ALICE Electricity Sector Country Study:
Poland

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Contents

1 Introduction

Following an idea raised by our project mentor Ines Weller during the December meeting, this is a short country study on a country in transition. We decided to look at Poland, being the largest country, though its industry is probably not as advanced as that in Hungary or the Czech Republic. Due to its geographical location between the former "West" (Germany) and the former "East" (Belarus, Ukraine), it is still connected to both western and eastern electricity power distribution systems (GENI, 2007).

Please note that I don't know Polish, and thus had to rely on translations or non-Polish resources to prepare this country study.

2 A Brief History of the Polish Electricity Sector

Until the breakdown of the "iron curtain" in 1990, electricity supply in Poland followed the stereotype of Eastern European centrally planned economies: five vertically integrated regional utilities (Kaderják 2005) run as a state-owned monopoly, whose budgets, purchases and production targets were assigned by government (IEA 1994). Planned electricity production targeted at low prices, in particular for household customers, which paid far less than industrial users. Average real prices were some 35% of western European ones, caused both by heavily subsidised pricing, as well as successive currency devaluations (IEA 1994:160). Clearly, this policy did not give any incentives to save energy and led to largely inefficient technology for electricity generation (Tahirov, 2005). Although Poland was a highly energy-intensive economy in relation to national income, its per capita energy consumption was still low compared to western European countries (IEA 1990).

Nevertheless, the Polish energy sector as a whole was one of the largest in the Polish economy, accounting for about 10% of GDP in 1990, but all parts of it suffered from severe underinvestment in the 1980s (IEA 1990). It was heavily linked to the Soviet Union, from which all gas and almost all oil imports came from. Oil was then priced according to the "Bucharest formula", which related prices to the moving average of world prices of the past five years, while payment was settled under special arrangements including commodity exchange (IEA 1990).

Decisions in the electricity sector were made on two levels: large projects, such as building a new power plant, were decided and funded by a central authority (Ministry of Mining and Energy, after 1987 the Power and Brown Coal Board), while smaller projects were decided by the enterprise and funded from its budget (IEA 1995). As enterprises only kept track of their expenses and revenues, they generated insufficient cash to cover the investment costs, which were taken by the central authority. Consequently, the accounts did not reflect the real costs, and costs and revenues were not linked transparently. Furthermore, managerial responsibilities were in fact limited to technical plant operation (IEA 1995).

After 1990, Poland (like the other countries of the Visegrad Group – Hungary, Czechia and Slovakia) started to liberalise its economy. As a first step in the electricity sector, unbundling started as soon as 1990, while further steps (like privatisation or market opening for foreign capital) were not introduced before 1997-1999 (Nagayama & Kashiwagi 2007). Unbundling (essentially the liquidation of the Power and Brown Coal Board) led to 28 generation companies, 33 distribution companies[1] and the Polish Power Grid Company (Polskie Sieci Elektroen-

[1] In 2003 five of these merged into Enea S.A., reducing this number to 29.

ergetyczne, PSE) for electricity transmission and trade. PSE also plays an important role in dispatching the major power plants (IEA 1995) due to long-term supply contracts between PSE and several large power plants (EIA 2006), that cover about 70 % of the electricity supplied to the grid (USDOE 2003). By 1994, all formerly state-owned companies had been transformed to joint stock companies, at that time still with the state as the sole stockholder (Kaderják 2005, IEA 1995).

Since the mid 1990s, becoming a member of the European Union was one of the main objectives of Poland and the Visegrad countries, which all became EU members in May 2004. Thus, the process of economic liberalisation evolved in-line with the respective EU directives. As one major step, the Energy Law of 1997 laid the ground for the restructuring of the Polish energy sector. It established the base for third party access, independent power producers, renewable energy sources (RES) and mechanisms for rational and efficient energy use (like least cost planning, integrated resource planning, demand side management, energy efficiency labels) (AEA 2008b). Furthermore, it established the Energy Regulatory Authority (now: Energy Regulatory Office, URE) to issue licenses for generation, transmission and distribution, to define quality measures and approval and control of prices (IEA 1994). Foreign capital was allowed to enter the market (Nagayama & Kashiwagi 2007), and privatisation of electricity companies became possible. However, as of 2002 two out of 33 distributors have been fully transferred to foreign owners (RWE and Vattenfall), while about 1/3 of the power plants are privatised, most of them having foreign corporate shareholders (USDOE 2003, Eurelectric 2006).

