed outside the power and industrial sector in Poland is higher than in most countries, in particular its high share of residential consumption. More than 50% of households use solid fuels for heating, and the sector consumes 10 Mt of coal of any quality and around 7 Mt of wood, plus other low-quality fuels such as wastes. Scattered, distributed coal burning in small, often inefficient domestic installations and without abatement equipment is a major contributor to poor local air quality. This problem is exacerbated by the use of waste and other low-quality fuels. Technical solutions are available: reduced heat demand (energy efficiency), use of cleaner fuels (gas), greater utilisation of district heating, and use of higher-quality solid fuels. Nevertheless, important challenges for the implementation of those measures remain. The number and dispersion of agents is one of them, but there are others such as economic barriers and availability. In addition, education and greater awareness of the problem is important.

4. Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006.

5. Coal-mine methane (CMM) is methane recovered during mining activities as the coal is in the process of being extracted and thus emitting significant quantities of the gas.

ASSESSMENT

Poland has abundant coal reserves throughout the country. Main hard coal deposits are located the Lower Silesian Coal Basin, now abandoned, the Lublin Coal Basin which has only one active mine, but a positive prospective, and the Upper Silesian Coal Basin, which accounts for the majority of production and employment today. In addition, lignite resources are also significant, with four areas in which lignite deposits are currently exploited. In 2015, hard coal production was 72 Mt and lignite production was 63 Mt.

Coal is the backbone of the energy system in Poland, providing over 50% of primary energy supply, the second-largest share among OECD countries. The electricity system is coal-based. In 2015, 81% of electricity came from coal, 48% from hard coal and 33% from lignite. Likewise, 75% of heat was generated from coal. In addition, apart from industrial use in steel, cement and others, around 10 Mt are consumed in residential heating and services, which has a strong negative impact on local air quality in some areas.

Coal mining, especially hard coal, is very labour-intensive. Coal mining in Poland directly employs almost 100 000 people and around three times this number in indirect employment. Any measure affecting the sector, therefore, has a large social and regional impact, and as a result is politically sensitive. Given the role of coal in the energy mix, the efficiency of the coal sector is of paramount relevance for the Polish economy. The new energy strategy will determine if coal is going to underpin the Polish economy over the longer term or if it is to be a burden for the country.

One-third of Polish electricity is generated from lignite, which is mined and consumed in four sites: Adamov, Bełchatów, Konin and Turów. Lignite is competitive even at prevailing low coal prices. Adamov is planned to be decommissioned as early as 2018. The continuation of the other plants and mines requires investments, which are unlikely to happen if there is uncertainty surrounding the future direction of the energy strategy.

Whereas the competitiveness of lignite is clear (it is a low-cost resource, mined in large open-pit mines and consumed in mine-mouth power plants), hard coal comes at higher cost, as it is mined in deep underground mines (average depth is 750 m). The Polish hard coal sector consists of a huge public sector (around 70 Mtpa) and a small private sector (three companies producing less than 3 Mtpa).

In the years 2011-14, Poland provided subsidies to cover exceptional costs related to mining closures, accounting for PLN 1.6 billion (or USD 507 million) (OECD, 2016). These aids are mostly directed to after-closure actions and to pay benefits to miners affected by the restructuring. Initially the Polish government anticipated supporting coal production losses. Low coal prices on the international markets and domestically, however, have resulted in losses in most Polish mines. This has triggered government actions to support the public mining sector to address losses accumulated in recent years. As of 2016, the exact amount of such support is unclear, as the strategy to save the sector, described in the next paragraph, has been patchy.

Two state-controlled electricity companies, TAURON and Enea, have acquired a number of mines and use the coal produced in these mines for power generation, at unknown prices. The Mine Restructuring Company (SRK), a company created in 2000 to manage assets from closed mines, is currently producing coal in the Makoszowy mine, and selling

its production at a loss on the Polish market. The Material Reserves Agency has bought coal from producers in order to provide them with cash. The cornerstone of the restructuring strategy has been the creation of PGG, a state-owned company, which acquired most of the mining assets of the former inefficient state company Kompania Węglowa.

There are significant problems with local air quality in parts of Poland. In 2013, the most recent year for which accurate data are available, Poland recorded the highest level of average concentrations of PM2.5 in Europe and exceeded recommended levels at a number of sites (EEA, 2015). Coal burning in the residential heating sector is an important contributor to poor air quality in many of the most polluted areas in Poland. Waste burning and transportation also cause air quality problems which must be tackled. Small-scale combustion of coal and biomass, and concentrated local pollution (particularly in heating season), are the main factors in these compliance issues (EC, 2013).

Many Polish coal power plants are old, inefficient and polluting: 62% of coal capacity is over 30 years old and 13% is between 26 and 30 years old. The replacement of these plants represents an economic challenge for the sector, but at the same time offers a good opportunity to reduce the air pollution and carbon footprint from power generation. World-class power plants can reduce CO_2 emissions by over 20% from the existing fleet, while air pollutant emissions can be reduced by 90% or even higher. Progress has been made in this regard, and hard coal plants under construction include Opole (1 800 MW), Kozienice (1 075 MW) and Jaworzno (910 MW, which offers around 45% efficiency on LHV basis); working with ultra-supercritical technology and modern pollutant abatement equipment can minimise local air pollution. Likewise, Turów (450 MW), a lignite-fired plant, is designed to work at 42% efficiency. The strategy of the government is to replace existing low-efficiency power units by new high-efficiency technologies. This will result in lower GHG emissions while maintaining energy security.

CCS technologies have not progressed in Poland as expected and the Bełchatów Demo CCS project never went ahead. The implementation of the EU Directive on CCS in Polish legislation on CCS only allows CO_2 storage in the Baltic Sea, offshore and far from CO_2 sources in the mining south. There has been intensive work in R&D, including two pilot projects of CO_2 capture, but given Poland's coal dependence, the feeble progress on CCS is very disappointing.

The energy strategy of Poland for the future is based on coal use. Given the advantages in terms of security and energy independence, the long tradition of Polish coal mining, with a well-established industry and highly skilled workforce in addition to the economic relevance of the sector, it makes sense to give long-term stability to the sector, but not at any cost. Whereas coal abundance and affordability in Poland is clear, a fair cost comparison between different sources needs to be taken into account, both environmental and closure costs, as well as externalities such as emissions of local air pollutants and CO_2.The serious issues Poland is struggling with are not unique. Other IEA countries were faced with similar problems in the past, and some of them still are. Lessons can be learned from restructuring in other countries, such as the United Kingdom, the Netherlands, Spain, Germany, the Czech Republic and the like. In the long run, state aid is unsustainable, as is coal use on such a large scale.

RECOMMENDATIONS

The government of Poland should:

- *Establish a roadmap for the coal sector, consistent with a broader long-term energy strategy, based on fair assessment of costs, transparent accountability, no cross-subsidies between power producers and coal mines, and giving the private sector opportunities to develop and compete in the coal market.*
- *Restructure the public sector, targeting privatisation in the medium term and focusing on competitiveness: unprofitable mines need to be closed down, investment must be directed towards profitable mines, use of mining assets needs to be optimised, over-staffing of mines must cease, etc.*
- *Given the implications for local air quality, establish a comprehensive strategy to phase out coal use at the small scale, i.e. residential sector, and replace it with cleaner sources, as well as use world-class coal power plants.*

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9. NATURAL GAS

Key data (2015 estimated)

Natural gas production: 6.1 bcm, +5.6% since 2005 [1]

Natural gas imports & exports: 12.1 bcm imported, 0.05 bcm exported

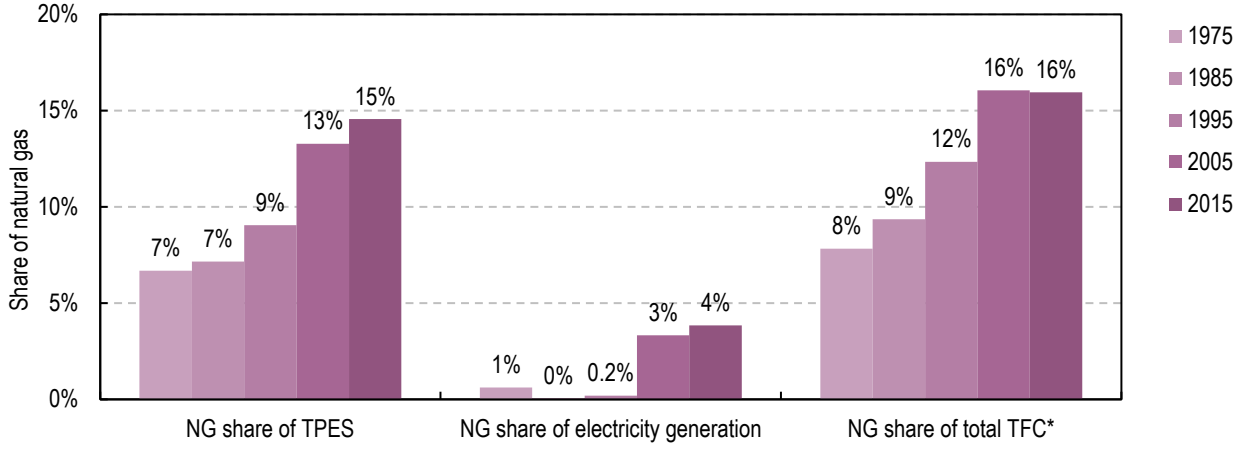
Share of natural gas: 14.6% of TPES and 3.8% of electricity generation

Consumption by sector (2014): 18.3 bcm (industry 39.3%, residential 23.5%, other energy industries 12.9%, commercial and public services, including agriculture and fishing 12.3%, heat and power generation 9.3%, transport 2.7%) [2]

OVERVIEW

Natural gas is the third-largest primary energy source in Poland, after coal and oil. It represents 15% of total primary energy supply (TPES) and 16% of total final consumption (TFC), a trend that has been slowly increasing in recent decades. Its share of heat and power production increased from a negligible level in 1995 to 4% in 2015, which is still low compared to the International Energy Agency (IEA) average of 19%. Poland produces about one-third of its natural gas supply and imports the remainder, with the Russian Federation as the largest source. The industry sector is the largest consumer, accounting for 39% of total demand, followed by the residential sector with 24%.

Figure 9.1 Natural gas share in different energy supplies in Poland, 1975-2015.



*Latest consumption data are from 2014.

Note: 2015 values are estimates.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

1. According to Polish methodology, in which all gases are brought to H-gas, production was 4.3 billion cubic metres (bcm).

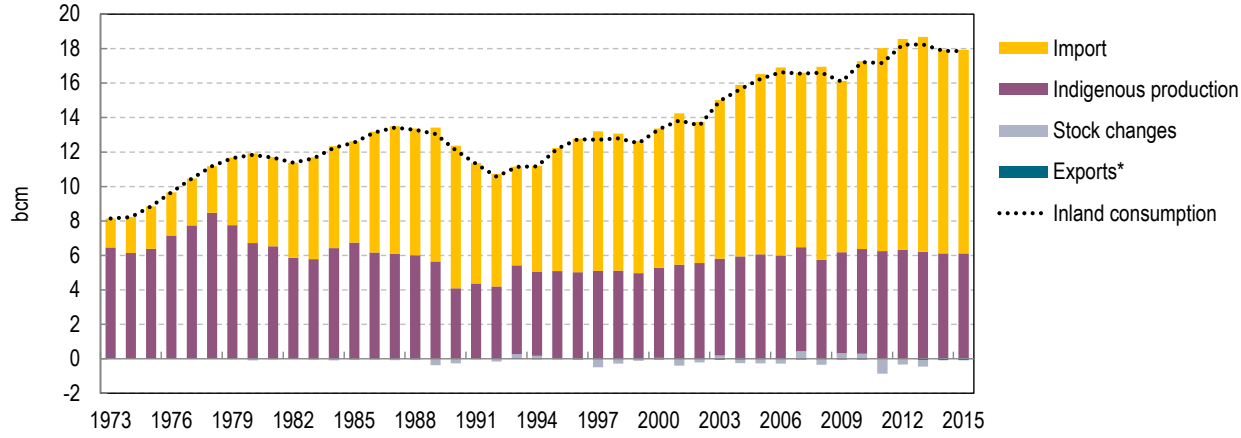
2. According to Polish methodology, in which all gases are brought to H-gas, consumption is 15.3 bcm.

SUPPLY AND DEMAND

SUPPLY

Poland's natural gas supply was 18.3 bcm in 2015, corresponding to 15% of TPES. Natural gas supply has been on an upward trend since the early 1990s, with 13% growth from 2005 to 2015. This increased demand has been met by higher import levels (Figure 9.2). One-third of total supply was produced domestically, of which the major part (91%) was non-associated gas from pure gas fields and the rest was colliery gas produced in coal mines. Production has been stable at around 6 bcm since 2005, with small variations from 5.8 bcm in 2008 to 6.3 bcm in 2012. All domestic gas is consumed in Poland, with insignificant levels of exports.

Figure 9.2 Natural gas supply by source and inland consumption, 1973-2015.



*Negligible.

Note: 2015 values are estimates.

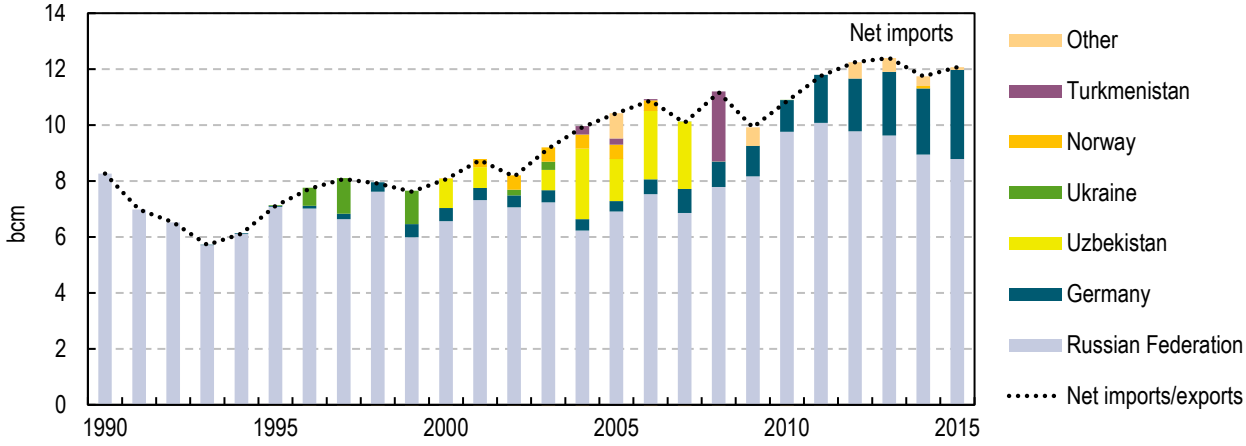
Source: IEA (2016b), *Coal Information 2016*, www.iea.org/statistics/.

Poland is a net importer of natural gas, with the Russian Federation as the dominant supplier (Figure 9.3). Russia was the source of 55% of Poland's natural gas consumption in 2015 (72% of Poland's imports in 2015); however, import possibilities have diversified over the last two decades. In October 2010, the 1996 long-term contract between PGNiG S.A. and Russia's Gazprom was amended. Under this new contract arrangement, Gazprom may supply Poland with a maximum of 11 bcm, depending on PGNiG S.A. requests. This supply contract will end in 2022. The second-largest source of gas is the German market, gas originally sourced from Russia, Netherlands and Norway and elsewhere, with a 26% share of imports in 2015. Imports from the German market have grown eightfold since 2005.

The start-up of the liquefied natural gas (LNG) terminal in Świnoujście in 2015 marked an important step towards further diversification of gas supplies. The facility is designed to have regasification capacity of 5 bcm per year, more than a quarter of the country's annual gas consumption. The terminal received a commissioning cargo from Qatar in December 2015 and its first commercial cargo in June 2016. More LNG will be delivered from Qatar in the future, based on a contract with PGNiG SA. The terminal offers free capacity to all interested parties on third-party access terms.

Over the longer term, Gaz-System, the Polish gas TSO, and Energinet.dk, the Danish gas TSO, are working on establishing a connection between the Polish and Danish gas transmission systems, better known as the Baltic Pipe project. The project, which will offer direct access to Norwegian supplies for the Central Eastern Europe region, is at the pre-investment stage and a feasibility study is underway. Should investment proceed, commissioning is projected for 2022 and the pipeline will offer up to 10 bcm/y of import capacity. Baltic Pipe is on the EU list of projects of common interest (PCI).

Figure 9.3 Natural gas imports by country of origin, 1990-2015



Source: IEA (2016c), *Natural Gas Information 2016*, www.iea.org/statistics/.

DEMAND

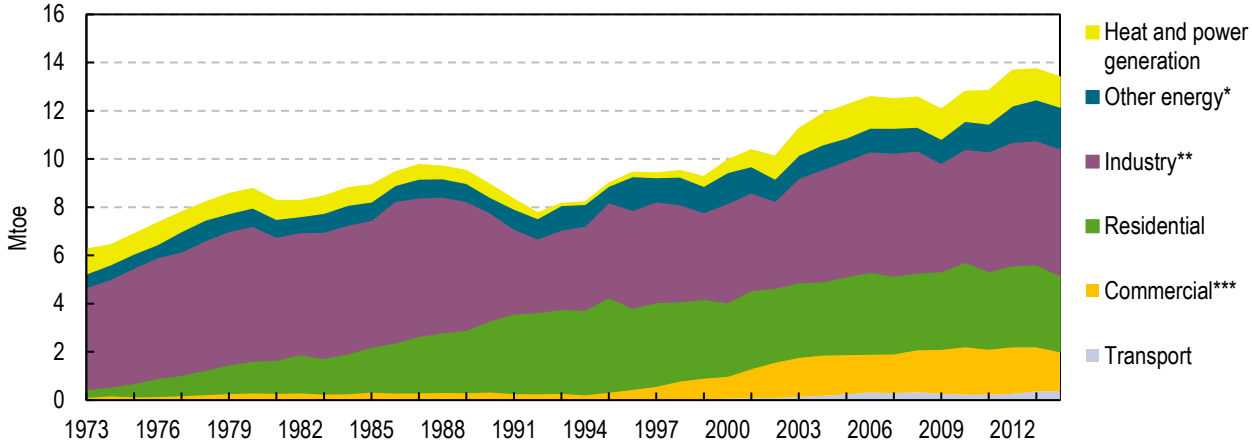
The industry sector is the largest natural gas consumer, with a 39% share of total demand in 2014 (based on primary energy supply). Industry consumption recovered from an 11% drop in demand in 2009 after the financial crisis and increased by 13% in the decade 2004-14. The largest consuming industries are the chemicals sector (with 46% of total industry demand), which uses natural gas mainly as feedstock, and non-metallic mineral industries (19%), which consumes natural gas as a fuel.

The residential sector is the second-largest natural gas user, consuming 24% of total demand. Consumption levels have been stable around 3 million tonnes of oil-equivalent (Mtoe) per year, with a small increase of 4% from 2004 to 2014. The commercial sector (12%) has had a similar stable trend in the last decade, with consumption levels around 2 Mtoe per year. Consumption declined by 3% in the sector from 2004 to 2014.

The heat and power sector consumed 9% of natural gas in 2014. The sector has shown small variations in the last decade, with a decline of 2% since 2004, after growing fast from very low levels a decade before. Poland uses small amounts of natural gas in the heat and power sector compared to the IEA average of 19%. Other countries with similar levels of natural gas in the sector usually have a large supply of nuclear and/or hydro power. The low level of natural gas in heat and power production in Poland is a result of the dominance of coal power. Other energy industries increased their natural gas consumption by 67% from 2004 to 2014, to a share of 13% of total consumption.

Transport is the smallest sector in natural gas consumption, with 3% of total demand. With consumption that more than doubled since 2004, it is the sector that has increased the most. Natural gas consumption in the transport sector is from the use of natural gas in compressor stations.

Figure 9.4 Natural gas consumption by sector, 1973-2014



*Other energy includes coke ovens, other refining and energy own use.

**Industry include non-energy use.

***Commercial includes commercial and public services, agriculture/forestry and fishing.

Note: TPES by consuming sector.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

NATURAL GAS TRANSIT

Poland is a key transit country for Russian gas to Western Europe by means of the Yamal pipeline. The Polish section of the Yamal pipeline is owned by TGPS EuRoPol GAZ S.A. The shareholders of this company are Gazprom Eksport (48%), PGNiG (48%) and Gas Trading S.A. (4%). The 684-km long Polish section runs through the country from Kondratki, on the Polish-Belarusian border, to Górzyca on the Polish-German border. The throughput of the Polish section of the pipeline is approximately 30 bcm/year. Since 2014, Poland has been able to use the Yamal pipeline in reverse flow to import natural gas from Germany. In November 2010, the ERO appointed OGP Gaz-System S.A. as the TSO of the Polish section of the Yamal gas pipeline system until 31 December 2025.

INSTITUTIONS

The Ministry for Energy is responsible for the development and implementation of natural gas policy in Poland. This includes the operation of the natural gas market, the development of natural gas infrastructure, and international co-operation in the sector. The Ministry is also responsible for ensuring the energy security of the country by way of diversification of the sources and routes of natural gas supply and by safeguarding a stable and uninterrupted supply of natural gas.

The independent ERO regulates the activities of participants in the natural gas and electricity markets with the aim of balancing the interests of the market and customers. The duties and competences of the ERO are strictly linked to state energy policy. The activities undertaken by the regulator are aimed at meeting the goals set out by the government, such as the creation of sustainable economic growth in the country, ensuring energy security, economical and rational use of natural gas, development of competition, counteracting negative effects of natural monopolies, and environmental protection as well as fulfilling obligations resulting from international agreements.

The Office of Competition and Consumer Protection is also active in the gas sector. The President of the Office is responsible for shaping the antitrust policy and consumer protection policy. Since 2004 the Office of Competition and Consumer Protection has been providing its opinion on state aid schemes and individual state aid decisions before their notification to the European Commission.

Licences for the exploration, appraisal and production of hydrocarbons are granted by the Ministry for the Environment (acting through the Chief National Geologist). Since January 2015, the previous model with a licence for exploration and appraisal of hydrocarbon deposits, and a separate one for production, has been replaced with a single joint licence covering the exploration, appraisal and subsequent exploration of hydrocarbon deposits. The Plenipotentiary for Strategic Energy Infrastructure is responsible for corporate supervision of TSOs in electricity and gas sectors.

INDUSTRY STRUCTURE

LNG

Construction of the Świnoujście LNG terminal was completed in October 2015 and the facility received its first commercial cargo in June 2016. The terminal is owned and operated by Polskie LNG, which is a subsidiary of Gaz-System. It has 5 bcm/y of regasification capacity, but a future extension could increase its capacity to between 7.5 bcm/y and 10 bcm/y. It has two storage tanks with capacity of 160 000 cubic metres (cm) each and the possibility for construction of an additional storage tank. Regulated third-party access (TPA) is offered to all interested customers. Gaz-System is assessing the possibility of extending the LNG terminal by increasing its regasification capacity and providing new functionality, depending on market demand, as well as providing new services at the facility.

