Report on the Polish power system

Version 2.0

COUNTRY PROFILE

Agora Energiewende

RAP

Report on the Polish power system

IMPRINT

COUNTRY PROFILE
Report on the Polish power system
Version 2.0

COMMISSIONED BY

Agora Energiewende
Anna-Louisa-Karsch-Straße 2 | 10178 Berlin
T +49 (0)30 700 14 35-000
F +49 (0)30 700 14 35-129
www.agora-energiewende.de
info@agora-energiewende.de

PRODUCED BY

Country Office Belgium
Rue de la Science 23
B – 1040 Brussels
Belgium
+32 2-894-9301
info@raponline.org

Edith Bayer
The Regulatory Assistance Project (RAP)

PROJECT LEADS

Dr. Fabian Joas
fabian.joas@agora-energiewende.de

Kevin Oswald
Wido Witecka

Layout: Marica Gehlfuß, Juliane Franz
Cover image: own illustration

137/01-CP-2018/EN
Published: August 2018
Version 2.0

ACKNOWLEDGEMENT

We would like to thank Forum Energii for their support and valuable contribution to this study.

This publication is available for download under this QR code.

Please quote as:
RAP (2018): *Report on the Polish Power System. Version 2.0 Study commissioned by Agora Energiewende.*

www.agora-energiewende.de

Preface

Dear Reader,

Poland stands at the crossroads of important decisions on its energy system. At this juncture, the Polish power mix is still dominated by hard coal and lignite. However, between 2020 and 2035, about 60 power plants constructed in the 1970s are expected to retire. This accounts for more than 50 percent of currently installed capacity. It presents a major modernisation and investment challenge that is discussed against the backdrop of concerns about energy supply security, clean air – particularly in cities –, climate change, rapidly declining costs for renewable energy, and the expected growth of electricity demand.

A new Polish energy strategy is expected by the end of 2018. Some particularly interesting statements in the public debate on this strategy are the announcement by Energy Minister, Krzysztof Tchorzewski, in September 2017, that the Ostrołęka coal-fired power plant would be the last big coal investment in Poland. Also, the announcement by Poland's largest utility (PGE SA) to develop offshore wind resources in the Baltic Sea is pathbreaking. Clearly, Poland's new energy strategy will also reflect energy security, foreign policy, and employment considerations in addition to concerns about costs, clean air or climate change.

The progressive integration of wholesale power markets and the growing level of interconnection of electricity systems in Europe also means that energy policy choices in Poland have implications for its neighbours and vice-versa. In this context, the Polish-German relationship is a special one. Both countries face similar challenges regarding the need to reduce carbon dioxide emissions from coal-fired power plants and the socio-economic changes linked to reducing the use of coal-related mining activities.

Furthermore, substantial amounts of unscheduled electricity flows from Germany to Austria over the polish grid have led to significant controversy between the two countries. The introduction of phase shifters on the German-Polish border and the upcoming split of the German-Austrian common bidding zone will – at least partly – mitigate this problem. However, further and intensified cooperation between the two countries remains important to avoid misperceptions, to broaden mutual understanding of domestic energy-policy choices, as well as to identify areas of common interest and opportunities for cooperation.

This updated country profile Poland provides a snapshot of the Polish Power Systems as it stands today. We present the country profile at a time when the domestic energy policy debate in Poland is in full swing, to allow for a better understanding of what is going on. The profile focusses on the main elements of the Polish power system. It is certainly not exhaustive and due to the rapidly changing energy landscape in Poland some parts may quickly be outdated. Hence, we invite you to send your eventual comments, updates or corrections to fabian.joas@agora-energiewende.de.

Enjoy the read!

Dr. Patrick Graichen
Executive Director of Agora Energiewende

Matthias Buck
Head of European Energy Policy

Content

Acronyms

CACM	Capacity allocation and congestion management
CCS	Carbon capture and sequestration
CEE	Central and Eastern Europe
CEER	Council of European Energy Regulators
CFIM	Commodity Forward Instruments Market with Physical Delivery
DSO	Distribution system operator
EC	European Commission
EDF	Électricité de France
ENTSO-E	European Network of Transmission System Operators for Electricity
ERO	Polish Energy Regulatory Office
ESD	Effort-sharing decision
ETS	EU Emissions Trading Scheme
EU	European Union
GHG	Greenhouse gas
GW	Gigawatt
GWh	Gigawatt-hour
HHI	Herfindahl-Hirschman Index
kW	Kilowatt
MW	Megawatt
PGE	Polska Grupa Energetyczna SA
POEE	Warsaw Stock Exchange Platform for Trading Electricity
PolPx	Polish Power Exchange
PSE	PSE Operator
SAIDI	System average interruption duration index
TSO	Transmission system operator
TW	Terawatt
TWh	Terawatt-hour
UOKiK	Urząd Ochrony Konkurencji i Konsumentów (Office of Competition and Consumer Protection)

1. Overview

This report explores the structure of the Polish power sector. It looks at the country's electricity fuel mix, production and consumption, ownership and market structure, cross-border power trade, and energy policy.

Main Indicators

Total population: 38.4 million (2015)
GDP: PLN 1.79 billion (2015)
Average electricity consumption:
1897 kWh/year per household (2014)
Total annual consumption: 161.4 TWh (2015)

Central Statistical Office of Poland; World Energy Council; PSE; Supreme Audit Office

Poland's power sector is dominated by hard coal and lignite, which in 2015 accounted for 83.7 per cent[1] of total electricity production. Between 2020 and 2035, about 60 power plants constructed in the 1970s are expected to retire. This accounts for more than 50 per cent of Poland's installed capacity.[2]

The power market is dominated by four large, vertically integrated power companies, which are legally unbundled. The three largest generating companies in Poland account for some two-thirds of production, and wholesale market concentration remains relatively high.

Poland is interconnected with its neighbours, Germany, Slovakia, the Czech Republic, Ukraine, Lithuania and Sweden. Over the past decade, Poland has been a net exporter of electricity, though exports have been dropping in recent years. There is a marked difference between contracted cross-border power flows and total physical flows, primarily due to unplanned flows through Poland carrying electricity from Germany towards Austria.

Poland expects to see an increase in overall demand for electricity through 2030, combined with a trend towards the decommissioning of old power plants.[3] The policy document Polish Energy Policy until 2030 sets forth a vision for the mix of technologies that will replace these plants. However, this policy was issued in 2009, and since then the government has not developed an updated policy. For this reason, it is difficult to predict the direction of investment in the energy mix going forward, including Poland's policy on renewables, lignite, hard coal, and nuclear power. Therefore, these projections should be considered with some caution. The Ministry of Energy is expected to issue a new Energy Policy by the end of 2018.

1 PSE, 2015 a.

2 Supreme Audit Office (NIK), 2015.

3 PSE, 2015 b and NIK, 2015.

2. Industry Structure, Ownership, and Regulation

2.1 Industry Structure

Poland has unbundled electric transmission from distribution. Poland's transmission system operator, PSE, is the owner and operator of the national transmission grid. PSE is in turn wholly owned by the State Treasury. There are five main distribution companies which, while legally unbundled, are in fact part of large parent companies with significant generation and distribution assets, as well as a significant share of the retail market. The exceptions are Energa, which has less generation assets than the other Polish parent companies, and Innogy, which focuses primarily on retail supply and network operation in Warsaw.

The consolidation of Polish power companies into four vertically integrated companies (PGE, Tauron, Energa, and Enea), three of them majority state-owned and the fourth with a state-owned controlling

4 Tauron, 2015.

5 PGE, 2016.

6 Id.

Market Share of Polish Electricity Companies — Table 1

Sector	Leading Companies	Market Share	Remaining Companies
Transmission	PSE Operator	100 %	None
Distribution [4]	Tauron Dystrybucja	37 %	164 vertically integrated DSOs
	PGE Dystrybucja	26 %	
	Energa-Operator	17 %	
	Enea Operator	14 %	
	Innogy Stoen Operator	6 %	
Generation [5]	PGE	37 %	ENGIE 6 %, ENERGA 3 % Remaining 20 % (mainly small independent companies)
	TAURON	11 %	
	EDF	8 %	
	Enea	9 %	
	ZE PAK	7 %	
Retail [6]	Tauron Polska Energia	29 %	More than 100 active suppliers in 2015
	PGE	31 %	
	Energa	13 %	
	Enea	14 %	
	Other	13 %	

PTPiREE, 2016

Geographical Service Areas

Figure 1

PGE Board of Directors' Report, 2016

share, is the result of a policy adopted in 2006, the Programme for the Electric Power Sector. This strategic document, adopted by the Council of Ministers, laid down a path for the development of the power market in Poland. The programme called for the consolidation of energy companies into four vertically integrated energy groups holding generation and distribution assets, which would be owned by the State Treasury. Today, three out of four of the largest distribution companies remain majority-owned by the State Treasury (for details, see Section 2.2).

PGE holds the largest share of power production, followed by Tauron Polska, Enea, and Électricité de France (EDF). Together, these companies account for 65 per cent of total electricity production in Poland.

In 2015 there were more than 100 active alternative retail suppliers on the electricity market, though the top four suppliers accounted for 87 per cent of the retail market. There were also 164 vertically integrated entities providing both distribution and supply services to customers.[7]

2.2 Ownership Structure of Polish Energy Companies

Most of the Polish power companies continue to be owned by the State Treasury. The Treasury wholly owns PSE (the transmission system operator, or TSO), and holds a majority share in PGE, Energa, and Enea. Tauron is the only one of the four energy giants not

7 Energy Regulatory Office, 2016 a.

Ownership Structure of Polish Energy Companies — Table 2

Companies	Ownership
PSE Operator	100 % owned by the State Treasury.
PGE	57.39 % State Treasury; 42.61 % other shareholders.[8]
Tauron	30.06 % State Treasury; 10.39 % KGHM Polska Miedź; 5.06 % ING Retirement Fund; 54.49 % other individual and institutional investors.[9]
Energa	51.52 % State Treasury; 48.48 % remaining shareholders.[10]
Enea	51.5 % State Treasury; 10 % PZU TFI ; 38.4 % others.[11]
Innogy	Innogy Polska is wholly owned by RWE East, which in turn is wholly owned by RWE AG, which is 86 % owned by institutional investors, 13 % by private shareholders, and 1 % by employees.[12]

Annual reports for 2015 of major Polish Energy companies

majority-owned by the Treasury, though the Treasury continues to hold a 30 per cent stake in the company. RWE Polska is wholly owned by RWE. Since the end of 2016, RWE Polska was re-branded and changed its name to Innogy.

