International Energy Agency

Energy Policies of IEA Countries

Poland

2011 Review

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Poland has made commendable efforts to develop a solid energy policy framework over the last years. As energy security is a high policy priority, the country is enhancing gas supply security by building an LNG terminal, expanding underground storage capacity and increasing domestic gas production. Polish plans for developing electricity and gas cross-border links will also contribute to regional security of supply. In addition, the government has announced an ambitious nuclear programme by 2030, envisaging the first unit to enter operation by 2022. Other achievements include energy intensity improvements, an increased share of renewables and a stronger focus on energy research and development (R&D).

Despite these positive developments, there is room for improving Poland's energy strategy. First, a more integrated energy and climate policy is needed to put Poland firmly on a low-carbon path while enhancing energy security. Second, energy policy could put more emphasis on promoting competition to make the energy markets more efficient. Decarbonising Poland's power sector will be a particularly significant challenge requiring huge investments. Coal accounts for 55% of Polish primary energy supply and 92% of electricity generation, raising significant climate change and environmental challenges. To this end, Poland's efforts to improve energy efficiency and to diversify the country's energy mix are praiseworthy and should be pursued. The government's attention to R&D on clean coal technologies, including carbon capture and storage (CCS) is also encouraging. The government could put more focus on the positive role that gas can play in decarbonising the electricity mix, especially if Poland's potential resources of unconventional gas are confirmed. To tap these resources, it will be vital to put the necessary legal and regulatory framework in place.

This in-depth review analyses the energy challenges facing Poland and provides sectoral critiques and recommendations for further policy improvements. It is intended to help guide the country towards a more secure and sustainable energy future.

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INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its mandate is two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply and to advise member countries on sound energy policy.

The IEA carries out a comprehensive programme of energy co-operation among 28 advanced economies, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency aims to:

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

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The European Commission also participates in the work of the IEA.

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1. EXECUTIVE SUMMARY AND KEY RECOMMENDATIONS

EXECUTIVE SUMMARY

OVERVIEW

Energy remains very high on the policy agenda in Poland. The government has made commendable efforts over the last years to comply with European Union requirements[1] and to develop a solid energy policy framework. *Energy Policy of Poland until 2030* (hereafter referred to as EPP 2030), approved by the government in November 2009, outlines the future direction of Polish energy policy, which is in line with the IEA's policy goals to achieve energy security, environmental sustainability and economic development.

This comprehensive document outlines strategic policy objectives, sets concrete targets and suggests actions relating to each of these targets. The key now is timely implementation of the *EPP 2030*, including its Action Plan for the Years 2009-2012. This will provide good foundations for a clean, clever and competitive energy future in Poland. The government is therefore encouraged to develop and implement the planned measures as soon as possible.

However, there is room for improving Poland's energy strategy. First, a more integrated energy and climate policy is needed to put Poland firmly on a low-carbon path while enhancing energy security. Secondly, energy policy could put more emphasis on promoting competition to make the energy markets more efficient.

Decarbonising Poland's power sector will be a particularly significant challenge requiring huge investments and an adequate policy and regulatory framework. Integration of energy and climate strategies will facilitate the design of effective policies to meet the dual goal of energy security and environmental sustainability while avoiding conflicting and/or overlapping measures. An updated version of Poland's 2003 climate policy, reflecting the latest EU energy and climate obligations, would help integrate climate policy into the broader energy policy picture presented in *EPP 2030*.

Poland has traditionally seen its domestic resources as the key pillar of energy security policy. The country relies heavily on indigenous coal that accounts for 55% of its primary energy supply and 90% of electricity generation. However, there are significant climate change and environmental challenges associated with coal use because of high emissions of greenhouse gases (GHGs) and air pollutants. Continued reliance on coal will make it difficult for Poland to meet its future GHG mitigation commitments. The government's objective to diversify the energy mix by introducing nuclear and increasing

1. Polish energy policy is driven to a very large extent by EU directives and requirements. In particular, Poland has to liberalise its gas and electricity markets in line with the EU directives. Also, as part of the EU "20-20-20" goals, Poland has quantitative targets for renewable energy (increasing its share in final energy consumption by 15%), energy efficiency (reducing energy consumption by 20%) and greenhouse gas emissions (limiting their growth to 14% above the 2005 level) by 2020.

the shares of renewables is commendable and should be pursued. Such diversification – along with enhancing energy efficiency – will help Poland address both energy security and climate change challenges. The government could also put more focus on the positive role that natural gas can play in decarbonising the Polish electricity generation mix while improving the power system's flexibility.

ENERGY SECURITY

Oil and gas

Energy security is the key priority of Polish energy policy. This is driven to a large extent by the country's heavy reliance on hydrocarbon imports. Poland is dependent on imports for 95% of its crude oil demand and for about two-thirds of its gas demand. Over 94% of oil imports and over 80% of gas imports come from Russia. The government is conscious of the inherent risks of dependence on one supplier, and is trying to diversify import sources and transport routes. Such diversification will not only enhance energy security but will also allow Poland to negotiate better prices thanks to competitive pressure on suppliers.

In the oil sector, the government supports the extension of the Odessa-Brody pipeline from Ukraine to the Polish refineries in Płock and Gdańsk as part of the larger regional initiative to transport Caspian oil to Europe.

In the gas sector, the key elements of Poland's policy include building an LNG terminal in Świnoujście to diversify supply sources, expanding underground storage capacity, extending the transmission and distribution system and increasing domestic gas production. All these efforts should be continued and enhanced. The government should seriously take into account the expected growth in gas demand and ensure that future gas supplies meet this growing demand. From this perspective, it will be imperative to make sure that the agreement for gas supplies until 2022, signed with Russia in October 2010, does not jeopardise Poland's efforts to diversify supply sources and to develop domestic resources. In particular, the construction of the LNG terminal should be pursued in a timely manner.

Poland may have large resources of unconventional gas. The first assessments based on drilling are expected by the end of 2011. If these resources are confirmed, they could give Poland an opportunity to reduce its import dependence and to change its fuel mix in the medium and long term. In the short term, the government is encouraged to continue supporting exploration activities. It should also start preparing future policy directions, should the existence of large unconventional gas resources be confirmed. If Poland is to tap its potential shale and tight gas resources, it will be vital to build the needed infrastructure and put the necessary legal and regulatory framework in place to support production and to allow non-discriminated access to transmission capacity. These measures will also allow gas consumers to benefit from competition between multiple suppliers. A similar supportive environment is also needed for conventional hydrocarbon exploration and production to make the most efficient use of Poland's oil and gas resources.

Overall, Poland has rather well-designed emergency response mechanisms both for oil and gas. The country has been compliant with the IEA 90-day emergency stockholding obligation since it entered the IEA in 2008 and currently has enough oil storage capacity to remain compliant in the near future. The government plans to further develop underground oil storage in the longer term, which is encouraging. It also envisages to revise the current oil stockholding regime by enhancing the role of public stocks. This initiative should be pursued.

The gas emergency response mechanism worked efficiently during the supply disruption in January 2009 following a Russia-Ukraine dispute. Russian gas supplies through Belarus could be increased. However, there is room for improvement. The government is encouraged to develop a mid-to-long term comprehensive gas emergency response policy.

Coal

Poland's rich coal resources are perceived as a major guarantor of energy security. However, economically recoverable hard coal reserves accessible from established mines are declining very fast. Hard coal production is likely to decrease considerably by 2030. Lignite production will also fall sharply by 2030 and shortages can be expected from 2015 onwards, unless new mines are opened. However, public opposition makes it extremely difficult to obtain planning permits to develop new mines. In 2008, Poland became a net hard coal importer for the first time as coal production was insufficient to meet demand. Imports from Russia have surged and accounted for 70% of total coal imports in 2009. The government's plan to reduce the country's dependence on coal is a welcome development.

Electricity

Enhancing security of supply in the electricity and heat sectors will require massive investments in the short and medium term. Nearly half of today's electricity and combined heat and power (CHP) generating capacity is older than 30 years and will need to be replaced when it reaches the end of its lifetime in the near future. Electricity networks are also ageing and see similar investment challenges.

Investment challenges

Following years of underinvestment, the need to upgrade Poland's energy infrastructure is pressing. This concerns not only the electricity sector but the energy sector as a whole. Poland has some significant sources of public funding for developing the energy sector, for example the National Fund for Environmental Protection and Water Management. It is important to ensure that these funds are spent in line with energy policy priorities. However, public financing will not be sufficient to meet the large investment requirements. To attract the much-needed financing to the energy sector, it will be vital to put in place clear policy frameworks that give the appropriate signals to potential investors.

At present, investments are often hindered by many barriers, including complex planning procedures and lack of public acceptance. To allow the development of energy projects that are in the national interest (such as new lignite mines, electricity generation and transmission infrastructure, underground gas storage or carbon capture and storage facilities), it will be necessary to streamline the planning system.

Regional co-operation

Growing interconnections between energy markets in Europe are contributing to regional security of supply. The Polish government is encouraged to put even more focus on this regional dimension when developing and implementing the country's energy policy. The current plans for developing and enhancing electricity and gas cross-border links are commendable. The government should continue supporting co-operation between the governments and electricity and gas transmission system operators (TSOs) of the neighbouring countries.

CLIMATE CHANGE

Poland's total GHG emissions from the energy sector have declined since 1989, although emissions per unit of output remain high. The national GHG emissions are much below Poland's target under the Kyoto Protocol, giving the country a significant surplus of tradable emission allowances. The Polish government is praised for reinvesting the profits from the use of the Kyoto Protocol flexibility mechanisms in projects under the Green Investment Scheme aimed at further emissions reductions.

Although Poland's energy-related CO_2 emissions continue to decline thanks to the restructuring of industry and energy efficiency improvements, according to the government's forecasts, emissions are expected to increase from 2020. This would not be a sustainable path. Poland, like other countries, must take crucial decisions in the energy sector in order to achieve global long-term stabilisation of greenhouse gas concentration at 450 parts per million (ppm) of CO_2-equivalent, which corresponds to an increase in global temperature of around 2°C. Meeting this goal will require innovative policies, an appropriate regulatory framework and increased investment in energy research, development and demonstration.

Investment decisions being made in the energy sector over the next decade will dictate the mitigation challenges and costs for Poland for a long time into the future. This is particularly true in the power generation sector where the risk of technology lock-in is the greatest. It is therefore crucial that incentives for long-term investments in new low-carbon generating capacity are provided to energy sector companies. One way would be to translate the targets and ambition in the *EPP 2030* into binding requirements, making it clear to the energy sector that the energy policy goals will be implemented.

If Poland is to continue using large quantities of indigenous coal, then it must continue to improve the environmental performance of coal extraction and use. The government is to be applauded for taking a lead in clean coal technologies like carbon capture and storage (CCS). While the economic viability of CCS is uncertain at this stage it will be important to continue research, pilot and demonstration work in this field. The planned EU-supported demonstration projects represent an important first step in this context. It will also be important to transpose the EU Directive on CCS into Polish law as soon as possible. This will help provide some clarity for investors in the power sector. The government will also need to consider what level of national support is required to realise CCS demonstration in Poland.

To ensure progress in the development and deployment of CCS and other low-carbon technologies, including nuclear and renewables, it is important to strengthen the links between national energy policy and research and development (R&D) policy. The Polish government is to be commended for the increased focus on energy R&D: energy has been designated as one of five priority areas of the National Programme for Scientific Research and Development Activities. Research priorities identified by the national R&D programme closely match the objectives outlined in *EPP 2030*, which is a very positive achievement.

However, the majority of implemented, ongoing and planned R&D projects focus primarily on one government priority − cleaner fossil fuels − while the other two priorities (energy efficiency and renewable energy) by comparison receive less government support. The portfolio of R&D projects should be more diversified to better match the stated policy directions.

WIN-WIN SOLUTIONS: ENERGY EFFICIENCY, NUCLEAR AND RENEWABLES

Energy efficiency improvements as well as nuclear and renewable energy will help Poland address both energy security and climate change challenges simultaneously.

Energy efficiency is the key instrument for reducing the country's CO_2 emissions, particularly in the short and medium term. Poland has considerable energy efficiency potential, and the government has clearly recognised the importance of energy efficiency as a key element of its energy strategy. The *EPP 2030* has two overarching objectives in this area, namely reducing energy intensity to the EU15 average and achieving "zero-energy" economic growth, *i.e.* gross domestic product (GDP) growth without increasing energy consumption. Such clear political ambition is welcome. Looking ahead, it is important that this strong political signal is underpinned by measurable targets and objectives and a clear delivery plan.

Poland is planning to build at least three nuclear units by 2030, with the first to enter operation by 2022. This will be a welcome diversification of the country's energy sources. The government has a well-organised plan to prepare for a nuclear programme, including establishing institutions and legal frameworks for nuclear regulation and radioactive waste management. Provided sufficient resources and political will are available to support the steps in the Action Plan to 2012 and beyond, then Poland should be in a position to go ahead with its proposed nuclear programme. However, keeping to the schedule will require timely implementation of all the steps set out in the draft nuclear programme which will call for considerable resources over the next few years. Maintaining political and public support will be a prerequisite for a successful nuclear programme.

The Polish government has taken commendable steps towards reaching the country's renewable energy targets: 15% of gross final energy consumption and 10% of transport fuels by 2020. The main instrument to support renewable electricity is a market-based mechanism: the quota obligation system with tradable green certificates introduced in 2005. It has been rather effective in stimulating investment in the most mature and economically attractive renewable energy technologies, such as biomass. However, the current renewable energy mix in Poland is unbalanced: it is dominated by biomass, while nearly 90% of all renewable energy is used for heating. Additional policies and support measures need to be put in place, particularly in the electricity sector. The share of renewables in electricity generation is the second lowest among the 28 IEA member countries. The government rightly aims to diversify renewable energy sources by supporting wind (including offshore), solar thermal and other technologies.

MARKET REFORMS

Well-functioning markets are a key basis for assuring security of supply and for improving efficiency and service quality. Poland has made progress towards liberalised electricity and gas markets in recent years. However, liberalisation is an ongoing process and, as is the case in other countries, there is more to be done before fully functioning competitive markets emerge. Electricity and gas markets are still dominated by incumbent companies, and competition is limited, particularly in the gas market.

PGNiG S.A., being practically the only importer of gas from Russia and the major domestic gas producer, effectively controls the wholesale market. The PGNiG Group also owns six regional distribution system operators. Importantly, it is the only owner and the appointed operator of all Polish underground gas storage capacity. Because of stringent rules related to holding compulsory gas stocks in Poland, potential competitors cannot enter the

national gas market as they have no access to storage capacity. Not surprisingly, PGNiG dominates the retail market: the total market share of new entrants is only 2%. The government should make further efforts to establish clear and effective rules that ensure undiscriminating access to underground gas storage by, for example, creating an independent storage system operator. It should also pursue its plan to revise the current compulsory gas stockholding regime in order to give more flexibility to newcomers, for example by allowing them to maintain compulsory stocks outside the national territory.

Access to transmission capacity is a key element of a well-functioning market and a particularly important prerequisite for the development of Poland's non-conventional gas resources, should they be confirmed. The lack of third-party access (TPA) to the Yamal pipeline that transits Russian gas through Poland to Western Europe has been an important competition barrier until recently. It is very positive that the new agreement signed in October 2010 appointed Polish state-owned network company GAZ-SYSTEM as the system operator for the Yamal pipeline. It will be vital to ensure that GAZ-SYSTEM provides TPA to the Yamal pipeline on a non-discriminatory basis.

Progress towards competition is more advanced in the electricity sector. The number of consumers changing suppliers is growing steadily although it is still rather low, especially in the residential sector. Retail competition is hindered by many factors, including the lack of competitive offers explained to a large extent by regulated prices for households and, more importantly, by the lack of a truly competitive wholesale market.

Developing competitive markets is one of the objectives of the *EPP 2030*. The *EPP 2030* Action Plan envisages a number of short-term measures to enhance competition in the electricity and gas markets. These measures should be implemented without delay. It is particularly important to devise and implement a roadmap towards a competitive gas market, as stipulated by the Action Plan.

The Ministry of Treasury actively proceeds with its plans to privatise – fully or partially – a number of energy sector companies. Privatisation in itself does not necessarily increase competition but it can contribute to creating a more competitive environment if it is designed and conducted with this objective in mind.

KEY RECOMMENDATIONS

The government of Poland should:

- *Continue to implement the policies outlined in the* Energy Policy of Poland until 2030 *and its Action Plan for the Years 2009-2012.*
- *Continue enhancing energy security, in particular through: i) promoting diversification of sources and routes of oil and gas supply and ii) supporting electricity and gas interconnections with neighbouring countries.*
- *Develop an integrated approach to energy and climate policy and make energy efficiency an even more important element of this policy. Step up efforts to improve energy efficiency, ensuring effective and timely implementation of the measures already outlined.*
- *Improve the policy and regulatory framework to attract the much-needed investment to the energy sector.*
- *Continue to introduce competition in the gas and electricity markets.*

PART I
POLICY ANALYSIS

Figure 1. **Map of Poland**

Source: IEA.

2. GENERAL ENERGY POLICY

COUNTRY OVERVIEW

Poland is a Central European country on the Baltic Sea, bordered by Germany, the Czech and Slovak Republics, Ukraine, Belarus, Lithuania and the Russian Kaliningrad Oblast exclave. It has been a member of the European Union (EU) since 2004, of the Organisation for Economic Co-operation and Development (OECD) since 1996 and of the International Energy Agency (IEA) since 2008. In November 2010, Poland also joined the OECD Nuclear Energy Agency (NEA).

With a total area of 312 679 square kilometres, Poland is the ninth-largest country in Europe. In 2009 its population was estimated at 38.1 million, making it, after Spain, the sixth-most populous member state of the European Union and accounting for nearly one-tenth of European Union's population.

Poland is a democracy, with a president as a head of State, and the government represented by the Council of Ministers, led by a prime minister. Polish voters elect a bicameral parliament consisting of a 460-member lower house (*Sejm*) and a 100-member Senate (*Senat*).

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

In terms of purchasing power parity (PPP), Poland's economy ranks quite high in the world (23rd), within the OECD (14th) and in the European Union (6th). GDP reached almost USD 670 billion in 2008 (measured in 2008 values and PPP), which was double its 1990 level. Poland has been catching up with other European Union and OECD economies. In the period 2006-2007, the economy recorded its best performance since the 1990s, growing at 6.2% and 6.8% annually, respectively. These were some of the highest growth rates in the OECD and the European Union. Growth was driven by increased private investment and private consumption. Consumer spending was stimulated by vigorous wage increases, rising employment, heavy remittances from abroad and, until very late in the year, wealth effects from house and equity price appreciation.[2]

The Polish economy was not as severely affected by the global financial and economic crisis as most other countries. It grew by 4.9% in 2008 and, unlike the negative growth experienced by most of its European partners in 2009, Poland actually grew by around 1.7% in 2009.[3] Reasons for this continued growth include: monetary easing, exchange rate depreciation, relatively limited dependence on international trade, a sound banking

2. OECD, 2008.

3. Central Statistical Office of Poland, 2010.

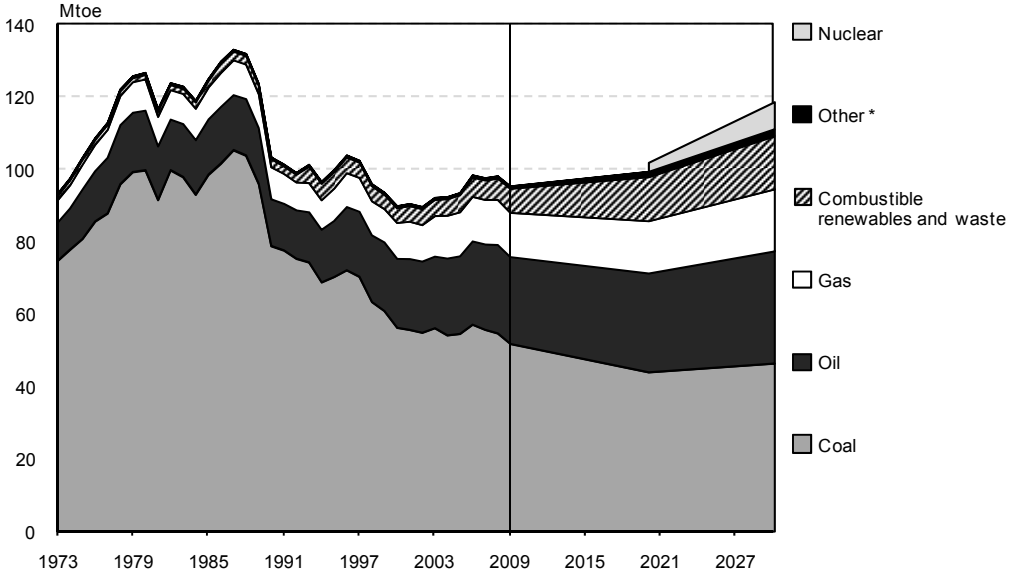
sector and unleveraged private sector, tax cuts and other fiscal measures and infrastructure investments linked to European Union transfers and the Euro 2012 football championship.[4] Per-capita income was about USD 17 500 in 2008, the third-lowest in the European Union, after Romania and Bulgaria. It is less than 60% the EU average and less than half the OECD average. Nevertheless, per-capita income has risen rapidly in recent years, growing by almost 40% between 2000 and 2008.

SUPPLY AND DEMAND

PRIMARY SUPPLY

Poland's primary energy supply was almost 95 million tonnes of oil equivalent (Mtoe) in 2009,[5] significantly lower than the peak of 133 Mtoe reached in 1987. It fell significantly in the 1990s, as a result of reduced economic activity in the first half of the decade but also as a result of structural changes in the economy and significant improvements in energy efficiency as the country moved from a centrally planned to a market economy. On average, total primary energy demand fell by 1.2% per annum during the period 1990-2002. The decline occurred mainly in the power sector, while total final consumption (TFC), mainly in the transport sector, expanded slightly.

Figure 2. **Total primary energy supply by source, 1973 to 2030**



* *Other* includes hydro, wind, geothermal and solar.

Note: this graph shows historical data until 2009 and the government's projections from 2010 to 2030.

Sources*: Energy Balances of OECD Countries*, IEA/OECD Paris, 2010 and country submission.

4. OECD, 2009.

5 In this report, data for 2009 are preliminary.

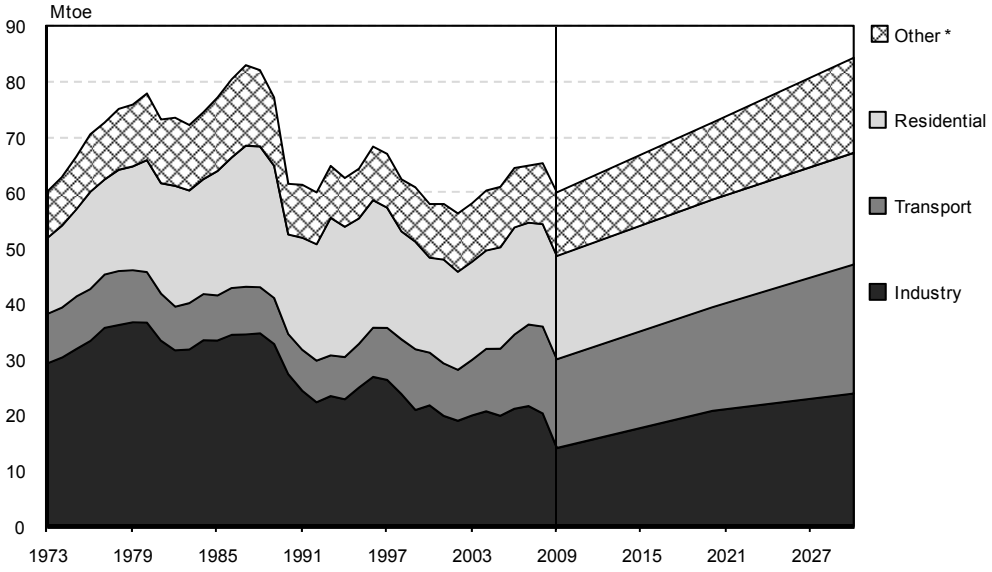
Since 2002, the downward trends in total primary energy demand have reversed as strong economic growth continued while fewer opportunities remained for modernising legacy energy-inefficient components of the economy. Between 2002 and 2006, with an average annual growth of 2.4%, primary energy demand grew by 9 Mtoe. In 2009 supply dropped by 3% compared to 2006-2008 levels. The average rate of growth in Poland's energy demand between 2000 and 2007 was nearly double that of the OECD and the European Union, largely as a result of rapid economic growth (Figure 2).

In 2009, 93% of Polish primary energy supply came from fossil fuels, with the majority of the rest in the form of biomass. While coal's dominance in the nation's fuel mix has weakened substantially from a share of 76% in 1990 to 55% in 2009, the share of fossil fuels put together fell only from 98% to 93% over the same time period, owing to the growing importance of oil and gas. Oil historically is the second most important fuel and since 1990 its share has nearly doubled to reach 25% in 2009. The contribution of both gas and biomass has increased by 4 percentage points over the last three decades, reaching a level of 13% and 7% respectively in 2009. Hydro and other renewables play a marginal role at present.

FINAL CONSUMPTION

The structure of final energy consumption has changed over the past decades. The most significant development is the decline of industry's share and the growth in the share of transport in final energy consumption. In contrast to a fall of 5.3 Mtoe between 1990 and 2002, Poland's total final energy consumption (TFC) over the past seven years rose by 8.3 Mtoe to reach a level of 65 Mtoe in 2009. Almost three-fourths of this recent surge in TFC came from the transport sector, while the remaining demand came equally from the buildings and industry sectors.

Figure 3. **Total final consumption by sector, 1973 to 2030**



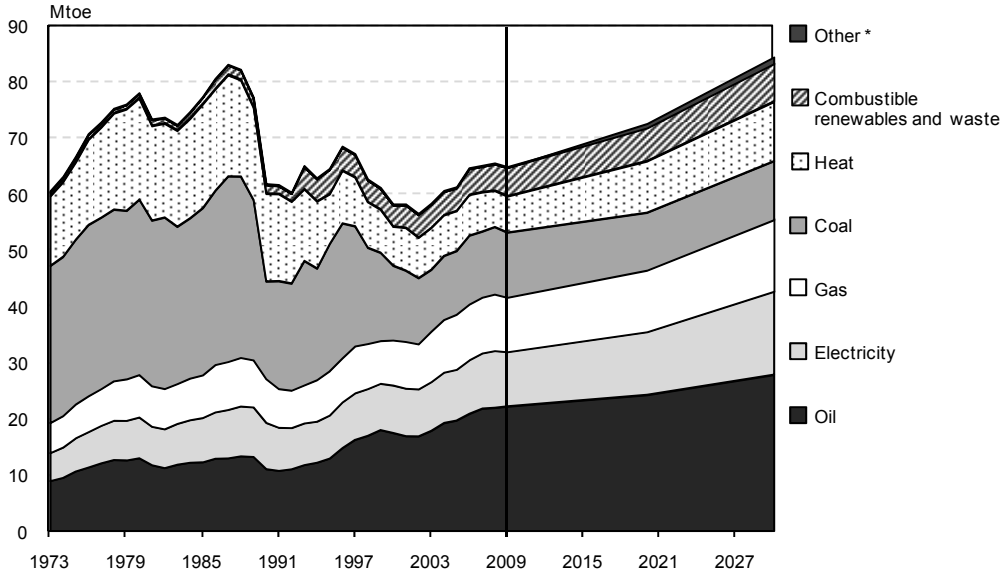
* *Other* includes commercial, public service, agricultural, fishing and other non-specified sectors.

Note: this graph shows historical data until 2009 and the government's projections from 2010 to 2030.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010 and country submission.

This trend reflects a period of strong economic activity during which GDP grew on average by 4.9% per annum and GDP per capita in purchasing power parity (PPP) terms increased by 39% between 2002 and 2009. Along with the increase in prosperity came more demand for personal mobility and lifestyle improvement. Back in 1980, the industrial sector consumed more than the buildings sector, but today the latter accounts for nearly 45% of TFC while the former accounts for 31%. In 2009 Poland's transport sector demand was 16 Mtoe or 25% of total final consumption (Figure 3).

Figure 4. **Total final consumption by source, 1973 to 2030**



* *Other* includes geothermal and solar (negligible).

Note: this graph shows historical data until 2009 and the government's projections from 2010 to 2030.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010 and country submission.

Because of the transport sector's reliance on oil, this fossil fuel's share of Poland's TFC has risen over time to 34% in 2009. Coal accounted for 18%, gas and electricity each for around 15%, with the remainder coming from heat and biomass (respectively 10% and 8%) and a minuscule contribution from other renewables (Figure 4).

FORECASTS AND SCENARIOS

The *EPP 2030* includes an annex "Projection of Demand for Fuel and Energy until 2030". These projections were prepared by the Energy Market Agency on the assumption that the primary directions of Poland's energy policy, including the European Union's requirements, would be implemented, and that domestic resources of hard coal and lignite would remain important pillars of Poland's energy security.[6] In this projection, primary energy demand grows by 22% between 2006 and 2030, reaching 118.5 Mtoe in 2030. Most of this growth occurs after 2020.

6. See *Energy Policy of Poland until 2030* for more detailed assumptions and projections.

In May 2010, the IEA's Office of the Chief Economist developed energy projections for Poland, towards a working paper entitled "Energy and CO_2 Emissions Scenarios of Poland". The first part of this report describes the Reference Scenario, an approach the IEA has been using for several years, notably in its flagship publication *World Energy Outlook* (WEO). It describes what would happen if, among other things, there were no new policy initiatives bearing on the energy sector, beyond those already adopted in Poland by the first quarter of 2010. Importantly, the Reference Scenario does not include potential future policy changes. Therefore, the Reference Scenario cannot be considered a forecast of what is *likely* to happen: rather, it is a baseline picture of how Poland's energy sector would evolve if the underlying trends in energy demand and supply do not change. Poland's primary energy demand reaches close to 115 Mtoe by 2030 in the Reference Scenario or around one-fifth higher than in 2008. The projected growth is mainly driven by the transport sector (10 Mtoe) and power generation (8 Mtoe).

The second part of the "Energy and CO_2 Emissions Scenarios of Poland" report sets out detailed results for the 450 Scenario, in line with the policy framework adopted for the European Union in the *World Energy Outlook 2009*, which assumes that Poland adopts commitments along with other members of the OECD+ region[7] to limit the long-term concentration of greenhouse gases in the atmosphere to 450 parts per million (ppm) of CO_2-equivalent and limiting global temperature rise to 2^0C. The 450 Scenario is based on a hybrid climate policy framework reflecting a plausible set of policies which could emerge – a combination of cap-and-trade, sectoral agreements and national policies. The aim is to illustrate how Poland's CO_2 emissions from fuel combustion would evolve under a given set of assumptions consistent with the overall stabilisation goal. Poland's primary energy demand in the 450 Scenario at 104 Mtoe by 2030 is 9% lower than in the Reference Scenario.

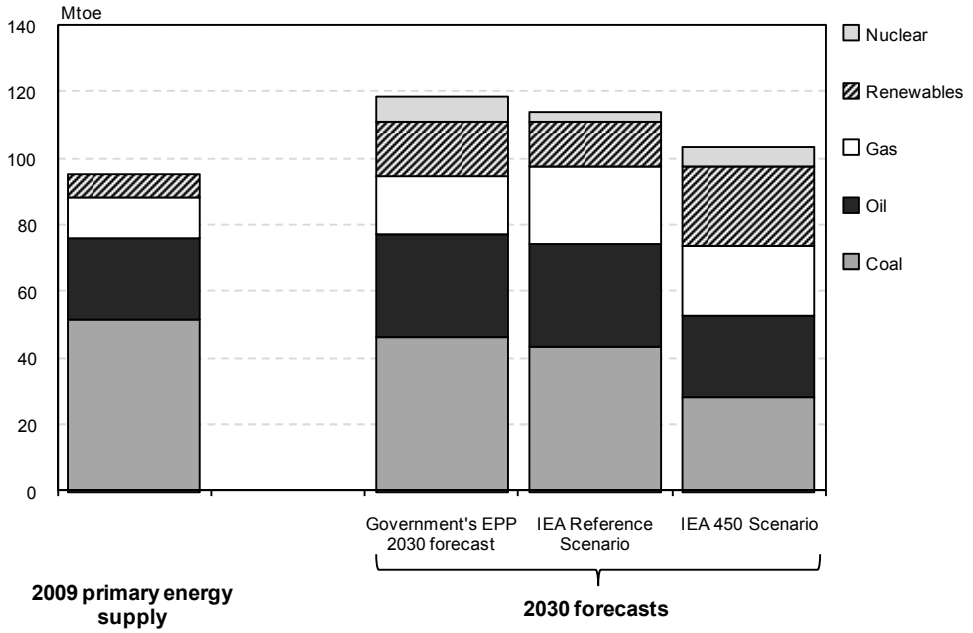
Figure 5 shows primary energy demand by fuel in 2030 in the *EPP 2030* Scenario and the two IEA scenarios. Chapter 3 on Climate Change discusses in more detail Poland's CO_2 abatement potential in the IEA's 450 Scenario and the related investment requirements. Chapter 5 on Electricity also highlights that the power sector could face challenges in raising the substantial investment needed to meet rising demand and to replace ageing power plants.

Importantly, the share of coal declines in all three scenarios as a result of significant changes in the electricity generation mix. As for oil, it remains the second most important fuel in Poland in all scenarios because of growing vehicle ownership and lack of alternatives to oil in the transport sector. In both IEA scenarios, the share of natural gas is projected to rise more sharply than in the government EPP Scenario. In the IEA Reference Scenario, gas-fired generation is projected to rise nearly sixfold by 2030, largely substituting for coal. In the 450 Scenario, a similar level of penetration of gas into electricity generation can be observed, with the share of gas reaching 11% by 2030. Securing the needed supply of gas, whether through pipeline and LNG imports and/or domestic conventional or unconventional production, will be crucial.

In the 450 Scenario, demand for renewables grows significantly above the levels in the government's EPP Scenario and the IEA Reference Scenario, in contrast to oil, gas and particularly coal. Nuclear energy makes a contribution to the energy mix in all three scenarios but its share is the lowest in the IEA Reference Scenario (Figure 5).

7. In *World Energy Outlook 2009* OECD+ region includes OECD countries and EU countries that are not members of the OECD.

Figure 5. **Demand for primary energy by source in the *Energy Policy of Poland until 2030* and the IEA Reference and 450 Scenarios, 2030**



Note: The forecast in the *EPP 2030* is an "energy policy scenario" that assumes the implementation of existing policies. The IEA Reference Scenario is a "business as usual" scenario, also taking into account current policies and measures. The total level of primary energy demand differs slightly in these two scenarios primarily because of differences in methodology and assumptions for GDP growth and international fossil fuel prices.

Sources: *Energy Policy of Poland until 2030,* Appendix 2; "Energy and CO_2 Emissions Scenarios of Poland", IEA working paper, Paris, 2010.

ENERGY POLICY INSTITUTIONS

The **Ministry of Economy** is in charge of energy policy, including energy security. It has a deputy minister responsible for energy issues, and several departments dealing with different aspects of energy policy: the Department of Energy (electricity, CHP, renewable energy, energy efficiency); the Department of Oil and Gas; the Department of Mining (coal); the Department of Nuclear Energy; and the Department of Economic Development (dealing with CO_2 emissions, among other issues).

The **Government Commissioner for Nuclear Energy** is responsible for developing and implementing the nuclear energy strategy. He(she) has a status of Under-Secretary of State and heads the Nuclear Energy Department in the Ministry of Economy.

The **Energy Regulatory Authority** (ERO) is the Polish energy regulator. It reports to the Minister of Economy but has independence in taking decisions. The President of ERO is appointed by the Prime Minister upon the request of the Minister of Economy. ERO's responsibilities include:

- granting licences for electricity and heat generation; electricity and gas transmission and distribution; gas storage, liquefaction and regasification; and fuel and electricity trade;
- appointing transmission and distribution system operators; approving their investment plans and grid codes;
- approving transmission and distribution tariffs; approving final electricity tariffs for residential customers and gas tariffs for all customers;

- issuing certificates of origin for electricity generated from renewable energy sources and co-generation;
- monitoring energy and fuels markets and promoting competition.

The **Ministry of Treasury** represents the government as the owner of companies fully or partly owned by the State. It formulates and implements privatisation strategy.

The **Ministry of Environment** is responsible for environmental aspects of the energy sector, including CO_2 and other greenhouse gas emissions, and environmental fees. It also grants licences for exploration and extraction of raw materials.

The **Ministry of Infrastructure** is responsible for transport policy, as well as policy in the fields of spatial development, construction and housing. It therefore plays an important role in the design and implementation of energy efficiency measures in these sectors.

The **Ministry of Regional Development** prepares and implements the national development strategy, and performs functions related to the management of the European Union's assistance funds.

The **National Atomic Energy Agency (NAEA),** established by the Minister of Environment, is competent for the issues related to nuclear safety and radiological protection.

The **Office of Competition and Consumer Protection** is a central authority of the state administration, reporting directly to the Prime Minister. The President of the Office, appointed by the Prime Minister, is responsible for shaping the antitrust policy and consumer protection policy.

The **Material Reserves Agency**, supervised by the Ministry of Economy, maintains public stocks of crude oil and petroleum products and supervises compulsory stocks held by industry.

The **Central Statistical Office** collects and reports statistics, including data on energy production and consumption as well as aggregated data on greenhouse gas emissions and other air pollutants.

The **Energy Market Agency** is a joint stock company that provides energy and environment-related information to the government, international organisations including the IEA, scientific institutions, universities, and companies under an agreement with the Ministry of Economy, which is in charge of energy data in Poland. It also develops energy projections at the government's request.

Environmental funds. Poland has a system of environmental funds at four levels. The National Fund for Environmental Protection and Water Management (NFOŚiGW), under the supervision of the Ministry of Environment, finances tasks relating to environmental protection, with priority recently given to investments in energy efficiency and renewable energy. Poland also has 16 regional Funds for Environmental Protection and Water Management, which are independent legal entities, as well as environmental funds in counties (*powiat*) and communes (*gmina*), which are dependent on local authorities. Poland also has an EcoFund and a Thermo-Modernisation Fund (see Chapter 4 for more details).

The government is planning to create an interministerial team to enhance co-ordination of energy-related issues among different institutions.

KEY POLICIES

POLICY OBJECTIVES

Polish energy policy is driven to a very large extent by EU directives and requirements. In particular, Poland has to liberalise its gas and electricity markets in line with the EU directives (see details in Chapter 5 on Electricity and Chapter 7 on Natural Gas). Also, as part of the EU "20-20-20" goals,[8] the following targets have been set for Poland for 2020:

- limit greenhouse gas emissions in the sectors not covered by the EU Emissions Trading Scheme (EU-ETS) to 14% above the 2005 level (binding);
- reduce energy consumption by 20% of the projected 2020 levels (non-binding); and
- increase the share of renewable energy to 15% of gross final energy consumption, including an increase in the use of renewables in transport to 10% (binding).

Another driving force for Poland's energy policy is high dependence on Russia for energy imports. In 2007, Poland imported 97% of its needs in oil and 68% of its needs in gas. Over two-thirds of gas imports and almost all of its crude oil come from Russia. As a result, energy security is one of the dominant features of the Polish energy policy. Poland has been keen to reduce its dependence on Russia and to diversify its energy sources and supply routes. So far, such diversification has proven quite difficult. Poland therefore places focus on maximising the use of existing domestic energy resources.

A key aspect of energy security policy is fuel and technology diversification. While the government expects coal to remain the main fuel, it also seeks to support the development of cleaner technologies and the production of liquid and gaseous fuels from coal. It considers providing support for the development of domestic gas production, constructing an LNG terminal and expanding gas storage capacity. It also considers expanding storage capacity for oil and supporting Polish companies that perform oil exploration in the Baltic Sea and outside Poland.

At the same time, Poland is keen to preserve its role as a transit state for Russian gas and oil and strongly opposes projects for alternative transit routes such as the Nord Stream for gas and the Baltic-2 pipeline for oil.

ENERGY POLICY TO 2030

The key policy document in Poland is *Energy Policy of Poland until 2030* (EPP 2030) prepared by the Ministry of Economy and adopted by the government in November 2009. The main objective of the energy policy document is to enhance the country's energy security by observing the principle of sustainable development. The key directions of Polish energy policy are:

- to improve energy efficiency;
- to enhance security of fuel and energy supplies;
- to diversify the electricity generation structure by introducing nuclear energy;
- to develop the use of renewable energy sources, including biofuels;

8. 20-20-20 at the EU level: reducing GHG emission by 20% of 1990 levels, reducing energy consumption by 20% of the projected 2020 levels and increasing the share of renewable sources of energy to 20% of total energy consumption.

- to develop competitive fuel and energy markets; and
- to reduce the environmental impact of the power industry.

As an Annex to the *EPP 2030*, the government adopted an *Action Plan for the years 2009–2012* outlining measures needed to meet the energy policy goals. Another action plan for the years 2013–2016 will be developed in 2012.

One of the annexes of *EPP 2030* assesses the implementation of the previous energy policy which was adopted in 2005. It identifies progress made in achieving the policy objectives, but also issues that still need to be addressed.

NUCLEAR ENERGY PROGRAMME

The introduction of nuclear power is a primary aim of Polish energy policy stipulated in *EPP 2030*. The first nuclear unit is planned to start operation by 2022. Beyond this, the government's plan is to have 4 500 MW_e by 2030. To implement its nuclear energy policy, the government has prepared a schedule of activities covering the period up to the first plant entering operation. This schedule has been included in *EPP 2030* as part of the Action Plan for the Years 2009-2012. The Ministry of Economy has also prepared a more detailed draft policy statement, the Polish Nuclear Power Programme, expected to be approved by the government by the end of 2010. The government has designated PGE SA, the country's largest utility, as the lead investor in the proposed nuclear power plants. Chapter 5 provides more detail on the Polish nuclear energy programme.

FUNDING

Poland has a significant number of public funding sources for its energy sector such as the Thermo-Modernisation Fund and the operational programme "Infrastructure and Environment" (see Chapter 4 on Energy Efficiency). The key institution managing public funds is the National Fund for Environmental Protection and Water Management (NFOŚiGW) which draws its finances both domestically and from the EU and international sources. In Poland, it raises its funds from various environmental and natural resources concession and utilisation fees, penalties for violation of environmental laws, sale of assigned amount units (AAUs), and substitution fees and penalties from the green certificates system. The National Fund is also the largest Polish institution that handles foreign funds designated for environmental protection. For example, it co-ordinated 88 investment projects which, within the framework of the ISPA (Instrument for Structural Policies for Pre-Accession) Fund and the Convergence Fund, received EUR 2 850 billion (PLN 12 340 billion) [9] financial support from the European Commission in the years 2000-2006. The National Fund is also the implementing institution for five priorities of the Infrastructure and Environment operational programme and is responsible for the absorption of EUR 5 035 billion (PLN 21 800 billion) in the years 2007-2013.

Loans and grants, as well as other forms of co-financing provided by the National Fund, are mainly designated for co-funding large national and pan-regional capital projects for controlling water, air and land pollution. Grants are also allocated for tasks related to geology and mining, environmental monitoring, preventing threats to the environment, protecting nature and forestry, and promoting environmental awareness. In recent

9. Throughout the book, on average in 2009, PLN 1 = EUR 0.231.

years, top priority has been given to investments related to energy efficiency and renewable energy. For the period 2010-2015, NFOŚiGW has a budget of PLN 2.7 billion (about EUR 620 million) for energy efficiency and PLN 2.5 billion (about EUR 580 million) for renewable energy.

The methods for allocating funds and the selection criteria for projects have not always been very clear to potential beneficiaries. The National Fund announced that from 2009 it was implementing new, more transparent working methods. It published documents reflecting the Fund's priority programmes, the rules for co-financing projects and selection criteria for projects. It also pays more attention to the training of applicants and future beneficiaries.

ENERGY SECURITY

As mentioned above, energy security is the key priority on the Polish energy policy agenda. The government aims at enhancing security of supply of all energy sources, including coal (more details in Chapter 6), oil (Chapter 8), natural gas (Chapter 7) and electricity (Chapter 5).

OIL

Poland is dependent on imports for 95% of its crude oil demand, and over 94% of these imports come from Russia through the Druzhba pipeline. Poland is also a net importer of oil products the sources of which are relatively well diversified. The Polish government is conscious about the inherent risks of dependence on only one crude oil supplier, and is trying to diversify import sources and transport routes. In particular, it supports the extension of the Odessa-Brody pipeline from Ukraine to the Polish refineries in Plock and Gdansk as part of the larger regional initiative to transport Caspian oil to Europe.

Overall, Poland has a solid emergency response policy in place. The country has been compliant with the IEA 90-day emergency stockholding obligation and currently has enough oil storage capacity to remain compliant in the near future. However, in the longer term, an expansion of storage capacity will be required, and the government envisages further development of underground oil storage.

The government is revising the existing stockholding regime. The plan is to enhance the role of public stocks by transition of the ownership of stocks from the obliged companies to the Material Reserves Agency.

NATURAL GAS

Poland is reliant on imports for about two-thirds of its total gas demand, and over 80% of gas imports come from Russia. The government is keen to reduce this dependence. Diversification of supply sources and routes, development of natural gas infrastructures for such diversification (an LNG terminal), expansion of underground storage capacity, extension of the transmission and distribution system, increase of domestic gas production and developing gas resources outside Poland are the key elements of Poland's gas security policy.

All companies importing gas to Poland or active in international gas trading are obliged to maintain compulsory gas stocks within the territory of Poland, in storage installations

connected to the gas system.[10] These compulsory stocks must be gradually increased to 30 days of imports by 1 October 2012. As gas storage capacity is limited and owned by the incumbent company, the stringent rules relating to compulsory stocks are a significant barrier to entry on the Polish gas market, thus seriously limiting competition. Moreover, the requirement to store the stocks on the national territory may contradict the EU directives on common gas market rules and on security of gas supply. Therefore the Polish government envisages to revise this system.

Poland has in place a rather well-designed emergency response mechanism. It worked efficiently during the gas disruption in January 2009 following a Russia-Ukraine dispute. However, a mid- to long-term comprehensive emergency response policy in the gas sector is still lacking.

Today, the Polish gas transmission system is still relatively isolated from other systems. Moreover, transmission and distribution infrastructure is ageing and needs modernisation and further development. The transmission system operator OGP GAZ-SYSTEM is implementing several investment projects to improve this situation.

Poland could have large resources of unconventional gas. The first assessments based on drilling are expected by the end of 2011. If these resources are confirmed and exploited, they could reduce Poland's import dependence in the medium and long term. At present, too many barriers exist to make unconventional gas production economically viable and even physically possible. If Poland is to tap its would-be shale and tight gas resources, it will be necessary to build the necessary infrastructure and the right legal and regulatory framework to support production.

ELECTRICITY

The government aims to enhance security of electricity supply through the following measures:

- continuing to use coal as the main fuel for power generation;
- building new generating capacity (including nuclear units and new highly efficient co-generation plants);
- developing and modernising the national transmission system;
- developing cross-border connections to exchange the equivalent of 25% of the electricity used in Poland by 2030;
- modernisation and extension of the distribution grids.

The development of renewable energy sources and an increase in energy efficiency will also be beneficial for the security of electricity supply.

Today, the Polish electricity sector is characterised by ageing infrastructure. Nearly half of today's generating capacity is older than 30 years, emphasising the requirement for substantial new investment in the short and medium term to satisfy electricity and heat demand (Chapter 5). Electricity networks see similar investment challenges: nearly 80% of 400 kilovolt (kV) lines and 99% of 220 kV lines are over 20 years old.

10. The Minister of Economy can grant an exemption to companies that import less than 50 million cubic metres of gas per year and have fewer than 100 000 customers.

INVESTMENT FRAMEWORK

The large investment needs will require clear policy frameworks that give the appropriate signals. At present, investments in the energy sector are hindered by various barriers, including complex siting and permitting procedures. Strong local opposition driven by land-use conflicts and environmental considerations makes it particularly difficult, if not impossible, to develop some large projects such as new coal mines, power plants, underground gas storage facilities or CO_2 storage facilities. Local authorities, driven by the interests of local populations, are at times unwilling to deliver permits for such projects even when they are in the national interest.

COMPETITION AND CONSUMER PROTECTION

ELECTRICITY AND GAS MARKET REFORMS

Poland has made progress towards liberalised electricity and gas markets in recent years. However, liberalisation is an ongoing process and, as is the case in other countries, there is more to be done before fully functioning competitive markets emerge.

Progress towards competition is more advanced in the electricity sector than in the gas sector. The Polish electricity market was fully opened to retail competition on 1 July 2007 in accordance with EU directives. With greater market flexibility, there is a steadily growing trend toward consumers switching suppliers, although the rate of switching is still rather low, especially in the residential sector. Retail competition is hindered by many factors, including the lack of a truly competitive wholesale market (see Chapter 5 for more details). The wholesale market is dominated by bilateral contracts signed by companies often belonging to the same vertically integrated capital groups. The new regulation requiring generators to offer 15% of their electricity on Power Exchange or on the regulated market is expected to enhance wholesale competition.

Poland has implemented ownership unbundling of the electricity transmission system operator (TSO). However, distribution system operators (DSOs), although legally separate, are still part of vertically integrated groups that have both generation and supply activities. These groups operate in distinct geographical segments of the country and there is little competition between them, particularly on the residential market.

The restructuring of the gas sector has also commenced, including the establishment of the independent and state-owned transmission system operator OGP GAZ-SYSTEM. Despite these efforts, however, the gas market is still effectively monopolised. PGNiG S.A. (73.50% owned by the State Treasury) has a dominant position in both upstream and downstream sectors. Being practically the only importer of gas from Russia and the major domestic gas producer, it effectively controls the wholesale gas market. The PGNiG Group owns six regional distribution system operators. It also dominates the retail market: several other companies have entered the market but their total market share is about 2%. PGNiG is also the only owner and the appointed operator of the underground gas storage capacity. Chapter 7 provides more details on the Polish gas market.

Developing competitive markets is one of the objectives of the *Energy Policy of Poland until 2030*. The *EPP 2030* Action Plan envisages a number of short-term measures to enhance competition in the electricity and gas markets.

CONSUMER PROTECTION

Several institutions deal with the protection of consumers in Poland. The Office of Competition and Consumer Protection (UOKiK), a central government authority reporting directly to the Prime Minister, is responsible for the development and implementation of the antitrust policy and consumer protection policy. It initiates administrative proceedings concerning infringements of the collective consumer interests.

On the other hand, an individual consumer may obtain free legal assistance from a local consumer ombudsman or a non-governmental consumer organisation,[11] choose mediation or arbitration, or file a court action. A spokesman for electricity and fuel customers has been established in the structure of the Energy Regulatory Office (ERO) with the objective of improving service quality. The spokesman advises complaining consumers on their rights, on the ways to resolve disputes and on relevant institutions competent to deal with each case.

The UOKiK published a report in March 2010 on "Ways of Improving Competition and Consumer Protection in the Polish Energy Sector". It concluded that the existing structure of the electricity market in Poland did not encourage competition, but noted that additional regulatory measures could improve the situation. According to the UOKiK, key issues to be addressed include supply and demand balance, liquidity on the wholesale market, and integration of the Polish electricity system with neighbouring countries. Other important concerns for consumers include low awareness about existing offers and switching possibilities, complex switching procedures, unclear energy bills and ineffective systems for handling complaints and resolving disputes.

The *EPP 2030* Action Plan envisages creating a system, as part of the social security system, for protecting the poorest electricity customers from rapid increases in electricity prices.

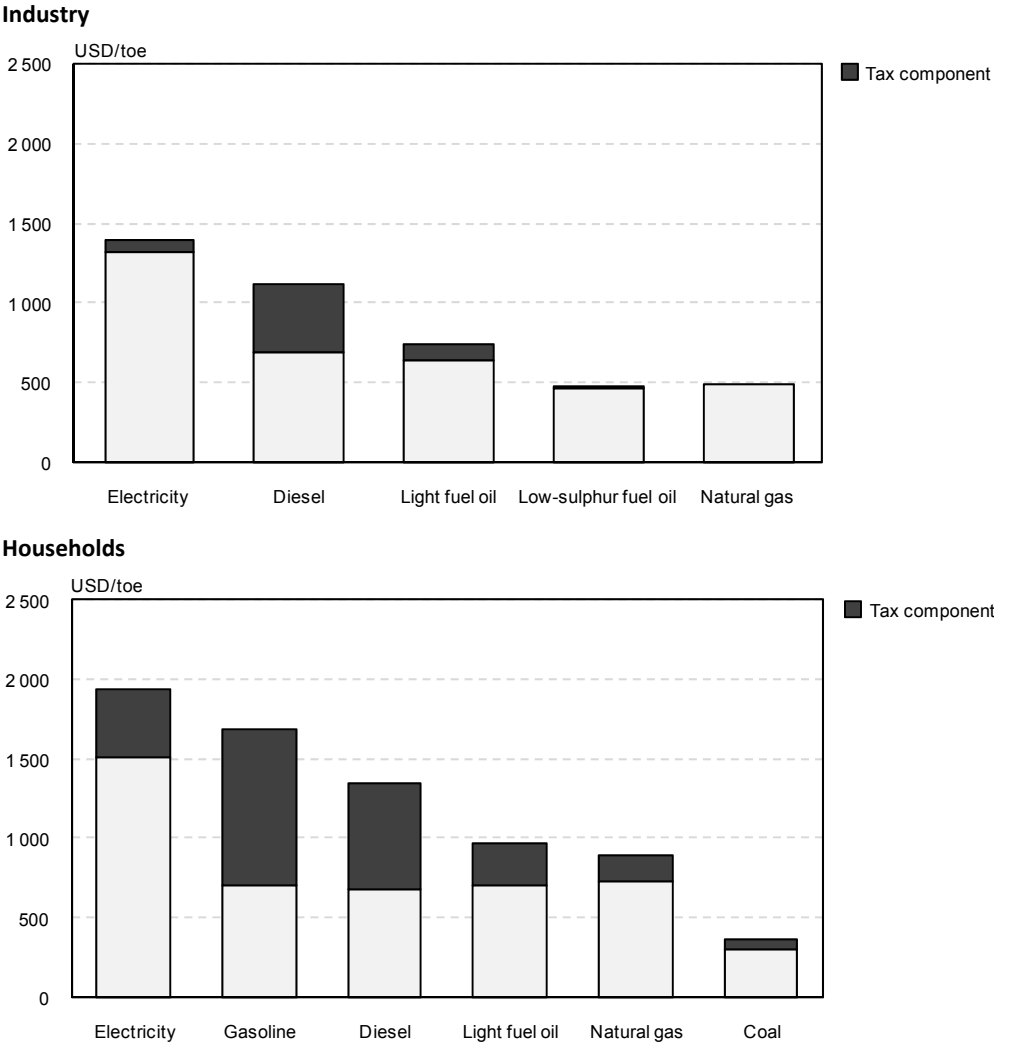
ENERGY PRICES AND TAXES

Prices for coal, oil and oil products are set by the market; they are neither regulated nor subsidised. End-user electricity prices are not regulated except for household tariffs which are subject to approval by the Energy Regulatory Office (ERO). The government plans to completely phase out the electricity price regulation. As for end-user gas tariffs, URE still regulates them for all consumer groups. URE also approves tariffs for network activities - electricity and gas transmission and distribution.