TRANSMISSION

TSO

OGP Gaz-System S.A. (Gaz-System), which is 100% owned by the State Treasury, is the sole owner and operator of the 11 000-km natural gas transmission system in Poland. The company was previously part of the PGNiG group and was fully unbundled from the parent company in April 2003. The rules of unbundling are set out in the Energy Law Act and are aimed at ensuring effective separation of transmission, distribution and storage activity from the activities connected with production or supply of natural gas or electricity. Poland has implemented two models of TSO unbundling: ownership unbundling (OU) and the independent system operator (ISO) model.

The Energy Law Act provides that only one gas TSO can be appointed in the territory of Poland and this operator shall act as a joint stock company whose sole shareholder is the state treasury. Gaz-System performs the function of TSO on its own network (under the OU model) as well as the function of TSO on the Polish section of the Yamal pipeline (under the ISO model). The president of the ERO granted Gaz-System its certification of independence under the OU model by virtue of a decision of 22 September 2014 and under the ISO model by virtue of a decision of 19 May 2015.

Table 9.1 Technical capacity of Polish natural gas entry points (as of 1 January 2015)

Border	Location	Technical capacity (Thousand cm/h)
BY-PL	Kondratki	3 850
PL-BY	Tietierowka	27
PL-BY	Wysokoje	625
PL-UA	Drozdowicze	500
PL-CZ	Cieszyn	104/15.8 (October-March/April-September)
PL-DE	Lasów	180
PL-PL	PWP	956

Note: cm/h = cubic metre per hour.

Source: Ministry of Energy, Poland IDR submission.

The transmission system

There are seven main entry points through which natural gas is imported into the transmission system: Lasów (from Germany), Cieszyn (from the Czech Republic), Drozdowicze (from Ukraine), Wysokoje (from Belarus) and Point of Interconnection (PWP) that is supplied from Kondratki (from Belarus; Yamal pipeline) and from Mallnow Rewers (from Germany; Yamal pipeline), and Tietierowka – only as local supply (from Belarus).

In 2014 and 2015, a number of major investment activities were completed. As a result, the transmission system connection between Poland and Germany was opened, allowing natural gas from Germany through the Mallnow entry point. In early 2015, the expansion of the Wloclawek entry point extended the possibility of receiving natural gas from the Yamal pipeline. Gaz-System has also finished an ambitious development plan for the transmission system, aimed at allowing gas from LNG terminals to freely flow to gas users. Additionally, since 2016 the flow of gas from Poland towards Germany via Lasów interconnection point has been possible.

Gaz-System has been implementing several investment projects. Apart from Baltic Pipe, new interconnectors are planned between Poland and the Czech Republic, Slovakia and Lithuania. The Poland-Lithuania Interconnection will offer capacity of up to 2.4 bcm/y towards Lithuania and 1.7 bcm/y towards Poland. The project will integrate the isolated gas markets in the East Baltic region and diversify supply. Interconnectors with the Czech Republic and Slovakia will have higher capacity, between 4.5 bcm/y and 6.5 bcm/y. Both are part of a North-South Gas Corridor project which, together with LNG capacity in Poland and the Baltic Pipe pipeline, aims at integrating the regional market within the Central Eastern Europe (CEE) and South East Europe (SEE) regions and attracting new sources of gas supply to the region. The Polish government supports flexible and well-developed gas infrastructure that provides competition and reduces the dominance of the largest supplier to the region.

The upgraded Poland-Ukraine Interconnection will offer capacity of between 5 bcm/y and 8 bcm/y towards Ukraine and 5 bcm/y to 7 bcm/y towards Poland. Connecting the two countries, natural gas will diversify gas supplies for Ukraine and further integrate transmission networks and markets in Eastern and Central Europe.

STORAGE

PGNiG owns nine underground gas storage (UGS) facilities located in two types of geological structures, salt caverns or partly depleted natural reservoirs. Seven of these facilities are used to store high-methane gas and two are used to store nitrogen-rich gas (UGS Daszewo and UGS Bonikowo). At the end of 2015, the total available working capacity of natural gas underground storage facilities amounted to 2.8 bcm, which corresponds to approximately 18.3% of annual consumption.

In order to meet legal requirements concerning the obligation to assign a storage system operator, PGNiG created a separate company, Operator Systemu Magazynowania (OSM). The company provides volumes and capacities of storage facilities that meet the needs of the market while at the same time enabling the optimal use of these facilities. Access to gas storage facilities is based on regulated TPA. OSM offers long-term and short-term capacity as well as firm and interruptible storage products. A substantial amount of information regarding capacity use and other technical information is published by OSM on its website.

Table 9.2 Natural gas storage facilities in Poland

Storage site/location	Type	Working Capacity (mcm)	Maximum withdrawal capacity [mcm/day]	Maximum injection capacity [mcm/day]
Kosakowo	Salt cavern	119	9.6	2.4
Wierzchowice	Depleted gas field	1 200	9.6	6.0
Brzeźnica	Depleted gas field	65	0.93	1.1
Swarzów	Depleted gas field	90	1.0	1.0
Strachocina	Depleted gas field	360	3.36	2.64
Mogilno	Salt cavern	594.65	18	9.6
Husów	Depleted gas field	500	5.76	1.15

Note: mcm = million cubic metres.

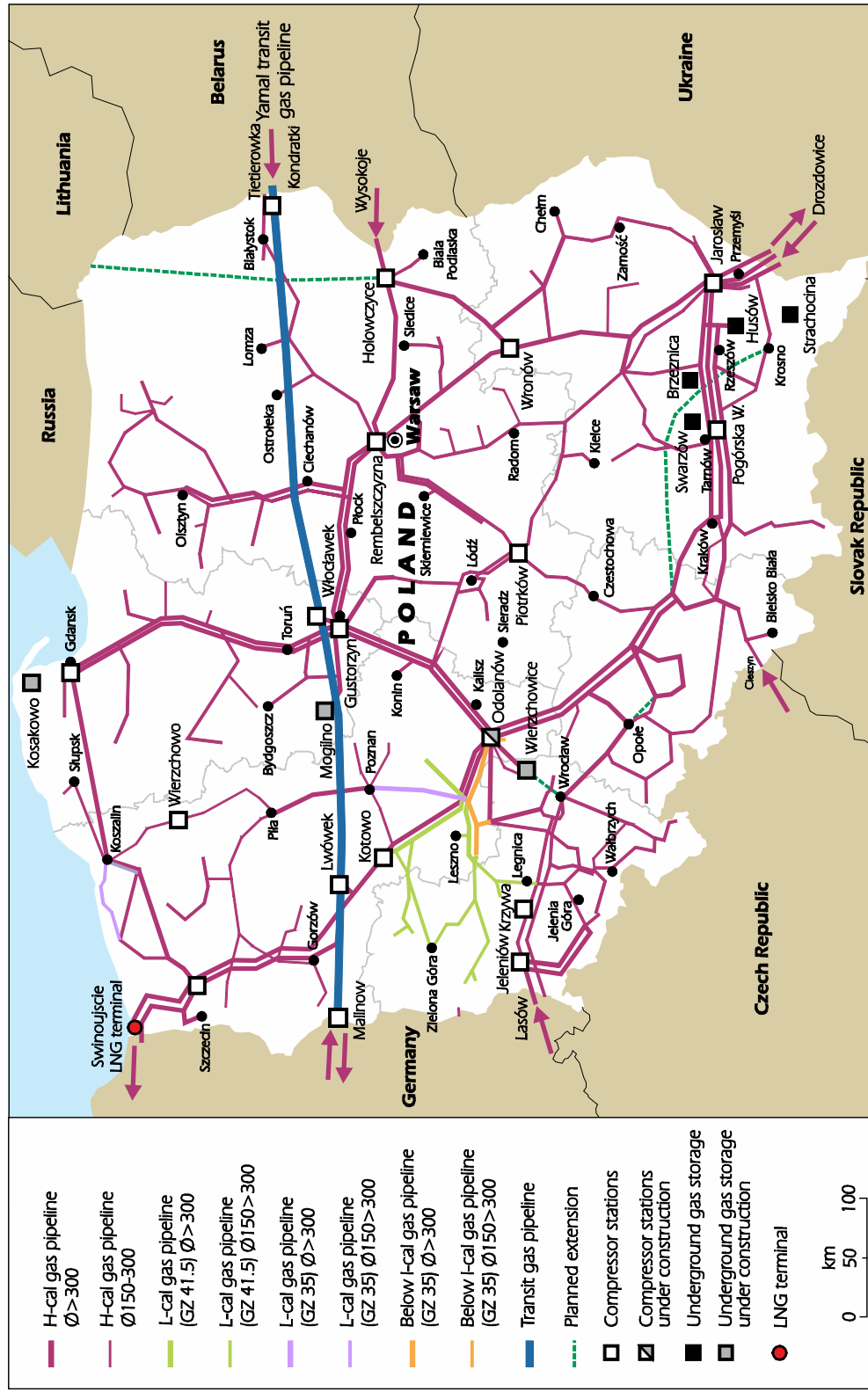
Source: Ministry of Energy, Poland IDR submission.

DISTRIBUTION

The main entity operating in the natural gas distribution sector is Polska Spółka Gazownictwa (PSG), which controls approximately 92% of the 170 000 km of gas pipelines that make up the Polish natural gas distribution network. PSG is a part of the PGNiG Capital Group and was established by consolidating six regional distribution system operators (DSOs) previously belonging to PGNiG.

PSG's duties include operating, expanding, maintaining and repairing the gas distribution network and testing the quality and quantity of transported gas. PSG operates through six branches, located in Gdańsk, Poznań, Warszawa, Wrocław, Tarnów and Zabrze, which are co-ordinated by the company's head office in Warsaw. About 4% of all distribution networks are owned by the remaining 49 companies, which engage in distribution activities on a local scale.

Figure 9.5 Map of natural gas infrastructure in Poland



Where a DSO operates within the structure of vertically integrated undertaking (VIU), legal and functional unbundling is required. In practice, this means that such a DSO is obliged to achieve independence with regard to its legal and organisational form, as well as decision-making. The obligation of legal and organisational unbundling of gas DSOs does not concern VIUs providing services to:

- Less than 100 000 customers connected to the gas distribution system, which is a part of the company if the sale of natural gas by the company during the year does not exceed 150 mcm.
- Less than 100 000 customers connected to the gas distribution system, which is a part of the company if the sale of the company applies to natural gas other than high-methane and nitrogen-rich gas, including LNG, supplied through the gas network.

TEN-YEAR NETWORK DEVELOPMENT PLANS

Within the European Network of Transmission System Operators for Gas (ENTSO-G), TSOs co-operate on the development of EU-wide transmission system planning, by means of EU-wide ten-year network development plans (TYNDPs), regional investment plans and national TYNDPs.[3] In March 2015, ENTSO-G published the fourth edition of the EU-wide TYNDP (TYNDP 2015) covering the 2015-35 period.

Furthermore, TYNDP 2015 plays a central role in the process of selecting PCIs. These have been defined as projects that help create an integrated EU energy market. The European Commission has drawn up a list of 195 PCIs, 77 of which are in the natural gas sector. These projects may benefit from accelerated licensing procedures, improved regulatory conditions, and access to financial support totalling EUR 5.85 billion from the Connecting Europe Facility (CEF) between 2014 and 2020. Among the Polish projects selected as PCIs are:

- North-South Gas Corridor in Central Eastern Europe and South East Europe, which includes the western line in Poland as well as the compressor station in Odolanów and the PL-CZ interconnection, together with the associated infrastructure. It also includes the eastern line in Poland together with the PL-SK interconnection and associated infrastructure.
- The Baltic Energy Market Interconnections Plan (BEMIP), which includes Gas Interconnection Poland-Lithuania, the Baltic Pipe and the capacity expansion of the Świnoujście LNG Terminal.

In January 2016, Gaz-System submitted for ERO approval its Ten-year Plan for the Development of the Gas Transmission System in Poland for 2016 to 2025. In May 2016, the president of the ERO agreed to Gaz-System's development plan for meeting current and future demand for natural gas for the period 2016-25. Over the period to 2025, Gaz-System plans to construct more than 2 000 km of gas pipelines and a number of additional infrastructures, such as above-ground installations and compressor stations, most of which will be located in the eastern part of the country.

3. The role of ENTSO-G is to facilitate and enhance co-operation between national gas TSOs across Europe in order to ensure the development of a pan-European transmission system in line with EU energy goals.

In December 2016, consultation on the draft 2018-27 TYNDP for the Gas Transmission Network started. The largest planned investment is a gas pipeline connecting the Polish and Danish transmission systems. The alternative scenario provides for the commissioning of a floating storage regasification unit (FSRU) terminal in Zatoka Gdańska.

NETWORK TARIFFS

Terms and conditions of TPA access to natural gas transmission and distribution networks are set out in the pipeline operators' Network Codes, and are fully transparent and available to all network users. All information about terms of access and transmission tariffs is available on the Gaz-System website. Similar access arrangements apply for the storage of natural gas and liquefaction or re-gasification of LNG. All tariffs and access conditions must be approved by the ERO.

WHOLESALE MARKET AND GAS EXCHANGE OBLIGATION

The publication of a transmission code of operations (the Transmission Grid Code or IRiESP) in July 2012 led to the establishment of a gas exchange on the Polish Power Exchange (POLPX) in December 2012. By the end of 2014, 25 entities were actively participating in trading of natural gas.

The volume of natural gas traded in 2014 was a record high, i.e. 111.6 terawatt hours (TWh), which represented more than 250% of domestic production and almost 68% of consumption. Trading continued to grow in 2015. During 2014, the average price of natural gas traded on the POLPX was PLN 102.17/megawatt hour (MWh). In the same period, the volume of concluded contracts amounted to 5.39 TWh on the spot market and 105 TWh on the forward market. The average price of gas delivered as a result of contracts concluded on the spot market was PLN 114.41/MWh. On the forward market, the average price was equal to PLN 109.30/MWh.

Development of the gas exchange market is, among other things, a consequence of the introduction into the Energy Law Act of Article 49b, which imposes on energy undertakings involved in trade in gas, an obligation to sell part of the natural gas into the transmission network on commodity exchange (obligation of a public sale of natural gas). In 2013 this obligation amounted to 30% of gas fed into the transmission network by an undertaking involved in trade in natural gas. The volume of gas covered by the obligation increased in subsequent years, from 1 January 2014 to 40%, and from 1 January 2015 to 55%. The introduction of the obligation of a public sale of gas is to enable the creation of wholesale natural gas market, characterised by a high number of transactions. This will allow market players access to natural gas on the domestic market in a transparent manner at prices determined by the market.

In reality, PGNiG is the only entity covered by the obligation to sell natural gas on the power exchange, and other market players are exempt from the obligation in a given year if they own the rights to less than 10% of the transmission capacity of all entry points to the national transmission system at interconnections with other countries' gas systems.

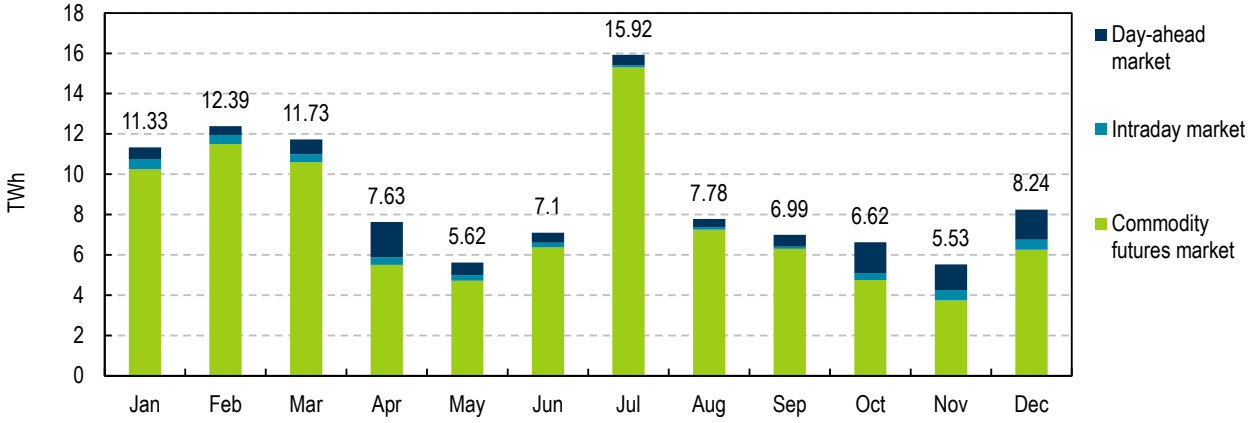
WHOLESALE MARKET

Natural gas has been traded on the Polish Power Exchange (Towarowa Giełda Energii or TGE) since 2012, supported by the obligation to sell at least 55% of the natural gas injected into the network on commodity exchanges or on organised markets. In 2015, gas prices fell sharply at TGE, both on the spot and the futures markets. Nonetheless, price levels remained higher than in Western European markets with relatively unchanged trading volumes. While a number of traders became more active at the commodity exchange, a single seller continued to dominate the wholesale market. Conversely, the share of the PGNiG Group in the retail and wholesale market fell below the 2014 level to less than 90% (TOE, 2016).

The total volume of gas traded in 2015 was approximately 106.9 TWh, 4.3% more than in 2014. Significantly higher volumes were recorded in the gas spot market (13.9 TWh, 111.8% more than in 2014). The volume at the intraday market for gas was 3.4 TWh (or an increase of 191.4% compared to 2014) and the volume at the day-ahead market was almost 10.5 TWh (or an increase of 94.4% compared to 2014). The volume-weighted average price of natural gas reached PLN 87.46/MWh on the spot market in 2015, lower by as much as PLN 17.54/MWh than in 2014 (PLN 105/MWh).

Prices of gas offered at the TGE day-ahead market were higher than in Western European platforms such as the NCG (Germany), GASPOOL (Germany) and TTF (the Netherlands) by less than 6% on average, and is the result of the cost of transporting gas between the markets. Within the Polish market, differences between wholesale TGE prices and average retail prices averaged approximately 25% in 2015, i.e. it was similar to 2014 or approximately 26% (TOE, 2016).

Figure 9.6 Trading volumes at the TGE in 2015



Source: TOE (2016), *Electricity and Gas Market in Poland, Status on 31 March 2016*.

EMERGENCY RESPONSE POLICY

Diversification of supply sources and routes, development of natural gas infrastructure, expansion of underground storage capacity, increasing domestic gas production and acquisition of shares in gas resources outside Poland are the key elements of Poland's gas security policy.

The Minister of Energy is the authority responsible for security of natural gas supply and is supported by a Natural Gas Supply Security Team (the Polish gas National Emergency Strategy Organisation [NESO]). The Ministry of Energy's Oil and Gas Department is at the core of the NESO structure and serves as the secretariat.

Under the Act of 16 February 2006 (amended in 2011 to reflect the EU Gas Security of Supply Regulation), energy enterprises running a business of international gas trading and importation are obliged to maintain compulsory gas stocks in storage installations connected to the gas system within the territory of Poland. Compulsory stocks of natural gas may be held in storage facilities located outside the territory of Poland, such as in other EU countries.

These mandatory stocks of natural gas must correspond to at least 30 days of the average daily amount of gas imported into Poland, and must be stored in installations that enable delivery of the entire inventory of these stocks to the gas transmission system within 40 days. The mandatory gas stocks in Poland are commingled with commercial stocks. The amount of mandatory gas stocks is reviewed regularly by the ERO. The costs incurred by enterprises/importers to fulfil the obligation are considered as the justified costs of their operations and could be included in tariffs.

Compulsory gas stocks are held at the disposal of the Minister of Energy. These stocks may be released by the operators of the gas transmission system or of the consolidated gas systems immediately after receiving permission from the Minister of Energy. In September 2016, an amendment to the Energy Act came into force. Among other changes, the amendment proposed elimination of the *de minimis* exemption (currently available upon the decision of the Minister of Energy to undertakings having not more than 100 000 customers and bringing in natural gas to the territory of Poland in volumes not exceeding 100 mcm annually). This amendment was introduced as it was believed that some market participants were abusing the existing law by selling natural gas at the border to others relying on the *de minimis* exemption. It was also a barrier to the development of the liquid market in Poland, as it decreased the level of traded volumes of gas and moved the trade to Germany. As a consequence, it resulted in lower compulsory stocks from year to year, while greater volumes of trade and imports were observed. This amendment also allowed for more flexibility in fulfilling the obligation, such that in recent years, stakeholders asked for the introduction of the possibility of contracting with other importers to maintain stocks. The proposed amendment is, however, doubted by stakeholders as expensive and complex, and a barrier to the development of a secure, liquid and competitive market (EFET, 2016).

The Council of Ministers has the right to impose restrictions on consumption while defining the method, duration, eligible consumers, etc. There is currently one voluntary load-shedding contract which corresponds to 1.38% of peak daily winter consumption.

There is limited possibility of increased domestic production in a crisis situation. Poland may increase the supplies of natural gas on the basis of the existing contracts, as well as using the reverse flow on the Yamal-Europe pipeline. Furthermore, within the framework of the existing contracts, subject to the consent of the suppliers, there is a possibility of temporary relocation of supplies between individual transmission system entry points – this measure can be made difficult if the disruption is of political background.

The Polish government has no legal authority or policy to promote fuel switching away from natural gas in an emergency. Gas-fired power plants are not legally required to

hold back-up fuel stocks on site. Nonetheless, the government has confirmed that 318 facilities have a combined fuel switching potential of approximately 47 mcm, which amounts to 3.35% of total consumption.

PRICES AND TAXES

The natural gas retail sector in Poland has yet to complete the liberalisation process. At present, regulated end-user prices are available to almost all small consumers. The Ministry of Energy is preparing a draft amendment to the Energy Law Act, which aims to eliminate regulated gas prices within the next eight years. The draft amendment is a result of the judgement of the European Court of Justice of 10 September 2015, where the court found that imposing regulated prices with regard to the sale of gas to non-household users for an indefinite period is contrary to EU law.[4]

The existing obligation to submit tariffs for approval of the ERO will be abandoned gradually. The government intends to deregulate the market in three stages. First, from entry into force of the regulation, regulated tariffs for sale of gas to the largest end users, which purchase at least 278 gigawatt hours (GWh) of gas per year, will be ended. Subsequently, the tariffs for sale of gas to any entities other than household customers will be ended from 1 October 2017. Finally, from 1 January 2024, regulated tariffs for householders will be eliminated.

PRICE LEVELS

Natural gas prices in Poland are among the lowest in Organisation for Economic Co-operation and Development (OECD) Europe for both household customers and industry. According to Eurostat, retail prices for gas in the second half of 2015 for medium-sized household consumers in Poland (EUR 0.0405/kilowatt hour (kWh) excluding taxes and levies or 0.0498/kWh including taxes and levies) are well below the EU average (EUR 0.0543/kWh excluding taxes and levies, EUR 0.0707/kWh including taxes and levies).[5]

Prices for industrial users (EUR 0.0285/kWh excluding taxes and levies or 0.0359/kWh including taxes and levies) are also less than the EU average (EUR 0.0333/kWh excluding taxes and levies or 0.0443/kWh including taxes and levies).[6]

RETAIL MARKET COMPETITIVENESS

In May 2015, The Agency for the Co-operation of Energy Regulators (ACER) commissioned a study regarding competitiveness of retail electricity and gas markets in EU member states and Norway.