2.3 Policy Setting and Regulation

The Polish Energy Regulatory Office (ERO) is responsible for the regulation of the electricity, gas, and heating sectors. Its responsibilities are set forth in the Polish Energy Act of 1997 ("Energy Act"), which has been amended over time. The ERO is an independent agency. The president of the ERO is appointed by the prime minister for a term of five years. The ERO's responsibilities include: licensing, setting tariffs, approving investment plans by regulated companies, deregulation of electricity and gas markets, and oversight of supply quality and customer service. The ERO also oversees compliance with energy company obligations under Poland's "coloured" certificate schemes. The ERO is in charge of issuing white certificates, as well as retiring certificates to track compliance with corresponding obligations.[13]

The Ministry of Energy was established in December 2015 as part of the broader reorganization of government ministries by the new government. The new ministry combines competencies relating to the development and execution of energy policy previously held by the Ministry of Economy and Ministry of Infrastructure and Development. The Ministry's remit also covers the mining sector and development of a policy to support development of nuclear power in Poland.

The Ministry of Energy is responsible for preparing a report on the security of electricity supply every

8 PGE (n.d.).

9 Tauron, 2016.

10 Energa (n.d.)

11 Enea (n.d.)

12 RWE, 2016.

13 For more on ERO's responsibilities, see President's duties on the office's website: http://www.ure.gov.pl/en/about-us/presidents-duties/22,Presidents-duties.html (in English).

two years. The last report was prepared in 2015, by the former Ministry of Economy.[14] The president of the ERO is also obliged to prepare a report on the conditions of conducting electricity business and the monitoring of network investments, which is also required on a biannual basis.[15]

Poland's competition authority is Urząd Ochrony Konkurencji i Konsumentów (UOKiK). It is responsible for shaping antitrust and consumer protection policies, including those in the power sector. The ERO also plays a role in antitrust and competition issues. For example, it has directed cases to UOKiK based on customer complaints about company activities related to customer switching.[16]

2.4 Transposition of EU Energy Policy

Currently, Poland is subject to several infringement proceedings relating to the energy sector:

→ In March 2013, the European Commission referred Poland to the Court of Justice for failing to transpose the **Renewable Energy Directive** (2009/28/EC). In February 2015 the Commission withdrew its case due to transposition of the directive into Polish law the month before.[17]
→ In January 2017, the Polish government introduced new regulations to complete transposition of the **Energy Performance of Buildings Directive** (2010/31/ EC).[18] This came after the Commission asked Poland to take action to ensure that the Directive is fully transposed into national law.[19]

14 Ministry of Economy, 2013.

15 Article 23.2a of the Polish Energy Act.

16 Woszczyk, 2013.

17 European Commission, 2015a.

18 Ministry of Infrastructure and Development, 2017.

19 European Commission, 2015b.

3. Energy Production and Consumption

Main Indicators

Installed capacity: 40.4 GW (2015)
Peak demand: 25.1 GW (Jan 2015)
Energy consumption: 161.4 TWh (2015)

Central Statistical Office of Poland; World Energy Council; PSE; Supreme Audit Office

3.1 Installed Capacity

Poland has a little more than 40 GW of installed capacity. The power mix is dominated by hard coal and lignite, which account for 84 per cent of total electricity production. Combined heat and power plays a significant role in the Polish power sector.

In 2014, 15.1 per cent of total electric generation in Poland was combined heat and power production.[20]

At the end of 2015, renewable energy accounted for about 8.0 GW of installed capacity, inlcud-ing 2,290 MW of hydro power, of which 1,330 MW accounted for pumped hydro and 960 MW for run-of-river hydro power plants. In 2015, the share of renewable energy increased due to the addition of significant wind resources. Figure 3 shows the mix of renewable sources in December 2015.[21, 22]

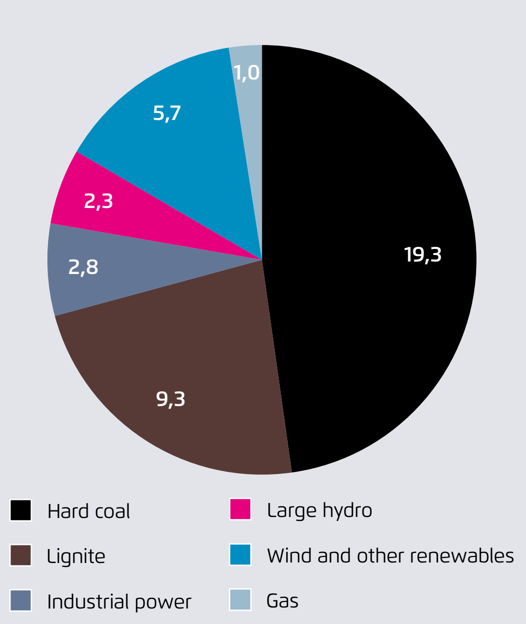
20 Eurostat, 2017.

21 Energy Regulatory Office, 2017.

22 Note that biomass in this graph counts only biomass-fired facilities, and does not account for co-firing.

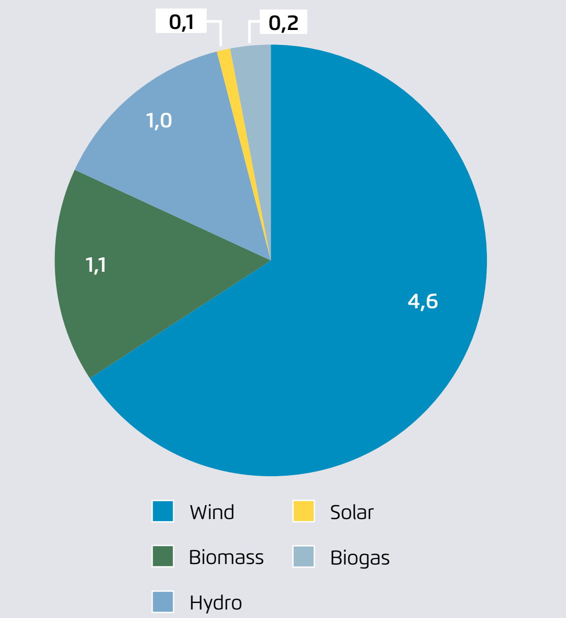
23 Note that in 2016, the share of total installed RES capacity grew to 8.4 GW due to an increase of over 1 GW of wind, and some increase in solar and biomass. Energy Regulatory Office, 2017.

Polish Power Mix, Installed Capacity in GWs (total of 40.4 GW), 2015 Figure 2



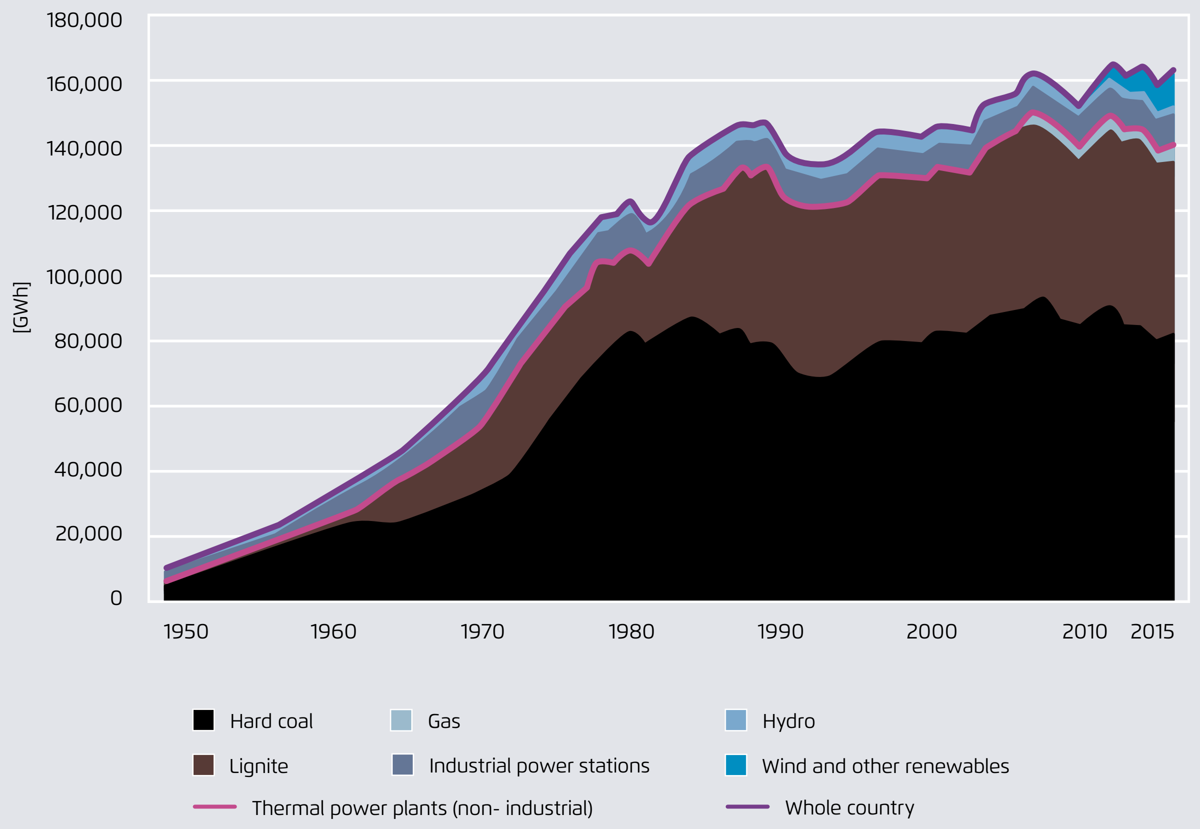
PSE, 2015a

Installed Renewable Capacity in GWs (total of 6.9 GW), 2015* Figure 3



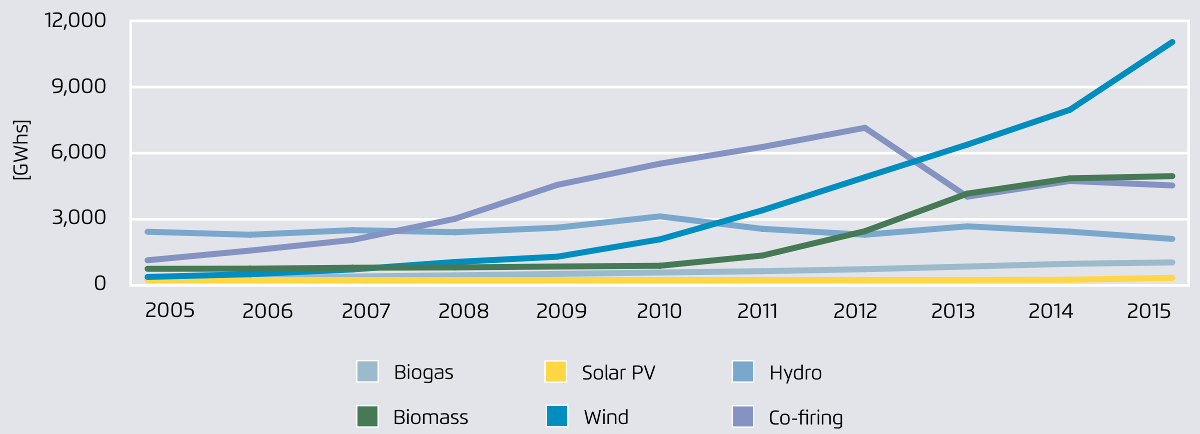
Energy Regulatory Office, 2017.[23] | *Hydro excluding pumped hydro

Electricity Production by Energy Source, 1950–2015 (in GWh) Figure 4



PSE, 2015a

Renewable Energy Production, 2005–2015 Figure 5



Energy Regulatory Office, 2016b

3.2 Electricity Production

In 2015, national gross electricity production was 161.7 TWh. This was 3.3 per cent higher than in the previous year.[24] Renewable electricity production has increased significantly since 2008, primarily due to increases in wind power and co-firing, though the share of co-fired biomass has decreased over the past few years, as shown in Figure 5. The main cause of this decline is an oversupply of green certificates, which have become overabundant in part because of aggressive investment in biomass co-firing followed by an unanticipated rise in onshore wind development.