In 2000, the Polish Power Exchange (Towarowa Giełda Energii, POLPX) started operation (Eurelectric 2006). In 2004, the operation of the transmission network was transferred from PSE to PSE-Operator. The electricity market was opened gradually after 1999, starting with the biggest customers, until in 2006 even households were able to freely choose their supplier.

In autumn 2007, the supply side was restructured in the spirit of the government's Programme for Electric Power Industry ("Program dla elektroenergetyki") of 2006. In order to create a company capable of competing with other players on the European scale, PSE merged with two generating companies (among these is BOT, the largest generator) and eight distribution companies to form the Polish Energy Group (Polska Grupa Energetyczna, PGE). Ownership of PGE currently remains state owned (PSE 2008). As of this writing, it is too early to ultimately assess this development, but both the formation of PGE as well as the failure to nullify long-term supply contracts between power plants and PSE (EIA 2006, PSE 2008b, Eurofound 2006) leave a question mark on how liberalisation and disentanglement of the Polish electricity sector will proceed.

3 Current Situation: Basic Data

3.1 Electric Power Capacity

Installed capacity in 2005 was 32 GW, of which 30 GW come from public power plants and 2 GW from industrial autoproducers (NRG 113a). Main generators include 17 large system power plants and 19 CHP plants (Eurelectric 2003). Poland is the largest electricity producer in Central and Eastern Europe; it generally meets its domestic demand and is a net exporter of electricity (AEA 2008b).

Poland's economy has traditionally been based on the coal and the abundant domestic coal reserves. This is still apparent in the composition of the electricity generation capacity (see

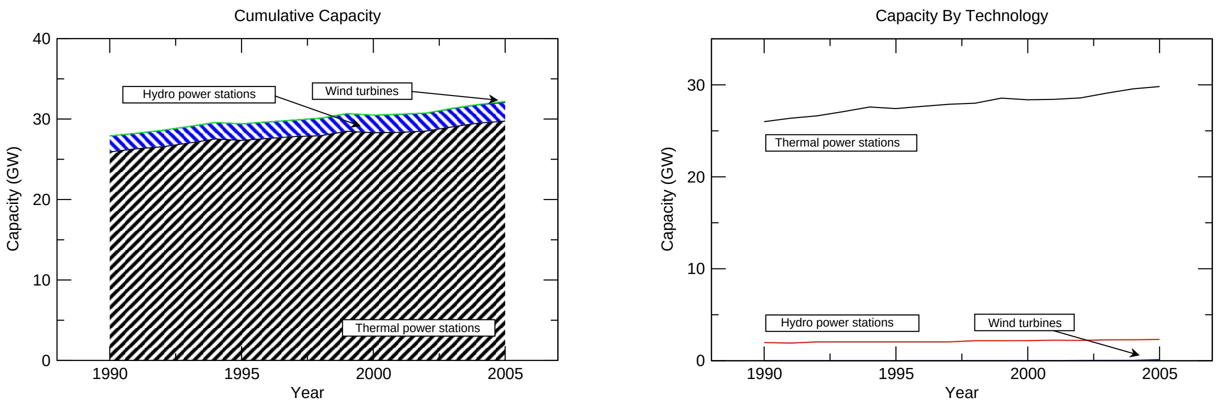
Figure 1): thermal power stations make up some 93 % of the country's 32 GW (NRG 113a). Roughly one fourth of the generating capacity is installed in lignite fired power plants, but since they produce cheaper electricity than hard coal fired ones their share in electricity production is more than one third (AEA 2008b, see also section 3.2). The rest is provided by hydro power, more than 60 % from pumped storage plants, which play an important role in Poland's load balancing system (IEA 1994). Unfavourable distribution of precipitation, relative flatness and high soil permeability prevent the hydro share from becoming larger (AEA 2008b). Wind energy is still negligible (2005: 121 MW, or 0.4 %), but is considered to have a great potential (AEA 2008b).