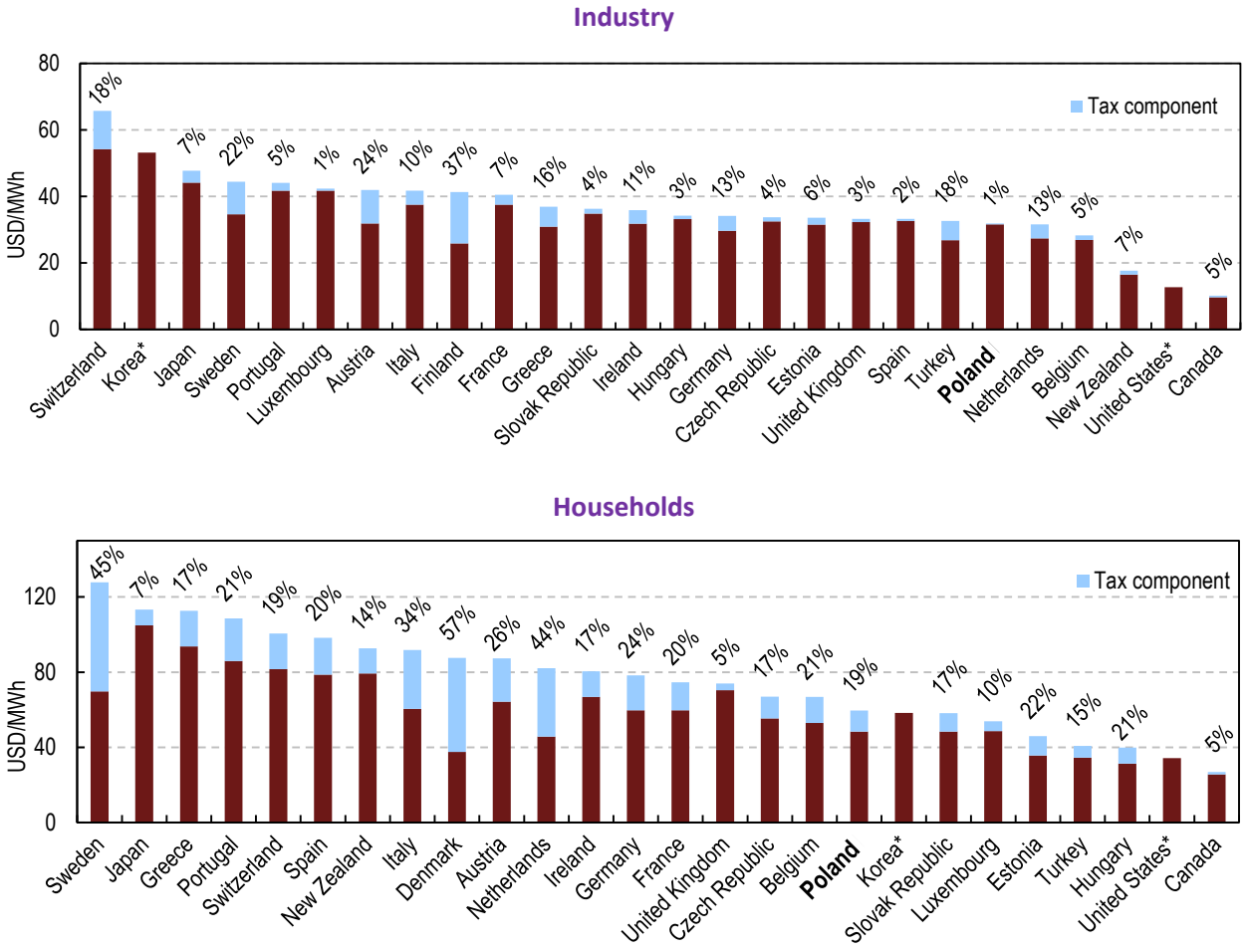
4. The court ruled that Poland failed to comply with its obligations under the provisions of Article 3(1) in conjunction with Article 3(2) of Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC.

5. Eurostat gas prices for domestic consumers – bi-annual data (from 2007 onwards) – Band D2: 20 gigajoules (GJ) < Consumption < 200 GJ (second semester 2015).

6. Eurostat gas prices for industrial consumers – bi-annual data (from 2007 onwards) – Band I3: 10 000 GJ < Consumption < 100 000 GJ (second semester 2015).

The outcome of the study, which was published in September 2015, ranked Poland among the least competitive natural gas retail markets in the group of countries studied alongside Bulgaria, Lithuania, Romania and Slovakia (IPA, 2015).

Figure 9.7 Natural gas prices in IEA member countries, 2015



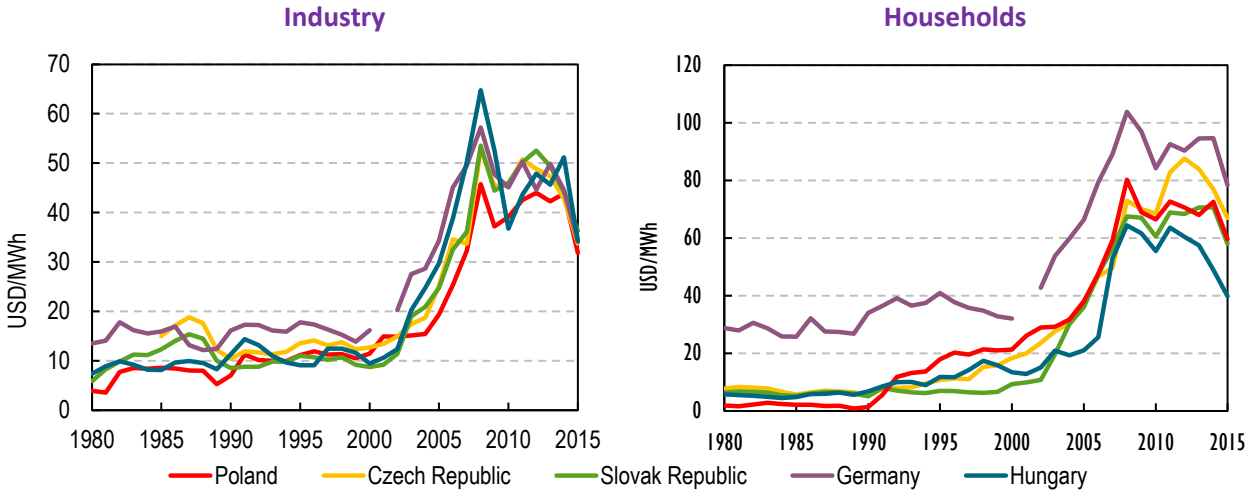
* Tax information is not available.

Note: Data are not available for Australia, Denmark (industry), Finland (household) Estonia, Italy, Japan and Norway.

Source: IEA (2016d), *Energy Prices and Taxes 2015*, www.iea.org/statistics/.

ACER, in a separate report, also examined the level of concentration of European retail markets for households at the national level in 2014, measured by the concentration ratio CR3101, expressed as the sum of the market shares of the three largest suppliers in a market and the number of main suppliers (i.e. suppliers with market shares equal to or higher than 5%). CR3 values above 70% and low numbers of main suppliers are indicative of possible competition problems (ACER/CEER, 2015). In the case of Poland, the ACER study found that the household market was one of the most uncompetitive among those surveyed. A similar situation was found to exist in the non-household market. Conversely, the same study also found that there was significant entry/exit activity in the household market in Poland, indicative of low barriers to entry, although most entries occurred from 2011 to 2012.

Figure 9.8 Gas prices in Poland and in selected IEA member countries, 1980-2015



Note: Data are not available for the Czech Republic (Industry) 1980-84 and Germany 2001 (Industry and Household).

Source: IEA (2016d), *Energy Prices and Taxes 2015*, www.iea.org/statistics/.

ACER also monitors consumer switching activity. The measures of consumer activity in the market indicate the extent of customer movement between suppliers (i.e. external switching) and between alternative products from the same supplier (i.e. internal switching). These are important indicators of competition in the market, as they provide an important insight into consumer participation in the market. According to ACER, household switching rates in Poland are among the lowest in the European Union. The number of customers switching supplier, however, was much higher in 2015 than in preceding years. According to ERO data, there were only small switches in 2011, 210 in 2012, 429 in 2013 and 7 007 in 2014. Since monitoring was put in place until the end of 2015, 30 749 customer switches took place (TOE, 2016).

ASSESSMENT

The Polish government has made good progress in the natural gas sector since the last in-depth review (IDR) visit in 2011. Notable achievements include continued unbundling within the natural gas market, breaking vertical integration in the sector, establishing an independent system operator (ISO) and reinforcing the independence of the TSO. Amendments to the gas system regulation and tariff regulation in 2012 and 2013, as well as the approval of a new Transmission Network Code by the ERO with introduction of, among other things, a decoupled entry-exit system, a virtual trading point and settlements in energy units, have enabled wholesale gas trading on the POLPX. Government policy has driven liquidity on the POLPX and allowed price regulation releases for large commercial users. Most significantly, the recent opening of the Świnoujście LNG terminal is a clear example of the major infrastructure investment within the sector. Nonetheless, there is more Poland can do to deliver a fully competitive natural gas market that supports affordable energy for consumers, opportunities for air quality improvements, additional security of supply by means of a diverse fuel mix, and sustained investment in infrastructure (including compressed natural gas [CNG] infrastructure to support e-mobility).

The government and the market expect gas consumption to remain relatively stable at approximately 16 bcm per year in 2016, rising to 20 bcm by 2030. It is a modest 15% of total primary energy use. Natural gas is predominantly used by industry (8.5 bcm) for industrial applications (e.g. as feedstock) and industrial energy use. Less than 0.5 bcm was used for electricity generation where gas is used in 4% of installed generation capacity. Households are the second-largest user (3.7 bcm/year).

The consumption characteristics and Poland's import dependence mean that while natural gas is important to the industrial economy, it is not a crucial part of the strategic energy mix. Even so, it is still vital that Poland's forthcoming energy strategy to 2050 provide clear signals of the government's long-term intent for the gas sector (either to support economic growth of industry and/or as part of the energy mix) in order to attract investment and support development of a fully functioning competitive market. The risk is that the absence of investor certainty could precipitate a declining market owing to fears of stranded assets and weak opportunities for return on investment.

Gas infrastructure has undergone a number of significant investments since 2011: the new Świnoujście LNG terminal has recently opened with the first cargo from Qatar on a long-term contract, and the first cargo purchased on the spot market being delivered in the first half of 2016. The LNG terminal provides 5 bcm/year capacity, sufficient to meet one-third of current demand. Further investment in interconnectors between Poland and her neighbours has seen, for example, increased capacity at the Lasów interconnection point with Germany and a new operational interconnector at Cieszyn at the Czech border. Important work at Mallnow and Wloclawek on the Yamal pipeline has enabled both physical flow and virtual reverse flow, providing firm capacity of 5.4 bcm from the west. Together with Poland's domestic production of 6 bcm/year, these investments allow diverse supply options that can, theoretically, be flexed in response to international markets to meet demand. To make best use of this flexibility, it will be important for Poland to have a clear natural gas strategy for when the long-term take-or-pay contract between PGNiG and Gazprom expires in 2022.

Further investment in interconnection and import capacity, as the TSO, Gaz-System, is investigating, will increase diversity of supply. Gaz-System has outlined options for, among other things, increasing regasification capacity at Świnoujście, potentially even doubling the current capacity to 10 bcm per year; for installing a floating storage and re-gasification unit at Gdansk Bay, thereby creating an additional entry point for LNG; and for creating a new pipeline between Denmark and Poland as a part of the North-South Gas Corridor. While the security of supply opportunities of these investments, both for Poland and the region, are clear, and the investments may benefit from EC support, attracting the additional capital funding will depend on a well-functioning market and certainty for investors, and the economic viability of the investments.

Despite the success of the government and regulator in introducing competition at retail level in the natural gas market, there remain concerns regarding the completion of the process. Small end users need to be given confidence that their rights as consumers will be rigorously protected by robust regulation. Complex and difficult supplier switching procedures relative to markets elsewhere, a lack of uniform standards for metering data exchange and online interaction, and the absence of a simple process for settlement under gas distribution and sales contracts are problematic. There needs to be a full review of the operation of the customer switching system and the standard terms and conditions of contracts. There are numerous models throughout the IEA membership that can provide Poland with guidance. The outcome of this review should be to identify

and address barriers to switching such as, among other things, punitive contract termination clauses, very long contract periods (greater than 18 months), unclear bills, or dual billing where complex contracts are not available. This review should also examine the current powers of the consumer protection regulators and consider strengthening these to better ensure consumer confidence.

Furthermore, Poland is one of the few IEA Europe countries to maintain regulated prices, and in September 2015 the European Court of Justice found that Poland had failed to comply with the provisions of the EU Directive on the internal market in natural gas with regard to non-household customers. Nonetheless, the government and the ERO have taken important steps to liberalise the gas market. Following the last IDR, the ERO published a roadmap towards deregulating prices in the market. This roadmap included, among other things, launching a gas trading platform on the POLPX, setting an obligation on the incumbent wholesaler PGNiG to sell a gradually increasing percentage of gas through the exchange, and exempting traders on the exchange from price regulation. Alongside implementing new Transmission Network Codes, which creates a balancing service market and virtual trading points, Poland is slowly moving towards a fully liberalised, competitive market in accordance with EU law. The ERO and Ministry of Energy will end price regulation on the basis of new legislation that came into force on 1 January 2017. This legislation provides for the deregulation of prices for non-household customers from 1 October 2017, and leaves room for the ERO to deregulate prices for households when it deems the market competitive enough not to allow for abuse, no later than 1 January 2024.

As PGNiG retains market dominance, it is unlikely that the benefits of a liberalised market will emerge quickly (for example price/service competition for consumers, attraction of capital for infrastructure investment, demand-side response to price signals); nevertheless, recent developments create a more level playing field for suppliers, based on the exchange obligation imposed on the incumbent. In parallel, with completing the liberalisation journey set out in the ERO roadmap, the government should review the regulatory framework to identify and address features that provide unwarranted support to the market incumbent. These might be unintended barriers to market participation by competitors, such as the requirement to book firm capacity for compulsory gas stocks held outside Poland, or the obligation to diversify away from gas imports via reserve flow, contractually from the European Union, but physically from the East (which impedes virtual trading of Yamal gas flows). Alternatively, there may be in-built advantages for semi-vertically integrated producer/wholesaler/retailers that PGNiG, as the only significant market participant of this type, is uniquely able to capitalise on.

The retail market, similar to the wholesale market, is dominated by PGNiG. A retail subsidiary, PGNiG Retail, was spun out from the group in 2014 and the effect of this restructuring has been to leave wholesale market and large natural gas users (many of whom contract gas on a wholesale basis) with one part of the PGNiG, while households and retail users purchase gas from another part of the company. While this provides separation of the different trading entities at different parts of the supply chain, PGNiG still accounts for 80% of sales by volume.

Natural gas exploration and production is also being carried out across Poland, as the country has substantial shale gas and tight gas resources. Published estimates concerning shale gas reserves in Poland differ from one another. According to the most optimistic scenario published by the United States Energy Information Administration

(EIA), the Polish shale may contain up to 5.3 trillion cubic metres (tcm) of gas. By mid-2014, Poland had granted 82 concessions to prospect for unconventional hydrocarbons: 72 of those were shale gas-related. Companies' interest in shale gas is evaporating fast. Disappointing test wells, regulatory constraints, public hostility and deteriorating economics as a result of lower oil and gas prices have all contributed to a poor outlook for shale gas.

RECOMMENDATIONS

The government of Poland should:

- ☐ *Present a clear vision for the natural gas market as part of the forthcoming energy strategy to 2050. A clear statement from the government will offer long-term certainty for investors, allowing the sector to best support Poland's goals of supply diversity and energy security and environmental protection.*
- ☐ *Use this vision to inform the strategic direction for the continued efficient development of interconnectors, pipelines and new transmission infrastructure in Poland to support the development of regional gas trading and diversity of supply and gas security.*
- ☐ *Review the operation of supplier switching in the household and commercial sector to ensure that switching is straightforward for consumers, that they can make informed decisions and that they have confidence their rights will be protected.*
- ☐ *Develop a clear and transparent programme for the implementation of full retail market liberalisation as soon as possible, including the elimination of regulated tariffs. Social policy should include protection measures for vulnerable customers and less-well-off consumers.*

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10. OIL

Key data (2015 estimated)

Crude oil production: 0.9 Mt, +9% since 2005

Crude oil net import: 26.2 Mt, +48% since 2005

Oil products net export: 3.1 Mt

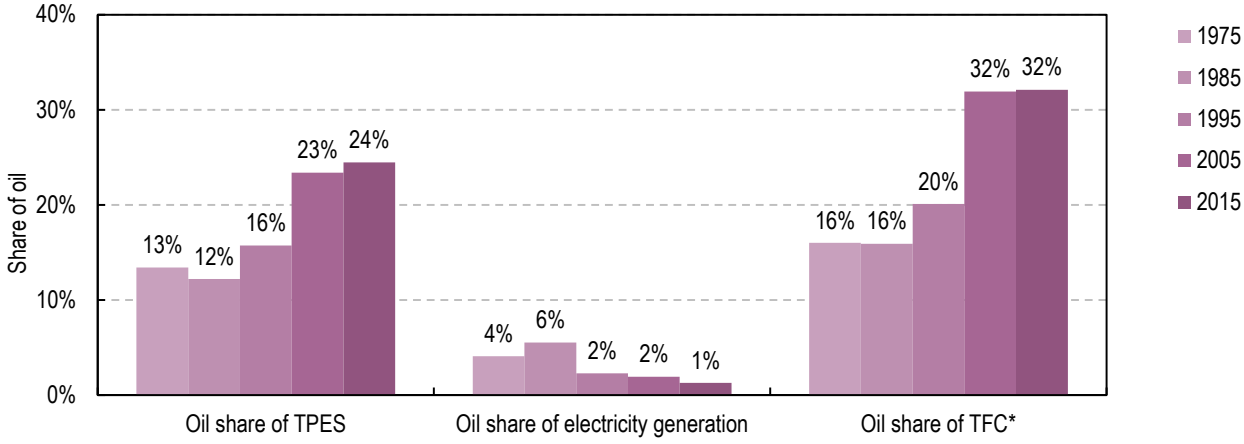
Share of oil: 24.5% of TPES and 1% of electricity generation

Consumption by sector (2014): 22 Mtoe (transport 64.3%, industry 17.3%, commercial and public services, including agriculture and fishing 9.8%, heat and power generation 1.5%, other energy industries 4.5%, residential 2.7%)

OVERVIEW

Oil is the second-largest primary energy source in Poland after coal, providing about one-quarter of total primary energy supply (TPES) in 2015. It is the largest fuel in terms of end consumption, about one-third of total final consumption (TFC) in the country. Oil is largely consumed in the transport sector, which is the only sector where oil consumption has increased in the last decade. Indigenous oil production is small and Poland is dependent on imports, mainly from the Russian Federation, which was the source of 88% of imported oil in 2015. Diesel oil is the most used oil product, followed by gasoline and liquefied petroleum gas (LPG). The demand for LPG in Poland's transport sector is the highest among Organisation for Economic Co-operation and Development (OECD) countries as a result of favourable taxes.

Figure 10.1 Oil share in different energy supplies in Poland, 1975-2015



*Consumption data available for 2014.

Note: 2015 values are estimates.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

SUPPLY AND DEMAND

SUPPLY

Poland's oil supply doubled between 1991 and 2011. The share of oil in TPES increased rapidly from 16% in 1995 to 23% in 2005, but has been relatively stable around one-quarter of TPES since.

Indigenous production accounted for 4% of total oil supply in 2015, with the remainder imported. There are 86 oilfields containing economically recoverable resources of 22.82 million tonnes (Mt), of which three accounted for about 87% of crude oil production in 2015.[1] Historically, all of Poland's oil imports came mainly from the Russian Federation. Since then, imports have diversified somewhat to include countries such as Norway and the United Kingdom. Imports from the Russian Federation, however, have also continued to increase in volume terms and accounted for around 88% of oil imports in 2015 (Figure 10.2).

Table 10.1 Sources of crude oil imports to Polish refineries, 2015

Country	Percentage of imports
Russia	88.28%
Iraq	6.82%
Kazakhstan	1.89%
Saudi Arabia	1.54%
Norway	1.29%
Lithuania	0.18%

Source: Ministry of Energy, Poland IDR submission.

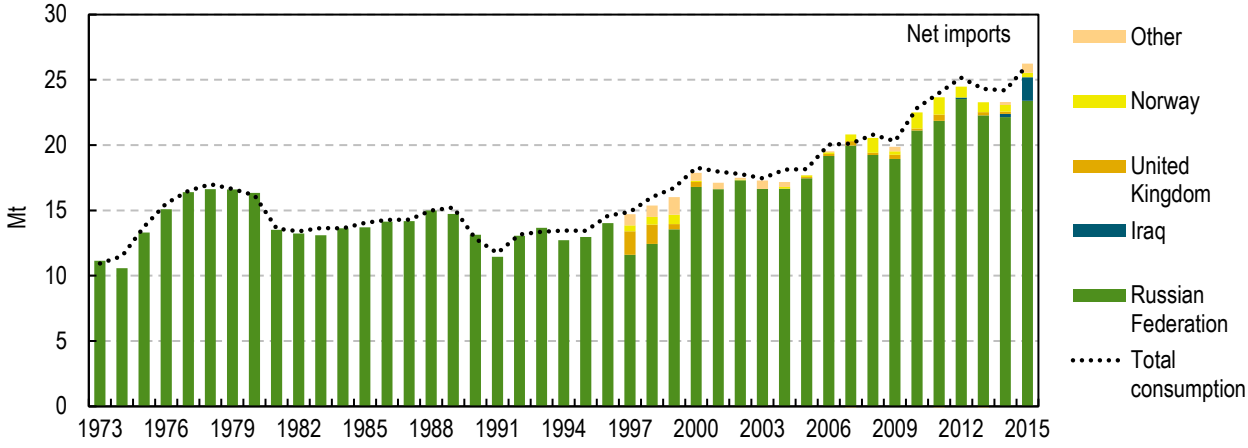
Crude oil is imported by refineries on the basis of commercial long-term contracts and by spot contracts. In 2016, long-term contracts accounted for about 54% of total refinery oil imports. Per refinery, long-term contracts make up 68.5% of supplies to PKN ORLEN S.A. (the part of crude oil [OAO Rosneft Oil Company contract] the refinery can pick up at Gdańsk oil terminal or at Būtingė oil terminal in Lithuania) and 22.86% of supplies for Grupa LOTOS S.A. Russia is likely to remain the largest crude oil supplier to Poland – Russian Export Blend Crude Oil (REBCO) is less expensive, and existing infrastructure (Druzhba pipeline) means it is the most convenient to import. Nevertheless, despite Russian crude oil dependency, there are technical possibilities to import other grades of crude oil (via Gdańsk). Polish refineries are also prepared to process various other grades of crude oil.