3.3 Electricity Consumption

Electricity consumption in 2015 was 161.4 TWh, 1.7 per cent higher than 2014.[25] This is a higher rate of growth than the average rate of around 1.2 per cent seen in 2005–2014[26], and slightly higher than the average rate of 1.5 per cent seen in 2009–2014. According to the PSE, which assumes a 1.6 per cent annual growth of electricity demand (see figure 7), electricity consumption is expected to rise to 190 TWh by 2025.

3.4 Peak Demand

In Poland, peak demand occurs in the early winter evening hours. In 2015, the annual peak occurred on 7 January at approximately 16:45, while the lowest level of demand occurred on 26 December at 19:43.[27] It is important to note that while peak demand occurs in the winter, the greatest reliability risk occurs in summer. This is due to the fact that less capacity is available in summer, as some combined heat and power plants close when the heating season is over. On 10 August 2015, for example, load exceeded available supply and the system operator curtailed power to large industrial consumers. The following summer, Poland reached a new summer peak of 22,750 MW on 24 June. High temperatures combined with low water tables and occasional unscheduled flows from neighbouring countries led to constraints for thermal generators similar to those experienced in summer 2015. However, a similar crisis was avoided due to a combination of factors, including energy imports and more available domestic capacity.

Figure 6 shows available capacity of domestic power plants during evening peaks, alongside peak demand, in 2015.

24 Energy Regulatory Office, 2016 a.

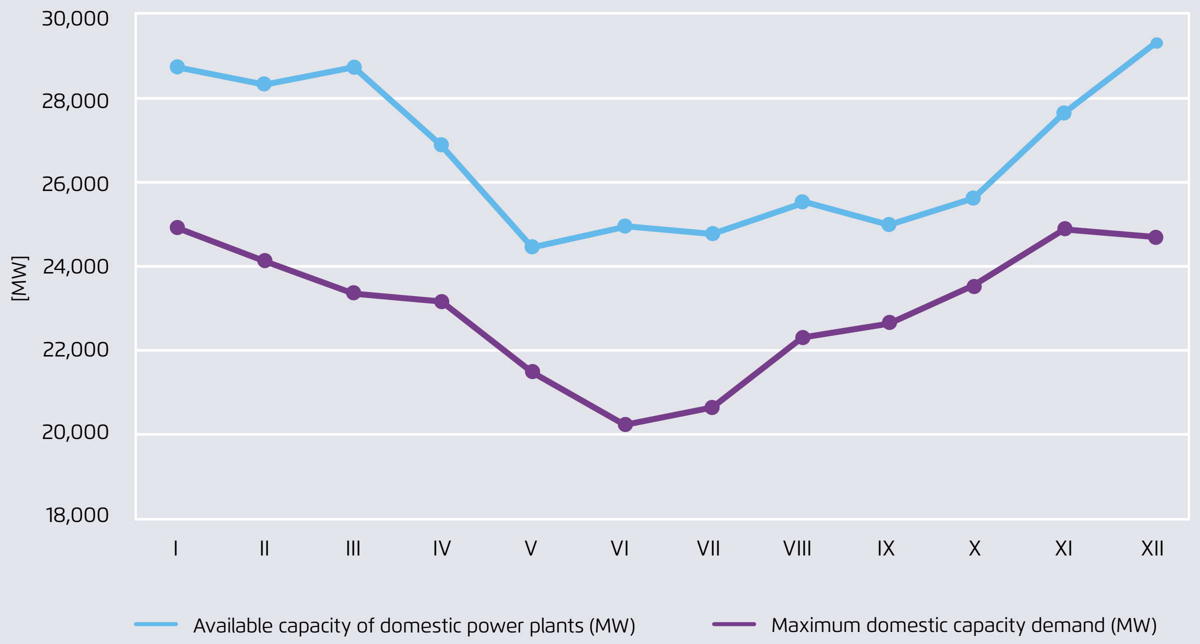
25 Energy Regulatory Office, 2016 a.

26 PSE, 2015 b.

27 PSE, 2015 c.

Available Domestic Capacity and Peak Demand at the Evening Peak

Figure 6



Energy Regulatory Office, national report 2016a
Explanation: Figure shows 2015 average values on working days in a month (in MW).

3.5 Planned Conventional Power Plants

Poland has a number of planned conventional power plants in the pipeline. To put these plants in context, it is useful to first consider the broader resource context in Poland. Between 2015 and 2025, a total of 4.4 GW of conventional power plants are expected to retire: 3.6 GW by 2020, and another 0.8 GW by 2025.[28]

At the same time, demand is expected to grow. Figure 7 demonstrates the anticipated increase in demand between 2015 and 2025 based on assumptions in demand growth prepared by the Polish Energy Agency (ARE, purple, assumes 1.4 per cent annual load growth), Polish Agency for Energy Conservation (KAPE, blue 1.6 per cent annual load growth), and PSE (pink, 1.5 per cent annual load growth).

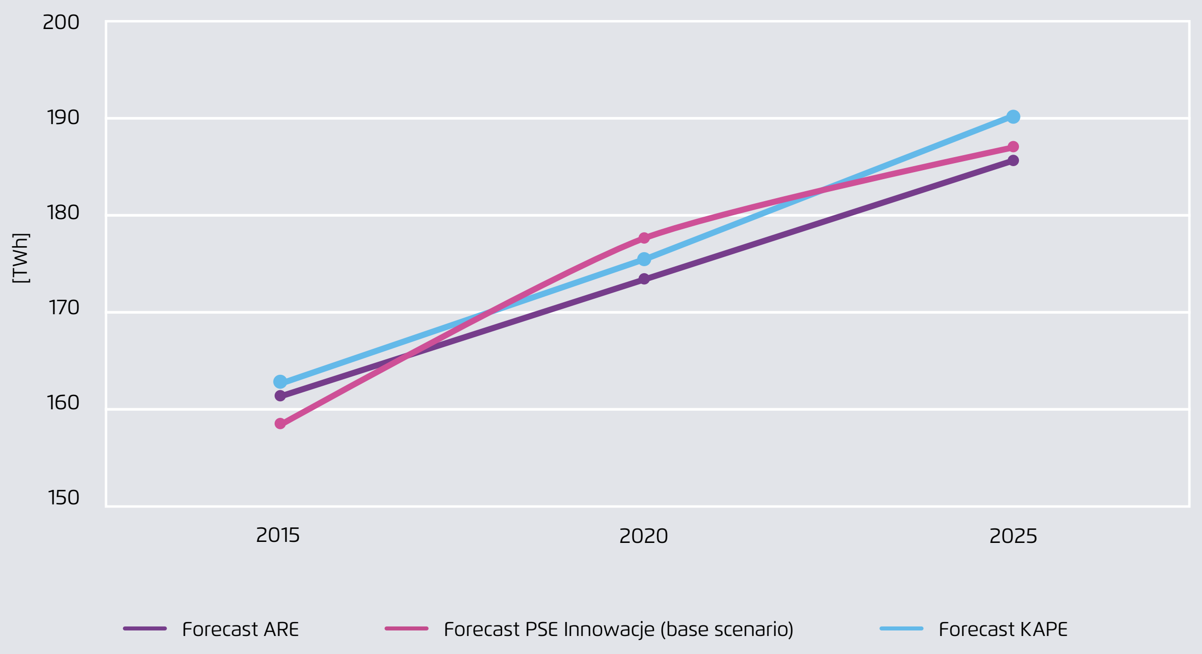
28 ENTSO-E 2016b

While there are differences in how the total demand is calculated, the material difference between the projections relates to the projected annual load growth.

According to the Polish Energy Policy until 2030, the gap in available capacity is expected to be met with a combination of lignite, hard coal, and nuclear power, as well as some increase in natural gas and renewable generation. At the same time, there is significant uncertainty as to how the fuel mix will in fact develop, given the timeframe and level of investment needed. An updated Energy Policy is expected in 2018.

A number of gas- and coal-fired power plants are being planned, though the dates for starting operations remain uncertain. Table 3 lists the conventional power plants that are being planned, their net capacity, fuel, and status.

Anticipated Increase in Electricity Demand, 2015 – 2025 Figure 7



PSE 2015 b

Planned Conventional Power Plants — Table 3

Company / name	Gross Capacity	Fuel	Status
PGE, Turów 11	496 MW	Lignite	Under construction, project over 40 % accomplished. Estimated time of commissioning: Q2 2020
PGE, Opole (units 5,6)	1,800 MW	Hard coal	Under construction, project over 85 % accomplished. Estimated year of commissioning – unit 5: Q4 2018, unit 6: Q2 2019 (both units are late about 6 months)
Tauron, Jaworzno II	910 MW	Hard coal	Under construction, project over 50 % accomplished. Estimated time of commissioning: November 2019 (6 month late)
Enea, Kozienice 11	1,075 MW	Hard coal	Commissioned on 19 December 2017
Energa, Enea, Ostrołęka C, unit	1,000 MW	Hard coal + biomass	In 2017 the process of issuing permit decisions restarted
PKN Orlen SA Włocławek and Płock	463 MW 596 MW	Gas CCGT	Włocławek commissioned on 19 June 2017 Płock in final phase of investment synchronized with National Grid since September 2017. To be officially commissioned in July 2018
PGNiG Termika, Żerań	497 MW	Gas CCGT	Under Construction. Estimated time for commissioning: 2020
PGNiG, Tauron, Stalowa Wola	450 MW	Gas CCGT	Currently under construction. According to the last update the estimate year of commissioning is 2020 (may be further postponed – project is already 5 years late)
Energa Invest SA Progaz Gas Power Plant	1,000 MW	Gas CCGT	Announced / planning begun
Energa Invest SA Progaz CHP Gas Power Plant	200 MW	Gas CCGT	Announced / planning begun

Based on CIRE (n. d.) and author’s analysis

4. Imports and Exports

Poland is interconnected with its neighbours Germany, Slovakia, the Czech Republic, Ukraine and Sweden. For the purpose of this paper, we focus on interconnections only with EU Member States, thereby omitting Ukraine from the analysis. Poland is a net exporter of electricity, though the ratio of exports to imports has been declining. The surplus of exports over imports amounted to 337 GWh in 2015.[29] This is in contrast to 2014, when Poland had net imports of 2,182 GWh. Most Polish exports flow to Slovakia and the Czech Republic, while most imports come from Germany and Sweden.