Currently, Poland does not have any nuclear power plants, after a program to build soviet-type plants was cancelled in 1990, despite the fact that the plant at Zarnowiec was in an advanced construction state. Reasons for stopping the program were to avoid dependencies on Soviet/Russian technologies and because the Chernobyl incident raised a strong anti-nuclear attitude among the population. However, while approving the cancellation, parliament also agreed to re-address that issue after 2005 (Latek, 2005). Therefore, there are currently attempts to initiate a nuclear power program (PSE 2008c), but government has linked this to public acceptance (IAEA CNPP 2004).

One peculiarity in the Polish electricity generation system when compared to western European standards is the large amount of large-scale CHP plants. This is, however, quite common for formerly socialist countries, where district heat has been widely used for the residential areas consisting of pre-fabricated tower blocks. In Poland, about 15 % (5.2 GW) of generation capacity is provided by CHP plants (IAEA CNPP 2004).

The age of the existing generation system is becoming an increasingly serious problem. AEA (2008b) states that "[m]ore than half of the current capacity was built in the 1970s. Approximately 60 % of the system is more than 15 years old, and 40 % is more than 20 years old. More than 1.5 GWe has been in operation for more than 30 years. [...] PSE has estimated that by 2005, over 20 GWe of capacity will need rehabilitation while almost 3 GWe will need to be retired."

Figure 1: Net installed electric capacity in Poland. Left: cumulative capacity. Right: capacity by generation technology.
Source: NRG 113a



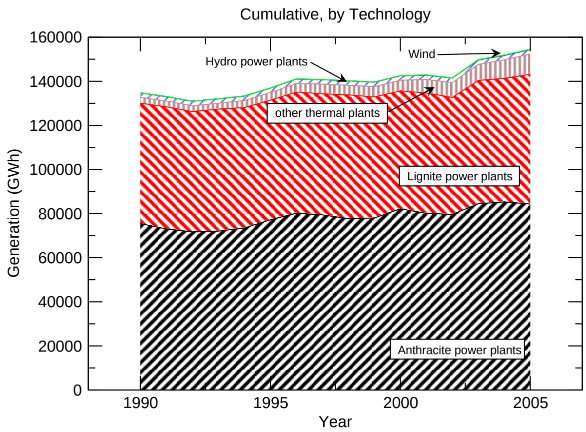
3.2 Electricity Production

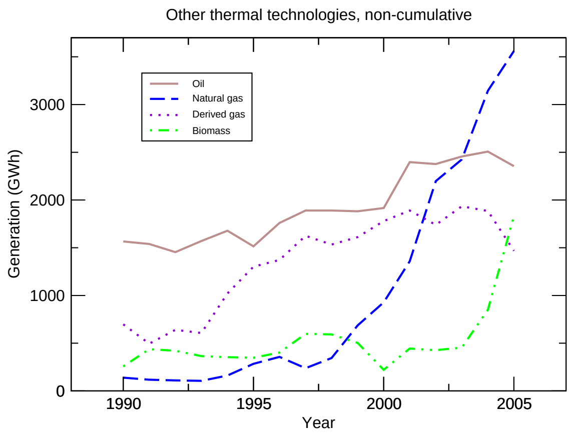
Electricity production (see Figure 2) declined between 1989 and 1992, due to reduced domestic non-household demand caused by recession and economic change (IEA 1994). In the following years, production reverted back to the values before 1990, followed by a slight increase in 2002, as the EU membership approached.

As already mentioned in section 3.1, the share of lignite in actual production is greater than in installed capacity, due to its cost advantage: about 37 % of electricity are produced from lignite, some 55 % from anthracite. CHP plants deliver more than 15 % of electricity, with some 16 TWh from district heating CHP and 6 TWh from industrial cogeneration plants (USDOE 2003). The rest is delivered by hydro power and other sources.

Among the thermal plants, natural gas plays an increasingly important role and has recently outstripped oil as the third most important fossil fuel source (see Fig. 2, right). This probably reflects the general trend to gas in newly built plants due to its (cost) efficiency, moderate CO_2-emissions, and relatively short construction time (EGL 2006, IAEA CNPP 2004). Since 2004, the use of biomass also started to increase. This is probably related to EU targets on RES use in electricity consumption (directive 2001/77/EC); the target for Poland is set to 7.5 % until 2010 (EIA 2006).

