The German energy transition and the Polish energy system

FACTSHEET

Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit

Umwelt Bundesamt

INSTYTUT JAGIELLOŃSKI

ECOFYS

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Part I: **The German energy transition**
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Ana Amazo (Ecofys)

Part II: **The Polish energy system**
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Key messages

Part I

By: Fabian Wigand,
Ana Amazo (Ecofys)

With the energy transition (Energiewende), Germany has started a fundamental and profound transformation of its energy supply, energy consumption and energy system. The energy transition has resulted in renewables becoming the number one source of electricity. Renewable energy sources accounted for the highest percentage (32.3%) of gross electricity consumption in 2016. Costs for RES have decreased significantly since start of EEG: e.g. successful ground-mounted solar PV projects in the December 2016 auction pilot will receive 6.90€ cents/kWh, compared to the 40.60€ cents/kWh paid in 2006 in the form of a feed-in tariff.

In the transport and heating sector substantial progress has been achieved but further efforts need to be taken to achieve targets for these sectors. While the share of renewables in gross energy consumption has tripled since 2000, it has remained constant in the heating sector (13.2%), and is in slight decline in the transport sector (5.2%).

Energy efficiency gains have been made but more is required to halve energy consumption by 2050. Germany has decoupled its energy consumption from GDP: final energy productivity increased 60% since 1990. In energy intensity, Germany ranks as one of the most efficient countries in the EU. Between 1990 and 2014, primary energy consumption decreased by 0.5% per year in average. However, between 2008 and 2015, final energy productivity rose by an average of 1.3% per year, which is below the annual 2.1% target. To meet the 2050 target, final energy productivity needs to increase by an average of 3.3% per year by 2020. A discussion about additional measures has been kick-started with a green book on energy efficiency.

German greenhouse gas (GHG) emissions have decreased by 28% compared to 1990. However, only in a best-case scenario, of "quick and ambitious implementation of the over 100 measures", would Germany be able to reach its goal of cutting GHG emissions by 40% by 2020. A coal exit remains an open question: concrete steps on this direction will be determined by a commission in 2018.

Part II

By: Christian Schnell PhD,
Antoni Olszewski (Instytut Jagielloński)

Poland's energy transition is on its way and results in RES development, decarbonisation and energy efficiency measures are comparable to other CEE countries, with a large share of onshore wind farms and solid biomass firing amounting to approx. 20 TWh, i.e. almost 90% of RES power production. Currently, further RES development is on hold due to regulatory uncertainty caused by Polish legislator, which however is agreeing RES support with European Commission, and is also waiting for the final outcome of the 4th legislative package of the Energy Union, the so-called winter package which has been published as a draft end of November 2016. It has to be emphasised, that Poland's energy mix is unique in Europe and also in CEE due to its very high share in power and heat production by solids, i.e. hard coal and brown coal, however, the decarbonisation of power and heat production is inevitable.

Poland's starting position is substantially different to other countries of the former Comecon block, which developed a fleet of nuclear power plants with Russian technology.

Poland's fleet of coal power plants is depreciated and urgently requires replacement, and further investments in coal power plants in the market environment created by the Energy Union are almost impossible. The strong political will to further develop coal power plants is caused mainly by 85,000 hard coal miners, which still are working in this sector, although due to early retirement programmes and leave-payments approx. 8,000 jobs are cancelled each year. Therefore, Poland's policymakers try to gain time to further reduce jobs in coal mines in a socially acceptable way, and investments in RES and energy efficiency are for the time being hampered, however should continue after the regulatory framework by the 4th Energy package has been finally agreed by end of 2018. Nevertheless, such policy approach may cause in the near future severe problems with European Commission, and is risky for attracting EU funds due to so-called "ex ante-evaluation" checking whether Poland adopted obliging policies and measures set by EU prior to pay-off of EU funds.

Poland's investments are largely based on EU funds, and Poland is by far the largest beneficent of such funds.

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Part I:
The German energy transition

By Fabian Wigand and Ana Amazo (Ecofys)

Figure 1 **SPECIFIC TARGETS OF THE *ENERGIEWENDE***
SOURCE: BMWI 2016, DENA 2017

		ACHIEVED 2015	2020	2025	2030	2035	2040	2045	2015
CLIMATE	% greenhouse gas reduction (vs. 1990)	**27,2%**	-40		-55		-70		-80 to -95
RENEWABLE ENERGIES	% gross electricity consumption	**32,3%** (2016)	35	40 to 50	50	55 to 60	65		80
	% gross final energy consumption	**14,9%**	18		30		45		60
ENERGY EFFICIENCY	primary energy consumption (vs. 2008)	**-7,6%**	-20						-50
	final energy productivity (vs. 2008)	**1,3%** (PER YEAR)	**+2,1%** p.a. (2008-2050)						
	building renovation	**~ 1% P.A.**	doubling of renovation rate: **1%** → **2%** p.a.						
	transport final energy consumption (vs. 2005)	**1,3%**	-40						-40

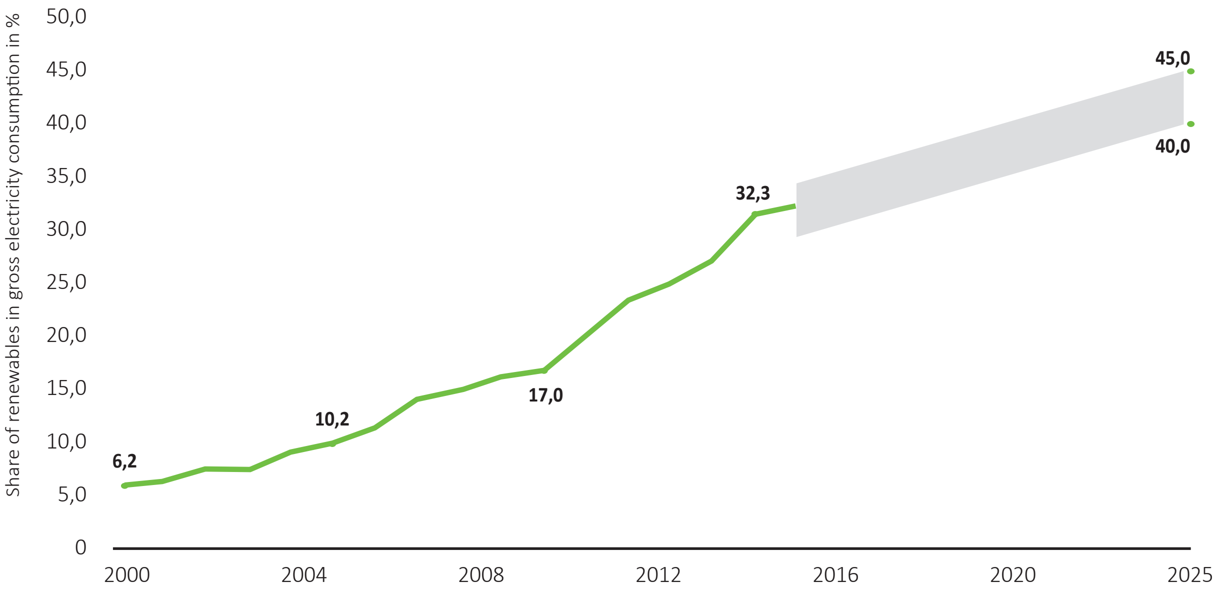
Germany's energy transition has resulted in renewables becoming the number one source of electricity

The German *Energiewende* (energy transition) is rooted in the anti-nuclear movement of the 1970s, long before the Fukushima nuclear disaster took place. The shock of the oil crisis of 1973 and the Chernobyl nuclear disaster of 1986 lead to the search for alternatives — and the invention of feed-in tariffs in 1991 (German Energy Transition, 2012a). The motivation, therefore, has been to increase energy security and economic competitiveness in general, with environmental concerns gaining importance in the decades that followed. Today, reducing greenhouse gas emissions, phasing-out nuclear energy, and safeguarding security of supply and competitiveness are key dimensions of Germany's policy framework toward the transformation of its energy supply (BMWi 2017).

The Energy Concept of 2010 pursues two fundamental strategies (i.e. „core objectives"), in order to advance the energy transition: expanding the use of renewable energy and boosting energy efficiency. These core objectives are to be attained in the areas of electricity, heat and transport. Figure 1 presents specific targets[1] of the *Energiewende* as laid out in the 2010 Energy Concept. These correspond to the EU Roadmap 2050 (from 2011), and were confirmed by the German Federal Government in the 2013 Coalition Agreement.

1. Additional targets (not illustrated on the graph) include (BMWi 2016): Energy efficiency: gross electricity consumption to be reduced: -10% in 2020 and -25% in 2050 compared to 2008; Buildings: Reduce primary energy demand to -80% by 2050 (and by -20% for heat in 2020); Transport: Increase number of electric vehicles to 1 Million in 2020 and 6 Million in 2030

Figure 2 | **SHARE OF RENEWABLES IN GROSS ELECTRICITY CONSUMPTION**
SOURCE: ECOFYS BASED ON BMWI 2016, AGORA 2017 AND EEG 2017



Renewable energy accounted for the highest percentage (32.3%) among all energy sources of gross electricity consumption in 2016 (Agora Energiewende 2017) (see Figure 2). In gross electricity production in 2016 (Figure 3), renewables made up 29.5%, while lignite accounted for 23%, hard coal for 17%, nuclear for 13%, and gas for 12% (AGEB 2016). Germany aims to have renewable energy sources cover 35% of electricity consumption by 2020 and 80% by 2050. The expansion of renewable energy sources has been primarily supported by the Renewable Energy Sources Act (EEG). As a result, achieving the 2020 target of 35% electricity from renewables is well within reach.

Figure 3 | **HISTORIC DEVELOPMENT OF GROSS ELECTRICITY GENERATION IN GERMANY BY SOURCES IN TWH**
SOURCE: ECOFYS BASED ON AGEB 2016

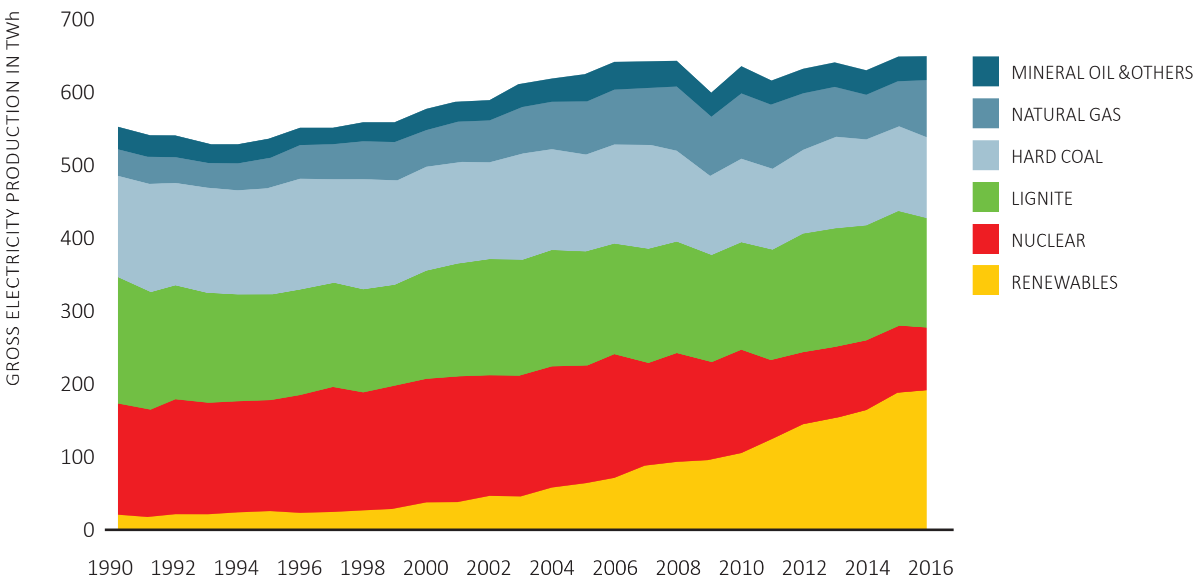
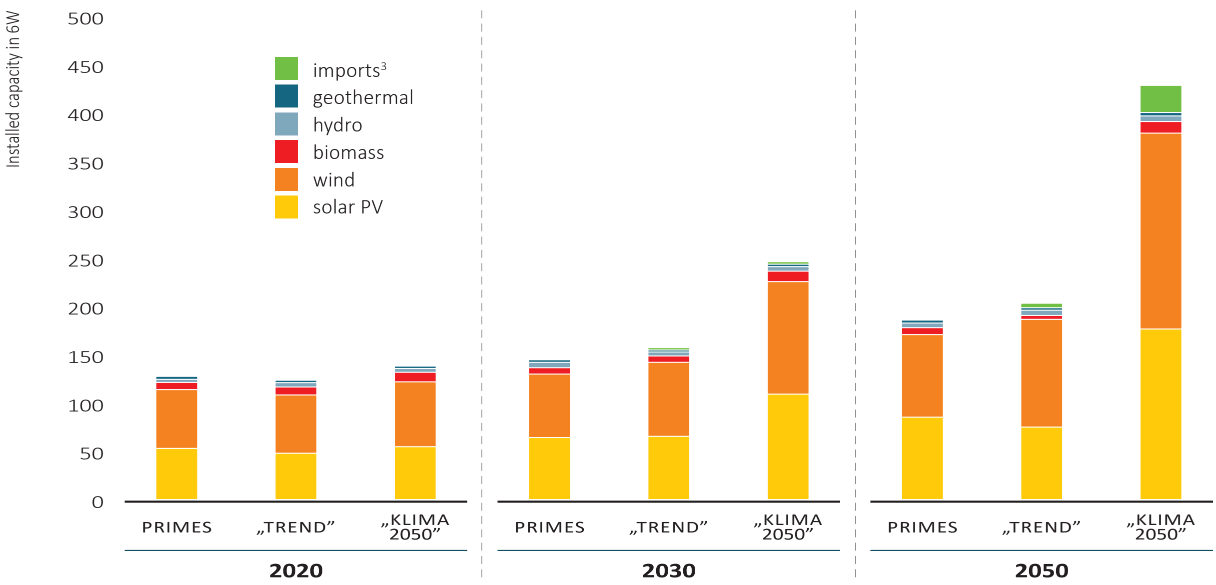


Figure 4 | **SCENARIO COMPARISON: INSTALLED CAPACITY OF RENEWABLES IN 2020, 2030 AND 2050**
SOURCE: ECOFYS BASED ON EUROPEAN COMMISSION 2016 B AND NITSCH 2016

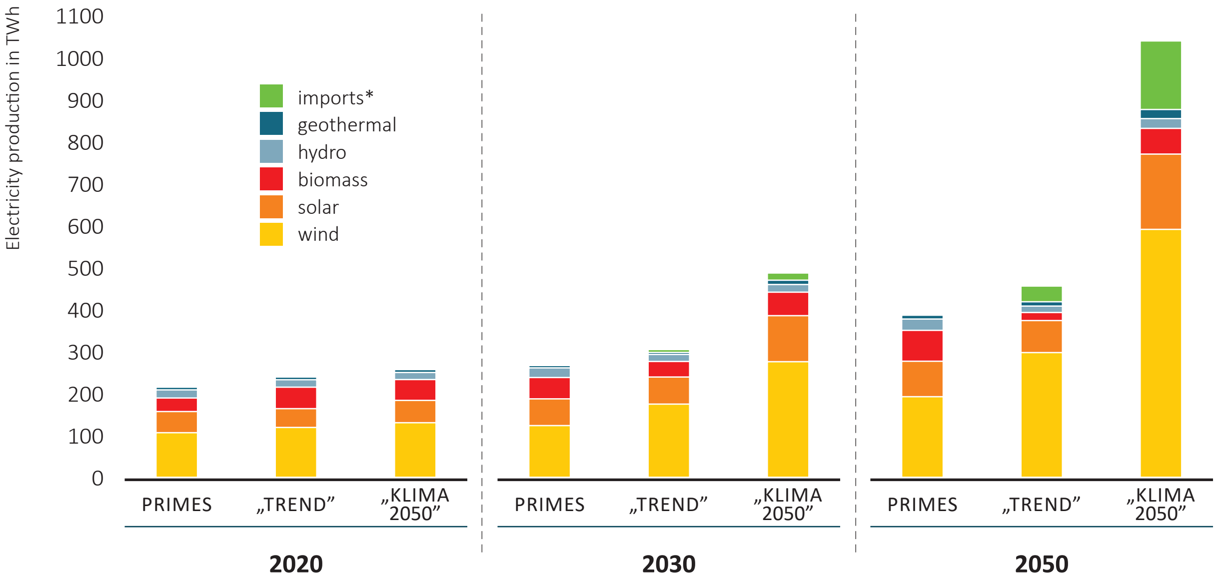


Even though significant progress has been made, it is uncertain whether the current growth rate of renewables in Germany is compatible with a decarbonised energy supply by 2050. Scenarios[2] developed by Nitsch (2016) for the Bundesverband Erneuerbare Energien e.V show that, although the electricity sector will be dominated by renewables, more capacity than outlined in the EEG deployment corridor is needed. According to these scenarios, although current policies ("Trend" scenario) will lead to achieving 2035 targets in electricity consumption from renewables (i.e. 55%), reaching the more ambitious 2050 target of 80% is unlikely. Instead, current policies are estimated to result in 68% of electricity consumption being covered by renewables in 2050 (Nitsch 2016).