Transmission capacity between Poland, Germany, the Czech Republic, and Slovakia is allocated via coordinated explicit auctions between the transmission system operators in the Central Eastern Europe (CEE) region. Auctions are organized and conducted by the Central Allocation Office in Freising/Germany. Trading along the Polish-Swedish interconnector, SwePol Link, is carried out through a market coupling mechanism. Transactions are carried out through the power exchanges (POLPX and Nord Pool Spot) on a day-ahead basis. It is also worth mentioning that a new link with Lithuania (Lit-Pol) became operational towards the end of 2015.

It is important to note that the import/export balances recorded for Poland reflect physical flows. There is a marked difference between the volume of physical flows and contractual imports/exports, particularly between Poland and Germany. As demonstrated by figure 9, and explained in the ACER Opinion on cross-border capacity allocation in the CEE region,

29 ENTSO-E 2017b.

Import/Export Balances (exports minus imports), in GWh — Table 4

	CZ	SK	SE	DE	LT	UA	Total
2005	11,090	2,792	365	-1,218	n/a	-984	13,029
2006	9,985	3,373	1,227	-1,826	n/a	-870	12,759
2007	9,197	3,600	-1,980	-4,841	n/a	-632	5,976
2008	6,840	2,551	-1,920	-5,481	n/a	-766	1,990
2009	7,095	2,337	-1,139	-5,482	n/a	-199	2,811
2010	5,364	1415	-267	-5,167	n/a	0	1,345
2011	8,208	3,028	-1,236	-4,705	n/a	-59	5,236
2012	8,754	3,498	-2,545	-5,877	n/a	-1,005	2,825
2013	7,663	3,051	-253	-4,909	n/a	-1,029	4,523
2014	7,158	3,496	-2,984	-9,153	-14	-685	-2,182
2015	9,549	4,926	-3,491	-10,644	64	-67	337

ENTSO-E 2017b

there is a significant volume of unplanned flows in the CEE[30] region, largely caused by structural congestion between Germany and Austria.[31] The ACER Opinion recommends that CEE countries take the following actions to address the high level of unplanned flows in the region:

- → Adopt a coordinated capacity allocation procedure on the Germany-Austria border.
- → Focus on implementation of flow-based market coupling in the CEE region as quickly as possible.
- → Evaluate interim measures taken to ensure network security (the phase shifter agreement between Poland and Germany) and to assess whether additional interim measures are necessary.

To address the unscheduled flows on the Polish and German border, PSE (the Polish TSO), has signed an agreement with 50 Hertz (the German TSO) to construct phase shifting transformers on the two transmission connections between Poland and Germany.[32] The first four phase shifting transformers were completed in June 2016 on the southern interconnection between the Mikułowa and Hagenwerder substations. At the northern interconnection between Vierraden und Krajnik, 50 Hertz is currently installing the first two of a total of four planned phase shifting transformers. The remaining two phase shifting transformers are expected to be completed by 2020.[33] The seperation of the common German-Austrian

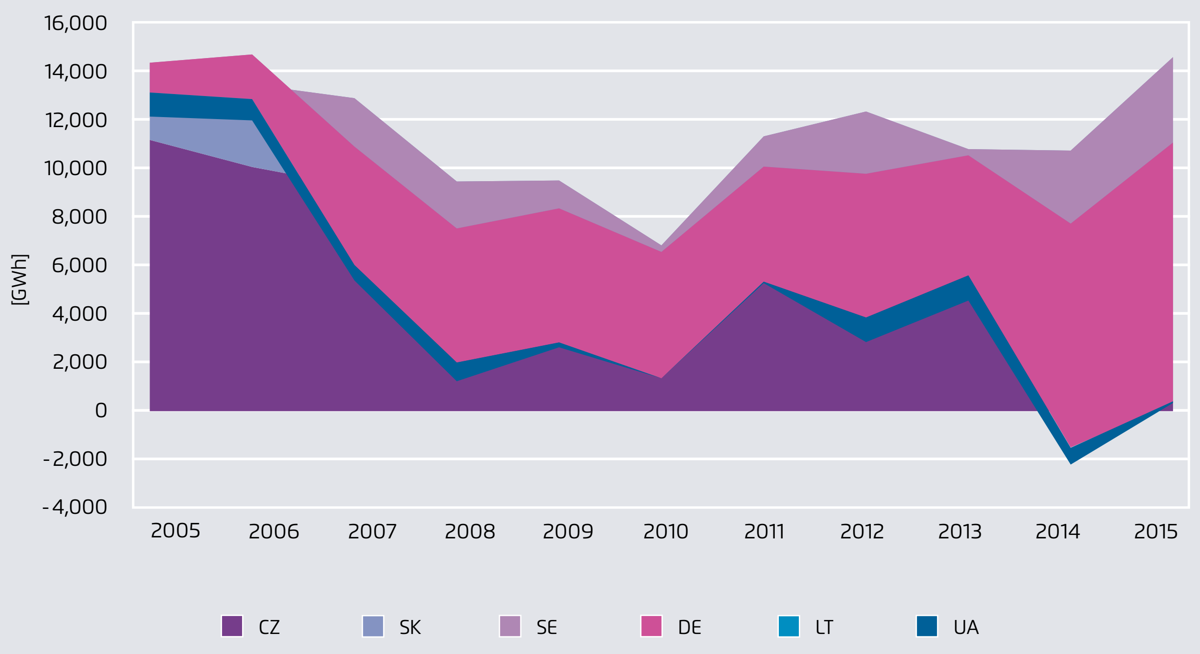
30 The CEE region is one of seven regions created for purposes of transmission planning and European electricity market integration. The CEE region is made up of Austria, the Czech Republic, Germany, Hungary, Poland, Slovakia, and Slovenia, and is led by Austrian regulatory authority E-Control. See CEPS et al., 2013, p. 2.

31 ACER, 2015.

32 PSE, 2014.

33 50 Hertz, n.d.

Import/Export Balance, 2005–2015 Figure 8

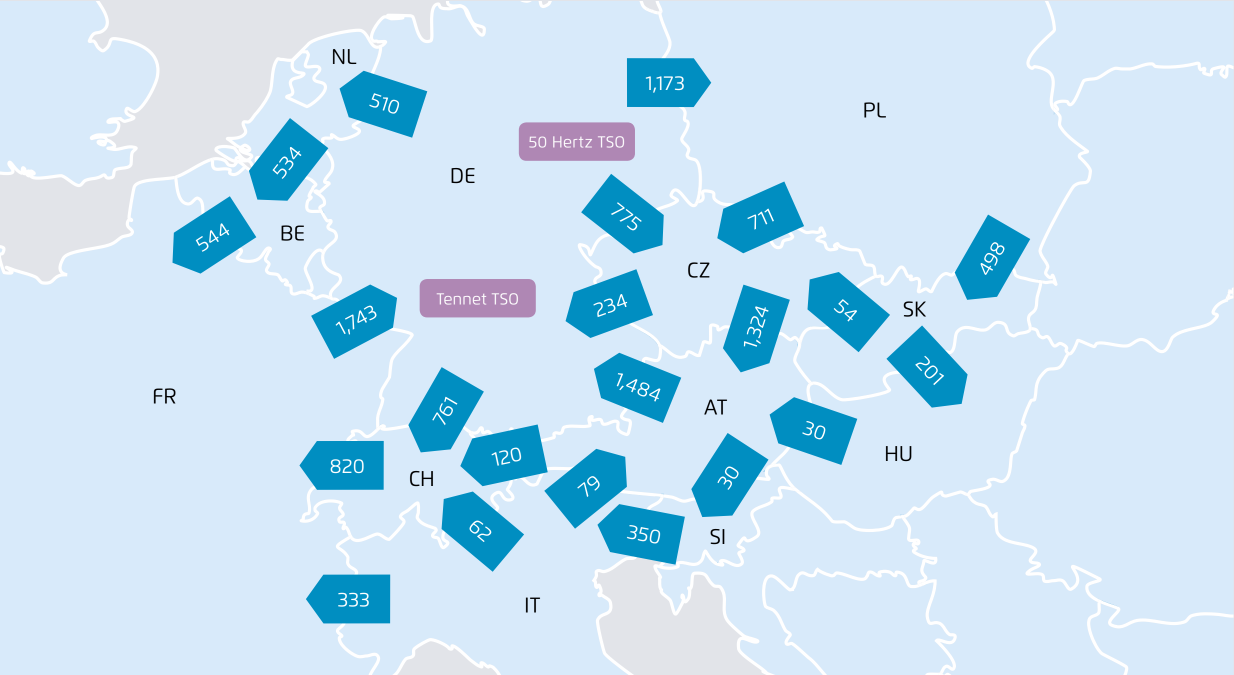


ENTSO-E 2017b

bidding zone and the introduction of a common congestion management scheme that will be enacted in October 2018 is also expected to reduce the problem of unscheduled flows.[34]

34 Bundesnetzagentur, 2017

Average Unscheduled Flows for Three Regions, 2016 (MW) Figure 9

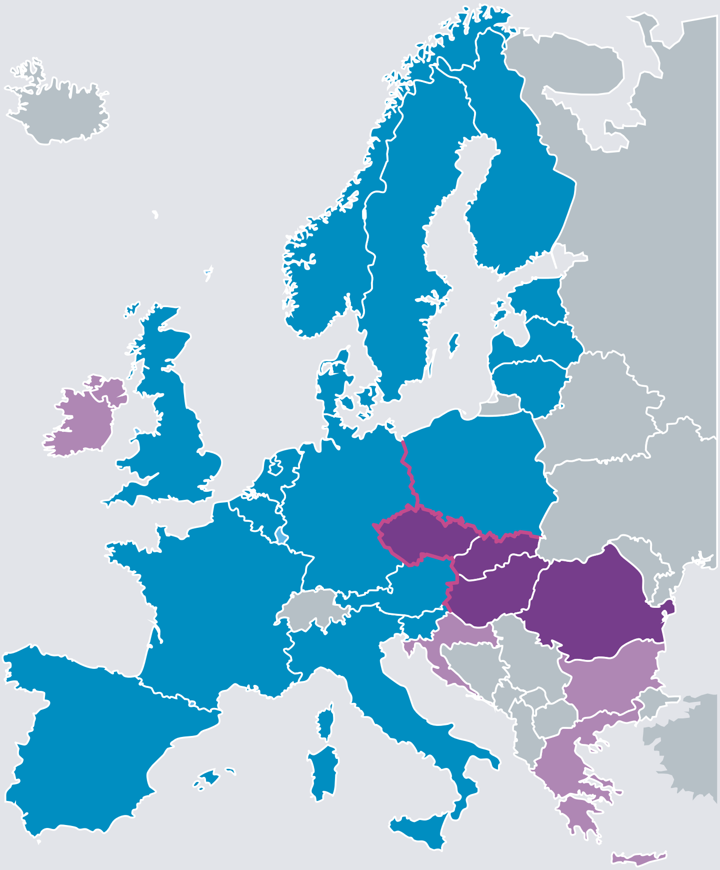


ACER 2017

Status of Day-Ahead Coupling in Europe

Figure 10

- Coupled under MRC
- 4M MC
- Progressing towards Market Coupling



ENTSO-E 2017a

5. Electricity Market

5.1 Wholesale Market, Prices, and Liquidity

5.1.1 Electricity Market Design

The structure of the Polish wholesale electricity market follows the typical West European model in that energy can be traded on a bilateral basis using "over the counter" standard contracts, via the PolPX power exchange, and also in the balancing market operated by the Polish TSO. In 2016, the total volume of energy traded on the PolPX power exchange dropped by 32 per cent from the previous year, largely due to a significant reduction in trading levels on the forward market. Trading levels have dropped due to high relative prices and the gradual phase out of obligations under long-term contracts that had to be traded through the power exchange.