In 2016, PERN S.A. built a new crude oil terminal in Gdańsk, which is the principal sea hub in Poland with a crude oil storage capacity of 375 000cubic metres (cm). This terminal provides the opportunity to blend different grades of crude for refineries and store crude oil for oil traders. There are also a number of other future projects under

1. The portion of technically recoverable resources that can be profitably produced, the volume of which is determined by oil prices and by the capital and operating costs that would be incurred during production.

consideration for the purpose of diversifying crude supplies, such as the Brody-Adamowo pipeline and the second line of the Pomeranian pipeline. Both projects have been considered as potential projects of common interest (PCIs) by the European Commission.

Figure 10.2 Crude oil net imports by country of origin, 1990-2015



Note: Data from 2015 are estimates.

Source: IEA (2016b), *Oil Information 2016*, www.iea.org/statistics/.

DEMAND

The transport sector represents almost two-thirds of TFC of oil in 2014 and was the main driver of total demand growth from 1990 to 2011. The industry sector is the second-largest oil consumer, accounting for 17% of demand, followed by the commercial sector (10%), with the remaining balance in the energy and residential sectors (Figure 10.3). Compared to the International Energy Agency (IEA) average, Poland uses a larger share of oil in the commercial sector (IEA average 5%), which includes the agriculture sector, and a smaller share in industry (IEA average 22%).

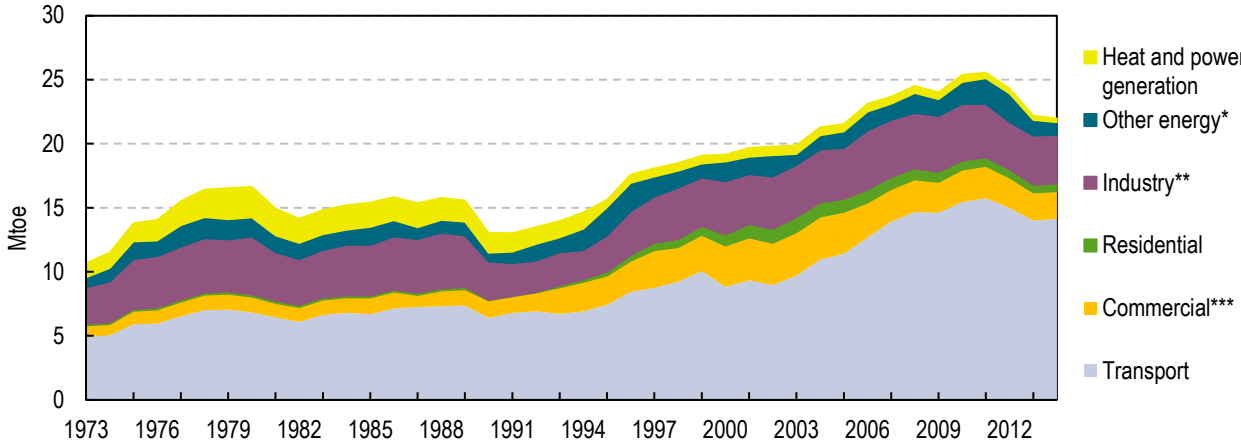
Oil consumption declined in 2013 and 2014 compared to 2012 as a result of lower energy use in the transport sector and a fuel shift from oil to natural gas and coal in the "other" energy sector (including refining and own use in energy generation).[2] In 2015, the total oil consumption[3] picked up again and increased by 8% to 26.1 Mt.

Oil consumption in transport depends mostly on road transport demand, which constitutes 95% of the energy consumption in the sector. Oil makes up 95% of energy in road transports, with biofuels covering the remaining 5%. Road transport oil consumption has grown significantly in recent decades, especially in the ten-year period 2001-11 when it increased by 77% (Figure 10.4). Since 2011 oil consumption has been rather stable in road transport, while consumption has increased rapidly in domestic aviation, although from a very low level. Airplanes consume only 0.2% of total oil in the transport sector.

2. Some of the fall may be attributed to the growing grey market for fuel, the volume of which is difficult to accurately quantify.

3. Oil consumption data per sector are only available for until 2014.

Figure 10.3 Oil consumption by sector, 1973-2014



*Other energy includes coke ovens, other refining and energy own use.

**Industry includes non-energy use.

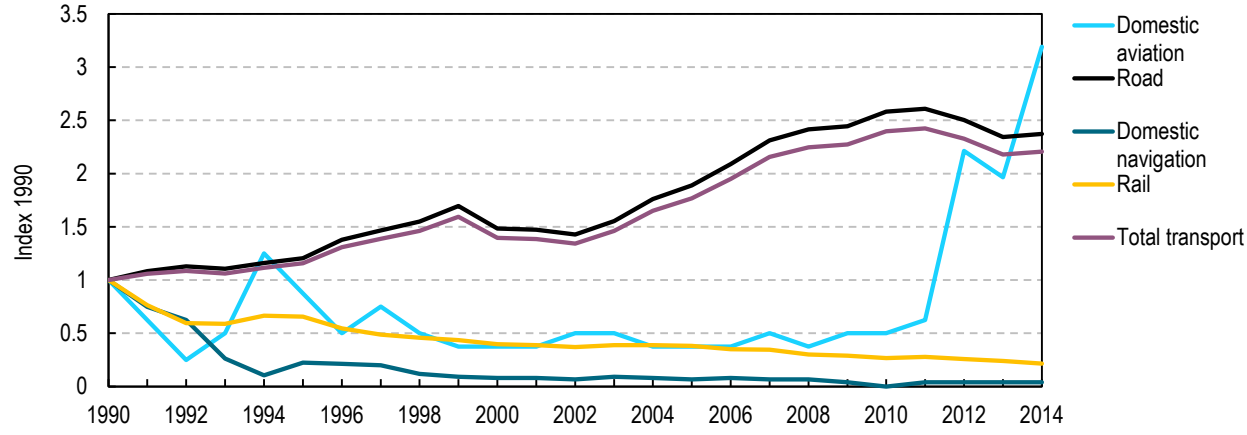
***Commercial includes commercial and public services, agriculture/forestry and fishing.

Note: TPES by consuming sector.

Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

Diesel (gas and diesel oil) is the most consumed oil product, accounting for half of all product use, followed by gasoline and liquefied petroleum gas (LPG) (Figure 10.4). These products are mainly consumed in the transport sector, which uses 58% diesel, 23% gasoline and 11% LPG. Naphtha is consumed in industrial processes for non-energy purposes.

Figure 10.4 Oil consumption in the transport sector, 1990-2014 (indexed 1990)

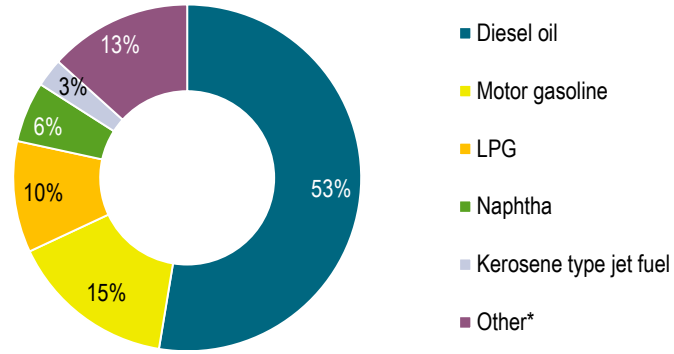


Source: IEA (2016a), *Energy Balances of OECD Countries 2016*, www.iea.org/statistics/.

The level of oil product consumption reflects the vehicle fleet in Poland, presented in Figure 10.5. Petroleum products and LPG are mostly used in passenger cars, while diesel is dominant fuel in freight transport vehicles.

The LPG share in Poland's transport sector is the highest in the OECD, owing to favourable taxes, which result in a low price at the pump compared to the price of competing products such as gasoline.

Figure 10.5 Oil consumption by product, 2015

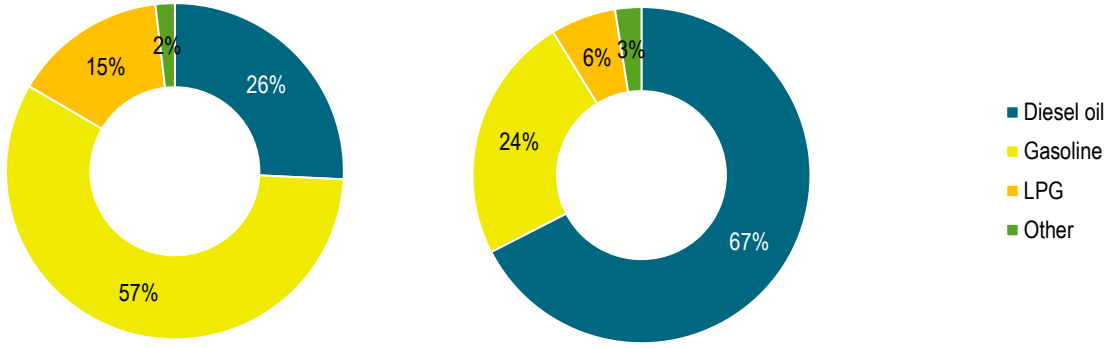


* Other includes refinery gas, other kerosene, fuel oil, petroleum coke, aviation gasoline and other non-specified oil products.

Note: Data from 2015 are estimates.

Source: IEA (2016b), *Oil Information 2016*, www.iea.org/statistics/.

Figure 10.6 Vehicle fleet of passenger cars (left) and lorries (right) by fuel type, 2012



Source: Eurostat (2016a), Transport Database – Road Transport Equipment, Stock of Vehicles, http://ec.europa.eu/eurostat/web/transport/data/database/, (accessed 1 October 2016).

There are four operational refineries in Poland and these are able to satisfy domestic demand for most oil products. A notable exception is LPG, for which imports account for around 76% of total supply (net imports). LPG imports are sourced from the Russian Federation (54% of total imports), Kazakhstan (23%) and Belarus (10%).

EXPLORATION AND PRODUCTION

Poland's crude oil production declined about 22 400 tonnes (t) in 2015, to 927 800 t, equivalent to 3.58% of annual consumption. Proven and probable oil reserves are estimated to be less than 24.79 Mt. Production is located in four areas – the Carpathian, the Carpathian Foredeep, the Polish Lowlands and the Polish Economic Zone of the Baltic Sea. Companies active in exploration and production include Polish Oil and Gas Company S.A. (onshore) and LOTOS Petrobaltic S.A. (offshore).

Most crude oil in Poland is produced by Polish Gas and Oil Company S.A. In 2015, the company produced about 796 000 t of crude oil. Thanks to development of the

Barnówko-Mostno-Buszewo (BMB) deposit near Gorzów Wielkopolski, crude oil production has been increasing.

Crude oil is also produced by LOTOS Petrobaltic S.A. (subsidiary to Grupa LOTOS S.A., second biggest oil company in Poland), which has the licence for exploration and exploitation of hydrocarbon deposits in the Polish Economic Zone of the Baltic Sea. In 2015, the company produced about 132 000 t of crude oil. In 2016, production is conducted from the B3 offshore oil field and from the B8 oil field where production started in 2015. The possibility of an increase in oil production is limited but possible.

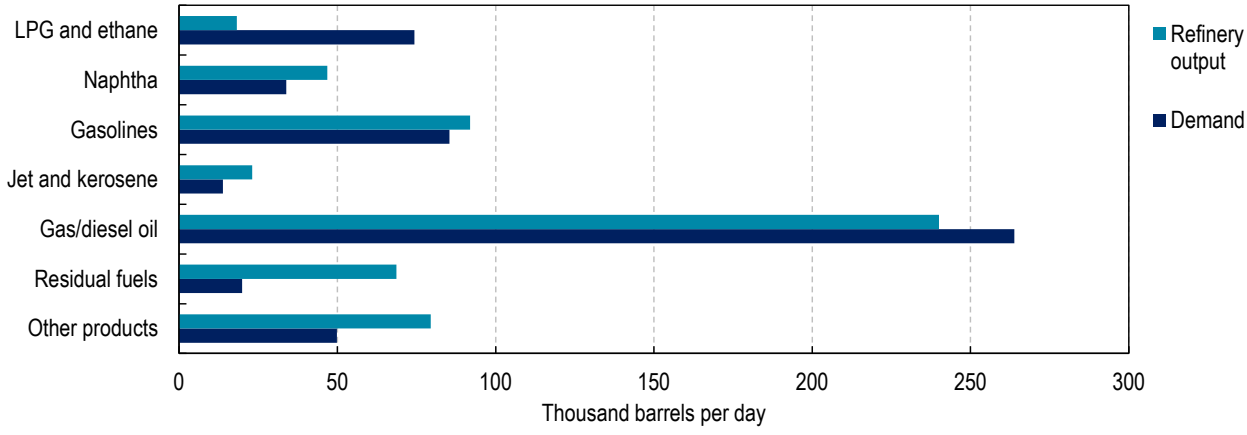
INFRASTRUCTURE

REFINING

There were four operating refineries in Poland in 2016. The two major refineries are in Płock (PKN ORLEN S.A., capacity 375 thousand barrels per day [kb/d]) and Gdańsk (Grupa LOTOS S.A., 216 kb/d), both of which process mainly REBCO. There are also two smaller refineries in Jedlicze and in Trzebinia (ORLEN Południe S.A., a subsidiary to PKN ORLEN S.A.), which are located in the southern part of Poland. The two largest refineries (Płock, Gdańsk) are supplied by crude oil which is received from the Druzhba pipeline or Naftoport's oil terminal in Gdańsk.

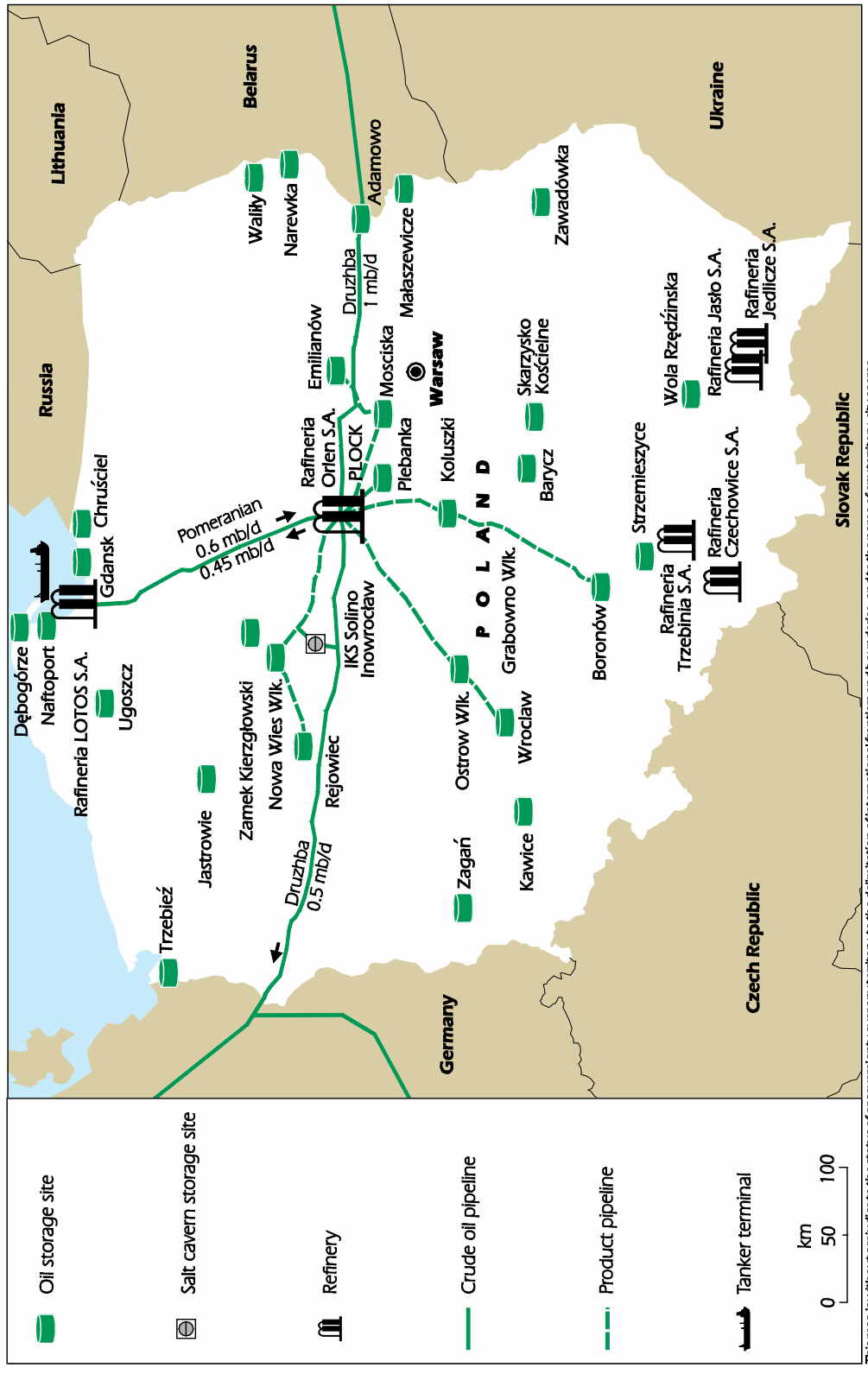
The refineries are able to meet domestic demand in all product categories except LPG and gas/diesel oil. In 2015, the country's refined product output averaged 568.1 kb/d and the average capacity utilisation rate was 85.3%. The composition of production in 2015 was 240.1 kb/d (43%) of gas/diesel oil, 23.1 kb/d (4%) of other middle distillates (entirely jet kerosene), 91.9 kb/d (16%) of motor gasoline, 68.6 kb/d (12%) of residual fuel oil, 46.8 kb/d (8%) of naphtha and 79.5 kb/d (14%) of other products..

Figure 10.7 Poland's refinery output, 2015



Source: IEA (2016b), *Oil Information 2016*, www.iea.org/statistics/.

Figure 10.8 Map of Poland's oil infrastructure



PORTS AND PIPELINES

Poland's main oil port terminal is the Naftoport in Gdańsk which has five jetties and a capacity of 40 Mt/yr. The terminal can receive very large crude carriers. In 2014, the port handled 9 Mt of crude oil (import and transit to German refineries) and 3.2 Mt of oil products (export). There are also two small oil terminals for imports of oil products; the Port of Gdynia (with a capacity of 3.5 Mt/yr or 70 kb/d) and Szczecin (1.5 Mt/yr or 30 kb/d).

The Druzhba and the Pomeranian are the main pipelines for transporting crude oil. These two pipelines supply Russian crude directly to the refineries at Płock and Gdańsk, to Naftoport for exports (however, crude oil transit stopped in 2012) and transit volumes on to the German refineries at Schwedt and Spergau.

The Polish branch of the Druzhba pipeline is composed of two main sections. The eastern section runs from the Belarus border in Adamowo to Płock, which has a nominal capacity of 870 kb/d (43 Mt/yr); however, with the use of a drag-reducing agent (DRA) it can transport up to 1 million barrels per day (mb/d) (50 Mt/yr). A third line, which is under construction, will help to keep the capacity of the eastern section at 1 mb/d (50 Mt/yr) with a significant reduction in operating costs. The construction is estimated to be finished in 2016. The western section of the Druzhba pipeline links Płock to the German border in Schwedt, which has a capacity of 545 kb/d (27 Mt/yr). PERN S.A., the operator of the Druzhba pipeline in Poland, is exploring the possibility of pumping crude oil through the eastern section of the pipeline in reverse flow in order to be able to use capacities of the Adamowo tank farm during emergencies.

The Pomeranian pipeline links the tank farm in Miszewko Strzałkowskie near Płock with a tank farm in Górki Zachodnie near Gdańsk. This is the route for Russian oil destined for the refinery in Gdańsk, which belongs to Grupa LOTOS S.A., and also for export through the oil terminal in Gdańsk (transit through the oil terminal in Gdańsk was stopped in 2012). The Pomeranian pipeline can transport oil in two directions. The route from Gdańsk to Płock provides the possibility to import the crude oil by sea and its further transport to Gdańsk or Płock refinery and to the refineries in Spergau and Schwedt (Germany). From Gdańsk to Płock, pipeline capacity is 30 Mt/yr (0.6 mb/d) of crude oil. The route from Płock to Gdańsk provides the possibility to deliver crude oil originating from Druzhba pipeline to Gdańsk refinery or to export. From Płock to Gdańsk, its capacity is 22 Mt/yr (0.45 mb/d).

A consortium of companies (known as MPR Sarmatia Sp. z o.o) is working on a project to extend the Ukrainian Odessa-Brody pipeline to Adamowo in Poland, where it would connect to the Druzhba system, thereby making it possible to transport crude to Poland from the Black Sea and the Caspian Sea. This project has been beset by several delays and remains in the planning phase. Nonetheless, it remains on the European Union's list of PCIs as a project that would significantly improve the security of supply of the region.

An oil products pipeline network, consisting of four main lines, connects the refinery in Płock, which is operated by PKN ORLEN S.A., to various storage depots. On the line from Płock to Nowa Wieś Wielka, PERN S.A. transports 2.1 Mt of fuel per year. An extension to the pipeline running to Rejowiec also allows the company to transport 1.4 Mt of fuel per year. On the Płock to Mościska and Emilianów line, the company can transport about 1 Mt of fuel per year along the entire length of the pipeline. The third line, from Płock to

Koluszki, has an annual capacity of 3.8 Mt of fuel, and a further extension running from Koluszki to Boronów, 1 Mt/yr. The total length of these pipelines equals 620 kilometres (km).

Other fuel pipelines are owned by PKN ORLEN S.A. The longest of these is a section of a pipeline running from Płock to the company's depot in Ostrów Wielkopolski and Wrocław. The other two pipelines are directly connected with the transport network of PERN S.A. The first one is a product pipeline, connecting to another PERN S.A. pipeline running from Płock to Nowa Wieś Wielka. The second (for crude oil) is almost 40 km long and is operated by PERN (inland tank farms) and IKS SOLINO S.A.

STORAGE

In 2015, Poland had crude oil storage capacity of around 8.88 million cubic metres (mcm). This is an increase of about 1.87 mcm (27%) from 7.01 mcm at the end of 2010. The vast majority of crude oil storage facilities in Poland are operated by IKS SOLINO S.A. (crude oil is stored in salt caverns with a capacity of 4.2 mcm) and PERN S.A. (inland tank farms with a capacity of 3.5 mcm). The largest storage capacities for fuels are with IKS SOLINO S.A. (2.1 mcm) and OLPP Sp. z o.o. (1.8 mcm), which since 2009 is a subsidiary company of PERN S.A. The company is the owner of 19 fuel storage depots spread over the entire country. The five largest of these facilities (Koluszki, Nowa Wieś Wielka, Boronów, Rejowiec and Emilianów) are connected by pipeline to the Płock refinery.