Figure 4 shows that the installed capacity of renewables is estimated to be around 157 GW ("Trend") by 2030: a gap of 92 GW (105 GW in the PRIMES model[3]) compared to a level compatible with a decarbonisation of the energy supply by 2050 ("Klima 2050"). By 2050, the projected gap compared to the "Trend" scenario and the PRIMES model will be 228 GW and 247 GW, respectively.

2. Figure 4 and Figure 5 show a comparison of the PRIMES model for Germany with the scenarios in Nitsch 2016, namely "Trend" and "Klima 2050". A brief description of each can be found below:
The PRIMES model is an EU energy system model that simulates energy consumption and the energy supply system. The EU Reference Scenario 2016, which PRIMES feeds into, includes policies and measures adopted at EU level and in the Member States by December 2014. In addition, amendments to three Directives only agreed in the beginning of 2015 were also considered. This concerns the ILUC amendment to the RES and FQD Directives, and the Market Stability Reserve Decision amending the ETS Directive. Relevant national policies and measures indicated in the answers to the Member States' questionnaire are also reflected in the Reference Scenario. This notably includes national RES and energy efficiency policies.
The "Trend" scenario incorporates current energy policy and announced action, namely: the amendment of the Renewable Energies Act (EEG 2017) and its electricity expansion targets, the Climate Action Program 2020, the draft law of the Electricity Market 2.0, and the National Action Plan for Energy Efficiency (NAPE).
In the "Klima 2050" scenario, energy production should be almost CO_2-neutral by 2050 to avoid global warming of more than 2 degrees Celsius. This scenario meets the objectives of the Energy Concept, in particular the climate protection target of a 95% reduction of GHG emissions by 2050.
3. While the "Trend" and "Klima 2050" in Nitsch 2016 count imported capacity from wind, solar (PV and CSP), and hydro, this is not the case in the PRIMES model. This factor explains only a small fraction of the differences seen in terms of installed capacity and electricity generation in Figure 3 and Figure 4, respectively. Another difference between the Nitsch scenarios and the PRIMES model is that the latter excludes hydro pumping from its hydro category and groups other renewable technologies under geothermal.

Figure 5 | **SCENARIO COMPARISON: ELECTRICITY PRODUCTION FROM RENEWABLES IN 2020, 2030 AND 2050**
SOURCE: ECOFYS BASED ON EUROPEAN COMMISSION 2016 B AND NITSCH 2016



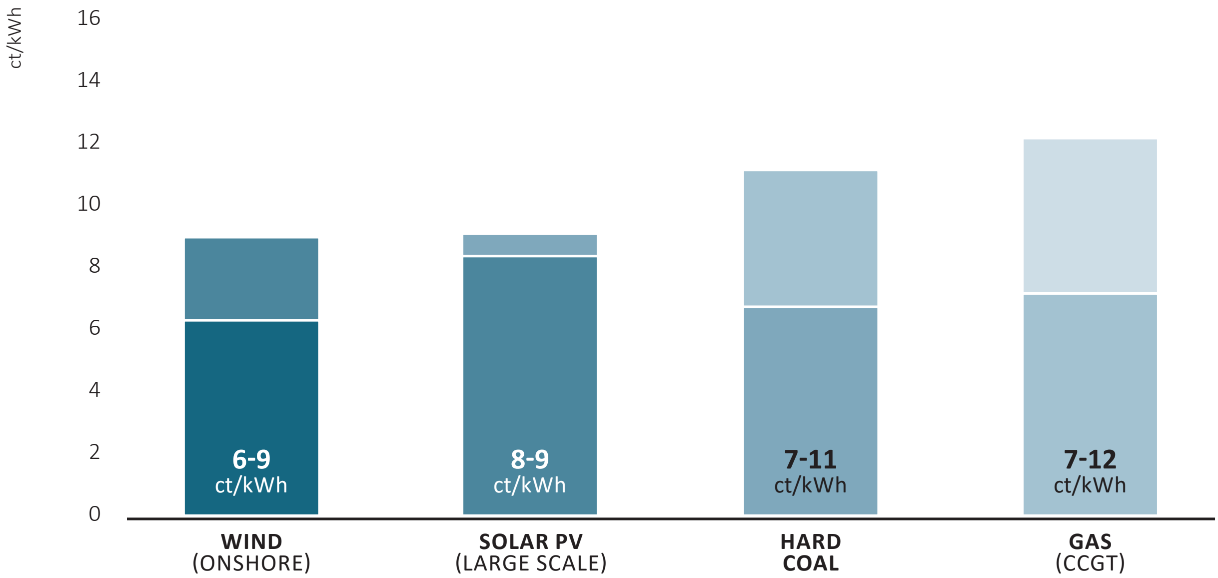
Even though significant progress has been made, it is uncertain whether the current growth rate of renewables in Germany is compatible with a decarbonised energy supply by 2050

While electricity from renewables in Germany is expected to double to 460 TWh by 2050 compared to today's level, it is estimated more will be required to crowd out fossil fuels in the heating & cooling and transport sectors (Nitsch 2016). By 2030, annual electricity generation will amount to 302 TWh ("Trend" in Figure 5), leading to a gap of 19 TWh (42 TWh in the PRIMES model) compared to a level compatible with the decarbonisation of the energy supply by 2050 ("Klima 2050"). By 2050, the projected gap compared to the "Trend" scenario and the PRIMES model will be 583 TWh and 654 TWh, respectively.

Onshore wind and solar PV costs are already competitive with conventional technologies. Figure 6 shows the range of levelised cost for electricity for various technologies (LCOE)[4]. Already in 2015 wind turbines at good onshore locations were able to generate electricity at lower costs than new hard coal or gas power plants. The 2016 auction results of 6.90€ cents/kWh for ground-mounted solar PV (see Figure 7) show installations are to be built at significantly lower costs than the 40.60€ cents/kWh paid in 2006 in the form of a feed-in tariff (IWR 2017).

4. LCOE is the net present value of the unit-cost of electricity over the lifetime of a generating asset. It is often taken as a proxy for the average price that the generating asset must receive in a market to break even over its lifetime.

Figure 6 **RANGE OF LEVELISED COST OF ELECTRICITY (2015)**
SOURCE: AGORA ENERGIEWENDE 2016

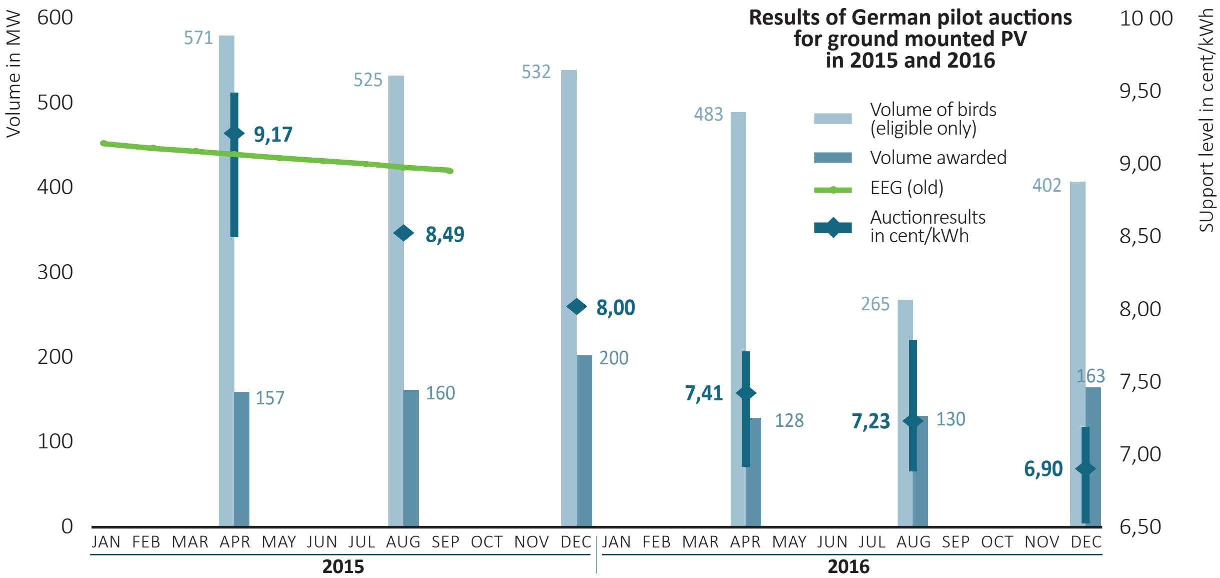


Auctions for renewable electricity have led to efficiency gains, resulting in lower support costs paid for electricity generated from ground-mounted solar PV.

Auctions for renewable electricity have led to efficiency gains, resulting in lower support costs paid for electricity generated from ground-mounted solar PV. Bringing down support costs, managing deployment, and complying with European state aid guidelines motivated the switch to auctions after support costs from its feed-in tariff (FIT) were higher than expected[5]. Average support level in the December 2016 auction pilot was 6.90€ cents/kWh, roughly 25% lower than the support level of 9.17€ cents/kWh seen when auctions were introduced in 2015 (see Figure 7). The main reason for the observed price reductions is the high level of competition, determined by the volume of eligible bids versus the volume awarded. In Germany's first solar PV auction open to Denmark, the entire volume (50 MW) was allocated to five solar projects in Denmark with bids of 5.38 euro cents/kWh on average (BNetzA 2016b). The winning bid will develop the projects on agricultural land. This is currently prohibited in Germany and may, combined with higher full load hours and a large pipeline of predeveloped, Danish PV projects with no other opportunity for support, have led to lower bids in Denmark. Auction winners, including those open to other countries, receive support for 20 years.

5. In 2014, Germany's FIT had an annual price tag for electricity consumers of 24 billion euros (Dinkloh, 2014)

Figure 7 | **SOLAR PV AUCTION RESULTS IN GERMANY**
SOURCE: ECOFYS BASED ON OFFICIAL RESULTS BY BNetzA



Remark: The pricing rule changed from pay-as-bid (1st round) to uniform pricing (2nd and 3 rd round), back to pay-as-bid (4th and 5th rounds)

The spot market electricity price has fallen by more than half since reaching its ten-year peak in 2008. While this was in part due to the global financial crisis that began the same year, a larger supply of cheap renewables is also driving more expensive conventional power out of the market. (BMWi 2016) (see Figure 8).

Germany has managed to meet as much as 85% percent of a day's electricity demand from renewables. On May 8 2016, both solar PV and onshore wind production peaked at 12 pm, with 28.6 GW and 15.7 GW respectively (see Figure 9). Electricity from conventional sources reached 18 GW at 12 pm, resulting in excess production that exceeded consumption and negative spot prices as low as €130/MWh at 2 pm. Over the course of 2015, 126 hours experienced negative prices, averaging to-9€ (Agora Energiewende 2016).

Figure 8 | **SPOT MARKET ELECTRICITY PRICES IN EURO/MWh**
SOURCE: ECOFYS BASED ON BMWI 2016

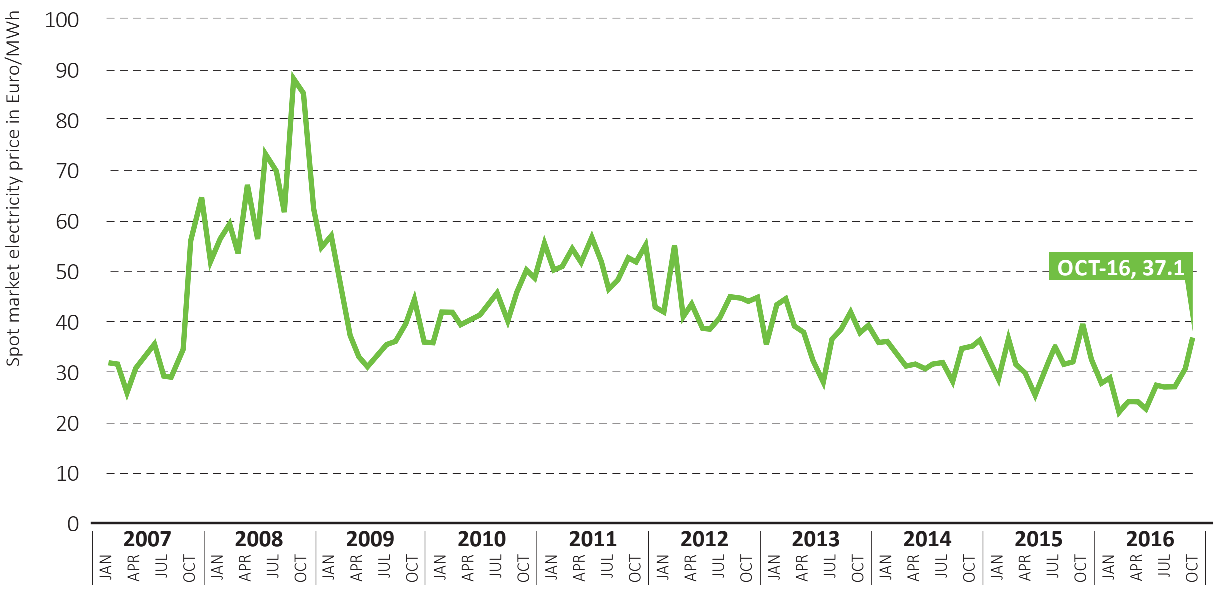
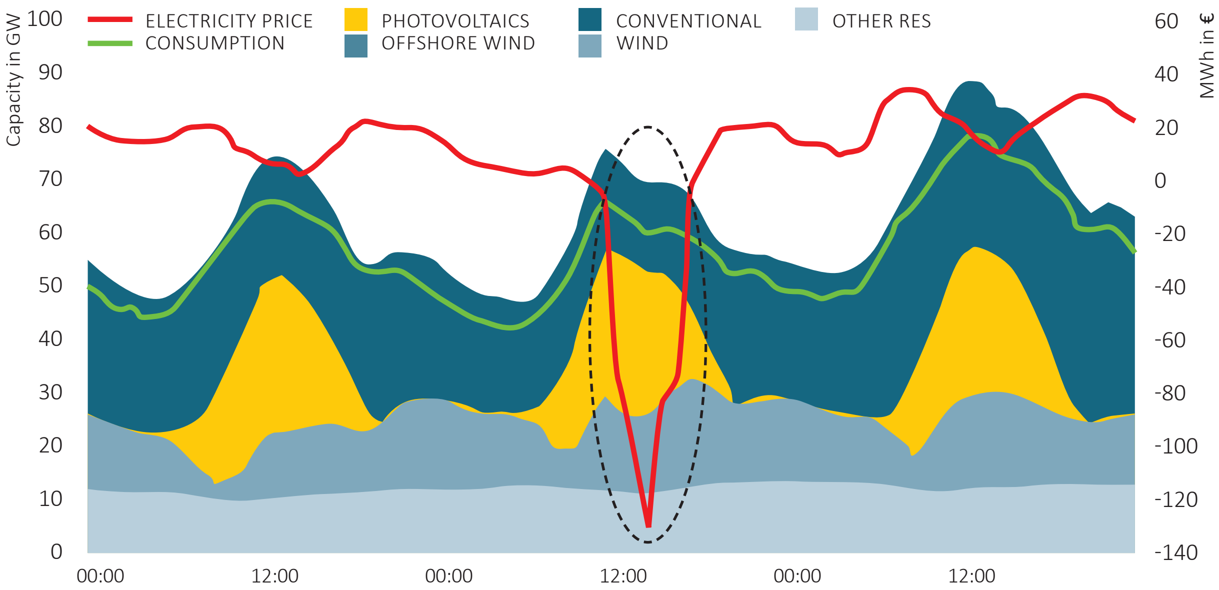