Final prices of fuels in Poland include a 22% value-added tax (VAT). Prices for oil products also include excise duties and a road tax. The excise duties influence the level of final fuel price, and contribute to the structure of fuel consumption in Poland (see Chapter 8 on Oil). The lower tax for LPG and diesel oil compared to gasoline was one of important factors contributing to increased consumption of LPG and diesel oil.

11. For example, the Polish Consumer Federation is a non-governmental organisation whose main objective is to protect individual consumers.

Figure 6. **Fuel and electricity prices, 2009**



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2010.

CRITIQUE

Poland's energy policy is driven to a large extent by EU directives and requirements. A further driving force is its high dependence on Russia for energy imports. As a result, energy security is a dominant theme of Polish energy policy.

The role of coal in maintaining Poland's energy security is very important. Coal gives the country strength in terms of energy security but also challenges in terms of climate change and the environment because of high emissions of GHGs and air pollutants. Recent moves by the government to diversify its energy sources are commendable.

Poland is planning to build at least three nuclear units by 2030, with the first to enter operation by 2022. Meeting this schedule will require timely implementation of the steps set out in the draft Nuclear Power Programme. In addition, Poland plans to diversify its energy sources and supply routes and continue to increase the share of gas and renewables. The government is to be commended for these initiatives. Securing the

needed supply of gas, whether through pipeline and LNG imports and/or domestic conventional or unconventional production, will be crucial (more details in Chapter 7).

Poland's energy intensity has declined in recent years but it is still much higher than the EU average. The government's aim to improve energy efficiency is laudable.

The government is also to be commended for its publication, in November 2009, of its energy policy paper *Energy Policy of Poland until 2030*. This comprehensive policy document outlines the future direction of the government's energy policy, which is broadly in line with the IEA's policy goals: to achieve energy security, environmental sustainability and economic development. However, the policy puts more weight on energy security and less weight on economic efficiency and the environment. Promoting competition in the energy markets is another policy area that could be strengthened.

The *EPP 2030* demonstrates that the government is very much aware of the challenges it faces in the energy sector. It states policy objectives, sets targets and, to some extent, suggests actions relating to each of these goals. In addition, the "Action Plan for the Years 2009-2012", which comes as an annex to *EPP 2030*, outlines a number of short-term targets. While *EPP 2030* and its Action Plan contain many meaningful objectives and measures, more detailed and quantified targets would be helpful. In addition, a longer-term action plan would be valuable in helping to build investor confidence. The sources of the necessary financial support for specific measures should be more precisely identified.

Restructuring and privatisation in the energy market are progressing. However, electricity and gas markets are still dominated by incumbent companies, and competition is limited, particularly on the gas market. The government should continue to remove barriers to competition, while the regulator is left free to oversee the market. This may be difficult in the short term but will lead to competitive prices in the long term. The government's plan to develop social policy measures to protect vulnerable customers should be pursued, along with the energy sector reforms. Indeed, low-income households are protected more effectively by well-designed targeted social policies, rather than by attempting to control energy prices for social considerations.

Following years of underinvestment, the need to upgrade Poland's energy infrastructure is pressing. Investments are often hindered by many barriers, including complex planning procedures and lack of public acceptance. To allow the development of energy projects that are in the national interest (such as new lignite mines, generation and transmission infrastructure, underground gas storage or carbon capture and storage facilities), it will be necessary to streamline and facilitate the planning system. Also, to build investors' confidence, a clear policy framework for the future – short-, medium- and long-term – is required.

Growing interconnections between energy markets in Europe are contributing to regional security of supply. The government is encouraged to put even more focus on this regional dimension when developing and implementing the country's energy policy. Plans for further electricity and gas links with neighbouring countries are commendable. The government should continue to support co-operation between the governments and electricity and gas TSOs of the neighbouring countries.

Poland's energy institutions face a very challenging period to deliver on the policies set out in the *EPP 2030*. Further resources should be made available to key government organisations and agencies, particularly in the five energy-related departments within the Ministry of Economy where staffing levels seem to be quite low.

Apart from the Ministry of Economy, other ministries, agencies and local governments have responsibilities for energy issues, including the Ministries of Treasury, Environment, and Infrastructure. The government is aware of the importance of ensuring effective co-ordination between all parties and is in the process of establishing an interministerial team to achieve that objective. This initiative should be pursued.

The role of the energy regulator is particularly important in pursuing energy sector reforms. In Poland, the Energy Regulatory Office regulates the energy and fuels markets and promotes competition on these markets. It reports to the Minister of Economy who is responsible for energy issues. It is very important to ensure that ERO is fully independent from the ministry in its decision-making process. Full independence of the regulator – both from stakeholders' interests and from political pressures – is an essential element of an effective market.

Poland has some significant sources of public funding for developing the energy sector. It is important to ensure that these funds are spent in line with energy policy priorities.

RECOMMENDATIONS

The government of Poland should:

- *Continue to implement the policies outlined in the* Energy Policy of Poland until 2030 *and its Action Plan for the Years 2009-2012, while developing a longer-term action plan to build investor confidence.*
- *Improve co-operation between all relevant ministries, agencies, local governments and funding bodies.*
- *Continue to promote diversification of sources and routes of oil and gas supply to Poland.*
- *Pursue efforts to increase electricity and gas interconnections with neighbouring countries.*
- *Continue to introduce competition in the gas and electricity sectors, ensuring that the regulatory authority is fully independent and has the powers and resources necessary to carry out its duties effectively.*
- *Streamline the planning system to allow energy projects that are in the national interest to proceed in a timely manner.*
- *Ensure that state funding bodies provide finance in accordance with national energy policy priorities.*

3. CLIMATE CHANGE

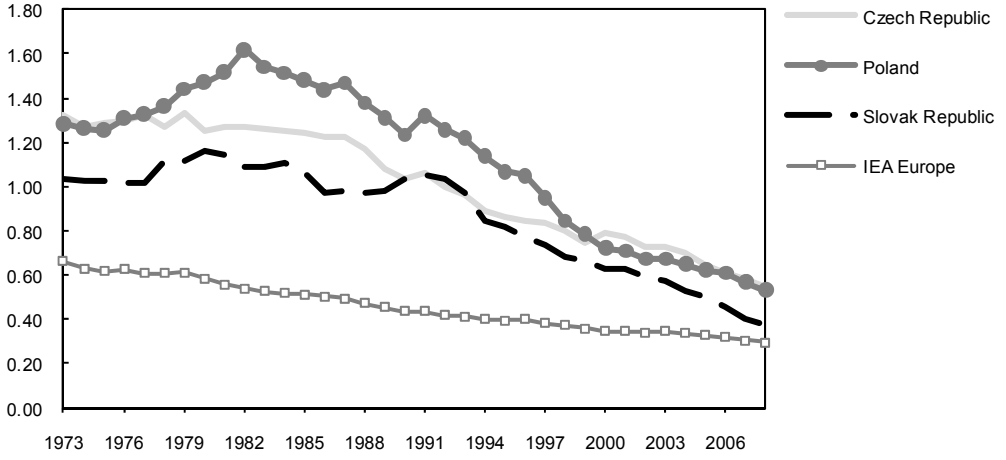
EMISSIONS TRENDS AND PROJECTIONS

CARBON INTENSITY

Although Poland's carbon intensity – energy-related CO_2 emissions per unit of GDP – has been falling sharply since 1991, continued heavy reliance on coal makes Poland a relatively carbon-intensive economy, compared to the IEA Europe average (Figure 7).

Figure 7. **Energy-related CO_2 emissions per GDP in Poland and in other selected IEA member countries, 1973 to 2008**

(tonnes of CO_2 emissions per thousand USD/GDP using 2000 prices and purchasing power parities)

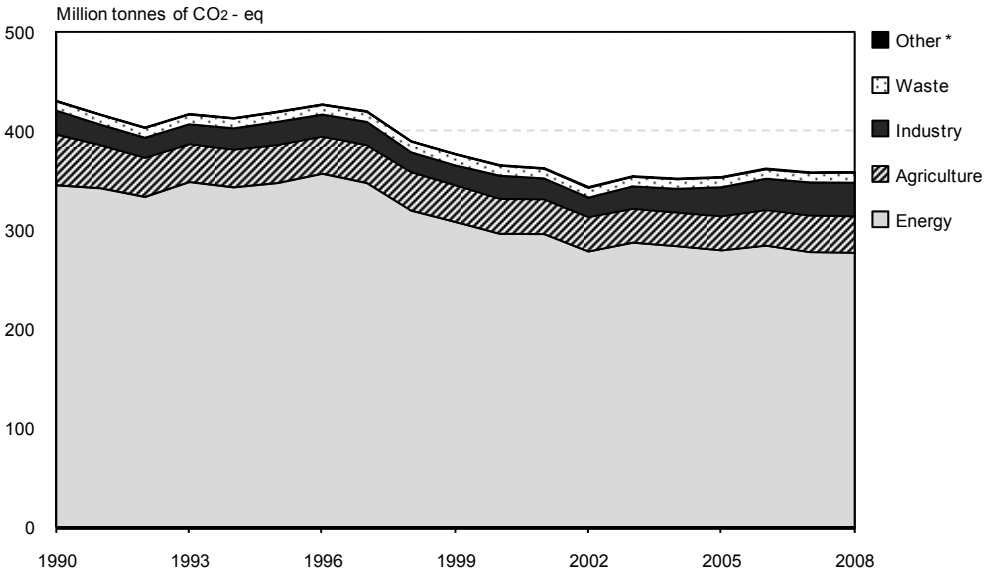


Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009 and *National Accounts of OECD Countries*, OECD Paris, 2009.

GHG EMISSIONS

Overall GHG emissions in Poland, excluding land-use, land-use change and forestry (LULUCF), declined from 1988 until 2002. Between 2002 and 2006, however, GHG emissions started growing again. In 2008, GHG emissions were 397 Mt of CO_2-equivalent and energy-related emissions accounted for more than 80% of the total. More than three-quarters of GHG emissions are solely due to CO_2 from fossil fuel combustion (Figure 8). This highlights the importance of the energy sector in Poland's efforts to reduce its GHG emissions.

Figure 8. **GHG emissions by source, 1990 to 2008**



* Negligible.

Source: Poland's National Inventory Report submitted to the UNFCCC, 2010.

CO_2 EMISSIONS FROM FUEL COMBUSTION

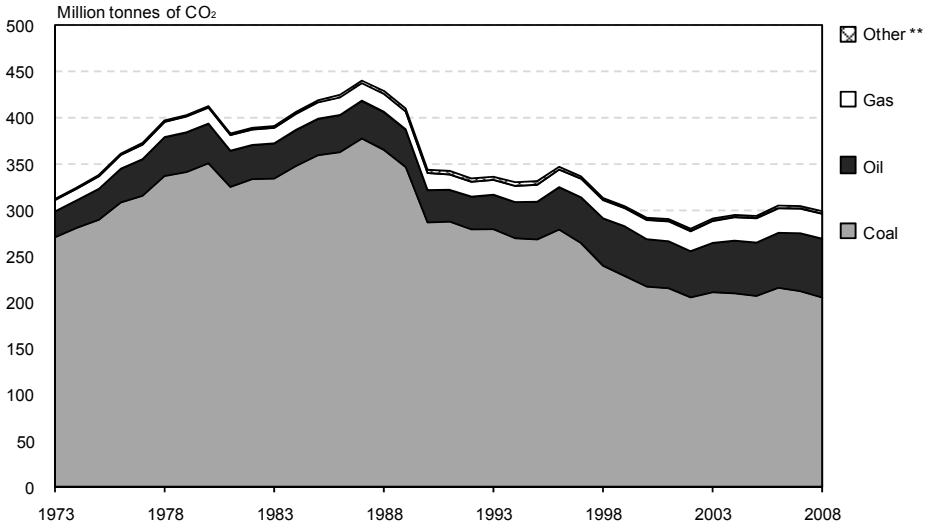
Historic emissions

In 2008 CO2 emissions from fuel combustion represented 92% of all CO_2 emissions and more than 80% of total GHG emissions in Poland. These emissions have followed the same trend as total GHG emissions; with emissions falling from 1988 to 2002 and then increasing slightly between 2002 and 2007 (Figure 9 and Figure 10). Overall, from 1988 to 2008 CO_2 emissions from fuel combustion decreased by almost 30%.

Coal, representing 70% of total energy-related CO_2 emissions, remains the dominant source of CO_2 emissions. Oil, however, has shown the largest increase in its relative share of CO_2 emissions, representing 21% in 2008, attributable to a sharp increase in the light-duty vehicle fleet in recent years. The third-largest source of CO_2 emissions is gas, which also increased its share of total emissions over the past few years (Figure 9).

By sector, as detailed in Figure 10, electricity and heat is the largest sector in terms of CO_2 emissions from fuel combustion. In 2008, this sector accounted for 53% of emissions, a relatively stable share since 1988. The largest increase in recent years can be found in the transport sector, representing 15% of total emissions in 2008. Manufacturing accounted for 13% of emissions in 2008.

Figure 9. **CO_2 emissions by fuel*, 1973 to 2008**

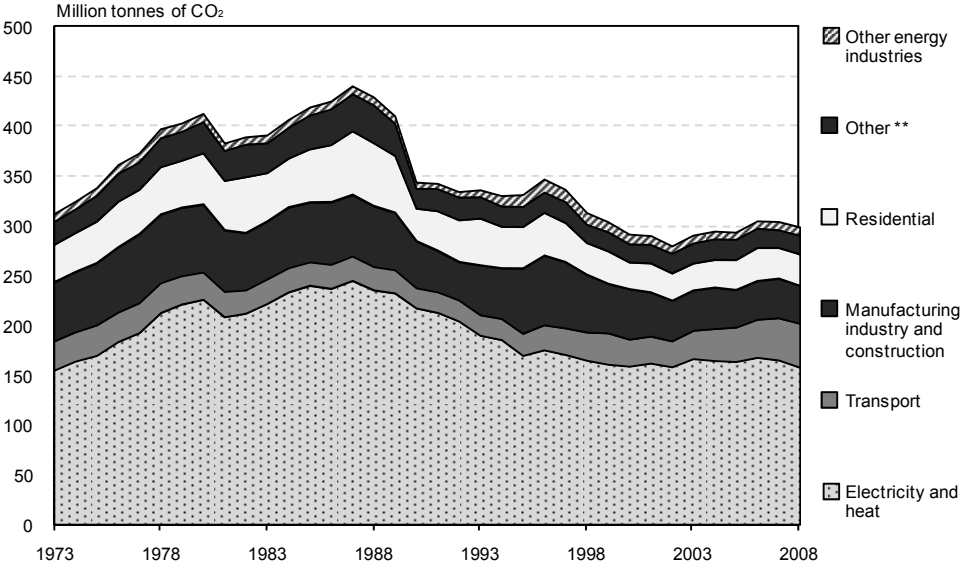


* Estimated using the IPCC Sectoral Approach.

** *Other* includes industrial waste and non-renewable municipal waste (negligible).

Source: *CO_2 Emissions form Fuel Combustion*, IEA/OECD, Paris, 2009.

Figure 10. **CO_2 emissions by sector*, 1973 to 2008**



* Estimated using the IPCC Sectoral Approach.

***Other* includes emissions from commercial and public services, agriculture/forestry and fishing.

Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2009.

Projected emissions

Poland's Fifth National Communication to the UNFCCC includes projections of CO_2 emissions up to 2030. According to these estimates, energy-related CO_2 emissions are expected to decrease from today's level to 266 $MtCO_2$ in 2020. In the period from 2020 to 2030, emissions are projected to increase by about 7% to 286 $MtCO_2$ (Table 1).

Table 1. **Projected energy-related CO_2 emissions to 2030**

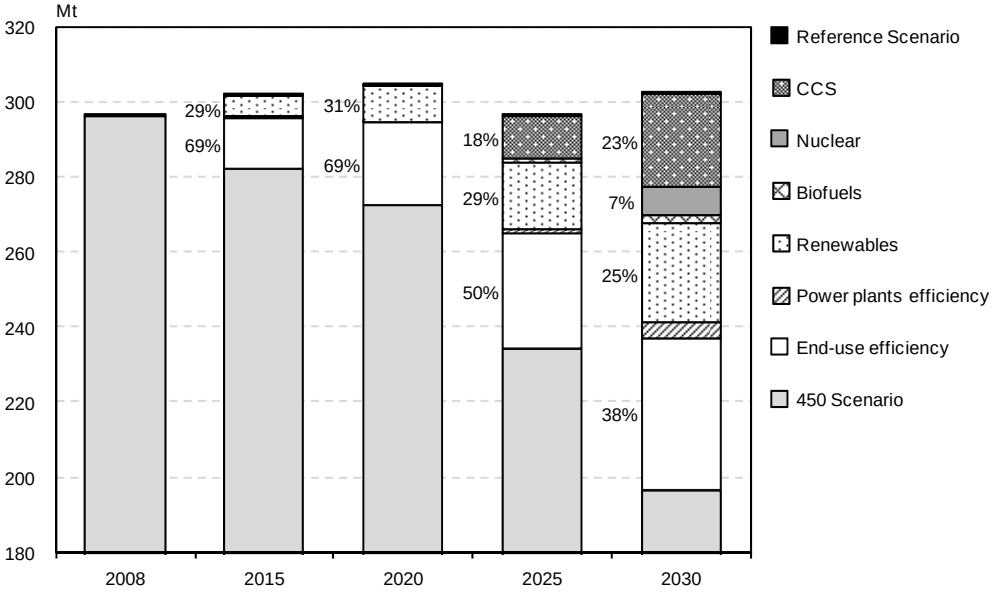
Source category	Carbon dioxide emissions by year (Mt)				
	1988	2007	2015	2020	2030
Fuel combustion	**440.39**	**302.63**	**278.85**	**266.34**	**286.27**
1. Energy industries	268.29	181.99	157.36	141.18	149.71
2. Manufacturing industries and construction	42.54	34.66	27.69	29.66	33.16
3. Transport	21.85	38.21	42.52	45.46	55.56
4. Other sectors	107.71	47.76	51.28	50.05	47.84
Fugitive emissions from fuels	**0.048**	**0.19**	**0.53**	**0.51**	**0.43**
1. Solid fuels	0.01	0.01	0.01	0.01	0.01
2. Oil and natural gas	0.05	0.19	0.53	0.51	0.43
Total energy	**440.44**	**302.82**	**279.38**	**266.85**	**286.70**

Source: Poland's Fifth National Communication to the UNFCCC, February 2010.

CO_2 EMISSIONS ABATEMENT POTENTIAL

In May 2010, the IEA's Office of the Chief Economist in a working paper[12] analysed energy and CO_2 emissions scenarios for Poland up to 2030, which are discussed in greater detail in Chapter 2.

Figure 11. **Fuel combustion-related CO_2 abatement by type, 2008 to 2030**



Source: *Energy and CO_2 Emissions Scenarios of Poland*, IEA working paper, Paris, 2010.

This analysis includes a Reference Scenario out to 2030, as well as a 450 Scenario reflecting efforts to put global greenhouse-gas emissions on a stabilisation path of 450 parts per million of CO_2-equivalent. In the Reference Scenario, Poland's energy-related CO_2 emissions

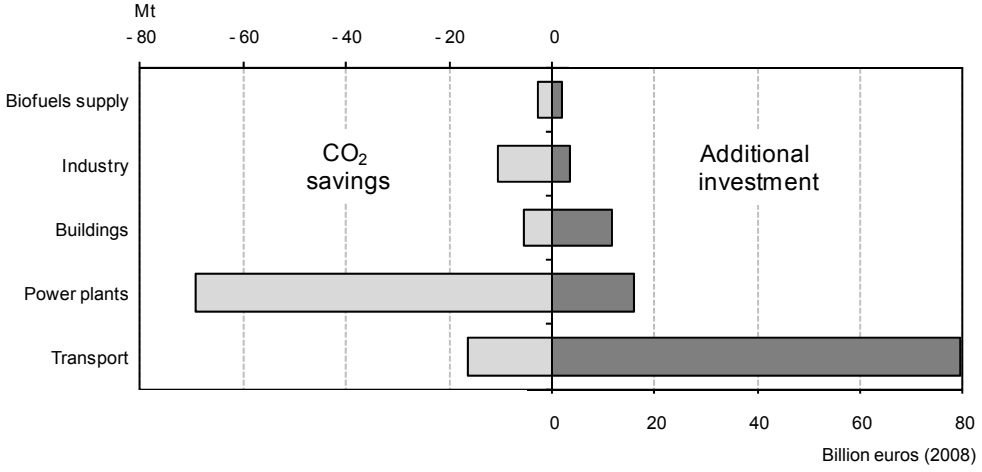
12. *Energy and CO_2 Emissions Scenarios of Poland*, IEA working paper, Paris, 2010.

increase slightly from their level in 2008 to reach a level of 302 Mt CO_2 in 2030. In the 450 Scenario, assuming additional mitigation measures beyond those already adopted[13], energy-related CO_2 emissions decrease by 35% compared to the Reference Scenario by 2030, with emissions at a level of 196 Mt CO_2 in that year. The largest mitigation potential in the 450 Scenario by 2030 is estimated to be from end-use energy efficiency, followed by renewables, carbon capture and storage (CCS), and nuclear power, respectively (see Figure 11).

INVESTMENT NEEDS

The 106 Mt reduction in CO_2 emissions from fuel combustion by 2030 relative to the Reference Scenario requires cumulative additional investment of EUR 113 billion (PLN 489 billion) in the period 2010-2030; 70% or EUR 79 billion (PLN 342 billion) of the cumulative incremental investment is needed within the transport sector, mainly towards purchasing more efficient internal combustion engine and hybrid vehicles. Another quarter altogether is required in power plants (EUR 16 billion or PLN 69 billion) and buildings (EUR 12 billion or PLN 52 billion), with the remaining incremental investment being placed into industry and biofuels supply.

Figure 12. **Cumulative incremental investment and CO_2 savings by sector in the 450 Scenario relative to the Reference Scenario, 2010-2030**



Source: "Energy and CO_2 Emissions Scenarios of Poland", IEA working paper, Paris, 2010.

Two-thirds of this investment is needed in the period 2021-2030, when the majority of abatement in CO_2 occurs. By 2030, annual incremental investment reaches 1.2% of projected GDP or EUR 8.9 billion (PLN 38.5 billion). The cost of the additional investments is offset by economic, health and energy-security benefits. Importantly, energy bills for industry, buildings and transport are EUR 132 billion (PLN 572 billion) lower over the projection period relative to the Reference Scenario, implying a significant reduction in spending on oil and gas imports.

13. The policies assumed in this context are in line with the policies assumed to be adopted by the European Union in the *World Energy Outlook 2009*.

ROLE OF THE ELECTRICITY SECTOR

Both IEA scenarios highlight large investment needs in the Polish electricity sector which is characterised by ageing infrastructure. As discussed in Chapter 5, nearly half of today's generating capacity is older than 30 years, and transmission and distribution networks are also ageing. This poses a short- to medium-term challenge in terms of new investment needs, but also an opportunity for reducing the carbon intensity of the generation fleet. Investments made in the power sector will lock in new generating capacity for a long time, so the choice of technologies made today will influence CO_2 mitigation challenges and costs in the long term. If the retiring coal plants are replaced by new, more efficient ones, the carbon intensity will somewhat decline because of efficiency improvements but will still remain relatively high. If new investments are instead directed towards lower-carbon technologies such as nuclear, renewables and, to some extent, natural gas, the related CO_2 emissions of the power sector could be reduced significantly.

TARGETS AND OBJECTIVES

Poland is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and a party to the Kyoto Protocol. It has an individual target to reduce its greenhouse gas (GHG) emissions to an average of 6% below their 1988 level in the period 2008-2012. Poland is not part of the EU Burden-Sharing Agreement for the first commitment period of the Kyoto Protocol. Like many other transition economies, Poland has achieved emissions reductions exceeding the target. In 2007, total GHG emissions, excluding LULUCF, were 30% below the base year level. As a result, Poland has a surplus of assigned amount units (AAUs) of about 500 million tonnes of CO_2-equivalent, the third-largest amount after Russia and Ukraine. Poland is expected to continue to exceed its Kyoto Protocol target up to 2012.

As an EU member state, Poland participates in the European Emissions Trading Scheme (EU-ETS) and has to comply with the EU climate and energy package. The EU package was adopted by the European Parliament and Council in December 2008 and became a law in June 2009 as an integrated approach to climate and energy policy that aims to deliver cost-efficient solutions to mitigate climate change and increase the EU's energy security. The energy and climate package sets the so-called "20-20-20" targets for the whole EU: reducing GHG emissions by 20% (or even by 30% if other developed countries commit to comparable reductions under a new global climate change agreement), increasing renewables' share in energy supply to 20% and improving energy efficiency by 20% by 2020. This translates into the following targets for Poland:

- limit GHG emissions in sectors not covered by the EU-ETS to 14% above the 2005 level;
- reduce energy consumption by 20% of projected 2020 levels;
- increase the share of renewable energy to 15% of gross final energy consumption.

In addition to this threefold target, EU's climate and energy package includes a revision and strengthening of the EU-ETS and a legal framework to promote the development and safe use of carbon capture and storage (CCS).

POLICIES AND MEASURES

INSTITUTIONS

The **Ministry of Environment** is responsible for carrying out tasks under the UNFCCC and Kyoto Protocol. It co-ordinates actions for environmental protection, including issues related to climate change and emissions trading mechanisms. It is also responsible for other environmental issues such as air quality (see Box 1). Within the Ministry of Environment, the **Department of Climate Change and Atmosphere Protection** evaluates policy strategies and climate programmes, prepares rules on emissions trading and joint implementation (JI) projects, and prepares rules on the allocation of emission allowances. The **Ministry of Economy** supports the Ministry of Environment in carrying out its climate policies and tasks under the UNFCCC for the power, heat and industry sectors. In addition, the **Ministry of Infrastructure** carries the responsibility for environmental and climate policies specific to the transport and construction sectors.

There are several governmental agencies under the supervision of the Ministry of Environment that are directly involved in developing and implementing climate change policies. The **Institute of Environmental Protection** is responsible for administrative and technical tasks under the UNFCCC. This institute also oversees the **National Administration of the Emissions Trading Scheme** and the **National Centre for Emissions Balancing and Management**, and, among other tasks, keeps the national inventory of GHG emissions and the national registry of Kyoto units.

The **National Fund for Environmental Protection and Water Management** (NFOSiGW) finances tasks relating to environmental protection. It is the operating entity for the Green Investment Scheme (GIS) in Poland. Chapter 2 provides more detail on this fund and other institutions involved in climate change and environmental policies.

ENERGY POLICY OF POLAND UNTIL 2030

The *Energy Policy of Poland until 2030* (EPP 2030) outlines the main objectives and measures for mitigating the environmental impact of the power sector, improving energy efficiency, introducing nuclear energy and developing renewable energy and biofuels. For the power sector, the document specifies an overall target of reducing the CO_2 intensity of electricity generation from the 2007 level of 0.95 tCO_2/MWh to 0.70 tCO_2/MWh by 2030. For comparison, the average CO_2 intensity in the EU/IEA is 0.45 tCO_2/MWh. The *EPP 2030* furthermore refers to the commitments in the new EU-ETS directive and lists different measures to meet these obligations. The measures include: devising a plan for CO_2 reductions for installations given free allowances in the period 2014 to 2019, developing an investment plan for reducing CO_2 emissions from the power sector and using income from auctions of emission allowances to support GHG-reducing activities. The *EPP 2030* also outlines the strategy for initiating CCS, which includes introducing standards for new power plants taking into account concerns about CCS readiness, active participation in the EC initiative to build large-scale CCS demonstration facilities in Poland and intensifying research and development of CCS technology. Other measures in the *EPP 2030* include promoting high-efficiency closed cooling cycles in power plants and heat and power stations, and increasing industrial use of waste coal.

Box 1. **Air quality**

In 1988 air pollution in Poland was among the highest in Europe. Major progress was made from 1990 to 2007; with sulphur oxides (SO_x) emissions reduced by 65%, carbon monoxide (CO) emissions by 65% and emissions of nitrogen oxides (NO_x) by 31%. For particulate matters, over the period 2000-2007, emissions fell by 4% and 5% for PM_{10} and $PM_{2.5}$, respectively.[14]

In Poland air quality is the responsibility of the Ministry of Environment which regulates the levels of the following substances: benzene, oxides of nitrogen, sulphur dioxide, particulate matter and carbon monoxide. Poland's average concentration of these substances is within the EU standards with the exception of particulate matter PM_{10}. In areas where the limit values for substances are exceeded, air protection programmes are developed. There are currently 69 air quality programmes being implemented in Poland. General air pollution issues that should be addressed relate to burning of unconventional materials for heating in rural areas, as well as air pollution from the mining and coal industry.

EXISTING POLICIES

In an effort to meet the commitments under EU legislation, Poland has implemented a range of sectoral and cross-sectoral policies. Existing government energy policies with a direct or indirect impact on GHG mitigation include:

- tradable certificates schemes promoting renewable energy and co-generation;
- a long-term programme for the promotion of biofuels, including excise tax exemption, corporate income tax reductions, support for energy crops, investment support, reduction of ecological fees, and preferences for biofuel-powered vehicles;
- exemption from excise tax, reduced grid connection fee and purchase obligation for electricity produced from renewable sources;
- an energy efficiency action plan which involves an energy evaluation system for buildings, a thermo-modernisation fund, a programme of economic energy consumption in he public sector, promotion of energy services companies (ESCOs) and promotion of sustainable transport systems;
- direct support of investments in renewable energy, high-efficiency co-generation facilities, energy efficiency (through the National Fund for Environmental Protection and Water Management).

Renewable energy policies and measures are discussed in greater detail in Chapter 9, and energy efficiency policies in Chapter 4.

The government is currently also working on a new national greenhouse gas emissions reductions strategy to succeed the 2003 climate policy document *(Climate Policy: The Strategies for Greenhouse Gas Emission Reductions in Poland until 2020)*, and to complement the recent *EPP 2030*.

14. European Community Emission Inventory Report 1990–2007 under the UNECE Convention on Long-Range Transboundary Air Pollution (LRTAP), European Environment Agency, 2009. For particulate matter PM_{10} and $PM_{2.5}$ emissions, the European Environment Agency has been compiling data for the years 2000 to 2007 only.

EU EMISSIONS TRADING SCHEME (EU-ETS)

The EU-ETS established in 2003 by Directive 2003/87/EC is a mandatory cap-and-trade system covering CO_2 emissions from installations in nine energy-intensive sectors: combustion installations, refinery processes, coke ovens, metal ores, steel, cement, glass, ceramics, and cellulose and paper. The EU-ETS was launched in 2005 and its first commitment period ran until the end of 2007. The second phase covers 2008-2012. Installations in the EU-ETS can meet their obligations either by implementing emissions reduction measures of their own, by purchasing allowances from other installations covered by the EU-ETS, or by purchasing credits from the Kyoto Protocol's flexible mechanisms (joint implementation or clean development mechanism).

Over the past couple of years, Poland has had a legal dispute with the European Commission over the Polish national allocation plan (NAP) for the second commitment period 2008-2012. This dispute was settled in April 2010 when Poland, after the Court of First Instance had annulled the EC's first NAP decision, submitted a new NAP with an allocation amount in line with the EC's original decision. For 2008-2012, Poland can allocate 208.5 Mt of CO_2 allowances per year to the about 900 Polish installations covered by the EU-ETS. This allowance allocation compares to emissions from the EU-ETS sectors in Poland of about 204 $MtCO_2$ and 191 $MtCO_2$ in 2008 and 2009, respectively. Poland's total emissions from EU ETS sectors account for about 64% of the country's total CO_2 emissions.

From 2013, new rules for the EU-ETS will apply. For example, all allowances for the power sector will have to be auctioned, whereas manufacturing industry can still receive part of its allowances for free, on the basis of stringent EU-wide benchmarks. However, certain countries, including Poland, will have temporary exemptions from the auctioning requirement for the power sector. In 2013, assuming the application for such derogation is accepted, Poland can allocate up to 70% of allowances to power producers for free. Between 2014 and 2019, the quantity of free allowances will gradually decrease, but at the discretion of the government. The aim is to gradually increase the auctioned amount of free allowances leading up to the introduction of full auctioning in 2020, in order to minimise the increase in electricity prices resulting from the CO_2 cost being included in electricity prices. This transition period also allows verifying the possibility of wide-scale use of commercial CCS technologies. Poland is negotiating with the European Commission the introduction of a domestic system of benchmarks, based on the most efficient installations in a given fuel, to determine free allocation of allowances to the power sector after 2013.

DOMESTIC MEASURES OUTSIDE THE EU-ETS

Important non-EU-ETS sectors in terms of GHG mitigation potential include the buildings and transport sectors. There are some measures in place for improving energy efficiency in the buildings sector, including an energy evaluation system for buildings, a Thermo-Modernisation Fund, promotion of energy-saving products and development of an energy management system and an energy audit system for industry. The National Fund for Environmental Protection and Water Management also provides financing for energy efficiency projects installing energy-efficient heating systems (heat pumps) and modernisation of existing heat distribution networks. Looking forward, the *EPP 2030* outlines various measures to improve efficiency in buildings. In addition, a draft act on energy efficiency proposes a "white certificates" system to attract energy efficiency investments. As

Figure 11 shows, there is considerable potential for improving end-use energy efficiency, and improved efficiency in the buildings sector represents a large part of this potential.

A sector representing considerable challenges is the transport sector. Poland's rate of passenger light-duty vehicle ownership increased from just under 200 vehicles per thousand people in 2003 to more than 400 in 2009. As a result, the transport sector accounted for nearly three-fourths of the increase in total final energy consumption over the last seven years, and was the second-largest sector in terms of CO_2 emissions in 2008. Furthermore, today 95% of Poland's transport sector energy demand comes from road transportation, compared to a share of 70% in 1980. Without any further policy measures, energy demand from the transport sector is expected to increase by more than 60% by 2030 compared to 2008 level.[15] These figures underline the importance and challenges of reducing CO_2 emissions from this sector. With the exception of policies promoting biofuels, and the promotion of management systems for sustainable transport systems, there are limited policies in place addressing the rapidly increasing emissions from the transport sector. Poland is subject to EC's regulation on new passenger car performance standards[16] limiting CO_2 emissions for new passenger cars registered up to 2020. The *EPP 2030* sets out measures for further promotion of biofuels, but does not indicate other measures for improved efficiency and reduced emissions in the transport sector.

GREEN INVESTMENT SCHEME AND JOINT IMPLEMENTATION PROJECTS

As indicated above, Poland expects a surplus of assigned amount units (AAUs) of about 500 million tonnes of CO_2-equivalent over the period 2008-2012. Poland has created a framework, known as a Green Investment Scheme (GIS), for investing the revenues from the sale of AAUs in GHG mitigation activities. These revenues are supplemented by funding from the National Fund for Environmental Protection and Water Management that is also the entity managing the GIS. Among the types of programmes and projects financed under the GIS are energy efficiency activities in various sectors, fuel-switching projects, developing renewable energy sources and reducing methane emissions. The first GIS emissions trading contract totalling EUR 25 million (PLN 108 million) was signed with Spain in November 2009. Later contracts have been signed with Japanese companies for EUR 42 million (PLN 182 million) and with Ireland for EUR 15 million (PLN 65 million).

By June 2010, 14 joint implementation (JI) projects had been approved in Poland, representing the total expected emissions reduction of about 11 $MtCO_2eq$. Depending on the development of the carbon market in the future and the stringency of Polish climate targets after 2012, there could be a good potential for developing JI projects in Poland also in the future. JI projects can be used to raise funds supporting the implementation of GHG mitigation programmes.

CRITIQUE

Poland's total GHG and other air pollutant emissions from the energy sector have declined since 1989, although emissions per unit of output remain high. As a result of the political and economic transformations that have been taking place since 1990, the

15. IEA, 2010.

16. EC No 443/2009.

national GHG emissions are much below Poland's target under the Kyoto Protocol, giving the country a significant surplus of tradable emission allowances. These emissions reductions were to a large extent achieved through the restructuring of industry and energy efficiency improvements. The government is praised for reinvesting the profits from the use of the Kyoto Protocol flexibility mechanisms in projects under the Green Investment Scheme aimed at further emissions reductions.

The *EPP 2030* includes ambitious targets on energy efficiency and greenhouse gas mitigation. Poland has put in place market-based schemes (tradable certificates) providing incentives for developing renewable energy sources and co-generation, and is developing a similar support system for energy efficiency. There is also a strategy for increasing the production and use of both biofuels and biomass, and efforts are being made in improving energy efficiency and establishing energy standards in the buildings sector. Yet, the *EPP 2030* seems to put more emphasis on energy security concerns than on environmental sustainability and climate change. An updated version of the 2003 climate policy, reflecting the latest EU energy and climate obligations, would help integrate climate policy into the broader energy policy picture presented in *EPP 2030*. Integration of energy and climate strategies facilitates the design of complementary policies that obtain the dual goal of energy security and environmental sustainability and avoid conflicting and/or overlapping policies. Furthermore, effectively addressing GHG emissions requires fundamental changes to the energy system that only come about through comprehensive and integrated energy and climate policies.

In Poland's Fifth National Communication to the UNFCCC, energy-related CO_2 emissions are forecast to decline somewhat from current levels until 2020, but then increase from 2020 to 2030. Although Poland may be able to gradually introduce auctioning of allowances in the third phase of the EU-ETS from 2013 to 2020, meeting its 2020 emission target in both EU-ETS and non-EU-ETS sectors may pose a challenge. The overall EU 2020 target could also change and end up as high as 30% and deeper EU emission cuts up to 2050 have been discussed. It is therefore possible that the forecast trends in emissions will not be in accordance with possible future mitigation commitments, in particular in the longer perspective beyond 2030.

Added to this picture is the ageing fleet of power plants and the corresponding need to make new investments in the near future. Against this background it is clear that investment decisions being made over the next decade could dictate the mitigation challenges and costs for Poland for a long time into the future. This is particularly true in the power generation sector where the risk of technology lock-in is the greatest. It is therefore crucial that incentives for long-term investments in new low-carbon generating capacity are provided to energy sector companies. One way would be to translate the targets and ambition in the *EPP 2030* into binding requirements, making it clear to the energy sector that the goals of the energy policy will be implemented.

Poland has considerable energy efficiency potential. Given the multiple benefits of energy efficiency in terms of energy security, GHG mitigation, and the often low or negative costs of such measures, unleashing the energy efficiency potential should be a priority. Without reaping the benefits of energy efficiency, the costs of reducing GHG emissions and obtaining energy security will increase. An important starting point would be to identify the main economic and non-economic barriers to implementing energy efficiency projects. On this basis, the targets and proposed measures in the energy policy should be adapted into detailed and quantified measures for each sector.

As coal seems likely to remain an important energy source, Poland should explore clean coal technologies like carbon capture and storage (CCS) in order to meet future GHG mitigation obligations. While the economic viability of CCS is uncertain at this stage, it will be important to continue research and pilot work in this field. The planned EU-supported demonstration projects represent an important first step in this context. It will also be important to transpose the EC Directive on CCS into legislation as soon as possible. This will help provide clarity for investors in the power sector.

Poland has a 2020 target allowing for a 14% increase in GHG emissions in the non-EU-ETS sectors. This target may be difficult to reach. The recent trends and potential increase in emissions from the transport sector pose a particularly difficult challenge in this regard. A detailed plan with specific actions and interim targets for each of these sectors is therefore needed. Without addressing the increasing emissions in the transport sector, it will be very difficult for the country to meet its EU commitments in the sectors not covered by the EU-ETS.

The IEA Reference and 450 Scenarios lead to one key conclusion that Poland, as well as other countries, must take crucial decisions in the energy sector in order to achieve global long-term stabilisation of greenhouse-gas concentration at 450 parts per million of CO_2-equivalent, which corresponds to an increase in global temperature of around 2°C. Meeting this goal will require innovative policies, an appropriate regulatory framework, the rapid development of a global carbon market and increased investment in energy research, development and demonstration. Energy efficiency is the key instrument for reducing Poland's CO_2 emissions, particularly in the short and medium term.

RECOMMENDATIONS

The government of Poland should:

- *Develop an integrated approach to energy and climate policy.*
- *Make energy efficiency an important element of overall energy and climate policy.*
- *Consider the longer-term implications of investment decisions made in the energy sector over the next few years given that Poland's GHG emissions reduction obligations are likely to become more onerous after 2020.*

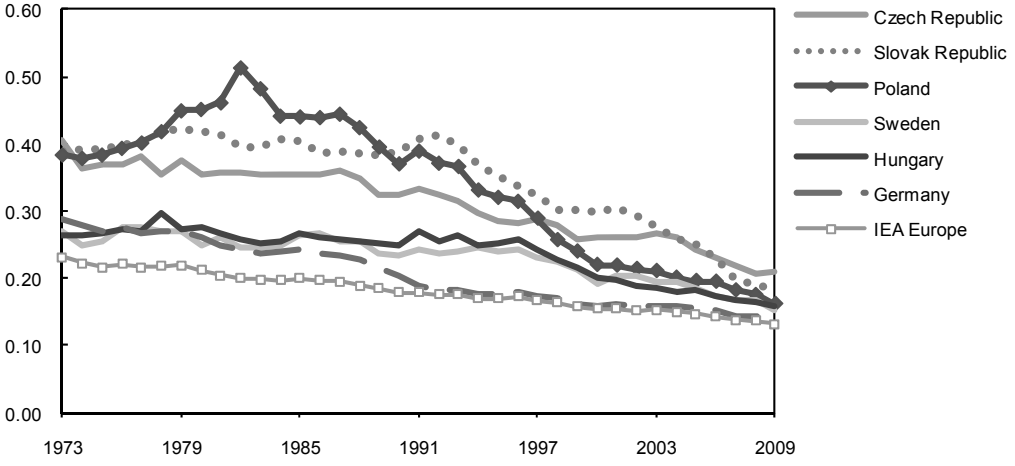
4. ENERGY EFFICIENCY

ENERGY INTENSITY

Energy intensity of the Polish economy[17] has improved considerably since the early 1990s, when it was twice as high as the IEA Europe average. It improved by 40% between 1990 and 2000 as Poland moved away from a centrally planned economy. Over the eight years since 2000, the pace of decline in energy intensity averaged 3% per annum, representing a slow-down compared to a decline of 5% over the previous decade, but the convergence with the European Union and OECD intensities continues. In 2008, Polish energy intensity was 30% higher than the IEA Europe average. According to preliminary data, it dropped significantly in 2009 to become only 22.5% higher than the IEA Europe average.

Figure 13. **Energy intensity in Poland and in other selected IEA member countries, 1973 to 2009***

(toe per thousand USD at 2000 prices and purchasing power parities)



*Estimates for 2009.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010 and *National Accounts of OECD Countries*, OECD Paris, 2010.

17. TPES per unit of GDP at PPP (expressed in year-2008 dollars at market exchange rates).

POLICY FRAMEWORK

TARGETS AND OBJECTIVES

The EU Directive on Energy End-Use Efficiency and Energy Services (2006/32/EC) sets an indicative target for Poland to achieve 9% of energy savings[18] by 2016 in the sectors not covered by the EU-ETS. To comply with this directive, the Ministry of Economy prepared a National Energy Efficiency Action Plan (NEEAP) in 2007. It sets an intermediate target of 2% by 2010 and outlines existing and planned measures that stimulate efficiency improvements.

The *EPP 2030* gives priority to improving energy efficiency and puts forth two main objectives towards this:

- achieve "zero-energy" economic growth, *i.e.* economic growth with no extra demand for primary energy; and
- reduce the energy intensity of the Polish economy to the EU15 level.

INSTITUTIONAL FRAMEWORK

The **Ministry of Economy** has the responsibility for the overall energy efficiency policy. The **Ministry of Infrastructure**, as well as regional and local governments, are responsible for the transport sector and buildings. The **Ministry of Environment** is in charge of the climate policy, as well as of the use of municipal and industrial wastes.

There are a number of institutions involved in the implementation of energy efficiency policies, including the **Polish Energy Conservation Agency** (KAPE), the **National Energy Conservation Agency** (NAPE), the **Polish Foundation for Energy Efficiency** (FEWE), the **Energy Market Agency** (ARE) and the **Poland-Japan Centre for Energy Efficiency** (PJCEE).

The **National Fund for Environmental Protection and Water Management**, as well as regional funds, provide financial support to energy efficiency projects.

KEY POLICY DIRECTIONS

The *EPP 2030* lists energy efficiency as the first policy priority. To achieve the main policy objectives (zero-energy economic growth and reducing energy intensity to the EU15 level), the *EPP 2030* outlines specific actions for the energy sector (see below section on Industry and Utilities) and envisages increasing the efficiency of energy end use.

The *EPP 2030* stipulates the introduction of a new legal framework for energy efficiency. The Ministry of Economy prepared a preliminary draft of an Energy Efficiency Law in 2008. The draft was approved by the Council of Ministers on 12 October 2009 and was passed on to the Polish Parliament for further work. As of November 2010, this draft law was still under discussion in Parliament. The draft Energy Efficiency Law defines a national energy efficiency target and introduces a number of measures to ensure the

18. Saving 9% of the annual average amount of end-use energy consumption in the period 2001–2005 by 2016 (*i.e.* by 53 452 GWh) laid down in the National Action Plan for Energy Efficiency, adopted by the European Committee of the Council of Ministers on 31 July 2007.

implementation of EU energy efficiency directives and to further enhance monitoring, enforcement of and compliance with energy efficiency requirements. One key measure suggested by the draft law is a system of white certificates (see section on Cross-Cutting Measures below).

EPP 2030 also envisages supporting research and development on technologies reducing energy consumption.

POLICIES AND MEASURES BY SECTOR

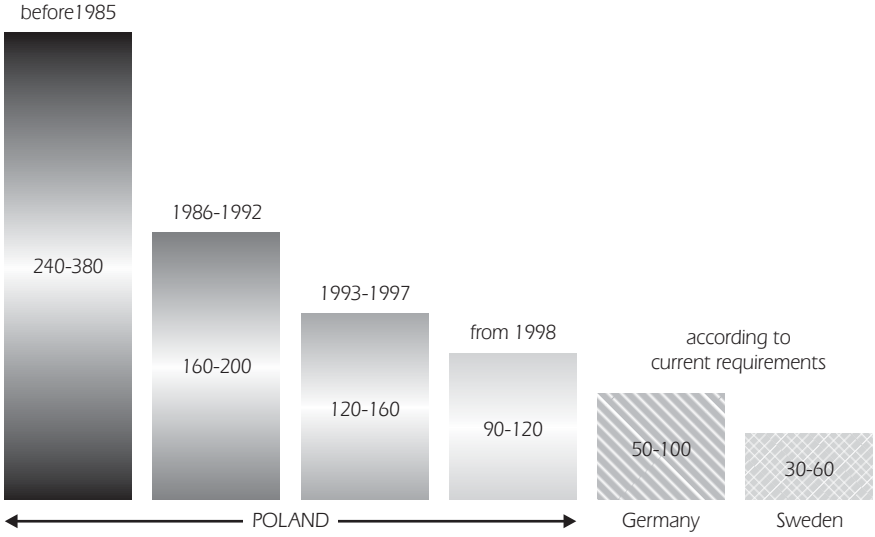
Figure 3 in Chapter 2 shows that the key energy-consuming sectors in Poland are industry, buildings and transport. Poland has specific policies and measures targeting these sectors, as well as a number of cross-cutting measures.

BUILDINGS

Trends

Energy demand in the buildings sector (comprising residential and services) totalled 30 Mtoe in 2009, making it the largest final energy consumer with a share close to 46%. Demand from buildings overtook that of industry in the early 1980s and reached a historical high of 40 Mtoe in 1987. It then collapsed over time by 40% to reach a new low of 27 Mtoe in 2000 as a consequence of increased investment in insulating buildings and the introduction of more efficient heating systems.[19] Since 2000, demand has grown on average by 1.3% per annum with demand from commercial buildings responsible for nearly two-thirds of the increase. As a result, by 2009 commercial buildings accounted for about 30% of total buildings demand.

Figure 14. **Average annual energy consumption for heating in residential buildings in Poland, Germany and Sweden** (kWh/m^2)



Source: Ministry of Infrastructure.

19. Central Statistical Office of Poland, 2009.

The fuel mix used in buildings has substantially changed over the last decades, mainly because of a move away from coal, the use of which declined by 1% on average between 1990 and 2009. However, in 2009 coal was still the dominant fuel in buildings, accounting for 26% of final energy consumption, mainly for water and space heating. Gas and district heating account for about 16.5% each, electricity for 20%, oil and renewables (mainly biomass) and waste for 10% each.

The largest share of energy consumption in buildings is for heat and hot water: 57% and 25% respectively in residential buildings and 52% and 9% in public buildings.[20] Despite significant progress made over the last 20 years, there is much room for energy efficiency improvements: buildings are still characterised by high heat losses because of bad insulation, low efficiency of heating sources and lack of heat meters/controllers in individual apartments, which means lack of incentives to save heat. Average energy consumption for heating in Poland's recent buildings is much lower than in older ones, but still higher than that in some Western European countries such as Germany or Sweden (Figure 14).

Policies and measures

The Directive on the Energy Performance in Buildings (2002/91/EC) sets requirements for more energy-efficient building codes, including minimum performance standards and energy certificates. To extend the scope and reinforce the impact of the 2002 directive, the EU adopted a revised directive that entered into force on 8 July 2010. The new Directive 2010/31/EC will be implemented in stages, with a first transposition deadline set for 9 July 2012, and the final one for 9 July 2013. New buildings will have to be "nearly zero-energy buildings" by the end of 2020, which means that energy needs are almost entirely met by on-site sources. New public buildings will have to meet this requirement by the end of 2018. Member states, including Poland, must draw up national plans for increasing the number of nearly zero-energy buildings by 30 June 2011.

Poland introduced new, more stringent, building codes in 2008. Since January 2009, new buildings are obliged to fulfil technical requirements whereby installations for water heating and space heating, cooling and ventilation should be designed and installed in such a manner that the quantity of electricity and heat consumed will be at rationally low levels. However, enforcement of buildings' energy performance standards is often weak. Moreover, new buildings represent only a small share of the total building stock, so their contribution to the overall energy efficiency improvement is still limited. By law, the building codes must also be applied when buildings are refurbished but this requirement is not always implemented in practice. According to the Action Plan for the Years 2009-2012 of the *EPP 2030*, minimum standards for energy efficiency of buildings are to be increased in 2010/11.

Furthermore, with the objective of complying with the EU directive, as of January 2009, all buildings that are newly constructed, that undergo major refurbishment, that are sold or rented out must have an energy performance certificate. However, these certificates have not proven yet to be a significant factor in decision making about buying or renting housing. Quality and reliability of information contained in the certificates should be improved, and public awareness about their use should be increased.

Financial support to investments has been the key measure stimulating energy efficiency improvements in existing buildings. The Thermo-Modernisation Fund was established by the

20. Ministry of Infrastructure.

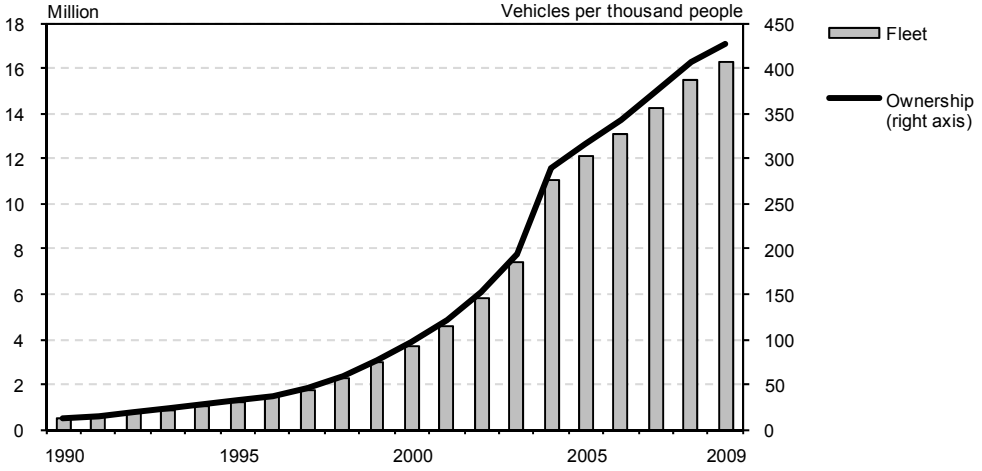
1998 Law on Support for Thermo-Modernisation Investment in Buildings. The law covers the rules of providing financial support to building owners or administrators whereby a premium can be given that covers up to 20% of the loan taken up towards thermal modernisation investments. Between 1999 and 2009 over 16 000 investments, of a cumulative value of over PLN 920 million (EUR 212 million), were realised thanks to this fund.