Figure 2: Gross electricity generation in Poland, 1990-2005. Left: cumulative generation. Right: generation from other thermal generation technologies apart from anthracite and lignite.
Source: NRG 105a





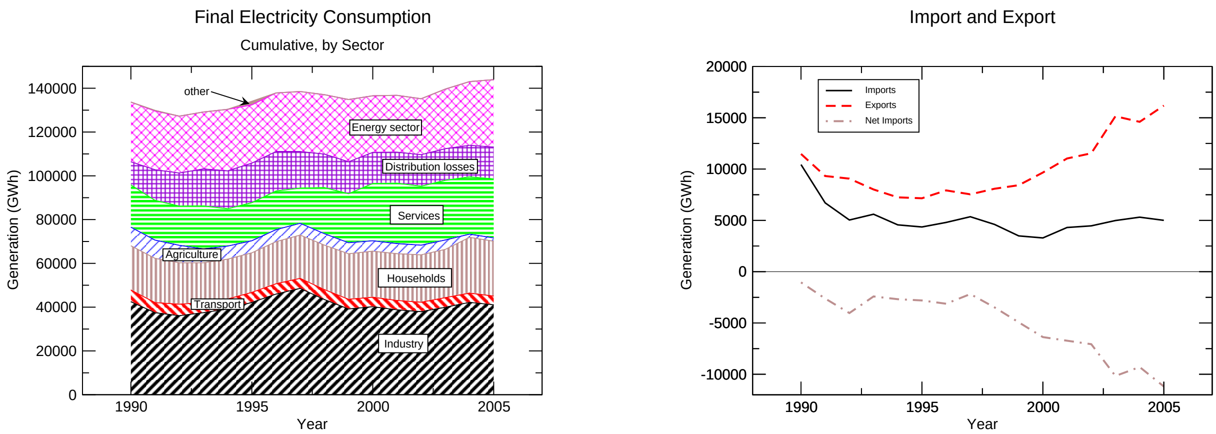
3.3 Electricity Demand and Trade

Poland's electricity demand did not change significantly over the past 15 years (see Figure 3 left). The largest consumers of final energy are industry followed by services and households. Note that the recent increase in the service sector consumption outweighed the reduced industrial consumption. This reflects both the growing service sector's share in the Polish economy, and the improved energy efficiency in the industry sector. Electricity consumed by agriculture has drastically decreased since 2001, which is related to the ongoing restructuring and modernisation in this sector, which was recently boosted by the EU membership.

Distribution losses have slightly declined in recent years, but still account for some 10 % of total generation. The energy sector itself is a large consumer of electricity, the largest shares of which are used in electricity generation (∼ 45 %) and the coal mines (∼ 25 %) (NRG 105a).

Poland is a net exporter of electricity (see Figure 3 right). This corresponds to the appraisal of the Union for the Coordination and Transmission of Electricity (UCTE), that Poland would be a structural exporter, because of its mix of generating capacity and current domestic demand (UCTE 2003). Although Germany would be the "natural target for Polish electricity exports" (Kaderják 2005:14), most of the exported electricity physically goes to the Czech Republic, from which it is then again exported to Germany, Austria and Slovakia (UCTE 2007a). The reason for this are the still weak physical interconnection links between Poland and Germany.

Figure 3: Left: Domestic electricity demand by sector. Right: Electricity im- and exports.
Source: NRG 105a



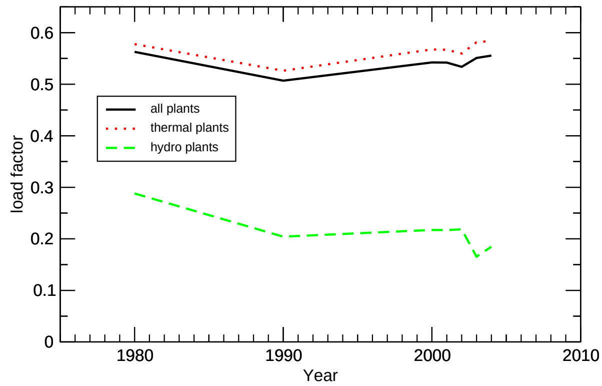
3.4 Load Factors

Load factors on average are around 55 % (see Figure 4), with thermal plants having slightly larger values. This simply reflects the Polish energy mix, where thermal coal based plants run both in base and in medium load mode. The load factor for hydro plants is significantly lower than for thermal plants. This results from the high share of pumped storage plants in the overall hydro capacity, since pumped storage plants provide peak load capacity. These plants are nevertheless essential for the Polish system in order to buffer rapid load fluctuations until additional thermal capacities are available.