Figure 9 **ELECTRICITY CONSUMPTION COVERED BY RENEWABLES ON 8 MAY 2016**
SOURCE: AGORA 2016



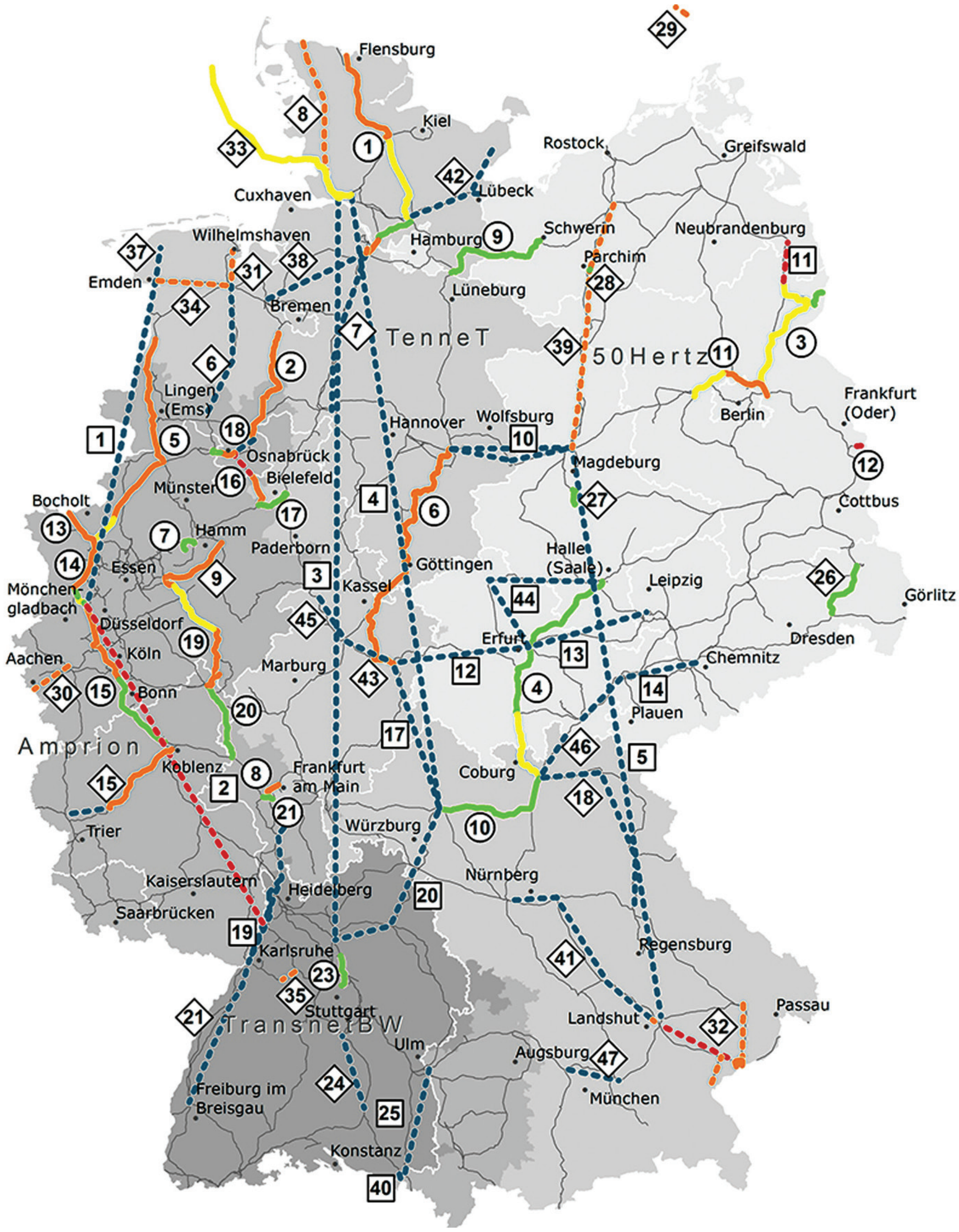
Germany's electricity market 2.0 aims to create stronger price signals for producers and suppliers in in the electricity market. The Electricity Market Act (2016) establishes that the state will not interfere in the electricity market even if high price peaks occur and allows providers of load management, flexible power production or storage capacity to access the electricity market (for balancing power).

A capacity reserve provides a buffer to the electricity market in case the transmission system operators (TSO) notice that demand exceeds supply. The reserve is planned to have roughly 4.4 GW of capacity, i.e. the equivalent of 5% of Germany's average maximum electricity demand (maximum peak load) of 86 GW for the next five years. The capacity reserve is to be procured jointly by the four TSOs through a technology-neutral tender. The first call for tender will take place in April 2017 for the period October 2017-2019 and have a volume of 1.8 GW (BMWi 2015). Electricity from the capacity reserve will not be sold on the electricity market. Once the contract governing their role as a reserve has ended, power plants can bid again to act as a reserve.

Though Germany is producing ever-more electricity from renewables, grid development has not followed the same pace. Electricity from wind parks in the north of Germany that cannot be consumed regionally needs to be transported by the grid to other regions. However, this electricity volume can exceed the capacity of the national grid, in which case it would take indirect routes (i.e. loop flows) through Poland and the Czech Republic. This has resulted in excess power on these countries' grids, which is costly and can lead to blackouts (Bloomberg 2016). Currently, one solution being considered is to split the Austrian-German market zone. The German grid regulator, the Bundesnetzagentur (BNetzA), requested that TSOs prepare themselves to limit electricity trading at the Austrian border from 3 July 3 2018 onwards. From that point, trading could be limited to the electricity that can be physically transported on interconnectors across the border.

Grid expansion in Germany is under way and creates flexibility at a low cost for the integration of renewables. The Federal Requirement Plan (Bundesbedarfsplan) (see Figure 10) lists the projects implemented or planned for the expansion of the transmission grid. Under the current Federal Requirement Plan, there are 6,100 km of priority lines planned and 3,050 km to be optimised (BBPlG-Monitoring 2016). Though set on the political agenda in Germany, there has been some delay in further expanding the grid. According to the BNetzA, the construction and completion of important power lines in Germany will be delayed by at least three years. In fact, additions to the grid were supposed to be completed by 2022, but many power lines are now scheduled for completion in 2025 (BNetzA 2016a).

Figure 10 | **GRID EXPANSION THROUGH THE FEDERAL REQUIREMENT PLAN**
SOURCE: BÜRGERDIALOG STROMNETZ 2016



6 100 km
of priority lines planned

43
projects

3 050 km
optimization

REALIZED

APPROVED OR UNDER CONSTRUCTION

OTHER PLANNED ROUTES (UNDER THE ENERGY EXTENSION PLAN ACT)

OTHER PLANNED ROUTES (UNDER THE FEDERAL REQUIREMENT PLAN ACT)

PROJECT OF COMMON INTEREST (EU)

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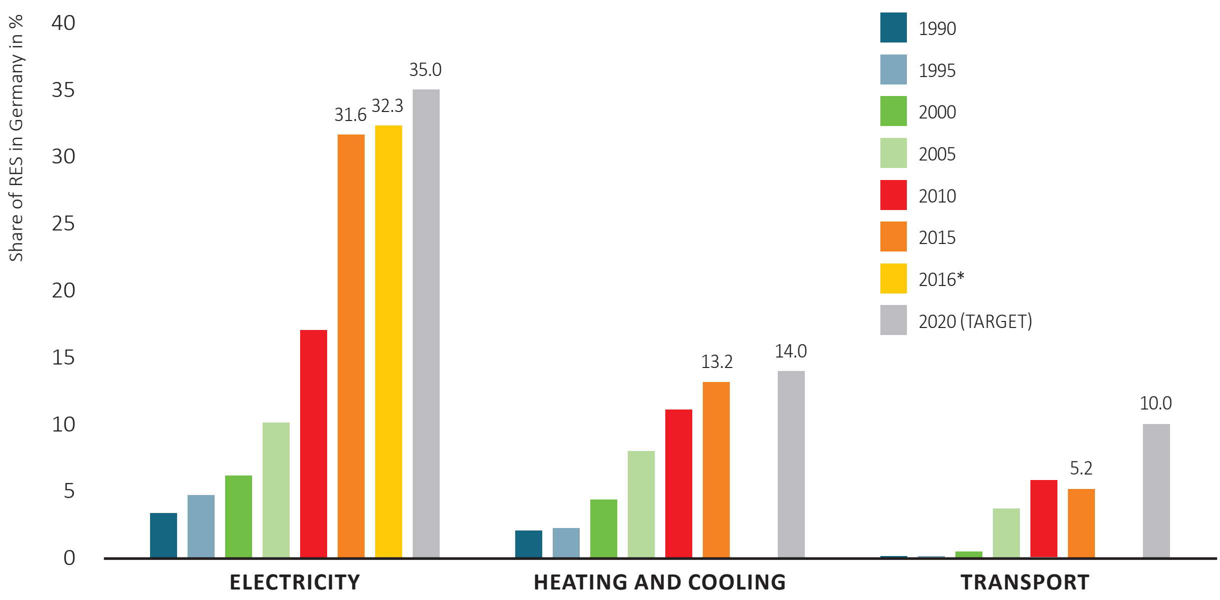
Expansion of renewables in the transport and heating sector is lagging compared to the electricity sector

While the share of renewables in gross energy consumption has tripled since 2000, it has remained virtually constant in the heating sector, and is in slight decline in the transport sector. In 2015, renewable energies amounted to 377.5 TWh or 14.9% of gross energy consumption (BMWi 2016). Renewable heating contributed 13.2% of total German heating (and cooling), compared to 11.1% in 2005 (see Figure 11). An updated market incentive program for renewables in the heating sector was launched in early 2016 to help trigger a switch to renewables and more efficient heating options. Renewables in the transport sector accounted for 5.2%[6] of the total fuel consumption in 2015, a decrease compared to the 5.8% observed in 2005. The decline in the share of biofuels compared to the previous year, which could not be offset by the increase in electric mobility, was the cause of the declining trend in renewable shares in transport. The step-wise ending of tax reliefs for biofuels until 2012 partly explains the downward trend in the share of biofuels.

Political targets have been more clearly defined for the electricity sector than for the heating and transport sectors. While the electricity sector has several intermediate targets (2025, 2030, 2035, 2040), the heating and transport sector have no intermediate targets on the way to 2050. Achieving a transition of the whole energy system therefore requires paying attention to the heating and transport sectors – of which the latter is still highly dependent on oil. The 2014 National Action Plan on Energy Efficiency (NAPE) outlines the promotion of a broad range of renewables technologies including the promotion of electric vehicles (EVs), hydrogen and fuel-cell technology, and biofuels (also for use in air travel). For e-mobility, a target of 1 million cars by 2020 has been set and a billion-euro action package was launched in the spring of 2016. It includes purchase premiums for buyers of electric cars.

Figure 11 | **SHARE OF RENEWABLES IN THE ELECTRICITY, HEATING AND TRANSPORT SECTORS**
SOURCE: ECOFYS BASED ON AGEE-STAT 2016, BMWI 2016, AGORA 2017



Energy efficiency gains have been made but more is required to meet the envisioned targets

Germany continues to produce more GDP with less energy[7], yet additional efforts are required. Final energy productivity[8] increased 60% since 1990 due to a rising GDP and decreasing energy consumption. Between 2008 and 2015, however, final energy productivity rose on average 1.3% per year, which is below the annual 2.1% target. To meet this target, final energy productivity needs to increase by an average of 3.3% per year by 2020 (BMWi 2016). The Energy Concept aims for a reduction of 50% in primary energy consumption by 2050 compared to 1990. By 2014, GHG intensity (resulting from dividing GHG emissions by GDP) had declined by 50% since 1990.

Germany promotes energy efficiency through regulation, financial incentives, and information & consultation. Since the oil crises of 1973 and 1979, energy efficiency has been on the German policy agenda. The Energy Savings Ordinance (EnEV) of 1976, and its subsequent reforms, stipulates all applicable energy standards for all building types. In the area of building insulation, the Federal Government aims to renovate around 2% of buildings per year, yet the renovation rate in 2016 was around 1% (dena, 2017). Financial incentives include KfW special low-interest loans for energy-efficient renovations, as well as a BAFA grant program that covers up to 30% of investment costs for SMEs and 20% for bigger companies. Finally, the Energy Consulting Program for Small and Medium-sized Enterprises seeks to advise SMEs on site and identify energy drains in their business operations.

With the National Action Plan on Energy Efficiency (NAPE) of 2014, a reduction of 350 to 380 PJ of primary energy consumption is expected, which is the equivalent of 21.5 to 23.3 Mio. t CO_2e. Central measures within the NAPE include: implementing a tender system for energy efficiency measures, increasing the financial support for building renovations, and implementing 500 energy efficiency networks with industry and businesses.

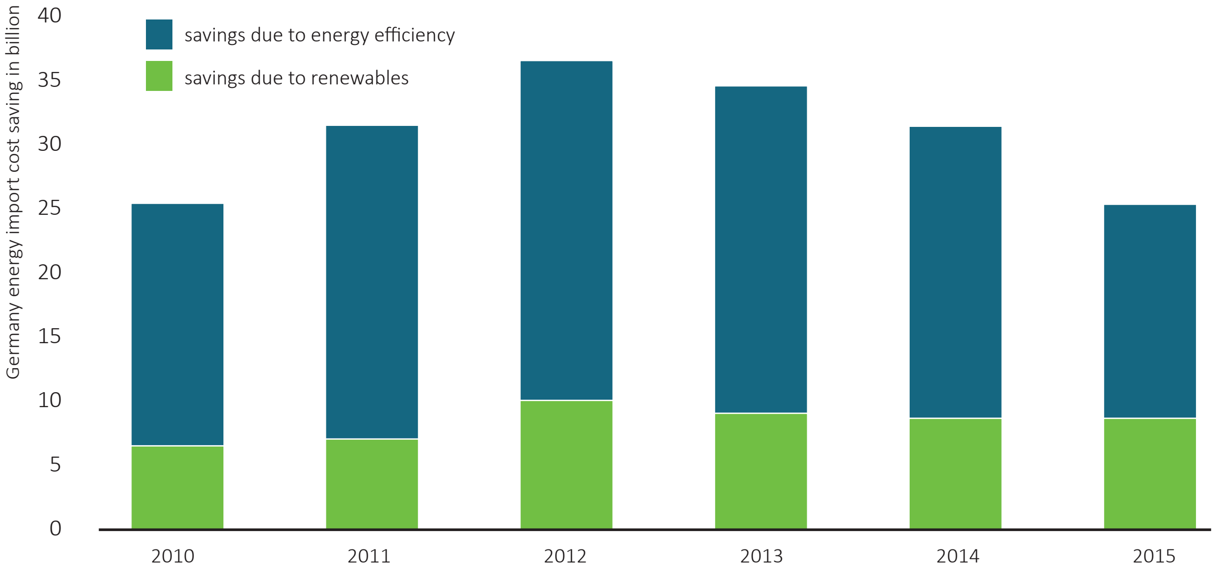
Figure 12 | **SELECTED NAPE MEASURES AND THEIR SAVINGS POTENTIAL**
SOURCE: ECOFYS 2015 BASED ON BMWI 2014

Measure	Savings	Total
Quality assurance and optimizing of energy consulting	4,0 PJ	32,0 - 76,5 PJ saving
Incentive program for energy-efficient renovation	Up to 40,0 PJ	
Increased funding of the CO_2 building modernization program	12,5 PJ	
Promoting “energy performance contracting”	5,5-10,0 PJ	
National energy-efficiency label for old heating installations	10,0 PJ	
National top runner initiative Pilot program for energy saving meters	85,0 PJ	85,0 PJ saving
Introduction of a competitive tendering scheme for energy efficiency	26,0-51,5 PJ	180,5-206,0 PJ saving
Upgrading the KfW energy efficiency programs	29,5 PJ	
Energy efficiency networks initiative	74,5 PJ	
Obligation to perform energy audits for non-SMEs	50,5 PJ	

6. This includes both renewable electricity (0.6%) and biofuels (4.6%).
7. For more information please refer to Factsheet 2 section 1.1
8. Resulting from dividing GDP by final energy consumption

Figure 13

GERMANY ENERGY IMPORT SAVINGS IN 2015 DUE TO RENEWABLES AND ENERGY EFFICIENCY
SOURCE: ECOFYS BASED ON BMWI 2016



Stepping up progress in energy efficiency is needed given that targets will not be achieved by the measures undertaken so far. The Expert Commission on the Monitoring Process "Energy of the Future" points out that current measures are insufficient to achieve the envisaged targets. Between 1990 and 2015, primary energy consumption decreased yearly by 1.1%. From 2020 onwards, an annual reduction of 1.6% would be necessary to halve primary energy consumption by 2050 (Expert Commission 2016). A discussion about additional measures has been kick-started with a green book on energy efficiency

The potential to increase energy efficiency is high and has not been fully tapped so far. In the buildings sector, for example, there are considerable efficiency potentials through measures such as insulation of the building envelope, and the use of efficient windows as well as heating & cooling systems (BMWi 2016). The government has allocated 17 billion euros for efficiency measures from 2016 to 2020 (Amelang 2016).

Ramping up renewables and energy efficiency led to less dependency in fossil fuel imports

In total, Germany imported 50-billion-euros of fossil fuels in 2015. This represents a substantial decline from the 92 billion euro imported in 2013. This reduction is due to both the currently low resource prices, as well as reduced import quantities. Without the use of renewables and gains in energy efficiency, this (gross) figure would have been even higher. Theoretically, these measures replaced fossil fuels worth 25 billion euro in 2015 (see Figure 13). Renewable use and gains in energy efficiency therefore lead to welfare gains for the German economy and illustrate how domestic energy sources can lead to a reduction in fossil fuel import dependency. Companies and households could save on heating and fuel costs, which can flow into private consumption or increase the profits of companies.

Germany's energy transition has had mixed results in its climate performance

German GHG emissions are already down 28% compared to 1990. Figure 13 shows that GHG emissions went from 1248 million tons in 1990 to 908 million tons in 2015. Moreover, about 156 million tons of CO_2 equivalent were avoided in 2015 compared to a reference system without renewable energies and with the same demand for energy. The electricity sector accounted for around 120 million tons, heating & cooling for 34 million tons, and transport for around 4.4 million tons (see Figure 14).