TRANSPORT

Trends

The importance of the transport sector for Poland's energy policy has grown phenomenally over the last several years. In 2009, with a demand of 16 Mtoe, the transport sector accounted for nearly a quarter of Poland's total final energy consumption (TFC). Since 2002 demand has nearly doubled as result of an average growth of 8% per annum. Fuelled for the most part by a surge in passenger and freight road traffic, the transport sector accounted for nearly three-fourths of the increase in TFC between 2002 and 2009. As a consequence, for the first time in history, demand from the transport sector overtook that of industry and became the second most important sector in TFC in 2008.

Figure 15. **Passenger light-duty vehicle fleet and ownership rate**



Source: CEPiK, 2010.

Figure 15 shows a strong growth in the passenger light-duty vehicle fleet, particularly since 2004. The ownership rate over six years went from just under 200 vehicles per thousand people in 2004 to around 430 in 2009. Along with rising income per capita, this surge in vehicle numbers was fed by imports of cheaper second-hand cars. CO_2 emissions, local air pollution and energy security are likely to be aggravated depending on the age of the imported cars and consequently their efficiency.

Today 95% of Poland's energy demand in the transport sector comes from road traffic, compared to a share of 70% in 1980. As a result of modal shift from rail to road, rail transportation accounts for only 3% (less than 0.5 Mtoe) of total transport sector demand in 2008, about ten times less than in 1980. The remaining energy demand in the transport sector is consumed in pipeline transportation, as Poland imports and serves as a transit

country mainly for Russian oil and gas, and in domestic navigation. There has been a significant increase in air transport in recent years (before the financial crisis): since Poland's accession to the European Union in 2004, international aviation demand has nearly doubled as a result of increased labour migration and tourism. The volume of sea and inland water transport has stabilised at a very low level, with a slight growth observed in the last few years. The share of public transport in local transportation has declined in most Polish cities.

With road traffic accounting for the lion's share of energy demand in the transport sector, consequently 92% and 4% of total transport demand in 2009 was fuelled by oil and biofuels, respectively. The remaining demand mainly stems from natural gas used in operating pipelines and electricity to power locomotives.

Policies and measures

The National Energy Efficiency Action Plan (NEEAP) adopted in 2007 includes measures for the transport sector, which are mainly programmes financed by the EU funds.

To improve energy efficiency in the transport sector, the Ministry of Infrastructure focuses on: *i)* the introduction of management systems for traffic and transport infrastructure, and *ii)* the promotion of sustainable transport systems and efficient fuel use.

Management systems for traffic and transport infrastructure are being introduced through the following measures:

- support for intelligent transport systems (EUR 140 million or PLN 600 million), which includes measures in traffic management, electronic fee collection, fleet management, crisis management, data management, logistics, road safety, and traveller information;
- increasing the use of rail transport: measures include financial support from public funds under the operational programme: "Infrastructure and Environment" for 2007-2013 (EUR 4.9 billion or PLN 21 billion) to projects that modernise and expand the railway infrastructure;
- promotion of intermodal transport, including financial support from public funds under the operational programme "Infrastructure and Environment" for 2007-2013 (EUR 111.26 million or PLN 482 million) to projects aiming at construction or expansion of infrastructure around railway or sea terminals, or logistical centres.

Promotion of sustainable transport systems (shift towards less polluting modes) and of efficient fuel use is implemented through the following measures:

- preparing urban plans for sustainable transport;
- offering alternative means of transport, integration of public transport, park and drive-type options;
- increasing safety for pedestrians and cyclists;
- training drivers to drive in an eco-friendly mode;
- encouraging car-pooling and lifestyles that are less dependent on cars;
- promoting tyre pressure checking.

Other measures used in Poland to influence users' choice of transport mode include:

- fuel taxation (more details in Chapter 2);
- vehicle taxation at purchase;

- mandatory standards for vehicles;
- speed limits;
- information/training.

INDUSTRY AND UTILITIES

Trends

Until the early 1980s, industry was the largest sector within total final energy consumption with a share of around 40%, before being surpassed by demand from buildings. Despite certain interim periods of growth around 1996 and 1998, industrial energy demand continued to fall over time before reaching its lowest historical level of 18.8 Mtoe in 2009. Reductions in energy demand occurred as industrial output fell, production facilities underwent modernisation and energy prices were gradually liberalised.

In 2008, 24% of total industry demand came from the chemicals and petrochemicals sector, 17% from the non-metallic minerals sector (such as cement, glass and ceramic), 14% from the iron and steel industry, 8% from the paper, pulp and printing sector and 37% from other sectors. Poland's industry underwent substantial transformations in terms of level of output, sub-sectoral rebalancing, privatisation processes, fuel switching and the scrapping of legacy energy-intensive equipment. For example, within the outdated and highly energy-intensive cement sector, production utilising the wet method has been virtually eliminated. Similarly, in the iron and steel sector, the last furnace utilising the uneconomic and energy-intensive open-hearth method of production was shut down in 2002.

Fuel mix in the industry sector has changed significantly, following the sector's transformations. Coal demand from industry reached its highest level of 12.5 Mtoe in 1996 and since then has declined by over 70% to reach 3.7 Mtoe in 2009. As a result, the share of coal in total industry demand declined from 47% in 1996 to 20% in 2009, and in 2005 coal became the second-largest fuel behind gas.

Electricity accounted for 18% of total industry demand in 2009, compared to 15% in 1996.

Gas saw its share rising from 15% in 1996 to 24% in 2009. While heat demand at 1.4 Mtoe in 2009 has a 7.6% share, its consumption declined drastically in the early 1990s with fuel switching and has remained fairly flat since 1996. While oil consumption in industry has been declining substantially over the past couple of years as a consequence of higher oil prices, biomass and waste use continues to grow and reached 1.4 Mtoe in 2009.

Policies and measures

The EU Emissions Trading Scheme (EU-ETS), discussed in Chapter 3, has an indirect but strong effect on energy efficiency in the heavy industry and heat and power sectors.

The *EPP 2030* focuses primarily on improving energy efficiency in the energy sector. It lists the following objectives:

- to enhance efficiency of power generation by building highly efficient generation units;
- to achieve a twofold increase (as compared to 2006) in power generation with the use of highly efficient co-generation technology by 2020;

- to limit grid loss during transmission and distribution by, for example, modernising the existing and building new grids, replacing low-efficiency transformers, and developing distributed generation;
- to increase the ratio of annual demand for power to the maximum demand for power at peak hours.

To comply with the Directive 2004/8/EC on the Promotion of Cogeneration, amendments to the Polish Energy Law introduced a system of certificates of origin for energy from co-generation (the so-called red and yellow certificates). *EPP 2030* envisages further stimulation of co-generation through support mechanisms, taking into account co-generation of up to 1 MW and appropriate commune policy (see more details in Chapter 5 on Electricity and Heating).

A number of projects to improve industrial energy efficiency have been implemented with the financial support from EU funds and multilateral funding organisations (*e.g.* the Global Environment Facility/United Nations Development Programme). In 2004, a Poland-Japan Centre for Energy Efficiency (PJCEE) was created to promote energy-saving technologies and provide training and consulting services for the industrial sector. The PJCEE has conducted, *inter alia*, energy audits of industrial companies and has disseminated information on industrial energy efficiency.

The National Fund for Environmental Protection and Water Management conducts several specific actions targeting the industrial sector in the framework of the operational programme "Infrastructure and Environment", in particular its priority axis "Adjusting enterprises to the requirements of environment protection". The programme allocates EUR 90 million (PLN 390 million) to the following actions that are expected to save 173 000 MWh/year:

- rationalisation of natural resources and waste management in enterprises;
- supporting enterprises in the implementation of the best available technologies (BAT).

The National Fund also plans to implement a programme on "Effective use of energy in enterprises". The programme will have two directions:

- co-financing energy audits in industrial enterprises (grants): with a budget of PLN 0.1 billion (EUR 23 million), the fund plans to finance 100 complex energy audits in industrial enterprises with minimal average energy use of 50 000 MWh/year;
- co-financing investment projects leading to energy efficiency improvements in industrial enterprises (soft loans): with a budget of PLN 1.4 billion (EUR 323 million), the fund plans to modernise 150 industrial installations.

The draft energy efficiency law envisages measures to stimulate energy savings by energy services companies (ESCOs).

APPLIANCES AND ENERGY-RELATED PRODUCTS

Poland must apply mandatory labelling of products, in accordance with the EU directives, to inform potential purchasers about products' energy consumption. Directive 92/75/EEC of 22 September 1992 introduced mandatory labelling of household appliances such as lamps, ovens, refrigerators, freezers, washing machines, tumble dryers and dishwashers. The new Directive 2010/30/EU of 19 May 2010 extended the scope of the mandatory labelling to "energy-related products" which "have a significant direct or indirect impact on the consumption of energy and, where relevant, on other

essential resources during use".[21] The revised energy labelling directive will have to be transposed into national law by 20 June 2011. The European Commission will review it by 31 December 2014. Appliances and energy-related products are classified from A to G, where class A is for the most energy-efficient ones. Three additional classes can be added, A+, A++ and A+++ showing even greater efficiency compared to class A.

To implement the EU Ecodesign Directive 2009/125/EC,[22] Poland is required to introduce minimum energy efficiency standards for new electric appliances sold. These standards are determined by EU regulations based on the Ecodesign Directive. Since autumn 2008, the EU Commission is gradually proposing such standards for different product groups. The Eco-Design Directive will improve the energy efficiency of all new products outside the transport sector.

In addition to the EU-driven measures described above, the Action Plan of the *EPP 2030* requires the Ministry of Economy to analyse and, if possible, to introduce incentives for end-users to buy energy-efficient products, in 2011–2012.

The Ministry of Economy purchased 54 500 energy-saving light bulbs (compact fluorescent lamps) to provide them to Polish communes. According to the Ministry of Economy, energy-saving light bulbs constitute only 2.5 % of light sources in Polish households, which is one of the lowest indicators in the European Union. If only one traditional light bulb is replaced with an efficient one, it is possible to save within a year over PLN 26 (EUR 6) and reduce CO_2 emissions by 62 kg. Replacing light bulbs in 13 million Polish households (5 light spots each on average) would result in a saving at the level of 4 TWh, which is more than 3.5% of Poland's yearly net energy consumption.[23]

CROSS-CUTTING MEASURES

Demand-side management

The *EPP 2030* Action Plan puts some emphasis on demand-side management (DSM). To encourage electricity customers to save energy, particularly at peak hours, the Ministry of Economy, the Energy Regulatory Office and other relevant bodies are expected to:

- oblige the electricity transmission system operator to implement a new architecture of the electricity market, including implementation of the intra-day market (2010);
- gradually implement an obligation to use electronic meters enabling transmission of price signals to energy customers (from 2011);
- create conditions for application of an incentive system with a view to rationalising electricity consumption through distribution tariffs (2011); and
- introduce a digital communication standard ensuring the creation of conditions for building a uniform all-national system of radio communication for the needs of the power sector that would ensure voice communication and data transmission both in normal times and in a crisis (2011).

21. It does not apply to second-hand products and any means of transportation.

22. Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products and amending Directives 92/42/EEC, 96/57/EC, 2000/55/EC and 2005/32/EC.

23. Ministry of Economy, 2009.

The *EPP 2030* Action Plan also envisages that trade and distribution enterprises will apply demand-side management techniques on an ongoing basis.

Local energy plans

The Polish Energy Law of 1997 requires local communities to develop local energy plans that would identify least-cost options of providing energy services to households, including heat, electricity and gas supply as well as demand-side measures to reduce energy consumption. This obligation has not been properly enforced, and only a small number of municipalities have developed such plans. Amendments to the Energy Law, adopted in March 2010, specify that such plans must be made for a 15-year period and updated every three years.

White certificates: a legislation proposal

The draft Energy Efficiency Law introduces a scheme of white certificates expected to stimulate energy efficiency in the whole economy. This scheme places an obligation on suppliers of electricity, heat and gas to achieve energy savings in their own businesses and in end-users' facilities. The scheme will include a detailed list of measures expected to lead to more efficient energy use by the generators for their own purposes (10%), reduction of losses in distribution and transmission of energy (10%) and energy savings by end-users (80%). The administrative bodies of the white certificates scheme include the Ministry of Economy, the Energy Regulatory Office and TGE SA (the Power Exchange).

The proposal is to organise tenders for energy savings and to issue white certificates to the winners of these tenders. To enter the tendering procedure, the minimum required value of energy savings is 10 tonnes of oil equivalent (toe). In order to reduce transaction and administration costs, a catalogue of proposed measures is available, with indicative measurable results. Auditing of energy savings is mandatory. If suppliers cannot fulfil their obligation, a penalty is foreseen.

Information awareness

Since 2007, Poland's Ministry of Economy is running a national information campaign, including distributing brochures and manuals, promoting energy-efficient products with the objective of spreading rational and cost-efficient methods of using energy. The *EPP 2030* Action Plan envisages further actions in this area in 2009-2012.

Investment support

Under the operational programmes carried out in the years 2007–2013 ("Infrastructure and Environment" and regional operational programmes), funds were earmarked to support investments in energy efficiency projects, in particular best available technologies in industry, highly efficient co-generation, reducing losses in distribution grid, and thermo-modernisation of buildings. The *EPP 2030* plans to continue support for investments in energy saving through preferential loans and grants from domestic and European funds.

Energy efficiency in the public sector

In accordance with European Commission directives, the public sector should play an exemplary role in energy saving. The *EPP 2030* Action Plan lists a number of measures to achieve this goal, including:

- obligation for public-sector entities to save energy and to inform the public about energy efficiency improvements; monitoring of the compliance with this obligation;
- promoting energy-saving solutions in communes;
- spreading information of best practices in public-sector entities in other EU countries;
- adjusting the main building of the Ministry of Economy to serve as a model of energy efficiency.

The draft Energy Efficiency Law had a proposed target for the public sector to save 1% of energy per year. However, as of November 2010, this proposal had been withdrawn from the draft law. The absence of such a target will make it difficult for the public sector to play a leading role in energy efficiency improvements.

CRITIQUE

Over the past decade, energy intensity in Poland has decreased by 30%. Nevertheless, it remains significantly higher than the IEA Europe average. It is clear that there are still potentially big savings to be made, which will in turn contribute to improving energy security, reducing emissions and increasing competitiveness. Moreover, EU legislation requires Poland to achieve energy savings of 9% of final energy consumption by 2016.

While structural changes in the Polish economy have made a significant contribution to decreasing energy intensity, measures adopted by the government also have played an important role. In particular, initiatives designed to improve the energy efficiency of buildings (*e.g.* tighter building regulations) are to be welcomed. This is important given that 46% of Poland's final energy demand is attributable to this sector and in particular to heating needs. To tap the energy efficiency potential in buildings, enforcement of the energy performance standards should be strengthened and the system of performance certificates should be improved.

Measures to increase the energy performance of appliances and to encourage more co-generation (including a system of certificates) are also to be noted. In addition, Poland has a number of national funds, and has identified opportunities to secure European funding to support implementation. These initiatives should be continued, and built upon.

The government has clearly recognised the importance of further improvements to energy efficiency as a key element of an energy security strategy. The *EPP 2030* has two overarching objectives in this area, namely reducing energy intensity to the EU15 average by 2030 and achieving zero-energy economic growth. Such clear political ambition is welcome. Looking ahead, it is important that this strong political signal is underpinned by measurable targets and objectives and a clear delivery plan. This is already the case in some sections. For example, the *EPP 2030* sets out measures to further improve efficiency in buildings (especially in the existing stock).

There are, however, several areas where detail is insufficient to provide either certainty to investors or a real basis for assessing likely effectiveness. Much of the detail (including that of the flagship horizontal project, a system of "white certificates") is to be set out in the forthcoming Energy Efficiency Law. Unfortunately, adoption of this law has been delayed. If properly implemented, white certificates can be an effective way to stimulate energy savings; Poland is therefore encouraged to pursue this initiative. While the delay in adopting the law risks damaging the credibility of the objectives, it also provides an opportunity to develop really effective legislation.

One sector that requires more attention is transport, where fuel consumption has been growing at an average annual rate of 4.7% between 1998 and 2009. While some measures are clearly planned, there are few clear objectives or timelines. Reducing energy consumption in the transport sector is a particularly difficult challenge for all IEA countries. The Polish government is encouraged to intensify its efforts in this direction, ensuring effective co-operation between different government bodies responsible for various aspects of energy and transport policies.

Good progress has been made in the industry and utilities sector to date (for example, efforts to promote co-generation), but further actions are needed here too. Further elaboration of priorities for research and development is also needed, for example the development of smart metering to support objectives on demand-side management.

Implementation of such a wide range of measures will clearly be challenging. The *EPP 2030* helpfully identifies who will be responsible for what measures and in so doing underlines the sheer number of partners who will be involved in delivering energy efficiency on the ground. The government should ensure that the relevant bodies are adequately resourced and that clear co-ordination and governance structures are in place. An audit of the current resources in government should be carried out. Regional and local authorities will also play a pivotal role (*e.g.* in drawing up local energy plans) and it is necessary to provide clarity on their contribution and ensure their active engagement (*e.g.* through statutory obligations). It is very important that the national government and local authorities play a leadership role in energy efficiency improvements, so that the public sector shows an example to be followed by other players.

Finally, the *EPP 2030* rightly points towards regular evaluation and review. This is particularly important with reference to energy efficiency given the current lack of data (especially quantitative) on the effectiveness of past policies. As referred to above, clearer, more measurable objectives will be important, backed up by a comprehensible picture of which measures are expected to achieve them and by when. It will also be important to develop robust methodologies where these do not already exist. Taken together, these measures should help to inform the update of the *EPP 2030* and ensure value for money.

To improve energy efficiency, the IEA also urges the government to continue its work in making the national and EU policies fully consistent with the energy efficiency policy recommendations the IEA presented to the Group of Eight (G8). The IEA Energy Ministers endorsed the initial 16 measures in 2007. Since then, nine new recommendations have been added (Box 2). Poland has made progress in implementing some of these recommendations, but in a 2009 study IEA identified significant gaps in policy implementation in the buildings, utilities, industry and transport sectors.[24] In the buildings sector, for example, Poland should consider developing policies that support passive energy houses and zero-energy buildings as well as promoting energy-efficient glazing.

As for appliances, there appears to be a lack of policies in areas not covered by EU legislation. While mandatory energy performance standards exist, as does an appliance labelling programme, the stringency of these standards is not always maintained. Progress with reviewing and developing appropriate test standards and measurement protocols would likely be useful in meeting energy efficiency goals.

24. IEA, 2009.

RECOMMENDATIONS

The government of Poland should:

- ☐ *Step up efforts to improve energy efficiency, ensuring effective and timely implementation of the measures already outlined.*
- ☐ *Develop a comprehensive approach to energy efficiency taking into account the potential contribution of all sectors, in particular buildings and transport.*
- ☐ *Ensure effective co-operation between the relevant ministries, agencies and local government involved in implementation.*
- ☐ *Improve monitoring and evaluation of the effectiveness of energy efficiency measures.*

Box 2. **IEA energy efficiency recommendations**

The IEA has prepared a set of energy efficiency policy recommendations covering 25 fields of action across seven priority areas: cross-sectoral activity, buildings, appliances, lighting, transport, industry and power utilities. The fields of action are outlined below.

1. The IEA recommends action on *energy efficiency* across sectors. In particular, the IEA calls for action on:

- Measures for increasing investment in energy efficiency.
- National energy efficiency strategies and goals.
- Compliance, monitoring, enforcement and evaluation of energy-efficiency measures.
- Energy efficiency indicators.
- Monitoring and reporting progress in relation to the IEA energy efficiency recommendations.

2. *Buildings* account for about 40% of energy used in most countries. To save a significant portion of this energy, the IEA recommends action on:

- Building codes for new buildings.
- Passive energy houses and zero-energy buildings.
- Policy packages to promote energy efficiency in existing buildings.
- Building certification schemes.
- Energy efficiency improvements in glazed areas.

3. *Appliances and equipment* represent one of the fastest growing energy loads in most countries. The IEA recommends action on:

- Mandatory energy performance requirements or labels.
- Low-power modes, including stand-by power, for electronic and networked equipment.
- Televisions and set-top boxes.
- Energy performance test standards and measurement protocols.

Box 2. **IEA energy efficiency recommendations** (continued)

4. Saving energy by adopting efficient *lighting technology* is very cost-effective. The IEA recommends action on:

- Best-practice lighting and the phase-out of incandescent bulbs.
- Ensuring least-cost lighting in non-residential buildings and the phase-out of inefficient fuel-based lighting.

5. About 60% of world oil is consumed in the *transport sector*. To achieve significant savings in this sector, the IEA recommends action on:

- Fuel-efficient tyres.
- Mandatory fuel efficiency standards for light-duty vehicles.
- Fuel economy of heavy-duty vehicles.
- Eco-driving.

6. *In* order to improve energy efficiency in *industry*, action is needed on:

- Collection of high-quality energy efficiency data for industry.
- Energy performance of electric motors.
- Assistance in developing energy management capability.
- Policy packages to promote energy efficiency in small and medium-sized enterprises.

7. *Energy utilities* can play an important role in promoting energy efficiency. Action is needed to promote:

- Utility end-use energy efficiency schemes.

Implementation of IEA energy efficiency recommendations can lead to huge cost-effective energy and CO_2 savings. The IEA estimates that, if implemented globally without delay, the proposed actions could save around 8.2 Gt CO_2/yr by 2030. This is equivalent to one-fifth of global energy-related CO_2 emissions in 2030 under the IEA Reference Scenario, in which no new policies are adopted or implemented. Taken together, these measures set out an ambitious road-map for improving energy efficiency on a global scale.

The IEA published its evaluation of the performance of all member countries, including Poland, in 2009 (available at www.iea.org/w/bookshop/add.aspx?id=368).

PART II
SECTOR ANALYSIS

5. ELECTRICITY, HEATING AND NUCLEAR ENERGY

ELECTRICITY SUPPLY AND DEMAND

DEMAND

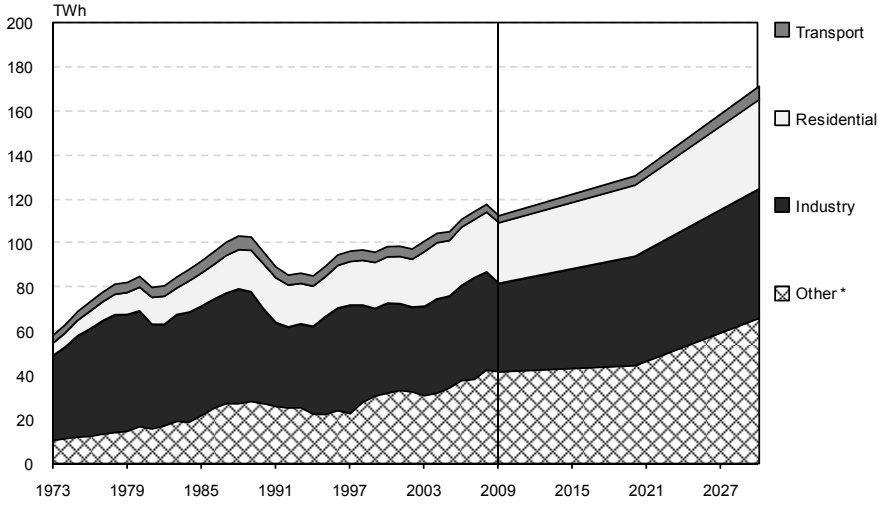
Polish demand for electricity grew since the mid-1990s, closely following economic growth. Between 2000 and 2009, growth averaged 1.5% per year and during this period demand in the services sector, at 3.1% per year, grew the most rapidly. Services today represent well over a third of Poland's electricity demand.

Demand for electricity in households also grew relatively fast along with rising personal incomes, which allow consumers to purchase more electric appliances. At the same time, Polish consumers were able to purchase more efficient goods, which tempered growth in overall demand. Household electricity demand grew at an average annual rate of 3% since 2000 and by 2009 it accounted for less than a quarter of total electricity demand.

Industrial electricity demand grew at a modest rate of 1.1% per year between 2000 and 2008, as a result of the shift from heavy industry to services and the introduction of more efficient processes. It decreased by 10% in 2009 following the economic crisis. Electricity has substituted for coal and oil to a large extent; consequently, its share in industrial energy demand grew from 16% in 2000 to 18% by 2009.

Per-capita electricity demand was around 3 733 kWh in 2008, substantially lower than the OECD Europe average of 6 287 kWh.

Figure 16. **Electricity consumption by sector, 1973 to 2030**



* *Other* includes commercial, public service, agricultural, fishing and other non-specified sectors.

Note: This graph shows historical data until 2009 and the government's projections from 2010 to 2030.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010 and country submission.

Electricity demand is higher in winter and lower in spring/summer. The maximum peak demand reached 25 120 MW in January 2008 and 24 593 MW in 2009. The lowest demand of 10 703 MW occurred on 17 August 2008.

SUPPLY

In 2009, Polish electricity generation reached 151 TWh. Since 2000, it grew only modestly, at about 0.6% per year, less than half the rate in demand for electricity. The country increased its electricity imports, which nearly tripled between 2000 and 2009, although Poland remains a net electricity exporter. Further, Poland was able to reduce network losses from 10% to 8% at the same time, although this rate remains higher than the 6% across the OECD. Electricity consumption at power plants was also reduced, both in absolute terms and as a share of total electricity generation. That share remains, however, extremely high. At around 15%, it is twice as high as the OECD average.

Total installed capacity was 35.6 GW in 2009, of which 31.6 GW is coal-fired (see Annex C for a detailed list of coal-fired power plants). The remaining capacity was split between hydropower (2.3 GW), gas (0.9 GW), biomass (0.6 GW), oil (0.5 GW) and wind (0.4 GW) (Table 2). Coal-fired power plants produce around 10 GW of electricity and heat at the same time. Poland is one of few countries in the world to make such extensive use of combined heat and power (CHP).

Table 2. **Available electricity generating capacity, 2008 and 2009**

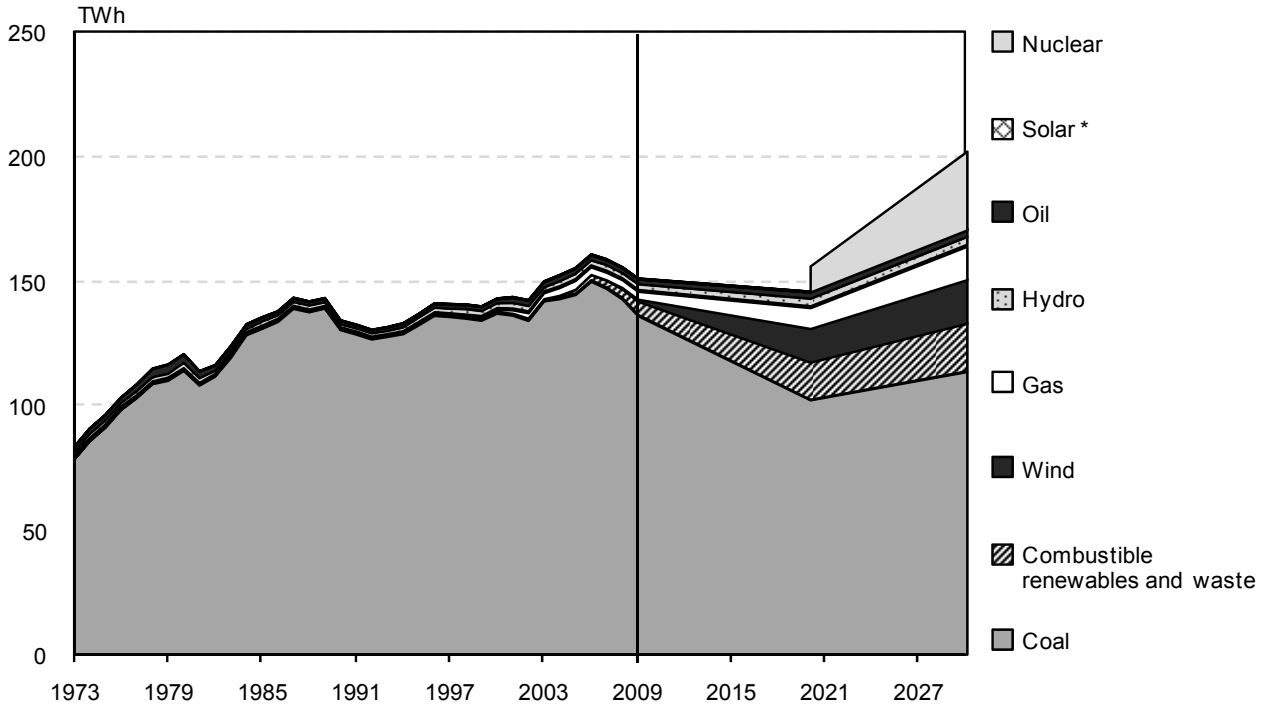
Specification	December		Dynamics index (in %)
	2008	2009	
	(in MW)		
Public plants *	33 022.8	33 075.2	100.2
hard coal	20 828.8	20 920.6	100.4
lignite	9 053.0	9 013.0	99.6
gas	874.3	874.3	100.0
hydro:	2 260.5	2 261.0	100.0
pumped storage **	1 406.0	1 406.0	100.0
river power station	854.5	855.0	100.1
Electricity self-producers	1 644.5	1 691.8	102.9
hard coal	1 551.3	1 573.3	101.4
gas	60.5	83.9	138.6
biogas	1.2	1.2	100.0
biomass	31.5	33.4	106.0
hydro	0.0	0.0	0.0
Remaining, independent power plants	678.8	870.9	128.3
hydro	78.3	80.9	103.4
wind	544.2	720.4	132.4
biogas	45.6	54.6	119.9
biomass	10.6	14.8	139.9
Total	35 346.0	35 637.8	100.8

* Public power plants and independent thermal plants.

** Pumped storage power stations include the following facilities: Żar, Żarnowiec, Żydowo.

Source: Energy Market Agency.

Figure 17. **Electricity generation by source, 1973 to 2030**



* Negligible.

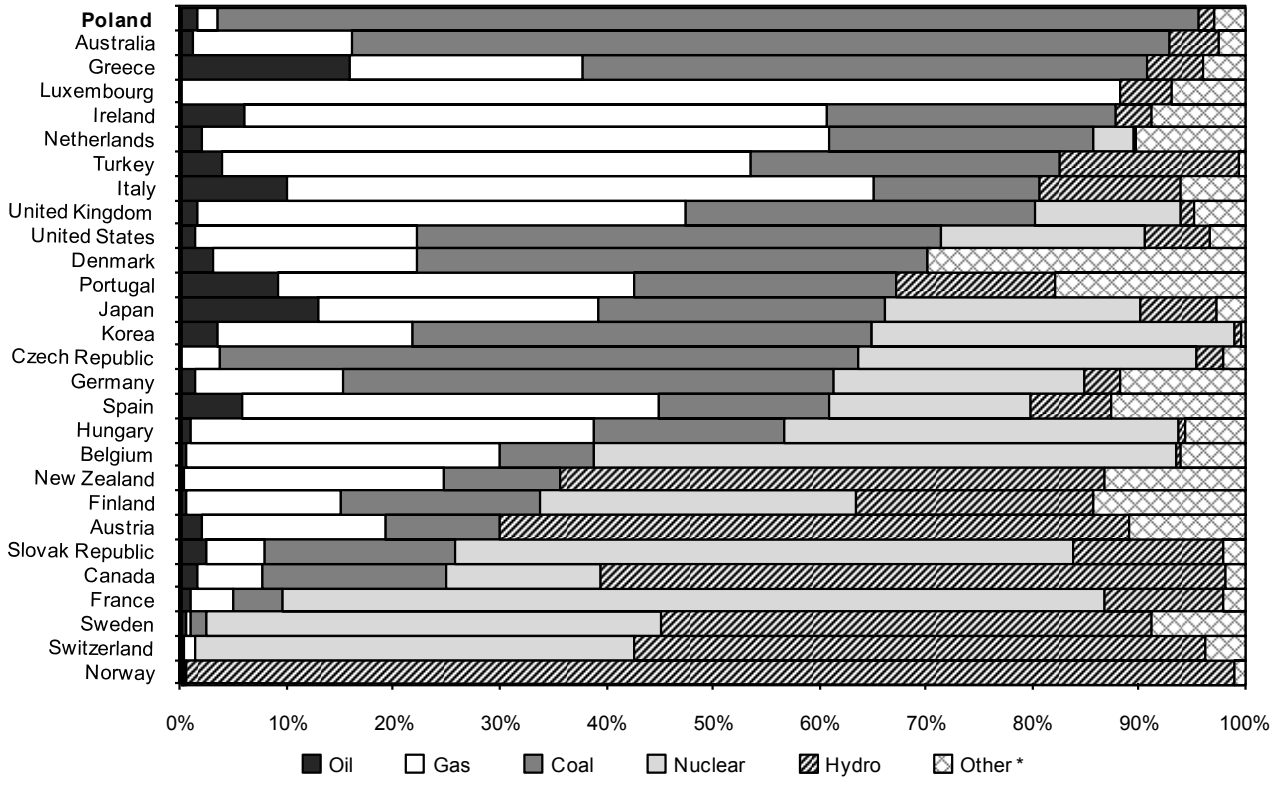
Note: This graph shows historical data until 2009 and government projections from 2010 to 2030.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010 and country submission.

Poland's electricity generation is dominated by coal: 90% of electricity came from coal-fired power plants in 2009. Gas-fired generation accounts for 2% and grew substantially over the past decade, to reach just over 3 TWh in 2009. A relatively rapid increase in biomass use occurred in recent years, with generation reaching 5.5 TWh in 2009. The use of hydropower remains marginal as the potential is limited. Wind power is just beginning to make inroads into Poland's electricity generation with a share of just 0.7% in 2009 but there is potential for further development. Oil-fired generation has been falling slowly but steadily since 2004, in response to higher oil prices.

The government projects a decline in the share of coal because of the introduction of nuclear power and the growing share of renewables (Figure 17). The decline of coal's share has already started at a slow pace. In 1990, 97% of electricity generation was coal-based. This share fell to 96% in 2000 and to 90% in 2009. Progress has been made in recent years to reduce dependence on coal reflecting efforts to comply with the European Union's Emissions Trading Scheme (EU-ETS) and the EU-wide renewable energy target. Chapter 6 and Annex C provide more information on coal-fired power plants.

Figure 18. **Electricity generation by source in IEA member countries, 2008**



* Other includes geothermal, solar, wind, and ambient heat production.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009.

Power plant efficiency

Power plant rehabilitation and boiler retrofits carried out over the last twenty years have considerably improved the efficiency and environmental performance of the power plants (see the list of coal-fired plants in Annex C). In 2007, the average efficiency of Poland's coal-fired power plants, including CHP plants, was 41%.[25] This figure is higher than the average efficiency of 37% achieved across OECD countries. The reason for this commendably high power plant efficiency is the wide use of combined heat and power.[26] The average age of coal-fired plants in Poland is 30 years (on a capacity-weighted basis) and suggests that further efficiency improvements could be made by renewing the oldest plants. However, if this means replacing small CHP plants with larger electricity-only plants, then overall energy efficiency may fall.

25. On a lower fuel heating value, gross electrical output basis. The calculation used follows the methodology of EU Directive 2004/8/EC on the promotion of co-generation based on a useful heat demand in the internal energy market (*Official Journal of the European Union*, OJ L 52, 21 February 2004, pp. 50-60). Harmonised efficiency reference values for the separate production of electricity and heat were tabulated in Commission Decision 2007/74/EC (OJ L 32, 6 February 2007, pp. 183-188), with further detailed guidance in Commission Decision 2008/952/EC (OJ L 338, 17 December 2008, pp. 55-61).

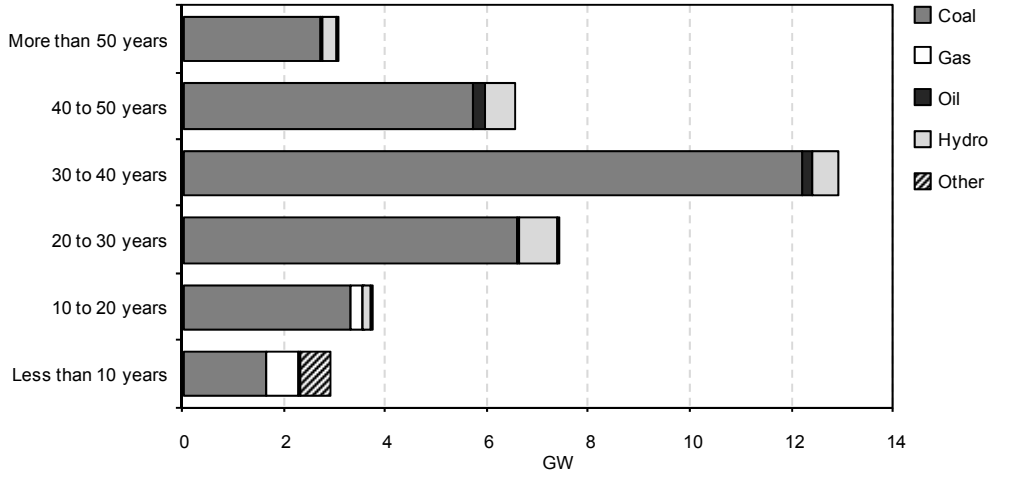
26. It is assumed that all heat supplied is used efficiently in Poland, which may not be the case in practice.

INVESTMENT NEEDS

Nearly half of today's generating capacity is older than 30 years (Figure 19), emphasising the requirement for substantial new investment in the short and medium term to satisfy electricity and heat demand (Figure 19). Electricity networks see similar investment challenges: nearly 80% of 400 kV lines and 99% of 220 kV lines are over 20 years old. Network breakdowns that occurred in 2009 because of extreme weather conditions highlight the need to invest in the grid maintenance and modernisation.

In the IEA Reference Scenario,[27] total investment in Poland's power sector over the period 2010-2030 amounts to EUR 195 billion (PLN 844 billion). Over two-thirds of this amount or EUR 134 billion (PLN 580 billion) is needed to build 92 GW of new capacity. The remaining EUR 61 billion (PLN 264 billion) is needed in distribution (75%) and transmission (25%). Transmission costs include those associated with the integration of wind power into the network. Total power sector investments represent 1.3% of GDP on an annual basis.

Figure 19. **Age distribution of Poland's power plants, 2009**



Primary source: Platts, World Electric Power Plants Database, available at http://www.platts.com, 1st quarter 2010.

Source: Energy and CO_2 Emissions Scenarios of Poland, IEA working paper, Paris, 2010.

In the IEA 450 Scenario, investment in power plants only is around EUR 141 billion (PLN 610 billion) over the period 2010-2030,[28] which is EUR 16 billion higher than in the Reference Scenario because investment is directed towards more capital-intensive technologies. Most of the investment goes into renewables (EUR 116 billion or over 80% of the total). Investment in nuclear power reaches EUR 8 billion (PLN 35 billion or 6% of the total) and carbon capture and storage (CCS) receives investment of EUR 9 billion (PLN 39 billion or 6% of the total). The remaining investment goes mainly into coal- and gas-fired power plants without CCS. The cost of new technologies is generally assumed to fall over time through learning effects, particularly the cost of renewables and to a lesser extent that of CCS.

The high investment needs highlighted by both scenarios will require clear policy frameworks that give appropriate signals to investors.

27. See Chapters 2 and 3 for more details on the IEA scenarios.

28. Excluding investment in photovoltaics in buildings.

POLICY PRIORITIES

The electricity sector faces environmental challenges mainly because of the extensive use of coal and related emissions of GHGs and local pollutants (see Chapters 3 and 6).

To address climate change issues and comply with the EU obligations, the key objective of the government's policy in the electricity sector is to reduce reliance on coal by developing nuclear power (see section on the Nuclear Energy Programme below) and increasing the share of renewables (see Chapter 9). As Figure 17 shows, the government expects that nuclear will provide nearly 16% of power generation in 2030 while the share of hard coal and lignite combined will decline from 90% in 2009 to 57% in 2030. At the same time, Poland takes a leading role in developing CCS. Issues related to CCS are discussed in more detail in Chapter 6 on Coal.

Other policy objectives include:

- enhancing security of electricity supply;
- mitigating the environmental impact of the power industry; and
- developing a competitive electricity market.

The government plans to enhance security of electricity supply through the following measures: *i)* building new generation capacity; *ii)* development and modernisation of the transmission and distribution grids; *iii)* developing cross-border connections, *iv)* efficiency and *v)* smart grids.

NUCLEAR ENERGY PROGRAMME

Poland does not have any nuclear generating capacity at present. However, as set out in the government's *Energy Policy of Poland until 2030* (EPP 2030), a primary aim of Polish energy policy is to diversify electricity generation by the introduction of nuclear power. As of August 2010, the government was projecting the beginning of operation of the first nuclear unit by the end of 2022. This is roughly in line with the IEA Reference Scenario for Poland that projects the first nuclear unit to start operation in 2025.[29]

Beyond this, the government's plan is to have at least 4 500 MW_e of nuclear capacity in operation by 2030. The exact capacity and number of units are likely to depend on the reactor technology chosen, and several options are being considered. According to the government's projections, nuclear will provide about 7% of electricity by 2022, rising to 16% in 2030.

To implement its nuclear energy policy, the government has appointed a Commissioner for Nuclear Energy with the status of Under-Secretary of State, who leads the Department of Nuclear Energy in the Ministry of Economy. A schedule of activities covering the period up to the first plant entering operation has been prepared. The first part of these activities was also included in *EPP 2030* as part of the Action Plan for the Years 2009-2012. This includes:

- establishing the necessary legal and institutional frameworks;
- preparing the National Atomic Energy Agency to act as nuclear regulator;
- holding public consultations and educational campaigns;

29. IEA, 2010.

- the training of personnel;
- site selection activities;
- planning for radioactive waste management and disposal;
- increasing nuclear research and development activity;
- preparing Polish industry to participate in the nuclear programme;
- planning transmission links;
- prospecting for uranium on Polish territory.

Box 3. **Background to the nuclear programme**

Poland is not a complete newcomer to nuclear power. Construction of four Soviet-designed nuclear units (similar to those built in other Eastern European countries) at Zarnowiec, near Gdynia on the Baltic Sea, was begun in 1984. Opposition to the plant greatly increased after the 1986 Chernobyl accident, and construction was halted in 1990 following the removal of the Communist government. However, Zarnowiec is now a candidate to be the site of a new nuclear unit, although several other sites are also under consideration.

The country also has a nuclear research facility, including a research reactor. This is operated by the Institute of Atomic Energy (also known as Polatom) at Otwock-Świerk, 30 km south-east of Warsaw. There are also nuclear research activities at other institutions and universities throughout the country.

Two other nuclear projects in neighbouring countries could potentially supply part of their output to Poland. However, no definite agreements exist for Polish participation in either of these, and at present it does not appear that they will affect the domestic nuclear programme.

Following the closure of the Soviet-era Ignalina nuclear plant in Lithuania, that country aims to build a new nuclear plant at the nearby Visaginas site, probably in co-operation with neighbouring countries. The most recent plan is for the three Baltic states and Poland to each participate in a plant with a total capacity of up to 3 400 MW_e. However, the export of power to Poland would require the construction of a new transmission link, and Poland has argued that to make this worthwhile it would need to have at least 1 000 MW_e of the Visaginas capacity. To date no agreement has been reached on this.

Meanwhile, Russia has stated that construction activities have begun for a 2 400 MW_e nuclear plant in the Kaliningrad region. Foreign investors and suppliers have been invited to participate in the project, which would clearly rely on export markets. These would include the Baltic states and Belarus, to which Kaliningrad already has transmission links, but also potentially Poland. However, exports to Poland would require a new transmission link.

A package of implementing legislation (including a Nuclear Energy Act) for many of these actions is expected to be presented to Parliament in late 2010, with the aim of it entering into force by June 2011. In particular, this will establish a "Nuclear Energy Agency", under the auspices of the Ministry of Economy, to take the programme forward. New institutions for nuclear regulation and radioactive waste management

will also be created. The ministry is confident of cross-party support for the nuclear programme in Parliament.

In addition, the Ministry of Economy is preparing a more detailed policy statement, the Polish Nuclear Power Programme, a draft of which was published and sent to other ministries for consultation in August 2010. This sets out five phases for the programme:

1. Adoption of the Nuclear Power Programme by the Council of Ministers by the end of 2010, and entry into force of the nuclear legislation by the end of June 2011.
2. Choosing a site for the first nuclear power station and concluding a contract for its construction, by the end of 2013.
3. Completion of detailed design and preparatory work, by the end of 2015.
4. From 2016, issuing of a construction licence and the start of on-site construction work. The first unit should be completed by the end of 2022.
5. Entry into operation of follow-on units after 2023. At least two further units are expected by 2030.

The government is planning a public information campaign to explain its proposed nuclear programme, and will also hold a special debate on nuclear issues.

Poland is thought to be interested in nuclear technology from France, Japan, Korea and the United States, and has signed or is negotiating co-operation agreements with these countries. The final choice of technology will be made by the consortium building the plant, but the government has specified a Generation III or III+ design that is already certified for construction in the EU. It has also sought advice from the International Atomic Energy Agency, requesting that the IAEA organise an International Nuclear Infrastructure Review (INIR) mission. A preliminary IAEA review visit took place in April 2010. Poland has also applied for membership of the OECD Nuclear Energy Agency (NEA).

The government has designated PGE, the country's largest utility, as the lead investor in the proposed nuclear power plants. For its part, PGE SA has stated that it plans two nuclear plants, each with a capacity of around 3 000 MW_e. It is currently envisaged that PGE will own at least 51% of the nuclear plants, with one or more other partners (expected to be foreign utilities) taking the remaining share.

INDUSTRY STRUCTURE AND REGULATORY FRAMEWORK

MARKET STRUCTURE

The Polish electricity market has been gradually opened to competition since 1998 and was fully opened on 1 July 2007, in accordance with EU directives. All customers are now eligible to choose their supplier. Poland has adopted all EU regulations regarding market liberalisation and security of supply relatively quickly, compared to some other countries that started market transformation earlier. Liberalisation is an ongoing process and is expected to continue in Poland.

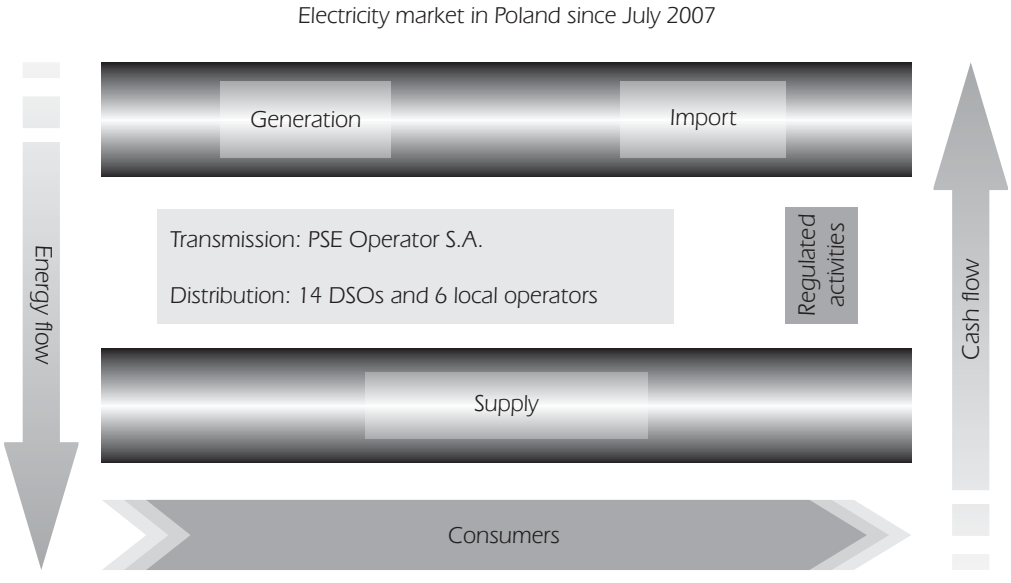
Until 2007, electricity generation was carried out by the state-owned Polskie Sieci Energetyczne SA (PSE) and by a number of independent power producers partly owned by private firms. The independents sold their electricity to PSE under long-term contracts. This practice was halted in 2008 as part of the liberalisation of the Polish

power market and the unbundling of the PSE. There is a system of compensation for power generators that cancelled long-term power purchasing agreements (PPAs). However, the elimination of long-term contracts has not yet brought all the expected consequences in terms of greater wholesale competition and market liquidity (see section on Wholesale Market).

The current structure of the electricity market is shown on Figure 20. There are more than 100 companies with a licence to generate power and about 310 companies with a licence to supply power to end-users, although many of them are not active. The regulated activities – transmission and distribution – have been legally unbundled from the competitive segments of the market – generation and trade/supply to end-users. Poland's transmission grid is operated and owned by PSE Operator S.A., a joint stock company wholly owned by the State and supervised by the Ministry of Economy. Poland has fourteen distribution system operators (DSOs) that have been legally unbundled from former distribution companies, as well as six so-called local distribution operators that were not subject to unbundling.

The four key players – Polska Grupa Energetyczna (PGE), Tauron Polska Energia, Energa and Enea – were created in 2007 in the process of the sector's restructuring and consolidation in line with the government's "Programme for the Power Sector" adopted in 2006. They are vertically integrated groups with generation, distribution and supply branches.

Figure 20. **Electricity market structure since 2007**



Source: Country submission.

These groups and two foreign companies (Vattenfall and RWE) own Poland's distribution system operators in six distinct geographical regions (Figure 21). As the majority of DSOs operate within vertically integrated groups which own generation and supply entities, the process of achieving real and complete independence has been slow, even though formal and legal requirements for DSOs' independence have been met. The supply branch of each group sells most of its electricity to the customers connected to the distribution networks of this group. However, the Energy Regulatory Office (ERO)

highlights significant progress achieved by the DSOs in 2009 in ensuring equal treatment for all users of the systems and in providing indiscriminating third-party access to their distribution networks. Competition beyond the borders of each DSO's zone is growing steadily, although at a slow pace because of very similar offers by potential competitors.

The ERO grants and revokes licences and approves transmission and distribution tariffs as well as retail tariffs for households, among other competences (see Chapter 2 for more detail on ERO).

Figure 21. **Distribution system operators' zones**

The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

Source: Country submission.

WHOLESALE MARKET

The generation and wholesale segments of the electricity market are rather concentrated. Three leading generators – PGE, Tauron and Enea – had more than half of installed capacity and accounted for 55% of power generation and for more than 75% of the wholesale market turnover in 2009. PGE alone accounted for over 36% of generation and nearly half of the turnover on the wholesale market.

In 2009, over 90% of all electricity generated in Poland was sold by generators to trading companies on the basis of bilateral contracts. Moreover, over 58% of total wholesale trade took place within vertically integrated groups. The dominance of bilateral contracts and concentration of trade within capital groups result in low liquidity in the wholesale market and lack of transparency in setting prices.

The remaining electricity is sold at the balancing market (9.1 TWh or 6.6% of generation) and to a smaller extent on the spot markets (Power Exchange or Internet Platform for Power Trade). Trade volume on the Polish Power Exchange (TGE SA) amounted to 3 TWh or only 2% of electricity consumption in 2009. Nevertheless, this represented a 45% increase in comparison to 2008. Another 4.36 TWh, *i.e.* 2.93% of national electricity consumption, was traded on the Internet Platform for Power Trade (IPPT) – an organised electricity trade market run by a market participant.

Since August 2010, all generators have a legal requirement to sell 15% of electricity at the Power Exchange, through tenders, contracts with final customers or on trade platforms operating on transparent and non-discriminatory rules. This measure is expected to increase liquidity in the wholesale market.

RETAIL MARKET

The demand side of the Polish retail electricity market consists of about 16 million end-users, over 85% of which are households. The volume of sales to households represents, on aggregate, about 24% of total electricity sales.

There are 310 entities which hold electricity sales licences. Twenty suppliers have capital links with DSOs. In 2009, the biggest share in electricity sales was achieved by the 14 incumbent suppliers, established on the basis of former distribution system operators. Incumbent suppliers are default suppliers for those household consumers who did not decide to switch to a new supplier. Table 3 shows the shares of electricity sales of five leading suppliers.

Table 3. **Structure of sales of major suppliers, end 2009**

Suppliers	Share in sales to final consumers (in %)		
	≥ 2 GWh	50 MWh - 2 GWh	≤ 50 MWh
ENERGA - Obrót SA	9.2	20.2	18.3
ENEA SA	12.5	18.1	12.4
ENION Energia Sp. z o.o.	11.9	9.9	14.2
EnergiaPro Gigawat Sp. z o.o.	10.7	11.1	9.7
RWE Polska SA	5.3	8.6	5.0
Vattenfall Sales Poland SA	4.9	5.9	6.5

Source: Energy Regulatory Office.

Since the opening of the market to non-residential customers in 2004 and to all customers in 2007, the number of consumers switching suppliers has grown but still remains quite low. Over 1 060 residential customers changed suppliers in 2009 compared to 905 in 2008 and 541 in 2007. The share of non-residential customers switching suppliers (measured by energy consumption) was higher than in the residential sector (Table 4). The number of businesses changing suppliers surged in 2009, compared to the previous years, driven by the economic crisis that pushed companies to look for better offers.

The administrative procedure for supplier switching was simplified and shortened in 2008. Despite this improvement, other barriers still remain. The insufficient number of competitive offers is the key reason behind low consumer interest. In the residential sector, this is explained to a large extent by the fact that tariffs for households are regulated and set at similar levels for different suppliers. According to the regulator, other barriers to switching include "time-consuming process of signing distribution service agreements and unfair modifications in the terms of service provision once the consumer has exercised the right to switch supplier." Moreover, the lack of knowledge about switching opportunities and procedures, especially among households, is another factor that hampers competition. A strong and independent regulator can significantly facilitate competition (see Chapter 2 for the description of the Energy Regulatory Office, ERO) The ERO has initiated educational campaigns, placing information on its website and launching an information centre dedicated to switching.