Energy trading takes place on an unconstrained basis, with network congestion managed with balancing-market redispatch. In its strategy for 2017–2019, PSE has prioritized a number of issues linked to the "Clean Energy for All" package, including the current division of European markets into sub-optimal pricing zones.[35]

35 PSE, 2017.

Energy trading via the PolPX power exchange has seen significant growth in recent years at the expense of both bilateral and "internal" trading. This growth has been driven primarily by the introduction in 2010 of the "exchange obligation," a requirement that electricity generators sell at least 15 per cent of power generated through a power exchange. Companies entitled to receive funds for covering stranded costs in connection with the early termination of long-term power and electricity contracts must offer 100 per cent of their electricity production on the power exchange.[36] The share of companies obligated to offer 100 per cent of their electricity on the power exchange is significant. In 2005, when the European Commission opened an investigation into the issue of long-term purchase power agreements in Poland, around 40 per cent of generation was covered by long-term agreements.[37]

36 Woszczyk, 2013, p. 12.

37 European Commission, 2013.

38 In Polish, this is the Rynek Terminowy Towarowy (RTT).

Polish Electricity Market — Table 5

Market	Volume traded
Commodity Forward Instruments Market with Physical Delivery (CFIM)[38]	99.025 TWh, 38.7 % decrease compared to 2015
Day-Ahead Market	27.556 TWh
Intra-Day Market	0.0714 TWh
Spot Market	22.627 TWh

TGE, 2016.

5.1.2 Market Liquidity

Wholesale market concentration in Poland remains relatively high, with the three largest generating companies accounting for some two thirds of production. In 2014, the wholesale market Herfindahl-Hirschman Index (HHI) [39] measured 2,096 indicating a highly concentrated market. [40]

5.2 The Retail Market

In 2015, there were 16.6 million total consumers in Poland. Residential and other small end-users consuming under 50 MWh per year accounted for 42 per cent of total consumption. Those consuming between 50 and 200 MWh per year accounted for 27 per cent of consumption, and large consumers (over 2,000 MWh per year) accounted for 31 per cent of consumption. [41]

Retail market concentration in Poland is high, with the four largest companies, Tauron, PGE, Enea, and Energa, holding a total market share of 87 per cent. The retail market had a high HHI level of 2,099 in 2013. [42]

Since 2007, all customer classes in Poland have had the right to switch their supplier. While the number of customers switching suppliers is increasing, the switching rate remains very low compared with other EU countries. [43] Still, the total portion of customers who have switched suppliers increased from 2.53 % in 2014 to 3.43 % in 2015. Tariffs for residential customers that have not switched from their incumbent supplier continue to be subject to approval by the ERO, and the majority of residential customers continue to have regulated rates.

Electricity prices for household and industrial consumers in Poland fall within the median range of prices in Europe. [45]

39 The Herfindal-Hirschman Index (HHI) is defined as the sum of the squares of the market share percentage of each market participant. The Index can range in value from 0 to 10,000; the higher the index, the more concentrated the market. A market with an HHI of less than 1000 is generally considered competitive, a market with an HHI in the range 1000–1800 is considered moderately concentrated, while a market with an index above 1800 is considered highly concentrated.

40 European Commission, 2014.

41 Energy Regulatory Office, 2016 a.

42 European Commission, 2014.

43 ERO 2015 report, supra. ACER market monitoring report 2015, p. 64.

44 PLN is the acronym for the Polish złoty, the national currency of Poland.

45 Eurostat, 2016.

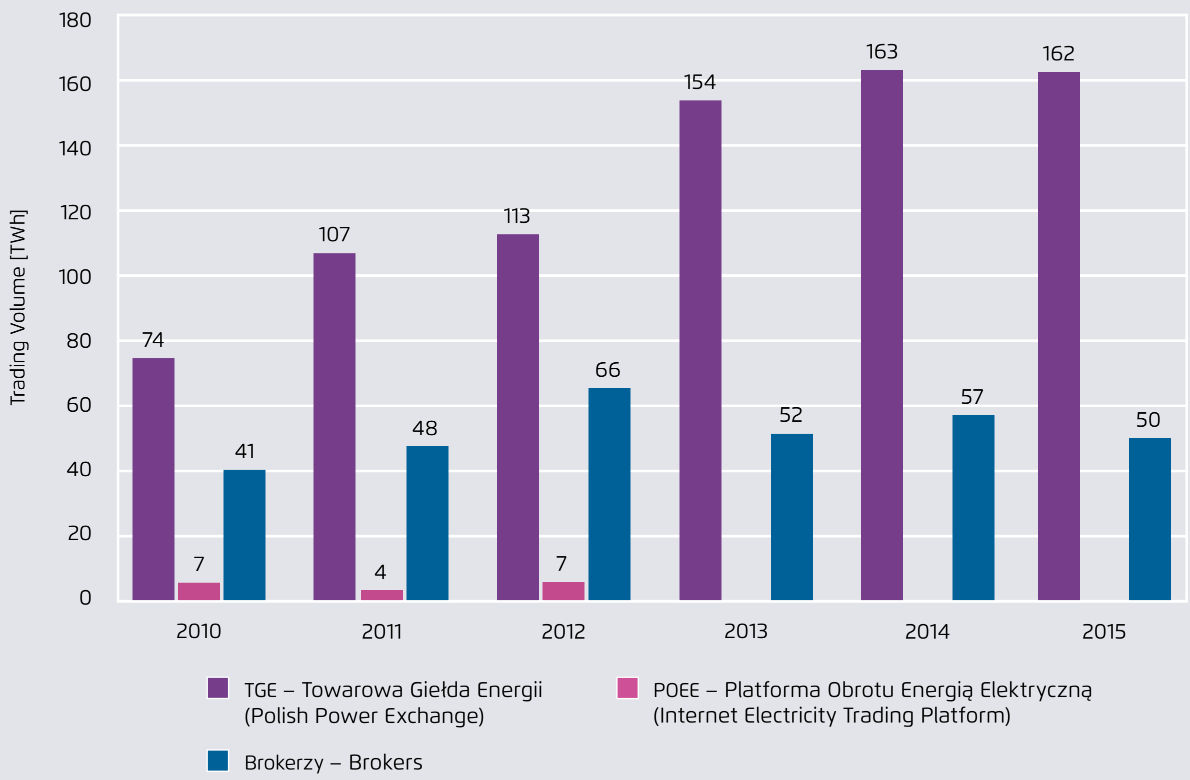
Electricity Consumption and Prices by Customer Size — Table 6

Consumer groups by consumption volume	Total number of consumers	Consumption volume [MWh]	Value [PLN] [44]	Average price [PLN/MWh]
<50 MWh	16,553,981	43,355,275	11,856,960	273.48
50–2,000 MWh	62,059	27,253,706	6,506,38	238.73
>2,000 MWh	3,503	31,509,886	6,362,693	201.93
Total	16,619,543	102,118,867	24,726,050	242.13

Energy Regulatory Office, National Report 2016

Trading Volumes

Figure 11



Wasik & Kulesa, 2016.

Electricity Prices (excluding taxes)

Figure 12

Eurostat, 2016

5.3 Allocation of Grid Costs

Transmission charges are applied on a uniform or "postage stamp"[46] basis within Poland and are paid almost entirely by load (in contrast to some EU member states such as the UK where part of the cost of transmission is paid by generators). In addition to recovering operational costs, depreciation, and return on capital invested, transmission charges cover net balancing costs, the costs of providing ancillary services, internal congestion costs, and the costs of transmission losses. Certain non-TSO costs are also included, such as a transition charge to cover the stranded costs of the early termination of long-term energy sales contracts. Recovery is split 57 per cent/43 per cent in terms of capacity and energy usage, respectively.

Customers connecting to the network are responsible for the costs of the connection but not for grid reinforcement. All wider or shared network costs associated with the connection are socialised through transmission charges. For a typical connection, final customers pay 25 per cent of the cost of connecting. Renewable generation units with an installed capacity of 5 MW or less and cogeneration units with an installed capacity of 1 MW or less pay 50 per cent, and generators and distribution companies pay 100 per cent. RES units with an installed capacity less than or equal to 40 kV do not pay a connection charge.[47]

46 Under "postage stamp" rates, "[e]very transmission customer pays a single rate for any transmission transaction within a defined region, regardless of the contractual origin and contractual destination of the electricity transmitted." See Hempling, 2009.

47 ENTSO-E, 2016 a.

6. Electricity Balancing/Reserve Markets

As is the case in the majority of Member States, the energy balancing arrangements in Poland consist of three main elements: programme responsibility, the single-buyer market for balancing energy operated by the TSO following market closure, and the imbalance settlement process. Balancing market participants can either be active (larger generators equipped with appropriate control and communication systems) or passive (smaller generators and all loads). All participants are required to submit forecast energy volumes at the day-ahead stage, with active participants also offering balancing energy bids and offers at this stage. However, with the introduction of intra-day trading, energy volumes can now be adjusted prior to market gate closure, two hours before real time.[48] In the case of renewable technologies, such as wind, forecasts of energy volumes can be modified up to one hour ahead of real time.

Accepted balancing offers and bids are remunerated on a "pay as bid"[49] basis, while imbalances are settled via a marginal dual-price mechanism: participants who are long with respect to their declared contractual position are paid at the system sell price, and participants who are short are required to buy balancing energy at the system buy price.

There is little opportunity for imbalances to be aggregated, other than for participants connected at the same connection point. This does, however, favour smaller distribution-connected participants.