Figure 14 | **GHG EMISSION SAVINGS THROUGH RENEWABLES USE**
SOURCE: ECOFYS BASED ON BMWI 2016

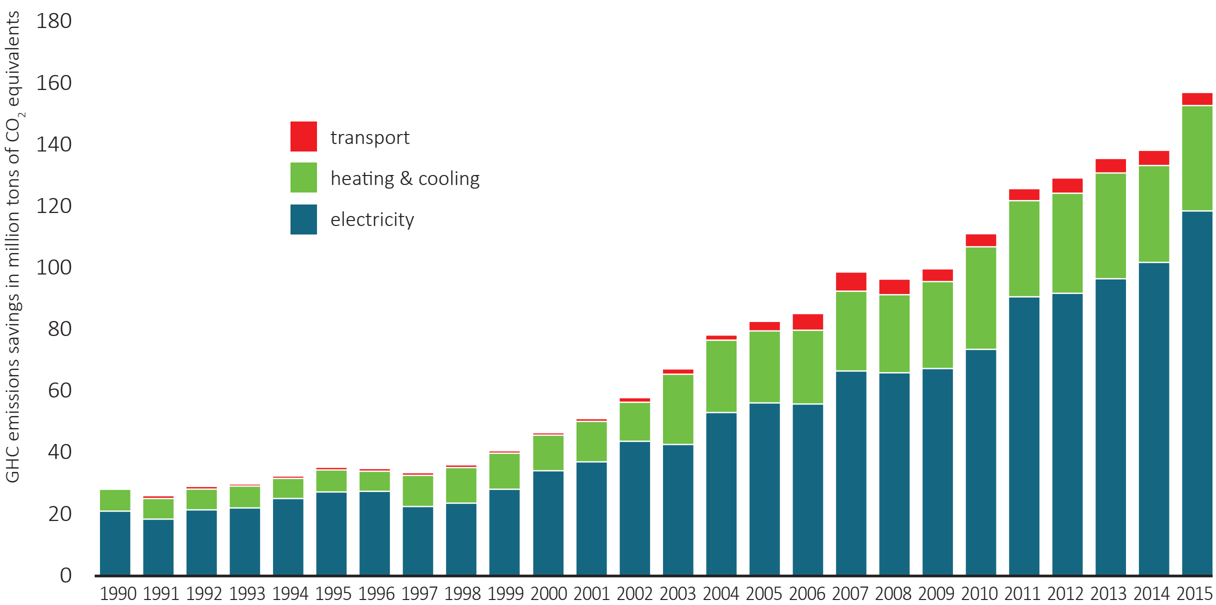


Figure 15 | **GHG EMISSIONS IN GERMANY 1990-2015 BY SOURCES**
SOURCE: ECOFYS 2015 BASED ON UBA 2017

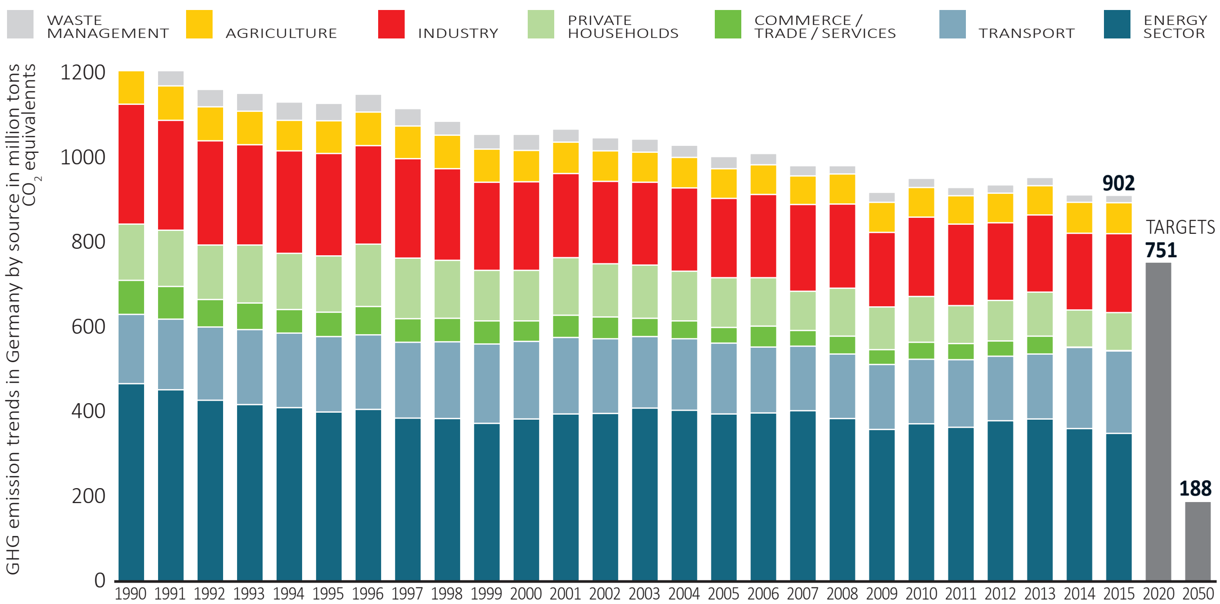
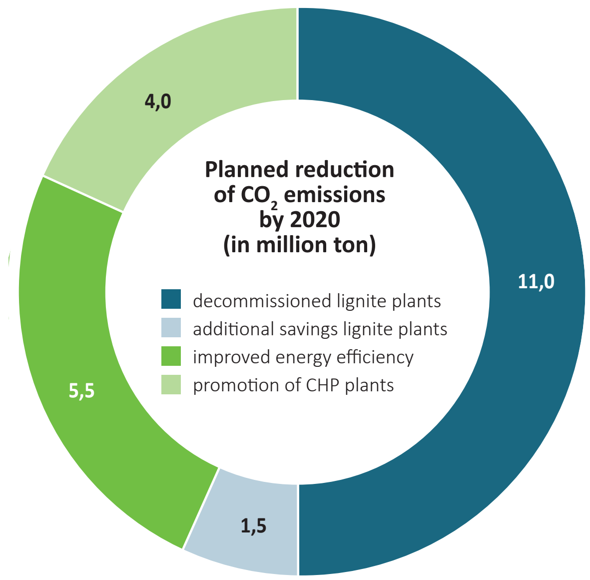


Figure 16 | **REDUCTION OF CO_2 EMISSIONS BY 2020 (IN MILLION TONS)**
SOURCE: FEDERAL GOVERNMENT STATISTA



Germany plans to set 2.7 GW of lignite plants in a security reserve to reduce CO_2 emission by an additional 11 million tons by 2020.

Germany has been struggling to keep its GHG emissions in check. In 2015, GHG emissions were roughly 902 million tons of CO_2 equivalent, or 0.3% less than in 2014 and 28% less than in 1990 (UBA 2017) (see Figure 15). In 2015, the energy sector was responsible for the largest reduction (11.7 million tons).

Germany's climate gap implied only a 33% reduction in CO_2 emissions instead of the targeted 40% that was to be achieved by 2020. In 2014, the German government acknowledged the current trajectory would result in a shortfall of 7% from its 2020 target and launched the Climate Action Program. The program contains over 100 additional measures designed to ensure 2020 climate targets are met. In the energy sector, these measures include, among others, the National Action Plan for Energy Efficiency (NAPE).

The lignite security reserve will only be called upon as a very last resort, will cost an estimated €230 million per year, and will last for seven years.

Germany plans to set 2.7 GW of lignite plants in a security reserve to reduce CO_2 emission by an additional 11 million tons by 2020. Originally, the government proposed the introduction of a climate levy that would require old coal-fired power plants to pay a fee if they emit more CO_2 than permitted, which would reduce emissions in the electricity sector by another 22 million tons (Appunn 2017). After protests from unions and large utilities, the government decided instead to have a capacity reserve for lignite. Figure 16 shows that the remaining reductions will have to come from efficiency measures, CHP plants, and additional savings from the lignite sector.

The lignite security reserve will only be called upon as a very last resort, will cost an estimated €230 million per year, and will last for seven years. Lignite plants will only be called upon, for example, in the case of long-lasting, extreme weather events. These plants will be on temporary "security standby" for four years, before being closed permanently, as agreed between the federal government and the respective utility companies. Utilities will be reimbursed for lost profits while their plants are on standby. Grid fees for consumers will likely rise by 0.05 cent per kilowatt-hour on average (Amelang & Appunn 2016).

A coal exit remains an open question since concrete steps on this direction will be determined by a commission in 2018. Germany's Climate Action Plan 2050 foresees the creation of a commission for "Growth, Structural Change and Regional Development". In contrast to an earlier proposal for a commission to set a date for the coal exit, the commission is designed to "support the structural changes" brought on by the country's transformation, and will "develop a mix of instruments that will bring together economic development, structural change, social acceptability, and climate protection (BMUB 2016a).

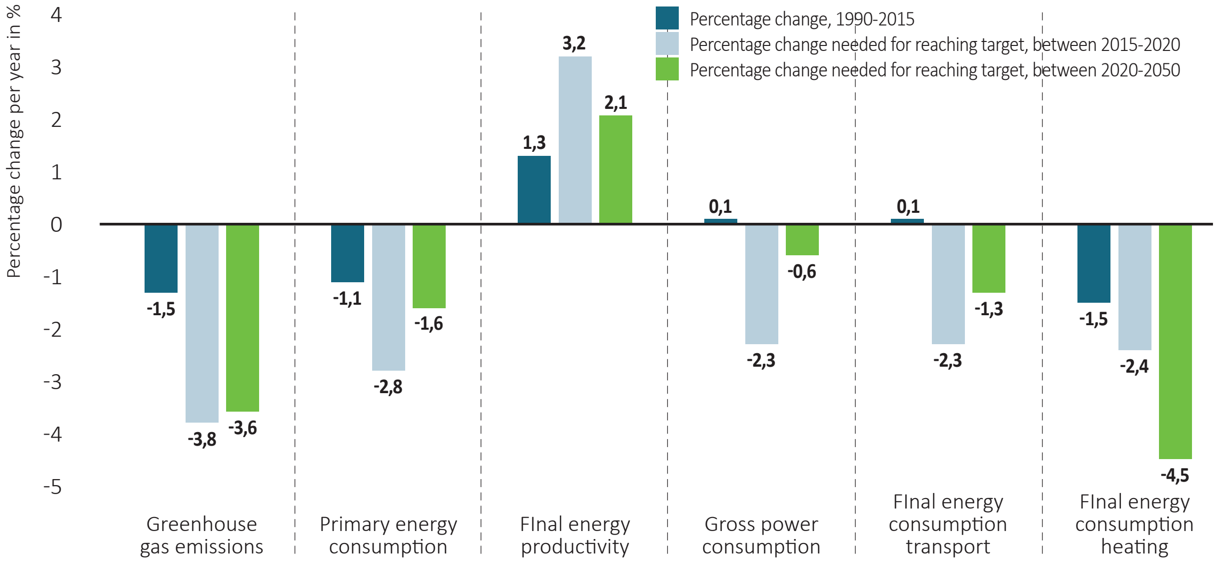
Germany's Climate Action Plan 2050 includes sector-specific target corridors to decarbonise its economy. In the run-up to COP22 in Marrakesh and after months of dispute, Germany's government agreed on a basic framework for largely decarbonising its economy to reach the 2050 climate goals. The Climate Action Plan 2050 (see Figure 17) says that emissions could be reduced by "about 55-56%" by 2030

Figure 17 **GERMANY'S CLIMATE ACTION PLAN 2050: EMISSION TARGETS PER SECTOR TO BE ACHIEVED BY 2030**
SOURCE: BMUB 2016

AREA OF ACTION	**1990** (IN MILLION TONES OF CO_2 EQUIVALENT)	**2014** (IN MILLION TONES OF CO_2 EQUIVALENT)	**2030** (IN MILLION TONES OF CO_2 EQUIVALENT)	**2030** (REDUCTION IN % COMPARED TO 1990)
Energy sector	466	358	175 - 183	62 - 61%
Buildings	209	119	70 - 72	67 - 66%
Transport	163	160	95 - 98	42 - 40%
Industry	283	181	140 - 143	51 - 49%
Agriculture	88	72	58 - 61	34 - 31%
Subtotal	1209	890	538 - 557	56 - 54%
Other	39	12	5	87%
Total	**1248**	**902**	**543 - 562**	**56 - 55%**

Figure 18

COMPARISON BETWEEN CURRENT PROGRESS AND PROGRESS REQUIRED TO MEET ENERGIEWENDE TARGETS
SOURCE: ECOFYS BASED ON EXPERT COMMISSION ON THE MONITORING PROCESS "ENERGY OF THE FUTURE" 2016



A monitoring process has been set up to track progress of the energy transition

The monitoring process of the Energiewende involves an assessment of the measures implemented and pinpoints areas in which further efforts are needed. One of its components, the Monitoring Report, provides a fact-based overview of the implementation progress of the energy transition in the previous year. In addition, an independent commission of experts provides a scientific opinion on the Monitoring Report. In its 2016 scientific opinion, for instance, the commission of experts argued that, from the comparison of current progress on specific Energiewende targets with the progress required to achieve these targets, further actions need to be taken (Figure 18). Another component is the Progress Report, which every three years takes stock of where the energy transition is at, and provides recommendations for future implementation.

The energy transition is part of an integrated European energy and climate strategy

After intense discussions with the European Commission in Summer 2016, a comprehensive energy policy package was deemed to comply with the EU state aid guidelines. Discussions between the parties covered the Act for the Promotion of Combined Heat and Power (KWKG), as well as the Electricity Market Act and the EEG 2017.

The European Commission's proposal for a Governance Directive include the need for Germany, as for any other European Member State, to draft an Integrated National Energy and Climate Plan.

In November 2016, the European Commission put forward a set of legislative proposals (named "Clean Energy for All Europeans"), which includes, among other elements, an Integrated National Energy and Climate Plan. *The EC proposal, especially the proposal for a Governance Directive, includes a series of details that Germany (as any other European Member State) will have to include in its plan*[9]. If the proposal text is approved in its current form by Member States and the European Parliament, Germany would need to consider several factors in setting its 2030 renewables target[10]. These factors include the equitable distribution of deployment across the European Union, its economic potential, geographical and natural constraints, and the level of power interconnection between Member States (European Commission 2016b). Public consultations would be expected from Member States in preparation of the draft of the plan, as well as a summary of the public's views attached to the document. Similarly, opportunities for regional cooperation would need to be identified and consultation with neighbouring Member States undertaken.

9. The European Commission's "Clean Energy for All Europeans" legislative proposals (previously known as the Winter Package) cover energy efficiency, renewable energy, the design of the electricity market, security of electricity supply and governance rules for the Energy Union.
10. As a share of Germany's gross final energy consumption

Part II:
The Polish energy system

By: Christian Schnell PhD,
Antoni Olszewski (Instytut Jagielloński)

Electricity production

The Polish electricity sector
remains dominated by coal which accounts
for 83.7% of gross electricity generation

The Polish electricity sector remains dominated by coal which accounts for 83.7% of gross electricity generation (see Figure 17 below). Poland continues to make use of its hard coal reserves, mainly located in the Silesia region, thus hard coal-based plants share in electricity generation reaches 50.6%. Additionally, lignite's share amounts to 33.1%, and has remained stable since the early 90s. In 2015, onshore wind and other RES other than hydropower plants produced only 6.3%, excluding biomass co-firing (since sources are distinguished by main fuel type), therefore RES share in generated electricity exceeds 12% in total. The share of gas-fired power/CHP plants rose recently to 2.6%.

Figure 19 | **HISTORICAL SHARE OF ELECTRICITY PRODUCTION BY TECHNOLOGY**
SOURCE: PSE S.A.