Table 4. **Share of consumers switching supplier, 2006 to 2009**

Year	Share of consumers who switched supplier, by energy consumption (%)			Number of renegotiated agreements*
	Large industrial consumers	Medium-sized industrial and commercial consumers	Small businesses and households	
2006	15.84	0.012	0	47
2007	16.95	0.128	0.001	44
2008	15.95	0.309	0.005	No data
2009	22.39	1.150	0.03	No data

* A renegotiated agreement is the modification of the terms of agreement with the previous supplier.

Source: Energy Regulatory Office.

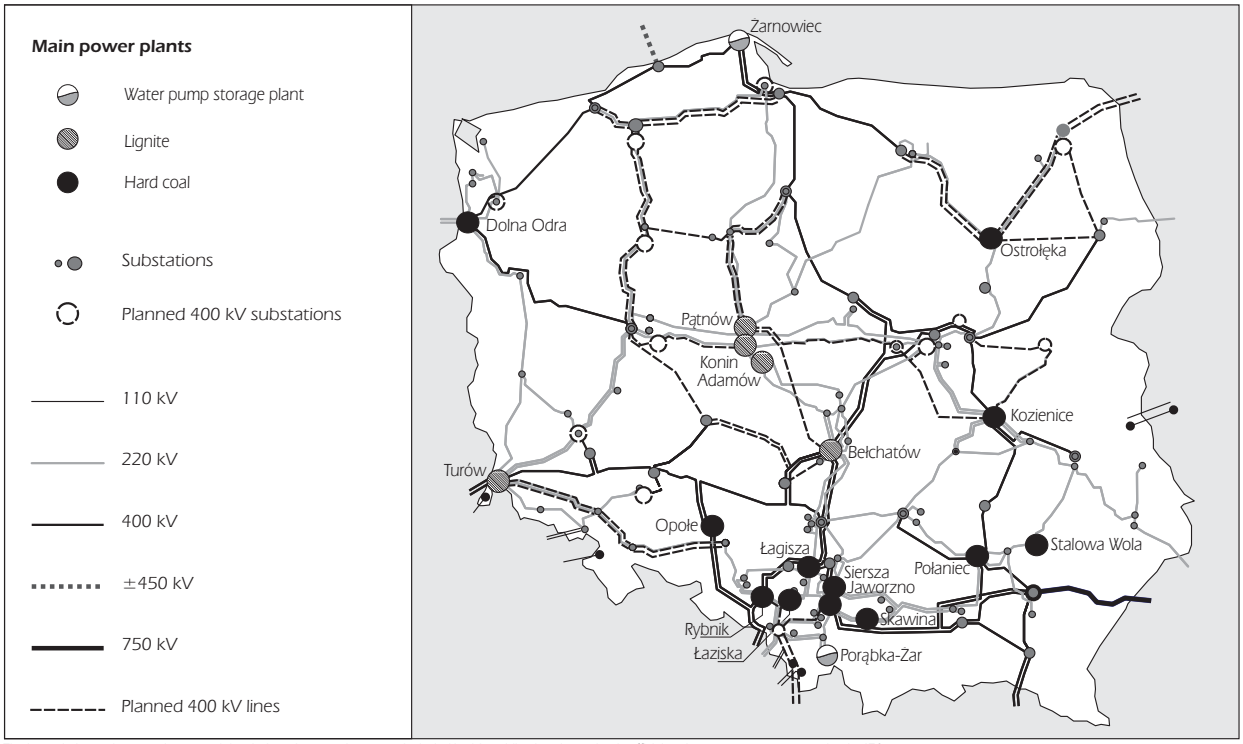
ELECTRICITY NETWORKS

Poland's electricity grid consists of 45 700 km of high-voltage lines, 300 500 km of medium-voltage lines and 423 900 km of low-voltage lines (Figure 22). As already mentioned, the transmission and distribution infrastructure is ageing and requires modernisation. The distribution grids in rural areas are particularly old and have relatively high losses. Overall transmission and distribution losses are about 9% of supply, which is approximately one-third more than the average in OECD Europe.

There is a lack of distribution capacity mainly in the north. Construction of new transmission and distribution lines has been limited. This hampers the development of new electricity sources, particularly renewables. In the north of Poland, applications for connecting renewables-based installations to the grid by far exceed the available capacity. Failure to address this issue will reduce investment in low-carbon generation and slow progress towards the government's renewable target.

The transmission system operator, PSE, is responsible for the maintenance and development of the transmission infrastructure and cross-border interconnections, as well as for the operational safety of the grid. Distribution system operators are responsible for maintaining and developing the distributions grids. Both system operators are required by law to prepare development plans (for 15 years for the TSO and three years for the DSOs). In these plans they have to specify the preferred locations of new generation capacities as well as the costs of their connection. The TSO and DSOs co-ordinate the development of the transmission grid and the distribution networks.

Figure 22. **Electricity infrastructure**



The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

Source: IEA.

INTERCONNECTIONS AND TRADE

The Polish transmission grid is connected with Sweden, Germany, the Czech Republic, the Slovak Republic, Ukraine and Belarus; connections to the last two countries are not in operation. Construction of a 400 kV line to Lithuania, a new line to Germany and network reinforcements at the connection points with the Czech and Slovak Republics have been planned to expand capacity. The planned electricity bridge between Poland and Lithuania is to be an important element of the so-called Baltic Ring, comprising electricity systems of the surrounding Baltic countries. It was deemed a priority project under trans-European energy networks (TEN-E). The implementation of this project will improve the energy security not only of Poland and Lithuania, but of the whole region. Poland has ensured funding for the development of grid and cross-border connections from the EU (operational programme "Infrastructure and Environment"). However, significant additional investment will be needed for Poland in order to realise the envisaged targets of allowing to exchange at least 15% of electricity used in Poland by 2015, 20% by 2020, and 25% by 2030, targets which were set in *EPP 2030.*

Because of limited capacity at the interconnections with neighbouring countries, cross-border trade is relatively small. Moreover, loop flows of wind-generated electricity from the north of Germany increasingly pose problems for the Polish grid. Availability of export and import transmission capacity is administered by PSE Operator SA by means of annual, monthly and daily auctions. No transmission capacity was offered for the annual auction. This was due to significant transmission reliability margin (TRM) resulting from, *inter alia*, substantial loop flows from Germany. There are no specific regulations on managing loop flows across border.

SYSTEM FLEXIBILITY

Enhancing the overall flexibility of the power systems will be necessary, particularly if taking into account the planned construction of nuclear capacity and the growing share of intermittent renewable energy sources. Issues related to the connection of renewable energy sources to the grid are discussed in Chapter 9. Demand-side management (DSM) is a cost-effective way of reducing peak loads (see Chapter 4 on Energy Efficiency for a more detailed discussion of DSM). Smart meters and smart grids can play an important role in demand-side management and enhancing overall system flexibility. The Energy Regulatory Office actively promotes smart metering to provide consumers with the information on their current energy consumption in almost real time. Flexible generation assets (such as gas-fired power plants) and electricity storage technologies such as hydro pumped storage or compressed air energy storage (CAES) are other important tools for consideration along with strengthened interconnections to neighbouring countries. The current and potential role of natural gas for power generation is discussed in Chapter 7.

PRIVATISATION

The Ministry of Treasury is responsible for the privatisation of state-owned assets, including energy-sector companies. Several privatisation transactions took place in the 1990s and early 2000s. In 2006, Poland suspended privatisations in the electricity sector and created four so called “national champions” – vertically integrated PGE, Tauron, Enea and Energa. Enea has been listed on the Warsaw Stock Exchange (WSE) since November 2008, PGE Group since November 2009, and the Tauron Group since June 2010.

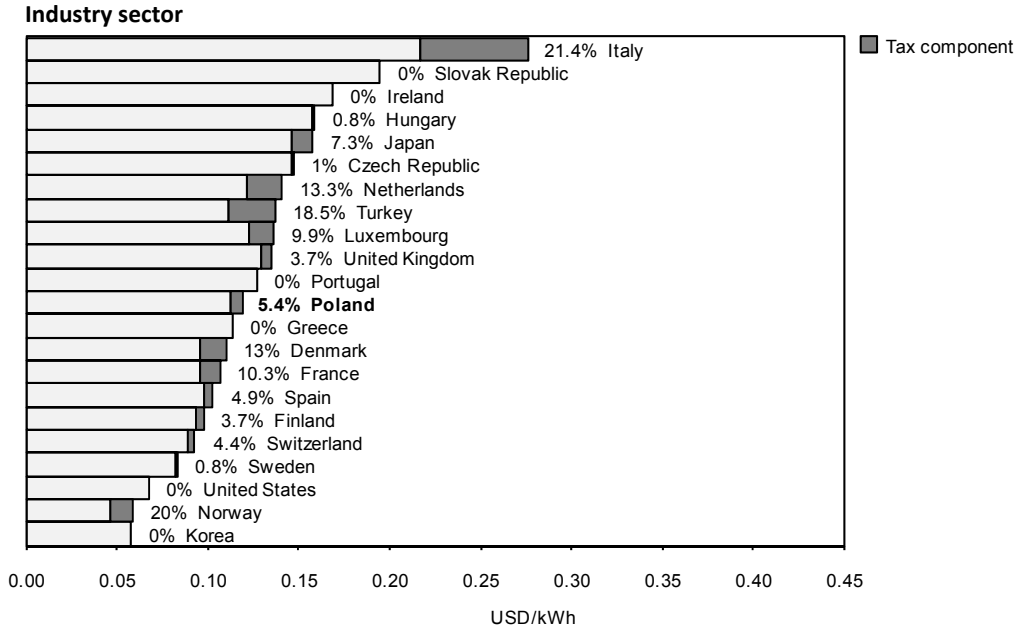
In July 2009 the government outlined an accelerated privatisation programme in the power sector in order to raise additional revenue for the state budget in the context of growing budget deficit. The government plans to maintain the controlling share in PGE and privatise – fully or partially – most other electricity sector companies in 2010-2011. In October 2010, the Ministry of Treasury held directly 85% of the PGE Group’s shares, 36.17% of the Tauron’s shares, 60,43% shares in Enea and 85.45% of shares in Energa, and the privatisation process was expected to continue.

In September 2010, the Ministry of Treasury agreed to sell an 84.19% stake in Energa to PGE for PLN 7.53 billion (EUR 1.74 billion). To make this transaction possible, Poland's government consequently amended its *EPP 2030*. The government argues that the merger is necessary in order to create a company large enough to be able to handle the financing and technological challenges of building nuclear power plants in Poland. It also argues that the total value of the two companies will not change. As of late October 2010, the merger was subject to approval by the Polish Office of Competition and Consumer Protection (UOKiK).

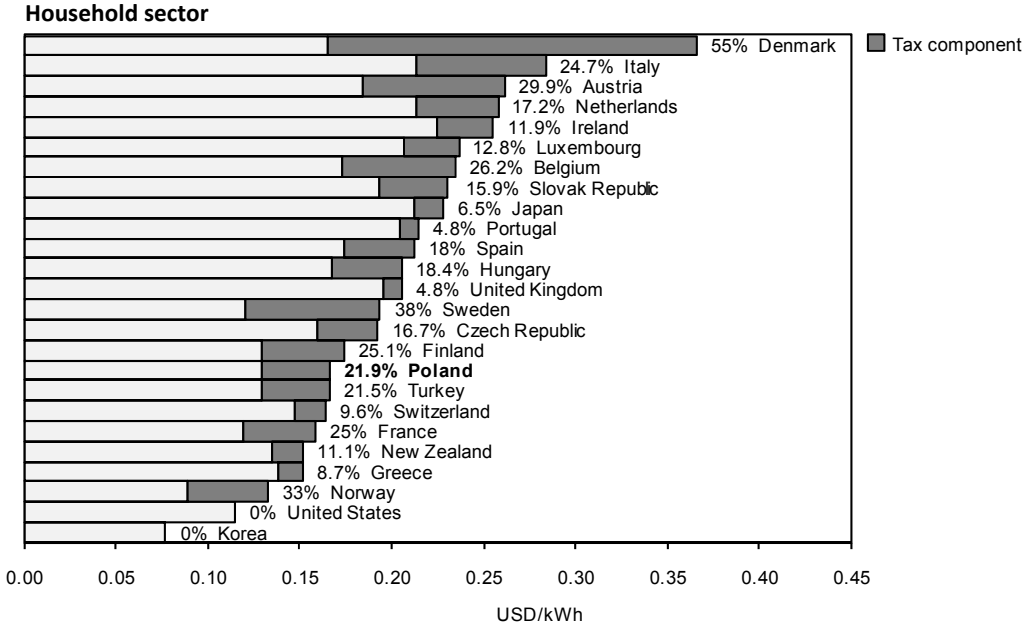
ELECTRICITY PRICING

Electricity prices for end-users are not regulated except for tariffs for households (and other very small users such as farmers) that are still subject to approval by the Energy Regulatory Office. Figure 23 shows Polish electricity prices for industry and households compared to other IEA countries.

Figure 23. **Electricity prices in IEA member countries, 2009**



Note: Tax information not available for Korea and the United States. Data not available for Australia, Austria, Belgium, Canada, Germany and New Zealand.



Note: Tax information not available for Korea, the United States. Data not available for Australia, Canada and Germany.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2010.

DISTRICT HEATING

Because of Poland's relatively cold climate, a large share of total energy is used for heating. According to the latest survey conducted in 2002, heating and hot water account for the majority of households' energy use (71% and 15% respectively). An important characteristic of Poland is the significance of district heating, similarly to most other

countries of the former Socialist block. Poland has 19 000 km of district heating grids which are owned by over 460 licensed enterprises. Installed heat generation capacity was over 60 000 MW_{th} in 2008.[30] According to a survey conducted in 2002, 40% of households are heated by district heating, 21% by furnaces, 36% by individual heating systems and 3% by other sources.[31] According to experts' more recent estimates, district heating provides 50% to 60% of residential heat, and up to between 75% and 80% in urban areas.[32]

Because of the local nature of district heating, there is no common district heating market in the whole country. There are large differences between local district heating markets in terms of infrastructure ownership and operation, number of connected clients and their density, availability of various heat sources, competitive pressure from other heat options (such as individual gas boilers) and other factors. In most cases, district heating enterprises are vertically integrated and have licences for different activities – heat generation, transmission and/or supply. Coal is the main fuel used for heat generation (76% in 2008) although its share has been gradually declining over the last years while the share of biomass has been growing.

The Energy Regulatory Office (ERO) has nine regional offices whose main responsibilities include issuing licences for heat generation, transmission, distribution and trade, and regulating district heating tariffs. The ERO approves district heating tariffs according to the "cost-plus" methodology whereby the tariff covers all justified costs. This system does not necessarily provide incentives for heating companies to reduce costs and improve efficiency. The *EPP 2030* stipulates reforming heat tariff regulation to make it more market-based.

Local communities are required by law to develop local energy plans that would identify least-cost options of providing energy services to households, including heat, electricity and gas supply (see Chapter 4 on Energy Efficiency). They are required to pay special attention to co-generation and utilisation of waste heat. This obligation has not been properly enforced, and only a small number of municipalities have developed such plans.

Poland has taken many steps to modernise its district heating systems. This includes installation of heat meters in individual buildings and improvements in customer services. However, many challenges remain. CO_2 emissions from the heating sector are high because of the predominant use of coal. In many municipalities, heat distribution networks are still of poor quality and heat losses are high. The government plans to achieve emissions reductions in the district heating sector through a wider use of combined heat and power generation (CHP, or co-generation).

COMBINED HEAT AND POWER

Combined heat and power (CHP) is relatively well developed in Poland. More than 15% of total electricity and over 60% of heat comes from co-generation.[33] According to the government and industry, there is economic potential for further increasing the use of CHP in Poland. Inefficient heat-only boilers that provide over a third of heat in district heating systems in many cases can be economically replaced by more efficient modern co-generation systems.

30. Licences are not required for installations with total capacity below 5 MW.

31. Central Statistical Office of Poland, 2003.

32. See, for example, Choromanski, P., *Current State of Heating and Cooling Market in Poland,* 2009, RES-H Policy.

33. According to the energy regulator, industry experts estimate the share of co-generated heat at between 55% and 65%.

Poland supports co-generation in accordance with the EU Directive on CHP. There is a legal obligation for energy suppliers to ensure that a certain share of electricity sales comes from co-generation (at least 13.7% in 2005 and 16% in 2010). Suppliers must either submit the requested amount of certificates of CHP origin (so called "red/brown certificates") to the Energy Regulatory Office, or pay a substitution fee. They can either obtain the certificates of origin by generating their own CHP or buy them on the tradable certificates market. The system is similar to the tradable "green certificates" system for renewable energy, discussed in Chapter 9. In addition, heat suppliers have an obligation to purchase heat from CHP in the amount not exceeding the demand of consumers connected to the network. The existing mechanisms have proven not very effective and have not stimulated significant investments in new co-generation. From 2009, the ERO is obliged to publish information on costs of heat produced by CHP and heat-only boilers. This is expected to create additional incentives for wider use of CHP, which provides heat at lower cost.

Energy Policy of Poland until 2030 stipulates a doubling of electricity produced from highly efficient co-generation by 2020. To implement this ambitious target, the government has adopted a Programme for the Development of Co-generation in Poland to 2030. This programme aims at identifying the CHP potential and developing new mechanisms for CHP support.

CRITIQUE

ELECTRICITY

Poland has made considerable progress towards a liberalised electricity market in recent years. It has adopted all EU regulations relating to the electricity market and security of energy supply. However, liberalisation is an ongoing process and, as is the case in other countries, there is more to be done before a fully functioning competitive market emerges.

The generation and wholesale sector remains highly concentrated. Most generated electricity (90%) is sold through bilateral contracts and the share of electricity traded on the spot markets is still very low, despite strong growth observed in 2009. The dominance of bilateral contracts and concentration of trade within capital groups results in low liquidity in the wholesale market and the lack of transparency in setting prices. Yet an open and well-functioning wholesale market is the key prerequisite for a truly competitive electricity market. The new regulation requiring generators to offer 15% of their electricity on the Power Exchange or on the regulated market is expected to enhance wholesale competition. However, a greater effort will be required to eliminate the barriers to real wholesale competition.

Poland is to be praised for having implemented ownership unbundling of the transmission system operator (TSO). The transmission grid is owned and operated by PSE Operator, a joint stock company owned by the State. However, Poland's distribution system operators (DSOs), although legally separate, are still part of four vertically integrated groups that have both generation and supply activities and account for 83% of electricity sales. The DSOs have made considerable progress in ensuring third-party access to their networks. However, the existing ownership structure can limit DSOs' complete independence because of the potential conflict of interests with their capital groups' objectives. Therefore, continuous monitoring of the market is necessary to ensure equal treatment for all market players.

Although the Polish electricity market was fully opened to retail competition on 1 July 2007 in accordance with EU directives, the majority of consumers have not switched suppliers. The major reason for this is the lack of attractive alternative offers available to consumers, especially in the residential market, which is explained to some extent by the regulated tariffs set at similar levels. This may be partly improved by increasing liquidity in the wholesale market. However, the government and the regulators should act, if necessary, to ensure that all market participants are behaving in a competitive manner. In addition, raising awareness and facilitating access to information about competitive offers encourage consumers to change suppliers. Finally, a strong and independent regulator is a key prerequisite of a competitive market.

The Ministry of Treasury plans to privatise – fully or partially – a number of electricity companies, while retaining controlling shares in PGE. Privatisation in itself does not necessarily increase competition but it can contribute to creating a more competitive environment if it is designed and conducted with this objective in mind. In Poland, however, the privatisation plan does not seem to fully reflect policy priorities outlined in the *EPP 2030*. In particular, companies are being privatised as vertically integrated groups, together with the DSOs among their assets. If the DSOs were ownership unbundled before the privatisation, this could significantly boost competition.

Another area that should receive strategic consideration from the government is the overall efficiency of the electric power system. The power sector infrastructure is ageing and urgently needs investments in modernisation and/or replacement. Improved efficiency can lead to lower costs and lower electricity prices. Transmission and distribution grids should be developed and modernised in order to reduce losses. Higher priority should be given to enhancing the flexibility of the power systems, particularly taking into account the planned construction of nuclear capacity and the growing share of intermittent renewable energy sources. Flexibility can be enhanced through demand-side management, flexible generation assets (such as gas-fired power plants), interconnections and storage. The potential role of natural gas for maximising the efficiency and security of the power system should not be underestimated.

Interconnections are important for an efficient and competitive market, and contribute to security of supply. It is positive that the government specifically focuses on interconnections in the *EPP 2030* and sets a target to exchange at least 25% of electricity with other countries by 2030. However, significant additional investment will be needed for Poland if this target is to be achieved.

HEATING

Poland has some of the largest district heating networks in Europe. District heating systems provide a unique opportunity for further development of CHP, as well as for using heat from various sources like industrial heat waste and heat from incinerators.

Only approximately 60% of the heat in district heating comes from CHP. Therefore, there is potential for replacing inefficient heat-only boilers with modern highly efficient co-generation. However, to fully exploit the environmental and energy efficiency benefits of co-generation, the overall system needs to be much more efficient. This is not always the case in Poland. In general, the plants are old and inefficient. Heat distribution networks are also very old and heat losses are high. This not only undermines the overall efficiency of co-generation, but also drives heat prices up and reduces service quality, thus decreasing the attractiveness of district heating for end-users. The government has

already taken measures to modernise the Polish district heating sector, but more could be done to this end. The government's plan to introduce incentive regulation for heat tariffs is particularly encouraging and should be implemented, to promote the more efficient heat supply options.

More generally, the government is encouraged to give higher priority to heating issues on the energy policy agenda, given that heat accounts for an important share of final energy consumption. Taking into account Polish climatic conditions, reliable, affordable and environment-friendly heat supply is a very important factor for people's well-being and the country's economic development.

While district heating with highly efficient co-generation can be the most economic and environment-friendly heating option in urban areas, other options could make more sense in areas with low population density. The existing requirement for municipalities to prepare local energy plans could be a viable approach to ensuring the optimum heating option, adjusted to specific local conditions.

NUCLEAR PROGRAMME

As set out in the *EPP 2030,* a primary aim of energy policy is to diversify electricity generation by the introduction of nuclear power. This will be a welcome diversification of the country's energy sources, increasing security of supply while helping to cut CO_2 emissions.

Overall, the government appears to have a well-organised plan to prepare for a nuclear programme, including establishing institutions and legal frameworks for nuclear regulation and radioactive waste management. Provided sufficient resources and political will are available to support the steps in the Action Plan and beyond, then Poland should be in a position to go ahead with its proposed nuclear programme. However, keeping to the schedule for operation of the first nuclear plant by 2022 will require timely implementation of all the steps set out in the draft nuclear programme. Carrying out all the necessary activities will require considerable resources – financial and human − over the next few years. Particularly important will be capacity building and the education and training of the necessary engineering and technical staff. International collaboration and lessons learned from other countries will be beneficial for a successful implementation of the programme.

The government has designated PGE, the country's largest utility, as the lead investor in the proposed nuclear power plants. PGE will need to apply commercial criteria in making its investment decisions, as will other investors and financial institutions involved. Nuclear power plants are very large investments, and need to operate as baseload generators with electricity prices adequate to achieve a return on investment. It is not clear whether the present wholesale market arrangements will support commercial investment in nuclear power plants.

Maintaining political and public support is a prerequisite for a successful nuclear programme, both nationally and in the localities chosen to host the nuclear plants. The planned public information campaign and debate are to be welcomed, and will be important in maintaining a consensus on the nuclear programme among the main political parties and gaining public acceptance for its implementation.

RECOMMENDATIONS

The government of Poland should:

Electricity

- ☐ *Continue efforts to develop a competitive electricity market.*
- ☐ *Create a transparent, well-functioning and liquid wholesale market.*
- ☐ *Introduce ownership unbundling of distribution system operators.*
- ☐ *Identify and address barriers to retail competition.*
- ☐ *Phase out regulated tariffs for households as competition grows.*
- ☐ *Ensure that privatisation of energy enterprises supports competition in the electricity market.*
- ☐ *Enhance integration with neighbouring countries by increasing interconnection capacity and reducing obstacles to cross-border trade, e.g. loop flows.*

Heating

- ☐ *Give higher priority to heating issues on the national energy policy agenda.*
- ☐ *Continue efforts to encourage the modernisation of heat supply and the uptake of the most efficient options.*
- ☐ *Ensure that the support system for co-generation takes into account the overall efficiency of the district heating and electricity supply to end users.*

Nuclear programme

- ☐ *Proceed in a timely manner with preparatory activities for the nuclear programme, ensuring that adequate financial and human resources are available and that the required legislation is put in place.*
- ☐ *Lead a national debate to enhance public awareness on the role that nuclear energy should play in the country's overall energy strategy.*
- ☐ *In consultation with potential investors, consider the options for financing the proposed nuclear plants and whether the electricity market arrangements will provide sufficient confidence of an adequate return on investment.*

6. COAL

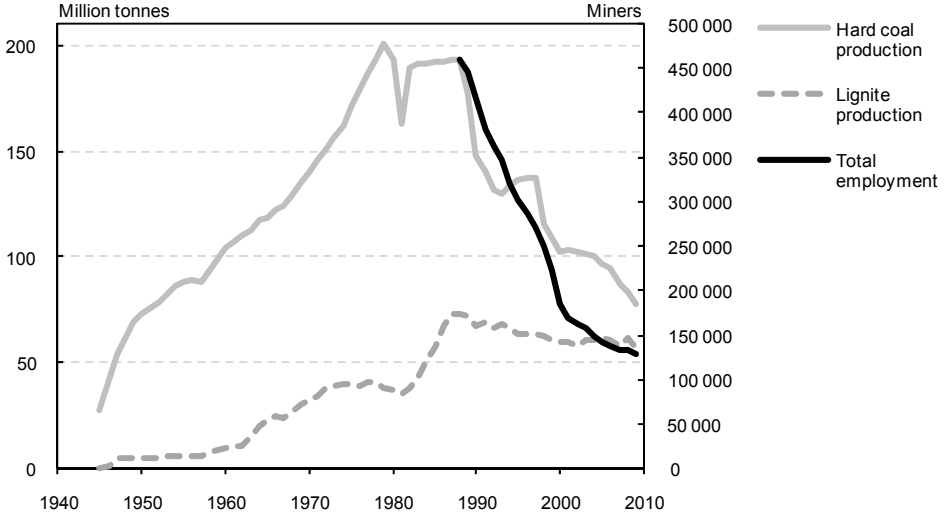
SUPPLY, DEMAND AND TRADE

PRODUCTION

Domestic production meets the majority of hard coal demand and virtually all brown coal demand. Hard coal production has declined significantly since reaching a peak of 201 million tonnes (Mt) in 1979 (Figure 24). Production of 77.4 Mt in 2009 (down from 83.4 million tonnes in 2008) reflects not only the lower demand for coal, but also the often poor economics of mining hard coal in Polish deep mines. However, Poland is still the world's ninth-largest hard coal producer. It accounts for 62% of EU hard coal production (the only other hard coal producers in the EU are the Czech Republic, Germany, Spain, Romania and the United Kingdom).

Since the 1990s, the number and capacity of coal-washing plants in Poland has increased such that most coal is now cleaned to reduce ash and sulphur content before delivery and providing a quality similar to internationally traded coals.

Figure 24. **Hard coal and lignite production and total number employed in the coal-mining industry, 1945 to 2009**



Sources: Hard coal production 1945-1957: NCB (1958); lignite production 1945-1959: Kasztelewicz (2006); production and export data 1960-2009: IEA database (World Coal Statistics.ivt available at http://data.iea.org) and Ministry of Economy; employment data: Piekorz (2004); Mining Annual Review (2000-2007); Kasztelewicz (2006) and Ministry of Economy.

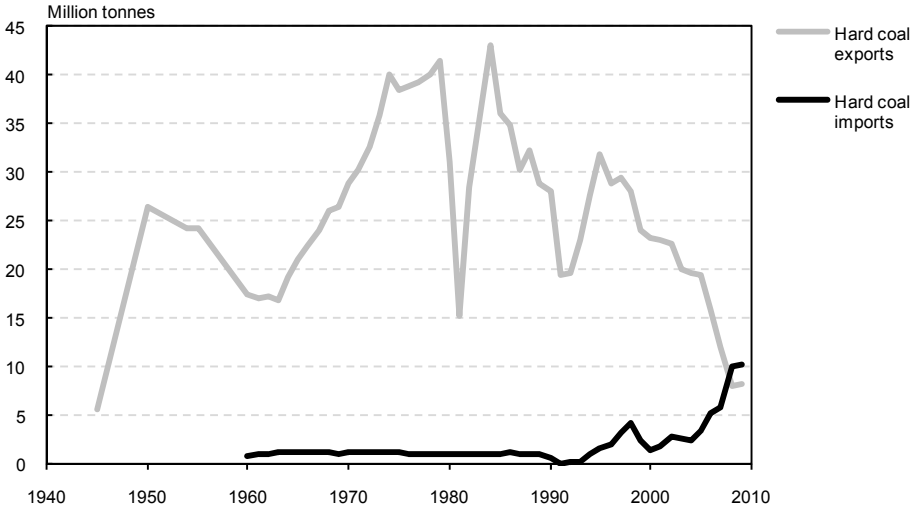
Brown coal (or lignite) production has been relatively stable over the last two decades at around 60 Mt per year. Poland is the third-largest lignite producer in the EU, after Germany and Greece. In 2009, 57.1 Mt of lignite were mined. The 4.3% fall in production since 2008 reflects the impact of the global financial crisis on demand for electricity from Poland's lignite-fired power plants.

IMPORTS AND EXPORTS

In the mid to late 1970s, Poland was exporting around 40 Mt of hard coal each year. Exports briefly peaked again in 1984 at 43 Mt before falling (Figure 25). For many years, coal imports were not significant, at around 1 Mt per year. However, imports have risen markedly since 1995. Between 1999 and 2001, quotas were used to limit imports of steam coal from Russia and the Czech Republic. Although weakly enforced, the quotas provided some protection to domestic coal producers. More recently, imports from Russia, the Czech Republic and Ukraine have grown because they are a competitive alternative to domestic coal supply. Poland also imports small quantities of coal from the United States, Kazakhstan, Columbia, China and South Africa.

In 2007, the Polish government was concerned that domestic coal supply would exceed domestic demand, leading to low prices for producers if the surplus could not be exported. The out-turn has been very different. In 2008, Poland became a net hard coal importer for the first time as coal production was insufficient to meet demand. Imports from Russia have surged and accounted for 70% of total coal imports in 2009.

Figure 25. **Hard coal imports and exports, 1945 to 2009**



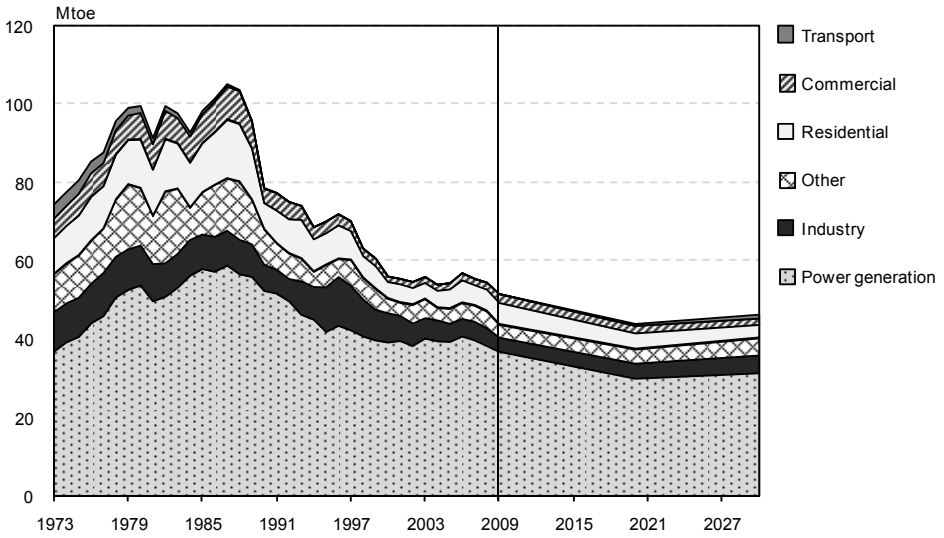
Sources: Hard coal exports 1945-1955: NCB (1958); IEA database (World Coal Statistics available at http://data.iea.org) and Ministry of Economy.

DEMAND

Over 70% of total coal supply (hard coal and lignite) is used for power generation. In the case of lignite, over 99% of production is used in plants supplying electricity and heat. Industry accounts for 8% and the residential sector for 9% of coal use (Figure 26). Among industrial users, the largest are coking works; the iron and steel sector; chemicals and petrochemicals; non-metallic minerals processing; food, tobacco and beverage production; and the agricultural sector.

Annex C lists Poland's larger coal-fired power plants, totalling 30 GW. There are many smaller units, not listed, with an additional total capacity of around 3 GW. Annex C also includes 19.5 GW of coal-fired power plants that are under construction or have been recently proposed, predominantly large units up to 1 000 MW. Not all of these plants will be built, especially given the recent economic downturn and the new EU Emissions Trading Scheme rules that will enter into force in 2013 and provide for full auctioning of CO_2 allowances.

Figure 26. **Coal supply by sector*, 1973 to 2030**



* TPES by consuming sector. *Other* includes other transformation and energy sector consumption. *Industry* includes non-energy use. *Commercial* includes residential, commercial, public services, agriculture/forestry, fishing and other final consumption.

Note: This graph shows historical data until 2009 and the government's projections from 2010 to 2030.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

Energy demand fell sharply during the early 1990s as industrial output slumped, but subsequently recovered in response to a general economic upturn. The country's accession to the European Union in 2004 requires stricter controls on emissions from all large coal-fired plants, and thus will speed the introduction of clean coal technologies over an agreed period – full implementation of the EC Large Combustion Plants Directive (2001/80/EC) being required by 2017, with specific dates agreed for particular installations and pollutants. Privatisation of Poland's steel industry led to major modernisation programmes in that sector, with reduced demand for coking coal.

RESOURCES AND RESERVES

Poland's coal resources are extensive, the largest in Europe, and dwarf the country's conventional oil and gas resources. Hard coal deposits occur in three basins (Figure 27): Upper Silesian coal basin (GZW); Lower Silesian coal basin (DZW) and Lublin coal basin (LZW). Reserves of hard coal are estimated at 12.65 billion tonnes, with a further 164.66 billion tonnes of resources.[34] Estimated lignite reserves total 3.79 billion tonnes, plus 219.65 billion tonnes of resources.[35] On a per-capita basis, Poland's coal reserves are about one-half of those found in the United States, host to the world's largest reserves. In terms of their longevity, Poland's coal reserves could last hundreds of years at current production rates. However, the coal reserves that are economically recoverable at existing mines are substantially less than these figures suggest.

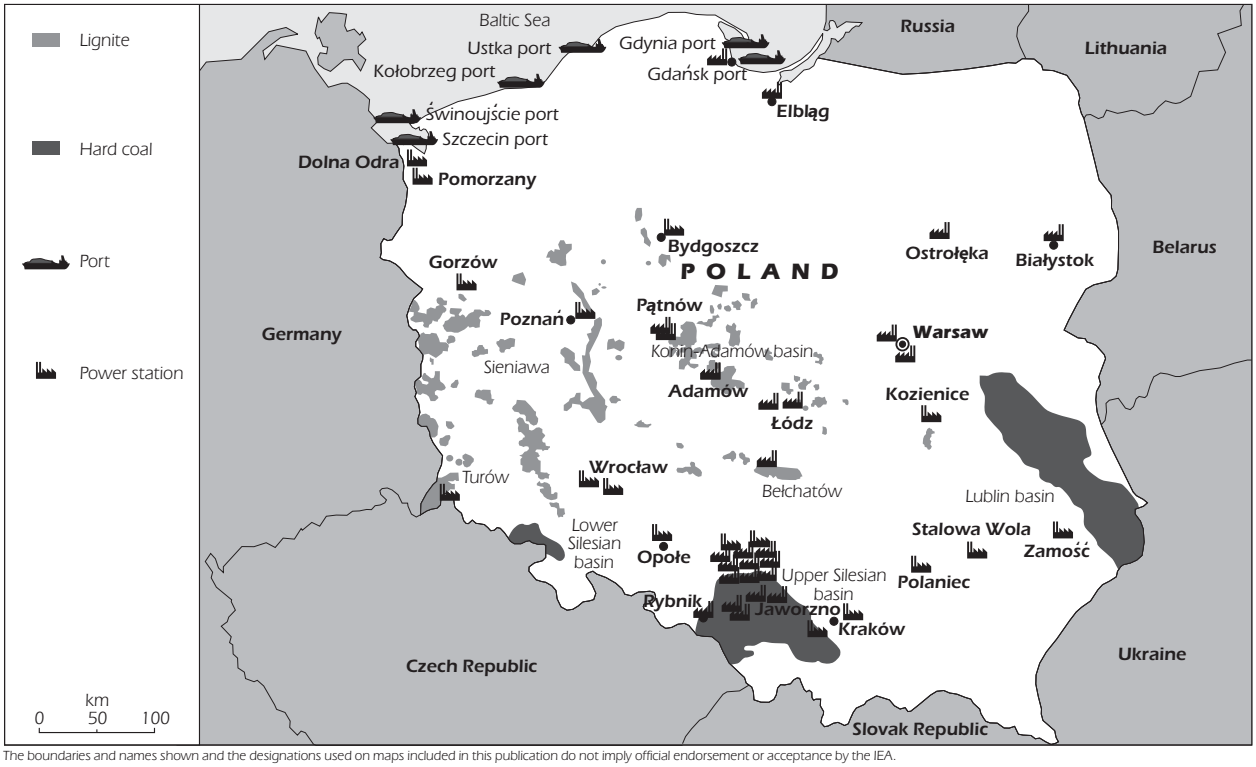
34. Source: BGR, 2009. The Polish Geological Institute reports economic reserves of 43.2 billion tonnes, of which 17.0 billion tonnes are measured, and a further 24.5 billion tonnes of uneconomic reserves (PGI, 2009).

35. Source: *ibid*. The Polish Geological Institute reports lignite resources of 40.15 billion tonnes, comprising the following deposits: Bełchatów (2.44 billion tonnes), Konin (1.05), Legnica (14.43), Łódź (0.77), North-Western (0.94), Radom (0.10), Western (6.12), Wielkopolska (14.23) and other deposits (0.04) (PGI, 2009). The Polish Brown Coal Producers Association reports proven economic lignite reserves of 14 billion tonnes.

At the end of 2008, hard coal reserves at established mines totalled 4.17 billion tonnes, sufficient for about 32 years (Table 5). However, further development at many of these mines would not be economic and hard coal production is likely to fall from 77.4 Mt in 2009 to 40 Mt in 2030 and to less than 30 Mt in 2050, with little prospect of new shafts being sunk except in the Lublin coal basin. On the basis of individual mining plans and the ongoing industry restructuring, hard coal reserves may fall to 2.83 billion tonnes by the end of 2015, according to the Ministry of Economy. Lignite reserves in mining areas currently being worked total 1.53 billion tonnes, but production could fall sharply before 2030. Unless new mines are opened, the remaining reserve life would be around 25 years at current annual production levels of around 60 Mt (Table 6). However, public opposition means that local governments are unwilling to grant planning permissions for new opencast mines, despite the very clear national need for new lignite production if shortages are to be avoided from 2015 onwards.

There is a widely held perception in Poland that indigenous coal offers a secure fuel source for the future. However, reported reserves of economically recoverable hard coal at operating mines and recoverable lignite at deposits being worked suggest that Poland could face coal shortages within the next decade. Prospecting activity now would allow exploitable coal deposits to be more precisely identified. This would avoid future land-use conflicts and encourage industry to create a pipeline of development projects by securing the relevant licences and permits.

Figure 27. **Hard coal and lignite infrastructure**



The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

Sources: Walker (2000), Brown Coal Producers Association (PPWB) and IEA analysis.

INDUSTRY STRUCTURE

Since 1989, when Poland's economic transition began, coal mining productivity has significantly improved, investments have been made to modernise production facilities and excess labour has been addressed. Over 330 000 jobs have been lost during restructuring, and the social implications have been sensitively managed by the government. Today, approximately 115 000 are directly employed in the coal mining sector. Others are employed in the well-developed Polish mining equipment industry.

HARD COAL INDUSTRY

Poland's hard coal industry has gone through major restructuring since the 1990s (Box 4). Today, the hard coal industry, comprising 27 mines, is dominated by the three state-owned enterprises, operating in Upper Silesia: Kompania Węglowa SA, Katowicki Holding Węglowy SA and Jastrzębska Spółka Węglowa SA. Apart from these three groups, Południowy Koncern Węglowy SA, also state-owned, operates a steam coal mine near to the Jaworzno power plant which it supplies. There are no mines in Lower Silesia and just one in the Lublin coal basin owned and operated by Lubelski Węgiel „Bogdanka" SA. The State relinquished its majority ownership of this large mine in March 2010 with a second public offering, following a successful initial public offering in June 2009. A second private company, KWK „Siltech" Sp. z o.o., mines steam coal at Bytom near Katowice, producing around 100 000 tonnes per year.

Węglokoks SA is the state-owned coal trading company that has managed Poland's coal exports since 1952. Although individual coal companies have been free to export since 1990, Węglokoks's continued domination of coal trade for export has been with the tacit agreement of Polish producers who wished to avoid competing against one another in the international market.

A state-owned company established in 2000, Spółka Restrukturyzacji Kopalń SA has responsibility for closure of non-productive mines and managing other aspects of the government's restructuring programme under the Minister of Economy.[36] The restructuring process is monitored by the Katowice branch of the industrial development agency Agencja Rozwoju Przemysłu SA (ARP). In 2009, restructuring costs to the State totalled PLN 386 million (EUR 89 million).

36. The activities of a second company, Bytomska Spólka Restrukturyzacji Kopalń Sp. z o.o. were consolidated into Spółka Restrukturyzacji Kopalń SA (SRK SA) in 2009. At the same time, Centralny Zakład Odwadniania Kopalń (CZOK) was separated from SRK SA to monitor and safely manage mine water at closed mines. In 2007, the estimated cost of pumping water from closed mines was PLN 166 million (EUR 38 million).

Table 5. **Hard coal mines in Poland, 2009**

Mine – COMPANY	Output in 2009, Mt	Industrial reserves, Mt	Reserve life, years
KWK Bobrek-Centrum	2.339	137.974	33
ZG Piekary	1.880	41.791	16
KWK Bolesław Śmiały	1.582	51.431	18
KWK Knurów-Szczygłowice	4.216	225.999	33
KWK Sośnica-Makoszowy	4.173	209.141	32
KWK Brzeszcze-Silesia	2.046	168.036	55
KWK Piast	4.705	265.785	42
KWK Ziemowit	4.288	120.902	17
KWK Halemba-Wirek	2.335	320.000	77
KWK Pokój	1.478	35.523	13
KWK Bielszowice	2.490	280.445	83
KWK Chwałowice	2.430	228.497	66
KWK Jankowice	3.056	201.904	46
KWK Marcel	2.613	64.455	15
KWK Rydułtowy-Anna	2.562	84.857	19
KOMPANIA WĘGLOWA S.A.	**42.199**	**2 436.740**	**37**
KWK Murcki-Staszic	4.774	197.607	25
KWK Mysłowice-Wesoła	3.333	129.848	25
KWK Wieczorek	1.701	37.909	16
KWK Wujek	3.075	88.820	17
KWK Kazimierz-Juliusz sp. z o. o.	0.608	8.888	8
KATOWICKA GRUPA KAPITAŁOWA	**13.493**	**463.072**	**21**
KWK Budryk	2.810	71.095	10
KWK Borynia	1.550	25.757	8
KWK Jas-Mos	1.305	70.383	25
KWK Krupiński	1.790	38.043	13
KWK Pniówek	2.696	67.817	13
KWK Zofiówka	1.246	28.583	7
JASTRZĘBSKA SPÓŁKA WĘGLOWA S.A.	**11.400**	**301.678**	**12**
ZG Sobieski	3.088	250.178	46
ZG Janina	1.850	372.848	107
POŁUDNIOWY KONCERN WĘGLOWY S.A.	**4.938**	**623.026**	**70**
Lubelski Węgiel „Bogdanka" S.A.	5.236	335.332	44
SILTECH sp. z o. o.	0.216	6.916	19
TOTAL	**72.031**	**4 166.764**	**32**

Note: Reserve life assumes that 60% of industrial reserves can be recovered.

Sources: Ministry of Economy and Polish Geological Institute.

Box 4. **Hard coal industry restructuring**

In common with other former Eastern Bloc countries, Poland's coal industry was state-run from the late 1940s until the reintroduction of a market economy in the early 1990s. The State has retained ownership of much of the industry since then. In 1989, responsibility for hard coal mining was transferred from the Ministry of Coal Mining to the State Hard Coal Restructuring Agency (PARG). At that time, hard coal production came from a total of 71 underground mines located in the Upper Silesia, Lower Silesia and Lublin coal basins (Figure 27). The government's first attempt to restructure the industry to improve productivity came in September 1991 with a mine closure and an employment reduction programme that was later amended in May 1992. In 1993, management of coal production in the Upper Silesian coal basin – Poland's principal source of hard coal – was transferred to seven major joint-stock holding companies (the Bytomska, Gliwicka, Jastrzębska, Nadwiślańska, Rudzka and Rybnicka companies, and the Katowicki Coal Holding Company).[37] The assets transferred excluded a number of mines that had been scheduled for early closure. These companies took over responsibility for 60 mines, eleven of which came under the Katowicki Coal Holding Company. A further four operations were established as stand-alone companies. Five mines had been closed since 1989, leaving 66 in production, 63 of which were in Upper Silesia.

Despite the restructuring, the hard coal sector as a whole was still making losses, which peaked at over USD 1.6 billion in 1998 (around USD 14 per tonne). A major government initiative in 1998, including an act of Parliament that was passed in November with support from trade unions, placed a new focus on restructuring over the following four years: to reduce the number of mines to 53 during 1998, with a further 12 closures by 2002.

The most recent phase of restructuring was stipulated by the 2003 Hard Coal Mining Restructuring Act, enacted in preparation for Poland's membership of the EU.[38] This measure saw a major reduction in the liabilities of state-owned hard coal producers, completing the move away from enterprises with both production and social responsibilities.[39] Debts of PLN 18.1 billion (then USD 4.5 billion) incurred before September 2003 were written off, other liabilities totalling around PLN 2.5 billion (USD 575 million) were deferred, and packages were put in place to provide support for redundant miners. Two production scenarios were established by the Act: a reduction in annual output to either 88.6 or 94.8 million tonnes by the end of 2006. Administratively, the industry was consolidated into three state-owned enterprises: Kompania Węglowa SA, which incorporated the operations of five of the former joint-stock companies to become Europe's largest coal company, Katowicki Holding Węglowy SA and Jastrzębska Spółka Węglowa SA.

37. This restructuring was carried out under the Act of Ownership Transformation of Some Companies of Particular Importance to the National Economy, passed on 5 February 1993.

38. *Journal of Laws* 2003 No. 210, item 2037.

39. For example, prior to restructuring, a coal company's remit may have included the provision of housing, medical care, social welfare, schooling, sports facilities and holiday resorts for its employees and their families.

BROWN COAL INDUSTRY

The brown coal (or lignite) mining industry has been much less affected by the restructuring compared to the hard coal industry. It provides Poland with a competitive fuel for power generation. Brown coal is mined at opencast mines in four principal mining areas located in central and western Poland: Adamów, Bełchatów, Konin and Turów (Table 6). These four mines feed mine-mouth power plants that supply 40% of total electricity output and remain competitive.

Table 6. **Brown coal mines in Poland, 2008**

Mine – COMPANY	Output in 2008, Mt	Commercial reserves, Mt	Reserve life, years
Adamów	3.125		
Koźmin	0.239		
Koźmin South	0.543		
Władysławów	0.524		
KWB „ADAMÓW" IN TUREK S.A.	**4.431**	**52**	**12**
Bełchatów	32.606		
Szczerców	-		
PGE KWB „BEŁCHATÓW" S.A.	**32.906**	**1 005**	**31**
Drzewce	1.592		
Jóźwin I B	2.655		
Jóźwin II	3.932		
Lubstów	1.352		
KWB „KONIN" IN KLECZEW S.A.	**12.111**	**101**	**8**
PGE KWB „TURÓW" S.A.	**12.104**	**376**	**31**
Sieniawa	0.133	-	-
TOTAL	**61.685**	**1 534**	**25**

Note: Reserve life assumes that 90% of commercial reserves can be recovered.

Sources: Polish Geological Institute and Brown Coal Producers Association (PPWB).

Two vertically integrated power utilities use lignite to produce electricity: PGE SA and PAK SA. The partly privatised PGE dominates the sector with two mines accounting for 73% of Poland's total production in 2008. The two other state-owned lignite mines, KWB Adamów and KWB Konin, form part of a package that is being offered for sale by the Ministry of Treasury, along with the heat and power generation assets of the PAK group.[40]

In order to maintain sufficient lignite output, reserves in other parts of the country will have to be exploited. Two promising deposits are located at Legnica and Gubin-Mosty. Mineable reserves at five potential mine sites (Legnica West, Legnica East, Legnica North, Ścinawa and Ruja) total 4.135 billion tonnes and could support mining with an annual production of around 40 Mt. At Bełchatów, lignite supply could be extended by exploiting reserves of 485 Mt at the Złoczew deposit located some 60 km away from the current mine and power station. Transporting lignite over that distance, however,

40. Ministry of Treasury announcement, 4 February 2010.

presents an economic challenge that may rule in favour of a new power plant, as would be the case at Legnica and Gubin. Before any new lignite mine projects can proceed, strong public opposition must be taken into account during the permitting process.

PRODUCTIVITY

Average productivity at Poland's hard coal mines is rather low – about 645 tonnes per man-year in 2009, compared to over 3 400 tonnes per man-year at the lignite mines. For comparison, productivities of 8 000-10 000 tonnes per man-year are routinely achieved at mines in Australia and the United States. Coal-mining productivity is generally much lower in Europe than in the major coal-exporting countries, such as Australia, Colombia, Indonesia and South Africa. The primary reasons for this lower productivity are less opencast mining of hard coal and more difficult geological conditions in underground mines.

Table 7. **Production, employment and productivity in the Polish hard coal and lignite mining sectors, 2005 to 2009**

Year	Hard coal mining sector			Lignite mining sector		
	Production, million tonnes	Number employed	Productivity, tonnes per man-year	Production, million tonnes	Number employed	Productivity, tonnes per man-year
2005	97.0	122 700	790.5	61.6	20 608	2 989
2006	94.3	118 900	793.1	60.8	18 844	3 226
2007	87.2	115 000	758.3	57.5	18 230	3 154
2008	83.4	115 100	724.6	61.7	17 392	3 548
2009	72.6	112 600	644.8	56.8	16 629	3 416

Sources: Ministry of Economy, Brown Coal Producers Association *(PPWB*) and IEA analysis.

Polish hard coal-mining companies aim to improve productivity in the future, principally through payroll incentives, greater professionalism and less job demarcation. (Labour accounts for over 40% of total costs.) In addition, there are many other areas where improvements can be made. For example, centralising support services, subcontracting certain activities, streamlining supervisory levels and functions (including those that are regulated by law), eliminating non-productive assets and greater automation.

The average productivity figures reported in Table 7 hide some highly productive mines. For example, Lubelski Węgiel „Bogdanka" SA achieves more than twice the national average productivity at its single mine in the Lublin coal basin, despite difficult hydro-geological conditions and relatively thin coal seams. By 2014, the company aims to double production to 11.1 Mt per year and is completing two new shafts into the Stefanów coal field to reach this target.[41]

COAL TRANSPORT

The coal industry makes use of a well-developed transport infrastructure, with cross-border rail links to neighbouring countries (Germany, the Czech Republic, the Slovak Republic, Ukraine, Belarus, Lithuania and Russia) and to Baltic ports.

41. The two shafts, of 993 metres and 1 020 m, had been abandoned during construction in 1989.

The transport of coal by rail within the country is dominated by the state-owned company PKP Cargo. In 2003, the company had a 96% share of the freight market. While two smaller carriers, CTL Logistics SA and DB Schenker Rail Polska SA (which acquired PCC Logistics and PTK Holding SA), have introduced competition, PKP Cargo still held over 70% of the freight market in 2008. Rates for shipping coal are not considered competitive when compared with rates in other large coal-producing countries. For example, the average mine-to-port rail rate in the first half of 2006 was EUR 15 per tonne (PLN 65).[42] Barges are also used to move coal efficiently by water.

The current and future coal-handling capacities at Polish ports are given in Table 8. Only Gdańsk has facilities for loading capesize (the largest) vessels. Two smaller ports, Ustka and Kołobrzeg, also have the potential to handle coal in handysize (considerably smaller) vessels. The annual import capacity of ports can readily be increased to 19 Mt with modest investment at facilities that previously exported coal. Poland has a competitive advantage in the Baltic/Scandinavian markets because of the proximity of Baltic ports many of which cannot be served by large bulk carriers. Coal delivered from Polish ports in smaller ships avoids transhipments of international coal from the main European coal-trading hubs.

Table 8. **Coal-handling capacity at Polish ports, 2009 and 2015**

Port	Current annual export handling capacity (and potential capacity in 2015), Mt	Current annual import handling capacity (and potential capacity in 2015), Mt
Gdańsk	10 (5)	0 (10)
Gdynia	1 (1)	2 (2)
Świnoujście	5 (5)	3 (5)
Szczecin	4 (4)	2 (2)
Total	**20 (15)**	**7 (19)**

Source: Ministry of Economy.

OUTLOOK

Prospects for the coal industry are mixed. Ongoing productivity improvements mean that a number of hard coal mines can look forward to a profitable future in the private sector, meeting a proportion of projected demand in 2030. The balance can be met by imports and sufficient capacity exists at ports to access the international coal market and to import coal by rail from Russia, Ukraine, the Czech Republic and Kazakhstan.