MARKET STRUCTURE

EXPLORATION AND PRODUCTION

The government maintains a very strong presence in the oil market through its ownership of a number of companies along the supply chain. Polish Oil and Gas Company S.A., known as PGNiG, is a Polish state-controlled oil and natural gas company, which deals with the exploration and production of natural gas and crude oil, natural gas imports, storage and distribution, and sales of natural gas and crude oil. PGNiG S.A. is one of the largest companies in Poland and is listed on the Warsaw Stock Exchange.

Exploration and Mining of Petroleum and Gas Deposits Petrobaltic S.A., known as LOTOS Petrobaltic S.A., a company belonging to Grupa LOTOS S.A., was established in November 1990. The company is the only one in Poland performing exploration and production of crude oil and gas in the Baltic Sea.

MIDSTREAM

PKN ORLEN S.A. is a major oil refiner and gasoline retailer. The company is listed on the Warsaw Stock Exchange and has refineries in Poland (Płock, Jedlicze and Trzebinia), the Czech Republic (Litvinov and Kralupy) and Lithuania (Mažeikiai). The company is Central Europe's largest publicly traded firm, with major operations in Poland, the Czech Republic, Germany and the Baltic States.

The Płock refinery, the main asset of PKN ORLEN S.A. in Poland, is located in the central region of Poland, and in 2015 it processed about 15.7 Mt of crude oil. The company is the largest crude storage capacity owner in Poland – the company is the owner of IKS SOLINO S.A., where reserves are kept underground in salt caverns. This site is composed

of seven crude caverns and three product caverns, with a total capacity of 6 mcm (including 4.2 mcm for crude oil and 1.8 mcm for products). The crude caverns are connected to the Druzhba pipeline, and product caverns are connected to the Płock Refinery by product pipeline.

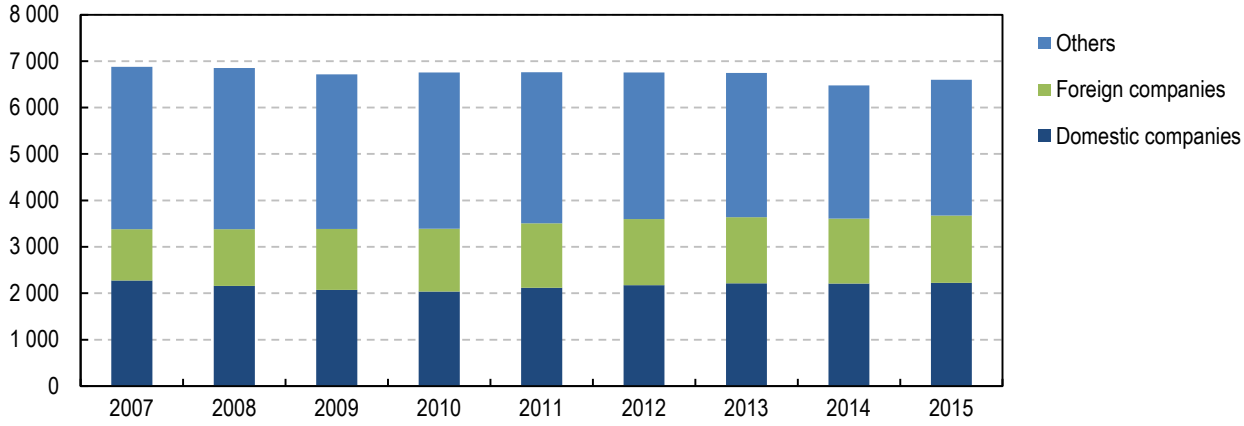
Grupa LOTOS S.A. is a vertically integrated oil company based in Gdańsk. The company is listed on the Warsaw Stock Exchange. Its main activities are crude oil production, refining and the marketing of oil products. It owns the Gdańsk Refinery and in 2015 it processed about 10.2 Mt of crude oil. In 2012, the refinery was upgraded and since then its throughput capacity has increased from 6 Mt/yr to 10.5 Mt/yr.

Naftoport is a company which manages crude oil shipments and deliveries. It is located in Gdańsk and was established in June 1991 by several Polish oil companies and the Marine Commercial Port in Gdańsk. The company oversees operations of the terminal for reloading of crude oil and products in the Port of Gdańsk.

DOWNSTREAM

Poland has a dense network of fuel stations, owned by Polish companies PKN ORLEN S.A. and Grupa LOTOS S.A., as well as foreign companies such as BP, Shell, Statoil and Lukoil, and independent operators. The total number of fuel stations is about 6 500, of which approximately 3 600 are owned by major domestic players and international operators. The remainder of stations are owned by independent dealers, while the large supermarkets own around 180 stations. The number of fuel stations has been decreasing in recent years, and the market is characterised by a high degree of competition.

Figure 10.9 Number of service stations in Poland (2007 to 2015)



Source: Ministry of Energy, Poland IDR submission.

In 2015, the PKN ORLEN S.A. retail network comprised 1 749 stations, while Grupa LOTOS S.A. operated 476 fuel stations. The number of stations operated by foreign companies was about 1 447 (a slight increase since 2010). The notable players in this group include BP (with 501 stations), Shell (426), Statoil (355) and Lukoil (116). According to data provided by the Polish Organization for the Oil Industry and Trade, new investments carried out by oil companies, supermarkets and main independent operators led to an increase in the number of stations of 115 in 2015 compared to 2014. At the same time, the networks of independent operators continued to expand. The most active companies in this sector were Delfin, Huzar and Moya.

OIL USE IN ROAD TRANSPORT SECTOR

The passenger car fleet in Poland has grown for many years (the number of cars in Poland in 2014 increased by 36.26% compared to 2007). Poland's car fleet was almost 26.5 million vehicles in 2014. Poland is the third-largest manufacturer in Central Europe (after the Czech Republic and Slovakia). It is also the regional leader in the manufacturing of light commercial vehicles (LCVs) as well as heavy trucks, buses and coaches. The key passenger car producers in Poland are: Fiat Auto Poland, Volkswagen Poznań and General Motors Manufacturing Poland (Opel). Poland is an important manufacturer of buses and coaches, and producers include: MAN Bus, Scania Production Słupsk and Solaris Bus & Coach. Poland is the world's third-largest player in the global market of natural gas-fuelled vehicles, according to the World LPG Association (WLPGA), after Turkey and Russia, followed by South Korea and India.

Box 10.1 LPG use in Poland

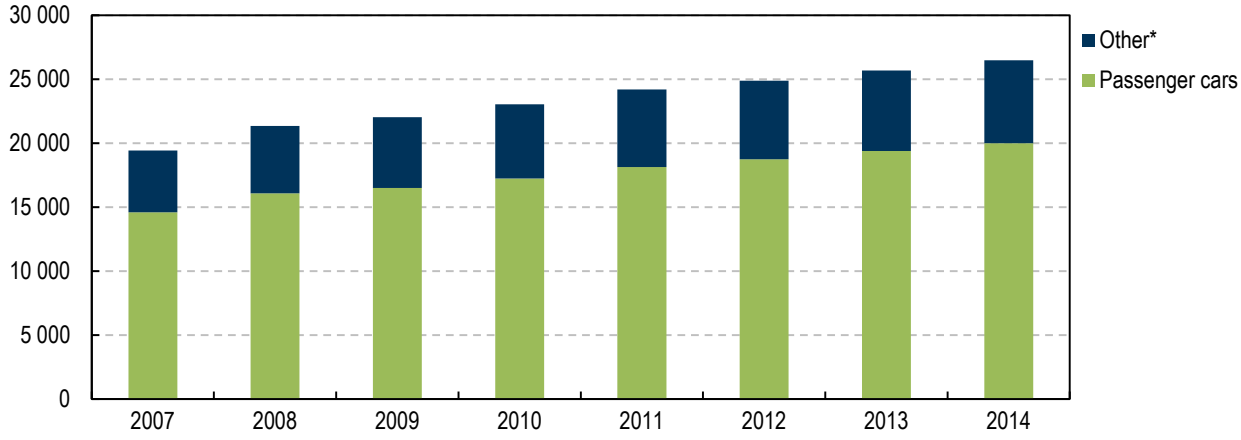
Poland is a relatively large market for LPG. In 2015, the country was the world's fifth-largest market and LPG sales to the transport sector accounted for the largest share of total LPG sales, or 75% of LPG consumption. There are approximately three million LPG vehicles (15% of the total number of passenger vehicles) in circulation, and about 5 400 service stations sell the fuel. Sales of LPG in cylinders (13%) and in tanks (12%) account for the remaining consumption.

In 2015, domestic production satisfied 16.7% of domestic demand for LPG but the domestic market is largely dependent on imports, which come from Russia (54%), Kazakhstan (23%) and Belarus (10%) with the European Union accounting for the remainder. Approximately 80% of imports are supplied by rail, 15% by road and the remainder by sea. Poland also exports LPG, to the Czech Republic, Germany and Slovakia. Similar to other fuels, the LPG sector has also been impacted by the grey fuel market and it is estimated to account for between 5% and 7% of total turnover.

There are 20 million cars in circulation in Poland and the country's passenger fleet is among the oldest in the European Union. The average age of a car in Poland is 17.5 years, compared to an EU-28 average of 9.65 years (ACEA, 2015). Over 80% of cars and 77% of heavy goods vehicles are more than ten years old and 78% of all vehicles are more than ten years old. There are 11.1 million gasoline-fuelled passenger cars and 5.7 million diesel-fuelled passenger cars in Poland.

From a fuel efficiency point of view, diesel vehicles are more efficient than gasoline-fuelled cars and can be seen solely from the carbon dioxide (CO_2) emission perspective as a better alternative. Conversely, they have a negative impact on local pollution and human health as a result of particulate pollutants (PM2.5, PM10). In Poland, the excise duty on diesel remains below that of gasoline even though diesel combustion emits more CO_2 and local pollutants per litre, thereby incentivising the purchase of diesel vehicles. The share of diesel in the passenger car fleet rose from 15% in 2007 to 28.5% in 2014. Since 2007, the tax differential has narrowed: the nominal excise duty on diesel increased while those on gasoline and LPG were unchanged. Given inflation, this means the rates for the latter two fuels fell, yet the nominal rate on diesel was still 13% below that of gasoline in 2013 and the differential is 27% if tax rates are expressed in terms of CO_2 emissions (OECD, 2015).

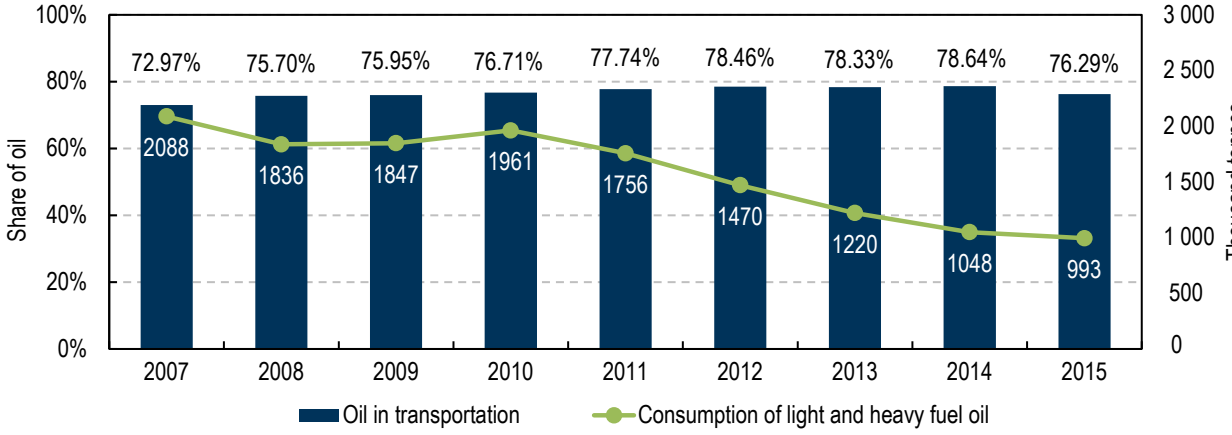
Figure 10.10 Number of road vehicles in Poland, 2007 to 2014



Source: Ministry of Energy, Poland IDR submission.

An increasing trend in diesel oil consumption can be seen from 2010, and also efforts undertaken by domestic refineries (PKN ORLEN S.A., Grupa LOTOS S.A.) to maximise profits generated a growth of production of engine gasoline and diesel oil output. In recent years, the domestic production of diesel oil was facilitated by commissioning of new installations in Grupa LOTOS S.A. (10+ Programme) and PKN ORLEN S.A. Transport, and demand keeps growing (oil in transport account for 76% of total oil consumption). Light and heavy fuel oil use declined mostly in power generation.

Figure 10.11 Share of fuels for transportation in total oil consumption



Source: Ministry of Energy, Poland IDR submission.

In 2015, gasoline consumption increased by 2.85% compared to 2014, mainly because of relatively low prices at fuel stations. Increasing domestic production output reduced the imports of this product. In the same year, consumption of diesel oil increased by 5.55% compared to 2014. The main factors responsible for the increase in demand are assumed to include economic growth and greater use of diesel engines in car fleets.

Box 10.2 Poland's oil market and and the shadow economy

The shadow economy is widely understood to comprise all currently unregistered economic activities that would contribute to the officially calculated gross national product if the activities were recorded. High levels of activity in the shadow economy can have significant economic and social implications, such as a reduced tax base, lower quantity and/or quality of public goods, distortions in market competition, the degradation of economic and social institutions, and lower economic growth.

In Poland, estimates as to the size of the shadow economy and its various components vary. A 2016 EY study of the shadow economy in Central and Southern Europe estimated that it accounted for 12.4% of gross domestic product (GDP), or lost government revenues equivalent to 2% of GDP, in Poland in 2014. A small proportion of this loss was attributable to the grey market in vehicle fuels. Another study published in 2015 estimated that the Polish shadow economy accounted for 23.3% of GDP (Schneider, 2015), while the Institute for Market Economics (Instytut Badań nad Gospodarką Rynkową) Poland estimated the shadow economy at 19.5% of GDP in 2014, and predicted 19.2% in 2015.

Poland is Europe's eighth-largest fuel market and the number of diesel- and gasoline-powered vehicles on the roads has been growing steadily since 2007. According to the industry, the lack of an increase in demand for diesel, despite the growth of GDP and vehicle numbers, can only be accounted for by availability of fuel in the grey fuel market. According to oil industry estimates, the fuel market in diesel was somewhere from 15% to 20% of the market in 2014.

The grey market in motor oils, which to a large degree is forced by inconsistent or incoherent provisions of the tax law, currently prevails mainly in two forms: the trade in base oils, i.e. using base oils as a substitute to engine oil, and in the trade of finished lubricants which have been purchased abroad and brought to Poland without paying the excise duty tax.

The government recognised the scale of the problem, and in 2014 an agreement between the Minister of the Interior, the Minister of Finance and the General Prosecutor on co-operation in the fight against economic crime was put in place. As a result, there has been a considerable intensification of actions performed by law enforcement and tax authorities. There has also been an increase in monitoring activities performed by tax control and customs authorities in co-operation with the police, road transport inspectorate and other bodies. Intensive actions along Poland's border resulted in detecting tax frauds estimated at PLN 450 million and the seizure of assets worth approximately PLN 100 million (POPiHN, 2015).

Generally, Poland's eastern neighbours are the main source of supplies to the grey fuel market, but large amounts also reach Poland from Germany. The Polish Chamber of Liquid Fuels estimates that the grey economy accounts for 30% of fuel on the Polish market and estimates revenue losses to the government of PLN 8.5 billion in 2015. POPiHN, the Polish Organisation of Oil Industry and Trade, has estimated that the unregistered fuel market currently amounts to between 2% to 3% of total fuel sales, but adds that since 2011, there has been an upsurge of supplies outside the official statistics. The former Ministry of Economy in its 2015 report on the Polish economy highlighted the threat to energy security represented by the growth of the grey market in liquid fuels, notably with regard to diesel fuel (POPiHN, 2015).

Box 10.2 Poland's oil market and and the shadow economy (continued)

The industry has proposed a number of measures to tackle the problem, such as a the creation of a "fuel platform", a register of entrepreneurs operating in the fuel sector, which would be an electronic database containing information about the entities operating in the field of production, logistics and fuel trade, as well as about their compliance with all the related responsibilities. This is in response to the present arrangement where industry information is stored by a variety of government ministries and agencies, with no comprehensive overview available. The OECD has recommended that the government place greater emphasis on tax enforcement (OECD, 2016).

EMERGENCY PREPAREDNESS

EMERGENCY RESPONSE POLICY

The Minister for Energy is in charge of oil emergency management and has legal power to take emergency actions. The main piece of legislation governing emergency response is the Act of 16 February 2007 on Oil Stocks, which defines the principles of creating, maintaining and financing the stocks of crude oil and petroleum products. [4]

In the event of a domestic supply disruption, a response action is undertaken upon the request of *voivodes* (local authorities), producers or traders of fuels (oil companies) or an eligible entity (of particular importance for protection of life, health, security, or running of economy). Each request is evaluated by the Ministry of Energy, which proposes to the minister appropriate response measures to be taken.

During a global supply disruption, the Minister for Energy will make the political decision necessary to participate in an IEA collective action and on emergency response measures, based on materials prepared by ministry staff and consultations which will take place during a meeting of the Intergovernmental Group for Ensuring Security of Supply of Natural Gas, Crude Oil and Liquid Fuels.

NATIONAL EMERGENCY STRATEGY ORGANISATION

The Oil and Gas Department in the Ministry of Energy is at the core of Poland's National Emergency Strategy Organisation (NESO) structure and works as the secretariat of the Intergovernmental Group for Ensuring Security of Supply of Natural Gas, Crude Oil and Liquid Fuels. It is responsible for preparing actions to be taken by the Minister for Energy, both on a national and international level, consultations with the oil industry as well as with key institutions (the Material Reserves Agency, the Energy Market Agency, local authorities), and is involved in the decision-making process or in implementation of emergency measures decided by the minister or the government.

The department is also the operational contact with the IEA and with the European Commission in matters of oil security. The decision on convening the meeting of the Intergovernmental Group is taken by the Chairman, the Secretary or Undersecretary of

4. Act of 16 February 2007 on stocks of crude oil, petroleum products and natural gas, the principles of proceeding in circumstances of a threat to the fuel security of the State and disruption on the petroleum market.

State, who is responsible for oil and gas policy at the Ministry. The Intergovernmental Group may also establish expert working groups and can be also used for consultation of emergency policy in normal times.

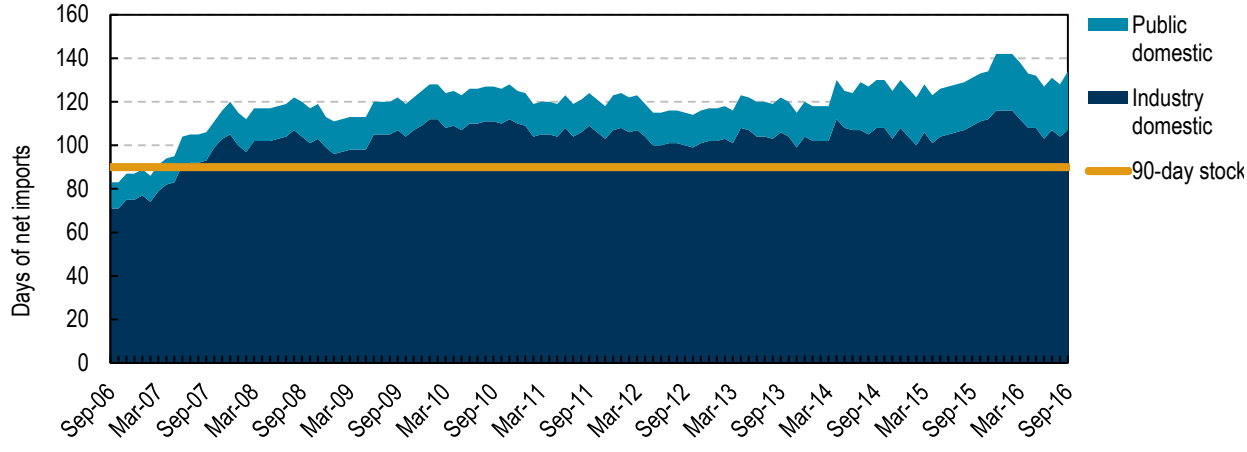
STOCKHOLDING REGIME

Poland sets an obligation on industry to meet an equivalent of 76 days of net imports, and the country is consistently compliant with the IEA's minimum obligation since its accession to the International Energy Programme (IEP) in 2008. The Material Reserves Agency (MRA) maintains at least the difference to 90 days. Currently, a transitional period has been set to decrease the share of industry compulsory stockholding down to the level of 53 days by the end of 2017 and increase the Agency holding to 37 days (agency stocks).

The MRA is a governmental body which, apart from oil stocks, is also responsible for maintaining strategic stocks of food, medical reserves, emergency equipment etc. Companies must create stocks in the form of products they produce/import. Producers may replace up to 50% by stocks of crude oil. Importers may do so only when they have a processing contract. Domestic tickets are allowed, and by the end of 2014 34% of compulsory stocks were held under 120 ticketing contracts. The MRA is responsible for approval and oversight of the contracts. While legislation allows for international stockholding, there are currently no bilateral contracts. International tickets are also allowed, but there are no bilateral agreements with any other country.

As of the end June 2016, Poland held 65 million barrels of stocks. Emergency reserves were composed of 64% crude and 36% refined products. All stocks were held within Poland and represented 125 days of net imports (101 held by industry and 24 public).

Figure 10.12 Poland's oil stocks and compliance with the IEA 90-day stockholding obligation (June 2006 to June 2016)



Source: IEA (2016c), *Monthly Oil Statistics*, www.iea.org/statistics/.

Drawdown procedures

Stocks are always released by decision of the Minister for Energy, who has full control over the parameters of the release, i.e. the eligible entities, price setting, type of release, volumes, etc. Agency stocks will be preferentially released by sale; however, loans are also not excluded. Companies paying the stockholding fee have priority of purchase by

default, but this can be overridden by decision of the minister if the circumstances demand. Compulsory stocks are released by a reduction of the obligation, but in case of necessity to ensure supplies of fuels from these stocks to eligible consumers, the Minister for Energy has powers to impose an obligation on companies holding compulsory stocks to supply these consumers. In such cases, the price at which fuels will be sold would be set in the same decision of the Minister. The price would be based on market price.

Financing and monitoring

Oil stocks held by the MRA are financed from a fee paid monthly by industry and are stored in rented capacities; most product stocks (90%) are not commingled and are stored in separate tanks. The MRA is entitled to control obligated companies, including physical controls on location, and to impose fines for non-compliance. By rule, 30% of stocks are controlled each year by a task force of 30 employees of the Agency. Very heavy fines can be imposed on companies in case of identified breaches of the compulsory stockholding obligation (CSO), and this occurs regularly: several dozen fines were imposed in a total amount of PLN 210 million in 2015.