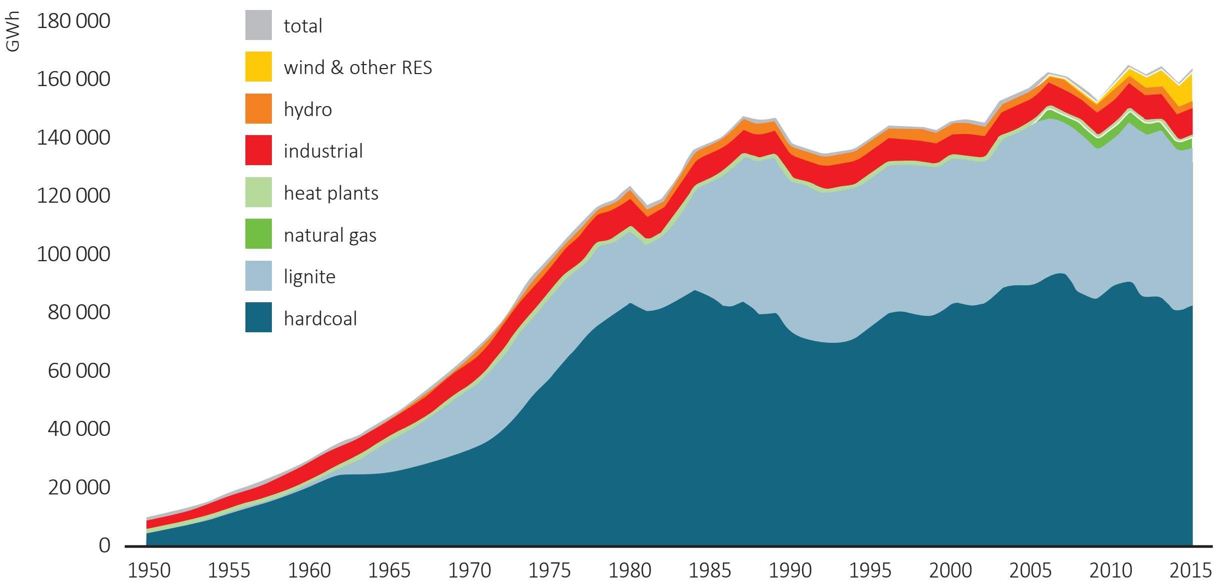
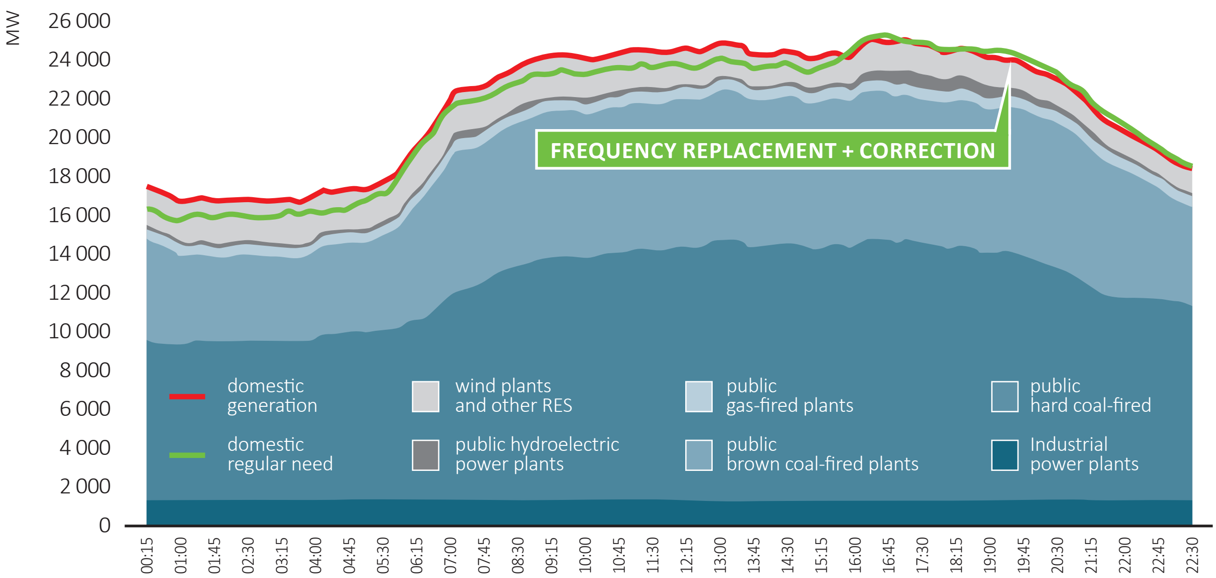


Figure 20

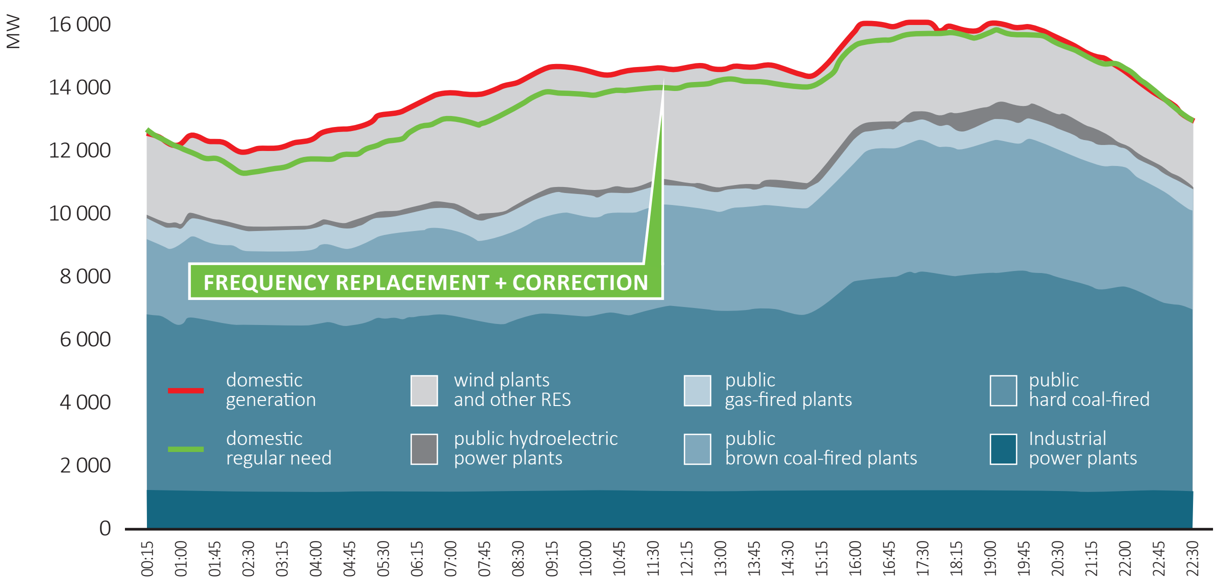
THE CAPACITY COVERAGE BY TECHNOLOGY DURING THE DAY OF THE HIGHEST ELECTRICITY DEMAND IN 2015
SOURCE: PSE S.A.



Poland's electricity market relies on coal-fired power plants, especially in times of high demand. The figure below shows that, during the day of the lowest electricity demand in 2015, up to 30% of the output was covered by RES, whereas during the day of the highest demand in 2015 RES accounted for only ca.8% of the output. Therefore, the role of coal plants in the Polish electricity system is not only baseload production, but also the main source of capacity reserve. Although coal plants are considered not to be suitable for balancing the demand due to their low flexibility and unprofitability of production below certain capacity factors (usually at least 50-60%), due to the lack of sufficient gas capacity, hydro-pumped storage and demand management mechanisms, they remain the vital source of electricity at the times of extraordinary high demand.

Figure 21

THE CAPACITY COVERAGE BY TECHNOLOGY DURING THE DAY OF THE LOWEST ELECTRICITY DEMAND IN 2015
SOURCE: PSE S.A.



Electricity consumption

Rising electricity consumption makes Poland unique in the EU and creates different challenges than in the Western European economies.

Rising electricity consumption makes Poland unique in the EU and creates different challenges than in the Western European economies. Taking into account the level of consumption, the Polish electricity market is the sixth largest market in the EU (data for 2014) which makes Poland an indisputable leader in Central and Eastern Europe.

Figure 22 | **CHANGE IN ELECTRICITY CONSUMPTION IN SELECTED EU COUNTRIES (2005-20014)**
SOURCE: CENTRAL STATISTICAL OFFICE GUS

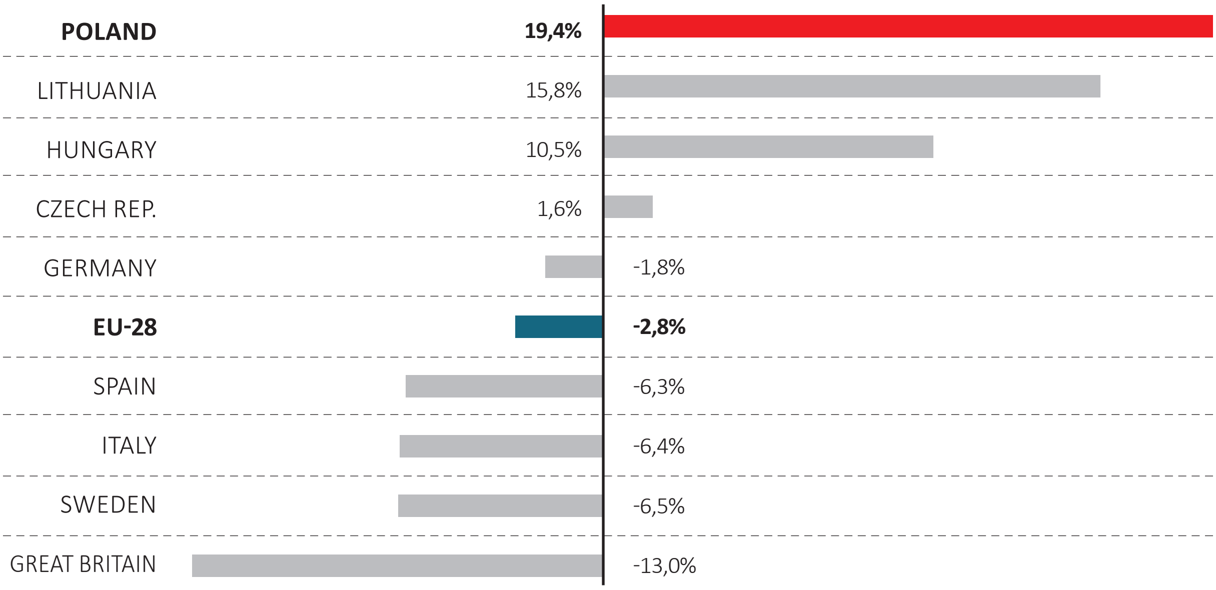
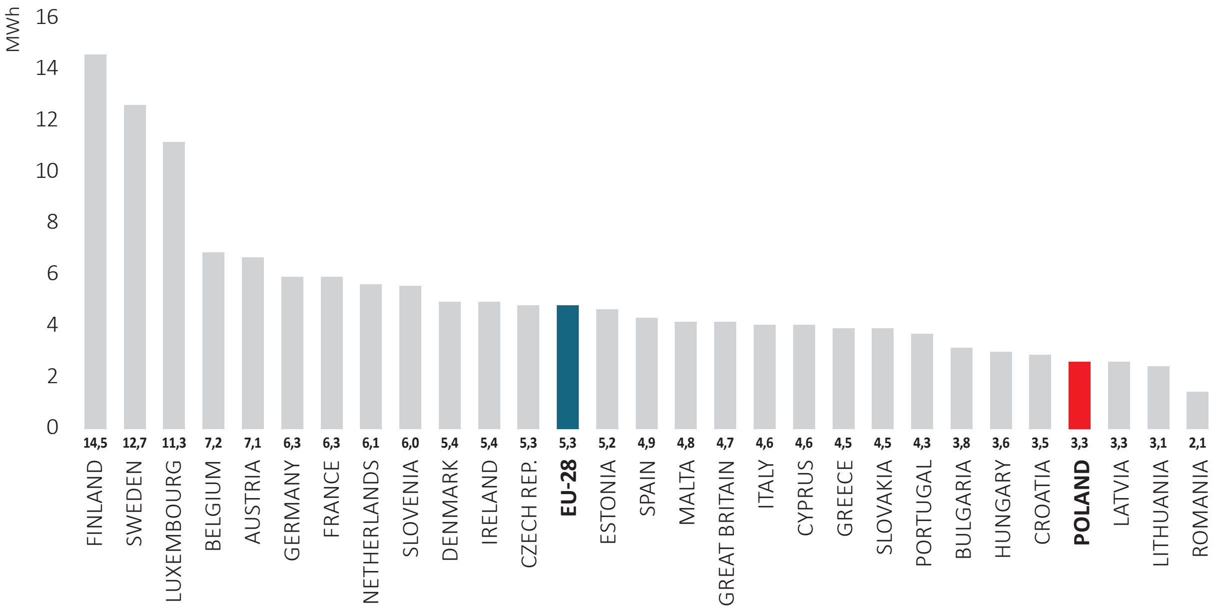


Figure 23 **FINAL CONSUMPTION OF ELECTRICITY PER CAPITA [MWh] IN 2014**
SOURCE: EUROSTAT



According to the Energy Regulatory Office (URE), volume of the national gross electricity production in 2015 amounted to 161.7 TWh, an increase of 3.3% compared to the previous year - a similar growth rate than of GDP, which grew by 3.6% in the same year.

Assuming the convergence of the level of development and structure of the Polish economy to achieve EU average in upcoming years, further increase in electricity consumption in Poland is likely to be continued in the future. Currently, the rate of electricity consumption per capita for

Figure 24 **ENERGY INTENSITY [KG OF OIL EQUIVALENT PER 1000 EUR PKB]**
SOURCE: EUROSTAT

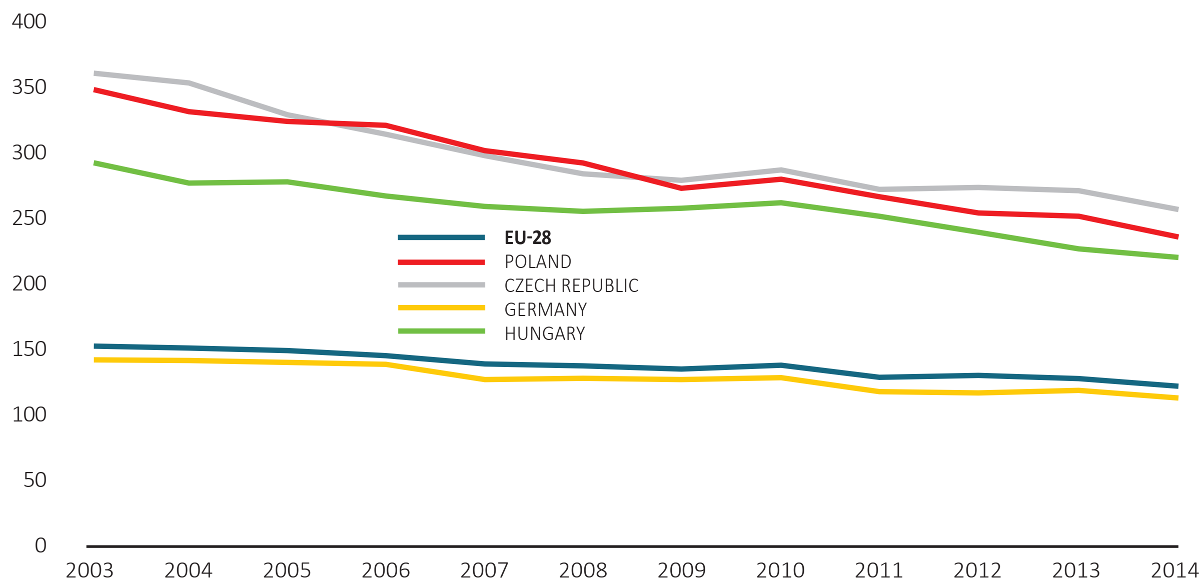
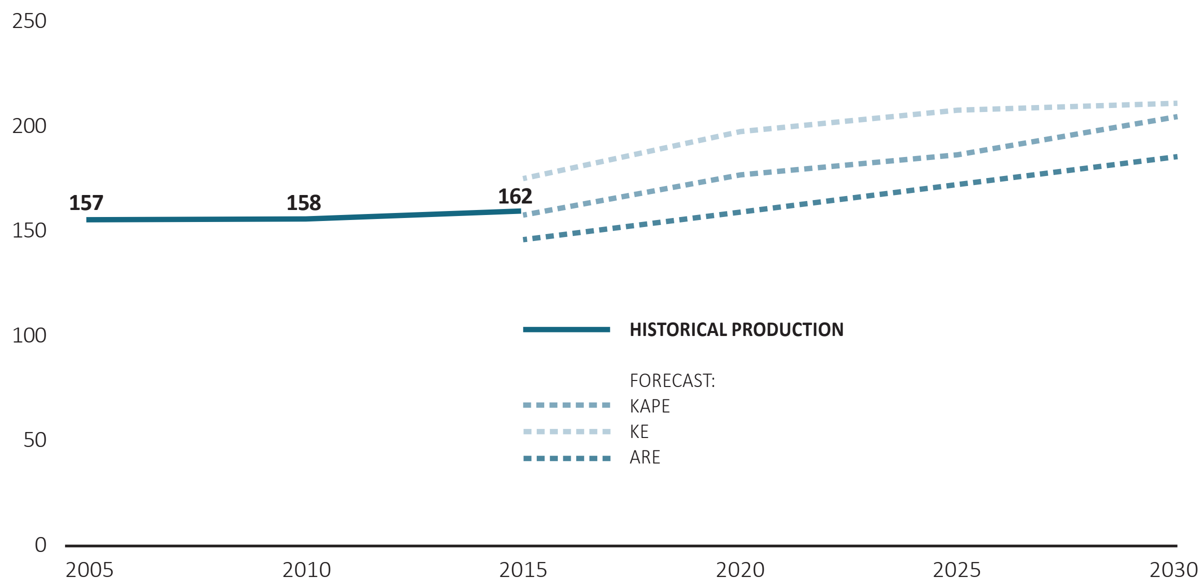


Figure 25 | **ELECTRICITY GENERATION FORECASTS**
SOURCE: KAPRE, EUROPEAN COMMISSION, AGENCA RYNKU ENERGII ARE



Poland is one of the lowest in the EU. However, having in mind further growth of GDP this indicator is supposed also to raise in a similar rate.

Poland is one of the lowest in the EU. However, having in mind further growth of GDP this indicator is supposed also to raise in a similar rate.

Assuming a decline in average electricity consumption per capita in the EU, a convergence effect to the EU average should result in an increase of consumption in Poland in the upcoming years, which is mainly due to a growing wealth of citizens and a reduction of technological gap (e.g. dissemination of air conditioning).