In the lignite sector, vertically integrated companies producing lignite to fuel mine-mouth power plants are very competitive for baseload power production. Although PGE SA dominates the lignite sector today, new entrants could be encouraged through competitive licensing rounds with safeguards to avoid hoarding of mining licences. New entrants would have the added benefit of bringing much needed competition into the power generation sector. Capital requirements for hard coal mine expansion projects and the development of new lignite mines can be met through commercial channels, notwithstanding Poland's decision in 2007 to offer investment aid to the hard coal industry.

42. The average rail transport distance for all hard coal movements in Poland was 240 km in 2008, including to power stations and to (and from) ports, at an average cost of PLN 25 (EUR 6) per tonne (Ministry of Economy).

The most pressing concern for the lignite mining sector is gaining planning permits for new mining projects. Even though proposed projects can be of national interest, the opposition of local populations and lack of support among local and regional authorities make it very difficult to obtain the permits.

The coal industry as a whole faces significant environmental challenges. The EU Large Combustion Plants Directive and the related Integrated Pollution Prevention and Control Directive require Poland to reduce emissions of conventional pollutants. Poland also has international obligations to limit CO_2 emissions from fuel combustion (*e.g.* the aforementioned EU-ETS). Although the country was granted certain derogations in its EU Accession Treaty, the end dates of these derogations are approaching fast. Poland is a signatory to the United Nations Economic Commission for Europe (UNECE) Long Range Transboundary Air Pollution Convention and the UNECE Second Sulphur Protocol. Under these treaties, Poland must limit sulphur dioxide emissions to 1.397 Mt in 2010, this being a 56% reduction on a 1980 baseline.[43]

Given that methane is a powerful greenhouse gas that cannot currently be traded within the EU-ETS, it is incumbent upon the government to ensure that regulations are in place to manage methane emissions from coal mines. These are estimated to account for 10.3% of Poland's total greenhouse gas emissions. Carefully structured incentives could encourage capture and use of coal mine methane, including that released in mine ventilation air.

Another challenge is subsidence and mine waste management. In Poland, most mining wastes are backfilled in underground workings after mining or reused for land reclamation, engineering and development work, rather than dumped. Finally, managing mine restoration is another important issue for gaining public support. Poland has a number of regulations on post-mining reclamation.[44]

COAL INDUSTRY POLICY

An objective of the *Energy Policy of Poland until 2030* is for the "efficient and effective management of coal deposits". Coal is expected to be used as the main fuel for electricity generation, with the following specific objectives for the industry:

- ensuring energy security of the country by meeting domestic demand for coal, ensuring stable supplies to customers and the required quality standards;
- applying efficient and low-emission technologies to all use of coal in the energy industry, including coal gasification and processing it into liquid or gas fuels;
- using modern technologies in the coal mining sector to enhance competitiveness, work safety and environmental protection, and to establish the basis for technological and scientific development;
- maximising use of methane released when extracting coal in mines.

The objectives are explained in more detail in *The Strategy of Hard Coal Mining Industry Activities in Poland for 2007-2015* (hereafter the Strategy) adopted by the Council of

43. In 2008, Poland's SO_2 emissions totalled 1.131 Mt, a 65% reduction on 1990 levels (EEA, 2009).

44. Geological and Mining Law 1994, as amended and published as a consolidated text in *Journal of Laws* 2005 No. 228, item 1947 and Conservation of Farmlands and Forests Act 1995, as amended and published as a consolidated text in *Journal of Laws* 2004 No. 191, item 1266.

Ministers on 31 July 2007.[45] This built on an earlier document, *Restructuring of the Hard Coal Mining Sector During the Period 2004-2006 and Strategy for the Period 2007-2010*, adopted by the Council of Ministers on 27 April 2004.

The Strategy for coal is based on an assumption that long-term stable supplies of high-quality coal are vital to Poland's energy security. Maintaining production of both steam coal and coking coal will require the construction of new mines and modernisation of equipment and methods. Surplus production, beyond that needed to meet domestic demand, can be exported, according to the Strategy. Price competitiveness, occupational safety, environmental protection and technological development are seen as key to achieving the strategic aims.

The Strategy sees opportunities for coal to be used in new ways. Coal upgrading, more efficient combustion technologies, and new technologies for coal processing into liquid fuels, synthetic natural gas and methanol could improve the environment and national energy security. Coupled with these, advanced clean coal technologies such as carbon capture and storage (CCS) are seen as important, not just in Poland. Amendments to the Geological and Mining Law are planned that will incorporate the requirements of the EU Directive on CCS. To improve the long-term prospects for coal mining, the government supports relevant R&D within the "Innovative Economy" operational programme (2007-2013) with the aim of using new technologies to improve the competitiveness of this traditional sector.

The government intends to continue with further privatisations of coal companies; minority stakes in Katowicki Holding Węglowy SA and Jastrzębska Spółka Węglowy SA will be sold and these companies will be able to issue bonds to fund investments. In the case of Kompania Węglowa SA, further restructuring and separation of historic liabilities are necessary, and privatisation plans have been delayed until 2011 on account of the global financial crisis.

COAL INDUSTRY SUBSIDIES

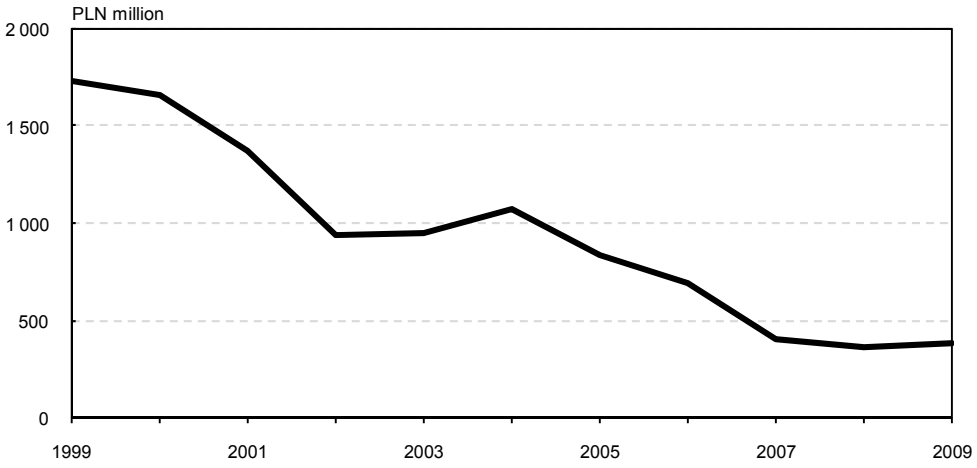
The selling prices of locally produced steam coal, coking coal and lignite in Poland are freely negotiated and competitive with seaborne and cross-border imports. Coal sales are not subsidised and no state aid is given to support operating costs or to maintain access to already exploited coal reserves.

The heavy costs of restructuring the Polish coal industry have been borne mainly by the State (Figure 28). Since Poland joined the European Union in 2004, the European Commission has taken a number of decisions on the compatibility of restructuring plans with the common market and approving state aid for the hard coal-mining industry.[46] In general, costs are associated with historic liabilities, such as entitlement by retired mineworkers to free coal, costs of mine closures, benefits paid to redundant miners, managing water, gas and fire risks at closed mines, and restoration and clean-up of damages caused by past mining activity. The total cost to the national budget of these liabilities over the period 2008 to 2015 is estimated to be PLN 2.7 billion (EUR 0.62 billion), including PLN 152 million (EUR 35 million) from the National Fund for Environmental Protection and Water Management (NFOŚGiW). Costs of mine closures after 31 December 2006 are met by a dedicated fund, established for this purpose by mining enterprises.

45. www.mg.gov.pl/english/economy/coal+mining+sector/

46. European Council Regulation 1407/2002 governs state aid to the coal industry, while Decision No. K(2005)1796 for the years 2004-2006 relates specifically to Poland; as does Decision No. K(2007)1943 for 2007.

Figure 28. **State aid paid to the hard coal sector, 1999 to 2009**



Source: Ministry of Economy.

In addition to restructuring costs, the Polish government may pay investment aid of up to 30% of eligible investments made at operating mines, as permitted by EU law. In 2010, PLN 400 million (EUR 92 million) was committed from the state budget.

COAL INDUSTRY EMPLOYMENT POLICY

Polish government policy on employment issues during coal sector restructuring has focused on the provision of alternative opportunities for redundant miners and on providing social protection for those left unemployed.[47] The policy has been a success in that the social disruption and violence associated with coal industry restructuring in other countries has been avoided. However, the policy has been costly. Box 5 provides more details on the employment aspects of the coal industry restructuring.

Poland's reliance on coal as its major energy source means that the government is committed to a long-term future for a slimmed-down industry. This has helped to maintain an equipment-supply sector as well as providing job security for a core mining workforce. Looking to the future, the policy to further reduce employee number through natural attrition (*i.e.* retirement) will lead to an ageing workforce. The challenge will be to ensure that the skills needed to operate coal mines safely are retained in the industry through the recruitment and training of young employees.

Box 5. **Employment policy in the coal industry restructuring**

In 1993 Poland established a legal basis for redundancy support and social benefits for those affected by coal mine closures. The subsequent restructuring programme, which ran from 1996 to 2000, achieved employment reductions through voluntary redundancy, "mining leave" (an alternative form of early retirement), transfers to other businesses created from assets spun out from the former coal mining enterprises, and preferential tax treatment for business start-ups or for companies creating jobs for ex-miners. This Mining Social Package programme (GPS) provided a wider range of benefits than before. ../..

47. ARP, 2004.

Box 5. **Employment policy in the coal industry restructuring** (continued)

In 2003, a programme to mitigate the impact of coal industry restructuring in the Silesia region was inaugurated with a Fund for Silesia to support regional development. A European Development Bank loan was used to help finance the first stage of this programme, which included measures to strengthen the local business support infrastructure and loans for small and medium-sized enterprises (SMEs), with the aim of creating new, long-term jobs.

The Hard Coal Mining Restructuring Act that came into force in 2003 introduced further support measures. For example, employment for an individual who was due to retire before 2007 was guaranteed, together with his or her rights to a retirement pension. Grants were also made available for vocational retraining and loans for setting up in business.

Between 1994 and 2003, the Polish government spent USD 1.6 billion on employment restructuring in the country's hard coal industry. The greatest proportion of this was spent between 1998 and 2002. Support of up to USD 1 billion, received from the World Bank through credits, grants and International Finance Corporation (IFC) investment, has been directed to closing uneconomic mines, labour rationalisation after 2003, remediation of environmental damage resulting from mining, and the creation of new jobs. Between 2004 and 2006, European Union Structural Funds totalling EUR 11.4 billion (USD 15.1 billion in 2005 values) were targeted on human resource development, improving economic competitiveness and carrying out an integrated regional development programme across Poland as a whole.

COAL TECHNOLOGY R&D

Poland has a long history in technology development related to coal and hosts many respected R&D centres, as discussed in more detail in Chapter 10 on Energy Technology and R&D. New mining techniques, high-capacity mining equipment, underground coal gasification, coal-bed methane extraction, coal preparation and conversion technologies, and power generation equipment have all been researched, developed and sometimes commercialised in Poland.

To ensure that the use of coal remains compatible with national and international sustainability goals, the country must continue to improve the environmental performance of coal extraction and use. Poland can play a leading role in the development and demonstration of new clean coal technologies. In particular, the need to demonstrate cost-effective CO_2 capture and storage at coal-fired power plants is an EU priority. By 2015, two CCS demonstration projects are expected to be operating in Poland as part of the wider EU demonstration programme (Chapter 10).

In the IEA 450 Scenario, discussed in Chapters 2 and 3, CCS accounts for 23% of total CO_2 abatement by 2030 compared to the Reference Scenario. Achieving this outcome depends on the public acceptability of CCS technologies and on making good progress with their development. Chapter 10 examines CCS projects in Poland.

CRITIQUE

The coal industry in Poland has undergone huge structural changes since the election of a democratic government in 1989. Productivity has significantly improved, investments have been made to modernise mines and overstaffing has been addressed. The social implications have been sensitively managed by the government, a commendable achievement given the loss of over 330 000 jobs.

Coal dominates Poland's energy mix, accounting for 55% of primary energy supply and 90% of electricity generation. The availability of indigenous coal brings security of supply benefits, balancing Poland's heavy dependence on oil and gas imports. However, there are risks. Perhaps the biggest is the potential disruption to electricity supply if coal supplies were interrupted as a result of, for example, industrial action in the coal mining or rail transport sectors. More energy diversity in the electricity sector would be desirable.

Hard coal production has declined since peaking in 1989. Production of 77.4 Mt in 2009 reflects not only the lower demand for coal, but also the often poor economics of mining hard coal from deep mines established some decades ago. Lignite production, on the other hand, provides Poland with a competitive energy source.

The selling prices of locally produced steam and coking coal in Poland are freely negotiated and competitive with seaborne imports. Coal sales are not subsidised.

Poland's coal resources dwarf the country's oil and gas resources and could last hundreds of years at current production rates. However, economically recoverable hard coal reserves accessible from established mines have a much shorter life. With no prospect of new mines being sunk, hard coal production is likely to decrease considerably by 2030. Lignite production will also fall sharply, unless new mines are opened. Public opposition to coal mining means that local governments are unwilling to grant permits for new mines, despite the very clear national need for new lignite production if shortages are to be avoided from 2015 onwards.

Gaining planning permits for new mining projects is the most pressing concern for the lignite mining sector. Poland should examine how other IEA member countries have tackled such major infrastructure planning. There is no perfect solution that can satisfy all stakeholders, but the legitimate claims of those affected by mining projects should be recognised. A streamlined planning system would allow energy sector projects that are in the national interest to proceed.

As recently as 2007, the Polish government was concerned that domestic hard coal supply would exceed domestic demand. The out-turn has been very different. In 2008, Poland became a net hard coal importer for the first time as coal production was insufficient to meet demand. Imports from Russia have surged and accounted for 70% of total coal imports in 2009.

The hard coal industry, comprising 27 mines, is dominated by four state-owned companies, Kompania Węglowa SA being the largest. Węglokoks SA is the state-owned coal trading company that dominates Poland's coal export trade. Lubelski Węgiel „Bogdanka" SA, which owns and operates a large hard coal mine in eastern Poland, became majority privately owned in 2010, following a successful initial public offering (IPO) in 2009. The lignite (or brown coal) industry consists of four mines: Adamów, Bełchatów, Konin and Turów. Two vertically integrated power utilities use lignite to produce electricity: PGE SA and PAK SA.

A state-owned company has responsibility for closure of non-productive mines and managing other aspects of the government's restructuring programme. While this is a welcome separation of activities best undertaken by the State from the commercial mining sector, it will be important to ensure that public funds are used transparently for their intended purpose. This could be achieved if these tasks were managed by an independent authority responsible to Parliament.

Prospects for the coal industry are mixed. Ongoing productivity improvements mean that a number of hard coal mines have a profitable future, meeting a proportion of projected demand. The balance can be met by imports, and sufficient port and rail capacity exists. In the lignite sector, vertically integrated companies producing lignite to fuel mine-mouth power plants should remain very competitive for baseload power production. The government should encourage new entrants through competitive licensing rounds. Capital requirements in the coal mining sector can be met through commercial channels, notwithstanding Poland's decision to offer investment aid to the hard coal industry.

The coal industry as a whole faces significant environmental challenges. Pollutant emissions from coal use in Poland must be reduced at the same time as meeting the country's obligations to limit CO_2 emissions, as required by EU directives. Although the country was granted certain derogations to environmental directives in its EU Accession Treaty, the end dates of these derogations are approaching fast. The government must therefore pursue a transparent and credible plan to meet the emission requirements of the EU Large Combustion Plants Directive and the related Integrated Pollution Prevention and Control Directive.

Given that methane is a powerful GHG that cannot currently be traded within the EU-ETS, the government also needs to manage methane emissions from coal mines. Carefully structured incentives could encourage capture and use of coal mine methane, including that released in ventilation air. Finally, if new mine developments are to have any hope of gaining public support, mine restoration needs to be completed to the highest possible standards. Existing regulations on post-mining reclamation must be strictly enforced.

In sum, if Poland is to continue using significant quantities of indigenous coal and enjoy the accompanying energy security benefits, then the country must continue to improve the environmental performance of coal extraction and use.

RECOMMENDATIONS

The government of Poland should:

- *Reassess and report economically recoverable hard coal and lignite reserves to inform future energy policy development.*
- *Continue with its policy to establish a vibrant and competitive coal mining industry in private ownership.*
- *Work with industry to create a stream of development projects, including securing the relevant licences and permits.*
- *Ensure that funding and legislation are in place to allow CCS demonstration projects to proceed quickly so that this technology can be available as a CO_2 mitigation option by 2020.*

7. NATURAL GAS

SUPPLY AND DEMAND

DEMAND

Gas demand steadily increased from 13.3 billion cubic metres (bcm) in 2000 to 16.4 bcm in 2009 according to IEA methodology (see Box 6), with an annual average growth rate of 2.3%. In the *Energy Policy of Poland until 2030* (EPP 2030), gas demand is forecast to increase by 28% in 2020 and by 52% in 2030, compared with the 2009 level.

Daily gas consumption in 2009 ranged from a minimum level of 30.2 million cubic metres per day (mcm/d) in August to a 62.2 mcm/d peak in January.[48] The daily gas consumption in January 2010 averaged at 71.2 mcm/d.

Box 6. **Gas statistics: methodological differences**

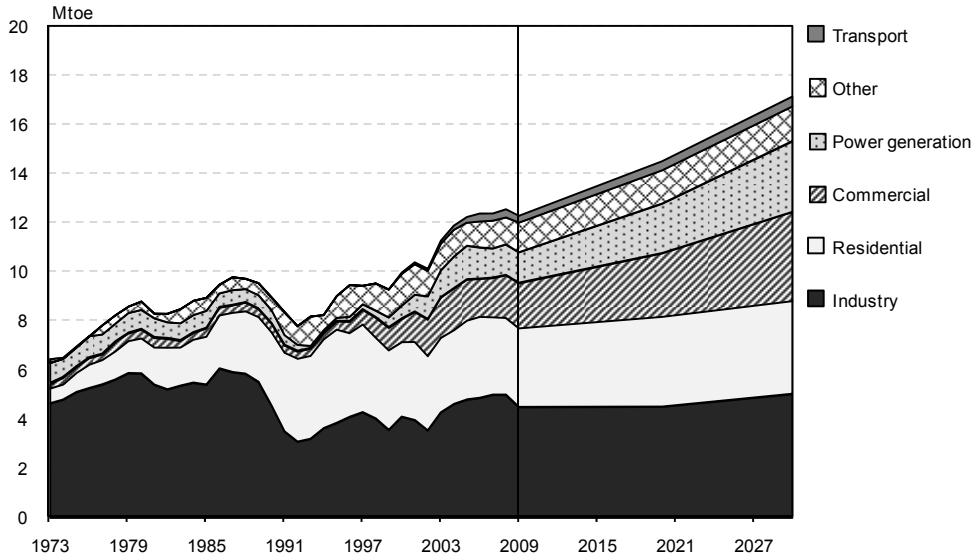
Natural gas production and consumption data in the IEA publications differ from the data in Polish sources because of methodological differences. For example, domestic gas production reported in Polish sources is 4.1 bcm in 2009, compared to 5.8 bcm reported according to the IEA methodology. Data submitted by the Polish Energy Market Agency to the IEA are the sum of natural gas of various types (including high-methane natural gas, low-methane natural gas and gas from mines methane drainage) in standard conditions without taking into consideration the nominal gross calorific value (GCV). In the data published in Poland, domestically produced low-methane natural gas is normalised to the GCV of high-methane natural gas.

In addition to these methodological differences, when using volume measurements for natural gas, it is also important to know at which temperature and under which pressure the gas has been measured. Indeed, there are several definitions of what are standard conditions of temperature and pressure. For the IEA, standard conditions are 15˚C and 760 millimetres of mercury (mm Hg); in Poland "normal" conditions are used measured at a temperature of 0 degree Celsius and a pressure of 760 mm Hg; while in Russia, state standard GOST 2939-63 "Gases. Conditions for determining their volume" sets the standard conditions as a temperature of 20˚C and pressure of 760 mm Hg. This difference is not unique, several other sets of conditions are commonly used, and, for instance, the International Organisation for Standardization (ISO) has more than one definition for standard conditions. Thus it is important to mention that, as gas is very compressible, large amounts may end up with significant differences.

48. These figures are monthly averages in these two months, according to the IEA *Monthly Oil Statistics*.

Industry is the major gas consumer, accounting for 37% of total gas demand in 2009, according to preliminary IEA data. It is followed by the residential and services sectors, accounting for 26% and 13% respectively. The electricity and heat generation sector represented only 10% of total gas consumption in 2009. As electricity generation is mainly coal-fired, the share of natural gas as fuel for this purpose stood at merely 2% in 2009. This share is likely to increase as the ageing coal-fired generation capacity is retired and replaced by other power plants. Gas-fired plants are the second-fastest plants to build, after wind farms, and are less subject to NIMBY (not in my backyard) reactions than coal or wind.

Figure 29. **Natural gas supply by sector*, 1973 to 2030**



* TPES by consuming sector. *Other* includes other transformation and energy sector consumption. *Industry* includes non-energy use. *Commercial* includes commercial, public services, agriculture/ forestry, fishing and other final consumption.

Note: This graph shows historical data until 2009 and the government's projections from 2010 to 2030.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010 and country submission.

SUPPLY

Natural gas accounted for 13% of total primary energy supply (TPES) in Poland in 2009, which is a two percentage points increase from the 2000 level. The *EPP 2030* forecasts the share of natural gas in TPES to increase slightly to 14.5% in 2030.

Approximately one-third of total gas supply is produced domestically, the rest is imported. Poland's total natural gas imports in 2009 amounted to some 10 bcm, while the stock change and exports were 580 million cubic metres (mcm) and 40 mcm, respectively. Currently, virtually all imported gas is supplied through pipelines by the Polish Oil and Gas Company (PGNiG) except for very small quantities of liquefied natural gas (LNG) transported by PGNiG's competitors by road in tanks (22.5 thousands tonnes in 2008 and 14 kt in 2009).

As Table 9 demonstrates, Russia is the key source of gas imports. In 2009, the share of Russian gas in total gas imports stood at 82%, while imports from Germany accounted for 11%. A new long-term contract between PGNiG and Russia's Gazprom was reached in October 2010 after long negotiations between Russia and Poland (see Box 7 for more detail).

Table 9. **PGNiG gas import contracts**

Purchaser	Supplier	Start from	Valid until	Volume/notes
PGNiG	Gazprom (Russia)	29 October 2010	2022	2010: 9 bcm/year 2011: 9.8 bcm/year 2012-2022: 10.25 bcm /year
PGNiG	VNG-Verbundnetz Gas AG (Germany)	17 August 2006	1 October 2016	0.4 bcm per year
PGNiG	VNG-Verbundnetz Gas AG (Germany)	29 September 2008	1 October 2011	0.5 bcm per year
PGNiG	NAK Naftogaz (Ukraine)	2004	2020	0.005 bcm per year*
PGNiG	RosUkrEnergo AG	2007	2010	2.5 bcm per year; Since 1 January 2009, RosUkrEnergo has not been fulfilling its contract obligations

* The volumes are provided in normal conditions, at 0 degree C.

** PGNiG expects to increase imports from Ukraine from 2011.

Source: Polish Administration.

Box 7. **Gas agreements with Russia**

Agreements for gas supply from Russia to its Eastern/Central European neighbours are usually reached at two levels – between the countries' governments and between the national gas companies. They are usually signed in a package with agreements related to transit of Russian gas through the importing country. Poland had an intergovernmental agreement with Russia since 1993 which was amended in 1996 and 2003. The parties renegotiated it in 2009 but the new agreement was vetoed by the European Commission as it breached internal market rules. The EC insisted that Poland should grant third-party access to the Yamal pipeline and allow gas to flow in both directions between Germany and Poland. It also wanted the elimination of the so-called "destination clause" forbidding resale of Russia's gas to other countries.

In October 2010, the governments of Russia and Poland as well as Gazprom and PGNiG agreed on the following terms. Gazprom will supply 9.7 bcm in 2010 increasing to 10.5 bcm in 2011 and 11 bcm from 2012 at GOST standards (this corresponds to 9.03 bcm, 9.77 bcm and 10.24 bcm respectively according to the Polish methodology). The supply contract ends in 2022, instead of 2037 as originally planned. The destination clause was removed from the contract.

The transit agreement signed in October 2010 ends in 2019 instead of 2045 as originally planned. The parties have decided, however, to discuss an extension of agreement for the transit of 28 bcm per year up to 2045. GAZ SYSTEM and EuRoPol Gaz agreed that GAZ SYSTEM would take over the management of the EuRoPol section of the Yamal-Europe pipeline. In early November 2010, the EC approved the Russia-Poland gas transit agreement but highlighted the need to ensure effective third-party access to the Yamal pipeline.

According to the *BP Statistical Review of World Energy 2010*, Poland possessed 110 bcm of proven reserves of natural gas at the end of 2009, which would be sufficient for approximately 27 years at the current production rates. The Ministry of Environment grants exploration and production concessions for natural gas and crude oil. As of 1 October 2010,

15 companies held exploration licences and four companies had production licences for conventional hydrocarbon deposits. Additionally, there are several dozen other companies, domestic as well as foreign, involved in prospecting and exploration of unconventional gas deposits. Poland produced 5.8 bcm of natural gas in 2009 (or 4.27 bcm according to the Polish methodology discussed in Box 6), which accounted for about one-third of the country's demand. About 98% of this gas was produced by PGNiG. The company plans to increase its conventional gas production in the short term. Chapter 8 on oil provides more detail about the Polish hydrocarbon upstream sector.

PROSPECTS FOR UNCONVENTIONAL GAS[49]

Preliminary estimates suggest that Poland could have between 1.4 and 3 trillion cubic metres (tcm) of unconventional gas; however, it may take between five to ten years before a complete assessment of the commercialisation of unconventional gas can be made on the basis of the first exploratory drillings that took place in 2010. The Polish Institute of Geology plans to publish its estimates of unconventional gas resources by the end of 2011. Several major and independent American oil and gas firms (including ExxonMobil, ConocoPhillips, Chevron and Marathon) are now exploring for the prospects of shale gas deposits in Poland. The Ministry of Environment in Poland had granted over 70 concessions for exploration of unconventional gas in Poland by October 2010. Poland also might have possible tight gas reserves as well as opportunities for developing coal-bed methane (CBM).

If the shale gas resources are confirmed, theoretically their large-scale exploitation has the potential to change the energy landscape not only in Poland but in all Europe. However, in practice, exploitation of unconventional gas can face severe barriers, including limitations on physical access to resources. Communities in areas with high population density, or in which land is owned in numerous small tracts, may be unwilling to accommodate drilling on a large scale because of the disruption it would cause and the increased demands on local infrastructure, in particular transport. Environmental regulations may also be a major barrier to the development of shale gas resources, since the nature of its drilling operations and the large number of wells needed to produce a given volume of gas leaves a comparatively large and invasive footprint on the landscape. The treatment and disposal of the large quantities of water required in the fracturing process may create conflicts with environmental regulations and, in any case, represents a substantial operating cost. Access to large volumes of water may also be a barrier, although technological progress is beginning to reduce the volume required.

Obtaining environmental approval will be most difficult in ecologically sensitive areas, and the time and expenditure required to obtain licences and permits for drilling and related activities will complicate development projects. Technical and economic challenges can also stem from the geological characteristics of the resources. Some of the geological basins are relatively small and the resource concentrations could be low. The complexity and cost of drilling, sufficient brittleness to facilitate fracturing and proximity to existing pipeline infrastructure are additional critical factors.

Given all these factors, production of unconventional gas in Poland could theoretically start no sooner than the early 2020s. But for this to happen, supportive policy and regulatory framework will be needed.

49. This section is based on the findings of the IEA working paper *Energy and CO_2 Emissions Scenarios of Poland*, 2010.

MARKET REFORM AND INDUSTRY STRUCTURE

MARKET REFORM

In line with the EU Directive 2003/55/EC on Gas Markets, Poland started the process of phased liberalisation of the domestic gas market. Different categories of customers gradually gained the right to choose their own supplier. Consumers with annual gas use higher than 15 mcm became eligible in January 2004, and all non-residential consumers in January 2005. All natural gas final customers became eligible in January 2006, ahead of the requirement of the EU directive to achieve complete market opening by July 2007.

Despite the market opening, competition grows slowly and the gas market is still largely monopolised (as discussed below). The government acknowledges this lack of competition. One of the objectives of *EPP 2030* is the development of competitive gas markets. *EPP 2030* and its Action Plan stipulate adopting regulatory mechanisms that would stimulate competition on the gas market.

The Ministry of Economy and the regulator are supposed to develop and introduce measures aiming at the gradual liberalisation of the gas market, including:

- rules of efficient access to gas infrastructure;
- the entry-exit model;
- the idea of a virtual gas sales point;
- a market model which allows isolating physical flows from trade flows;
- market balancing rules;
- a market model which allows effective switching between sellers.

The Energy Regulatory Office (ERO) is expected to adjust the regulatory framework to the new conditions mentioned above and to prepare a framework for the gradual phasing-out of regulated tariffs.

The *EPP 2030* also requires the Ministry of Economy and the ERO to devise a roadmap to achieve a competitive gas market, taking the following issues into account:

- providing infrastructural conditions of competition development, including extension and modernisation of the transmission and distribution grid and the storage infrastructure taking into account the third-party access (TPA) principle;
- ensuring access to gas infrastructure;
- devising assumptions for regulations to allow the implementation of the competition principles;
- implementing the rules on a choice of supplier;
- extending access to gas sources for entities operating on the market.

INDUSTRY STRUCTURE

As part of the market reform, the gas transmission assets of the incumbent Polish Oil and Gas Company (PGNiG) were ownership-unbundled. An independent transmission system operator (TSO) fully owned by the State - OGP GAZ-SYSTEM - was established within PGNiG in 2004 and transferred under the state control in 2005. In June 2007, six regional distribution companies were legally unbundled from PGNiG and granted the

status of distribution system operators (DSOs) by the Energy Regulatory Office. These DSOs are wholly owned by the PGNiG Group.

PGNiG (72.5% owned by the State Treasury, 12.7% by employees and the rest freely floating) has a dominant position in both upstream and downstream sectors. It is practically the only importer of gas: it has booked nearly 100% of transmission capacity at all entry points.[50] Being also the major domestic gas producer (98% of domestic production), it effectively controls the wholesale gas market. Gas is traded only in bilateral contracts. There is no gas exchange or gas hubs.

PGNiG also dominates the retail market: several other companies (including G.EN Gaz Energia, CP Energia, EWE Polska, Enesta SA and KRI SA) have entered the market but their total market share was about 2% in 2009. As they have no access to gas resources, they purchase gas from PGNiG and resell it to final customers, often via their own local distribution networks. One exception is EWE Polska which also imports gas from the west via its own network connection with the EU transmission system. In 2009 EWE Polska imported from Germany approximately 35.65 mcm of gas under its agreement signed with EWE AG. Some other players import small volumes of LNG in tanks.

As their sales volumes are small, the suppliers independent from the PGNiG Group are not required to provide TPA to their distribution networks. Therefore, there are practically no supplier switching opportunities for end-users, although formally a consumer can switch suppliers twice a year and this procedure is free of charge.

Moreover, PGNiG is the only owner and operator of the underground gas storage capacity. In 2008, the regulator appointed PGNiG as the storage system operator for 17 years. Current working storage capacity is 1.63 bcm (12% of annual gas demand). PGNiG plans to increase it to 2.7 bcm by 2012. There are regulations in place that oblige the storage system operator to publish data on available storage capacity and to guarantee non-discriminating treatment of storage users. In practice, however, PGNiG is the only user of storage.[51] This is another factor that hampers competition because gas supply companies are legally required to have strategic reserves of gas in storage (see section on Gas Security Policy below). Without access to storage they cannot fulfil this obligation thus cannot operate on the Polish market.

INFRASTRUCTURE

PIPELINES

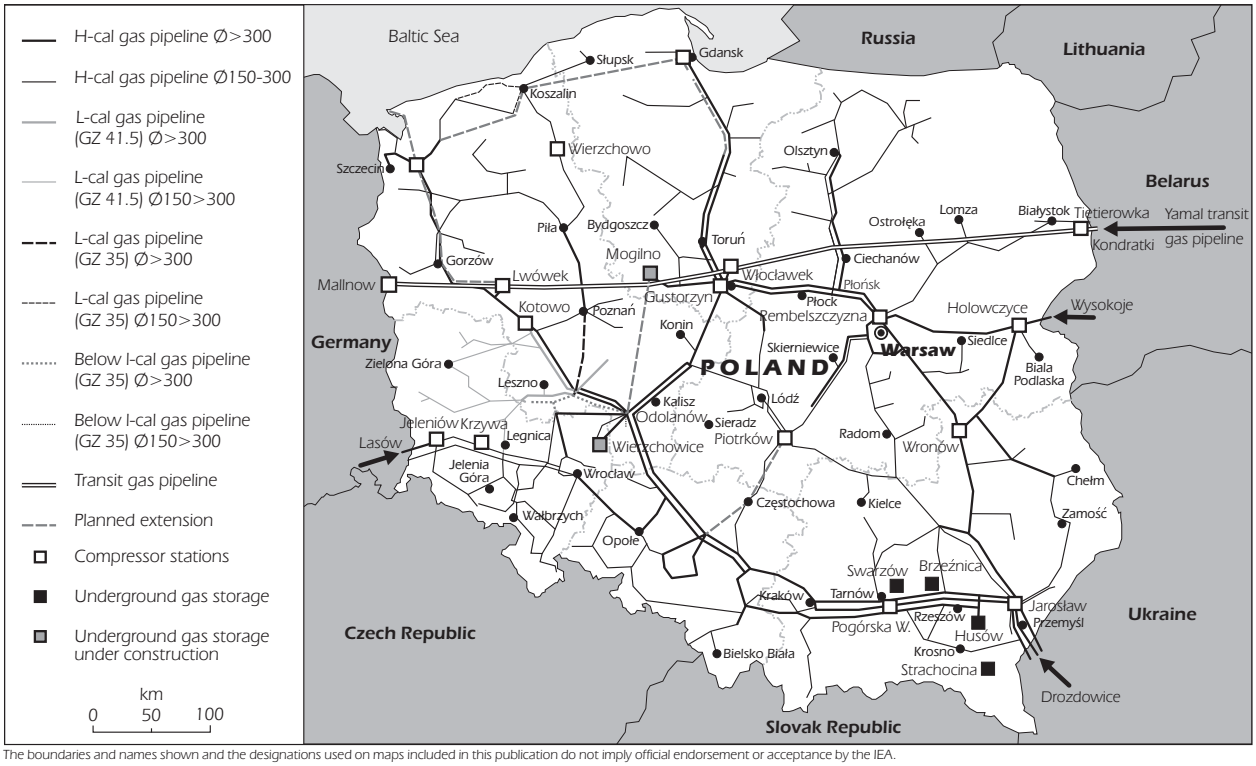
The Polish gas system is connected with the European gas network system but mostly along the East-West direction (Figure 30). There are four key entry points through which natural gas is imported into the Polish transportation system: Lasów (from Germany), Drozdowicze (from Ukraine), Wysokoje (from Belarus) and Kondratki (from Belarus through the Yamal pipeline) (Table 10). PGNiG has booked nearly 100% of available transmission capacity at all the entry points.[52]

50. In 2008 only one importer of gas, apart from PGNiG, reportedly obtained access to one entry point for a volume of 25 m^3/hour.

51. It provides 50 mcm to the transmission system operator under a bilateral contract.

52. Transit capacity is booked by Gazprom Export, as discussed below.

Figure 30. **Natural gas infrastructure, 2010**



The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

Source: *Natural Gas Information*, IEA/OECD Paris, 2010.

The Polish gas transmission system currently includes 9 709 km of pipelines, 14 compressor stations and 833 gas stations. OGP GAZ-SYSTEM is the transmission system operator appointed by the Energy Regulatory Office.

Poland is a key transit country for Russian gas to Western Europe through the Yamal pipeline. It is keen to preserve this role. EuRoPol Gaz S.A. owns the Polish section of the Yamal-Europe pipeline and operated it until the end of 2010. EuRoPol Gaz is owned by Gazprom and PGNiG (48% each) and a Polish company Gas-Trading S.A (4%).[53] It provided transmission services only to PGNiG and Gazprom Export, a company owned by OAO Gazprom. It transited about 28 bcm for Gazprom in 2009 (9% less than in 2008) and transported 2.65 bcm for PGNiG in the same year. Pipeline utilisation was equivalent to 89% of its technical capacity.

Third-party access to the Yamal pipeline is not offered, which has been a subject of the EU objections. Encouragingly, the new transit deal signed in October 2010 made OGP GAZ-SYSTEM the operator of the Yamal pipeline in Poland (see Box 7). The EC approved this agreement but highlighted the need to ensure that GAZ-SYSTEM provides access to the Yamal pipeline on a non-discriminatory basis. Currently, the flow of gas through this pipeline is possible only in the East-West direction.

53. Gazprom owns 15.88% in Gas-Trading SA.

Table 10. **Technical and actual flow volumes* of natural gas at entry points, January 2010**

Entry point	Maximum flow capacity	Gas flow rate via entry point in Jan. 2010	Spare flow capacity in Jan.2010
Lasów (from Germany)	3.2 mcm/d**	3.35 mcm/d	-0.15 mcm/d
Drozdowicze (from Ukraine)	16.46 mcm/d	12.4 mcm/d	4.06 mcm/d
Wysokoje (from Belarus)	15.8 mcm/d	11.86 mcm/d	3.94 mcm/d
Kondratki (Yamal pipeline; from Belarus to Germany)	88.8 mcm/d	86.6 mcm/d	2.2 mcm/d

* Flow capacity volumes are in standard conditions: 15 degrees and 760 mm Hg.

**Because of work operations at Lasów, the maximum technical capacity has been temporarily reduced from 3.24 mcm/d to 2.78 mcm/d.

Source: IEA.

There is a deficit of transmission capacity resulting from lack of investment in the system development. Moreover, the infrastructure is ageing, which further highlights the need for investment. In 2009, 60% of gas transmission pipelines was over 25 years old and another 8% between 21 and 25 years old. Network congestions are frequent in some parts of the system; as a result there is a significant number of refusals of connection to transmission and distribution networks.

Table 11. **Gas pipeline projects**

Project	Description of the project	Transmission capacity	Status of project
Czech-Poland interconnector (Moravia)	Construction of a new 22-km pipeline (Polish section)	0.5 bcm per year (up to 1.6 mcm/d in emergency)	Under construction and to be ready for operation in 2011
Extension of gas transmission system Germany-Poland (Lasów)	Increase of receiving capacity of the existing Lasów entry point	Expansion to 1.5 bcm (4.1 mcm/d)	Under construction and to be completed by end 2011
Germany-Poland interconnector (Börnicke – Police)	Construction of a new two-way 140-160 km pipeline and two compressor stations	3 bcm per year (8.2 mcm/d)	Planning permission for construction on Polish section has been granted. Construction to be completed by end 2012
Baltic pipeline (Denmark-Poland)	Construction of new offshore and onshore pipelines (Polish section)	3 bcm per year (8.2 mcm/d)	Preinvestment phase in progress to safeguard the future location of the project.

Source: Polish Administration.

In order to expand transmission and import capacity, OGP GAZ-SYSTEM has been implementing several investment projects as described in Table 11. In 2009, OGP GAZ-SYSTEM carried out an open season for interconnectors Poland-Denmark and Poland-Lithuania, but no interest was expressed for these projects.

The Polish distribution network consists of some 115 800 km of pipelines. Six distribution system operators are responsible for the operation, maintenance and expansion of the system. Poland's DSOs are:

- Dolnośląska Spółka Gazownictwa (DSG), 7 800 km
- Górnośląska Spółka Gazownictwa (GSG), 20 700 km
- Karpacka Spółka Gazownictwa (KSG), 44 300 km

- Mazowiecka Spółka Gazownictwa (MSG), 18 600 km
- Pomorska Spółka Gazownictwa (PSG), 9 400 km
- Wielkopolska Spółka Gazownictwa (WSG), 15 200 km.

LNG TERMINAL

The country's first LNG terminal is planned to be constructed at Świnoujście. Polskie LNG S.A., a 100% subsidiary of the OGP GAZ-SYSTEM S.A. (TSO), is to construct, own and operate the LNG terminal. In the first stage of operation, the LNG terminal will enable the regasification of 2.5 bcm/year (6.8 mcm/d) of natural gas. It is planned to build two standard-sized containers with a capacity of 160 000 m^3 each. In the next stages, it will be possible to increase the dispatch capacity up to 5 bcm/year (13.7 mcm/d), and even up to 7.5 bcm/year (20.5 mcm/d), depending on gas demand, without the need to increase the area on which the terminal will be constructed.

In June 2009, Qatargas and PGNiG signed a Sales and Purchase Agreement (SPA) for LNG supply from Qatar to Poland. Under the SPA, Qatargas will supply 1.5 bcm/year of LNG to PGNiG under the 20-year long-term agreement, starting from 2014. In March 2010, PGNiG signed a regasification services contract with Polskie LNG according to which Polskie LNG will provide LNG regasification services to PGNiG at the terminal for a period of 20 years from July 2014. As the operator of the LNG terminal, Polskie LNG will be expected to provide services to all the other market participants.

STORAGE

There are eight underground gas storage facilities in operation in Poland. Their full capacity (1 830 mcm) equates to 41 days of the average gas demand in 2009 and 67 days of the average gas imports in 2009. The full capacity is also equivalent to 26 days of the average daily demand in January 2010.[54] The maximum withdrawal rate of these storage facilities is 35 mcm/d, which covers some 78% of average gas demand in 2009 and 49% of the average daily demand in January 2010.

In December 2008, the Energy Regulatory Office appointed PGNiG as the storage system operator (SSO) for a period of 27 years until the end of 2035. PGNiG owns all the Polish underground gas storage facilities. Under the Energy Law which entered into force in May 2005, PGNiG as the SSO is required to publish data on available storage capacity and to guarantee non-discriminatory treatment of the storage system users. However, except for the portion (50 mcm) made available to OGP GAZ-SYSTEM (TSO), PGNiG is the only user of the gas storage facilities in Poland. In practice, entities other than PGNiG did not obtain access to gas storage facilities in the country although PGNiG conducted open-season procedures. Pursuant to the Act of 16 February 2007, access to storage facilities is a precondition for entering into transmission agreement as well as for obtaining the licence for trading natural gas with other counties or for supplying customers in Poland. Therefore, lack of access to storage is a significant barrier for potential new entrants to the Polish gas market.

PGNiG plans to expand the storage capacity to 2.7 bcm by 2012 and to 3.8 bcm by 2015 (Table 12 provides details on the underground storage development plan to 2012).

54. Days of the average gas demand in 2009 and January 2010 as well as those of the average gas imports in 2009 are calculated on the basis of monthly statistics submitted by the Polish Administration.

Table 12. **Underground storage development plan up to 2012, as of September 2010**

UGS	Gas type	Current state		2012	
		Working capacity, mcm	Max withdrawal rate, mcm/day	Working capacity, mcm	Max withdrawal rate mcm/day
CUGS Mogilno	high-methane gas	370	20.64	396	20.64
UGS Wierzchowice	high-methane gas	575	4.80	1 200	14.40
UGS Husów	high-methane gas	350	5.76	350	5.76
UGS Strachocina	high-methane gas	150	1.50	330	3.85
UGS Swarzów	high-methane gas	90	1.00	90	1.00
UGS Brzeźnica	high-methane gas	65	0.93	65	0.93
CUGS Kosakowo	high-methane gas	0	0.00	0	0.00
UGS Bonikowo	low-methane gas	200	2.40	200	2.40
UGS Daszewo	low-methane gas	30	0.38	30	0.38
Total		**1 830**	**37.41**	**2 661**	**49.36**

Source: Polish Oil and Gas Company (PGNiG).

GAS SECURITY POLICY

Diversification of supply sources and routes, development of natural gas infrastructure for such diversification, expansion of underground storage capacity, extension of the transmission and distribution systems, increase of domestic gas production and developing gas resources outside Poland are the key elements of Poland's gas security policy.

The *EPP 2030* and its Action Plan stipulate the following measures to enhance gas security:

- encouraging investment in pipeline infrastructure through appropriate tariff policy;
- building a terminal for receiving liquefied natural gas (LNG) and concluding LNG supply contracts;
- establishing sustainable management policy for domestic gas resources to allow extension of the natural gas reserve base in the territory of Poland;
- promoting investments which allow extending natural gas extraction in the territory of Poland;
- diversifying supplies by building a transmission system for natural gas supplies from the North, West and South, as well as building connections primarily to meet the requirement of supply sources diversification;
- encouraging Polish companies to win access to natural gas deposits located outside Poland;
- supporting investments in infrastructure with the use of European funds;
- streamlining the crisis response mechanism;
- securing state interests in strategic companies of the gas sector;
- creating investment incentives for expanding storage capacity (by appropriate tariff structure and ensuring return on invested capital);

- adopting legislative measures aimed at lifting barriers to investments, particularly in respect of large investment projects in infrastructure (warehouses, LNG infrastructure, gas compressor stations, etc.) and linear investments;
- conducting further pilot work on making coal-bed methane from hard coal deposits available.

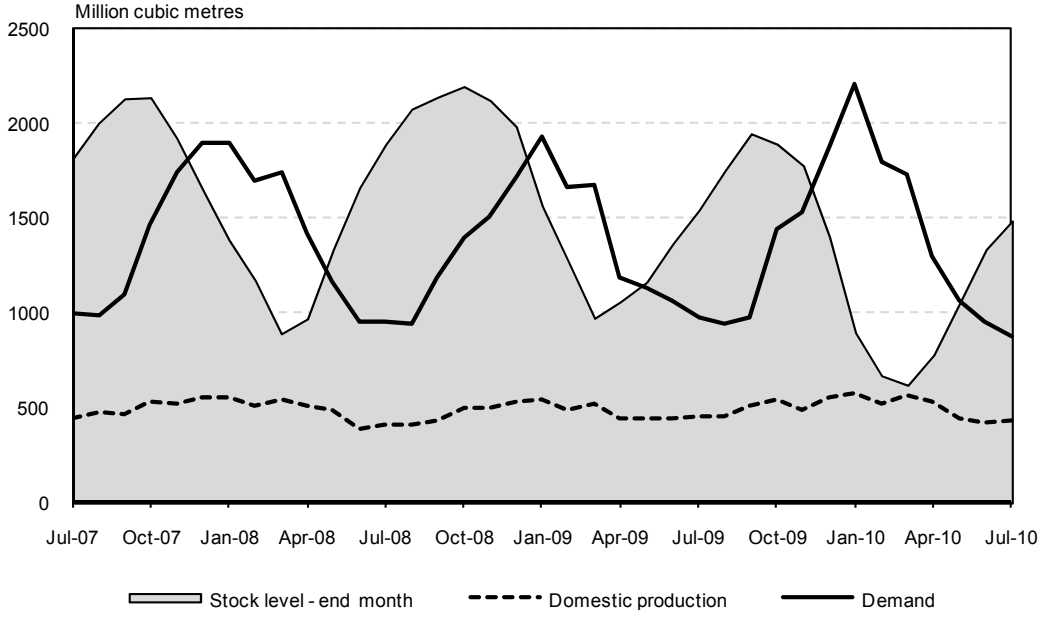
EMERGENCY RESPONSE POLICY

Under the Act of 16 February 2007, energy enterprises running a business of international gas trading or importers are obliged to maintain compulsory gas stocks within the territory of Poland, in storage installations connected to the gas system. The Act stipulates gradual increases of compulsory stocks as a number of days of the actual average daily amount brought into the territory of Poland within the framework of an intra-Community acquisition or imports according to the following schedule:

- from April 2007 to 30 September 2009 : 11 days;
- from 1 October 2009 to 30 September 2010: 15 days;
- from 1 October 2010 to 30 September 2012: 20 days;
- from 1 October 2012: 30 days.

These mandatory stocks of natural gas are required to be stored in installations that enable delivery of the entire stocks to the gas transmission system within 40 days. The amount of mandatory gas stocks is reviewed by the President of the Energy Regulatory Office on the basis of transport forecast for the nearest year. The costs incurred by enterprises/importers to fulfil the obligation are considered as the justified costs of their operations and could be included in tariffs.

Figure 31. **Monthly supply, demand* and stock levels**



*Demand as used here is monthly gross inland deliveries (observed) as reported in the IEA *Monthly Oil Statistics*.

Source: IEA.

In 2009, PGNiG was the only entity that maintained compulsory gas stocks in the volume determined by the President of the Energy Regulatory Office and was compliant with the provisions of the law on stocks. The other energy companies subject to stockholding obligations did not have to maintain such stocks because either they did not start trading natural gas with other countries, or they took advantage of the exemption[55] from that obligation when the decisions were issued by the Minister of Economy.

Compulsory gas stocks are held at the disposal of the Minister of Economy. These stocks may be released by the operator of the gas transmission system or of consolidated gas systems immediately after receiving a permission from the Minister of Economy. Trade enterprises and importers are obliged to prepare relevant procedures in the case of a threat to the continuity of supplies and to give early notification to the TSO.

New entrants perceive the stringent rules relating to compulsory stocks as a significant entry barrier on the Polish gas market. Moreover, the requirement to store the stocks on the Polish territory contradicts the EU Directives 2003/55/EC and 2004/64/EC on Common Gas Market Rules and on Security of Gas Supply. To open the Polish gas market to competition and to align the Polish system with the EU directives, the Polish government envisages the following revisions to the Act:

- allowing the maintenance of compulsory stocks of natural gas in storage facilities located outside the territory of Poland – in other EU countries such as Germany;
- raising thresholds allowing to apply to the Minister of Economy for an exemption from the stockholding obligation;
- granting the right to apply for exemption from the stockholding obligation to entities which have yet to import natural gas.

The amendment to the Act is expected to be adopted by the Parliament by the end of 2010.

EMERGENCY RESPONSE MEASURES

In case disruptions occur in the supply of natural gas to the gas transmission system of Poland or if natural gas consumption by consumers increases in an unforeseen way, the following procedures are envisaged to be taken in phases.

In the initial stage of a gas emergency (Phase I), trade enterprises and/or importers will secure additional supplies of natural gas from other sources or origins on a commercial basis, and/or will reduce their gas supply to major consumers according to their contracts. PGNiG has some contracts with natural gas consumers, which allow to apply restrictions for commercial reasons. Such interruptible contracts provide for the requirement to notify the client at least 8 hours in advance, before the agreed restriction level starts to be implemented.

If the TSO assesses that the measures introduced in Phase I are insufficient to eliminate the threat to security of natural gas supply in Poland, the Minister of Economy will decide on the use of compulsory stocks (Phase II). The TSO is responsible for conducting a withdrawal of compulsory gas stocks, in co-ordination with the storage system operator. Gas stocks are to be replenished by gas traders or gas importers within a

55. Exemptions can be granted to enterprises which have fewer than 100 000 customers and annually bring up to 50 mcm of natural gas.

period of four months starting from the end of the month when a withdrawal took place. This replenishment period may be extended to eight months by means of a decision by the Minister of Economy.

Box 8. **Poland's reaction during the Russia-Ukraine gas dispute in January 2009**

The January 2009 gas crisis highlighted vulnerabilities of the Polish isolated transmission system, which were represented by insufficient transmission capacity of existing interconnectors. At the same time, the gas crisis showed that Poland's emergency response mechanisms in place worked properly and efficiently. Below is a brief chronology of actions performed by PGNiG and GAZ-SYSTEM (TSO) during the crisis.

2 January: Because of a noticeable pressure drop at the Drozdowicze entry point (Poland-Ukraine border), PGNiG began to negotiate an increase of the gas delivery through the interconnection point in Wysokoje on the Poland-Belarus border. PGNiG began to fill in the missing gas supplies from underground storage facilities.

6 January: PGNiG was hit by the cut-off of gas deliveries contracted with RosUkrEnergo. The supplies from Ukraine through the Drozdowicze delivery point (14 mcm/d) were completely halted from 6 to 20 January 2009. During this period, gas imports from the East to Poland dropped by 18%.

GAZ-SYSTEM requested the Ministry of Economy to introduce the restrictions of gas supplies and consumption.

7 January: GAZ-SYSTEM requested PGNiG to apply trade restrictions. PGNiG reduced the gas supply to its two biggest consumers, PKN Orlen and fertilizers producer Zakłady Azotowe Puławy, for a period of nearly two weeks. As the gas delivery to PKN Orlen was cut by 25%, PKN Orlen switched fuel from gas to heating oil.

8 January: Gas supplies were stabilised. Shortages in the gas balance were compensated by 5 mcm/day higher deliveries of natural gas realised through the Wysokoje delivery point at the Poland-Belarus border. The use of supplies from underground gas storage facilities also increased.

21 January: Natural gas deliveries to Poland from Ukraine through the Drozdowicze interconnection point resumed, with a reduced volume. Only deliveries on the basis of the Yamal contract with Gazprom were executed; deliveries on the basis of the contract with RosUkrEnergo (7 mcm/day) did not resume (see also Table 9.)

Source: Country submission.

If the measures taken in Phases I and II do not restore the state of Poland's natural gas security, the TSO will notify the Minister of Economy of the need to impose restrictions on the use of natural gas (Phase III). According to the regulation of the Council of Ministers of 19 September 2007 concerning the mode and mechanism of imposing restrictions in the field of natural gas drawing, households and other customers whose total contracted capacity from the exit point is less than 417 m^3/hour are not subject to restrictions. The restrictions will be imposed on the basis of plans, which are elaborated by the TSO, DSOs and enterprises fulfilling the role of network operators and need to be approved by the President of the Energy Regulatory Office.

If the response measures of Phases I to III turn out to be ineffective, the Council of Ministers can notify the Chairman of the Gas Coordination Group and apply to the

European Commission for calling the Group. The Council of Ministers can also include commercial stocks available in storage facilities throughout the country into the compulsory stocks of natural gas (Phase IV).