OIL DEMAND RESTRAINT AND OTHER OIL EMERGENCY RESPONSE MEASURES

Demand restraint is considered as a secondary response measure which might be introduced in a long-lasting and severe crisis. The decision-making procedure of demand restraint measures is expected to be longer and more complex than that of stock release, as introduction of these demand restraint measures needs an ordinance of the Council of Ministers.

Poland's possible demand restraint measures range from light-handed measures to compulsory measures. Light-handed measures include information campaigns to promote eco-driving and use of public transport. There is no clear set of rules for implementation of the light-handed category.

Compulsory measures are set in legislation and include restrictions on trade in fuel by limiting the maximum quantity of fuel sold by the filling station, the maximum quantity of fuel which a consumer may purchase in a single transaction and the opening hours of gasoline stations for fuel sales, as well as restrictions on fuel consumption through speed limits, limiting or banning distribution of fuel in canisters, a driving ban, rationing of fuel, etc.

The government has prepared a manual for implementation of demand restraint measures, which is part of the general emergency handbook. Implementation of demand restraint measures is not planned in a pre-crisis situation or in the early stage of a crisis, because of the restrictive nature of the measures. No automatic triggers exist to implement specific demand restraint measures.

Radio and TV broadcasters have an obligation to immediately inform the public about implemented measures. The measures are enforced and monitored on *voivodship* (regional) level, where implementation plans are also prepared (including lists of priority users). These plans are approved by the Ministry of Energy (previously the Ministry of Economy) in consultation with the Ministry of the Interior and updated each year. In 2014, the government conducted a study on the potential of fuel switching, but very little potential was identified.

PRICES AND TAXES

End-use prices of oil products contain the following components: the wholesale price, excise tax, fuel surcharge, distribution margin and value-added tax (VAT).

Table 10.2 Excise tax and fuel surcharge, as of 31 March 2016

Product	Excise tax	Fuel surcharge
Motor gasoline	PLN 1 540/ 1 000 litre	PLN 129.41/ 1 000 litre
Automotive diesel oil	PLN 1 171/ 1 000 litre	PLN 288.05/ 1 000 litre
Automotive LPG	PLN 670/ 1 000 kg	PLN 159.71/ 1 000 kg
Light fuel oil and marine gasoil	PLN 232/ 1 000 litre	N/A
Heavy fuel oil	PLN 64/ 1 000 kg	N/A

Source: Ministry of Energy, Poland IDR submission.

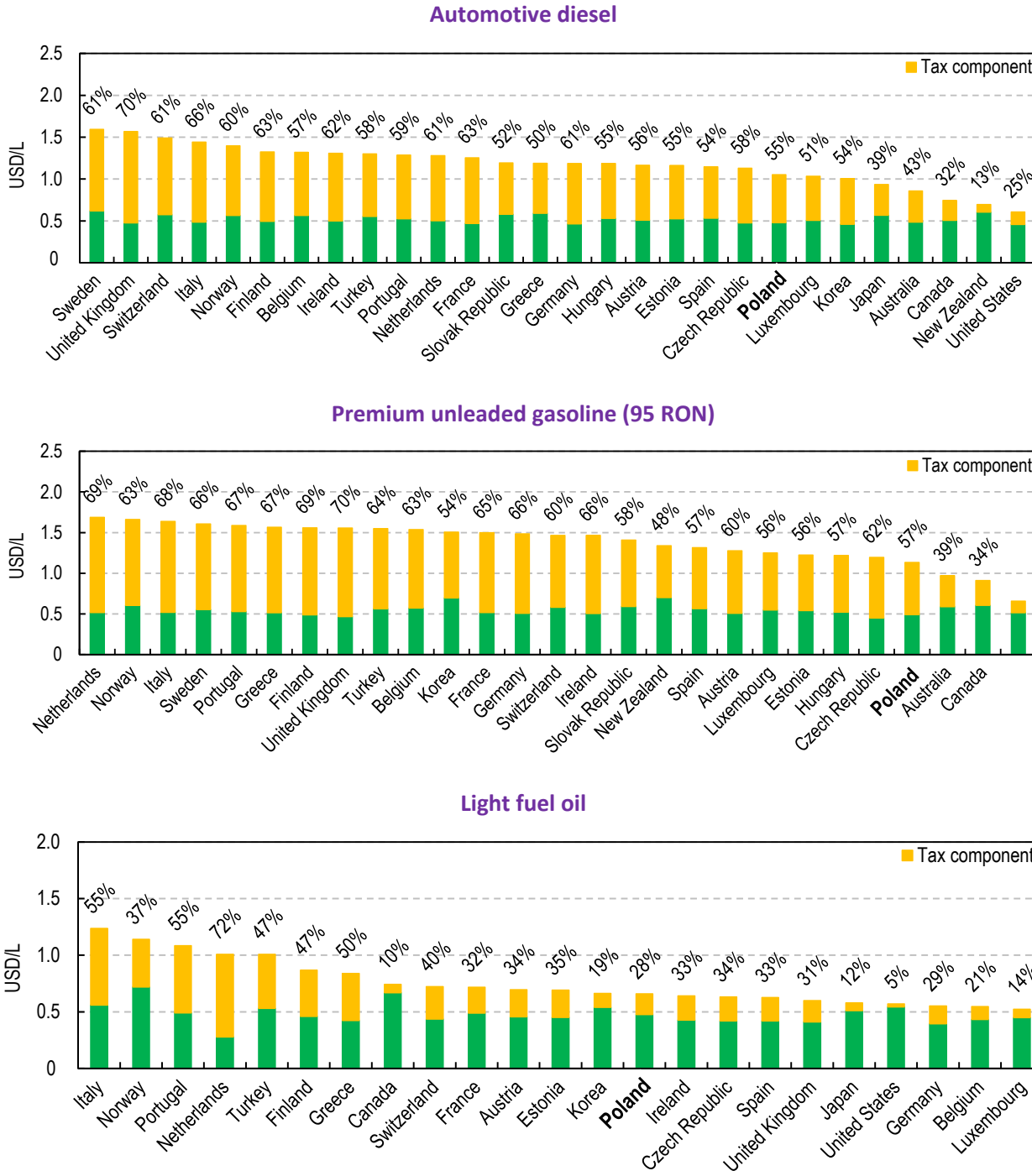
Wholesale prices are unregulated and, while they reflect the refiners' and importers' costs and profits, they are reflective of world prices for crude oil. Distribution margins are matter for the suppliers.

The values of excise tax and fuel surcharge are determined by the parliament and/or government. Excise tax is imposed on many oil products, primarily motor fuels and heating oils. Fuel surcharge applies only to motor fuels (gasoline, automotive diesel and automotive LPG). The proceeds of the fuel surcharge are used for the construction of highways, through the so-called National Road Fund. Current values of excise tax and fuel surcharge are presented in the table below.

Since 2000, revenue from environmentally related taxes has increased, mostly as a result of higher taxes on transport fuels, the broadening of the energy tax base and rising levels of energy consumption. In 2014, revenue from environmentally related taxes reached 2.5% of GDP and 7.8% of total tax revenue, compared to the EU averages of 2.5% and 6.4% respectively (Eurostat, 2016b). Nonetheless, there is scope to adjust the structure of these taxes to better reflect environmental externalities. For example, the excise duty on diesel is still below that of gasoline even though diesel combustion emits more CO_2 and local pollutants per litre.

Vehicle taxes account for a lower share of revenue from environmentally related taxes than in most OECD countries. Passenger vehicle tax rates are not based on environmental criteria, and this has contributed to a large increase in imports of polluting second-hand vehicles (OECD, 2015).

Figure 10.13 Fuel prices in IEA member countries, third quarter, 2015

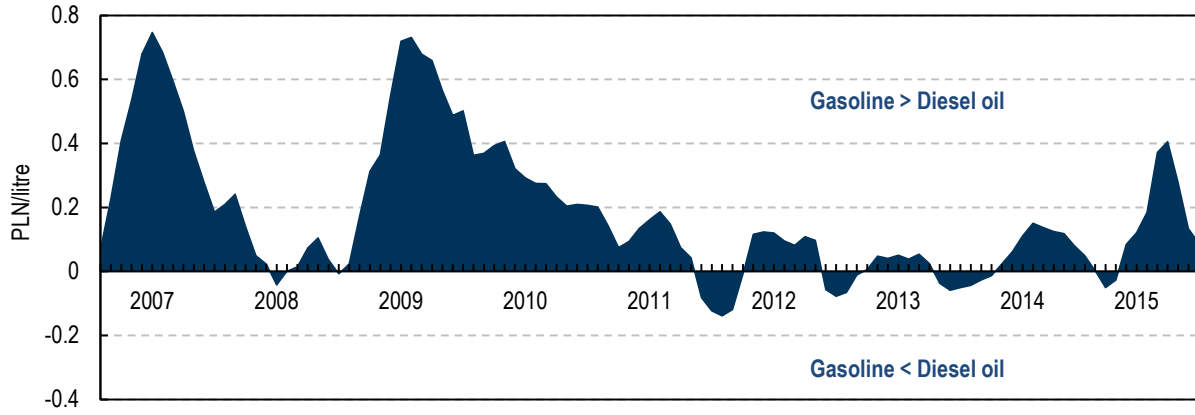


* Tax information not available.

Note: Data not available for diesel in Denmark, gasoline in Denmark and Japan, and light fuel oil in Australia, Hungary, New Zealand, the Slovak Republic, Sweden and Denmark.

Source: IEA (2015), *Energy Prices and Taxes*.

Figure 10.14 Differences between diesel and gasoline prices in Poland, 2007 to 2015



Source: Ministry of Energy, Poland IDR submission.

ASSESSMENT

Oil remains the second-largest energy source in Poland, representing 24% of the country's TPES in 2015. Poland's oil demand has increased by about 30% from 2000 to 2011 (driven by an increase in demand for transportation fuels), but slightly decreased thereafter, from 24 million tonnes of oil-equivalent (Mtoe) in 2011 to 23.2 Mtoe in 2015, the first year in which demand picked up again. The transport sector accounted for 62% of Poland's total oil consumption in 2015.

Indigenous oil production is limited, but – stimulated by high oil prices – increased from 0.7 Mtoe in 2009 to 0.95 Mtoe in 2015, representing just over 4% of oil consumption. A further increase, albeit modest, is possible. Accordingly, almost all crude oil used in Poland is imported. The Russian Federation is Poland's single largest source of crude oil imports and provided about 88% of the total in 2015. Crude oil imports from Russia are through the Druzhba pipeline and the Naftoport oil terminal in Gdańsk.

The Polish government is conscious of the inherent risks of being dependent on only a few sources of oil supply, and as a consequence large investments have been considered to develop a versatile system for pipe transportation. The key diversification project considered is the Brody-Adamowo oil pipeline, which would link the Polish oil transportation system with Ukrainian Odessa-Brody pipeline, creating a corridor for the transportation of Caspian oil to Europe. This project has, however, been beset by several delays and is still in the planning phase. Implementation of the project would improve access to other sources and enhance the oil security of the country. The same holds for increased use of the port facilities to import oil from other sources and expansion of the Pomeranian pipeline (second line), which links Gdańsk to Płock, where the largest inland refinery is located. This refinery is now linked to the Druzhba pipeline, and expansion of the Pomeranian pipeline would minimise the risk of reduction of oil transports through the Druzhba oil pipeline and ensure stable oil supplies to refineries, also those located in northern Germany.

In recent years, about one-quarter of oil products had to be imported, mostly LPG (60%) and diesel (25%), although in 2015 on balance, for the first time in years, no imports of diesel were required, thanks to changes in the configurations of the domestic refineries.

Most of Poland's refined product imports also came from Russia and former Soviet Union (FSU) states (62%), while 17% of refined products were imported from Germany.

There are four operational refineries in Poland of two partly state-owned companies. The total primary distillation capacity is around 590 kb/d. The country's refineries are able to meet domestic demand for most products, with the notable exception of LPG. LPG accounts for about 18% of transport fuel (gasoline 21%), which is one of the highest shares in the OECD. Some 80% of LPG needs to be imported. LPG is favoured by low taxes, resulting in a pump price of less than 50% of the gasoline price.

Poland meets its stockholding obligation to the IEA and the European Union by holding 22 days of agency stocks and by placing a stockholding obligation on oil importers of 68 days. The role of the agency stocks is gradually increasing from 14 days in 2013 to 37 days in 2020.

A final issue in the oil sector is the so-called grey fuel market (fuels for which no VAT or excise duties are paid), which notably occurs in the diesel market, but to a lesser extent also in gasoline and LPG markets. According to estimates of the sector, 18% to 24% of the diesel market can be labelled as being grey. This can result in avoided taxes of between PLN 8 billion and PLN 10 billion (EUR 1.8 billion to EUR 2.2 billion). This not only results in unfair competition, but also in fuel insecurity, as these supplies are mostly imported and not accounted for in the import balance. As a consequence, these supplies are not incorporated in the calculation for the national emergency reserves. This would entail that if 10% of total fuels are not accounted for, the country as a whole would hold some nine days less of emergency stocks than otherwise would be required.

RECOMMENDATIONS

The government of Poland should:

- *Enhance the domestic exploration sector by attracting new entrants and thus strengthening competition and innovation.*
- *Enhance energy security by expanding the oil infrastructure, notably by building a second line of the Pomerania pipeline and constructing the Brody-Adamowo oil pipeline.*
- *Address the grey fuel market, to increase government revenues, promote fair competition and improve oil supply security.*

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PART III
ENERGY TECHNOLOGY

11. ENERGY TECHNOLOGY RESEARCH, DEVELOPMENT AND DEMONSTRATION

Key data (2015 estimated)

Government energy RD&D spending: PLN 385 million (EUR 92 million)

Share of GDP: 0.021% (IEA median: 0.028%)*

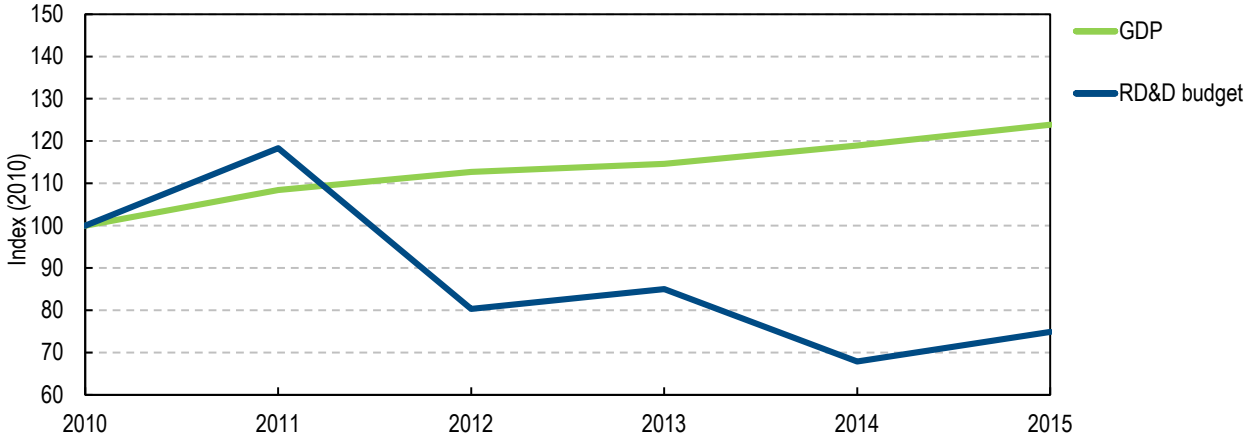
RD&D per capita: PLN 10

* Median of 16 IEA member countries for which 2015 data are available.

OVERVIEW

Poland's economic development has been on a stable upward trend with an annual gross domestic product (GDP) growth of 4.4% from 2010 to 2015, giving a total increase of 24% in five years. The government budget for research, development and demonstration (RD&D) in the energy field has, during the same period, followed a downward trend. Following a spending peak in 2011, the energy RD&D budget declined to a level that is 25% lower than in 2011 (Figure 11.1).

Figure 11.1 Energy RD&D budget compared to GDP (nominal) in Poland, 2010-15



Source: IEA (2015), *IEA Energy Technology RD&D* (database), www.iea.org/statistics/.

Poland's share of GDP spent on energy RD&D is relatively low compared to other International Energy Agency (IEA) member countries. Energy is, however, well represented among the seven research areas prioritised in Poland's 2011 National Research Programme.

One of the priority areas is new energy-related technologies, including research in energy efficiency, nuclear and clean coal technologies. At present, around one-third of public energy RD&D funding goes to fossil fuels projects, the largest share of total spending.

Energy research priorities are in line with the main directions of the Polish energy and environment policy which are outlined in the Energy Policy of Poland until 2030 (EPP 2030), adopted by the Council of Ministers in 2009, as well as in the EU 20-20-20 targets. The main aim of these policies is diversification of energy resources and development of clean, sustainable, competitive and secure energy and greater energy efficiency. The goal is to reduce or eliminate emissions causing air pollution and climate change.

INSTITUTIONS

The Ministry of Science and Higher Education is responsible for the development, implementation and co-ordination of research policy and funding, and the promotion of international collaboration. The consultative and advisory body for the minister is the Council for Science.

Sectoral ministries (e.g. Ministries of Energy, Defence, Agriculture, Environment, etc.) are responsible for the implementation of demonstration projects and for the deployment of new technologies in their respective areas.

Research orientations and programmes (including those related to energy) are defined and steered by two national funding agencies acting on behalf of the Ministry of Science and Higher Education:

- The National Centre for Science formulates the priorities for national research in the form of the National Research Programme (KPB). It funds basic research by universities and research institutions in areas including energy.
- The National Centre for Research and Development (NCBR) formulates individual research programmes within the framework of the KPB and manages applied research programmes and projects and their funding.

At least 40 state-run research institutes, higher education institutions and institutes of the Polish Academy of Sciences permanently carry out energy research. They receive basic financial support for their statutory activities and top up their budgets by competing for project funding. Most of them are also partners in EU research projects funded from EU framework programmes.

In January 2016, a new governmental body, the Innovativeness Council, was established. The Council has as its members the Ministers of Development (Head of Council), Science and Higher Education, Culture and National Heritage, Digital Affairs and State Treasury. It aims to promote competitiveness of the Polish economy and co-operation between science and business. The means include deregulation and supporting, encouraging and facilitating industry involvement in developing innovations, for example through fiscal incentives and partnerships between government, industry and academia. The plans for 2016 include amending and improving legislation on innovation.

PROGRAMMES

2011 NATIONAL RESEARCH PROGRAMME

In 2011, the Council of Ministers approved the National Research Programme (NRP). The Programme replaced the 2008 National Programme for Scientific Research and Development. It defines priority areas for publicly funded RD&D and sets goals and guidelines related to them.

The NRP lists the following seven national priority research areas that steer NCBR in identifying and preparing strategic research and development programmes and projects:

1. new energy-related technologies
2. diseases of affluence, new medicines and regenerative medicine
3. advanced information, telecommunications and mechatronic technologies
4. new materials technologies
5. natural environment, agriculture and forestry
6. Poland's social and economic development in the context of globalising markets
7. state security and defence.

Energy is an important area for RD&D, with three priority areas (new energy technologies; new materials technologies; and natural environment, agriculture and forestry) that directly relate to it, and a number of other priority areas are indirectly linked to the sector. Activities identified within these priority areas directly relate to the government's energy policy priorities.

Priority research areas are implemented by strategic research and development projects that are managed by the National Centre for Research and Development (NCRD) (applied and industrial research) and National Centre for Research (basic research).

The main focus of the NRP in the energy sector is clean fossil fuels, energy efficiency, and renewable energy including biofuels. Also included are materials science, electricity distribution and the modernisation of the national electricity grid, energy storage, fuel cells and hydrogen etc. The majority of implemented, ongoing and planned R&D projects focus primarily on government priorities: cleaner fossil fuels but also renewable energy, nuclear energy and energy efficiency.

MAJOR ENERGY PROGRAMMES

The following are examples of the largest current and/or recent programmes related to energy all of which are managed by the NCRD.

Advanced technologies for energy production

The programme ran from 2010 to 2015 and had a budget of around EUR 80 million. It consisted of four main blocks: improving energy efficiency and limiting pollutant emissions of power generation, coal gasification, oxycombustion of coal and renewable energy generation in dispersed systems. The programme supported the development of highly efficient technologies for coal combustion and gasification, as well as the creation of fuel, heat and electricity from biomass and waste.

The programme aimed at developing technological solutions, the implementation of which will be important to increase energy efficiency and reduce the negative impact of the energy sector on the environment. Solutions have been developed to help reduce emissions of air pollutants and to achieve the 2020 EU objectives for climate and energy (improving energy efficiency by 20%, increasing the share of renewable energy to 20% and reducing carbon dioxide (CO_2) emissions by 20% in the total balance of the European Union by 2020, in comparison with 1990). The results of the programme help support the deployment of Poland's domestic fuels, mainly lignite, hard coal and biomass, and other primary energy sources in a more sustainable way.

According to NCBR, the work done within the programme has shown that it is possible to reach almost zero emissions from coal-fired power generation. It is particularly important to reduce emissions of particulate matter (dust), sulphur oxides and nitrogen oxides, which affect air quality, health and life expectancy of citizens.

An important part of the programme was demonstration in a real industrial environment. With the participation of, among others, energy companies (TAURON S.A., ENERGA S.A., PGE S.A.) and Rafako S.A., Polish manufacturer of power boilers, a number of solutions has been developed which improve the efficiency of electricity generation to nearly 50%. Implementation of some of these technological solutions to commercial units will require additional long-term research in full-scale demonstration.

Possibilities of refurbishment and emissions reduction from existing power units were examined, e.g. in power stations at Łagisza, Łaziska, Dolna Odra and Turów. Some solutions for emissions reductions of CO_2 from the combustion of fuels were examined in pilot industrial installations.

The programme also examined various technologies enabling the use of distributed generation from biomass and biogas facilities. It also included a commercial-scale demonstration for underground coal gasification based on pilot installation in Wieczorek coal mine.

Blue Gas – Support Programme for Shale Gas Technologies

This EUR 240-million programme will operate from 2012 to 2022. Its budget is made up of 50% national funding and 50% industry co-funding. Its main objective is the development of shale gas technology and the establishment of shale gas in the Polish economy. The programme covers several areas of co-operation: extraction and production, assessing environmental impacts, etc. This involves different disciplines, particularly engineering, geology and geography.

BIOSTRATEG

This EUR 120-million programme will operate from 2014 to 2019. It concerns environmental issues and includes food safety, rational use of natural resources including water, climate change mitigation and adaptation including agriculture, protection of biodiversity, forestry including the wood and timber sector, and renewable energy, i.e. biofuels from agriculture.

GEKON – Generator of Ecological Concepts Programme

This EUR 100-million programme was launched in 2012 and it is jointly managed by NCRD and the National Fund for Environmental Protection and Water Management.

GEKON aims to fund projects that cover the execution of R&D activities, experimental development and implementation of innovative pro-ecological technologies in the following areas:

1. environmental aspects of search and gas exploitation from non-conventional sources
2. energy efficiency and energy storage
3. protection and rational use of water
4. clean energy
5. novel technologies for production of fuels, energy and materials from waste and recycled waste.