Despite a significant increase in energy efficiency, expressed in energy intensity of the economy[11], historical data confirm that the GDP growth in Poland is most often associated with an increase in consumption of electricity and natural gas. Although correlation between the economic growth and the energy demand might be weaker in the future- because the structure of the economy is heading towards more energy-efficient solutions - projections of electricity demand indicate the continuation of an upward trend. It is worth highlighting that almost all of the previous governments' forecasts on electricity consumption appear to be overestimated. According to the 1984 forecast, electricity consumption for 2000 was predicted at 223 TWh, whereas the real value amounted to 145 TWh (by 35% less than expected). In 2000 it was expected that the consumption in 2015 would amount to 205 TWh, whereas in fact it reached 161 TWh only. The main factor of error in these forecasts was underestimation of a decline in energy intensity of the economy.

11. in years 2003 to 2014 a decrease by 33%, whereas the EU average decrease amounted to 21%

Electricity prices

Electricity prices on the wholesale market follow the pattern of going down.

Electricity prices on the wholesale market follow the pattern of going down. In 2015, the base energy price (volume-weighted) the one day-ahead market amounted to 155.66 PLN/ MWh (37.59 EUR/MWh) and was lower in comparison to 2014 by 16% - amounting to 184.75 PLN/ MWh (44.61 EUR/MWh). Furthermore, in the above period a decline was observed in electricity prices on the futures market for energy.

A reflection of this trend was a decline in futures prices BASE_Y-16 (annual contract baseload delivery in 2016) whereas the volume weighted average price transaction of this contract throughout 2015 amounted to 164.37 PLN/MWh (39.69 EUR/MWh). In 2014 the price of futures contracts BASE_Y-15 concluded in 2014 with delivery for the following year amounted to 169.25 PLN/MWh (40.87 EUR/MWh).

A decrease in the prices of annual futures by approx. 2.9 % has been noticed. At the same time, average monthly price contracts BASE_Y-16 in December 2015 amounted to 166.75 PLN/ MWh (40.27 EUR/MWh), whereas an average monthly price of similar contracts (BASE_Y-15) in December 2014 was at the level of 175.53 PLN/ MWh (42.39 EUR/ MWh), which leads to a decrease of prices by 5% in 2015 compared to the previous year.

Figure 26 | **ELECTRICITY PRICES AT THE POLISH POWER EXCHANGE IN 2016**
SOURCE: EUROSTAT

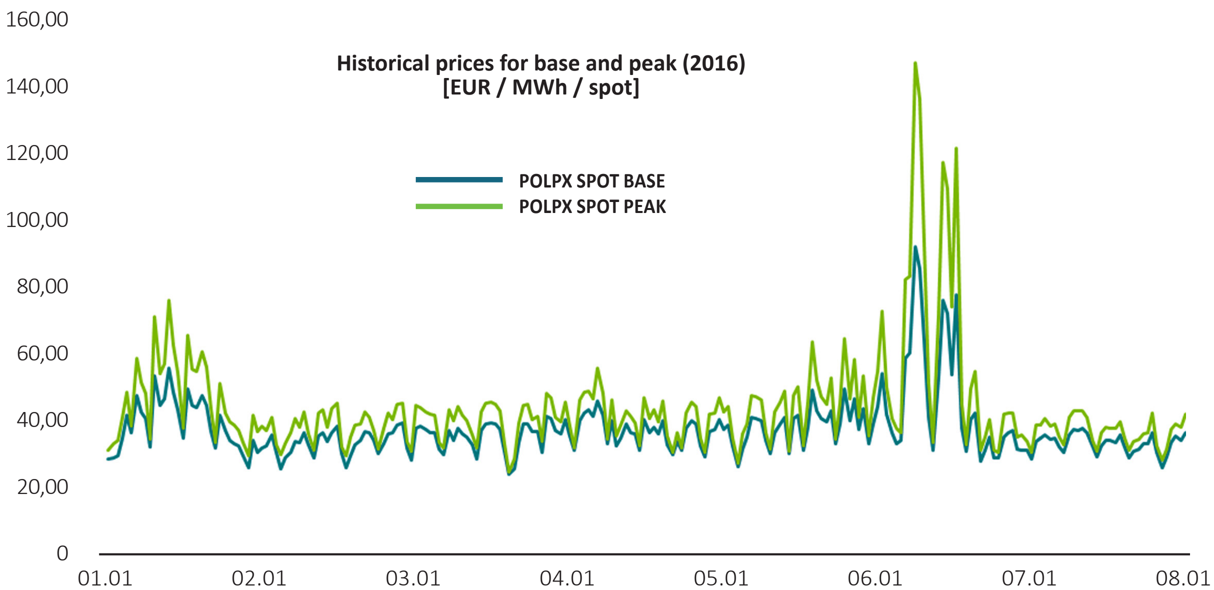
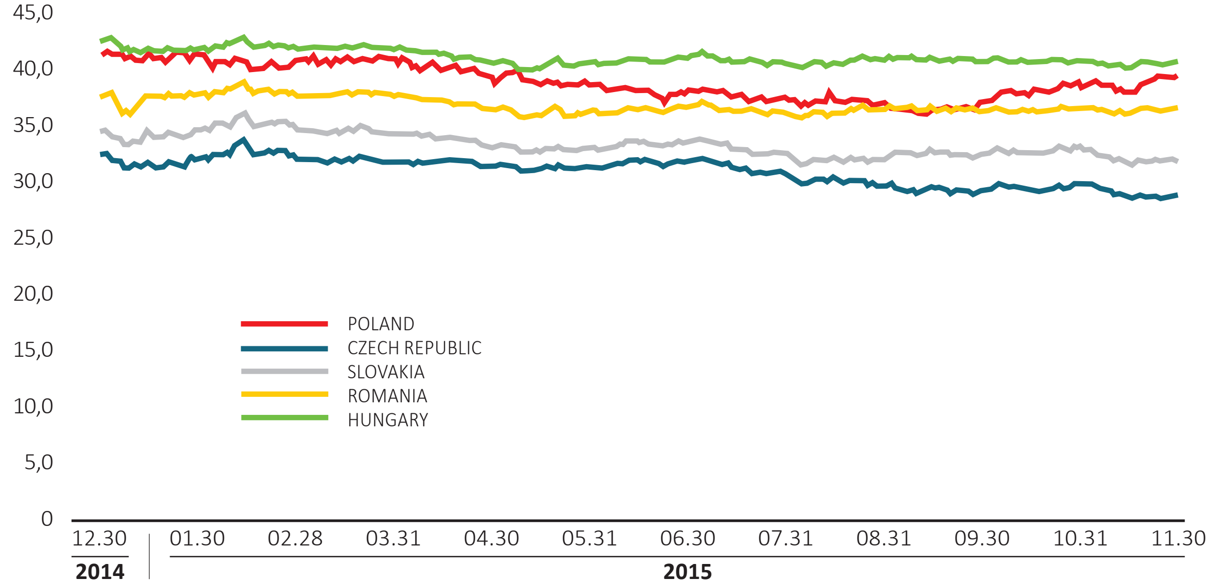


Figure 27 | **HISTORICAL BASE CONTRACT PRICES IN CENTRAL AND EASTERN EUROPEAN MARKETS[EUR/MWH, SPOT]**
SOURCE:

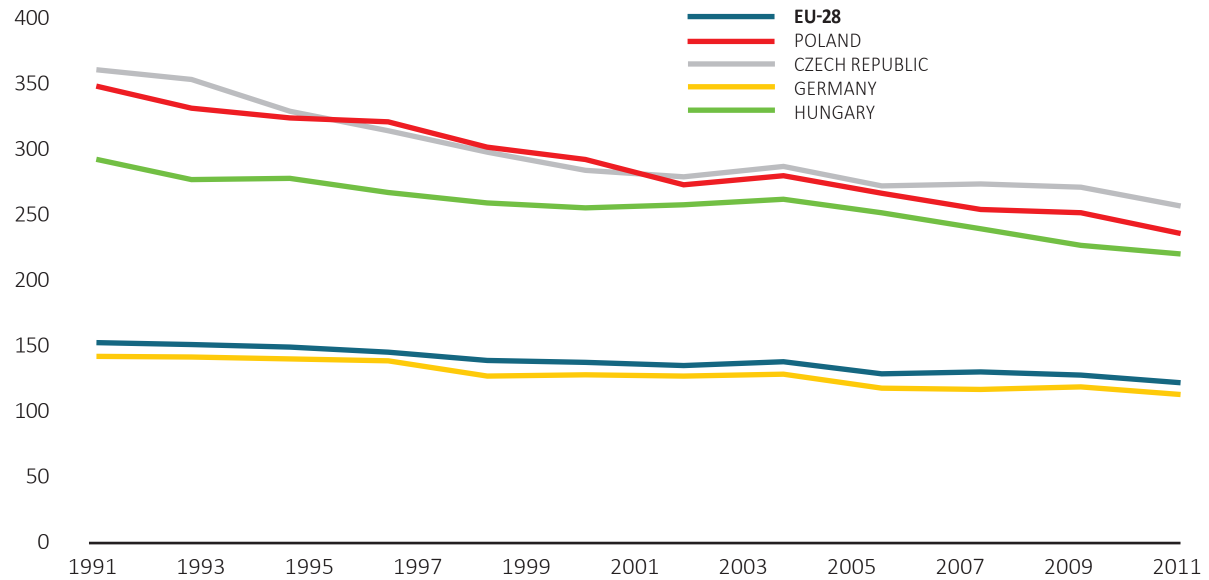


Wholesale prices on the Polish energy market are currently often above values listed on the neighboring markets, in particular on the German (Phelix) and Swedish (Nordpool) wholesale markets but also on the Czech and Slovak wholesale markets. This happens mainly because of higher RES subsidies in Western Europe. Higher wholesale prices often occur in Hungary, Lithuania and other Baltic countries, however, due to the new interconnector between Sweden and the Baltic countries, their wholesale prices are currently decreasing.

Climate performance

At the same time, Poland has made a far-reaching progress in reducing emissivity of the economy, expressed as the quotient of mass of the released carbon dioxide into the atmosphere and the GDP measured by purchasing power parity which is mainly caused by the use of more modern technologies and changes in the economic structure of the leading role of heavy industry in favor of the service sector.

Figure 28 | **EMISSION REDUCTION 1919-2011 [KG CO_2 PER 1000 USD GDP (PPP)]**
SOURCE: EUROSTAT



Green certificate support system for RES

The system creates an additional demand for green energy production by putting an obligation on market parties (e.g. suppliers who deliver to final customers) to procure a certain share of their demand from RES-E.

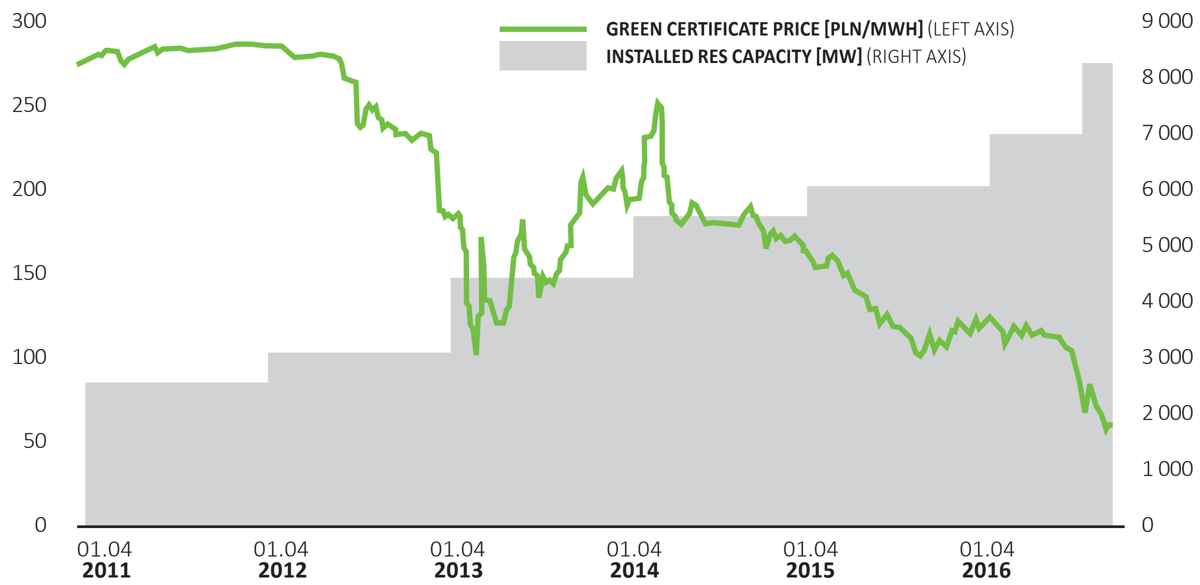
RES generators which were connected to the grid until end of June 2016 receive so-called green certificates per produced MWh. Therefore, the deployment of renewable energy in Poland has been so far driven by the green certificate ("GC") trading scheme based on certificates of origin ("quota system") which has continued to exists for 15 years. The system creates an additional demand for green energy production by putting an obligation on market parties (e.g. suppliers who deliver to final customers) to procure a certain share of their demand from RES-E. The obliged parties have two options to meet their obligation. They can either redeem a certain amount of green certificates which they obtain from either own certified green production or which they buy from OTC green generators or at POLPX. Or, alternatively, they pay a yearly substitution fee if they cannot turn in an adequate amount of green certificates according to their required quota- this price amounts to 300.03 PLN per MWh. Thus, production from RES has an extra value compared to power production from conventional sources which are not eligible to "produce" a green certificate that can be used by obliged suppliers to cope with the quota obligation. The technical minimum price of green certificates is equal to the rate of a duty tax amounting to 20 PLN/MWh.

The price of a green certificate is determined by the interaction of supply and demand for these certificates - and to some extent by the "substitution fee" as a maximum price. The scheme was originally implemented in 2005 by the first government ruled by PiS party and the quotation was extended in 2012 to reach the 2020 targets agreed with the EU – 15 percent of the general energy gross consumption to come from renewable energy sources, whereas the RES share with electricity (RES-E) should amount to 19.13 percent. In 2017, the quota amount to 16 percent. Green certificates are traded at the power exchange (e.g. PMOZE_A OZEX_A Index) and OTC whereas approximately 80 percent of the green certificates are traded OTC.

The prices of green certificates are volatile – even though green certificates can be banked without limitation. Therefore, the amount of investments in RES-E units influenced the supply. RES-E generation in Poland in 2012 and 2013 added up between 16 and 17 TWh/a while in 2015 and 2016 RES-E generation amounted to 22.5 TWh. In the last years wind energy has substantially replaced co-firing of biomass and coal which currently provides approximately 2.5 TWh "green energy" produced by so-called dedicated installations. Since January 1, 2016 only dedicated co-firing installations will still receive 1 green certificate per MWh whereas "simple" co-firing installations will receive only 0.5 green certificates and consequently will not pay off anymore. Additionally, large hydro-power plants amounting to 1.5 TWh production are phased out of the green certificate support system.

It is expected that due to the current quota obligation, 2017 will be the first year where production and demand will balance out. However, the current over-supply of green certificates amounts to approximately 20 TWh. Therefore, although green certificates are bankable, an oversupply corresponding to yearly production keeps pressure on green certificates prices for the time being. For the last two years the market floor for green certificates has been determined by the so-called technical minimum price, i.e. the revenue the cheapest RES technologies such as dedicated co-firing and biomass firing in large converted former coal burning boilers require to pay off. This breakeven price amounts to approximately PLN 280 per MWh in total whereas increasing wholesale prices lead to decreasing green certificate prices and vice versa.