48 Obersteiner, 2008.

49 Winning parties are paid at the price they bid, rather than at a uniform clearing price.

Reserve Requirements — Table 7

Primary or second reserve	Secondary or minute reserve	Tertiary or hourly reserve
Delivered automatically via governor response/load frequency control (LFC) in order to contain frequency deviations within prescribed limits. All generators with "rotating masses" and a capacity in excess of 5 MW are required to reserve 1% of that capacity for use as PCR. The service, which needs to be fully delivered within 30 seconds and maintained for up to 5 minutes, is not remunerated.	An automatically called service which is to be fully deployed over a period of 30 seconds to 15 minutes. The service is used to replace primary or second reserve and restore frequency to its nominal level.	A manually dispatched reserve product, which needs to be fully deployed over the period 15 minutes to 1 hour in the case of spinning reserves and 4 to 8 hours in the case of plant at standstill.

Polish Power Grid Company, SA, 2001.

Primary and secondary reserves (referred to as "second" and "minute" reserves respectively) are procured on an annual basis via bilateral agreements. Tertiary or hourly reserves are predominately purchased via the day ahead balancing market. Remuneration for contracted second and minute reserves is via an enabling payment when the service is activated and a utilisation payment for energy. The technical requirements of second, minute and tertiary or hourly reserve are given in Table 7.

7. Long-Term Energy Policy/Decarbonisation

The EU has set the goal of reducing GHG emission 20 per cent below 1990 levels by 2020. This target is divided between sectors covered under the EU Emissions Trading Scheme (ETS), covering about 45 per cent of total GHG emissions, and the Effort Sharing Decision (ESD), which sets targets for all remaining economic sectors. Under the ETS Directive there are no country-level targets; however, Poland is part of the EU-wide cap requiring covered sectors in the EU to cut greenhouse gas emissions 21 per cent below 2005 levels by 2020. The ESD caps Poland's GHG emissions in non-ETS sectors at 14 per cent over 2005 levels by 2020.

The main policy document laying out Poland's long-term energy policy, including the strategy for decarbonising the power sector, is the Polish Energy Policy until 2030 and the accompanying Energy and Fuel Demand Forecast to 2030 (updated September 2011). The Polish Energy Policy until 2030 sets six leading priorities for development of the energy sector to 2030:

→ Improving energy efficiency
→ Increasing energy security
→ Developing nuclear power
→ Increasing the share of renewable resources, including biofuels
→ Developing competitive energy and fuel markets
→ Limiting the effect of the power sector on the environment [50]

A public consultation was held in 2015 to proposed revisions to the Energy Policy. A new policy is under development and publication is anticipated in 2018. [51]

50 Ministry of Economy, 2009, p. 4 – 5.

51 Ministry of Energy, 2016 a.

8. Renewable Energy

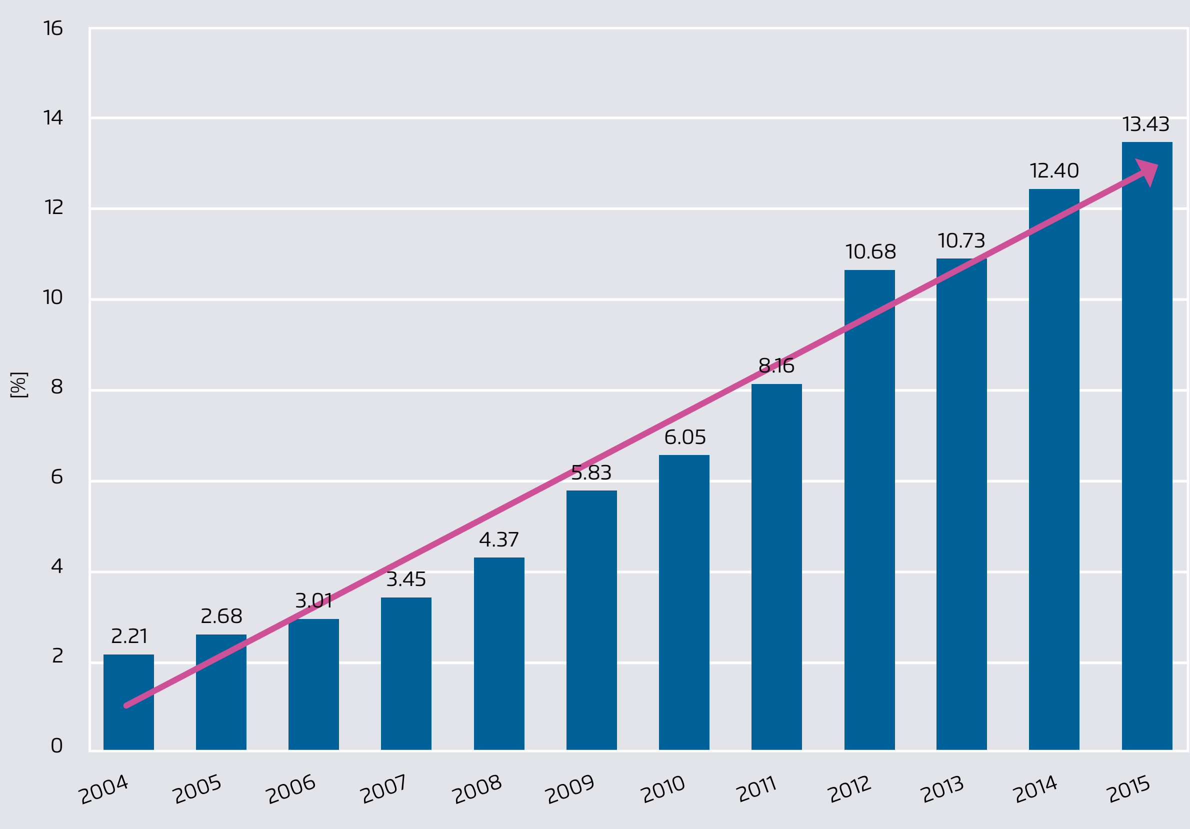
Under the Renewable Energy Directive, Poland is expected to increase the share of energy from renewable energy sources to 15% of gross final consumption by 2020. In case of electricity production the target is 19%. In 2015 renewables accounted for more than 13 % of total electricity production and more than 17 % of installed electricity capacity (including large hydro). [52]

Until recently, Poland had a green certificate scheme. Originally introduced in 2005, it is being phased out as 15-year contracts either expire or transition to the auctioning system. In recent years, there was a drastic fall in prices, as widespread co-firing of biomass with coal caused an oversupply of green certificates. In the current transition period, green certificates can be traded, though their price has fallen to as low as 5 euros/MWh in June 2017, compared to prices as high as 70 euros/MWh in the past.

Since 2016 the government has held RES auctions as the primary support mechanism for new renewable energy sources. Poland uses a pay-as-bid, reverse auction system, with separate auctions carried out

52 Own calculations based on data from GUS and PSE.

Share of Renewable Energy in Gross Electricity Consumption | Figure 13



Central Statistical Office, 2016.

for defined categories of technologies and volumes (for example, one auction may be carried out for solar PV with an installed capacity no greater than 1 MW, and another for solar PV with an installed capacity greater than 1 MW). Auctions are carried out with a predefined maximum volume of energy (MWh) and price (in total zlotys over 15 years). Resources that clear the auction receive a 15 year contract for differences.

The first auctions were carried out in December 2016.[53] The Energy Regulatory Office (ERO) announced two auctions for 2017, one dedicated to existing small hydro power plants (less than 1 MWe) and the second dedicated to new PV and wind (less than 1 MWe). Other auctions that were planned in 2017 have been cancelled due to changes of the Renewable Energy Law of Poland and the notification process.

The further development of onshore wind has been thrown into question in Poland with the passage of legislation in June 2016 that restricts the allowed distance between a wind turbine and residential buildings, forests, or national parks to ten times the height of the wind power plant.[54] In practice, this means a buffer of 1.5 and 2 km, and largely restricts further development of onshore wind in Poland.

53 Rozporzadzenie Ministra Energii z dnia 16 marca 2017r. w sprawie ceny referenyjnej energii elektrycznej z odnawialnych źródeł energii w 2017 r. oraz okresów obowiązujących wytwórców, którzy wygrali aukcje w 2017 r. https://www.ure.gov.pl/pl/rynki-energii/energia-elektryczna/aukcje-oze/dokumenty/6539,Ceny-referencyjne.html

54 Ustawa z dnia 20 maja 2016 r. o inwestycjach w zakresie elektrowni wiatrowych.

9. Energy Efficiency

According to Poland's national energy efficiency action plan, Poland has a national, economy-wide target of achieving a 9 per cent reduction in final annual energy use by 2016, compared with Poland's average energy use from 2001 to 2005. The central compliance mechanism to meet this target is an energy supplier obligation, combined with a tradable white certificate scheme. Pursuant to the new Energy Efficiency Act, adopted on 20 May 2016, the national target will be revised in the national plan and submitted to the Commission by 30 April 2017. [55]

The energy efficiency obligation covers suppliers of electricity, natural gas, and district heating, as well as brokerage firms and end-users transacting on the Polish Power Exchange. Annual targets are set at a level of 1.5 per cent of annual sales. Obligated entities comply with requirements by undertaking verified savings themselves or procuring and retiring white certificates in the amount corresponding with their target (or a combination of the two). They can also pay an alternative compliance fee to cover any shortfall, though the proportion of the target that can be met with the compliance fee is limited to 30 per cent in 2016, 20 per cent in 2017, 10 per cent in 2018, and will be phased out thereafter. Money from the alternative compliance fee is paid into an Energy Efficiency fund dedicated to investment in end-use energy savings and is managed by the National Fund for Environmental Protection and Water Management.

The Energy Efficiency Act was heavily reformed in 2016, due to difficulties with implementation of the previous Act and to fully transpose the European Energy Efficiency Directive into National law.

55 Ministry of Energy, 2016 b.

10. Grid Infrastructure and Reliability

10.1 Generation Adequacy Standard

Poland's transmission grid code requires the TSO to plan, on a day-ahead basis, for a 9 per cent reserve margin (de-rated)[56] above planned demand on the system for every hour of the following day. (And, in fact, generation totaling 18 per cent above planned demand levels receives remuneration under the operating reserve.)

A significant portion of the Polish power fleet is expected to retire from the system in coming years due to old age and inability to comply with EU environmental standards. Between 2015 and 2025, a total of 4.4 GW of plants is expected to retire: 3.6 GW by 2020, and another 0.8 GW by 2025.[57] According to the Supreme Audit Office, over half of the installed capacity is expected to retire by 2035.

It is important to note that while these retirements represent a significant decline in installed capacity, Poland has in many ways a surplus of capacity today, with an installed capacity of 40.4 GW and (winter) peak demand of 25.1 GW (both at the end of 2015). However, despite being a winter peaking country, Poland faces tight margins in the summer. This is for a number of reasons, including CHP plants that are offline during the summer months, operational limitations in dry, hot weather for 1/3 of the fleet with open cooling systems, and high levels of planned and unplanned maintenance.[58] To understand the effect these retirements will have on resource adequacy, it is important to understand which plants are expected to retire when, and what contribution these plants make to meeting the seasonal peaks.

56 A de-rated margin is the average excess of available generation over peak demand, taking into account the expected capacity factor of different resources.