3.5 Electricity Prices

Polish electricity prices are partly set by market forces, when the market segment is competitive enough, but for most customers the Energy Regulation Office (URE) prescribes tariffs. Industrial consumers fall in either of eight tariff groups depending on the voltage level and the magnitude of their demand. Household users fall in either of two tariff groups depending on whether they differentiate between day and night delivery or not. All prices are subject to 22 %

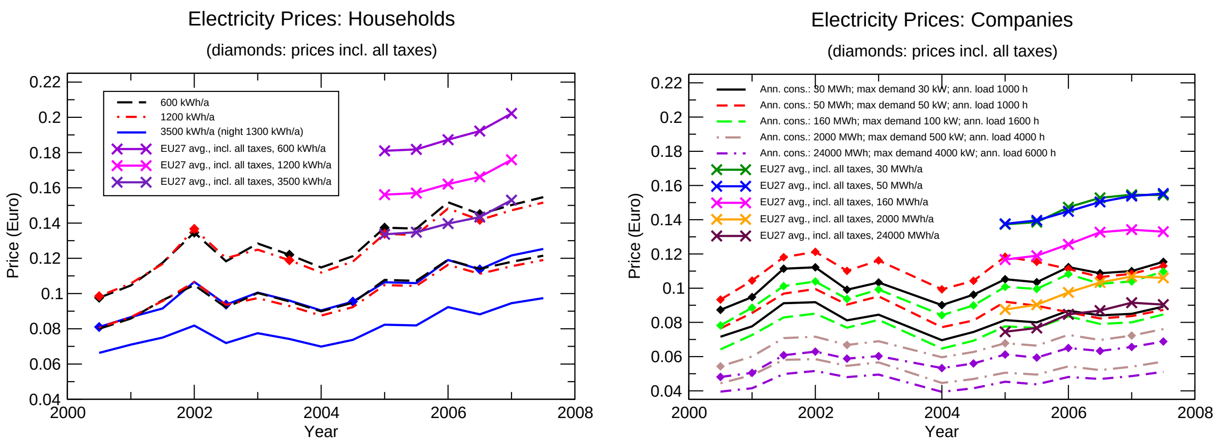
Figure 4: Averaged annual load factors in Polish electricity generation.
Source: own calculation based on IAEA CNPP (2004)



VAT, and an excise duty of currently 0.02 PLN/kWh (0.005 €/kWh[2]). The excise duty is not applicable to RES and is not included directly in the household tariffs (Eurostat 2007).

Electricity prices for households have increased by some 50 % between 2000 and 2007, independent from household size (see Figure 5 left). Thereby, Polish household prices caught up with western European values: they are now comparable e.g. to French prices (see the ALICE country study on France), though still below the EU27 average values. It should be noted, however, that household prices in 1989 were at 0.6 US cent per kWh (AEA 2008c), i.e. only 1/20 of current values.

Figure 5: Electricity prices for various consumer types (left: households. right: industrial consumers). Lines without symbols show prices without any taxes in several consumer categories, lines with diamonds have all taxes included for the same categories, and lines with crosses are respective EU27 average values including all taxes.
Source: NRG 204, NRG 205



A similar, though less pronounced picture can be found for industrial electricity prices (Figure 5 right). These started at 1.6 US-cent/kWh in 1989 (AEA 2008c), about 1/5 of today's levels.

[2]The exchange rate has fluctuated around 4 PLN for 1 Euro since 1999. Since 2006, the Euro values less than that, currently (03.04.2008): 1 €=3.48 PLN (ECB, 2008).