Figure 29 | **GREEN CERTIFICATE PRICE DEVELOPMENT**
SOURCE: EUROSTAT



Transmission infrastructure

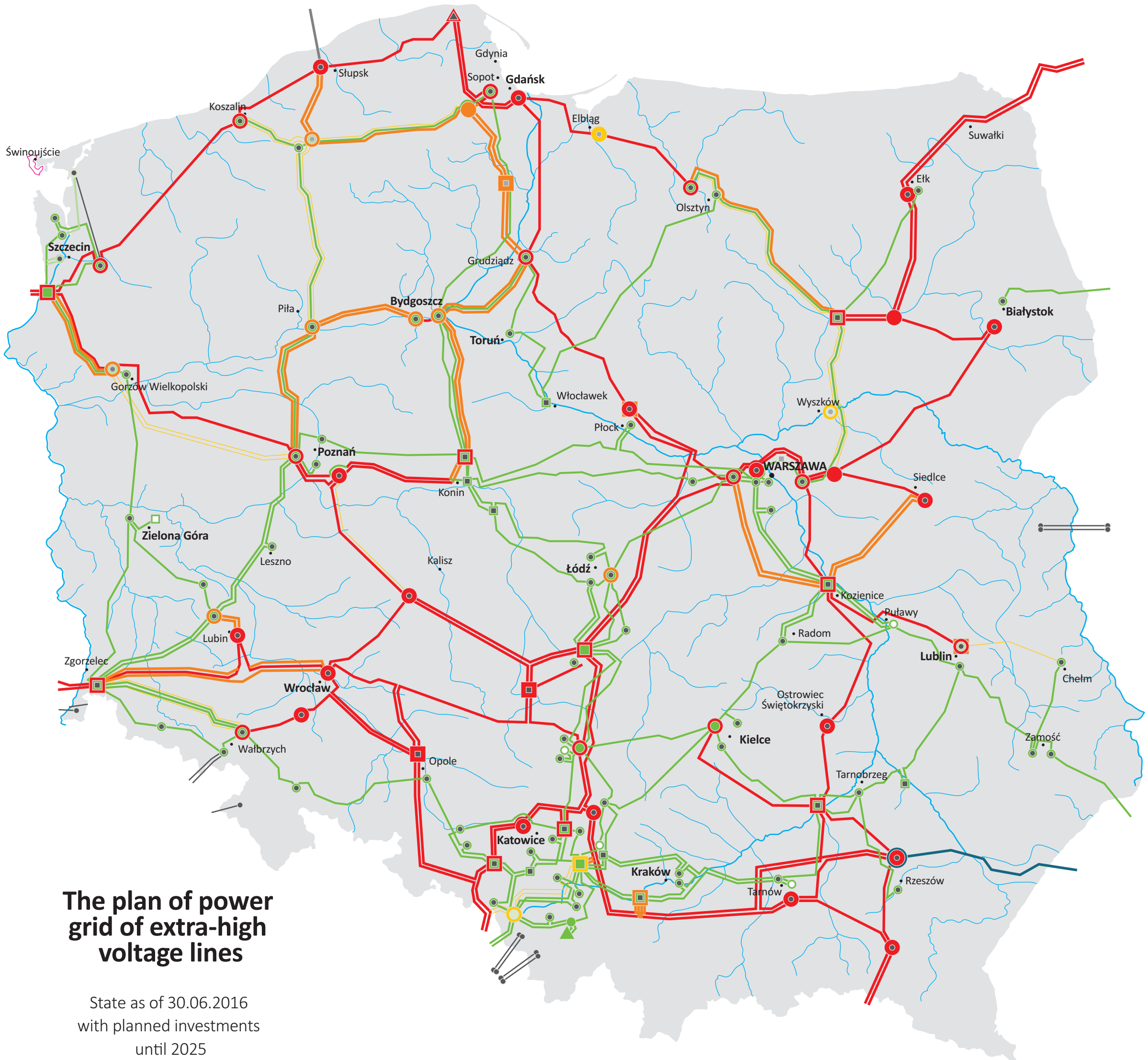
Low capacity of cross-border transmission infrastructure is the main reason for which the international power trade does not yet play a significant role in shaping the Polish energy market.

Low capacity of cross-border transmission infrastructure is the main reason for which the international power trade does not yet play a significant role in shaping the Polish energy market. In addition to this, physical loop flows from Germany through Poland back to Austria due to Phelix market-coupling technically blocked the contracted electricity trade. In 2015, the balance of cash flow closed at a level close to zero. The data show that 14.8 TWh was sent abroad while import amounted to 14.5 TWh. Each of these volumes constitutes approximately 8% of the total energy demand. In contrast, Germany in 2015 exported 84.8 TWh (approximately 13% of national production) and net exports amounted to 49.2 TWh.

Investment plans of PSE are aimed at expansion of interconnectors which will allow for an increase of import capacities. In addition, the currently installed phase shifters at the Polish-German interconnectors provide for a possibility to control energy transit as a remedy for loop flows.

For Polish energy companies (heavy reliant on coal plants), the perspective of increasing interconnector capacity might be a threat because of a high share of subsidized renewable energy sources, i.e. wind and PV especially in German energy mix. Due to this development, wholesale prices are artificially undervalued. Cheaper energy from Germany may prompt Polish market participants to purchase it through the EEX platform. Similarly, the interconnections with Sweden – directly or indirectly through LitPolLink - contribute to the growth of share of NordPool exchange on Polish trading market. On the other hand, the planned expansion of a cross-border capacity with Ukraine may result in increasing interest of TGE platform. In general, the industry is interested in further integration of the Polish energy system with its neighboring countries in order to achieve lower wholesale prices, whereas the 'Big4' Polish state-owned utilities together with coal mining companies are not in favor.

Figure 30 **GRID EXPANSION PLANS TILL 2025**
SOURCE: PSE S.A.



The plan of power grid of extra-high voltage lines

State as of 30.06.2016
with planned investments
until 2025

LINES:	750 kV	+/- 450 kV	400 kV	220 kV	110 kV
Existing	▬	▬	▬	▬	▬
Under construction			▬	▬	
Planned			▬	▬	

STATIONS:	750 kV	+/- 450 kV	400 kV	220 kV	110 kV
Distribution	●		●	●	●
Distribution under construction			●	●	●
Distribution planned			●	●	●

POWER PLANTS:	750 kV	+/- 450 kV	400 kV	220 kV	110 kV
Thermal			■	■	■
Thermal under construction			■	■	■
Thermal planned			■	■	
Water turbine			▲	▲	▲

CONVERSIONS

400/110 kV

400/220/110 kV

220/110 kV

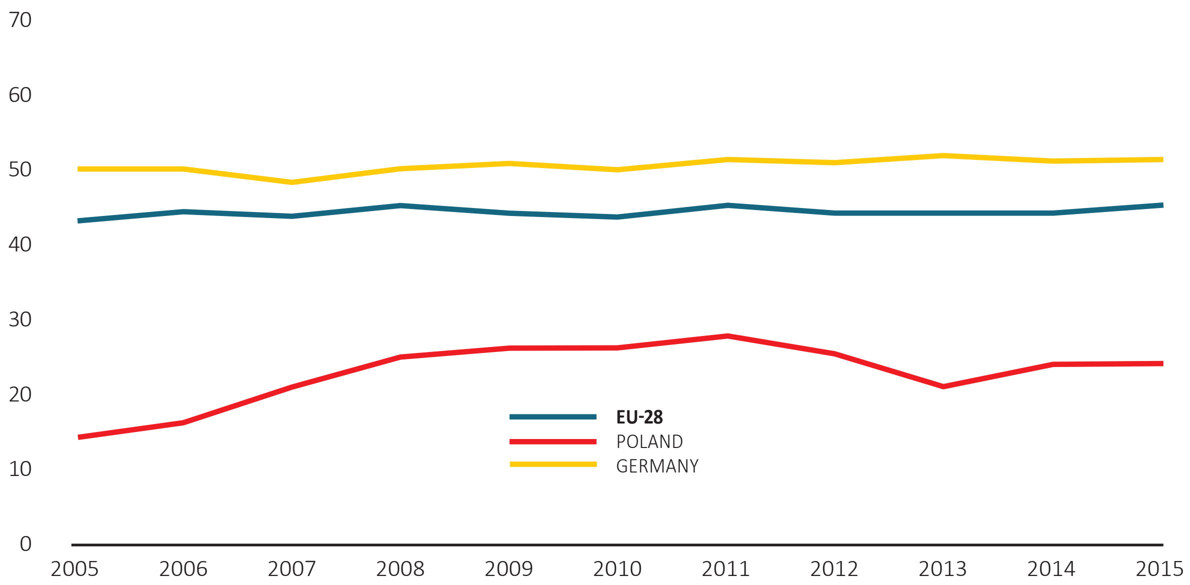
220 SN

Energy dependency

Energy dependency shows the extent to which an economy relies upon imports in order to meet its energy needs.

Energy dependency shows the extent to which an economy relies upon imports in order to meet its energy needs. The indicator is calculated as net imports divided by the sum of gross inland energy consumption plus bunkers. Figure 28 clearly shows that the Polish energy market based primarily on domestic coal reserves is much less dependent on foreign imports, and therefore, is much less vulnerable to shocks in commodity prices, terms of trade etc. However, Germany succeeded to maintain a steady dependence level despite a significant rise in the RES share, whose volatility is offset mainly by gas plants production.

Figure 31 | **ENERGY DEPENDENCY INDEX FOR POLAND, GERMANY AND EU28 AVERAGE**
SOURCE: EUROSTAT



Expansion of renewables in Poland

Since 2004, when Poland joined the EU, a rapid growth of RES is observed. The current policy assumes a 20% RES share in total electricity consumption by 2021.

Since 2004, when Poland joined the EU, a rapid growth of RES is observed. The current policy assumes a 20% RES share in total electricity consumption by 2021.

The percentage of electricity from RES in the gross final energy consumption in the electric power industry has been growing steadily since 2004, in 2015 reaching the level of 12.4%. Record-breaking growth was noted in 2012 at a level of 10.68% compared to 8.16% in 2011 due to a significant development of so-called simple co-firing power plants. Furthermore, a significant increase of onshore wind has been observed which at the same time constitutes the fastest growing technology. Co-firing and onshore wind account currently for almost 90% of RES-E.

Contribution of onshore wind power has been increasing steadily since 2010 recording the highest increase in 2012 and 2013 finishing with the total installed capacity of 3.8 GW in 2014. Due to the close of the GC support system, investments in onshore wind in 2015 and in the first half of 2016 have been significant (as investors believed the new auction scheme will provide a higher support) providing the currect installed capacity in wind turbines of 5.8 GW.

In case of co-firing of biomass in coal power plants and in so-called dedicated co-firing installations, production of renewable electricity grew steadily until 2012, reaching the highest level of 9.5 TWh, but in 2013 a sharp decrease to less than 8 TWh was observed due to a crash of green certificate prices. In 2014, the biomass sector again recorded a noticeable increase in the share of consumption energy from renewable sources as by end of 2012, due to a legislative change, large dedicated biomass plants have been commissioned. Currently, the production is at the same level as in 2012. Furthermore, also biogas plants provide their share in the renewable energy mix, however currently it is at a low level.

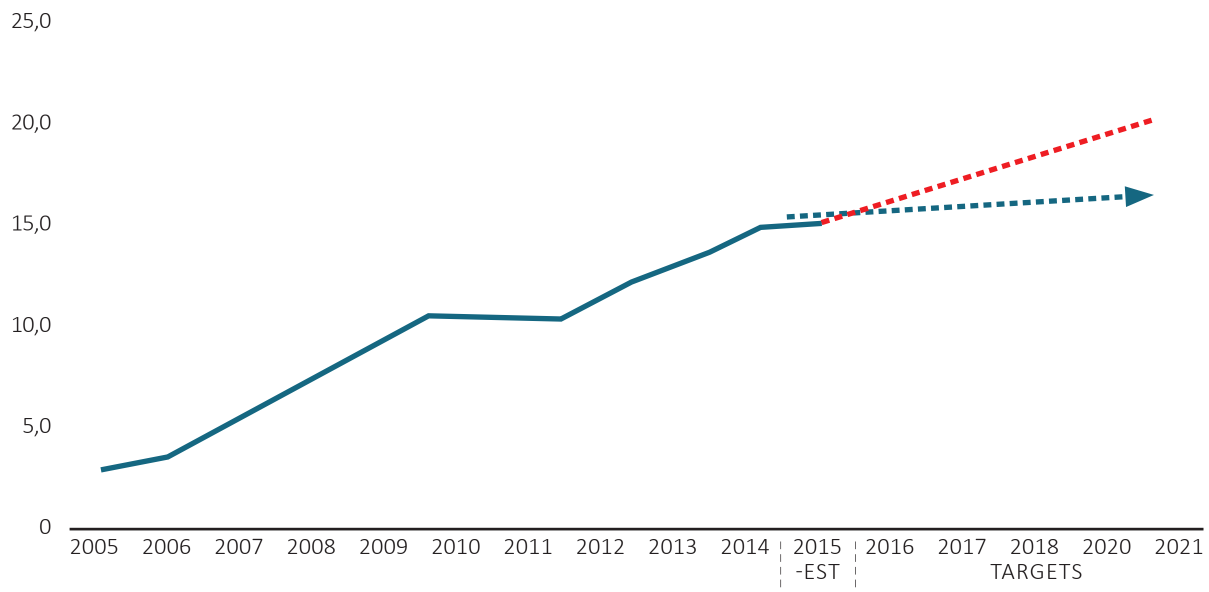
Hydropower is highly dependent on weather conditions and has not recorded any significant change due to lack of investments for many years. Generally, due to the climate change, a lack of water in central and northern Poland has been observed in the recent years.

A recognizable share of photovoltaic in production of renewable energy basically does not exist. In 2014 the production amounted to only 7 GWh. Currently, a more significant growth can be observed, however, the installed capacity still amounts to less than 200 MW providing for a RES-E production of 41 GWh.

Figure 32 | **RES-E GENERATION BY TECHNOLOGY [MWh]**
SOURCE: EUROSTAT

	2010	**2011**	**2012**	**2013**	**2014**	**2015**
HYDRO	2 349 260	2 364 379	2 360 890	2 360 890	2 372 520	1 828 417
WIND	1 700 306	2 921 456	4 510 114	6 132 499	7 573 456	10 536 563
PV	0	0	1 163	1 163	6 978	40 898
BIOMASS	5 905 714	7 147 798	9 528 459	7 931 660	9 159 788	9 484 221
TOTAL RES	**9 955 280**	**12 433 633**	**16 400 626**	**16 426 212**	**19 112 742**	**21 890 099**

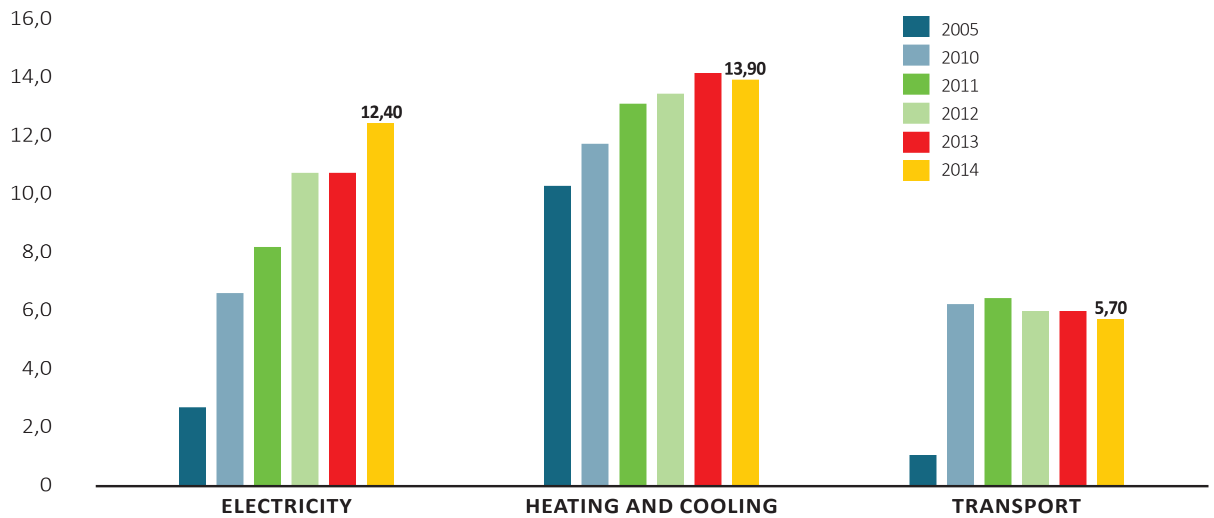
Figure 33 | **RES SHARE IN GROSS ELECTRICITY CONSUMPTION IN PERCENT/PLAN AND TREND**
SOURCE: EUROSTAT



Currently, RES-E development has stopped due to a switch of the support system. A larger auction for ready-to-build projects can be expected by the end of 2017, and depending on the technology, larger capacities will not be connected to the grid before the end of 2018 (PV), mid-2019 (onshore wind), beginning of 2020 (biogas) or even 2021 (biomass CHP plants). Meanwhile, power consumption has significantly increased during recent months by about 2.18%. The RES target is also growing further. Therefore it can be predicted that after record-breaking years of development of renewable energy sources in the electricity sector there will be years of stagnation in the investment market which will result in difficulties to fulfill the Action Plan (KPD) goals for 2020 assumed in the National RES. According to the calculation provided by Instytut Jagiellonski, the gap between the 2020 production and the target will amount to 8 TWh, i.e. one quarter of the target for RES-E.

Also the targets for RES heat and RES transport will be missed. The total gap for the 2020 target may amount to 30% which equals to approx. 3,000 ktoe or 35 TWh.

Figure 34 | **SHARE OF RENEWABLES IN THE ELECTRICITY, HEATING AND TRANSPORT SECTORS [%]**
SOURCE: EUROSTAT



Contrary to Germany, Poland is characterised by relatively highest use of renewables in heating and cooling, mainly due to the popularity of wood firing. However, the share of RES in the electricity generation is growing most rapidly. For transportation, RES target, as for most EU countries, is lagging behind.

Consequences of missing the EU 2020 RES target

The Renewable Energy Directive does not provide for any specific mechanism aimed at forcing the Member States to fulfill the RES targets defined for 2020 or any detailed mechanism to impose sanctions if a Member State does not achieve the same.

Consequences of missing the EU 2020 RES target
If Poland fails to achieve its target of the use of energy from renewable sources in the gross final consumption of energy (15% in 2020), two parallel scenarios will be possible, i.e. a statistical transfer and imposition of a fine in the course of an infringement procedure instituted against Poland.