The Polish Administration does not have any legal authority or policy to promote switching from natural gas to other fuels in an emergency. Gas-fired power plants are not legally required to hold a certain level of backup fuel stocks on site. Surge production of natural gas is not regarded as an effective response measure in a gas crisis, owing to its limited capacity.

PRICES AND TARIFFS

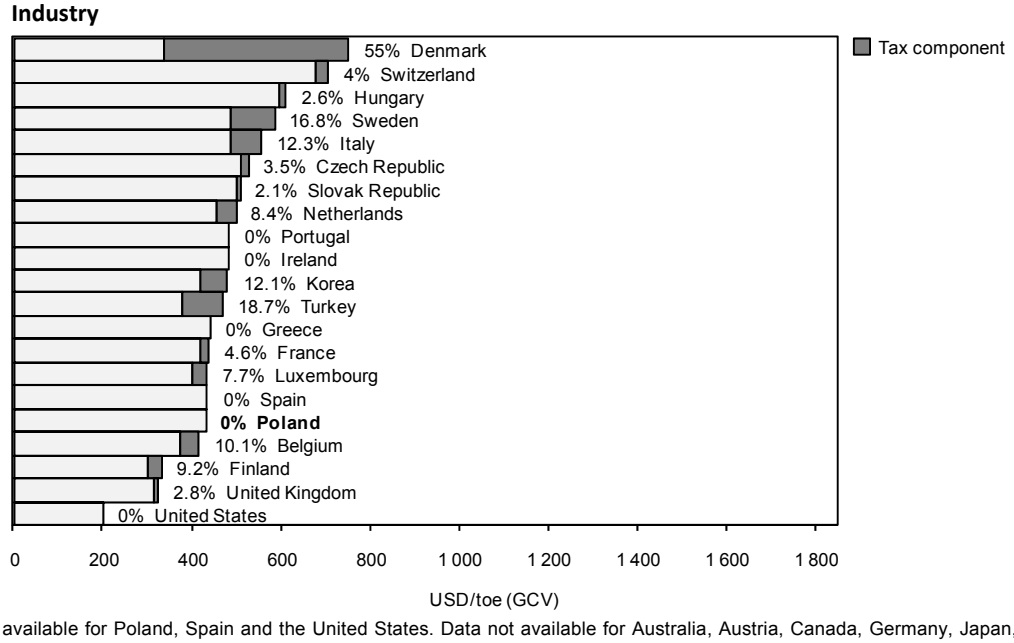
Gas tariffs for all consumer groups, including industry, are regulated by the Energy Regulatory Office (ERO). The regulated tariffs are supposed to cover all the costs of gas supply, including the cost of purchase or production, transportation and storage. In calculating the end-user tariffs, the ERO uses the weighted average of the costs of gas imports and domestic production. From March 2008, compressed natural gas (CNG) used in the transport sector is exempt from tariff approval.

The *EPP 2030* stipulates continuing regulation "in the areas characterised by natural monopoly in a way which ensures a balancing of interests of all market participants". It aims at reducing regulations in the sectors where a competitive market functions.

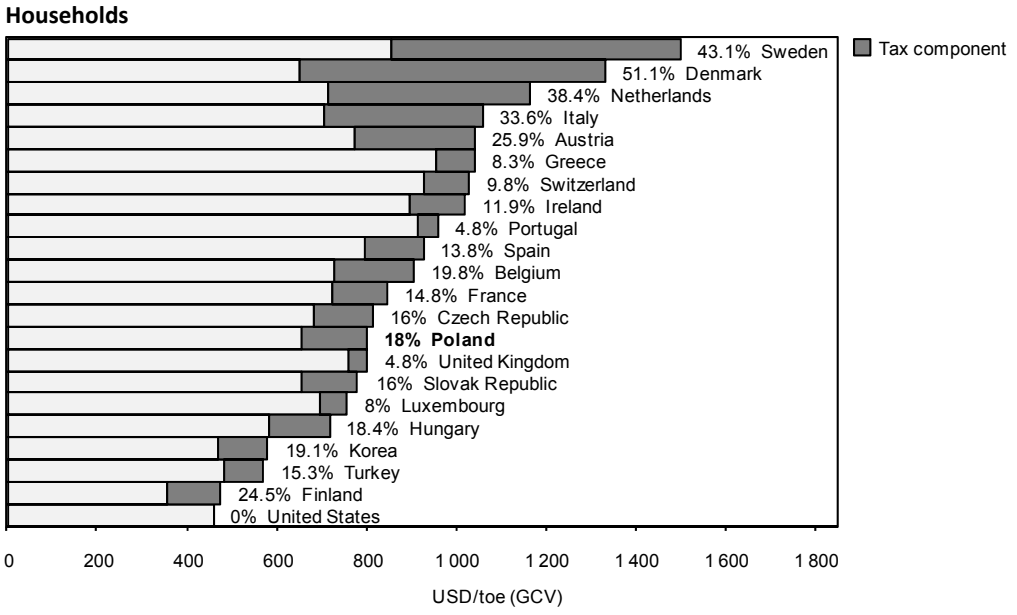
There are no "social" gas tariffs for vulnerable customers; the government tries to address the "energy poverty" issues by targeted social policies (Chapter 2).

Compared with other IEA countries, natural gas prices for households in Poland, whether before or after tax, are in the lower range (Figure 32). Information on the tax component in final gas prices for industrial consumers is not available to the IEA, but the pre-tax prices to industry are in the medium range among IEA countries.

Figure 32. **Natural gas prices in IEA member countries, 2009**



Note: Tax information not available for Poland, Spain and the United States. Data not available for Australia, Austria, Canada, Germany, Japan, New Zealand and Norway.



Note: Tax information not available for the United States. Data not available for Australia, Canada, Germany, Japan, New Zealand and Norway.

Source*: Energy Prices and Taxes,* IEA/OECD Paris, 2010.

CRITIQUE

The *EPP 2030* and its Action Plan include a set of important objectives for the development of foundations for a well-functioning gas market. It is commendable that both the security of gas supply and the competitive gas market were listed among the most important energy policy objectives. The government could put more focus on the positive role that gas can play in decarbonising the Polish electricity generation mix, thus helping the country comply with its climate change commitments. Gas-fired plants are the second-fastest plants to build, after wind farms, and are less subject to public opposition than coal or wind. They also provide reserve capacity for wind, since the intermittency in Baltic wind represents an increasing issue for the Polish transmission system operator.

The government is encouraged to continue its efforts to diversify import sources and transport routes of natural gas, as well as to implement other planned measures to enhance energy security. In particular, the construction of the LNG terminal in Swinoujscie should be pursued in a timely manner.

Poland has in place a rather well-designed emergency response mechanism. It has worked efficiently during the gas disruption in January 2009 following a Russia-Ukraine dispute. However, there is room for improvement. The government should develop a mid-to-long term comprehensive emergency response policy, including the promotion of fuel switching from natural gas to other fuels and the establishment of a legal framework for obliging gas-fired power plants to hold a certain level of backup fuel stocks on site. The government is advised to prepare an operational handbook that describes a gas structure as described by the National Emergency Sharing Organisation (NESO), emergency response measures and procedures. It should also conduct nationwide emergency response exercises on a regular basis. Last but not least, the government should conduct a survey to quantify fuel-switching capacities from gas to other fuels during a gas supply disruption.

On the other hand, well-functioning markets are the best way to assure security of supply. Therefore, the government is encouraged to enhance its efforts to promote a competitive gas market. Overall, implementation of the *EPP 2030* Action Plan would be one of the important steps towards addressing the situation and pursuing market liberalisation. It is particularly important to devise and implement a roadmap towards a competitive gas market, as stipulated by the Action Plan.

The restructuring of the gas sector has commenced, including the establishment of the structures stipulated by the second EU liberalisation package: an independent and state-owned transmission system operator (TSO) and six distribution system operators (DSOs). Despite these efforts, however, the gas market is still effectively monopolised. PGNiG S.A. has a dominant position in both upstream and downstream sectors. Being almost the only importer and domestic producer of gas, it effectively controls the wholesale gas market. PGNiG also dominates the retail market: other companies' market share is about 2% altogether.

Given the monopolistic structure of the gas market, the energy regulator continues to regulate tariffs for all end-users to avoid excessively high prices that could be established without regulation and without competitive pressure. Upward pressure on prices for households is a particular concern and, as a result, these prices are kept artificially low. However, regulated and artificially low end-user tariffs are an additional barrier to competition as they do not create incentives for potential competitors to enter the market. This results in a sort of "chicken-and-egg" situation: tariff regulation cannot be abolished as long as there is no competition, and competition is slow to develop as long as there are no market prices. However, there are many other barriers to competition, and the government and the regulator can take several actions in order to reduce them.

One key barrier is the very limited access of new entrants to gas resources. As PGNiG has booked practically all import capacity and is the major domestic gas producer, other companies can source their gas mainly by purchasing it from PGNiG.

Limited access to underground storage is another barrier to competition. PGNiG is the only owner and the appointed operator of the underground gas storage capacity and, in practice, its only user. It is encouraging that PGNiG has investment plans to expand the storage capacity. However, at current market setting and regulatory regime, expanding PGNiG's storage capacities might even further consolidate its dominant position on the market. Clear and effective rules are needed in Poland to ensure equal access to storage capacity for all market players; and these rules must be strictly enforced. An independent storage system operator might be the best option to ensure indiscriminated third-party access to storage.

Stringent rules related to compulsory gas stocks are another factor that deters potential competitors from the Polish gas market. The government's plan to amend these rules in order to create more flexible options for newcomers to the market is welcome.

Another obvious step towards a competitive gas market is the improvement of interconnections with neighbouring countries where Poland is making commendable progress. Today, the Polish gas transmission system is still relatively isolated from other systems. It allows only for one direction gas flows (east-west). OGP GAZ-SYSTEM is implementing several investment projects covering the period 2009-2014 that should radically change this situation.

The long-term take-or-pay contract for gas supplies between PGNiG and Gazprom, as well as the lack of third-party access to the Yamal pipeline, has been an important competition barrier. It is very positive that the new supply and transit agreements signed in October 2010 appointed GAZ-SYSTEM as the TSO for the Yamal pipeline and eliminated the "destination clause" forbidding re-export of Russian gas to other countries. It will be vital to ensure that GAZ-SYSTEM enables the application of third-party access and provides access to the Yamal pipeline on a non-discriminatory basis. It will be also important to ensure that the supply contract with Russia does not jeopardise Poland's efforts to diversify supply sources by building an LNG terminal, as well as to develop domestic conventional and unconventional gas resources.

Possible large resources of unconventional gas in Poland – if they are confirmed and exploited − could prove a game changer in the medium and long term, reducing Poland's import dependence and giving an opportunity to change its fuel mix currently dominated by coal. This would obviously have an impact on the overall energy and climate change policy. In the short term, the government is encouraged to continue supporting exploration activities and to start preparing future policy directions in case the large unconventional gas resources are confirmed. At present, too many barriers exist to make unconventional gas production economically viable and even physically possible. If Poland is to tap its potential shale and tight gas resources, it will be necessary to build the necessary infrastructure and the right legal and regulatory framework to support production. Such supportive environment for hydrocarbon exploration and production is also needed to make the most efficient use of Poland's conventional gas resources, as discussed in the following chapter.

RECOMMENDATIONS

The government of Poland should:

- *Devise and implement a roadmap towards a truly competitive gas market.*
- *Establish a regulatory framework that ensures efficient capacity use and non-discriminatory access to the transmission network, and an independent storage operator.*
- *Phase out regulated tariffs, starting with industry, as competition increases.*
- *Continue efforts to increase interconnections with neighbouring countries and work towards enabling reverse flow operations for all interconnectors.*
- *Develop a mid-to-long term comprehensive emergency response policy, including the promotion of fuel switching from natural gas to other fuels and the establishment of a legal framework for obliging gas-fired power plants to hold a certain level of backup fuel stocks on site.*

8. OIL

SUPPLY AND DEMAND

SUPPLY

Oil remains the second-largest energy source in Poland, whose share in the country's TPES steadily increased from 12% in 1988 to 25% in 2009, with the gradual decrease of coal's share in TPES from 79% in 1988 to 55% in 2009. The Polish Administration forecasts that the share of oil in TPES will remain flat at the current level in the coming 20 years.

In 2009, Poland produced about 1.6 million tonnes (Mt) (25 thousand barrels/day) of oil (0.7 Mt of crude oil and 0.9 Mt of other products[56]) which covered some 5% of the country's total oil demand.

Poland's oil imports in 2009 were 26.7 Mt (558 kb/d), consisting of 407 kb/d crude oil, 26 kb/d of natural gas liquids (NGLs) and feedstock, and 125 kb/d refined products. Russia is the single largest source of crude oil imports and provided about 94% of the total in 2009. Crude oil imports from Russia are via the Druzhba pipeline. In 2009, the remaining portions of crude oil were imported mainly from Algeria (some 2% of the total), the United Kingdom and Norway (some 1% of the total).

Crude oil is imported by refiners mainly under commercial long-term contracts. In the first eight months of 2010, PKN Orlen, the biggest refiner in Poland, secured 85% of crude oil through long-term contracts while the remaining 15% of crude oil was delivered through spot markets. In the same period, 96% of crude oil that the company imported was via the Druzba pipeline. The second-biggest refiner, LOTOS Group, imports roughly 70% of crude oil on the basis of long-term contracts.

In 2009, roughly 60% of the refined product imports came from the former Soviet Union, such as Russia (20%), Lithuania (13%), Kazakhstan (8%) and Belarus (6%), while some 40% of refined products were imported from OECD Europe, including Germany (30%), the Slovak Republic (9%), the Czech Republic (3%).

Poland exported some 50 kb/d of oil in 2009 consisting of 5 kb/d of crude oil and 45 kb/d of refined products. Most of crude oil was exported to Germany, while some 70% of refined products were exported to OECD Europe, such as Denmark, Germany and the Czech Republic.

DEMAND

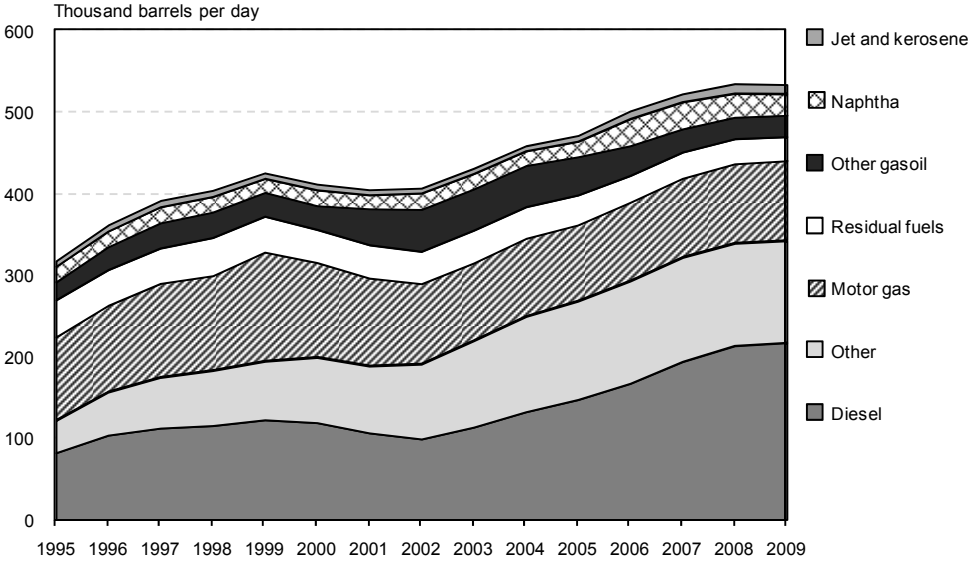
Poland's oil demand increased from 19.1 Mt (411 kb/d) in 2000 to 24.5 Mt (533 kb/d) in 2009, with an annual average growth rate of 2.9%. Oil demand is dominated by middle distillates (gas/diesel oil), which accounts for roughly 50% of the total (Figure 33). In the

56. Including crude oil and non conventional oil, such as biofuels.

period between 2000 and 2009, demand for transport diesel increased by 110% (from 5.1 Mt in 2000 to 10.8 Mt in 2009), whereas demand for gas/diesel oil increased by 65% (from 7.2 Mt in 2000 to 11.9 Mt in 2009). In the same period, consumption of gasoline decreased by some 14% (from 5.0 Mt in 2000 to 4.3 Mt in 2009). During the last decade, the consumption of liquefied petroleum gas (LPG) in the transport sector increased as this fuel became more competitive relative to gasoline. LPG demand, however, reached a peak in 2008 as its price advantage eroded and as the conversion of gasoline engines into LPG-fuelled ones became more expensive. Gasoline demand followed an inverse trend, gradually decreasing during most of the 2000s from its late 1990s peaks in favour of LPG, but picking up again since 2008 as price differentials began to penalise the latter fuel.

Over the past few years, heating oil demand has declined, displaced by alternative energy sources such as natural gas, thus resulting in falling imports. Meanwhile, residual fuel oil demand, mostly used for power generation, has also fallen owing to interfuel substitution, although part of its recent decline was also related to lower electricity use as a result of the recession.

Figure 33. **Total oil consumption by product, 1995 to 2009**

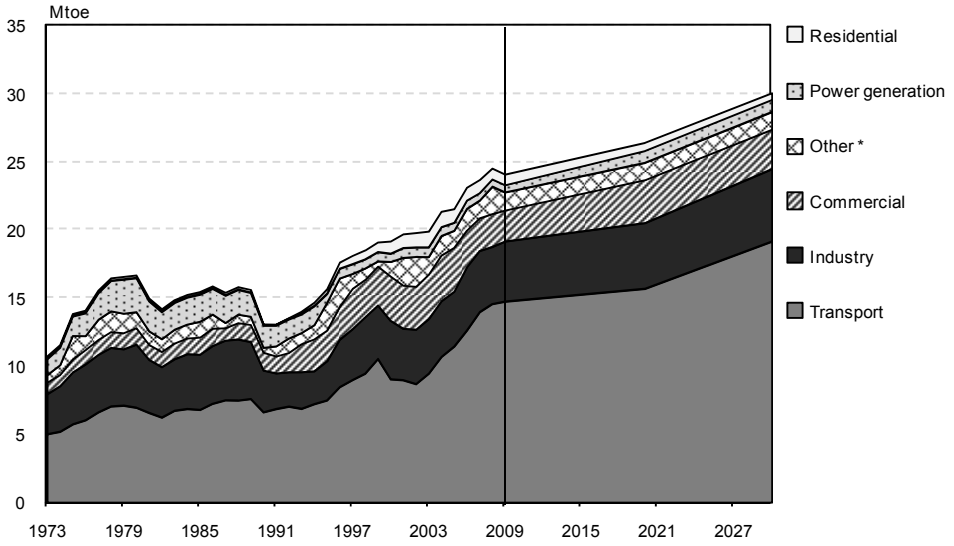


Source: *Energy Statistics of OECD Countries*, IEA/OECD Paris, 2010.

Oil demand growth in the medium term is expected to be driven by diesel demand, on the back of the ongoing "dieselisation" of the vehicle fleet. Nonetheless, diesel demand growth is likely to be less buoyant relative to recent years, partly because of the global economic recession, efficiency gains and the gradual levelling-off of new vehicle sales as the country catches up with other European countries.

The transport sector accounted for around 60% of the total oil consumption in Poland in 2009. Its share in total oil consumption rose by some 10% in the last decade, while the shares of industry and the commercial/agriculture sector dropped by around 5% (see Figure 34).

Figure 34. **Oil consumption by sector, 1973 to 2030**



* *Other* includes other transformation and energy sector consumption.

Note: This figure shows historical data until 2009 and the government's projections from 2010 to 2030.

Sources: *Energy Statistics of OECD Countries*, IEA/OECD Paris, 2010 and country submission.

THE UPSTREAM SECTOR

RESOURCES

Poland has oil fields in the Polish lowland (76.4 % of the national resources), the Baltic Sea (18.6 %), the Carpathian foredeep (1.6 %), and on the Carpathians (1.5%). As at the end of 2009, the documented reserves of crude oil were estimated at 25.9 Mt. The possibility of an increase of the oil reserves in Poland is limited. Such an increase is possible mainly in the Polish lowland, in the Baltic Sea and in the Carpathians where exploration is actually under way.

EXPLORATION AND PRODUCTION

The Ministry of Environment grants licences for exploration and production of hydrocarbon deposits in accordance with the 1994 Geological and Mining Law. Before granting a licence, the ministry has to consult the Ministry of Economy and the relevant local authority. In 2009, most exploration licences were held by six companies, while most production licences belonged to only two companies (Table 13). The Polish Oil and Gas Company (PGNiG) and LOTOS Petrobaltic (a subsidiary of LOTOS Group) are the two main producers of crude oil in Poland; the former produces oils from onshore fields while the latter from offshore fields in the Baltic Sea.

In early 2010, 85 oil fields were in exploitation. About 85% of oil was produced at the Polish lowland oil fields and 11% at the Polish economic zone of the Baltic Sea. In 2009, Poland's total crude oil production was 679 thousand tonnes (kt) of which LOTOS Petrobaltic produced 175 kt and PGNiG 504 kt. PGNiG plans to increase its crude oil output to 1.0 Mt in 2013 by developing and starting production from the Lubiatow-Miedzychod-Grotow deposits (LMG), located in the western part of Poland.

Table 13. **Oil concessions in Poland, 2009**

Exploration concessions	
Company	**Number of concessions**
PGNiG	74
FX Energy	24
RWE Dea AG	14
LOTOS Petrobaltic	8
Lane Energy Poland	6
PKN Orlen	5
Others	20
Production concessions	
Company	**Number of concessions**
PGNiG	219
LOTOS Petrobaltic	4
Others	4

Source: Country submission.

INFRASTRUCTURE

REFINING

There are six refineries in Poland, with a total primary distillation capacity of around 580 kb/d (28 Mt per year). Two capital groups, PKN Orlen and the LOTOS Group, represent the entire Polish refining industry.

Plock refinery, which is owned by PKN Orlen and located in the central region of the country, has a total crude distillation capacity of 355 kb/d. LOTOS Group possesses the Gdansk refinery, the second-largest refinery in Poland. These two major refineries account for over 98% of the country's total refining capacity. Both Plock and Gdansk refineries process mainly REBCO (Russian export blend crude oil).

Gdansk refinery is in the final stage of increasing processing capacities to 10.5 Mt per year (216 kb/d) by installing a new crude and vacuum distillation unit (CDU/VDU) under the "Programme 10+", which is expected to be completed at the beginning of 2011. In late 2010, PKN Orlen launched a new unit (VII diesel oil hydrorefining unit – HON VII) that will add approximately one million tonnes to the annual diesel oil production capacity of the main plant in Plock.

The remaining four refineries are located in the southern part of Poland and have very small processing capacities. Two of them (in Jaslo and Czechowice) are processing refined petroleum proheavy heating oil and focus on storage and distribution of fuels.

In 2009, the four operating refineries (in Plock, Gdansk, Jedlicze and Trzebinia) processed around 467 kb/d of crude oil, including natural gas liquids (NGL) and feedstocks. In the same year, the composition of production from these refineries was motor gasoline (22%), gas/diesel oil (30%), residual fuel oil (24%) and LPG (5%).

Poland had a diesel deficit of 35 kb/d in 2009. Some 20% of the total diesel consumption was met by imports in 2009. The country also faced an LPG deficit of 61 kb/d in 2009.

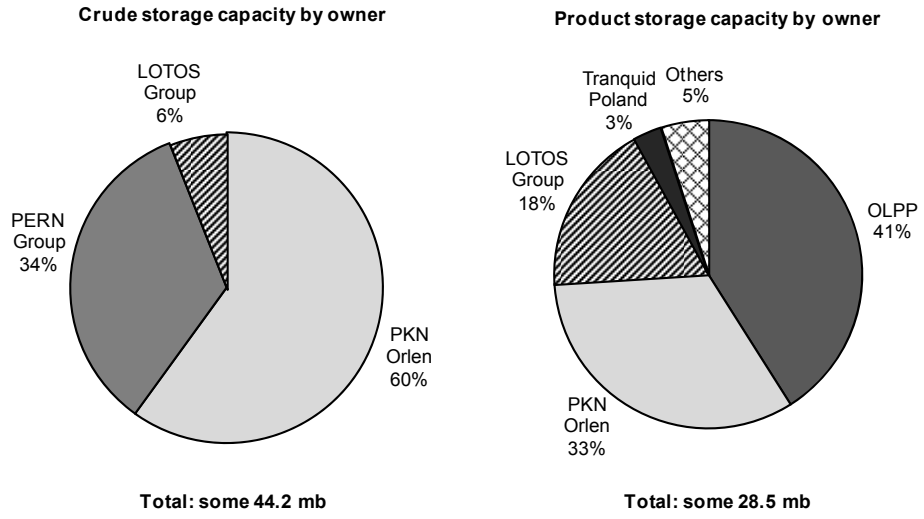
However, ongoing capacity expansion projects at refineries are expected to contribute to a reduction of the current diesel and LPG deficits. Nevertheless, the country is expected to remain a net diesel importer in a long-term perspective.

STORAGE

Poland, as all other IEA member countries, is obliged to hold oil stocks equivalent to at least 90 days of net imports of the previous year (see more details in section below on Emergency Oil Reserves). According to the IEA's methodology for calculating emergency reserves, Poland's daily net imports for 2009 were some 455 thousand barrels (kb). During 2010, to meet the 90-day commitment, some 38 to 48 million barrels of oil stocks were required, the equivalent of 6 to 7.5 mcm of oil storage capacity.[57] Poland held some 63.5 mb of oil stocks at the end of July 2010, equating to 126 days of 2009 net imports.

In June 2010, Poland possessed a total storage capacity of 72.7 million barrels (11.6 mcm). Roughly 60% of the total storage capacity is used for crude oil. This capacity is owned and operated by PKN Orlen, the LOTOS Group and the PERN Group (Figure 35). PERN Group is a strategic enterprise owned entirely by the Polish State Treasury, operating in the market of crude oil and oil products logistics. The PERN Group includes OLPP – the largest provider of storage services for oil products in Poland. The companies merged in 2009.

Figure 35. **Ownership of storage capacity, June 2010**



Source: Polish Administration.

57. The stock levels required for the 90-day commitment vary, depending on the type of stocks. The figures stated here (some 38 to 41 million barrels) show the theoretical range between the two extreme cases when all the stocks are held in oil products only and in crude oil only. The basis of calculation of the 90-day requirement, namely daily net imports, will be reviewed and change every year.

PKN Orlen, through its subsidiary IKS Solino, owns and operates the largest underground storage facility (salt caverns) in the country, with a total storage capacity for crude oil and oil products of 5.1 mcm (32.1 million barrels). It is directly connected to the Druzhba pipeline with a drawdown rate of 107 kb/d, as well as connected to the Plock refinery through product pipeline.

PERN plans to expand its total storage capacity to some 3.8 million barrels by 2013, through constructing additional crude storage depots in Plock, Gdansk and Adamowo.

OLPP has 22 oil product storage facilities, which are spread over the country. The five key oil product storage facilities are located in Koluszki, Nowa Wies Wielka, Boronow, Rejowiec Poznanski and Emilianow, which are connected to the Plock refinery via pipeline.

In response to the expected increase of demand for storage capacities, PERN and the LOTOS Group are considering building underground salt caverns for crude oil and fuel storage in the Pomorski region near Gdansk. The caverns are projected to have a total capacity of 6 mcm (some 38 million barrels).

PIPELINES

Existing pipelines

The Druzhba and the Pomeranian are the main pipelines for transporting crude oil in Poland. These two pipelines supply Russian crude directly to the refineries at Plock and Gdansk, and transit volumes on to the German refineries at Schwedt and Spergau.

The Polish branch of the Druzhba pipeline is composed of two main sections of pipeline. The eastern section spans from the Belarus border in Adamowo to Plock, which has a nominal capacity of some 870 kb/d (43 Mt/yr). PERN Group is currently using a substance reducing hydraulic drag which helps to pump more oil than it was specified in the technical design of the pipeline. A third line is under construction on this eastern section to increase the section's nominal transportation capacity to over 1 million barrels/d (50 Mt/year) by the end of 2012. PERN Group is considering the possibility of changing the first line of the eastern section of the Druzhba pipeline into a product pipeline. However, no final decisions have been taken as of end November 2010. The western section of the Druzhba pipeline links Plock to the German border in Schwedt, which has a capacity of some 545 kb/d (27 Mt/year).

The Pomeranian pipeline can transport crude oil in two directions between Gdansk and Plock. From Gdansk to Plock, the line has a capacity of 0.6 mb/d (30 Mt/year), while the capacity is 0.45 mb/d (22 Mt/year) in the opposite direction. This is the route for the Russian oil destined for the refinery in Gdansk and also for export through Naftoport.

The Polish government is concerned with Russia's decision to build the Baltic Pipeline System-2. This project would allow Russia to deliver oil to its Baltic ports, bypassing a number of transit countries. As a result, the volumes of oil transported through the Druzhba pipelines may decline. Therefore, the Polish government believes it is essential to increase the capacity of the Pomeranian pipeline, for example by constructing a second line. This would allow increasing transportation of oil from the Gdansk terminal to the Plock refinery and German refineries located at the Druzhba pipeline.

There are four main oil product pipelines, connecting the Plock refinery to various storage depots (see Table 14).

Table 14. **Oil products pipelines**

Start of pipeline	End of pipeline	Capacity (kb/d)
Płock	Nowa Wieś Wielka	42
Nowa Wieś Wielka	Rejowiec	28
Płock	Emilianów	20
Płock	Koluszki	76
Koluski	Boronów	20
Płock	Ostrów Wielkopolski	54
Ostrów Wielkopolski*	Wrocław	20

* Operational by January 2011.

Source: Polish Administration.

Odessa-Brody-Płock-Gdansk pipeline

There is a plan to extend the Ukrainian Odessa-Brody pipeline to Plock or Adamowo (the decision of the connection point has not been taken so far), and further to Gdansk in Poland, with the aim of decreasing oil import dependence on Russia and diversifying oil import sources and routes. The Odessa-Brody pipeline was originally built to carry Caspian oil westwards, but in 2004 the Ukrainian Cabinet took the decision to reverse the pipeline flow, thus making it transfer Russian crude southwards to the Black Sea and from there to other destinations. The extension and re-reversal of the pipeline would provide a non-Russian route for the transportation of Caspian oil supplies to Europe. The Odessa-Brody-Plock/Adamowo-Gdansk pipeline, which would be a part of the Euro-Asian oil transport corridor (EAOTC), would thus reopen the oil route from the Azerbaijan port of Baku to the Black Sea port of Supsa in Georgia and then to Ukraine's port of Odessa by tanker. From Odessa, it would be piped to Brody in Ukraine and further to Poland.

This project has been negotiated during energy summits since 2007. At the first summit held in Krakow in May 2007, the Presidents of Poland, Ukraine, Lithuania, Georgia and Azerbaijan, and the special envoy of the President of Kazakhstan agreed on extending the Odessa-Brody pipeline into Poland. At the follow-up summit held in October 2007 in Vilnius, the agreement to form a pipeline consortium (SPV Sarmatia) was signed by the Presidents of Poland, Ukraine, Lithuania, Georgia and Azerbaijan.

The project on the construction of the Polish section of the Brody-Plock oil pipeline is listed as a priority under an operational programme of the European Union, "Infrastructure and Environment". Roughly PLN 495 million (about EUR 114 million) is allocated to this project, but the whole project will need to be completed no later than 2014 if the costs are to be claimed.

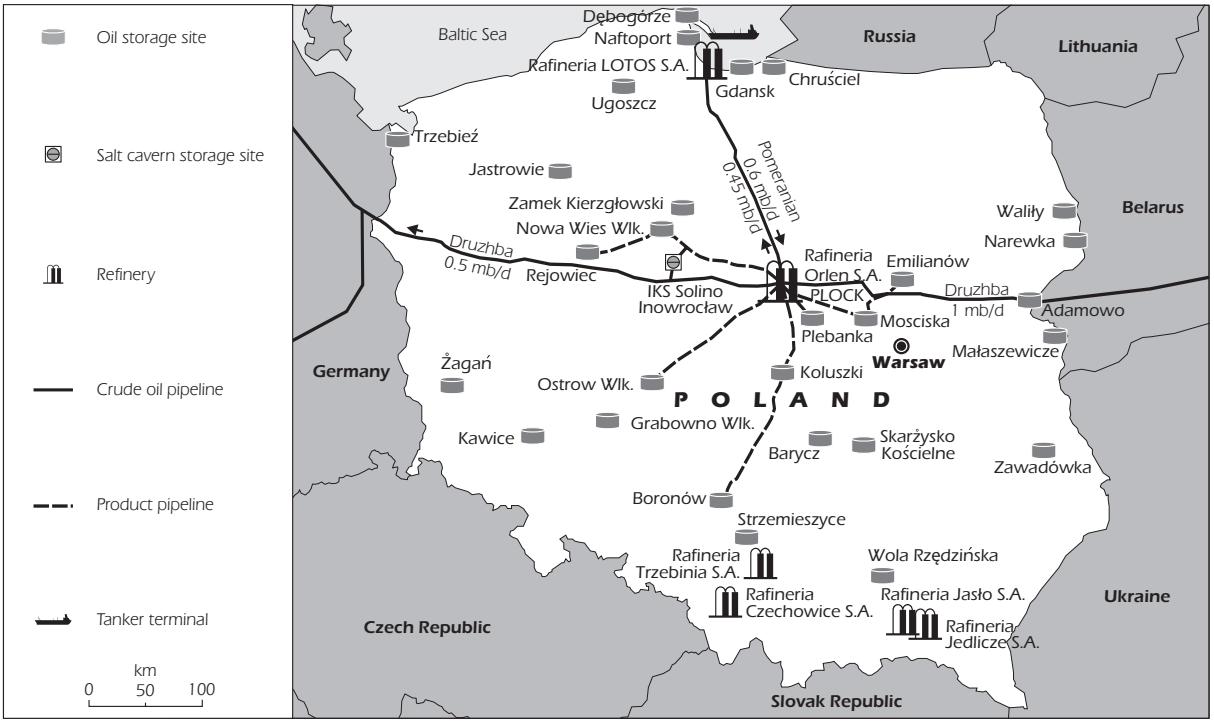
PORTS

There are three oil port terminals in Poland. The main one in Gdansk has a capacity of about 700 kb/d (34 Mt/year). Naftoport owns and operates four jetties in Gdansk Port. Some 67% of the Naftoport's shares are held by PERN Group. The remaining portions are held by PKN Orlen (some 18%), LOTOS Group (some 9%) and others.

In 2009, over 7.1 Mt of crude oil and fuels was loaded and discharged at Naftoport's jetties in Port Gdansk, of which 6.1 Mt was crude oil. Gdansk Port is used primarily for exports of Russian crude oil.

There are two small oil terminals for imports of oil products; Gdynia Port (with a capacity of 3.5 Mt/year or 70 kb/d) and Szczecin (1.5 Mt/year or 30 kb/d).

Figure 36. **Oil infrastructure, 2010**



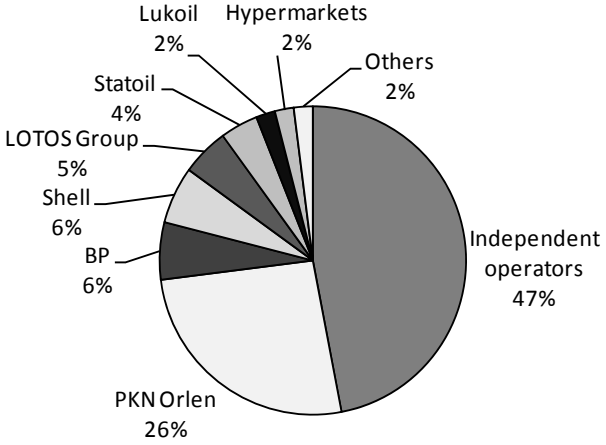
The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

Source: *Oil Information*, IEA/OECD Paris, 2010.

RETAIL MARKET STRUCTURE

Poland has a dense network of fuel stations owned by Polish companies PKN Orlen and LOTOS Group, as well as stations belonging to foreign companies such as BP, Shell, Statoil and Lukoil. The total number of fuel stations amounted to about 6 700 in 2009, out of which some 3 200 were owned by independent operators. At the end of 2009, the share of PKN Orlen in the total number of fuel stations was 26%, while the share of LOTOS Group was 5%. Roughly 190 fuel stations were closed by major companies as well as independent operators in the last two years, owing to unprofitability or technical obsolescence of fuel stations.

Figure 37. **Structure of the retail market in terms of number of fuel stations in 2009**



Source: Polish Administration.

EMERGENCY RESPONSE POLICY AND EMERGENCY ORGANISATION

EMERGENCY RESPONSE POLICY

The 2009 governmental document *Energy Policy of Poland until 2030* (EPP 2030) sets a long-term strategy for the energy sector. This document specifies six basic directions for the development of the Polish energy sector, including ***"increased security of fuel and energy supplies"***.

Under the *EPP 2030,* the oil supply security is foreseen to be enhanced by the further diversification of supply sources of crude oil and liquid fuels as well as expansion of oil storage capacities.

The use of emergency oil stocks is central to Poland's emergency response policy. Demand restraint is considered as a secondary response measure which could be introduced in a long-lasting and severe crisis.

The Act of 16 February 2007 forms the legal framework for oil stockholding and oil crisis management in Poland. Under this Act, three general levels of emergency response are described. In Level 2 (national crisis) and Level 3 (international crisis), a reduction of the stockholding obligation on industry or sale of government stocks is envisaged, depending on the nature of disruption and market needs. The Administration considers the use of compulsory stocks held by industry as the most likely first response measures because of their location in the logistic system.

EMERGENCY ORGANISATION

The Minister of Economy is responsible for Poland's energy security policy, including oil emergency response policy. The Governmental Group on Energy Emergency Management serves as the core body in the National Emergency Sharing Organisation (NESO) in Poland. The Group is an advisory body to the Minister of Economy and does not have any specific authority to decide on stockdraw or demand restraint. Its main role is to recommend to the Minister of Economy the actions to be taken.

The Governmental Group is headed by the Deputy Minister of Economy in charge of the oil and gas sectors and is composed of representatives from the Ministries of Internal Affairs, Transport, State Treasury, and from the Energy Regulatory Office and Material Reserves Agency. The Department of Oil and Gas in the Ministry of Economy functions as the Secretariat of the Polish NESO. This department (NESO Secretariat) is responsible for the preparation of actions to be taken by the Minister of Economy, consultations with oil industry and institutions (such as the Material Reserves Agency and the Energy Market Agency) and for the implementation of emergency response measures.

During an emergency, the Minister of Economy will take a political decision to participate in an IEA collective action and on emergency response measures. The decision-making procedure for demand restraint measures is expected to be longer and more complex, as introduction of these demand restraint measures needs the consent of the Council of Ministers.

EMERGENCY OIL RESERVES

EXISTING STOCKHOLDING REGIME

Poland meets its stockholding obligation to the IEA and the EU by holding 14 days of government stocks (on the basis of average daily internal demand) and by placing a stockholding obligation on industry. Industry's obligation has been progressively increased in anticipation of IEA membership (which took place in September 2008), rising from the 66 days required at the end of 2006 to 76 days by the end of 2008.

All liquid fuel producers and importers are obliged to hold minimum stock levels based on their production or imports from the previous calendar year. Some 130 companies had stockholding requirements at the end of 2009.

Under the direction of the Ministry of Economy, the Material Reserves Agency (MRA) manages the state-owned oil emergency reserves and also monitors the stockholding obligation on industry. The MRA is required to hold oil stocks equivalent to no less than 14 days of net imports. If for any reason the combination of public stocks and stocks held by industry failed to meet minimum obligations, the level of public stockholding would be increased by the necessary amount.

Industry holds stocks in excess of its actual obligation, thereby providing an additional buffer for meeting the minimum 90 days of net imports.

Furthermore, the Act of 16 February 2007 obliges producers and traders to gradually increase their mandatory stocks of LPG up to the levels corresponding to at least three days of production/import by the end of 2007, to 20 days by the end of 2010 and to 30 days by the end of 2011.

REVISION OF THE CURRENT STOCKHOLDING REGIME

According to the governmental documents (*the Policy of the Government of Poland for the Oil Industry* dated 6 February 2007 and *Energy Policy of Poland until 2030* adopted by the Council of Ministers in November 2009*)*, the Minister of Economy is obliged to submit a legislative proposal aiming at the modification of the oil stockholding system.

The Administration is considering moving towards abolition of the obligation to maintain physical stocks by producers and traders in exchange for a fee allocated to the deliberate maintenance of those stocks through the Material Reserves Agency. The assumptions for the new act on stocks were drafted by the Department of Oil and Gas in the Ministry of Economy and were submitted to public and intra-ministerial consultations in June 2010. Results of the consultations are under assessment, and it is anticipated that the draft assumptions for the new act on oil stocks will be submitted to the Council of Ministers for adoption in early 2011.

The new legislation is expected to contribute to lowering the market entry cost incurred by new oil market participants as well as to eliminating financial risks, thus fostering competition in the domestic oil market.

LOCATION, QUALITY OF CRUDE AND PRODUCT TYPES

Poland does not have bilateral agreements on stockholding with any other countries. Emergency oil stocks are entirely held in the national territory. Poland held some

63.5 mb of oil stocks at the end of July 2010, equating to 126 days of 2009 net-imports. Some 59% of the total stocks were held in the form of crude oil.

At the end of July 2010, the Material Reserves Agency held some 8.2 mb of government stocks, which were equivalent to 13% of the country's total stocks (16 days of 2009 net imports); 87% of the public stocks were maintained in the form of crude oil, while the remainder was in middle distillates (12%) and motor gasoline (1%). The public stocks of crude oil are held mainly in storage tanks rented from PERN Group, with some amounts in the salt dome storage facilities of PKN Orlen. Volumes of gasoline and diesel oil stocks are held in storage rented from OLPP. Public stocks are not allowed to be held outside the territory of Poland.

Industry stocks in Poland at the end of July 2010 stood at some 55.3 mb, which equated to 87% of the country's total stocks (110 days of 2009 net imports). At that time, 55% of the total industry stocks was in crude oil, while major remaining portions were in middle distillates (28%), motor gasoline (12%) and residual fuel oil (1%). A maximum of 55% of the industry stockholding obligation may be held in the form of crude oil. This level was lowered to 50% in 2010, requiring half of all compulsory industry reserves to be held in the form of refined products. Obligatory industry stocks may be commingled with operational and commercial stocks, and the obligation can be covered by ticketing, with a limit of 5% of the total obligation held outside Poland.

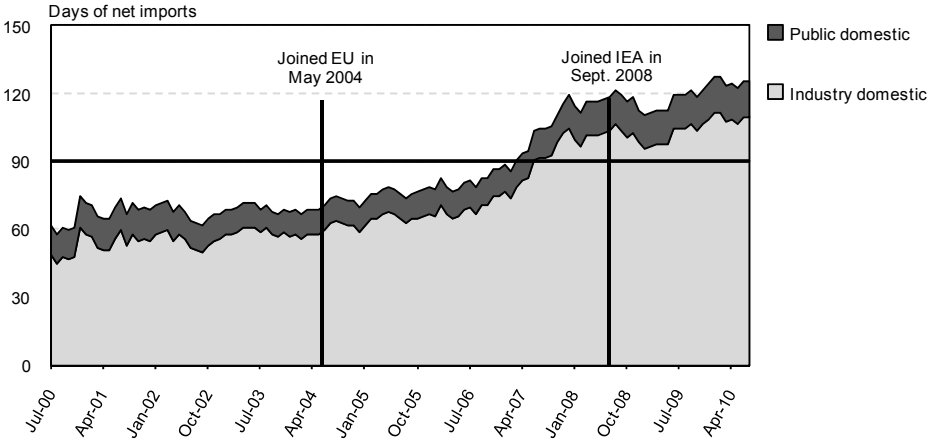
Concerning LPG stocks, at the end of July 2010, Poland held some 0.9 mb (75 kt) of LPG stocks, which was equivalent to 25 days of domestic LPG demand.

In 2009, there were nine storage agreements for maintenance of compulsory stocks of crude oil and products. The total volume of stocks under the storage agreements in 2009 was 13 mb, which was equivalent to some 20% of the total stocks in Poland. A domestic ticket market exists. In 2009, there were 32 ticket agreements, under which 1.5 kb of crude and 1 mb of products were held.

DAYS OF COVER

Poland has been consistently compliant with its IEA 90-day obligation since it became a member of the IEA in September 2008. Poland's oil stocks in terms of days of net imports have consistently been above 110 days since October 2007, and have been most of the time above 120 days since August 2008 (see Figure 38).

Figure 38. **Oil stocks and compliance with the IEA 90-day obligation, July 2000 to July 2010**



Source: IEA.

STOCK DRAWDOWN

The Minister of Economy is authorised to decide on the release of government stocks or mandatory industry stocks.

Public stocks could be made available to the oil industry through a number of options, including auction, tender or sales to specific entities. In case of releasing state stocks of crude oil, refiners may be required to process crude oil for products according to instructions of the ministry.

Industry stocks would be made available either by a reduction of the minimum stockholding obligation or by instructing industry to make stockdraw compulsory. During a supply disruption of the Druzhba oil pipeline in January 2007, the Polish Administration lowered the stockholding obligation for the Plock refinery, permitting a drawdown of some 130 kb/d of crude oil for a period of 11 days.

The industry stocks may be released by Ministerial Decree or by administrative decision of the Minister of Economy. The choice of tool depends on the nature of the crisis. In case the stockholding obligation on industry is lowered during a crisis by decree, the Department of Oil and Gas in the Ministry of Economy (NESO Secretariat) will prepare the draft Ministerial Decree, which is to be approved by the Minister of Economy and is subject to public consultations and consultations with other members of the Council of Ministers. It is expected to take about one week to issue the Ministerial Decree from the moment of the Notice of Activation by the IEA. The Ministerial Decree will stipulate the volume and type of oil to be released as well as the replenishment period. In the event a drawdown of crude oil stocks is chosen as a response to disruptions, an administrative decision by the Minister of Economy is a more probable tool to be used. In particular urgent cases, the time needed for preparation and signature of the decision by the minister may be reduced even to a few hours.

In the event of a threat to the oil security in Poland, upon the proposal of the Minister of Economy, the Council of Ministers may, by way of regulation, include the commercial stocks owned by producers and traders in their compulsory stocks. Commercial stocks are estimated to stand at around 10 to 12 days of domestic consumption.

FINANCING AND STOCKHOLDING COSTS

Government stocks are financed from the state budget. The average maintenance cost for government stocks (8 mb) in 2009 was some EUR 3.4 per barrel (PLN 15). No financial assistance or public funding is provided to industry to meet emergency reserve requirements. The average maintenance cost for obligatory industry stocks (some 40 mb) in 2009 was estimated at roughly EUR 7 per barrel (PLN 30).

PRICES AND TAXES

End-use prices of oil products contain the following components:

- wholesale price,
- excise tax,
- fuel surcharge,
- distribution margin, and
- value -added tax (VAT).

Wholesale prices, set by the refiners and importers, are not regulated by the government or the energy regulator. They reflect the refiners' and importers' costs and profits, and they depend on the world prices of crude oil and oil products. The distribution margins are not regulated either.

Table 15. **Excise tax and fuel surcharge, as of 1 January 2010**

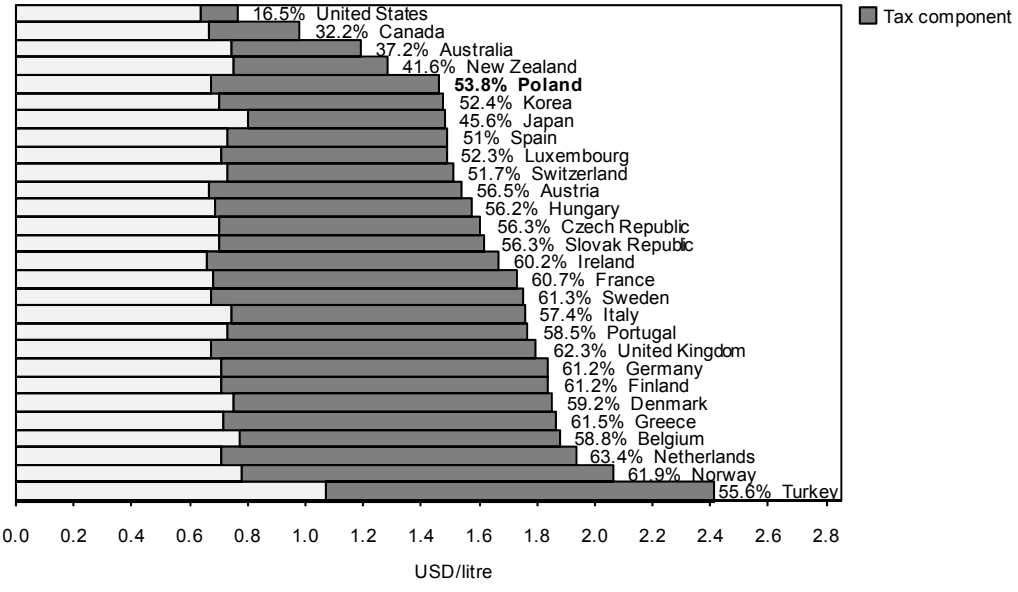
Product	Excise tax (PLN)	Excise tax* (EUR)	Fuel surcharge (PLN)	Fuel surcharge* (EUR)
Motor gasoline	1 565/1 000 L	397/1 000 L	92.87/1 000 L	23/1 000 L
Automotive diesel oil	1 048/1 000 L	266/1 000 L	233.99/1 000 L	59/1 000 L
Automotive LPG	695/1 000 kg	176/1 000 kg	119.82/1 000 kg	30/1 000 kg
Light fuel oil, marine gasoil	232/1 000 L	58/1 000 L	-	-
Heavy fuel oil	64/1 000 kg	16/1 000 L	-	-

*Data are from the European Central Bank, Euro foreign exchange reference rates, 1 October: EUR 1 = PLN 3.9370.

Source: Country submission.

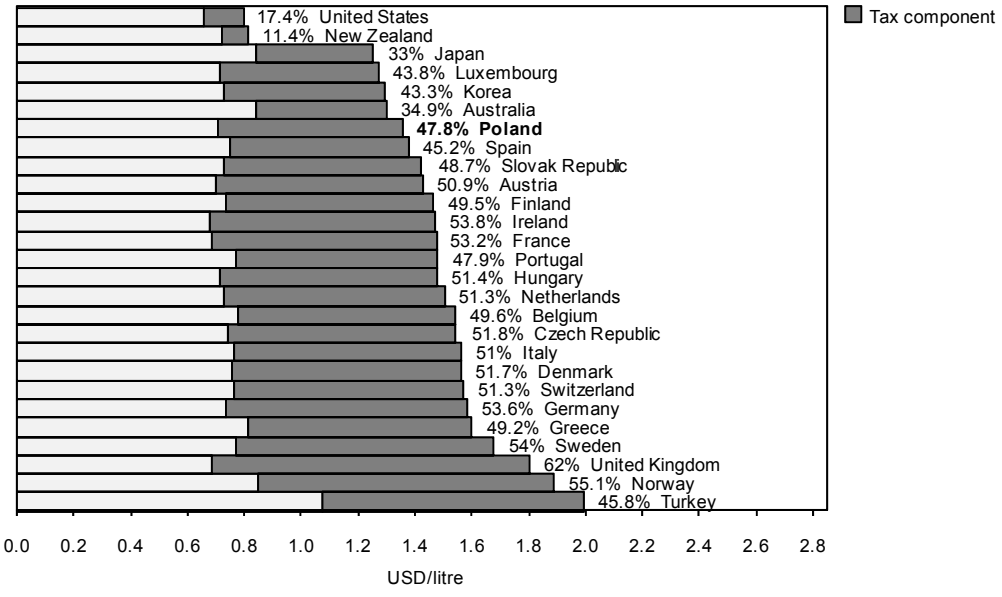
The values of the excise tax and fuel surcharge are set by the Parliament and/or the government. Excise tax is imposed on many oil products, primarily motor fuels and heating oil. Fuel surcharge applies only to motor fuels (gasoline, automotive diesel and LPG). The proceeds of the fuel surcharge are used for the construction of highways, through the so-called National Road Fund. Values of the excise tax and fuel surcharge are presented in Table 15.

Figure 39. **Unleaded gasoline prices and taxes in IEA member countries, second quarter 2010**



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2010.

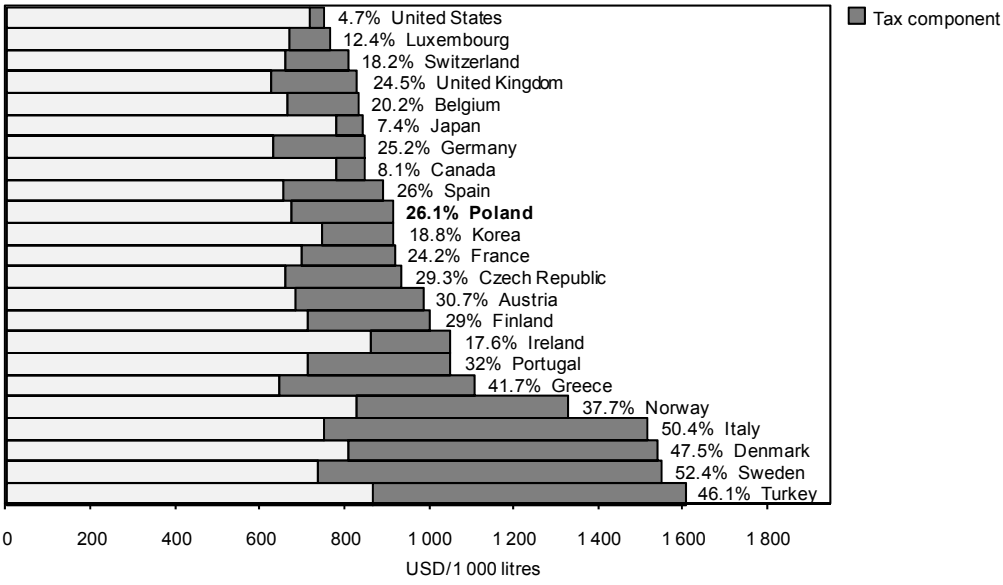
Figure 40. **Automotive diesel prices and taxes in IEA member countries, second quarter 2010**



Note: Data not available for Canada.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2010.