Other

Energy efficiency is included in all the above-mentioned programmes and projects. This is an integral part of those initiatives (i.e. Advanced Technologies for Energy Production, BIOSTRATEG, GEKON). Moreover, some projects are dedicated especially to energy efficiency, like the strategic programme Integrated System for Reducing Energy Consumption in the Maintenance of Buildings concerning new technologies in buildings, including thermo-modernisation. This project was running for the period 2010-13 with a budget of PLN 30 million and it supported technical and organisational solutions to improving energy efficiency and increasing the share of renewable sources in the energy balance of buildings.

The TECHMATSTRATEG programme, which was launched in 2016, focuses on materials, including for energy. It has a budget of EUR 125 million and runs from 2016 to 2021.

MONITORING AND EVALUATION

The NCRD is obliged by law to systematically evaluate its R&D programmes. NCRD conducts pre-programme, ongoing and post-programme evaluations. Most of these are outsourced to independent evaluation companies, but some are conducted in-house. In 2016, the NCRD was planning to evaluate two ongoing energy RD&D programmes: the Blue Gas (Polish Shale Gas) programme and the GEKON Programme.

Planned evaluation covers the following areas: the adequacy of the activities carried out in relation to the objectives of the programme; potential commercialisation of results of R&D projects; the level of innovation of supported projects; and the effectiveness of the programme in supporting scientific co-operation with industry. In recent years, the NCRD has focused on improving data collection for monitoring and evaluating programmes.

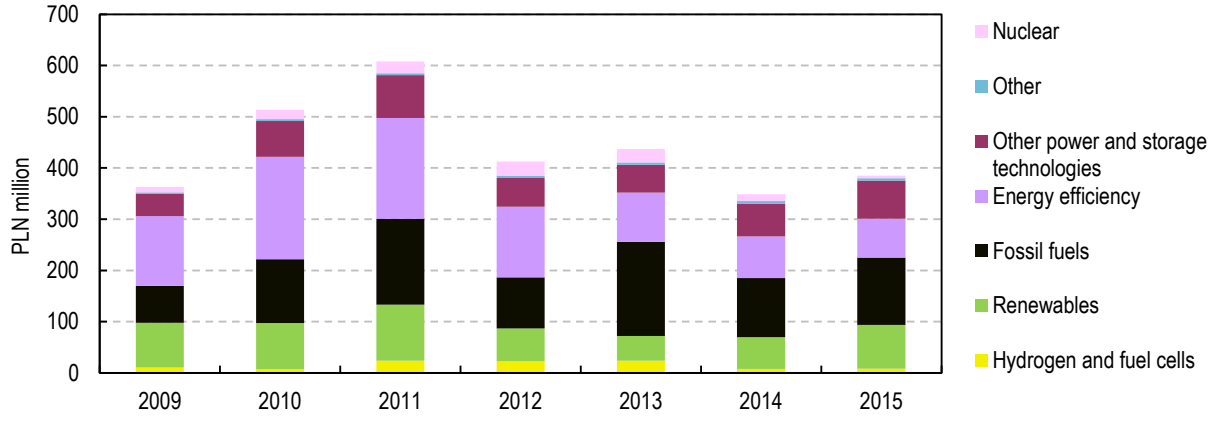
PUBLIC FUNDING

Poland spent PLN 385 million on energy-related RD&D in 2015. This was an increase of 10% since the year before, but 37% lower than the peak in 2011 (Figure 11.2). Compared to other IEA member countries, Poland's share of GDP spent on energy research is modest. In 2014, Poland's government spending on energy RD&D was the ninth-lowest

of 23 countries and in 2015 it was the sixth-lowest of 16 countries[1] (Figure 11.3). The largest share (34%) was spent on fossil fuels, followed by renewable energy (22%), energy efficiency (20%) and other power and storage technologies (20%).

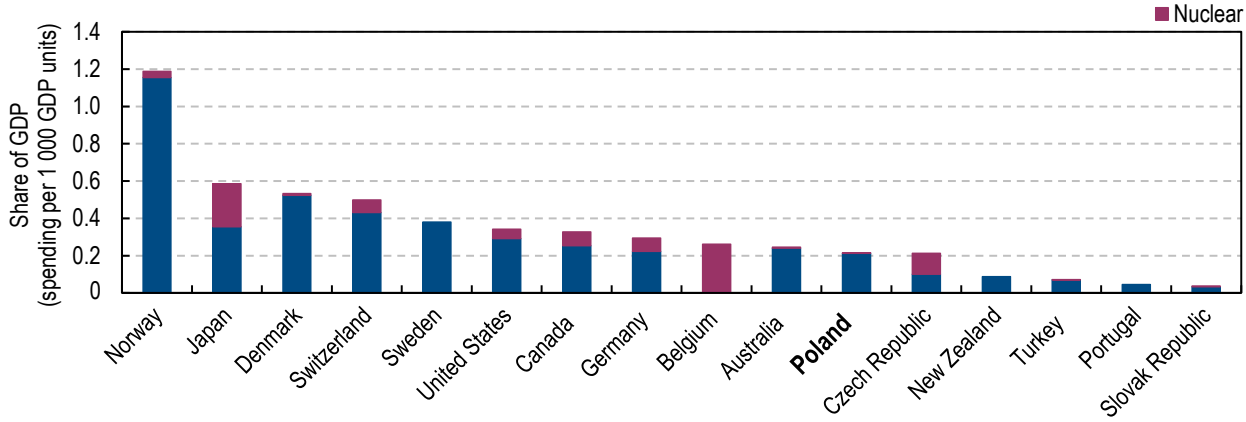
The slight decrease in government spending on energy RD&D from 2014 to 2015 is because of a change in EU funding programmes. A large number of projects running during the previous budget term 2007-13 have been finished. For the term 2014-20 many energy-related projects have just been launched or are yet to be started, especially the ones co-funded from the EU Operational Programmes implementing European Structural and Investment Funds in Poland in 2014-20. It is anticipated that funding levels of energy R&D projects will be much higher after all programmes and projects have been launched. Moreover, in 2016, NCRD will introduce two new mechanisms of co-operation for encouraging industry participation: joint undertakings and sectoral programmes will be launched.

Figure 11.2 Government energy RD&D spending by category, 2009-15



Source: IEA (2015), *IEA Energy Technology RD&D* (database), www.iea.org/statistics/.

Figure 11.3 Government energy RD&D spending as a ratio of GDP in IEA member countries, 2015



Note: 2015 data are estimates, and not available for all IEA member countries.

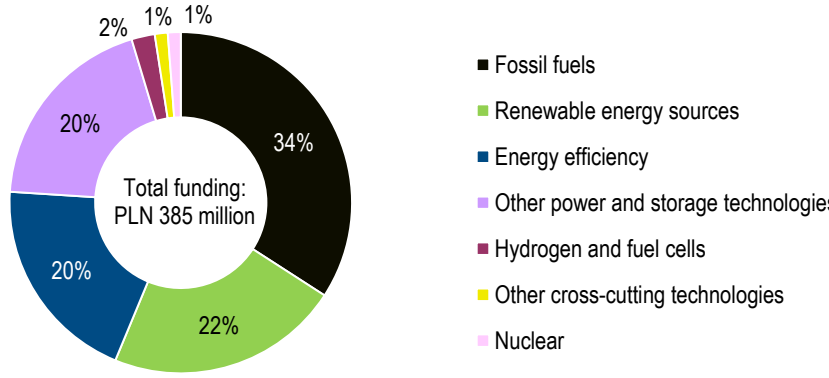
Source: IEA (2015), *IEA Energy Technology RD&D* (database), www.iea.org/statistics/.

1. RD&D data not available for all member countries each year.

In a joint undertaking, NCRD may partner with a large public or industrial company (such as Synthos S.A. or PGE S.A.) from a specific sector of the economy. The research agenda is elaborated by NCRD's partner. NCRD also offers opportunities for co-operation with academia and companies with venture capital as part of the Bridge Venture Capital programme. The majority of NCRD's programmes are open for entrepreneurs and often offer favourable conditions of participation, especially for small and medium enterprises (such as a high percentage of eligible costs coverage and short time of proposal evaluation – only 60 days in the Fast Track programme).

Sectoral programmes, in turn, follow a bottom-up approach. R&D is funded to answer industrial needs of a chosen sector. Feasibility studies for creating a new sectoral programme have been submitted by collaboration entities uniting enterprises, running R&D activities and representing a specific sector (e.g. associations, technological platforms). The aim of the programme is to translate sectoral needs into practical solutions through R&D activities. New sectoral programmes dedicated to energy technology RD&D include the Research Programme for the Power Sector (PBSE) (electro-energetic sector) and Intelligent Devices and Diffuse Energy Systems IUSER (intelligent devices and systems for energy management and energy generation); calls for proposals were expected to be announced in the third quarter of 2016.

Figure 11.4 Government energy RD&D spending, 2015



Source: IEA (2015), *IEA Energy Technology RD&D* (database), www.iea.org/statistics/.

INTERNATIONAL COLLABORATION

Poland participates in several international collaborative efforts, including two IEA Technology Collaboration Programmes focusing on fossil fuels (coal supply, electricity generation and related environmental issues; and fluidised bed conversion plants). The country also participates indirectly in the technical co-operation programmes (TCPs) related to nuclear fusion through the European Atomic Energy Community (Euratom).

Within the European Union, Poland participates in several European research area networks (ERA-NETs), mostly in the areas of bioenergy and fossil fuels. ERA-NETs are networks of national science and technology funding organisations in Europe. They identify common priorities and co-ordinate national activities within the European research area (ERA), and their co-operation is funded from the EU framework programme for research, technological development and demonstration activities (Horizon 2020 for 2014-20, FP7 for 2007-13).

In 2015, NCBR conducted two ERA-NET COFUND programmes dedicated to ETRDI: BESTF3 – Bioenergy demonstrations of the European Industrial Bioenergy Initiative and Bioenergy Sustaining the Future 3 (first call in December 2015), and ERA-NET SmartGrids Plus – four calls planned (NCBR participated in the first one in 2015).

NCBR took part also in the network co-operation dedicated to ETRDI, such as the ERA-NET BIOENERGY programme, which are bio-based economy projects focusing on energy use with an energy component (tenth joint call in October 2015; an eleventh call is planned for the end of 2016) and FENCO-ERA – Fossil Energy Coalition (last call in 2013).

Other international programmes on ETRDI with Polish participation include the Polish-Norwegian Research Programme, including the project Post-Combustion CO_2 Capture on New Solid Sorbents and Application in a Moving Bed Reactor (contracts signed in 2013 and ERA-NET Solar (contracts signed in 2014).

ASSESSMENT

Since the last review in 2011, Poland has made progress in the research and innovation sector, such as the establishment of the NRP and the Innovativeness Council. Present priorities in the sector are consistent with the energy strategy to 2030 and are likely to remain so under any new long-term strategy. Nonetheless, the level of resources devoted to research and innovation, both private and public, is significantly lower in Poland compared to most other IEA member countries. This is partly compensated, as Poland has been very successful in obtaining research and demonstration grants to the value of EUR 15.3 million in the energy part of the EU framework programmes for research and technological development (RTD) and forthcoming structural funds.

In 2011, the Council of Ministers approved the NRP, which identified seven national priority research areas. These national priority research areas are used by the National Centre for Research and Development to identify and prepare strategic research and development programmes and projects. Three priority areas – new energy technologies, new materials and environment, agriculture and forestry – are directly related to the energy sector and a number of other priority areas are indirectly linked to the sector. The programme of activities identified within these priority areas appears directly related to the government's energy priorities.

Energy R&D is an important policy instrument to meet national energy policy objectives. The development of a new energy strategy presents an opportunity for the research and innovation sector. The new strategy should contain a coherent set of policies which supports national energy policy and sets out clear measures and quantifiable objectives for the short, medium and long term. Priorities should be established, targets should be set and stakeholders should be kept well informed. To maximise the efficiency of publicly funded energy RD&D, the government should maintain the already strong links between the energy RD&D strategy and other relevant policy areas such as science and technology, education, economic development and industry. The strategy should also focus on measures to commercialise domestic research activities with a view to meeting broader economic targets such as broadening the domestic industrial base and expanding exports.

Several agencies and ministries are overseeing the sector, which sometimes results in complex decision-making and funding arrangements. In this regard, the IEA welcomed the establishment of the Innovativeness Council in January 2016. This body is

responsible for co-ordinating the innovation policy of the country and defining national innovation priorities where the Polish economy has the greatest potential. While energy may be one of the key sectors identified, this cannot be guaranteed, and participation in the Council should be broadened to include the Ministry of Energy. Furthermore, deciding on which areas are to receive funding – and how much – should be determined through structured analytical processes and mechanisms such as technology road-mapping, foresight exercises, and technology assessment and evaluation.

A notable feature of the research environment in Poland is the use of external evaluators to monitor and assess the outcomes of publicly funded energy RD&D activities. The IEA supports this as an effective way to provide an independent basis for political decision-making and to help maximise the cost-effectiveness of the R&D programmes.

The IEA understands that a new long-term strategy for the energy sector is being developed: energy-related research, development and innovation should form part of this strategy. All innovation and research-related elements of the new strategy should be developed with the co-operation of the institutions active in the sector as well as industry stakeholders, other government ministries and agencies, and European funding agencies as appropriate. As part of the consultation with stakeholders, the government should propose fewer research areas and instead focus on adapting to technology development in other areas.

The strategy should look to best practice elsewhere within the IEA membership, as well as seek to support the key goals of national energy policy. Without a comprehensive strategy that considers the entire innovation chain, different parts of government have a tendency to support different energy technologies at different times, often leading to inadequate co-ordination or follow-up.

The primary role of the government in this sector should be to encourage energy technology innovation in two ways: through technology push and market pull. They can bring the costs and risks of innovation in line with the available benefits by implementing measures that reduce the cost to firms of producing innovation and encouraging investment in energy technologies and innovation on the supply side (technology-push measures). A second, and often complementary, approach is that governments can create a value for the public benefit by implementing measures that increase the private payoff to successful innovation, thereby increasing demand for low-carbon energy technologies (market-pull measures). Literature on the effectiveness of energy technology policy and on the economics of innovation reaches the consensus that both types of approaches are necessary.

RECOMMENDATIONS

The government of Poland should:

- *Define, on the basis of the forthcoming energy strategy to 2050 and through a multi-stakeholder involvement process, clear priorities for energy technology research, development and innovation alongside an increased and stable funding mechanism.*
- *Broaden the scope of the Innovativeness Council to include the Ministry of Energy and ensure that energy innovation plays a prominent role in this new co-ordinating body.*

References

IEA (2015), "RD&D budget", *IEA Energy Technology RD&D* (database), www.iea.org/statistics/.

PART III
ANNEXES

ANNEX A: ORGANISATION OF THE REVIEW

REVIEW CRITERIA

The Shared Goals, which were adopted by the International Energy Agency (IEA) Ministers at their 4 June 1993 meeting in Paris, provide the evaluation criteria for the in-depth reviews (IDRs) conducted by the IEA. The Shared Goals are presented in Annex C.

REVIEW TEAM

The IDR team visited Warsaw from 27 June to 1 July 2016. During the visit, the review team met with government officials, representatives from ministries and government agencies, market participants, non-governmental organisations, consumers groups, and other organisations and stakeholders. This report was drafted on the basis of the information obtained in these meetings, the Polish government response to the IEA energy policy questionnaire and information from many other sources. The team is grateful for the co-operation and hospitality of the many people it met during the visit. Thanks to their openness and willingness to share information, the review visit was highly productive.

The team is grateful for the co-operation and assistance of the many people from the many state, public and private institutions it met throughout the visit. Thanks to their openness and willingness to share information, the visit was highly informing, productive and enjoyable. The team wishes to express its gratitude to Mr. Michal Kurtyka, Undersecretary of State in the Ministry of Energy and his management team for hosting our visit. The team is also grateful to Ms Elzbieta Piskorz, Director, Oil and Gas Department and Mr. Janusz Michalski, Head of Unit, Energy Department, their teams and support staff for their input and support throughout the week. The team is especially thankful to Mr. Michal Paszkowski, Expert, Oil and Gas Department for organising the team visit, facilitating our many requests but also for his patience throughout the week.

The members of the review team were:

- Team Leader – Ms Theresia Vogel, Managing Director, Climate and Energy Fund, Austria
- Alasdair Harper, Senior Policy Advisor, Civil Nuclear & Resilience Directorate, Department of Energy and Climate Change, United Kingdom
- André Hempel, Advisor, Department of Energy Policy (Heating and Efficiency), Federal Ministry for Economic Affairs and Energy, Germany
- Daniel Friberg, Programme Manager, Energy Analysis Department, Swedish Energy Agency, Sweden
- Jon Trap Jespersen, Advisor, Centre for Climate and Energy Economics, Danish Energy Agency, Denmark

- Jacek Truszczynski, Policy Officer, Unit A4 Economic Analysis & Financial Instruments, Directorate-General for Energy, European Commission
- David Henderson, Nuclear Energy Analyst, Nuclear Energy Agency, OECD
- Carlos Fernandez Alvarez, Senior Coal Analyst, IEA
- Aad van Bohemen, Head of Country Studies, IEA
- Kieran McNamara, Desk Officer, IEA

The review was prepared under the guidance of Mr Paul Simons, Deputy Executive Director, IEA, and Mr Aad van Bohemen, Head of Country Studies Division, IEA. Kieran McNamara managed the review and is the author of the report with the exceptions of Chapter 4 on energy efficiency, which was drafted by Mr. Oskar Kvarnström, Chapter 11 on energy technology, which was drafted by Mr. Miika Tommila and Chapter 7 on nuclear energy, which was drafted by Mr Dave Henderson of the Nuclear Energy Agency. Mr. Jan Bartos was also a substantial contributor to Chapter 10 on oil.

Mr Oskar Kvarnström prepared and drafted the sections relating to energy data contained in each chapter. Mr Aad van Bohemen, Mr Carlos Fernandez-Alvarez, Ms Karolina Daszkiewicz, Ms Ute Collier, Ms Rebecca Gaghen and Ms Costanza Jacazio each contributed helpful comments throughout.

Mr Oskar Kvarnström, Ms Jiyeon Lim and Mr Bertrand Sadin prepared the figures. Ms Quadrelli and Mr Remi Gigoux provided support on statistics. Ms Kristine Douaud and Ms Therese Walsh provided editorial assistance, while Ms Muriel Custodio, Ms Astrid Dumond and Ms Katie Russell managed the production process. Mr Oskar Kvarnström and Ms Jiyeon Lim helped in the final stages of preparation.

ORGANISATIONS VISITED

Association of Energy Trading

Association of Lignite Producers

Central Mining Institute

Chief Geologist of Poland

Climate Coalition

Climate Coalition

Economic Society Polish Power Plants

Eko-Plus

Energa

Enea

Energy Market Agency

Energy Regulatory Office

Federation of Consumers

Forum of Electricity and Gas Consumers

Gaz-System

Institute for Renewable Energy

Jastrzębska Spółka Węglowa

Katowicki Holding Węglowy

Lewiatan Confederation

Lubelski Węgiel Bogdanka

Ministry of Energy

Ministry of Environment

Ministry of Infrastructure and Construction

Ministry of Science and Higher Education

National Administration of the Emission Trading Scheme in Poland

National Centre for Emissions Management

National Centre for Research and Development

National Chamber of Biofuels

National Fund for Environmental Protection and Water Management

Office of Competition and Consumer Protection

Office of Competition and Consumer Protection

PERN

PGE

PGE EJ1

PGNiG

Polish Association of CHP

Polish Association of Electricity Transmission and Distribution

Polish Chamber of Biomass

Polish Chamber of Chemical Industry

Polish Chamber of Liquid Fuels

Polish District Heating Chamber of Commerce

Polish Economic Chamber of Metals

Polish Economic Chamber of Renewable and Distributed Energy

Polish Economic Chamber of Renewable Energy

Polish Foundation for Energy Efficiency

Polish Geological Institute

Polish LPG Association

Polish National Energy Conservation Agency

Polish Organization of Oil Industry and Trade

Polish Power Exchange

Polish Steel Association

Polish Wind Energy Association

Polska Grupa Górnicza

Przedsiębiorstwo Górnicze Silesia

Polskich Sieci Elektroenergetycznych (PSE) S.A.

RWE

Siltech

Spółka Restrukturyzacji Kopalń

Straight Consult

TAURON Polska Energia

Tauron Wydobycie

University of Science and Technology (AGH)

Węglokoks

ANNEX B: ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY		1973	1990	2000	2010	2013	2014	2015E
TOTAL PRODUCTION		**44.2**	**111.9**	**130.7**	**135.4**	**135.7**	**137.1**	**137.3**
Coal		18.0	8.2	2.5	0.2	0.2	0.2	0.0
Peat		-	-	-	-	-	-	-
Oil		2.1	3.5	1.8	1.1	1.0	0.9	1.0
Natural gas		6.3	2.5	1.5	0.6	0.3	0.0	0.0
Biofuels and waste[1]		9.8	11.0	10.8	15.3	15.7	14.5	14.8
Nuclear		3.8	81.9	108.2	111.7	110.4	113.7	114.0
Hydro		4.1	4.6	5.7	5.4	6.1	5.4	4.7
Wind		-	-	0.0	0.9	1.4	1.5	1.8
Geothermal		0.0	0.1	0.1	0.2	0.2	0.2	0.2
Solar/other[2]		0.0	0.1	0.1	0.2	0.5	0.7	0.8
TOTAL NET IMPORTS[3]		**138.3**	**113.8**	**124.8**	**123.2**	**116.5**	**106.8**	**107.7**
Coal	Exports	1.3	0.6	0.5	0.2	0.1	0.0	0.1
	Imports	10.8	13.7	13.5	12.4	11.8	9.2	8.8
	Net imports	9.5	13.0	13.0	12.2	11.6	9.2	8.7
Oil	Exports	13.6	14.6	22.7	23.1	19.2	19.0	21.3
	Imports	142.2	100.5	112.5	104.9	97.7	95.8	98.2
	Int'l marine and aviation bunkers	-7.2	-5.6	-7.9	-7.8	-7.7	-7.4	-7.3
	Net imports	121.5	80.3	82.0	74.0	70.8	69.3	69.6
Natural Gas	Exports	0.1	0.3	0.7	2.6	4.5	6.4	4.9
	Imports	7.6	24.7	36.4	42.1	42.5	40.1	39.4
	Net imports	7.6	24.4	35.8	39.5	38.0	33.8	34.6
Electricity	Exports	0.6	4.5	6.3	4.3	5.2	6.5	6.4
	Imports	0.4	0.6	0.3	1.7	1.0	0.7	0.9
	Net imports	-0.2	-3.9	-6.0	-2.6	-4.2	-5.8	-5.5
TOTAL STOCK CHANGES		**-2.3**	**-1.7**	**-3.5**	**2.6**	**0.8**	**-1.3**	**0.7**
TOTAL SUPPLY (TPES)[4]		**180.1**	**224.0**	**251.9**	**261.2**	**253.0**	**242.6**	**245.7**
Coal		29.3	20.2	15.0	12.1	12.4	9.3	8.9
Peat		-	-	-	-	-	-	-
Oil		119.8	84.0	82.2	75.6	71.2	70.2	70.7
Natural gas		13.5	26.0	35.8	42.5	39.0	32.6	35.0
Biofuels and waste[1]		9.8	11.0	10.8	15.4	15.9	14.8	15.1
Nuclear		3.8	81.9	108.2	111.7	110.4	113.7	114.0
Hydro		4.1	4.6	5.7	5.4	6.1	5.4	4.7
Wind		-	-	0.0	0.9	1.4	1.5	1.8
Geothermal		0.0	0.1	0.1	0.2	0.2	0.2	0.2
Solar/other[2]		0.0	0.1	0.1	0.2	0.5	0.7	0.8
Electricity trade[5]		-0.2	-3.9	-6.0	-2.6	-4.2	-5.8	-5.5
Shares in TPES (%)								
Coal		*16.3*	*9.0*	*6.0*	*4.6*	*4.9*	*3.8*	*3.6*
Peat		-	-	-	-	-	-	-
Oil		*66.5*	*37.5*	*32.6*	*28.9*	*28.1*	*29.0*	*28.8*
Natural gas		*7.5*	*11.6*	*14.2*	*16.3*	*15.4*	*13.4*	*14.3*
Biofuels and waste[1]		*5.4*	*4.9*	*4.3*	*5.9*	*6.3*	*6.1*	*6.1*
Nuclear		*2.1*	*36.5*	*43.0*	*42.8*	*43.6*	*46.9*	*46.4*
Hydro		*2.3*	*2.1*	*2.3*	*2.1*	*2.4*	*2.2*	*1.9*
Wind		-	-	-	*0.3*	*0.5*	*0.6*	*0.7*
Geothermal		*0.0*	*0.0*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Solar/other[2]		*0.0*	*0.0*	*0.0*	*0.1*	*0.2*	*0.3*	*0.3*
Electricity trade[5]		*-0.1*	*-1.7*	*-2.4*	*-1.0*	*-1.6*	*-2.4*	*-2.2*

0 is negligible, - is nil, .. is not available, x is not applicable. Note: rounding may cause totals to differ from the sum of the elements.
2015 estimated data are only available for energy supply and economic indicators.