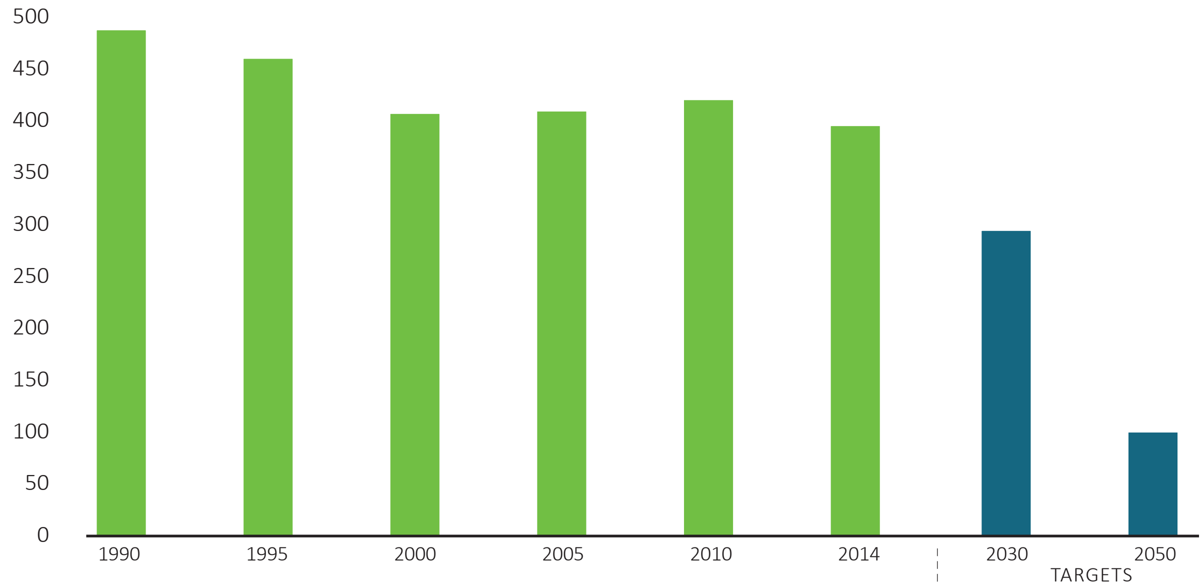
The Renewable Energy Directive does not provide for any specific mechanism aimed at forcing the Member States to fulfill the RES targets defined for 2020 or any detailed mechanism to impose sanctions if a Member State does not achieve the same. Therefore, it is assumed that standard infringement procedures will apply if a Member State does not fulfill its obligations under the EU regulations as provided in the Treaty on the Functioning of the European Union. As a result of such procedure, a Member State infringing its obligations towards the EU is subject to sanctions, including fines, depending on the circumstances of the infringement of the obligation, as well as its significance and scope. In the light of the foregoing, it is notable that the goal of such a procedure is not to punish a Member State for the non-fulfillment of its obligations towards the EU, but to mobilise it to take relevant steps aimed at reaching the target. Therefore, the potential fines are imposed on a Member State until the obligations are fulfilled rather than for the sheer fact of infringing them. The relevant measure applied by the EU includes daily rates charged until the implementation of the relevant measures by a Member State. At the same time, each state will be accounted for the obligations it defined in the national action plans, and the potential fines will be imposed with respect to the minimum national targets presented in the Directive. It must be also remembered that, in the case of a potential procedure, not only the fact of infringing specific obligation, but also the reasons of such a development as well as the actions taken to date by the state to achieve the target will be taken into account. It will be also significant whether a Member State did not achieve the minimum target for the share of energy from RES due to the failure to take the relevant steps in all three sectors, or e.g. the failure to achieve the target resulted from a change of market or climatic conditions, beyond the control of the state, the state having taken initiatives to compensate the shortage of energy from RES in one sector with a surplus in another sector so as to achieve the minimum target.

Furthermore, statistical RES energy transfers from another Member State having a surplus of "green energy" are required. Poland may benefit from the fact that many states should exceed their targets, and the EU as a whole is likely to have a surplus of green energy, which may be traded in. Poland would need to form a cooperation agreement with another EU Member State to either implement a joint quota scheme (according to Article 7 of the RED) or to implement an agreement on statistical transfers (according to Article 6 of the RED).

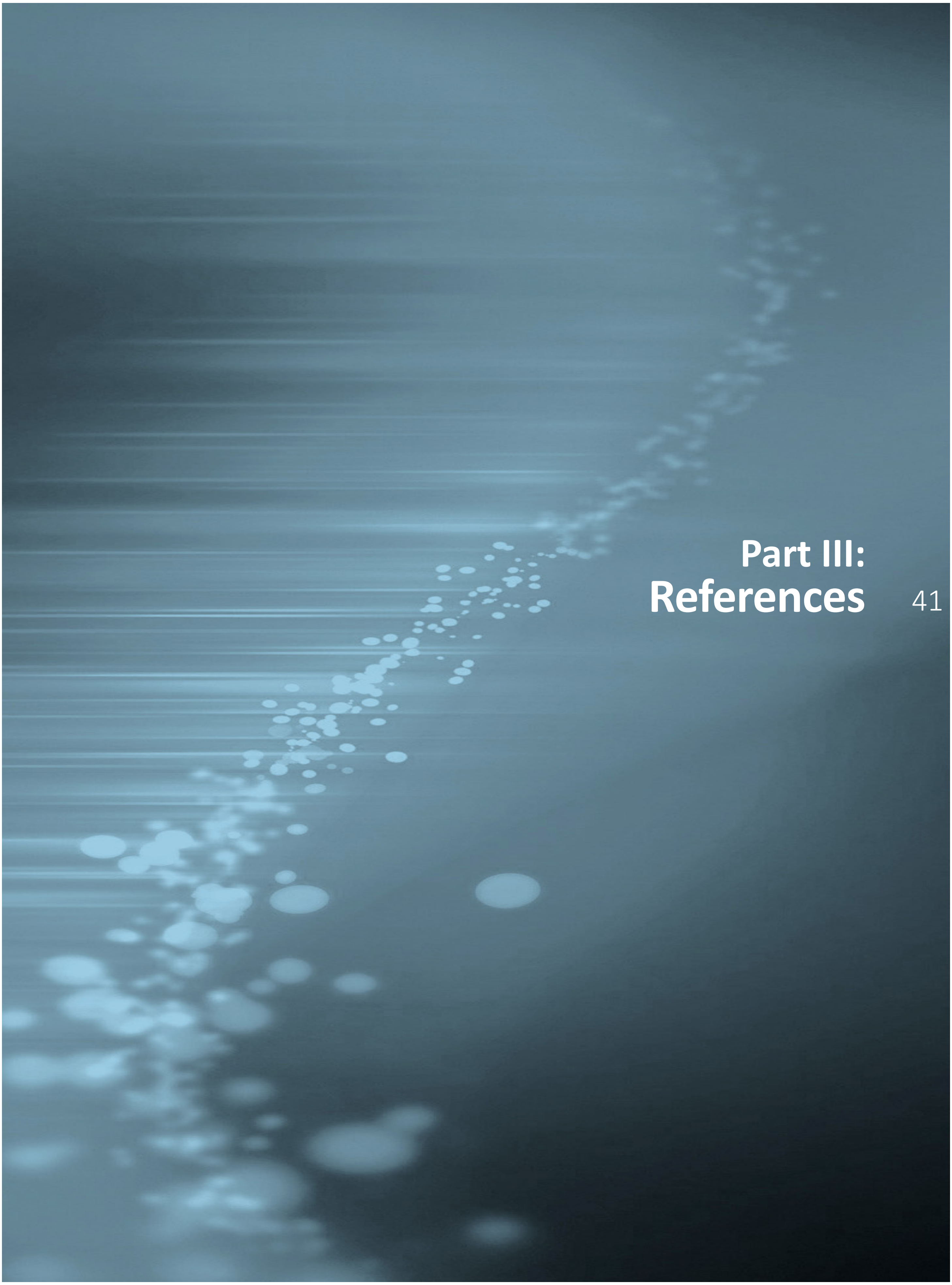
Future of Polish energy policy by 2030/2050

Poland GHG emissions are already down 19% compared to 1990. Below figure shows GHG emissions decreasing from 473,5 million tons in 1990 to 382 million tons in 2014.

Figure 35 | **GHG EMISSION TRENDS IN POLAND**
SOURCE: EUROSTAT



It should be assumed that the global climate deal and the EU's long-term low greenhouse gas emission development strategy will strengthen the emerging trend of fossil fuel divestment. In the last year, a number of investors have decided to reduce their coal portfolio, for example, ING (gave up crediting Jastrzębska Spółka Węglowa, a Polish coking coal producer) or the Norwegian Government Pension Fund Global (the world's largest sovereign wealth fund, which withdrew from Bogdanka coal mine). Furthermore, a gradual increase of renewables in the energy balance will further push wholesale electricity prices down. This will deteriorate the financial situation of conventional energy companies, possibly leading to increased pressure on the government to provide state aid.



Part III: References

AEE (2016): Bundesländer mit neuer Energie- Statusreport Föderal Erneuerbar 2016/17, available from: https://www.foederal-erneuerbar.de/bundeslaender-mit-neuer-energie-statusreport-foederal-erneuerbar-2016

AGEB (2016): Bruttostromerzeugung 1990-2015 (Stand: 25.11.2016) http://www.ag-energiebilanzen.de/

AGEE-Stat (2016): Anteile erneuerbarer Energien an der Endenergiebereitstellung in Deutschland: Strom, Wärme, Verkehr, available from: https://www.umweltbundesamt.de/themen/klima-energie/erneuerbare-energien/erneuerbare-energien-in-zahlen#textpart-1

Agora Energiewende (2017): Die Energiewende im Stromsektor: Stand der Dinge 2016, available from: https://www.agora-energiewende.de/fileadmin/Projekte/2017/Jahresauswertung_2016/Agora_Jahresauswertung-2016_WEB.pdf

Agora Energiewende (2016): Die Energiewende im Stromsektor: Stand der Dinge 2015, available from: https://www.agora-energiewende.de/fileadmin/Projekte/2016/Jahresauswertung_2016/Agora_Jahresauswertung_2015_Slides_web_DE.pdf

Amelang, S. & Appunn, C. (2016): Germany's new power market design. Clean Energy Wire, available from: https://www.cleanenergywire.org/factsheets/germanys-new-power-market-design

Amelang, S. (2015): The Energiewende and efficiency – Taming the appetite for energy. Clean Energy Wire, available from: https://www.cleanenergywire.org/dossiers/energiewende-and-efficiency

Amelang, S. (2016): Germany's dependence imported fossil fuels. Clean Energy Wire, available from: https://www.cleanenergywire.org/factsheets/germanys-dependence-imported-fossil-fuels

Amelang, S. (2016): Lagging efficiency to get top priority in Germany's Energiewende. Clean Energy Wire, available from: https://www.cleanenergywire.org/news/lagging-efficiency-get-top-priority-germanys-energiewende

Amelang, S., Wehrmann, B. & Wettengel, J. (2016): Germany's Climate Action Plan 2050. Clean Energy Wire, available from: https://www.cleanenergywire.org/factsheets/germanys-climate-action-plan-2050
Appunn, C. (2017): Germany's greenhouse gas emissions and climate targets. Clean Energy Wire, available from: https://www.cleanenergywire.org/factsheets/germanys-greenhouse-gas-emissions-and-climate-targets

BMUB (2016a): Climate Action Plan 2050, available from: http://www.bmub.bund.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/klimaschutzplan_2050_kurzf_en_bf.pdf

BMUB (2016b): Projektionsbericht 2015 gemäß der Verordnung (EU) Nr. 525/2013/EU (Bericht wurde ergänzt durch Ergebnisse des Mit-Weiteren-Maßnahmen-Szenarios), available from: http://www.bmub.bund.de/themen/klima-energie/klimaschutz/klima-klimaschutz-download/artikel/projektionsbericht-der-bundesregierung-2015/?tx_ttnews%5BbackPid%5D=289

BMWi (2014): Green Paper - An Electricity Market for Germany's Energy Transition BMWi 2016 Gruenbuch Energieeffizienz, available from: https://www.bmwi.de/BMWi/Redaktion/PDF/Publikationen/gruenbuch-energieeffizienz,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

BMWi (2015): Informationen zum Energiekabinett am 4. November 2015, available from: https://www.bmwi.de/BMWi/Redaktion/PDF/F/fact-sheet-zum-energiekabinett,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

BMWi (2016): Fünfter Monitoring-Bericht zur Energiewende- Berichtsjahr 2015, available from: https://www.bmwi.de/Redaktion/DE/Publikationen/Energie/fuenfter-monitoring-bericht-energie-der-zukunft.pdf?__blob=publicationFile&v=23

BMWi (2017): A target architecture for the energy transition: from policy goals to specific measures, available from: https://www.bmwi.de/Redaktion/EN/Artikel/Energy/target-architecture.html

BNetza (2016a): Stand des Ausbaus nach dem Bundesbedarfsplangesetz (BBPlG) zum ersten Quartal 2016

BNetzA (2016b): Bundesnetzagentur erteilt Zuschläge in PV-Ausschreibung mit Dänemark, available from: https://www.bundesnetzagentur.de/cln_1412/SharedDocs/Pressemitteilungen/DE/2016/161128_PVDK.html

Deutsche Energie-Agentur (dena) (2017): dena-Gebäudereport: Sanierungsrate weiterhin viel zu gering, available from: https://www.dena.de/newsroom/meldungen/2017/dena-gebaeudereport-sanierungsrate-weiterhin-viel-zu-gering/

Dinkloh, P. (2014): Germany revamps renewables law as it adapts to future with green power. Clean Energy Wire, available from: https://www.cleanenergywire.org/dossiers/eeg-20-new-legal-framework-german-energy-transition-0

EEG 2014: Erneuerbare-Energien-Gesetz vom 21. Juli 2014, available from: http://www.gesetze-im-internet.de/bundesrecht/eeg_2014/gesamt.pdf

EEG 2017: Gesetz zur Einführung von Ausschreibungen für Strom aus erneuerbaren Energien und zu weiteren Änderungen des Rechts der erneuerbaren Energien, available from: https://dipbt.bundestag.de/dip21/brd/2016/0355-16.pdf

Egenter, S. & Wettengel, J. (2016): Ministry projections highlight risk of Germany missing emissions goal. Clean Energy Wire, available from: https://www.cleanenergywire.org/news/ministry-projections-highlight-risk-germany-missing-emissions-goal

Energy Transition (2012a): History of the Energiewende- The oil crises lead to the first energy efficiency policies, available from: http://energytransition.de/2012/10/the-oil-crisis-the-oil-crisis

Energy Transition (2012b): Energy-Conservation Ordinance (EnEV) and financial support schemes, available from: http://energytransition.de/2012/10/energy-conservation-ordinance-enev-and-financial-support-schemes/

European Commission (2016a): EU Reference Scenario 2016 - Energy, transport and GHG emissions Trends to 2050, available from: https://ec.europa.eu/energy/sites/ener/files/documents/ref2016_report_final-web.pdf

European Commission (2016b): Proposal for a Regulation of the European Parliament and of the Council on the Governance of the Energy Union. Brussels, Belgium.

Expert Commission on the Monitoring Process "Energy of the Future" (2016): Opinion on the Fifth Monitoring Report of the Energy Transition, available from: http://www.bmwi.de/Redaktion/DE/Downloads/V/fuenfter-monitoring-bericht-energie-der-zukunft-stellungnahme.pdf?__blob=publicationFile&v=5

GWS, DIW, DLR, Prognos, ZSW (2015): Beschäftigung durch erneuerbare Energien in Deutschland: Aus-bau und Betrieb, heute und morgen. Studie im Auftrag des Bundesministeriums für Wirtschaft und Energie. Osnabrück, Berlin, Stuttgart

Internationales Wirtschaftsforum Regenerative Energien (IWR) (2017): EEG-Mindestvergütungssätze 2004 – 2008 gemäß der Fassung vom Juli 2004. EG-Vergütungssätze für Strom aus erneuerbaren Energien – Photovoltaik. Available from: http://www.iwr.de/re/wf/EEG%20Photovoltaik.htm

Nitsch, J. (2016): Die Energiewende nach COP 21 – Aktuelle Szenarien der deutschen Energieversorgung, Kurzstudie für den Bundesverband Erneuerbare Energien e.V., available from: http://www.bee-ev.de/fileadmin/Publikationen/Studien/Joachim_Nitsch_Energiewende_nach_COP21.pdf

Russell, R. & Schlandt, J. (2015): Loop flows- Why is wind power from northern Germany putting east European grids under pressure? Clean Energy Wire, available from: https://www.cleanenergywire.org/factsheets/loop-flows-why-wind-power-northern-germany-putting-east-european-grids-under-pressure

Schmid, L. (2014): Germany's Energy Transition: a Blueprint for European Energy Security? Heinrich Böll Stiftung North America, available from: https://us.boell.org/sites/default/files/schmid_-_energy_security.pdf

Appendix A UBA (2017): Treibhausgasemissionen 2015 im zweiten Jahr in Folge leicht gesunken, available from: https://www.umweltbundesamt.de/presse/pressemitteilungen/treibhausgasemissionen-2015-im-zweiten-jahr-in

Zha, W. (2016): How German wind power is complicating EU unity: QuickTake Q&A. Bloomberg, available from: https://www.bloomberg.com/news/articles/2016-11-15/how-german-wind-power-is-complicating-eu-unity-quicktake-q-a