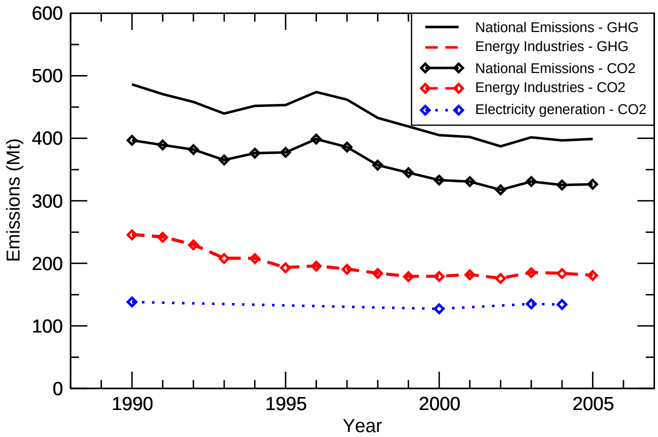
Here, the main price increase occurred before the year 2000, and have remained more or less constant after 2001. Industry prices are also at the lower edge but within the bulk of EU27 prices.

In a recent press release, the URE president mentioned the following reasons for price increases: financing growing shares of energy from RES and CHP; a need to secure a remuneration for grid companies (i.e. to secure the return on capital); a need to secure funds for generators to modernise and develop their generating units (URE 2006).

3.6 Greenhouse Gas Emissions

Poland's greenhouse gas (GHG) emissions have been declining since 1990 by 18 %)see Fig. 6. Part of this is due to population loss, but per capita GHG emissions have also been reduced (1997: 11.96 t; 2005: 10.5 t). CO_2 is responsible for an almost constant share of 81 % of the national GHG load. The energy industries (heat and electricity) are responsible for about half

Figure 6: Greenhouse gas (as CO_2 equivalent) and CO_2 emissions (diamonds) in Poland. For the energy sector (dashed lines) both curves are almost indistinguishable, indicating that the energy sector virtually emits no other GHG than CO_2.
Source: ENV_AIR_EMIS; Eurelectric, 2006



of the national GHG emissions. Here, almost all GHG emissions come from CO_2, indicating the major role of fossil resources in energy generation. The amount of CO_2 emissions from electricity generation has remained largely constant, while emissions in the overall energy sector fell by 30 % since 1990. A probable cause may by energy efficiency improvements in heat distribution and use, as well as population reduction.

4 Resource Endowment

Traditionally, Poland relied on its massive coal resources, which still form the backbone of today's energy and electricity supply. Because of these coal resources, Poland is virtually self-sufficient in energy supply, and a net exporter of electricity (EREC, 2004). Nevertheless, RES have played a small, but important role in electricity supply in the form of pumped storage hydro plants to balance load fluctuations. The importance of other RES is slowly increasing.

4.1 Available Fossil Resources/Reserves

Poland is well endowed with hard coal and lignite (see Table 1). The significant resources and the competitive labour costs allow Poland to be among the eight largest producers of these fuels in the world (BGR, 2006). While lignite is only used domestically, some 20 % of hard coal production is exported. A large amount of these exports go to other EU member states.

Table 1: Polish non-renewable resources and reserves. Data are from 2001/2 or 2004/5, depending on the source.
Source: BGR 2006,

Fuel type	Reserves	Resources	Production	Consumption
conventional oil (Mt)	13	40	0.9	21.3
conv. natural gas (10^9 m^3)	165	150	5.0	13.6
hard coal (Mt)	8354	50900	96.3	77.9
lignite (Mt)	1878	40149	59.9	59.5
Uranium (t)	0	0	0	0

In contrast, oil and gas is rather scarce in Poland, and consumption exceeds domestic production, in particular for oil (see Table 1). Imports of crude oil and natural gas come mainly from Russia (EC-DGET, 2007a). Uranium was exploited between World War 2 and the late 1970s, initially for the German nuclear bomb project, later to be exported to the Soviet Union, and cumulated to some 660 tons (OECD-NEA 2005, WISE 1991).

4.2 Use of Domestic Fuels in Electricity Production

Electricity production in Poland is based on domestic coal, both lignite and hard coal (EC-DGET, 2007a), making Poland's electricity supply almost independent from imported fuels. Though slowly decreasing, the share of coal used for electricity production still exceeds 91 % (NRG 105a, see also Fig. 2, left). This is the highest coal share among EU member states (EC-DGET, 2007a).