Figure 41. **Light fuel oil prices and taxes for households in IEA member countries, second quarter 2010**

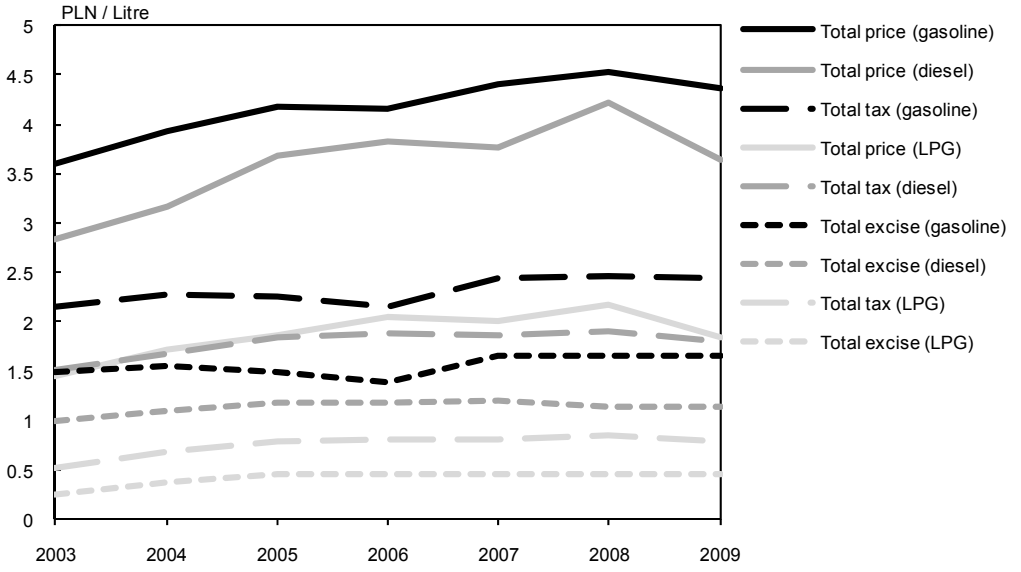


Note: Data not available for Australia, Hungary, the Netherlands, New Zealand and the Slovak Republic.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2010.

The tax rate of LPG has been roughly one-third of that of gasoline in the period from 2005 to 2009. Because of this difference between the two oil products, the price of LPG has been about 45% to 50% lower than that of gasoline, which contributed to the increase of LPG consumption in the transport sector. During the same period, the tax rate of diesel ranged from around 75% to 90% of that of gasoline, resulting in keeping diesel price by 2% to 12% lower than gasoline price.

Figure 42. **Average fuel prices and taxes in Poland, 2003 to 2009**



Source: IEA Energy Prices & Taxes 2nd Q 2010.

CRITIQUE

Poland is to be commended for its progress in enhancing oil security. The government is conscious about the inherent risks of being dependent on only a few sources of oil supply, and is making considerable efforts to diversify import sources and transport routes of crude oil. It should pursue projects to increase transportation capacity of crude and refined product pipelines, notably the Odessa-Brody-Plock-Gdansk pipeline project, from a viewpoint of economic feasibility as well as of strategic importance for the energy security of the country. In order to make further progress in diversification, the government should also look into the possibilities of acquiring oil from shipment to ports where it could come from a multitude of suppliers.

Overall, Poland has a solid emergency response policy in place. The country has been compliant with the IEA 90-day emergency stockholding obligation and currently has enough oil storage capacity to remain compliant in the near future. However, the projected increase in the oil demand in Poland and the expected execution of the Odessa-Brody-Plock-Gdansk pipeline project would require an expansion of storage capacity in the long term, for which the planned development of underground storage could be an efficient solution. The government should make further efforts to facilitate new entrants' access to newly built oil storage facilities.

To improve its emergency preparedness further, the government should consider and assess the possible negative impacts of worst-case scenarios of both domestic and global oil supply disruptions, and prepare contingency plans to cope with such oil crises that may last more than a few weeks. The IEA also encourages the government to reshape its National Emergency Sharing Organisation (NESO) operational structure for more rapid decision making in emergencies, to establish an operational handbook that brings together organisational structures, emergency response measures and procedures, and to conduct regular exercises.

A well-prepared media strategy is key for emergency response policy. Poland should prepare such a media strategy and, in the event of a domestic crisis, co-ordinate it with the IEA, the EC and neighbouring countries to maximise its effects on the oil markets.

The IEA supports the government's efforts to revise the existing stockholding regime, enhancing the role of public stocks by transferring stocks owned by the obliged companies to the Material Reserves Agency. The transition period to the new system should be as short as possible, given existing budget limitations. Furthermore, the government should conduct a study to evaluate the minimum operating requirements (MOR) of the main refineries and assess the appropriate level of stocks these refineries should voluntarily or mandatorily maintain. Last but not least, the IEA encourages the government to conduct a feasibility study on holding emergency stocks of bio-components in amounts proportional to their share in transport fuels or to address the problem of increasing the share of bio-components in transport fuels in another way.

Another important issue for the government's consideration is oil demand, which increased by nearly one-third since 2000. It is dominated by middle distillates, which account for about 50% of the total. High demand for LPG, largely due to the tax difference between LPG and gasoline, is also to be noted. Poland relies heavily on LPG imports. The Polish refineries have made investments to adjust their capacity and product range to the growing demand for diesel. Despite these improvements, there will still be a need for imports of diesel, albeit in relatively low quantities.

Rising demand for oil products is driven by the transport sector because of the growing number of vehicles and modal shift from rail to road transport (as discussed in Chapter 4 on Energy Efficiency). Oil demand growth in transport is very difficult to control, as in most other countries, and the government should make this challenge one of its policy priorities.

Demand response measures are a very important part of the energy security policy. The government is encouraged to undertake a study that will estimate the volumetric effects of available demand restraint measures, adapted to the circumstances of the Polish oil market. It is also very important to regularly exchange information on available demand restraint measures in the transport sector and the implementation procedures of these measures with neighbouring countries in order to facilitate regional co-ordination, if deemed possible. The government should also investigate potential volumes of fuel switching.

Domestic oil and gas production is another area where government action is required. The prevailing view is that the possibility of an increase of oil reserves in Poland is limited. On the basis of geological surveys and exploration activities to date, this is likely to be correct. However, experience from other petroleum provinces tells us that frontiers can be pushed. If one takes into account technology development, the likelihood of rising oil prices due to an expected rise in energy demand globally, new business models that reduce costs, such dynamics can change the picture altogether. It can thus be argued that a proactive approach to resource management helps overcome what currently is perceived to be absolute limits.

In order to improve the sector dynamics, the Polish government has undertaken commendable efforts in restructuring and privatising the oil sector. Yet there is a limited number of companies holding exploration and production licences, most of which are in the hands of PGNiG and LOTOS Petrobaltic. In order to underpin competition, diversity and innovation in the upstream oil and gas sector, the Ministry of Environment and the Ministry of Economy should promote their upstream sector more actively and assess the current licensing system with a view to improving framework conditions for new entrants.

This is particularly relevant as Poland may have substantial deposits of shale gas (as discussed in Chapter 7). For these resources to be explored, the competence and financial capital of major oil multinationals and international service companies could be a welcome addition to established players, but the government should also use this window of opportunity to involve these companies in the regular onshore and offshore activities.

Along the same lines, the government should ensure that sufficient incentives are in place for R&D co-operation in the upstream sector. Even if the upstream sector is relatively small, it has the potential of capturing a substantial resource rent. Thus, the kind of co-operation developing between industry players and research institutes in other Polish energy sectors should be encouraged. However, it is important that such efforts are based upon the needs of the industry and that they underpin the competitive advantages of Polish research institutes. Provided the government succeeds in making the Polish exploration and development business attractive to new international entrants, R&D co-operation should not be limited to domestic players only. The potential development of a shale gas industry should be taken into account when working out R&D priorities, as R&D policies should have a long-term strategic view.

RECOMMENDATIONS

The government of Poland should:

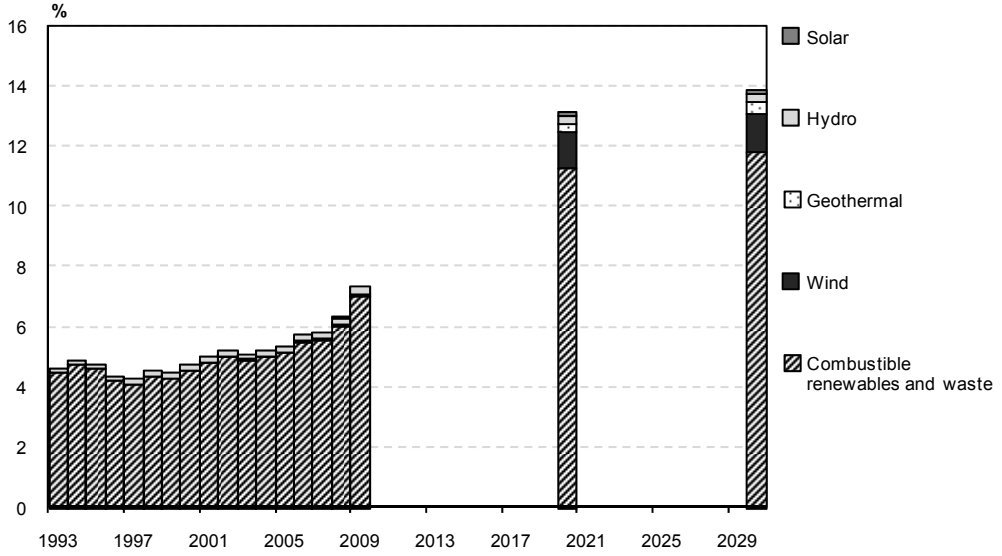
- *Continue to promote diversification of sources and routes of oil supply to Poland,* e.g. *by building the Odessa-Brody-Plock-Gdansk corridor for the transportation of Caspian oil to Europe.*
- *Continue efforts to increase oil storage capacity and oil transport capacity,* e.g. *by building a second line of Pomerania pipeline.*
- *Pursue efforts to revise the existing stockholding regime by further enhancing the role of public stocks.*
- *Enhance the domestic exploration and production sector by attracting new entrants, thus strengthening competition and innovation.*
- *Promote R&D co-operation between research institutes and companies, especially in areas that may unlock the full resource potential and underpin industry development.*
- *Enhance efforts to reduce oil demand, particularly in the transport sector.*

9. RENEWABLE ENERGY

SUPPLY AND DEMAND

The share of renewable energy and waste in Poland's total primary energy supply (TPES) has increased steadily over the last years, from 5.1% in 2003 to 7.3% (6.95 Mtoe) in 2009 (Figure 43). This places Poland on the sixteenth position among 28 IEA member countries ranked by the percentage of TPES coming from renewable sources and waste (Figure 44). This rank is similar to Hungary, but places Poland higher than the neighbouring Czech Republic and Slovak Republic. In terms of electricity generated from renewable sources, Poland holds the third-lowest position among the 28 IEA countries (Figure 45), before Korea and the Czech Republic. This is because most of renewable energy is used for heating purposes, as discussed below.

Figure 43. **Renewable energy as a percentage of total primary energy supply, 1993 to 2030**



Note: This figure shows historical data until 2009 and the government's projections for 2020 and 2030.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010, and country submission.

In 2009, 95.7% of the total renewable energy supply came from biomass and waste[58], and smaller amounts came from hydropower (2.9%), wind power (1.3%) geothermal and solar power contributions being negligible. Biomass supply has been growing at an average rate of 4.5% per year between 1998 and 2009.[59] Approximately half of all

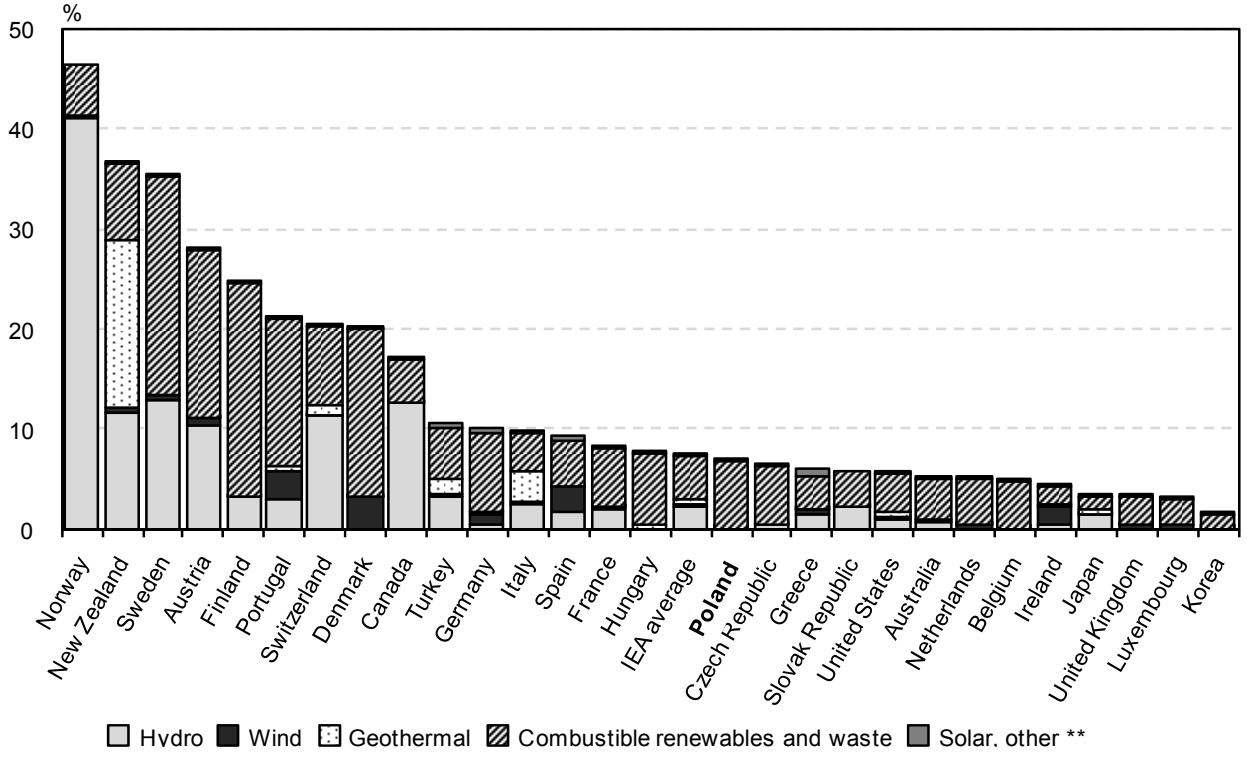
58. Biomass, industrial waste, renewable and non-renewable municipal waste.

59. The share of biogas and biofuels in total biomass and waste increased from 0.5% to almost 10% between 1998 and 2009, with an especially strong increase between 2007 and 2009.

biomass is used in the residential sector, which presumably consists to a large extent of "traditional use of biomass" in conventional applications with low efficiencies and high particulate matter emissions.[60]

The government expects that renewable energy production will expand considerably in the coming years. Its share in TPES is expected to double before 2020, and stabilise from there on (13.8% in 2030). The greatest absolute growth is expected in biomass, increasing its contribution by 6.4 Mtoe between 2009 and 2020. Solar thermal energy use is expected to have the highest relative increase due to its low starting point.

Figure 44. **Renewable energy as a percentage of total primary energy supply in IEA member countries, 2009***



*Estimates.

** *Other* includes tide and wave and ambient heat used in heat pumps (negligible).

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

About 26% of renewable energy supply is used in the transformation sector, producing heat and electricity; 35% is used directly by the residential sector (mainly by means of traditional use of biomass for heating), and another 20% by industry, mainly pulp and paper and wood industries.

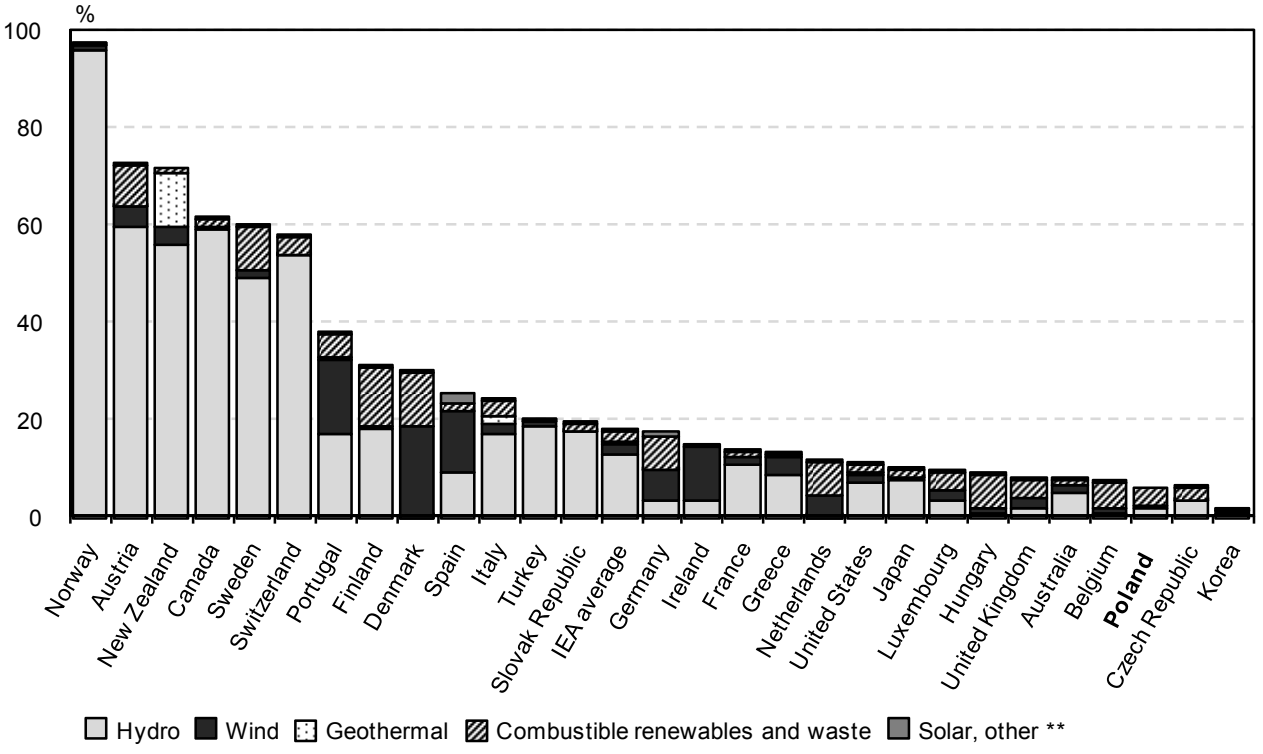
According to Polish sources, about 90% of all renewable energy in Poland was used for heating, 8% for electricity generation and 2% for the transport sector (biofuels) in 2006. The government projects that by 2030 the share of the electricity and transport sectors will grow to 26% and 15% respectively, while the share of heat will drop to 59% of total demand for renewable energy.

60. Traditional use of biomass has its drawbacks in terms of very low combustion efficiencies and (indoor) air pollution, and is not advocated by the IEA as sustainable renewable energy use.

ELECTRICITY GENERATION

In 2009, the electricity generated from biomass, solar, wind and hydropower produced 8.9 TWh, *i.e.* 5.9% of the total electricity generation of the country. This is the third-lowest share of electricity generated from renewable sources among the 28 IEA member countries (Figure 45).

Figure 45. **Electricity generation from renewable sources and waste as percentage of all generation in IEA member countries, 2009***



* Estimates.

** *Other* includes tide and wave and ambient heat used in heat pumps (negligible).

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2010.

Table 16. **Net electricity generating capacity from renewable and waste sources, 2000 to 2008**

Technology	Capacity installed (MW)					Average annual percentage change
	2000	2002	2004	2006	2008	
Hydro	2 183	2 207	2 282	2 331	2 335	0.9%
of which pumped storage	*1 366*	*1 366*	*1 406*	*1 406*	*1 406*	*0.4%*
Wind	4	32	40	172	526	107.7%
Industrial waste	3	7	3	3	3	6.4%
Solid biomass	0	0	24	25	40	11.5%
Biogas	9	14	24	32	52	24.9%
Total	**2 199**	**2 260**	**2 373**	**2 563**	**2 956**	**3.8%**

Source: *Renewables Information*, IEA/OECD Paris, 2010.

Total installed electricity generating capacity from renewables and waste was 2 956 MW in 2008 (including hydro pumped storage), up from 1 977 MW in 1990 and 2 199 MW in 2000 (Table 16). Wind power capacity has grown at the most significant rate (average annual percentage change of 107.7%).

SOLAR HEATING

As in other countries, it is quite difficult to collect statistical data on the use of small, decentralised renewable energy systems. In particular, in Poland the use of solar thermal energy is not fully covered by national official statistics because data are collected from industrial and services companies only, while solar thermal installations are also used by individual households and condominiums, according to the Institute for Renewable Energy. In 2007 the total reported surface of solar collectors was 236 000 m^2, with a total capacity 165 MW_{th}.[61] Recently published studies[62] reported that solar thermal capacity was 249.3 MW_{th} in 2008 and 357 MW_{th} in 2009, thus showing a 100 MW_{th} increase in 2009 as compared to 2008.

POLICIES AND MEASURES

TARGETS

Polish renewable energy policy is increasingly guided by the EU requirements. The EU Directive 2009/28/EC[63] introduced a binding target for Poland to increase the share of renewable energy to 15% of gross final energy consumption (from 7.2% in 2005) and a set of indicative intermediary targets (Table 17). The overall target for all EU member states combined is 20% by 2020. The directive also set a separate target for the transport sector: 10% of energy use in transport must come from biofuels or other renewable energy sources by 2020. Poland also has a specific target for renewables-based electricity set by Directive 2001/77/EC: 7.5% in 2010.

Table 17. **Renewable energy intermediate targets to 2020**

Year	Share of renewable energy in gross final energy consumption, %
2010	7.5
2012	8.76
2014	9.36
2016	10.44
2018	11.88
2020	15

Source: Country submission.

Poland is on track for meeting its overall target: in 2008 renewables accounted for 7.9% of gross final energy consumption. The specific target for electricity is more challenging: only 4.2% of electricity came from renewables in 2008 and 5.8% in 2009. However, the government expects that the growth in the renewable energy share will accelerate in the

61. Converted at 0.7 kWh_{th}/m^2 of solar collector area, as estimated by the IEA Solar Heating and Cooling programme.

62. IEA SHC, 2010 and ESTIF, 2010.

63. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

coming years as the country gains more experience with its support schemes. Eurostat, the EU statistical agency, annually reports on the progress of EU member states in meeting the target. The share of renewables in "gross final energy consumption" is not directly available in the IEA statistics because of methodological differences (see Box 9).

Box 9. **Final energy consumption: statistical differences between IEA and EU data**

The EU Directive 2009/28/EC introduced a target for all EU countries combined to increase the share of renewable energy to 20% of gross final energy consumption by 2020 and set specific binding targets for each EU member state. While the IEA annually publishes detailed energy statistics and energy balances for all EU countries, it uses different statistical methodologies compared to the EU directive. The IEA publications, including this study, report the countries' *net* total final energy consumption (TFC). Therefore, the share of renewables in "gross final energy consumption" is not directly available in the IEA statistics. By the definition of the EU directive, "gross final consumption of energy" means the energy commodities delivered for energy purposes to industry, transport , households, services including public services, agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution and transmission. By contrast, the IEA's TFC does not include transmission and distribution losses and own use of electricity and heat by the energy transformation sector, as well as consumption for international aviation. On the other hand, it includes non-energy use. More information about the IEA statistics can be found at http://www.iea.org/stats/index.asp.

ENERGY POLICY OF POLAND UNTIL 2030

Energy Policy of Poland until 2030 (EPP 2030) aims to stimulate various renewable energy technologies while giving particular attention to biomass. It sets the same objectives for renewable energy as the EU directive (15% of gross energy consumption, including 10% of transport sector fuels by 2020) and stipulates a further increase in the share of renewable energy in the following years. The *EPP 2030* highlights the need to protect forests and to use agricultural areas in a balanced way. It underlines the benefits of distributed power generation based on locally available resources. It also underlines the importance of solutions which will ensure the stability of the power system, taking into consideration the dynamic development of renewable sources.

According to the *EPP 2030*, the existing support mechanisms for the electricity and transport sectors (such as the certificates of origin, biofuels obligations and excise duty exemptions) will be retained. At the same time, additional support instruments are planned to be introduced to stimulate renewable heating and cooling. The document also outlines plans to support agricultural biogas plants, offshore wind farms and utilisation of biodegradable waste, and to evaluate plausibility of producing hydropower at the existing dams. It also plans to stimulate the Polish industry which manufactures machinery for the renewable energy sector such as wind turbine components and solar panel systems. The government considers that public support can help renewable energy industry to emerge in Poland. For example, good wind resources and the relatively large size of the country have the potential to make Poland an attractive market for wind energy technologies. *EPP 2030* stipulates direct financial support to renewable energy projects from European funds and environmental protection funds.

RENEWABLE ENERGY ACTION PLAN

To implement the EU Directive on Renewable Energy, Poland had to submit a Renewable Energy Action Plan to the European Commission by the end of June 2010. In late October, it had not been submitted yet because of a complex adoption process. A draft Action Plan was published for public consultation in May 2010. It outlines the existing measures in different sectors – electricity, heating and cooling, transport – and foresees financial support for renewables and high-efficiency co-generation projects. The draft plan projects that 15.5% of gross final energy consumption will come from renewable energy by 2020, slightly exceeding the country's target. While biomass is expected to remain the main renewable energy source, the biggest growth is expected to come from wind and solar energy for heating purposes.

ELECTRICITY

The main instrument to support renewable electricity is the quota obligation system with tradable certificates of origin, so called “green certificates”. It was introduced in October 2005. All electricity suppliers must ensure that a certain percentage of electricity sold to end-users comes from renewable sources (Table 18). The system works similarly to the system of CHP certificates discussed in Chapter 5.

To comply with this obligation, companies can either buy certificates of origin (green certificates) at the Polish Power Exchange or pay a “compensation fee”. As a result of this scheme, generators of electricity from renewable sources have two sources of income: the sales of electricity at a guaranteed price which is equal to the average market price in the previous year, and sales of green certificates. The average price of green certificates was PLN 250 per MWh in 2009 (approximately EUR 58).

Table 18. **Obligatory share of renewables-based electricity in total electricity sales, 2007 to 2017**

Year	Share of renewable energy in gross final energy consumption, %
2007	5.1
2008	7
2009	8.7
2010	10.4
2011	10.4
2012	10.4
2013	10.9
2014	11.4
2015	11.9
2016	12.4
2017	12.9

Source: Country submission.

The level of the substitution fee is set once a year by the regulator. It does usually match the maximum price for a green certificate in a given year. The substitute fee in 2009 amounted to PLN 258.89 per MWh (around EUR 60), the guaranteed price being PLN 155.44 (around EUR 36) per MWh. Energy companies that did not fulfil their obligation to purchase the certificates or pay the substitute fee are subject to penalties.

Substitute fees and penalties are transferred to the account of the National Fund for Environmental Protection and Water Management. Until the end of 2009 these revenues could be spent only on supporting investments in renewable energy sources, but since 2010 they can also be used for other purposes.

As stated in the Action Plan of the *EPP 2030*, the Ministry of Economy is to monitor the effectiveness of the green certificates system in achieving Poland's renewable energy targets. The ministry is tasked with a cost-efficiency analysis of the support mechanism, with particular consideration of the substitution fee formula, while ensuring the stability of the mechanism at the same time. Possible changes to the system, if any, are to be introduced in 2012.

Other support measures include:

- the obligation to buy all electricity generated from renewable sources connected to the grid at a guaranteed price which is equal to the average market price in the previous year;
- 50% of the cost of connecting renewable sources to electricity grids is covered by a subsidy;
- renewables-based facilities with a capacity up to 5 MW benefit from free licences for the connection to the grid;
- balancing rules for wind power plants are different from those for other power generation;
- loans and grants for investments in renewable energy projects from various funds (more details below in section on Financing and Project Development).

The Action Plan of the *EPP 2030* lists a number of measures to facilitate investment decisions on building offshore wind farms. It also tasks several ministries with the evaluation of possibilities of using the existing dams for hydropower generation.

GRID INTEGRATION

Like in many countries, key barriers to investment in renewable electricity sources are related to the connection and integration of renewables-based generation units to the grid. Key problems in this area include:[64]

- poor physical condition of the infrastructure and lack of grid development plans, which results in a lack of information on the current and future capacity available in the power transmission and distribution systems;
- no clear answers on the connection conditions and costs in the existing laws and regulations; in particular, there is no official methodology that would define which costs apply directly to the connection of a new unit, and which are related to the grid upgrade that would be carried out anyway;
- burdensome and costly administrative procedures related to the connection to the grid: in particular, the generator must pay a deposit when applying for a connection and this deposit is not refunded if the project is not implemented for whatever reason;
- lack of detailed studies on how much electricity from intermittent renewable sources the Polish grid can integrate without jeopardising the grid security;[65]

64. According to: Polish Economic Chamber for Renewable Energy; country submission; and the Polish Wind Energy Association.

65. The Polish Wind Energy Association estimates that the Polish grid can integrate 13 600 MW of wind energy capacity by 2020.

- insufficient interconnections with other countries; Poland already has several interconnections in place and more are planned (see Chapter 5 on Electricity).

HEATING AND COOLING

District heating system operators are legally obliged to buy heat from renewables installations connected to a heat network in an amount not exceeding the demand of customers connected to this network. The government plans to introduce measures to encourage wider use of geothermal resources, including heat pumps, as well as solar thermal systems. It also plans to analyse and possibly introduce additional instruments to promote district heating and cooling systems using renewable energy sources, as stated in the Action Plan to the *EPP 2030*. This Action Plan also tasks the Ministries of Economy and of Environment to issue technical regulations on the conditions for qualifying municipal waste as renewable energy.

In March 2010, the Ministry of Environment suggested amendments to the Geological and Mining Law. If these amendments are adopted by the Parliament, they are expected to stimulate the development of geothermal energy in Poland, through:

- waiving of the concessions for prospecting and/or exploration of thermal waters;
- reduction of the duration of the concession procedure;
- zero royalty rate;
- transfer of the competence to grant concessions for the extraction of thermal waters from the Ministry of Environment to *voivodships* (provinces).

The Ministry of Environment estimates that exploitation of geothermal resources is possible in several regions, particularly in the Carpathian Mountains. As of 1 March 2010, eight exploitation concessions and 20 concessions for prospecting and/or exploration of thermal waters were in force. Five geothermal heating plants are operated in Poland.

The draft Renewable Action Plan envisages offering a subsidy for individuals covering up to 45% of the total investment costs of solar thermal installations. Interestingly, the Polish solar thermal market has been growing steadily even without any financial incentive schemes because of the relatively low cost of installations and relatively fast return rate (see subsection on Solar Heating above).[66]

According to the Polish Chamber of Biomass, there is economic potential for further increasing biomass use for heating and/or combined heat and power in small, highly efficient boilers (in local systems that do not involve large transportation costs).

TRANSPORT

In July 2007, Poland adopted a comprehensive "Long-Term Biofuel Promotion Programme 2008-2014". It aims to improve the competitiveness of biofuels by measures along the entire production chain, from cultivation to conversion, distribution and end use.

At present, the key active instruments to promote biofuels are supply-side measures. The Biocomponents and Liquid Biofuels Law of 25 August 2006 introduced an obligation for all fuels suppliers − producers and importers – to ensure that a certain percentage of fuel sales comes from renewable sources as from 2008. This percentage, or national

66. ESTIF, 2010.

indicative target by energy value, gradually increases (see Table 19). Fines for non-compliance are to go into the National Fund for Environmental Protection and Water Management and to be spent only on activities related to biofuels or biocomponents. According to the Polish Act on Monitoring and Control of Fuel Quality, fuel suppliers are allowed to blend up to 5% of biocomponents in traditional fuels.

The Biocomponents and Liquid Biofuels Act allows farmers to produce liquid biofuels for their own use. Under the Fuel Quality Monitoring and Control Act, liquid biofuels produced by farmers for their own use must meet only minimum quality requirements that are essential for reasons of environmental protection. The annual limit on own-use production is 100 litres per hectare of the utilised agricultural area owned by the farmer.

Table 19. **National indicative biofuel targets**

Unit	Conversion rate from % of energy value	National indicative target for Poland, %						
		2008	2009	2010	2011	2012	2013	2014
% of energy value	1	3.45	4.60	5.75	6.20	6.65	7.10	7.55
% per volume for FAMEs in diesel	1.0772	3.7162	4.9549	6.1936	6.6784	7.1631	7.6478	
% per volume for ethanol in petrol	1.5088	5.2053	6.9403	8.6754	9.3544	10.0333	10.7123	

FAMEs: fatty acid methyl esters.

Source: Polish Petroleum Industry Association.

The share of biofuels in transport fuels was very small in recent years: from 0.35% in 2000 it grew to 0.68% in 2007 (by energy value). Following the adoption of the obligation, the share of biofuels grew to 3.66% in 2008 and 4.63% in 2009, *i.e.* above the target.[67] However, the Polish Petroleum Industry Association argues that the targets for the consecutive years will be difficult to reach because of low demand for the biofuels allowed to be traded on the Polish market: B100, B20 and E85.[68] The Association advocates for the introduction of B7 to trading which would facilitate meeting the national indicative targets.

Other measures to promote renewables in transport include tax and excise duty exemptions and reductions for biofuels and traditional fuels with bio-components.

As mentioned earlier, the "Long-Term Biofuel Promotion Programme 2008-2014" also includes demand-side measures such as exemption from parking fees and obligations for public administrations to use biofuels. However, as of early 2010, the implementation of such measures has not been sufficient to significantly boost demand for biofuels in Poland.

BIOGAS

The amended Energy Law of Poland provides the legal basis for connecting agricultural biogas plants to the gas distribution network. The gas system operator is legally obliged to purchase biomethane of agricultural origin but there is no minimum guaranteed price. The biomethane supplier must fulfil the quality requirements for the gas introduced into the network.

67. From 2010, the target exceeds 5% so it is impossible to meet it by simply adding the maximum allowed share of biocomponents (5%) to traditional fuels.

68. Low demand is partly explained by the fact that some car manufacturers do not provide warranty for such high blends. If car producers were obliged to warrant at least for B20, this could increase the demand for this blend considerably and could be a relatively low-cost solution.

From January 2011, any amount of biomethane introduced into the grid will be recalculated into an electricity-equivalent and then be subject to the green certificate support mechanism (the methodology for calculating biomethane into an electricity-equivalent had not been adopted at the time of writing).

The Action Plan to the *EPP 2030* lays down the following measures:

- adoption of the document "Development directions for agricultural biogas plants in Poland" by the Council of Ministers (it was adopted in July 2010);
- lifting barriers to agricultural biogas plants as identified in the programme (from 2009);
- drafting a guide for investors willing to build agricultural biogas plants, including, *inter alia*, sample biogas plant designs (2010);
- conducting an information campaign to provide comprehensive and reliable information on the advantages of constructing biogas plants, in co-operation with local authorities (2010);
- monitoring the implementation of the programme.

FINANCING AND PROJECT DEVELOPMENT

The Action Plan of the *EPP 2030* aims to provide assistance for renewable energy projects, as well as the infrastructure necessary for their connections, from public funds including:

- operational programme "Infrastructure and Environment" for the years 2007–2013;
- regional operational programmes for the years 2007–2013;
- National Fund for Environmental Protection and Water Management (NFOŚiGW).

At present, the National Fund for Environmental Protection and Water Management is the key institution for financing renewable energy projects in Poland. In the period 1989-2009 it co-financed 647 renewables projects, contributing PLN 914.7 million (EUR 211 million) or 32.2% of the cost. The total cost of all these projects was PLN 2.8 billion (EUR 0.65 billion). The Fund earmarked PLN 1 500 million (EUR 346 million) for implementing renewable energy and highly efficient co-generation projects in 2009-2012 (biomass, wind and geothermal). An additional PLN 560 million (EUR 129 million) is to be spent for a broader range of renewable energy technologies in 2009-2011 through Regional Funds for Environmental Protection and Water Management. The National Fund also plans to allocate PLN 300 million (EUR 69 million) to households and associations of apartment owners for the installation of solar collectors in 2010-2014.

The Action Plan to *EPP 2030* also highlights the need to analyse potential solutions facilitating access to domestic and foreign aid funds through the elimination of excessively stringent requirements and restrictions.

Although access to financing remains key, another important issue for renewable energy project development is the long and complicated regulatory procedures. Depending on the technology, obtaining permits for renewable energy projects in Poland requires several steps (between 6 and 8) that differ from region to region. Co-ordination of all the stages of project development is the responsibility of the investor, apart from assessing the environmental impact, in which the decision-making body co-ordinates the whole procedure. A one-stop-shop servicing of renewable energy projects (integrated permitting procedure) does not exist in Poland.

CRITIQUE

Renewable energy supply in Poland has been growing steadily over recent years, mainly driven by the system of green certificates and investment incentives. However, if the country is to meet its international obligations and domestic goals, additional policies and support measures need to be put in place, particularly in the electricity sector. The share of renewables in electricity generation is the third-lowest among the 28 IEA member countries. In 2009, renewable energy accounted for 5.9% of electricity generation, which is still low compared to the fast-approaching target of 7.5% in 2010. Contrary to some other IEA countries, Poland has significant renewable energy resources, particularly biomass and wind; and studies suggest that their economic potential could be higher than Poland's binding target for renewable sources to provide 15% of gross final energy consumption by 2020. To take full advantage of this potential, more effective policies are needed.

The Polish government has already taken steps towards reaching the targets, such as purchase obligation for renewables-based electricity and heat, and investment support for renewable energy projects. The main instrument to support renewable electricity is a market-based mechanism - the quota obligation system with tradable green certificates, introduced in 2005. It has been rather effective in stimulating investment in the most mature and economically attractive renewable energy technologies, such as biomass, thus allowing the country to increase the share of renewables in the energy mix in the most cost-efficient way.

However, the current renewable energy mix in Poland is quite unbalanced: renewable energy supply is dominated by biomass, while nearly 90% of all renewable energy is used for heating. The government rightly aims to diversify renewable energy sources by supporting wind (including offshore), and other technologies.

The key support mechanism – the green certificate system – can be effective for stimulating onshore wind, if the existing legal and regulatory barriers are addressed simultaneously. However, it does not provide incentives for the development of more expensive renewable energy technologies. This market-based approach is viable only if the renewable energy policy is mainly driven by climate change concerns and aims at maximising GHG emissions reductions at the least cost. However, in many countries other considerations also influence renewable energy policy. Renewable energy sources may contribute to improving local air quality, creating jobs, boosting the economic development of regions, and growth of the domestic scientific and industrial base. If, in addition to climate change goals, the Polish government wants to exploit the potential of a larger basket of renewable energy technologies over time and take advantage of their environmental and societal benefits, it may consider providing more active support to less mature and therefore more expensive technologies.

The government should pursue its efforts to address various barriers that hinder the development of renewable energy sources in Poland, such as difficult access to financing, lack of awareness, the NIMBY syndrome ("not in my backyard"), and integrating renewable energy systems into the grid. One key barrier is the weak and old transmission and distribution grids. Integrating large amounts of variable renewables into electricity networks can be challenging and involves additional costs. Transmission interconnections add flexibility and can be a cost-effective way to address variability, besides facilitating exports and improving security of supply.

The lack of a clear regulatory framework for connection conditions and costs is another barrier to increasing the share of electricity from intermittent renewable energy sources, especially wind. The government is aware of these problems and is trying to address them, but further efforts in these areas are necessary. For example, Poland can consider adopting a "one-stop-shop" approach to issuing permits for renewable energy projects, like in Denmark. The Danish Energy Authority introduced streamlined permitting, the "one-stop-shop", for dealing with approvals of sites, environmental impact assessments, permits for construction and operation, and licences to produce electricity.

Given the large share of heat in the total Polish energy balance, it is necessary to put stronger policy emphasis on heat from renewable sources in order to realise the targets of the EU Renewable Energy Directive. Targeted policies that encourage the use of modern, highly efficient heating and cooling technologies will not only help Poland increase the share of renewables in its balance but will also improve the quality of life of its citizens. Currently, about half of biomass is used directly in the residential sector, to a large extent in conventional appliances with low efficiencies and high particulate matter emissions. Modernising biomass use in the residential sector will therefore improve energy efficiency and reduce the negative impact on people's health.

Most of the support measures in Poland to date address the electricity and biofuels sectors. It is commendable that the government plans to analyse the possibility of introducing additional instruments to encourage district heating and cooling systems based on renewable energy sources. Conversion of coal-powered CHP plants to using biomass or biodegradable municipal waste will contribute to attaining the targets for both renewable electricity and heat. Plans to encourage wider use of geothermal resources, including heat pumps, as well solar panels and renewable municipal waste should also be pursued.

RECOMMENDATIONS

The government of Poland should:

- *Ensure timely and effective implementation of the measures outlined in the* Energy Policy of Poland until 2030 *and the (draft) Renewable Energy Action Plan in order to realise the full potential of renewable energy sources in electricity, heat and transport.*
- *Create a framework for investment in upgrading and extending the electricity transmission and distribution grids to enable timely connection of intermittent electricity sources.*
- *Pursue plans to encourage renewable energy use for heating and cooling, focusing in particular on:*
  - *stimulating the use of modern, highly efficient biomass technologies in the residential sector; and*
  - *enhancing the sustainable use of biomass and municipal waste in the existing CHP plants and district heating systems.*
- *Consider introducing additional support mechanisms for less mature renewable energy technologies (such as offshore wind) that are not stimulated by the existing green certificates system).*
- *Reduce administrative barriers to renewable energy projects.*

PART III
ENERGY TECHNOLOGY

10. ENERGY TECHNOLOGY AND R&D

ENERGY R&D STRATEGY

Stimulating technology uptake and innovation, including in the energy field, is one of the government objectives that is described in the National Development Strategy 2007-2015 and the National Strategic Reference Framework 2007-2013.

In October 2008, the government adopted the National Programme for Scientific Research and Development Activities *(*KPBNiPR). It defines priority research areas for 5 to 10 years and strategic R&D programmes for 3 to 5 ears. "Energy and Infrastructure" is one of the five priority areas in this programme. It is the first time the government clearly identified energy as a strategic direction of its R&D policy. In the past, energy R&D was dispersed among various programmes and projects with little official strategic direction.

The research area "Energy and Infrastructure" sets the following research priorities:

- reduction of energy consumption by developing and implementing energy-saving solutions in industry, services and households;
- effective and environment-friendly use of national fossil fuel resources;
- development of alternative energy sources and carriers (renewables, nuclear and hydrogen technologies).

These research priorities are in line with the main directions of the Polish energy policy which aims at enhancing energy efficiency, introducing nuclear power and increasing the share of renewable energy while extracting the most from domestic coal resources (see Chapter 2 for more details on the general energy policy).

The *Energy Policy of Poland until 2030* (EPP 2030) identifies "diversification of technologies" as a tool for enhancing energy security. It highlights the need to deploy modern technologies in the electricity sector and to enhance innovation efforts in most other sectors – from natural gas and district heating to energy efficiency. It stipulates "supporting R&D on new solutions and technologies" in the areas of energy efficiency, renewables and clean coal, including carbon capture and storage (CCS).

Although there are certain links between the Polish R&D policy and the general energy policy (in particular as regards the climate change and energy security goals), Poland has not yet developed a coherent energy R&D strategy with clear objectives, long-term funding, and monitoring and evaluation of results. A new package of laws adopted in April 2010 will have an impact on R&D policy, including energy R&D in the future.

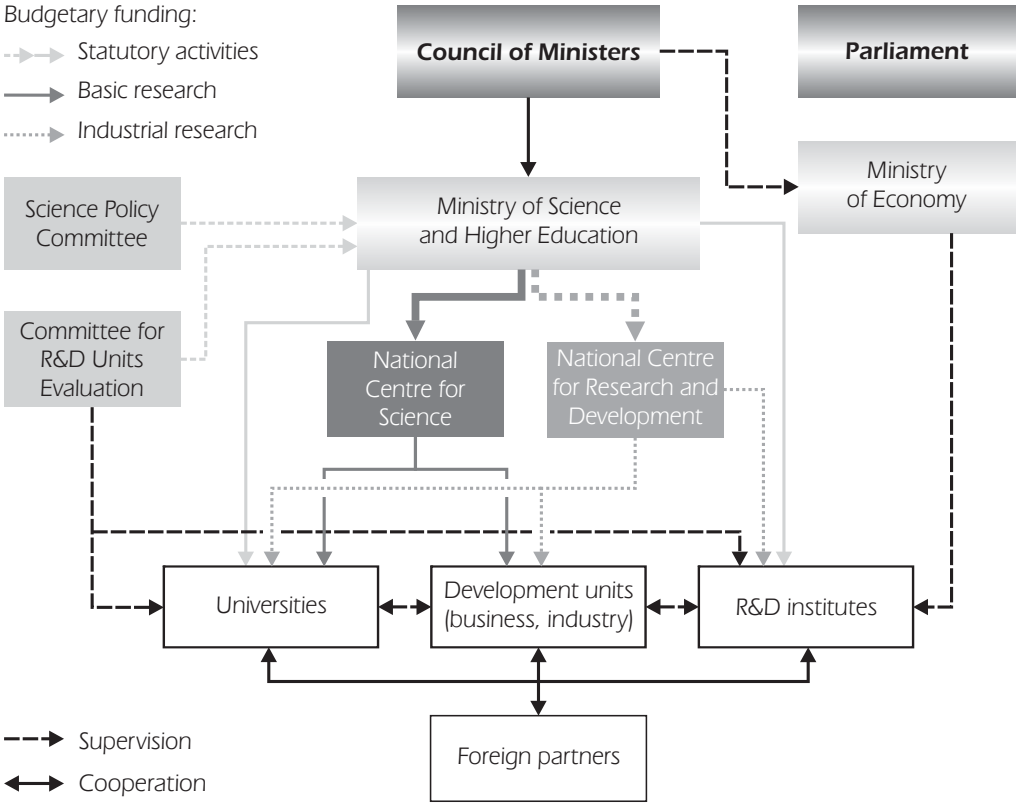
Annex 1 to the *EPP 2030* which assesses the implementation of the previous Polish energy policy (2005) emphasises that Poland has made progress in supporting energy R&D since 2005, driven by climate change and energy security concerns. However, the document concludes that current support activities have not significantly accelerated energy research and have not led to the modernisation of the energy sector so far. The implementation of the National Programme for Scientific Research and Development

Activities (KPBNiPR) with active participation of the energy industry is expected to improve the situation. The government reports that this national programme, and other specific strategic programmes relevant to energy issues, will be subject to monitoring and evaluation (ongoing and *ex post)*.[69]

INSTITUTIONAL ORGANISATION

In Poland, the Ministry of Science and Higher Education has the main responsibility for policy in the area of scientific research, while "sectoral" ministries (of Economy, of Agriculture, of Environment, etc.) are responsible for the implementation of demonstration projects and for the deployment of new technologies in their respective areas. Figure 46 shows the various institutions involved in energy R&D design and implementation.

Figure 46. **Institutional structure of energy R&D from 1 October 2010**



Source: IEA on the basis of the country submission.

The **Ministry of Science and Higher Education** is responsible for the development, implementation and the overall co-ordination of research policy, the funding of the research[70] and the promotion of international co-operation in the area of research. A consultative and advisory body for the minister is the Council for Science, established in 2005.

69. *Ex ante* examination of R&D needs for the energy sector has been linked to a foresight project carried out by the Central Mining Institute (GIG) in Katowice (project ended in 2007).

70. Except for funding military R&D.

The energy branch of the **Ministry of Economy** is responsible for the implementation of demonstration projects (for example CCS) and for the general deployment of new energy technologies (for example renewable energy). The Ministry of Economy supervises **Energy Research-Development Units** which are state institutions operating as separate entities in terms of their legal basis, organisational arrangements and funding mechanisms, and which conduct targeted R&D work. The budget of these units is allocated in two ways. R&D units receive financial support for their statutory activities (based on the assessment of their performance carried out every four years). The second stream of financial support is budget allocation for projects on a competitive basis.

The **National Centre for Research and Development** (NCBiR) was established in July 2007 to manage and implement strategic scientific R&D programmes (including energy-related) that translate directly into innovation development. The tasks of NCBiR include support for technology deployment. The National Centre is financed from the state budget. Since October 2010, in accordance with a new law adopted in April 2010,[71] NCBiR will gain more independence in obtaining funds and managing its research budget, and in developing future strategic programmes and projects.

Higher education institutions play a major role in national research. Fourteen Polish universities perform research and education in areas relevant to energy. Historically, this work has taken place in the faculties of mechanical and electrical engineering, and the main focus was on upstream fossil fuels production and conversion. In 2004/05, the Ministry of Science approved a new area of study – energy and energy technology. At present four Polish universities have energy and energy technology faculties where students can study, research and develop energy technologies.

Box 10. **Selected R&D institutions**

Poland hosts many respected R&D institutions specialising, in particular, on coal and other fossil fuels. The Central Mining Institute (GIG) in Katowice, established in 1945, is an R&D organisation under the responsibility of the Minister of Economy. It serves the mining industry with a wide range of scientific and engineering skills and capabilities, including specialist training and product certification. Its twenty departments cover all aspects of mining, from rock mechanics and mine design, through blasting safety and mine ventilation, to site restoration and waste management. The experimental "Barbara" coal mine in Mikołów opened in 1925 and continues to offer a unique facility for carrying out research activities 30 metres and 46 metres underground within its 5 km of workings. Current R&D includes techniques to improve coal recovery rates and co-operation with Ukraine on exploitation of thin coal seams.

Other coal R&D centres include: the Institute for Chemical Processing of Coal *(Instytut Chemicznej Przeróbki Węgla* at Zabrze); the Institute of Organic Chemistry and the Institute of Chemical Engineering at the Polish Academy of Sciences; the Institute of Power Engineering (Warsaw); POLTEGOR-projekt Sp. z o.o. (Wroclaw); AGH University of Science and Technology (Krakow); the Czestochowa University of Technology; Gdańsk Technical University; Krakow University of Technology; Technical University of Łódź; Silesian University of Technology (*Politechnika Śląska*, Katowice); Warsaw University of Technology; and Wrocław University of Technology.

71. Law on the National Centre for Research and Development.

Development Units are business entities which lead experimental development aimed at the practical application of the results of basic or applied research.

The **National Centre for Science** is a new institution created by the law adopted on 30 April 2010. It is a government agency, located in Cracow, that will take over activities of the Ministry of Science and Higher Education aimed at financing basic research.

The **Clean Coal Technologies Centre** (CCTW), launched in 2009, is a joint venture project of the Central Mining Institute (GIG) and the Institute for Chemical Processing of Coal (ICHPW)[72] Its work focuses on commercialisation of innovative clean coal technologies such as pressurised coal gasification, coal combustion in oxygen and underground coal gasification. The European Regional Development Fund is co-funding around EUR 38 million (PLN 165 million) of the total EUR 45 million (PLN 195 million) cost of establishing the centre. Box 10 mentions several other R&D institutions.

ENERGY R&D FUNDING

The main funding sources for energy R&D and demonstration include the national budget, EU funds, and the National Fund for Environmental Protection and Water Management. Until 1 October 2010 most of the funding was provided directly from the Ministry of Science and Higher Education.[73] Only selected projects were financed by the National Centre for Research and Development, among them the strategic programme "Advanced Technologies for Energy Production".

As of 1 October 2010, the Ministry of Science and Higher Education became responsible for allocating the budget, monitoring and supervising R&D activities. It channels the funding for industrial research, strategic programmes and projects to R&D units, universities and other beneficiaries (including industry). The National Centre for Science channels the funding for basic research.

Energy technology demonstration projects are financed by the EU funds and the National Fund for Environmental Protection and Water Management and co-ordinated by the Ministry of Economy.

The Polish government does not require centralised collection of data on public funding for energy R&D. As this funding comes from various sources and is channelled through different institutions, as stated above, it is difficult to estimate the overall amounts of total public spending, particularly before 2008. Until 2008, when the National Programme for Scientific Research and Development was adopted, the Polish system of science funding did not recognise the thematic approach in financing R&D activities. Calls for projects (applied and industrial research) were horizontal and funds were allocated for a variety of scientific fields and multidisciplinary research. That is why it is very difficult to assess the exact amount of budgetary resources for research projects. The overall funding of energy research from the state budget did not exceed 10% of the overall resources for project funding (although the amount varied and could be significantly lower).

The government reports that over the last few years, even in the context of the global economic crisis, it has effectively spent all funds earmarked for energy R&D.

72. www.gig.eu and www.cctw.gig.eu

73. Except for military R&D projects which are financed through direct transfers from the Ministry of Finance to the Ministry of Defence.

ENERGY R&D PROGRAMMES

Most of the implemented, ongoing and planned R&D programmes and projects draw on Poland's long-standing scientific and technological expertise in coal mining, processing and conversion. Poland has a long history in coal technology development. New mining techniques, high-capacity mining equipment, underground coal gasification (notably at the Mars experimental mine during the 1960s), coal-bed methane extraction, coal preparation technologies (grinding, drying and feeding), coal conversion technologies (for liquid fuels, gaseous fuels and chemicals), and power generation equipment have all been researched, developed and sometimes commercialised in Poland.

The growing pressure to reduce greenhouse gases stimulates Poland to explore ways to reduce CO_2 emissions from coal use. To ensure that the use of coal remains compatible with national and international sustainability goals, Poland places particular emphasis on new clean coal technologies – both for coal extraction and conversion, and for carbon capture and storage.