57 ENTSO-E, 2016 b.

58 For a more in-depth analysis of this dynamic, see Hogan, M. et al., 2016.

In response to concerns over resource adequacy, on 8 December 2017, the Polish parliament adopted an Act on the Capacity Market ("Act") to introduce a market-wide capacity mechanism. In February 2018, the proposal for a capacity market was approved for a period of ten years by the EU Commission under the condition that the introduction of a capacity mechanism has to be accompanied by market reforms. Compared to previous draft proposals, it is notable that the capacity auctions will not only be open to existing and new generators, but also open to storage, demand-response and foreign generation capacity from Poland's direct neighbouring countries. The first preliminary capacity auction is expected to take place in 2019.[59]

In this context, an important question is whether an emissions performance standard of 550g/kWh, as suggested by the EU electricity regulation, will apply to Polish generation plants that receive payments under the capacity market. A decision is expected to be taken by the end of 2018 under the Austrian presidency.

In addition to the capacity proposal, PSE recently expanded its auctions for demand side response, or DSR. In June 2017, 371 MW of guaranteed DSR was contracted for summer, and 315 MW for winter (Polish: Program Gwarantowany). Additional DSR resources were contracted as part of the optional DSR program (Polish: Program Bieżący).[60]

PSE has also issued a strategy to improve price formation and efficiency of the energy market in order to further strengthen signals for investment in electricity and balancing markets.[61]

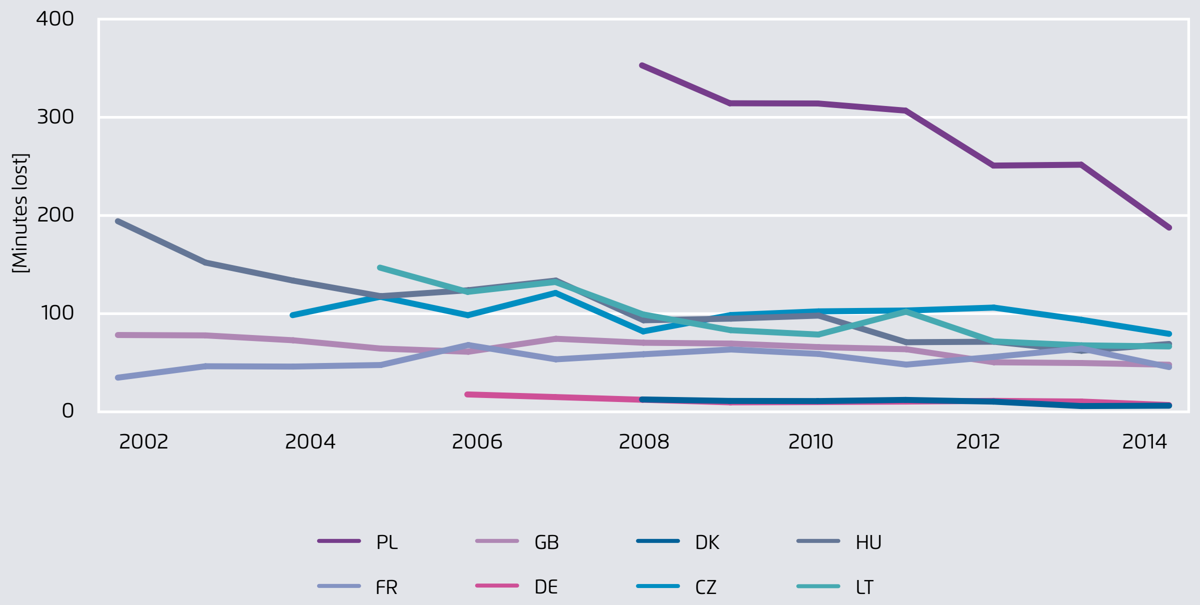
59 European Commission, 2018

60 PSE, 2017

61 Przybylski, 2017.

SAIDI – Unplanned Interruptions, Excluding Exceptional Events

Figure 14



CEER, 2016

10.2 Current System Average Interruption Duration Index (SAIDI)

Although there are limited historic data available for Poland, the number of supply minutes lost by consumers due to unplanned transmission and distribution outages is high compared to many other EU Member States. Likely contributing factors are the overall age and state of the transmission and distribution networks, as well as the relatively low ratio of underground cables (as opposed to overhead lines) to total circuit km in the Polish low- and medium-voltage distribution networks. There is a clear correlation between the use of overhead lines and increased SAIDI. The ratio of underground cable to total circuit km for the Polish low-voltage and medium-voltage distribution systems is 0.42 and 0.24 respectively,[62] compared with figures of 0.87 and 0.75 for Germany.

A comparison of average Polish SAIDI with that of other European Member States is given in Figure 14.

10.3 Smart Metering

A number of smart metering pilot projects have been already implemented in Poland. Several of the large power companies, including Energa, Innogy, PGE, and Tauron, have installed more than 1 million smart meters. However, currently there is no national roll-out plan and the government does not encourage utilities to provide smart meters to all customers by 2020.[63]

62 www.gazetaprawna.pl/amp/1111442,resort-energii-chcemy-zazegnac-konflikt-z-160-lasami-to-przyspieszy-inwestycje-w-kable.html

63 52 CEER, 2014. See also information about Energa's smart grid projects: http://www.energa-operator.pl/projekty_smart_grid.xml

References

ACER. (2015). Opinion 09-2015 on the compliance of NRAs' decisions approving methods of cross-border capacity allocation in the CEE region. Retrieved from http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Opinions/Opinions/ACER%20Opinion%2009-2015.pdf

ACER/CEER. (2017). Annual Report on the Results of Monitoring the Internal Electricity and Gas Marketsin 2016. Retrieved from http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/ACER%20Market%20Monitoring%20Report%202016%20-%20ELECTRICITY.pdf

Bundesnetzagentur. (2017). Austria and Germany: agreement on common framework for congestion management. Retrieved from www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/EN/2017/15052017_DE_AU.html

Council of European Energy Regulators (CEER). (2016). 6th CEER Benchmarking Report on the Continuity of Electricity Supply, Annex A. Retrieved from https://www.ceer.eu/documents/104400/-/-/7b028b43-f188-2b86-a89b-f3de2d7f9356

CEER. (2014). Status Review on European Regulatory Approaches Enabling Smart Grids Solutions ("Smart Regulation"). Retrieved from https://www.ceer.eu/7th-eap-workshop/-/document_library_display/MHR47WoZZFAV/view_file/3729065.

Central Statistical Office of Poland (GUS). (2016). Energia ze źródeł odnawialnych w 2015 r (Energy from renewable sources in 2015). Retrieved from http://stat.gov.pl/download/gfx/portalinformacyjny/pl/defaultaktualnosci/5485/3/10/1/energia_ze_zrodel_odnawialnych_w_2015_roku.pdf

CEPS, MAVIR, PSE, and SEPS. (2013). Unplanned Flows in the CEE Region. Warsaw: Authors. Retrieved from http://www.pse.pl/uploads/pliki/Unplanned_flows_in_the_CEE_region.pdf

CIRE. (n.d.) Budowane i planowane elektrownie (power plants planned and under construction). Retrieved from http://www.rynek-energii-elektrycznej.cire.pl/st,33,335,tr,145,0,0,0,0,0,-budowane-i-planowane-elektrownie.html

Enea. (n.d.) Shareholders structure. Retrieved from https://ir.enea.pl/en/ir/investor-relations/shares-and-shareholders/shareholders-structure

Energa. (n.d.) Akcjonariat (Shareholder Structure). Retrieved from http://www.ir.energa.pl/pl/ir/serwis-relacji-inwestorskich/Akcjonariat/akcjonariat

Energy Regulatory Office (Urząd Regulacji Energetyki, URE). (2017). Installed capacity (MW). Retrieved from https://www.ure.gov.pl/pl/rynki-energii/energia-elektryczna/odnawialne-zrodla-ener/potencjal-krajowy-oze/5753,Moc-zainstalowana-MW.html

Energy Regulatory Office. (2016 a). National Report 2016. Retrieved from https://www.ure.gov.pl/en/about-us/reports/67,Reports.html

Energy Regulatory Office. (2016 b). Ilość energii elektrycznej wytworzonej z OZE w latach 2005-2016 potwierdzonej wydanymi świadectwami pochodzenia (Amount of electricity produced from RES in 2005-2016 confirmed by certificates of origin issued). Retrieved from https://www.ure.gov.pl/pl/rynki-energii/energia-elektryczna/odnawialne-zrodla-ener/potencjal-krajowy-oze/5755,Ilosc-energii-elektrycznej-wytworzonej-z-OZE-w-latach-2005-2016-potwierdzonej-wy.html

ENTSO-E. (2017 a). 2nd Report on the progress and potential problems with the implementation of Single Day ahead and Intraday Coupling. Retrieved from https://www.entsoe.eu/Documents/MC%20documents/2nd%20report%20on%20DA%20and%20ID%20coupling%20progress%20V0.6%20-%20170206%20-%20MC_voting.pdf

ENTSO-E. (2017 b). Detailed Electricity Exchange. Retrieved from https://www.entsoe.eu/db-query/exchange/detailed-electricity-exchange

ENTSO-E. (2016 a). Overview of Transmission Tariffs in Europe (Synthesis 2016). Retrieved from https://nttg.biz/site/index.php?option=com_docman&view=download&alias=840-nrri-postage-stamp-coursebook-1&category_slug=cost-allocation-meeting-material-10-19-2009&Itemid=31

ENTSO-E (2016 b). Mid-term Adequacy Forecast 2016. Retrieved from https://www.entsoe.eu/outlooks/maf/Pages/default.aspx

European Commission. (2018). State aid: Commission approves six electricity capacity mechanisms to ensure security of supply in Belgium, France, Germany, Greece, Italy and Poland - Factsheet. Retrieved from europa.eu/rapid/press-release_MEMO-18-681_en.pdf.

European Commission. (2015 a). Commission withdraws Court case against Poland for failing to transpose EU rules [Press release]. Retrieved from https://ec.europa.eu/energy/node/2285

European Commission (2015 b). Energy efficiency in buildings: Commission asks Italy, the Netherlands and Poland to comply with EU rules [Press release]. Retrieved from https://ec.europa.eu/energy/node/2508

European Commission (2014). EU Energy Markets in 2014. Retrieved from http://ec.europa.eu/energy/sites/ener/files/documents/2014_energy_market_en.pdf

European Commission. (2013). Electricity. Retrieved from http://ec.europa.eu/competition/sectors/energy/electricity/electricity_en.html

Eurostat. (2017). Combined heat and power generation, % of gross electricity generation. Retrieved from http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tsdcc350&plugin=1.