The trend to reducing coal in producing electricity has two reasons. One is the increasing amount of gas in electricity production, which is mainly imported from Russia, thereby leading to reduced energy independence (see Fig. 2, right). The other is the increase in RES, namely wind and biomass (see Fig. 2), which add to the domestic electricity sources. In effect, the current situation of Poland being almost independent in electricity supply is not likely to change in the foreseeable future.

4.3 Potentials for Renewable Energy Sources (RES)

Although Poland has negotiated with the EU a target to provide 7.5 % of its gross electricity consumption from RES by 2010, governmental support for RES has been limited in the past, therefore most projects in the 1990s have been developed by bottom-up initiatives (EREC, 2004). In recent years, improved legislation has stimulated investments in wind energy, with installed capacity growing at rates exceeding 80 % in 2006 and 2007 (EWEA, 2006, 2007).

Nevertheless, the actual onshore production is still far below the estimated technical potential (see Table 2). For offshore wind, no estimates have been found.

For hydro power, the World Energy Council gives as technically exploitable potential of 14 TWh/year (see Table 2), of which only 7 TWh/year are economically exploitable (WEC, 2007). The actual usage is already more than half of the economically exploitable potential, indicating that growth potential is limited.

Table 2: Polish potential and use of renewable energy sources (RES) for electricity generation.

RES	Tech. Potential [TWh/year]	Actual usage[a] [TWh/year]	used Pot. [%]	Source(s)
Wind[b]	10.5–24[c]	0.1	1	Eurelectric, 2006; EWEA, 2004; NRG 105a
Hydro	14	3.8	27	WEC, 2007, NRG 105a
Solar, el.	18–52[d]	0.0003	0.0017	INFORSE, 2005; ObservER, 2007
Biomass	24–69[e]	1.83	2.6	EREC, 2004; NRG 105a; Eurelectric, 2006

[a] most recent values, usually 2005

[b] only onshore

[c] Upper value assumes that wind farms are built on 5 % of the regions with the most favourable conditions (Eurelectric, 2006).

[d] Upper value: own estimate based on (Šúri et al., 2007) and the assumption, that about 10 % of the residential areas ($5.77 \cdot 10^9\, m^2$, GUS, 2007) can be used for PV modules.

[e] Upper value: own estimate, assuming that the unspecified 755 PJ/year from (EREC 2004) can be used for electricity generation with an efficiency of 33 %.

Potential estimates for photovoltaics (PV) are in the order of magnitude of some ten TWh/year. Given the geographical conditions of Poland, there is a considerable annual cycle, which limits the potential of PV for electricity supply. In 2004, PV utilisation was still rather exotic, many installations were off-grid and non-domestic, like traffic lights, maritime navigation signs or yachts (EREC, 2004).

Biomass is another RES that received considerable attention in Poland during the past decade, which is not so surprising given the agricultural structure of Poland's economy[3]. However, most of the current usage is used only for thermal purposes, in particular in small and medium boilers for domestic heating. Only a very minor fraction is used for electricity generation, mainly in cogeneration plants using organic and wood waste (EREC, 2004, NRG 105a).

Geothermal energy widely abundant in Poland, but only available at relatively low temperatures below 130°C. Thus, there is growing use of geothermal heat, while electricity generation is not suitable today. So-called binary plants that may be operated at 90°C might be an option (WEC, 2007).

Overall, there is still a lot of potential to grow for all RES except hydro. On the other hand, Polish electricity demand will only be met when the technical potential of all RES together are used, which will probably not not be the case for the foreseeable future.

[3] In 2006, Poland's agricultural sector employed 19.2 % of the workforce and generated 4.7 % of gross value added. The respective average numbers for the EU-27 are 6.4 % and 1.9 %, and for the Euro zone 4.2 % and 1.9% (LFSI_GRT_A, DAA15120)

5 Investments and Decommissions of Plants and Installations

The generation capacity in Poland is old and modernisation and maintenance investments have been insufficient until recently: More than half of the current capacity was built in the 1970s. Approximately 60 % of the system is more than 15 years old, and 40 % is more than 20 years old. More than 1.5 GW have been in operation for more than 30 years (AEA 2008b). According to an estimate of PSE, by 2005 about 20 GW (ca. 60 % of the country's installed capacity) will need rehabilitation (AEA, 2008b).