Poland has no specific basic research programmes related to energy.

ADVANCED TECHNOLOGIES FOR ENERGY PRODUCTION

The National Centre for Research and Development (NCBiR) implements a strategic programme "Advanced Technologies for Energy Production", commissioned by the Ministry of Science and Higher Education within the framework of the National Programme for Scientific Research and Development Activities. This programme is designed to support the consolidation of research teams and the integration of scientific and business communities.

The budget of the strategic programme is PLN 300 million (EUR 69 million) over 5 years (2010-2015) and an additional PLN 63 million (EUR 14.5 million) will come from industry. The programme focuses on technologies with the greatest potential for commercial application in the following areas:

- highly efficient power generation with CO_2 capture (PLN 70 million or EUR 16 million);
- oxyfuel combustion for pulverised coal and fluidised boilers with CO_2 capture (PLN 80 million or EUR 18.5 million);
- coal gasification for production of fuels and electricity (PLN 80 million or EUR 18.5 million);
- electricity and fuel production from biomass, agricultural waste and other recyclable products (PLN 70 million or EUR 16 million).

The first call for the performance of the research tasks was announced in June 2009 and the contracts were signed in spring 2010. Energy and chemistry sector companies such as PGE Elektrownia Turów SA, Tauron Polska Energia SA, Eurol Innovative Technology Solutions Sp. z o.o., Energa SA, Południowy Koncern Energetyczny SA, and ZAK SA as well as equipment manufacturers (Rafako SA, Foster Wheeler Energia Polska Sp. z o.o.) and mines (KGHM Polska Miedź SA, Katowicki Holding Węglowy SA, Południowy Koncern Węglowy SA), all provide co-financing as well as other contributions, and participate in the consortium that implements this programme. NCBiR monitors and evaluates the implementation progress.

COAL EXTRACTION AND CONVERSION

The Ministry of Science and Higher Education finances the following research projects:

- optimising the economic and ecological impacts of hard coal extraction and use by 2020 (co-ordinated by the Central Mining Institute and completed in 2004);
- materials and technologies for water management (co-ordinated by the Central Mining Institute and completed in 2009);
- the chemistry of prospective coal conversion processes (co-ordinated by the Institute for Chemical Processing of Coal and scheduled for completion in 2010);
- supercritical coal-fired power plants (co-ordinated by the Silesian University of Technology and scheduled for completion in 2010).

The technologies available for coal mining will continue to evolve as commercial mining equipment companies compete for market share. Different technologies offer the possibility of exploiting coal more cleanly and safely; government-supported R&D has a role here. The programme of improvements to reduce emissions of conventional air pollutants in Poland has progressed well with the retrofit of flue-gas desulphurisation (FGD) at many power plants and the rehabilitation of others with modern circulating fluidised bed combustion (CFBC) boilers.

The Polish government supports coal-to-chemicals, coal-to-liquids and coal gasification technologies mainly because of energy security considerations. It considers that these technologies – if they become commercialised - have the potential to reduce Polish demand for imported natural gas and oil in the future. A number of coal conversion projects have been implemented in Poland. For example, in April 2010, as part of the EU HUGE (Hydrogen Oriented Underground Coal Gasification for Europe) programme that the Central Mining Institute co-ordinates, the eleven project partners gasified an underground panel of coal at the Barbara coal mine.

CARBON DIOXIDE CAPTURE AND STORAGE

Government initiatives include the National Programme for the Geological Storage of CO_2, led by the Ministry of Environment, and the Clean Coal Programme for Energy under the Ministry of Economy which will include CCS demonstrations. By 2015, two CCS demonstration projects are expected to be operating in Poland as part of the wider EU demonstration programme.

At the Polska Grupa Energetyczna SA (PGE) Bełchatow power plant, post-combustion CO_2 capture using amine (MEA) scrubbers is proposed on the 858 MW unit now under construction. About one-third of the CO_2 produced (1.8 $MtCO_2$ per year) will be captured from this lignite-fired unit, compressed to a supercritical fluid and transported 60 to 140 km to a deep saline aquifer storage site. The total investment cost is in the order of EUR 600 million (PLN 2.6 billion), of which 30% (EUR 180 million or PLN 780 million) will come from the EU Economic Programme for Recovery. As well as corporate investment, other funding may come via the new entrant reserve under the EU Emissions Trading Scheme, Poland's Green Investment Scheme, the National Fund for Environmental Protection and Water Management, and via the European Environment Agency (EEA) and Norway Grants.[74]

74. www.eeagrants.org

A second pre-combustion CCS demonstration is planned by Zakłady Azotowe Kędzierzyn SA (ZAK) at a proposed polygeneration plant on the company's Kedzierzyn chemical works in co-operation with Południowy Koncern Energetyczny SA (PKE). An integrated gasification combined cycle (IGCC) retrofit at the adjacent PKE Blachownia power plant will produce electricity (309 MW), heat (137 MW), methanol (0.529 Mt/year) and synthesis gas (0.703 Mt/year) using two gasifiers, with the possibility of hydrogen production. It is fuelled with hard coal and biomass, the aim is to capture 2.8 $MtCO_2$ per year at the plant, assuming 90% capture. Such polygeneration plants are expensive and Kedzierzyn SA is expected to cost around EUR 1.4 billion (PLN 6 billion), with commissioning in 2015. However, the project could deliver benefits that justify its cost. The plant will replace old and inefficient units at the Blachownia power plant and will provide heat for the town of Kedzierzyn. Methanol production will reduce the chemical sector's dependence on imports from Belarus. In the longer term, these projects could improve Poland's energy security by reducing demand for imported natural gas, crude oil and liquid fuels. Such an outcome depends on achieving the anticipated reductions in the cost of this technology.

Along with the Polish Geological Institute and the AGH University of Science and Technology, the Central Mining Institute is currently developing a geological map of Poland to identify the CO_2 storage potential. This is needed to assist with decisions today on where new emission-free power plants should be built, including the two proposed CCS demonstration plants. According to conservative estimates made by the Polish Geological Institute, the CO_2 storage capacity in Poland is 6-7 $GtCO_2$, with deep saline aquifers accounting for the largest share. Limited storage potential exists in depleted oil and gas reservoirs in western and south-eastern Poland, although enhanced hydrocarbon recovery using CO_2 could make this option economically attractive at Borzecin, Kamien Pomorski and possibly offshore in the Baltic Sea. The possibility of storing CO_2 in coal seams, where it displaces methane, is also interesting, but conflicts with coal exploitation, whether through conventional mining or underground coal gasification.

RENEWABLE ENERGY

In addition to the biomass and waste research under the Advanced Technologies for Energy Production programme (see above), the Ministry of Science and Higher Education finances a project on the use of biomass and biodegradable waste for power generation and biogas production (co-ordinated by the Institute of Power Engineering and scheduled for completion in 2010).

Poland's Long-Term Programme for the Promotion of Biofuels and Other Renewable Fuels for 2008-2014 (see Chapter 9) supports R&D for advanced biofuel production technologies. The Polish Technology Platform on Biofuels and Biocomponents, co-ordinated by the Institute of Fuels and Renewable Energy under the aegis of the Minister of Economy, was created in 2006.[75]

In 2008, eleven biofuels research projects were in implementation with a total cost of PLN 2.3 million (EUR 0.5 million), plus sixteen development projects related to biofuels with a total cost of PLN 13.4 million (EUR 3.1 million). One commissioned development project (PLN 9.892 million or EUR 2.3 million) − conversion of biomass and biodegradable waste into gas fuel − was implemented in 2008. A technological initiative "Container installation for the production of fatty acid esters from waste fats" was awarded

75. http://www.pptbib.pl/eng/news.html

PLN 2.6 million (EUR 0.6 million). One Eureka Programme − "Development of technology for producing biofuels from plant oils and animal fats using camelina oil as a new raw material" − was awarded more than PLN 2 million (EUR 0.46 million) over 2007-2011.[76]

ENERGY EFFICIENCY

The National Centre for Research and Development (NCBiR) implements a strategic project "Integrated System for Reducing Energy Consumption in the Maintenance of Buildings" with a budget of PLN 30 million (EUR 6.9 million) over 2010-2013. NCBiR manages ten other energy efficiency projects within the existing funding tools.

NUCLEAR ENERGY

Nuclear energy R&D is discussed in Chapter 5. In June 2010, NCBiR started preparing a strategic project concerning nuclear energy with a budget of PLN 50 million (EUR 11.5 million). The calls are expected to be announced by the end of 2010.

INTERNATIONAL COLLABORATION

Poland's accession to the European Union has intensified the participation of Polish scientists in numerous international research programmes. For example, Poland is a member of the Multi-Annual Framework Programme of the European Atomic Energy Community, the European Scientific Foundation, and the Eureka initiative (in particular, the EUROGIA+ cluster that focuses on low-carbon energy technologies).

Through international collaborative efforts, Poland is gaining funding from the European Commission for some of the research programmes. Participating in international collaborative efforts also provides access to expertise and networking, which, in the long term, will build Poland's national research capacity.

Polish researchers have been active participants in projects under the EU Framework Programmes and projects supported by the EU Research Fund for Coal and Steel, including RECOPOL (pilot tests of CO_2 injection into coal seams for enhanced methane production), C3-CAPTURE (dry CO_2 capture using a novel limestone calcination-carbonation process), ISCC (innovative CO_2 capture from coal gasification using regenerable sorbents), CO_2-REMOVE (monitoring, measurement and verification of CO_2 storage sites), MOVECBM (extension of RECOPOL with further analysis), MINTOS (safer and cleaner underground mine transport systems) and HUGE (hydrogen from underground coal gasification).[77]

NCBiR participates in two ERA-NET projects related to energy: ERA-NET BIOENERGY and ERA-NET FENCO (Fossil Energy Coalition). In the framework of these projects NCBiR is involved in exchange of information about R&D policy in partner countries as well as in calls for R&D proposals established by ERA-NET consortia. As a result of calls organised by ERA-NET BIOENERGY "Clean Biomass Combustion" two international R&D projects with Polish participants have been financed by NCBiR since 2009.

76. Cabinet of Ministers, 2009.

77. Full details of all these R&D projects can be found on the European Commission CORDIS website http://cordis.europa.eu.

To ensure effective co-operation between researchers, the Joint Technology Initiative for Clean Coal (Polish Clean Coal Technology Platform) was established in 1998 to provide opportunities for networking and collaboration, with links to Europe-wide networks.

Poland is part of the Knowledge and Innovation Community InnoEnergy (KIC-InnoEnergy)[78], established by the European Institute of Innovation and Technology, to develop sustainable energy technologies. One of the six Collocation Centres of KIC-InnoEnergy is based in Poland and co-ordinated by the AGH University of Technology. This centre co-ordinates work on clean coal technologies, which is performed in co-operation with research institutions, companies, the banking sector and local and national authorities.

Poland participates in four or the IEA multilateral technology initiatives, or implementing agreements (IA), concerning coal and energy conservation in the buildings sector[79]:

- buildings and community systems;
- energy storage ;
- fluidised bed conversion; and
- clean coal.

Polish research teams also conduct contracted research for foreign companies; and universities and scientific institutes implement bilateral agreements with foreign partners.

CRITIQUE

The Polish government is to be commended for the increased focus on energy R&D. It is positive that the National Programme for Scientific Research and Development Activities designated Energy and Infrastructure as one of five priority research areas. This sort of strategic direction is an important element of a successful energy R&D programme.

Research priorities identified by the national R&D programme (reduction of energy consumption, effective and environment-friendly use of national fossil fuel resources and development of alternative energy sources) closely match the objectives outlined in the *EPP 2030*, which highlights the link between energy policy and R&D policy. Such links are to be strengthened as they are important for ensuring the progress of modern technologies through the whole R&D chain: from research to development, demonstration, and commercial deployment.

However, the majority of implemented, ongoing and planned R&D projects focus primarily on one government priority − cleaner fossil fuels − while the other two priorities (energy efficiency and renewable energy) by comparison receive less government support. The portfolio of R&D projects should be more diversified to better match the stated policy directions.

Poland is to be applauded for taking a lead in clean coal technologies, which may be of significant importance for the country. If Poland is to continue using large quantities of indigenous coal and enjoy the accompanying energy security benefits, then the country must continue to improve the environmental performance of coal extraction and use.

78. www.innoenergy-initiative.com

79. Implementing agreements are legal contracts under the aegis of the IEA Framework for International Energy Technology Co-operation that foster the research, development and deployment of particular technologies. For more information see http://www.iea.org/techno/index.asp

Poland has a proud history in technology development related to coal. Mining techniques, high-capacity mining equipment, underground coal gasification, coal-bed methane extraction, coal conversion technologies and power generation equipment have all been developed. New technologies are now needed to ensure that the use of coal remains compatible with national and international sustainability goals. In particular, the need to demonstrate cost-effective CO_2 capture and storage is a priority and the proposed demonstration project at the Bełchatow power plant is welcome. The government must ensure that funding arrangements are put in place to allow this project to proceed.

Energy extraction from Poland's vast coal resources using non-conventional technologies could change the country's energy outlook. Ongoing R&D in this area should therefore be encouraged. The rationale for pursuing coal conversion technologies is less clear. The polygeneration plant proposed at Kedzierzyn appears to make little economic sense given that cheaper sources of methanol are available on the international market.

More broadly, government support for coal-to-chemicals, coal-to-liquids or coal gasification based on energy security considerations is to be questioned, taking into account that the coal-mining sector will struggle to meet forecast demand from other sectors, including power generation (as discussed in Chapter 6).

Coal-to-chemicals, coal-to-liquids or coal gasification plants are currently not competitive with the alternative sources of chemicals or fuels. Their application in the past has always been in unique situations where alternative sources were not available. In the case of large remote coal reserves that can be mined at very low cost, there may be an economic rationale for making the multi-billion dollar investments required to convert coal into more transportable products with a higher value.

While significant progress has been made on the Polish energy R&D scene, many challenges still remain. Since different stages of technology development – from scientific research to commercial deployment – are financed and supervised by various institutions, stronger co-ordination among relevant bodies will be necessary in order to underpin rapid deployment of new energy technologies. In particular, the government should ensure that it has a coherent R&D strategy which directs financial resources from different sources in line with the country's energy R&D priorities. Energy issues are becoming increasingly linked with other policy areas such as transport and regional development. Similarly, R&D in these sectors will become more multidisciplinary and closer co-operation between the different ministries and research laboratories will become necessary.

Given the limited public resources for energy research, development and demonstration, the cost-effectiveness of the R&D programmes needs to be enhanced. A major impediment to the effective cost-benefit analysis – and the ultimate optimisation – of R&D programmes is the lack of reliable data on R&D activities, funding and the allocation of that funding. The government should improve R&D data collection and the method to review energy R&D policies and spending to ensure that they are in line with overall energy policies, and that projects are cost-effective. It is positive that the National Programme for Scientific Research and Development Activities and other strategic programmes and projects financed via NCBiR are subject to monitoring and evaluation. Other energy R&D programmes and funding should also be carefully evaluated.

It is positive that the energy industry participates in strategic research programmes. The government should further increase engagement with energy industry in the energy R&D area, with a view to increasing R&D investment, sharing information and commercialising R&D outcomes.

Poland has traditionally educated engineers mainly in the upstream fields of fossil fuel production and conversion. Today, the country is facing significant new energy and climate policy challenges. In order to respond to these, the government needs to explore all possible technological means, especially low-carbon technologies. It is commendable that Polish universities have started developing a new discipline: energy and energy technology. The government should accelerate the development of human resources in the energy and energy technology sectors.

Poland is actively seeking possibilities to participate in international co-operation programmes bilaterally and multilaterally, especially in the field of clean coal technologies. This is encouraging and should be pursued. Poland may consider opportunities for participation in more IEA implementing agreements and other international initiatives which are in line with its R&D priorities. International collaboration can help Poland in the acquisition and adaptation of the best available technologies that suit the country's circumstances. For example, the government could take advantage of the research carried out under the GHG IA[80] and its research networks, and also take part in the Carbon Sequestration Leadership Forum, and other international collaborative efforts.

Poland could also multiply its existing research capacity in the areas of biomass and biofuels by participating in the Bioenergy IA[81], the Advanced Motor Fuels IA[82] and the Global Bioenergy Partnership.

RECOMMENDATIONS

The government of Poland should:

- *Continue to ensure consistency between energy/climate change policy and energy R&D strategies; put more focus on energy efficiency and renewable energy in the portfolio of R&D projects in order to better match the stated policy directions.*
- *Enhance monitoring and evaluation of progress in energy R&D in order to maximise the cost-effectiveness of public spending.*
- *Encourage increased R&D activities by industry, including through fiscal incentives and partnerships between government, industry and academia.*
- *Continue to increase efforts in energy education to meet future demands for researchers and engineers.*

80. Implementing agreement for a Co-operative Programme on Technologies Relating to Greenhouse Gases Derived from Fossil Fuel Use.

81. Implementing agreement for a Programme of Research, Development and Demonstration on Bioenergy.

82. Implementing agreement for a for a Programme on Research and Demonstration on Advanced Motor Fuels.

PART IV
ANNEXES

ANNEX A: ORGANISATION OF THE REVIEW

REVIEW CRITERIA

The *Shared Goals* of the IEA, which were adopted by the IEA Ministers at their 4 June 1993 meeting held in Paris, provide the evaluation criteria for the in-depth reviews conducted by the IEA. The *Shared Goals* are set out in Annex D.

REVIEW TEAM

The in-depth review team visited Warsaw between 29 March and 2 April 2010. The team met with government officials, energy companies, interest groups and various other organisations. The report was drafted on the basis of these meetings, the government response to the IEA energy policy questionnaire and other information. The team is grateful for the co-operation and assistance of the many people it met during the visit. Thanks to their hospitality and willingness to share information, the visit was both highly productive and enjoyable. The team wishes to give particularly warm and sincere thanks to Mr. Miłosz Karpiński, Head of Oil Unit, Oil and Gas Department and Mr. Leszek Banaszak, Counselor to the Minister, Department of Energy and all their colleagues including Ms. Elżbieta Piskorz and Mr. Michał Paszkowski for their unfailing helpfulness, dedication and enthusiasm displayed in preparing and guiding the visit. The team also wishes to express its gratitude to Ms. Hanna Trojanowska, Deputy Minister of Economy, for her hospitality and personal engagement in briefing the team on energy policy issues, and to Mr. Maciej Kaliski, Head of the Oil and Gas Department, for providing support and resources for the organisation of this review.

The team members were:

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Elena Merle-Beral organised and managed the review team visit, and drafted the report with the exception of Chapter 3 on Climate Change written by André Aasrud, Chapter 6 on Coal written by Brian Ricketts and most of Chapters 7 and 8 on Natural Gas and Oil drafted by Akihiro Tonai of the IEA Emergency Preparedness Division. Martin Tailor drafted the section on Nuclear Energy in Chapter 5. The report also includes some of the findings of the working paper "Energy and CO_2 Emissions Scenarios of Poland", prepared by the IEA Office of the Chief Economist in May 2010.

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Monica Petit, Georg Bussmann and Bertrand Sadin prepared the figures. Georg Bussmann, Alex Blackburn and Karen Treanton provided support on statistics. Viviane Consoli provided editorial assistance.

ORGANISATIONS VISITED

The team held discussions with the following energy and environment stakeholders:

Government agencies and regulatory authorities

Ministry of Economy

Ministry of Environment

Ministry of Infrastructure

Ministry of Treasury

Ministry of Science and Higher Education

Energy Regulatory Office (ERO)

Office of Competition and Consumer Protection (UOKIK)

Energy Market Agency

National Fund for Environmental Protection and Water Management

Companies, research institutions, non-governmental organisations and other stakeholders

AGH University of Science and Technology

Association of Brown Coal Producers (PPWB)

Central Mining Institute (GIG)

Climate Coalition (Association of Non-Governmental Organisations)

CP Energia

Economic Society of Polish Power Plants

Enea S.A

Energa S.A

EWE Polska

Forum of Electricity and Gas Consumers

GAZ-SYSTEM S.A. (gas transmission system operator)

Institute for Renewable Energy

Institute for Sustainable Development

Institute of Environmental Protection

Katowicki Holding Węglowy S.A.

LOTOS Group S.A.

Lubelski Węgiel Bogdanka S.A.

National Centre for Research and Development

OLPP (Liquid Fuels Logistics Operator)

PERN Group

PGE S.A.

PGNiG S.A.

PKN Orlen S.A.

Polish Association of Professional Heat and Power Plants

Polish Chamber of Biomass

Polish Chamber of Chemical Industry (PIPC)

Polish Consumer Federation

Polish Economic Chamber of Renewable Energy

Polish Foundation for Energy Efficiency (FEWE)

Polish Geological Institute (PIG);

Polish Liquefied Gas Organisation

Polish National Energy Conservation Agency (KAPE)

Polish Organisation of Oil Industry and Trade

Polish Power Transmission and Distribution Association

Polish Steel Association (HIPH)

Polish Wind Energy Association “Vis Venti”

PSE Operator S.A.

RWE

Spokesman for Fuel and Energy Consumers (within the Energy Regulatory Office)

Tauron Polish Energy S.A

Vattenfall

ANNEX B: ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY		1973	1990	2000	2008	2009P	2020	2030
TOTAL PRODUCTION		**107.41**	**103.87**	**79.59**	**71.39**	**67.52**	**74.28**	**80.52**
Coal		100.73	98.97	71.30	60.91	56.43	51.89	49.44
Peat		-	-	-	-	-	-	-
Oil		0.39	0.18	0.72	0.79	0.70	1.99	1.70
Gas		4.87	2.38	3.31	3.69	3.68	4.16	4.17
Comb. Renewables & Waste[1]		1.29	2.23	4.07	5.74	6.42	11.42	14.01
Nuclear		-	-	-	-	-	2.92	8.76
Hydro		0.13	0.12	0.18	0.19	0.20	0.27	0.28
Wind		-	-	-	0.07	0.09	1.18	1.53
Geothermal		-	-	0.00	0.01	-	0.31	0.50
Solar		-	-	-	0.00	-	0.13	0.14
TOTAL NET IMPORTS[2]		**-13.89**	**0.25**	**9.02**	**29.48**	**29.80**	**27.12**	**38.55**
Coal	Exports	26.98	20.51	17.33	10.07	8.91	10.53	5.80
	Imports	0.82	0.39	1.02	6.49	6.55	2.86	2.96
	Net Imports	-26.17	-20.12	-16.31	-3.58	-2.36	-7.67	-2.85
Oil	Exports	1.12	1.48	1.92	3.27	2.74	8.06	7.39
	Imports	12.87	15.79	21.74	27.96	27.47	33.66	37.51
	Int'l Marine and Aviation Bunkers	-0.71	-0.62	-0.56	-0.81	-0.74	-1.16	-1.72
	Net Imports	11.04	13.68	19.27	23.88	23.99	24.44	28.40
Gas	Exports	-	0.00	0.03	0.03	0.03	0.09	0.09
	Imports	1.39	6.78	6.64	9.15	8.16	10.44	13.08
	Net Imports	1.39	6.78	6.61	9.12	8.12	10.34	12.99
Electricity	Exports	0.32	0.99	0.83	0.83	0.83	0.43	0.43
	Imports	0.17	0.90	0.28	0.73	0.64	0.43	0.43
	Net Imports	-0.15	-0.09	-0.55	-0.11	-0.19	-	-
TOTAL STOCK CHANGES		**-0.64**	**-1.02**	**0.52**	**-2.99**	**-2.35**	**-**	**-**
TOTAL SUPPLY (TPES)[3]		**92.88**	**103.11**	**89.12**	**97.88**	**94.98**	**101.40**	**119.07**
Coal		74.70	78.87	56.30	54.75	51.84	44.22	46.60
Peat		-	-	-	-	-	-	-
Oil		10.68	13.04	19.16	24.54	24.10	26.44	30.10
Gas		6.26	8.94	9.96	12.54	12.28	14.51	17.16
Comb. Renewables & Waste[1]		1.27	2.23	4.07	5.89	6.66	11.42	14.01
Nuclear		-	-	-	-	-	2.92	8.76
Hydro		0.13	0.12	0.18	0.19	0.20	0.27	0.28
Wind		-	-	-	0.07	0.09	1.18	1.53
Geothermal		-	-	0.00	0.01	-	0.31	0.50
Solar		-	-	-	0.00	-	0.13	0.14
Electricity Trade[4]		-0.15	-0.09	-0.55	-0.11	-0.19	-	-
Shares (%)								
Coal		*80.4*	*76.5*	*63.2*	*55.9*	*54.6*	*43.6*	*39.1*
Peat		-	-	-	-	-	-	-
Oil		*11.5*	*12.6*	*21.5*	*25.1*	*25.4*	*26.1*	*25.3*
Gas		*6.7*	*8.7*	*11.2*	*12.8*	*12.9*	*14.3*	*14.4*
Comb. Renewables & Waste		*1.4*	*2.2*	*4.6*	*6.0*	*7.0*	*11.3*	*11.8*
Nuclear		-	-	-	-	-	*2.9*	*7.4*
Hydro		*0.1*	*0.1*	*0.2*	*0.2*	*0.2*	*0.3*	*0.2*
Wind		-	-	-	*0.1*	*0.1*	*1.2*	*1.3*
Geothermal		-	-	-	-	-	*0.3*	*0.4*
Solar		-	-	-	-	-	*0.1*	*0.1*
Electricity Trade		*-0.2*	*-0.1*	*-0.6*	*-0.1*	*-0.2*	-	-

0 is negligible, - is nil, .. is not available.

2009P is preliminary data.

Unit: Mtoe

DEMAND							
FINAL CONSUMPTION BY SECTOR	**1973**	**1990**	**2000**	**2008**	**2009P**	**2020**	**2030**
TFC	**60.55**	**61.83**	**58.21**	**65.52**	**64.86**	**72.88**	**84.62**
Coal	27.99	17.39	13.30	12.00	11.59	10.49	10.72
Peat	-	-	-	-	-	-	-
Oil	8.96	11.07	17.51	22.00	22.25	24.29	27.89
Gas	5.45	7.90	8.15	10.21	9.82	11.14	12.86
Comb. Renewables & Waste[1]	0.81	1.63	3.89	4.78	5.13	6.39	7.53
Geothermal	-	-	0.00	0.01	-	0.13	0.20
Solar	-	-	-	0.00	-	0.13	0.14
Electricity	5.01	8.28	8.48	10.13	9.69	11.25	14.75
Heat	12.33	15.56	6.89	6.39	6.38	9.07	10.54
Shares (%)							
Coal	*46.2*	*28.1*	*22.8*	*18.3*	*17.9*	*14.4*	*12.7*
Peat	-	-	-	-	-	-	-
Oil	*14.8*	*17.9*	*30.1*	*33.6*	*34.3*	*33.3*	*33.0*
Gas	*9.0*	*12.8*	*14.0*	*15.6*	*15.1*	*15.3*	*15.2*
Comb. Renewables & Waste	*1.3*	*2.6*	*6.7*	*7.3*	*7.9*	*8.8*	*8.9*
Geothermal	-	-	-	-	-	*0.2*	*0.2*
Solar	-	-	-	-	-	*0.2*	*0.2*
Electricity	*8.3*	*13.4*	*14.6*	*15.5*	*14.9*	*15.4*	*17.4*
Heat	*20.4*	*25.2*	*11.8*	*9.7*	*9.8*	*12.4*	*12.5*
TOTAL INDUSTRY[5]							
Coal	10.15	6.87	7.60	4.62	3.70	3.90	4.61
Peat	-	-	-	-	-	-	-
Oil	2.92	3.04	4.27	4.17	4.39	4.80	5.29
Gas	4.65	4.56	4.10	5.00	4.50	4.51	5.03
Comb. Renewables & Waste[1]	0.17	0.68	0.99	1.26	1.37	1.56	1.80
Geothermal	-	-	-	-	-	0.01	0.02
Solar	-	-	-	-	-	-	-
Electricity	3.28	3.68	3.48	3.81	3.42	4.24	5.02
Heat	8.30	8.64	1.45	1.58	1.42	2.57	2.96
Shares (%)							
Coal	*34.4*	*25.0*	*34.7*	*22.6*	*19.7*	*18.1*	*18.6*
Peat	-	-	-	-	-	-	-
Oil	*9.9*	*11.1*	*19.5*	*20.4*	*23.4*	*22.2*	*21.4*
Gas	*15.8*	*16.6*	*18.7*	*24.5*	*23.9*	*20.9*	*20.3*
Comb. Renewables & Waste	*0.6*	*2.5*	*4.5*	*6.2*	*7.3*	*7.2*	*7.3*
Geothermal	-	-	-	-	-	*0.1*	*0.1*
Solar	-	-	-	-	-	-	-
Electricity	*11.1*	*13.4*	*15.9*	*18.6*	*18.2*	*19.6*	*20.3*
Heat	*28.2*	*31.4*	*6.6*	*7.7*	*7.6*	*11.9*	*12.0*
TRANSPORT[3]							
TOTAL OTHER SECTORS[6]							
Coal	14.19	10.34	5.69	7.38	7.89	6.09	5.11
Peat	-	-	-	-	-	-	-
Oil	1.03	1.41	4.19	3.23	3.09	3.78	3.41
Gas	0.80	3.34	3.99	4.87	5.05	6.25	7.42
Comb. Renewables & Waste[1]	0.65	0.95	2.90	3.08	3.09	3.39	3.85
Geothermal	-	-	0.00	0.01	-	0.12	0.18
Solar	-	-	-	0.00	-	0.13	0.14
Electricity	1.43	4.13	4.60	6.02	5.99	6.65	9.21
Heat	4.03	6.92	5.44	4.81	4.96	6.49	7.58
Shares (%)							
Coal	*64.1*	*38.2*	*21.2*	*25.1*	*26.2*	*18.5*	*13.9*
Peat	-	-	-	-	-	-	-
Oil	*4.7*	*5.2*	*15.6*	*11.0*	*10.3*	*11.5*	*9.2*
Gas	*3.6*	*12.3*	*14.9*	*16.6*	*16.8*	*19.0*	*20.1*
Comb. Renewables & Waste	*2.9*	*3.5*	*10.8*	*10.5*	*10.3*	*10.3*	*10.4*
Geothermal	-	-	-	-	-	*0.4*	*0.5*
Solar	-	-	-	-	-	*0.4*	*0.4*
Electricity	*6.5*	*15.2*	*17.2*	*20.5*	*19.9*	*20.2*	*25.0*
Heat	*18.2*	*25.6*	*20.3*	*16.4*	*16.5*	*19.7*	*20.5*

Unit: Mtoe

DEMAND							
ENERGY TRANSFORMATION AND LOSSES	**1973**	**1990**	**2000**	**2008**	**2009P**	**2020**	**2030**
ELECTRICITY GENERATION[7]							
INPUT (Mtoe)	**39.67**	**55.17**	**40.79**	**41.58**	**40.55**	**42.31**	**52.08**
OUTPUT (Mtoe)	**7.22**	**11.56**	**12.31**	**13.38**	**13.00**	**14.47**	**18.62**
(TWh gross)	83.91	134.42	143.17	155.58	151.12	168.28	216.47
Output Shares (%)							
Coal	*93.9*	*97.5*	*96.2*	*92.2*	*90.4*	*67.5*	*58.1*
Peat	-	-	-	-	-	-	-
Oil	*2.3*	*1.2*	*1.3*	*1.5*	*1.5*	*1.7*	*1.4*
Gas	*1.7*	*0.1*	*0.6*	*2.0*	*2.1*	*5.1*	*6.4*
Comb. Renewables & Waste	*0.4*	*0.2*	*0.4*	*2.4*	*3.7*	*9.0*	*8.9*
Nuclear	-	-	-	-	-	*6.7*	*15.5*
Hydro	*1.7*	*1.1*	*1.5*	*1.4*	*1.6*	*1.9*	*1.5*
Wind	-	-	-	*0.5*	*0.7*	*8.1*	*8.2*
Geothermal	-	-	-	-	-	-	-
Solar	-	-	-	-	-	-	-
TOTAL LOSSES	**28.95**	**37.58**	**31.80**	**30.71**	**29.15**	**28.52**	**34.45**
of which:							
Electricity and Heat Generation[8]	18.21	25.94	20.34	20.73	20.10	17.66	21.76
Other Transformation	4.02	3.73	3.12	2.43	1.87	3.95	5.02
Own Use and Losses[9]	6.73	7.91	8.34	7.56	7.18	6.91	7.67
Statistical Differences	**3.38**	**3.69**	**-0.89**	**1.65**	**0.97**	**-**	**-**
INDICATORS	**1973**	**1990**	**2000**	**2008**	**2009P**	**2020**	**2030**
GDP (billion 2000 USD)	102.82	118.17	171.28	237.47	237.89	428.71	705.00
Population (millions)	33.37	38.03	38.26	38.12	38.17	37.83	36.80
TPES/GDP[10]	0.90	0.87	0.52	0.41	0.40	0.24	0.17
Energy Production/TPES	1.16	1.01	0.89	0.73	0.71	0.73	0.68
Per Capita TPES[11]	2.78	2.71	2.33	2.57	2.49	2.68	3.24
Oil Supply/GDP[10]	0.10	0.11	0.11	0.10	0.10	0.06	0.04
TFC/GDP[10]	0.59	0.52	0.34	0.28	0.27	0.17	0.12
Per Capita TFC[11]	1.81	1.63	1.52	1.72	1.70	1.93	2.30
Energy-related CO_2 Emissions (Mt CO_2)[12]	312.1	343.8	291.4	298.7	..	..	..
CO_2 Emissions from Bunkers (Mt CO_2)	2.2	1.9	1.7	2.5	..	..	..
GROWTH RATES (% per year)	**73-79**	**79-90**	**90-00**	**00-08**	**08-09**	**09-20**	**20-30**
TPES	5.2	-1.8	-1.4	1.2	-3.0	0.6	1.6
Coal	4.9	-2.1	-3.3	-0.4	-5.3	-1.4	0.5
Peat	-	-	-	-	-	-	-
Oil	7.6	-2.1	3.9	3.1	-1.8	0.8	1.3
Gas	5.4	0.4	1.1	2.9	-2.1	1.5	1.7
Comb. Renewables & Waste	-1.9	6.4	6.2	4.7	13.0	5.0	2.1
Nuclear	-	-	-	-	-	-	11.6
Hydro	3.7	-2.2	4.0	0.3	10.3	2.6	0.2
Wind	-	-	-	-	29.2	26.0	2.6
Geothermal	-	-	-	20.1	-100.0	-	4.7
Solar	-	-	-	-	-100.0	-	1.0
TFC	3.9	-1.9	-0.6	1.5	-1.0	1.1	1.5
Electricity Consumption	5.9	1.4	0.2	2.2	-4.4	1.4	2.7
Energy Production	3.9	-2.4	-2.6	-1.3	-5.4	0.9	0.8
Net Oil Imports	7.2	-1.8	3.5	2.7	0.5	0.2	1.5
GDP	2.4	-0.0	3.8	4.2	0.2	5.5	5.1
Growth in the TPES/GDP Ratio	2.7	-1.8	-5.0	-2.9	-3.2	-4.6	-3.3
Growth in the TFC/GDP Ratio	1.4	-1.8	-4.2	-2.6	-1.1	-4.2	-3.4

Please note: Rounding may cause totals to differ from the sum of the elements.

Footnotes to energy balances and key statistical data

1. Combustible renewables and waste comprises solid biomass, liquid biomass, biogas and municipal waste. Data are often based on partial surveys and may not be comparable between countries.
2. In addition to coal, oil, gas and electricity, total net imports also include combustible renewables.
3. Excludes international marine bunkers and international aviation bunkers.
4. Total supply of electricity represents net trade. A negative number in the share of TPES indicates that exports are greater than imports.
5. Industry includes non-energy use.
6. Other Sectors includes residential, commercial, public services, agriculture, forestry, fishing and other non-specified sectors.
7. Inputs to electricity generation include inputs to electricity, CHP and heat plants. Output refers only to electricity generation.
8. Losses arising in the production of electricity and heat at main activity producer utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of 100% for hydro and wind.
9. Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.
10. Toe per thousand US dollars at 2000 prices and exchange rates.
11. Toe per person.
12. "Energy-related CO_2 emissions" have been estimated using the IPCC Tier I Sectoral Approach from the Revised 1996 IPCC Guidelines. In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2008 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology

ANNEX C: EXISTING AND PLANNED COAL-FIRED POWER PLANTS, 2009

Plant name	Location	Owner	CHP	Capacity, MW	Units, MW (commissioned)	Fuel	Notes
Adamów	Turek, Konin	Zespół Elektrowni PAK SA (50% state-owned, 47% Elektrim SA and 3% private)	Y	600	5 x 120 (1964-66)	lignite / biomass	
Będzin	Sosnowiec, Katowice	Elektrociepłownia Będzin SA Mitteldeutsche Energieversorung AG (MEAG)	Y	80	1 x 80 (1978)	bituminous coal	
Bełchatów	Bełchatów	PGE Górnictwo i Energetyka Konwencjonalna S.A. Oddział Elektrownia Bełchatów		4440	12 x 370 (1982-88)	lignite	FGD (Unit 8 & 10 (1995); Units 11 & 12 (1996); Units 5 & 6 (2000); Units 7 & 9 (2003); Units 3 & 4 (2007); Units 1 & 2 (2012)
Bełchatów	Bełchatów	PGE Górnictwo i Energetyka Konwencjonalna S.A. Oddział Elektrownia Bełchatów		858	1 x 858 (2011)	lignite	SC, FGD, CCS Ready (30% capture from 2015)
Białystok	Białystok	Elektrociepłownia Białystok SA Société Nationale d'Electricité et de Thermique (SNET)	Y	173	1 x 63 (1978) 2 x 55 (1981/91) 1 x 230 (----) p	bituminous coal	
Bielsko-Biała	Bytom, Katowice	PKE Zespół Elektrociepłowni Bielsko-Biała SA	Y	135	2 x 25 (1965) 1 x 30 (1970) 1 x 55 (1997) 1 x 50 (2013) p	bituminous coal	CFBC
Blachownia	Kędzierzyn Koźle	PKE Elektrownia Blachownia	Y	165	4 x 55 (1957-60) 1d 1 x 29 (1968) d 1 x 32 (1968) d 1 x 900 (----) p	bituminous coal	
Bydgoszcz II	Bydgoszcz	Zespół Elektrociepłowni Bydgoszcz SA	Y	227	1 x 50 (1971) 1 x 35 (1971) 2 x 55 (1976/99) 1 x 32 (1983) 1 x 190 (2018) p	bituminous coal	
Chorzow II	Chorzow, Katowice	CEZ AS (75%) Elektrociepłownia Chorzow SA (25%)	Y	226	2 x 113 (2003)	bituminous coal	CFBC
Czechnica	Wroclaw	Zespół Elektrociepłowni Wroclaw SA	Y	132	1 x 32 (1961) 2 x 50 (1982/83)	bituminous coal	
Czeczott	Wola, Pszczyna	RWE Elektrownia Czeczott			1 x 800 (2015) p	bituminous coal	
Czestochowa	Czestochowa	Fortum Czestochowa SA	Y		1 x 64 (2010) c	coal / biomass	CFBC
Dolna Odra	Gryfino Szczecin	Zespół Elektrowni Dolna Odra SA	Y	1600	8 x 200 (1974-77)	bituminous coal	FGD (Units 7 & 8 (2002))
Elbląg	Elbląg, Gdansk	Elblaskie Zaklady Energetyczne SA Elektrociepłownia Elbląg Spolka z o.o.	Y	49	2 x 12 (1955) 1 x 25 (1957)	bituminous coal	
Gdansk II	Gdansk	Elektrociepłowni Wybrzeże SA (45% owned by EDF)	Y	242	1 x 22 (1971) 4 x 55 (1973-94)	bituminous coal	
Gdynia III	Gdynia, Gdansk	Elektrociepłowni Wybrzeże SA (45% owned by EDF)	Y	110	2 x 55 (1990)	bituminous coal	
Gorzow	Gorzow	PGE Elektrociepłownia Gorzow SA	Y	73	1 x 5 (1958) 1 x 6 (1971) 1 x 32 (1978) 1 x 30 (1977)	bituminous coal	
Gubin	Lubuskie	Gubin Power Project JV			2 x 1000 (2018) p	lignite	
Halemba	Ruda Śląska	PKE SA Elektrownia Halemba	Y	100	4 x 50 (1962-63) 2d 1 x 440 (2012) p	bituminous coal	
Jaworzno II	Jaworzno, Katowice	PKE S.A. Elektrownia Jaworzno III SA		190	4 x 50 (1954-55) 3d 3 x 50 (1962) 3d	bituminous coal	

Plant name	Location	Owner	CHP	Capacity, MW	Units, MW (commissioned)	Fuel	Notes
					2 x 70 (1999)		CFBC
Jaworzno III	Jaworzno, Katowice	PKE Elektrownia Jaworzno III SA	Y	1345	5 x 225 (1977-78) 1 x 220 (1978)	bituminous coal	FGD (1996) FGD (1996)
Katowice	Katowice, Silesia	PKE Elektrociepłownia Katowice SA	Y	135	1 x 135 (2000)	bituminous coal / waste coal	CFBC
Kedzierzyn Polygeneration	Kędzierzyn Koźle	Poludniowy Koncern Energetyczny SA Zaklady Azotowe Kedzierzyn SA			1 x 300 (2015) p	coal / biomass	IGCC with CCS
Konin	Konin	Zespół Elektrowni PAK SA (50% state-owned, 47% Elektrim SA and 3% private)	Y	193	1 x 28 (1961) 1 x 55 (1961) d 1 x 65 (1994) 4 x 50 (1958-59) 2d 2 x 120 (1963) 2d	lignite / biomass	FGD (1997)
Kozienice	Kozienice, Radom	Elektrownia Kozienice SA	Y	2600	8 x 200 (1972-75) 2 x 500 (1978-79) 2 x 1000 (2015/16) c	bituminous coal	FGD (Units 4-8 (2007)) FGD (2001)
Kraków Łęg	Kraków	Electricité de France EDF (66%) Elektrociepłownia Kraków SA (33%)	Y	460	2 x 120 (1977/78) 2 x 110 (1984/85)	bituminous coal	
Łagisza	Będzin, Katowice	PKE SA Elektrownia Łagisza	Y	1060	4 x 120 (1963-69) 2d 3 x 120 (1969-70) 1 x 460 (2009)	bituminous coal	FGD (dry) (1998) SC CFBC
Łaziska	Łaziska Górne, Silesia	PKE Elektrownia Łaziska SA (85%) employees (15%)	Y	1155	2 x 125 (1967) 3 x 225 (1971-72) 1 x 230 (1970)	bituminous coal	FGD (1996) FGD (1999-2000) FGD (1999)
Łódź II	Łódź	Zespół Elektrociepłowni Łódź SA	Y	181	3 x 26 (1958) 2 x 25 (1959/60) 1 x 20 (1960) 1 x 33 (1967)	bituminous coal	
Łódź III	Łódź	Zespół Elektrociepłowni Łódź SA	Y	199	1 x 34 (1969) 3 x 55 (1971-77)	bituminous coal	
Łódź IV	Łódź	Zespół Elektrociepłowni Łódź SA	Y	215	2 x 55 (1977/78) 1 x 105 (1993)	bituminous coal	FGD (2003)
Lublin Bogdanka	Lubelskie	Polskiej Grupy Energetycznej			2 x 800 (2016) p	bituminous coal	
Miechowice	Bytom, Katowice	Zespół Elektrowni Bytom SA	Y	110	2 x 55 (1953/86)	bituminous coal	
Opalenie	Pomorskie	Vattenfall AB			2 x 800 (----) p		
Opole	Opole	Zaklad Energetyczny Opole SA		2160	6 x 360 (1993-97) 2 x 800 (2015) p	bituminous coal	FGD (1993-97)
Ostroleka A	Ostroleka	Zespół Elektrowni Ostroleka SA	Y	75	1 x 25 (1958) 1 x 17 (1958) 1 x 6.9 (1961) 1 x 26 (1967)	bituminous coal	BFBC (1997)
Ostrołęka B	Ostrołęka	Zespół Elektrowni Ostroleka SA	Y	652	2 x 226 (1972) 1 x 200 (1972)	bituminous coal	
Ostrołęka C	Ostrołęka	Stora Enso Poland SA	Y		1 x 1000 (2015) p	coal / biomass / paper & fibre rejects / sludge	CFBC
Pątnów I	Konin	Zespół Elektrowni PAK SA (50% state-owned, 47% Elektrim SA and 3% private)		800	6 x 200 (1967-69) 2d 2 x 200 (1973/74) 2d	lignite	FGD (2008)
Pątnów II	Konin	Zespół Elektrowni PAK SA		464	1 x 464 (2008)	lignite	SC + FGD (2008)

Plant name	Location	Owner	CHP	Capacity, MW	Units, MW (commissioned)	Fuel	Notes
		(50% state-owned, 47% Elektrim SA and 3% private)					
Pelplin Kulczyk	Pomorskie	Kulczyk Holdings			2 x 800 (----) p		
Polaniec	Staszow, Tarnobrzeg	Elektrownia im Tadeusza Kosciuszki SA (1%) Electrabel SA (99%)	Y	1800	8 x 225 (1979-83)	bituminous coal / biomass	FGD (Units 1-4 (2008); Units 5-8 (1998))
Pomorzany	Gryfino, Szczecin	Zespół Elektrowni Dolna Odra SA	Y	120	2 x 60 (1960)	bituminous coal	FGD (electron beam) (2002)
Poznan Karolin	Poznan	Dalkia Poznan ZEC SA Zespół Elektrociepłowni Poznanskich SA	Y	155	1 x 55 (1984) 1 x 100 (1990)	bituminous coal	 FGD (dry)
Rybnik	Rybnik	Electricité de France EDF(56.67%) EnBW (28.33%) employees (15%)	Y	1720	3 x 225 (1972-74) 3 x 215 (1973-78) 2 x 200 (1978) 1 x 800 (----) p	bituminous coal	FGD (dry) (1998) FGD (dry) (1991) FGD (dry) (1992)
Siekierki	Warszawa	Elektrociepłownie Warszawskie SA (31%) Vattenfall AB (69%)	Y	490	4 x 30 (1962) 4d 1 x 50 (2002) 3 x 105 (1974-78) 1 x 125 (1975) 1 x 480 (2013) p	bituminous coal	 CFBC FGD (2002)
Siersza	Trzebinia	PKE Elektrownia Siersza SA	Y	796	2 x 130 (1962) 1d 4 x 120 (1969-70) 1d 2 x 153 (2001/03)	bituminous coal	 FGD (1998) CFBC
Skawina	Skawina, Krakow	CEZ AS (75%) Elektrownia Skawina SA (25%)	Y	490	1 x 50 (1961) 4 x 110 (1958-60)	bituminous coal	FGD (1993)
Stalowa Wola	Stalowa Wola, Tarnobrzeg	Elektrownia Stalowa Wola SA	Y	350	1 x 35 (1954) d 1 x 10 (1957) d 2 x 125 (1966) 1 x 60 (1982) 1 x 40 (1982)	bituminous coal	
Turów	Bogatynia, Dolny Slask	PGE Górnictwo i Energetyka Konwencjonalna S.A. Oddział Elektrownia Turów	Y	2106	3 x 235 (1998-2000) 3 x 261 (2003-04) 1 x 200 (1964) d 3 x 206 (1970-71) 1 x 460 (2016) p	lignite	CFBC retrofit Units 1-3 CFBC retrofit Units 4-6 Unit 7 closed 2004 FGD (dry) (1994) , FGD (2010-2012)
Tychy II	Tychy	Fortum Power and Heat Oy Elektrociepłownia Tychy SA	Y	40	1 x 40 (2002)	coal / peat / wood	CFBC
Wola	Piast Ruch, Wola	RWE Power(75%) Kompania Węglowa (25%)			1 x 800 (2015) p	bituminous coal	
Wrocław	Wrocław	Zespół Elektrociepłowni Wrocław SA		255	1 x 55 (1972) 2 x 100 (1984/87)		
Zabrze	Zabrze, Katowice	Elektrociepłownia Zabrze SA	Y	103	1 x 25 (1976) 1 x 35 (1953) 1 x 32 (1997) 1 x 11 (1953)	bituminous coal	FGD (dry) (1997) FGD (dry) (1997) FGD (dry) (1997) FGD (dry) (1997)
Zamosc	Zamosc	ZKE Zakład Energetyczny Zamość SA (51%) Southern Energy Inc (USA) (49%)	Y	80	1 x 80 (1999)	coal / gas	
Zarnowiec STEAG	Pomorskie	Polish Power			1 x 800 (----) p		
Żerań	Warszawa	Elektrociepłownie Warszawskie SA (31%) Vattenfall AB (69%)	Y	250	8 x 25 (1954-58) 1 x 35 (1963) 1 x 15 (1969)	bituminous coal	CFBC (1997-2001, 3 units)
Total				**29 959**			

Notes: *i)* Total capacity listed in the table includes 9 461 MW of lignite-fired generation capacity. *ii)* In addition to the units listed, there are a further 342 small power generation units in Poland with a total capacity of approximately 3 000 MW_e. They range in size from 0.5 MW_e to 60 MW_e, with just 13 units above 30 MW_e. Most are located on or near industrial sites and supply heat as well as power.

Abbreviations: BFBC: bubbling fluidised bed combustor; c: under construction; CEZ: CEZ Group (Czech Republic); CHP: combined heat and power; CFBC: circulating fluidised bed combustor; d: decommissioned; FGD: flue gas desulphurisation; IGCC: integrated gasification combined cycle; LCPD: EU Large Combustion Plants Directive; p: planned; PAK: Pątnów Adamów Konin SA; PGE: Polska Grupa Energetyczna SA; PKE: Poludniowy Koncern Energetyczny SA; SC: supercritical.

Sources: IEA Clean Coal Centre CoalPower5 database, Ministry of Economy, Platts UDI *World Electric Power Plants Database 2009* and IEA analysis.

ANNEX D: INTERNATIONAL ENERGY AGENCY'S "SHARED GOALS"

The member countries* of the International Energy Agency (IEA) seek to create conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and to the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants. In order to secure their objectives, member countries therefore aim to create a policy framework consistent with the following goals:

1. Diversity, efficiency and flexibility within the energy sector are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group.

2. Energy systems should have **the ability to respond promptly and flexibly to energy emergencies**. In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.

3. The environmentally sustainable provision and use of energy are central to the achievement of these shared goals. Decision makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should respect the Polluter Pays Principle where practicable.

4. More environmentally acceptable energy sources need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA member countries wish to retain and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5. Improved energy efficiency can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6. Continued research, development and market deployment of new and improved energy technologies make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

7. Undistorted energy prices enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8. Free and open trade and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9. Co-operation among all energy market participants helps to improve information and understanding, and encourages the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives. (The Shared Goals were adopted by IEA Ministers at their 4 June 1993 meeting in Paris.)

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

ANNEX E: GLOSSARY AND LIST OF ABBREVIATIONS

In this report, abbreviations are substituted for a number of terms used within the International Energy Agency. While these terms have been generally written out on first mention and abbreviated subsequently, this glossary provides a quick and central reference for many of the abbreviations used.

AAU	assigned amount units
bcm	billion cubic metres
CCS	carbon capture and storage
CDM	clean development mechanism (under the Kyoto Protocol)
CHP	combined heat and power
CNG	compressed natural gas
CO_2	carbon dioxide
CO_2-eq	carbon dioxide equivalent
DSM	demand-side management
DSO	distribution system operator
EC	European Commission
ERO	Energy Regulatory Office
ESCO	energy services company
ETS	Emissions Trading Scheme (European Union)
EU	European Union
FAME	fatty acid methyl ester
GCV	gross calorific value
GDP	gross domestic product
GHG	greenhouse gas
GWh	gigawatt-hour
IEA	International Energy Agency
IPCC	Intergovernmental Panel of Climate Change
JI	joint implementation (under the Kyoto Protocol)
kb/d	thousand barrels per day
LCPD	Large Combustion Plant Directive (European Commission)
LNG	liquefied natural gas

LPG	liquefied petroleum gas
mb	million barrels
mcm	million cubic metres
Mt	million tonnes
Mtoe	million tonnes of oil equivalent
MW	megawatt
NAP	National Allocation Plan
NEEAP	National Energy Efficiency Action Plan
NESO	National Emergency Sharing Organisation
NGO	non-governmental organisation
NIMBY	not in my backyard
OECD	Organisation for Economic Cooperation and Development
PPA	power purchasing agreement
ppm	parts per million
PPP	purchasing power parity: the rate of currency conversion that equalises the purchasing power of different currencies, *i.e.* estimates the differences in price levels between countries
PV	photovoltaic
R&D	research and development
SME	small and medium-sized enterprises
SSO	storage system operator
TFC	total final consumption of energy
TJ	terajoules
toe	tonne of oil equivalent
TPA	third-party access
TPES	total primary energy supply
TSO	transmission system operator
UNFCCC	United Nations Framework Convention on Climate Change
UNECE	United Nations Economic Commission for Europe
USD	United States dollars
VAT	value-added tax

POLISH ABBREVIATIONS

CCTW:	Centrum Czystych Technologii Węglowych - Clean Coal Technologies Center
ICHPW:	Instytut Chemicznej Przeróbki Węgla at Zabrze - Institute for Chemical Processing of Coal
DZW:	Dolnośląskie Zagłębie Węglowe) - Lower Silesian coal basin
GIG:	Główny Instytut Górnictwa - The Central Mining Institute
GZW:	Górnośląskie Zagłębie Węglowe) - Upper Silesian coal basin
LZW:	Lubelskie Zagłębie Węglowe - Lublin coal basin
NFOŚiGW:	Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej - National Fund for Environmental Protection and Water Management
PARG:	Państwowa Agencja Restrukturyzacji Górnictwa Węgla Kamiennego - State Hard Coal Restructuring Agency
PKP:	Polskie Koleje Państwowe SA - Polish State Railways
PPWB:	Porozumienie Producentów Węgla Brunatnego - Association of Brown Coal Producers

ANNEX F: BIBLIOGRAPHY

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