Eurostat. (2016). Statistics explained: Electricity prices for household consumers. Retrieved from http://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_price_statistics#Electricity_prices_for_household_consumers

Hempling, Scott. (2009). Postage Stamp Transmission Pricing: The Seventh Circuit Reverses FERC. Washington, D.C.: NRRI. Retrieved from https://docstore.entsoe.eu/Documents/MC%20documents/ENTSO-E_Transmission%20Tariffs%20Overview_Synthesis2016_UPDATED_Final.pdf

Hogan, M., Bayer, E., and Maćkowiak-Pandera, J. (2016). Zapewnienie niezawodności systemu energetycznego a mechanizm mocy. Forum Energii. Retrieved from http://forum-energii.eu/files/file_add/file_add-45.pdf.

Ministry of Economy. (2013). Sprawozdanie z wyników monitorowania bezpieczeństwa dostaw energii elektrycznej za okres od dnia 1 stycznia 2011 r. do dnia 31 grudnia 2012 r. (Report on Results of Monitoring the Security of Electricity Supply from 1 January 2011 to 31 December 2012). Warsaw: Author. Retrieved from http://www.cire.pl/pokaz-pdf-%252Fpliki%252F1%252FSprawozd_Monit_B_D_E_E_2011_2012_31_07_2013_o.pdf

Ministry of Economy. (2011). Aktualizacja Prognozy Zapotrzebowania na Paliwa i Energie do Roku 2030. Warsaw: Author. Retrieved from http://www.mg.gov.pl/files/upload/11099/ARE%20MG_2011_Raport_koncowy_01_09_2011.pdf.

Ministry of Economy. (2009). Polityka Energetyczna Polski do 2030 roku (Polish Energy Policy to 2030). Warsaw, Author. Retrieved from http://www.mg.gov.pl/files/upload/8134/Polityka%20energetyczna%20ost.pdf.

Ministry of Energy. (2016 a). Polityka Energetyczna (Energy Policy). Retrieved from http://www.me.gov.pl/Energetyka/Polityka+energetyczna

Ministry of Energy. (2016 b). Krajowy Plan Działań Dotyczący Efektywności Energetycznej (Energy Efficiency Action Plan). Retrieved from http://www.me.gov.pl/Energetyka/Efektywnosc+energetyczna/KPDEE

Ministry of Energy. (2016 c). Projekt ustawy o rynku mocy (Proposal for a capacity market law). Retrieved from https://legislacja.rcl.gov.pl/projekt/12292758

Ministry of Infrastructure and Development. (2017). Efektywność energetyczna budynków (Energy efficiency of buildings). Retrieved from http://mib.gov.pl/2-567ab849c4abe.htm

Obersteiner, Carlo. (2008). Market Potentials, Trends, and Marketing Options for Distributed Generation in Europe. Freiburg: MASSIG. Retrieved from http://www.iee-massig.eu/papers_public/MASSIG_Deliverable2.1_Market_Potentials_and_Trends.pdf.

PGE. (2016). Sprawozdanie Zarządu z działalności PGE Polska Grupa Energetyczna S.A. oraz Grupy Kapitałowej PGE za rok 2016. Retrieved from http://slimak.onet.pl/_m/nb/biznes/20170307/233944/sz_gkpge_2016.pdf

PGE. (n.d.) Investor Relations, Shareholders. Retrieved from http://www.gkpge.pl/en/shares/shareholders

Polish Power Grid Company, SA. (2001). Instruction of Transmission System Operation and Maintenance (Rules of Ancillary Services). Warsaw: Author. Retrieved from http://erranet.org/index.php?name=OE-eLibrary&file=download&id=217&keret=-N&showheader=N.

Przybylski, M. (2017). Wyzwania stojące przed KSE i jednostkami wytwórczymi centralnie dysponowanymi (Challenges facing the NPS and centrally manufactured units). PSE. Retrieved from http://forum-energii.eu/files/file_add/file_add-58.pdf

PSE. (2017). Nowa Strategia PSE 2017-2019. Retrieved from https://www.pse.pl/home

PSE. (2015 a). Procentowy udział w krajowej produkcji energii elektrycznej poszczególnych grup elektrowni według rodzajów paliw w 2015 roku (Per centage share in national electricity production of power plant groups by fuel type in 2015). Retrieved from https://www.pse.pl/home#r6_2

PSE. (2015 b). Plan rozwoju w zakresie zaspokojenia obecnego i przyszłego zapotrzebowania na energię elektryczną na lata 2016-2025 (Development plan for meeting current and future electricity demand for 2016-2025). Retrieved from www.pse.pl/uploads/pliki/projekt-PRSP2016-2025-13072015.pdf

PSE. (2015 c). Zestawienie danych ilościowych dotyczących funkcjonowania KSE w 2015 roku (Summary of quantitative data on the operation of the NPS in 2015). Retrieved from http://www.pse.pl/index.php?did=2870#top

PSE. (2014). Agreement between Polish (PSE) and German (50Hertz) transmission system operators on phase shifting transformers marks important step towards completion of the European energy market [Press release]. Retrieved from http://www.pse.pl/uploads/pliki/596320140312_Press%2BRelease%2B_PST%2BAgreement.pdf

PTPiREE. (2016). Rok 2016 w dystrybucji i przesyle w liczbach. Retrieved from http://www.ptpiree.pl/documents/2017/ulotka_ptpiree_dane2016.pdf

RWE. (2016). Annual Report 2016. Retrieved from http://www.rwe.com/web/cms/mediablob/en/3688522/data/105818/7/rwe/investor-relations/RWE-annual-report-2016.pdf

Supreme Audit Office (Najwyższa Izba Kontroli, NIK). (2015). Zapewnienie mocy wytwórczych w elektroenergetyce konwencjonalnej (Ensuring power generation in conventional power), p. 8. Retrieved from https://www.nik.gov.pl/plik/id,8459,vp,10547.pdf

Tauron. (2015). Raport Zintegrowany. Retrieved from http://raport2015.tauron.pl/o-grupie-2/dzialalnosc-grupy/tauron-na-tle-branzy/

Tauron. (2016). Shareholder Structure. Retrieved from http://en.tauron.pl/tauron/investor-relations/Pages/shareholder-structure.aspx

TGE. (2016). Najlepszy rok dla TGE na rynku gazu ziemnego (The best year for TGE in the natural gas market). Retrieved from http://www.polpx.pl/pl/27/aktualnosci/732/najlepszy-rok-dla-tge-na-rynku-gazu-ziemnego

Wasik, P., & Kulesa, M. (2016). Obrót energią elektryczną i gazem w Polsce - wybrane uwarunkowania, wpływ MiFID II na uczestników rynków (Electricity and gas trading in Poland - selected conditions, impact of MiFID II on market participants) [Presentation]. Retrieved from https://www.tge.pl/fm/upload/komunikaty/2017/2017_03_08_Prezentacja_TOE.pdf

Woszczyk, M. (2013). 2013 National Report of The President of the Energy Regulatory Office in Poland. Warsaw: Energy Regulatory Office. Retrieved from www.ure.gov.pl/download/2/436/National Report2013.pdf.

50 Hertz. (n.d.) Interconnections between Germany (50Hertz) and Poland (PSE) Retrieved from www.50hertz.com/en/Grid-Access/Power-trading-and-Congestion-Management-in-Europe/International-transmission-lines/to-Poland

Publications by Agora Energiewende

IN ENGLISH

The Future Cost of Electricity-Based Synthetic Fuels

A Future for Lusatia
A Structural Change Plan for the Lusatia Coal-Mining Region

The European Power Sector in 2017
State of Affairs and Review of Current Developments

Reducing the cost of financing renewables in Europe
Report of a multi-stakeholder dialogue on the proposed EU Renewable Energy Cost Reduction Facility

Renewables versus fossil fuels – comparing the costs of electricity systems
Electricity system designs for 2050 – An analysis of renewable and conventional power systems in Germany

FAQ EEG – Energiewende: What do the new laws mean?
Ten questions and answers about EEG 2017, the Electricity Market Act, and the Digitisation Act

Refining Short-Term Electricity Markets to Enhance Flexibility
Stocktaking as well as Options for Reform in the Pentalateral Energy Forum Region

A Pragmatic Power Market Design for Europe's Energy Transition
The Power Market Pentagon

Eleven Principles for a Consensus on Coal
Concept for a stepwise decarbonisation of the German power sector (Short Version)

The Integration Costs of Wind and Solar Power
An Overview of the Debate of the Effects of Adding Wind and Solar Photovoltaics into Power Systems

IN GERMAN

Die zukünftigen Kosten strombasierter synthetischer Brennstoffe

Wie weiter mit dem Ausbau der Windenergie?
Zwei Strategievorschläge zur Sicherung der Standortakzeptanz von Onshore Windenergie

Die deutsche Braunkohlenwirtschaft
Historische Entwicklungen, Ressourcen, Technik, wirtschaftliche Strukturen und Umweltauswirkungen

Charta für eine Energiewende- Industriepolitik
Ein Diskussionsvorschlag von Agora Energiewende und Roland Berger

Neue Preismodelle für Energie
Grundlagen einer Reform der Entgelte, Steuern, Abgaben und Umlagen auf Strom und fossile Energieträger

Energiewende und Dezentralität
Zu den Grundlagen einer politisierten Debatte

Wärmewende 2030
Schlüsseltechnologien zur Erreichung der mittel und langfristigen Klimaschutzziele im Gebäudesektor

Elf Eckpunkte für einen Kohlekonsens
Konzept zur schrittweisen Dekarbonisierung des deutschen Stromsektors
(Lang- und Kurzfassung)

Erneuerbare vs. fossile Stromsysteme: ein Kostenvergleich
Stromwelten 2050 – Analyse von Erneuerbaren, kohle- und gasbasierten Elektrizitätssystemen

Wie hoch ist der Stromverbrauch in der Energiewende?
Energiepolitische Zielszenarien 2050 - Rückwirkungen auf den Ausbaubedarf von Windenergie und Photovoltaik

Die Entwicklung der EEG-Kosten bis 2035
Wie der Erneuerbaren-Ausbau entlang der langfristigen Ziele der Energiewende wirkt

12 Thesen zur Energiewende
Ein Diskussionsbeitrag zu den wichtigsten Herausforderungen im Strommarkt, (Lang- und Kurzfassung)

All publications are available on our website: www.agora-energiewende.de

137/01-CP-2018/EN

Agora Energiewende develops evidence-based and politically viable strategies for ensuring the success of the clean energy transition in Germany, Europe and the rest of the world. As a think tank and policy laboratory we aim to share knowledge with stakeholders in the worlds of politics, business and academia while enabling a productive exchange of ideas. Our scientifically rigorous research highlights practical policy solutions while eschewing an ideological agenda. As a non-profit foundation primarily financed through philanthropic donations, we are not beholden to narrow corporate or political interests, but rather to our commitment to confronting climate change.

This publication is available for download under this QR code.

Agora Energiewende
Anna-Louisa-Karsch-Straße 2 | 10178 Berlin
P +49 (0)30 700 14 35-000
F +49 (0)30 700 14 35-129
www.agora-energiewende.de
info@agora-energiewende.de

Agora Energiewende
Energiewende

Agora Energiewende is a joint initiative of the Mercator Foundation and the European Climate Foundation.