Unit: Mtoe

DEMAND FINAL CONSUMPTION	1973	1990	2000	2010	2013	2014	2015E
TFC	**142.2**	**143.2**	**163.2**	**161.4**	**157.5**	**147.7**	**..**
Coal	14.0	7.8	4.4	3.5	3.2	3.2	..
Peat	-	-	-	-	-	-	..
Oil	96.0	75.2	81.2	71.6	68.4	67.3	..
Natural gas	10.3	23.9	32.1	33.0	33.3	28.2	..
Biofuels and waste[1]	8.9	9.7	9.0	11.6	12.2	10.9	..
Geothermal	0.0	0.1	0.1	0.0	0.0	0.0	..
Solar/other[2]	-	0.0	0.0	0.1	0.1	0.1	..
Electricity	12.8	26.0	33.1	38.2	37.9	35.7	..
Heat	0.3	0.5	3.2	3.5	2.3	2.2	..
Shares in TFC (%)							
Coal	*9.8*	*5.4*	*2.7*	*2.1*	*2.0*	*2.1*	..
Peat	-	-	-	-	-	-	..
Oil	*67.5*	*52.5*	*49.7*	*44.3*	*43.4*	*45.6*	..
Natural gas	*7.2*	*16.7*	*19.7*	*20.4*	*21.2*	*19.1*	..
Biofuels and waste[1]	*6.3*	*6.7*	*5.5*	*7.2*	*7.8*	*7.4*	..
Geothermal	*0.0*	*0.1*	*0.1*	*0.0*	*0.0*	*0.0*	..
Solar/other[2]	-	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	..
Electricity	*9.0*	*18.2*	*20.3*	*23.7*	*24.1*	*24.2*	..
Heat	*0.2*	*0.3*	*2.0*	*2.2*	*1.5*	*1.5*	..
TOTAL INDUSTRY[6]	**56.3**	**46.3**	**50.9**	**40.8**	**41.7**	**39.9**	**..**
Coal	7.3	6.1	3.8	3.1	2.9	2.9	..
Peat	-	-	-	-	-	-	..
Oil	35.0	17.8	19.3	15.8	14.9	15.2	..
Natural gas	5.7	11.1	14.7	10.4	12.9	10.9	..
Biofuels and waste[1]	1.2	1.5	1.6	1.5	1.4	1.3	..
Geothermal	-	-	-	-	-	-	..
Solar/other[2]	-	-	-	-	-	-	..
Electricity	7.2	9.9	11.6	10.1	9.6	9.6	..
Heat	-	-	-	-	-	-	..
Shares in total industry (%)							
Coal	*12.9*	*13.2*	*7.5*	*7.5*	*6.9*	*7.3*	..
Peat	-	-	-	-	-	-	..
Oil	*62.1*	*38.3*	*37.9*	*38.6*	*35.8*	*38.1*	..
Natural gas	*10.0*	*23.9*	*28.8*	*25.5*	*30.9*	*27.3*	..
Biofuels and waste[1]	*2.1*	*3.2*	*3.1*	*3.6*	*3.4*	*3.3*	..
Geothermal	-	-	-	-	-	-	..
Solar/other[2]	-	-	-	-	-	-	..
Electricity	*12.8*	*21.3*	*22.7*	*24.7*	*23.0*	*24.0*	..
Heat	-	-	-	-	-	-	..
TRANSPORT[4]	**24.7**	**38.6**	**45.0**	**43.8**	**43.3**	**43.5**	**..**
OTHER[7]	**61.2**	**58.2**	**67.3**	**76.8**	**72.5**	**64.2**	**..**
Coal	6.6	1.7	0.6	0.4	0.3	0.3	..
Peat	-	-	-	-	-	-	..
Oil	37.0	19.6	18.2	15.5	14.0	12.6	..
Natural gas	4.6	12.8	17.5	22.5	20.4	17.2	..
Biofuels and waste[1]	7.7	8.2	7.1	7.7	8.1	6.7	..
Geothermal	0.0	0.1	0.1	0.0	0.0	0.0	..
Solar/other[2]	-	0.0	0.0	0.1	0.1	0.1	..
Electricity	5.0	15.4	20.5	27.0	27.2	25.1	..
Heat	0.3	0.5	3.2	3.5	2.3	2.2	..
Shares in other (%)							
Coal	*10.8*	*2.9*	*0.9*	*0.5*	*0.4*	*0.4*	..
Peat	-	-	-	-	-	-	..
Oil	*60.4*	*33.7*	*27.0*	*20.2*	*19.4*	*19.6*	..
Natural gas	*7.5*	*22.0*	*26.0*	*29.3*	*28.1*	*26.8*	..
Biofuels and waste[1]	*12.6*	*14.0*	*10.5*	*10.1*	*11.2*	*10.4*	..
Geothermal	-	*0.2*	*0.2*	*0.0*	*0.0*	*0.0*	..
Solar/other[2]	-	-	-	*0.1*	*0.1*	*0.2*	..
Electricity	*8.2*	*26.4*	*30.5*	*35.2*	*37.6*	*39.0*	..
Heat	*0.4*	*0.8*	*4.8*	*4.6*	*3.2*	*3.5*	..

0 is negligible, - is nil, .. is not available, x is not applicable. Please note: rounding may cause totals to differ from the sum of the elements.
2015 estimated data are only available for energy supply and economic indicators.

Unit: Mtoe

DEMAND							
ENERGY TRANSFORMATION AND LOSSES	**1973**	**1990**	**2000**	**2010**	**2013**	**2014**	**2015E**
ELECTRICITY GENERATION[8]							
Input (Mtoe)	36.7	98.3	127.6	137.5	133.2	131.9	..
Output (Mtoe)	15.7	35.9	46.0	48.5	48.8	47.9	48.4
Output (TWh)	182.5	417.2	535.2	564.3	567.2	557.0	563.2
Output Shares (%)							
Coal	*19.7*	*8.5*	*5.8*	*4.7*	*4.3*	*2.2*	*2.2*
Peat	-	-	-	-	-	-	-
Oil	*40.2*	*2.1*	*1.3*	*1.0*	*0.4*	*0.3*	*0.3*
Natural gas	*5.5*	*0.7*	*2.2*	*4.2*	*3.0*	*2.3*	*3.5*
Biofuels and waste[1]	*0.1*	*0.4*	*0.7*	*1.1*	*1.2*	*1.2*	*1.3*
Nuclear	*8.1*	*75.3*	*77.6*	*75.9*	*74.7*	*78.4*	*77.7*
Hydro	*26.1*	*12.9*	*12.4*	*11.1*	*12.5*	*11.3*	*9.7*
Wind	-	-	-	*1.8*	*2.8*	*3.1*	*3.8*
Geothermal	-	-	-	-	-	-	-
Solar/other[2]	*0.3*	*0.1*	*0.1*	*0.2*	*1.0*	*1.2*	*1.5*
TOTAL LOSSES	**38.1**	**76.3**	**94.0**	**98.9**	**93.6**	**93.3**	**-0.2**
of which:							
Electricity and heat generation[9]	20.8	62.0	78.3	85.2	81.2	81.1	..
Other transformation	5.3	2.4	1.9	1.3	1.8	1.8	-0.2
Own use and transmission/distribution losses[10]	12.1	11.9	13.8	12.5	10.6	10.4	..
Statistical Differences	**-0.2**	**4.5**	**-5.3**	**0.9**	**1.9**	**1.7**	**..**
INDICATORS	**1973**	**1990**	**2000**	**2010**	**2013**	**2014**	**2015E**
GDP (billion 2010 USD)	1223.98	1907.28	2346.48	2646.84	2724.58	2729.47	2761.02
Population (millions)	53.33	58.23	60.87	64.97	65.88	66.17	66.49
TPES/GDP (toe/1000 USD)[11]	0.15	0.12	0.11	0.10	0.09	0.09	0.09
Energy production/TPES	0.25	0.50	0.52	0.52	0.54	0.57	0.56
Per capita TPES (toe/capita)	3.38	3.85	4.14	4.02	3.84	3.67	3.70
Oil supply/GDP (toe/1000 USD)[11]	0.10	0.04	0.04	0.03	0.03	0.03	0.03
TFC/GDP (toe/1000 USD)[11]	0.12	0.08	0.07	0.06	0.06	0.05	..
Per capita TFC (toe/capita)	2.67	2.46	2.68	2.48	2.39	2.23	..
CO_2 emissions from fuel combustion ($MtCO_2$)[12]	474.2	345.5	364.6	340.1	317.1	285.7	..
CO_2 emissions from bunkers ($MtCO_2$)[12]	22.6	17.3	24.2	23.9	23.6	22.7	..
GROWTH RATES (% per year)	**73-90**	**90-00**	**00-10**	**10-12**	**12-13**	**13-14**	**14-15**
TPES	1.3	1.2	0.4	-1.8	0.4	-4.1	1.3
Coal	-2.2	-2.9	-2.2	-2.5	8.5	-25.4	-4.4
Peat	-	-	-	-	-	-	-
Oil	-2.1	-0.2	-0.8	-1.5	-2.9	-1.3	0.6
Natural gas	3.9	3.2	1.7	-5.2	2.1	-16.4	7.5
Biofuels and waste[1]	0.7	-0.2	3.7	-1.7	6.8	-7.0	2.0
Nuclear	19.7	2.8	0.3	-0.4	-0.4	3.0	0.2
Hydro	0.7	2.1	-0.6	-3.2	20.4	-11.2	-12.6
Wind	-	-	71.0	22.5	7.5	7.5	22.8
Geothermal	26.6	1.4	3.3	2.3	18.0	1.4	0.9
Solar/other[2]	2.1	-0.5	9.4	71.4	14.1	22.5	20.2
TFC	0.0	1.3	-0.1	-2.2	2.0	-6.2	..
Electricity consumption	4.3	2.4	1.4	-1.1	1.5	-5.8	..
Energy production	5.6	1.6	0.4	-0.5	1.3	1.0	0.1
Net oil imports	-2.4	0.2	-1.0	-1.4	-1.6	-2.1	0.4
GDP	2.6	2.1	1.2	1.1	0.7	0.2	1.2
TPES/GDP	-1.3	-0.9	-0.8	-2.9	-0.2	-4.3	0.1
TFC/GDP	-2.5	-0.8	-1.3	-3.3	1.4	-6.4	..

0 is negligible, - is nil, .. is not available, x is not applicable. Please note: rounding may cause totals to differ from the sum of the elements.

2015 estimated data are only available for energy supply and economic indicators.

Footnotes to energy balances and key statistical data

1. Biofuels and waste comprises solid biofuels, liquid biofuels, biogases, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.
2. Other includes tide, wave and ambient heat used in heat pumps.
3. In addition to coal, oil, natural gas and electricity, total net imports also include peat, biofuels and waste and trade of heat.
4. Excludes international marine bunkers and international aviation bunkers.
5. Total supply of electricity represents net trade. A negative number in the share of total primary energy supply (TPES) indicates that exports are greater than imports.
6. Industry includes non-energy use.
7. Other includes residential, commercial and public services, agriculture/forestry, fishing and other non-specified.
8. Inputs to electricity generation include inputs to electricity, combined heat and power (CHP) and heat plants. Output refers only to electricity generation.
9. Losses arising in the production of electricity and heat at main activity producer utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of approximately 33% for nuclear and solar thermal, 10% for geothermal and 100% for hydro, wind and solar photovoltaic.
10. Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.
11. Tonnes of oil-equivalent (toe) per USD 1 000 at 2010 prices and exchange rates.
12. "CO_2 emissions from fuel combustion" have been estimated using the Intergovernmental Panel on Climate Change (IPCC) Tier I Sectoral Approach from the *2006 IPCC Guidelines.* In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2013 and applying this factor to forecast energy supply. Projected emissions for coal are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

ANNEX C: INTERNATIONAL ENERGY AGENCY "SHARED GOALS"

The member countries* of the International Energy Agency (IEA) seek to create conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and to the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants. In order to secure their objectives, member countries therefore aim to create a policy framework consistent with the following goals:

1. Diversity, efficiency and flexibility within the energy sector are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group.

2. Energy systems should have **the ability to respond promptly and flexibly to energy emergencies.** In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.

3. The environmentally sustainable provision and use of energy are central to the achievement of these shared goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should respect the Polluter Pays Principle where practicable.

4. More environmentally acceptable energy sources need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA member countries wish to retain and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5. Improved energy efficiency can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6. Continued **research, development and market deployment of new and improved energy technologies** make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

7. Undistorted energy prices enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To

the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8. Free and open trade and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9. Co-operation among all energy market participants helps to improve information and understanding, and encourages the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA Ministers at the meeting of 4 June 1993 Paris, France.)

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

ANNEX D: GLOSSARY AND LIST OF 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.

AAU	Assigned Amount Units
ACER	Agency for the Cooperation of Energy Regulators
ARA	Amsterdam Rotterdam Antwerp
AZM	Administration of Housing Resources
BaP	benzo(a)pyrene
BEMIP	Baltic Energy Market Interconnections Plan
BEV	battery electric vehicles
BMB	Barnówko-Mostno-Buszewo
CACM	Capacity Allocation and Congestion Management
CBA	cost benefit analysis
CCGT	combined-cycle gas turbine
CCS	carbon capture and storage
CCS&U	carbon capture storage and utilisation
CCU	carbon capture and utilisation
CDM	clean development mechanism (under the Kyoto Protocol)
CEE	Central Eastern Europe
CEF	Connecting Europe Facility
CER	certified emissions reduction
CFB	circulating fluidised bed
CfD	contracts for difference
CFIM	Commodity Forward Instruments Market
CH_4	methane
CHP	combined heat and power
CIF	cost, insurance and freight
CMM	coal-mine methane
CNG	compressed natural gas
CO_2	carbon dioxide
CSO	compulsory stockholding obligation
CZOK	Central Plant of Mines Dewatering
DAM	Day-Ahead Market
DH	district heating
DRA	drag-reducing agent
DSO	distribution system operator
EC	European Commission
EDP	Electromobility Development Plan
EEA	Energy Efficiency Act

EEA	European Economic Area
EED	energy efficiency directive
EHV	extra-high voltage
EIA	Energy Information Administration
EIA	environmental impact assessment
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSO-G	European Network of Transmission System Operators for Gas
EPC	Energy Performance Contract
EPP 2030	Energy Policy of Poland until 2030
ERA	European research area
ERA-NET	European research area networks
ERO	Energy Regulatory Office
ERU	emissions reduction unit
ESCO	energy service company
ESD	Effort Sharing Decision
ESE	Energy Security and Environment
EU	European Union
EU ETS	European Union Emissions Trading Scheme
EUA	emission unit allowances
EUR	euro
EV	electric vehicle
EVSE	EV supply equipment
FEA	Forum for Energy Analysis
FSU	former Soviet Union
GDDKiA	General Directorate for National Roads and Motorways
GDP	gross domestic product
GEKON	Generator of Ecological Concepts Programme
GHG	greenhouse gas
GIS	green investment scheme
GUS	Central Statistical Office
HFC	hydrofluorocarbon
HHI	Herfindahl-Hirschman Index
HTR	high-temperature reactor
IAEA	International Atomic Energy Agency
IBL	Forest Research Institute
IEA	International Energy Agency
ICV	internal combustion engine vehicles
IDR	in-depth review
IDM	intraday market
IEA	International Energy Agency
IEP	International Energy Programme
INIR	Integrated Nuclear Infrastructure Review
IRiESP	Transmission Grid Code
ISO	independent system operator
JI	Joint Implementation
JSW	Jastrzebska Spolka Węglowa
KHW	Katowicki Holding Węglowy
KP	Kyoto Protocol
KPB	National Research Programme

KW	Kompania Węglowa
KWK	Hard Coal Mines in Total Liquidation
LCV	light commercial vehicles
LHV	lower heating value
LNG	liquefied natural gas
LPG	liquefied petroleum gas
LULUCF	land use, land-use change and forestry
MRA	Material Reserve Agency
N_2O	nitrous oxide
NAEA	National Atomic Energy Agency
NAP	national allocation plan
NAS 2020	Polish National Strategy for Adaptation to Climate Change
NCBJ	National Centre for Nuclear Research
NCBR	National Centre for Research and Development
NCRD	National Centre for Research and Development
NEEAP	National Energy Efficiency Action Plan
NEPIO	Nuclear Energy Programme Implementing Organisation
NER	New Entrants' Reserve
NESO	National Emergency Strategy Organisation
NFEPWM	National Fund for Environmental Protection and Water Management
NIP	National Investment Plan
NO_x	nitrogen oxide
NPP	nuclear power plant
NREAP	National Renewable Energy Action Plan
NRO	nuclear regulatory organisations
NRP	National Research Programme
OECD	Organisation for Economic Co-operation and Development
OSM	Operator Systemu Magazynowania
OU	ownership unbundling
PAA	Polish National Atomic Energy Agency
PBSE	Research Programme for the Power Sector
PCI	Projects of Common Interest
PFC	perfluorocarbon
PFRON	National Fund for Rehabilitation of Disabled People
PGE	Polska Grupa Energetyczna
PGE EJ	PGE Energia Jadrowa
PGG	Polska Grupa Górnicza
PHEV	plug-in hybrid electric vehicles
PiS	Law and Justice Party
PLN	Polish zloty
PM	particulate matter
PM10	coarse dust particles: 10 micrometres or less in diameter
PM2.5	fine particles: 2.5 micrometres in diameter or smaller
PNPP	Polish Nuclear Power Programme
POLPX	Polish Power Exchange
POPiHN	Polish Organisation of Oil Industry and Trade
PPP	purchasing power parity
PSE	Polskie Sieci Elektroenergetyczne
PSG	Polska Spółka Gazownictwa

R&D	research and development
RD&D	research, development and demonstration
REBCO	Russian Export Blend Crude Oil
REMIT	Regulation on Wholesale Energy Market Integrity and Transparency
RES	renewable energy system
RMR	reliability-must-run
RTD	research and technological development
RWDE	Radioactive Waste Disposal Enterprise
SAIDI	System Average Interruption Duration Index
SEE	South East Europe
SF_6	sulphur hexafluoride
SO_2	sulphur dioxide
SRK	Spółka Restrukturyzacji Kopalń (Mine Restructuring Company)
SSO	storage system operator
TCP	technical co-operation programme
TFC	total final consumption
TGE	Towarowa Giełda Energii
TPA	third-party access
TPES	total primary energy supply
TRNC	Turkish Republic of Northern Cyprus
TSC	Transmission System Operators Security Co-operation
TSO	transmission system operator
TYNDP	ten-year network development plans
UGS	underground gas storage
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar
VAT	value-added tax
VIU	vertically integrated undertaking
VRE	variable renewable energy
WCS	white certificate scheme
WLPGA	World Liquefied Petroleum Gas Association
ZUS	Social Insurance Institution

UNITS OF MEASUREMENT

b/d	barrels per day
bcm	billion cubic metres
cm	cubic metre
cm/h	cubic metres per hour
gCO_2/km	grammes of carbon dioxide per kilometre
GJ	gigajoule
Gt	gigatonne
GW	gigawatt
GWh	gigawatt hour
GW_e	gigawatt electrical capacity
kb/d	thousand barrels per day
kg	kilogramme
km	kilometre
km^2	square kilometre

kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
m	metre
mb/d	million barrels per day
mcm	million cubic metres
mcm/d	million cubic metres per day
mg	milligramme
Mt	million tonnes
$MtCO_2$	million tonnes of carbon dioxide
$MtCO_2$-eq	million tonnes of carbon dioxide-equivalent
Mtoe	million tonnes of oil-equivalent
Mtpa	million tonnes per annum
Mt/yr	million tonnes per year
MW	megawatt
MW_e	megawatt electrical
MWh	megawatt-hour
MW_{th}	megawatt thermal
Nm^3	normal cubic metre
PJ	petajoule
t	tonne
tcm	trillion cubic metres
toe	tonne of oil-equivalent
TWh	terawatt-hour
W	watt

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Energy Policies of IEA Countries

Poland

Coal dominates the power sector of Poland, where it is the largest source of greenhouse gas emissions as well as a major employer. Whether coal continues to fuel the economy over the longer term will be one of the central issues addressed in an update to Poland's long-term energy strategy, which is expected in 2017.

The country's new energy plan will prioritise long-term energy security, placing a strong emphasis on reducing greenhouse gas emissions and air pollution, increasing energy efficiency and decarbonising the transport system. Nuclear power could play a significant role in the country's energy supply. While the country has experienced strong growth in renewable energy over the past decade, the future looks uncertain.

Given these possible changes, the new energy strategy will require significant investments to reduce the share of carbon-intensive power plants and increase the share of low-carbon energy. While Polish energy infrastructure has been modernised, further investments are needed to strengthen integration with neighbouring markets.

In this context, this latest IEA review of the energy policies of Poland examines the present landscape and makes recommendations for further improvements – recommendations that are intended to guide the country towards a more secure and sustainable energy future.