Between 2000 and 2005, there were 3.6 GW of thermal plants to be newly commissioned, 2.6 GW of which were fuelled by natural gas. Additionally 0.4 GW of RES were to be commissioned, while only 0.2 GW of coal power were scheduled for decommissioning during that period (Eurelectric, 2002) Additional 0.5 GW were commissioned from 2005-2006, with 384 MW conventional thermal capacity (of which 217 MW natural gas), 79 MW run of river hydro and 72 MW other RES (probably wind) (Eurelectric 2006).

Recently announced plant constructions/extensions comprise a "gaseous coal" plant by General Electric (900 MW, US-$ 1 bn, ready by 2011), an additional lignite block by BOT in co-operation with Alstom (833 MW, 830 mio €, ready by 2010), and an additional block at the Lagisza plant by PKE (460 MW, 500 mio €, ready by 2009) (BFAI, 2006c). Wind turbines with a capacity of 2 GW for some 2.9 bn €[4] are currently being planned (BFAI, 2008).

Current investments will not result in significant expansion of installed capacity until 2010. In the long run, however, capacity is expected to increase again with conventional thermal as the main technologies (Eurelectric, 2006). It is expected, that in 2030 gas and hard coal will be the main technologies, both with a capacity share of some 40 % (2004: hard coal had 60 %, gas only 2.6 %). The share of lignite is expected to fall from 33 % (2004) to 22 % in 2030. Wind power will by then have the largest capacity of all RES (9.7 TWh or 5 % of national capacity) (Eurelectric, 2006).

It should be noted, however, that when browsing the available literature I had the impression that the big players on the market were rather reluctant with respect to investments. It is widely acknowledged, that much has to be done to improve the current system, but few actors seem actually to be doing something. The necessary investments are estimated to be in the order of US-$ 50 bn over the next 15 years, and rehabilitation costs, including environmental protection costs, are estimated between US-$ 50 and US-$ 350 per kW of capacity (AEA, 2008b). As it is proposed to cover much of this cost by privatisation (AEA, 2008b), which is not proceeding as expected (see section 8), it is likely that the necessary liquidity is still not available.

6 Regulatory Environment

The Polish electricity market is regulated by the Energy Regulatory Authority (Urzedu Regulacji Energetyki, URE). Its president is nominated by the Minister of Economy and regulates the activities of energy companies pursuant to the Energy Law Act of 1997, amended in 2005 (EC-DGET 2006b). Among other things, URE issues licenses for electricity companies, approves and controls tariffs to end users, enforces quality and safety standards and resolves disputes under the Energy Law (OECD, 2002).

Since July 1, 2007, the Polish electricity market is fully liberalised, with regulated third

[4] Own estimate using average investment costs of 1.45 mio €/MW, derived from BFAI (2008).

party access (TPA) possible for all customers, including households (approx. 15 million legal entities). However, as described in more detail in Section 8.2, the actual switching rates to other suppliers are negligible. Reasons for this are (Zmijewski and Kassenberg, 2007):

- non-objective price structures (that do not reflect actual cost structures) and occurrence of official cross-subsidising (e.g. of prices with transmission tariffs);
- the market still being dominated by Single Buyer contracts and long term PPAs;
- lack of separation between distribution (service) and sale (product), which leads to a tendency to cross-subsidise (non-officially) from trading tariffs to supply tariffs, which can be hard to detect for the Regulator;
- bureaucratic obstacles when switching suppliers;
- "punishment" of switching customers to install more sophisticated metering devices at the customer's cost.

Distribution unbundling has occurred very late: in accordance with EU guidelines, the legal unbundling of Distribution System Operators (DSOs) had been postponed till July 2007 and DSOs had not taken any steps in that direction by 2006 (EC-DGET, 2006a; 2006b). There are indications that unbundling will not result in independent entities, but that administrative dependencies will persist (Zmijewski and Kassenberg, 2007).

Furthermore, the urge to establish the newly formed PGE group as a 'national champion', as well as the setup of vertically integrated electricity holdings are expected to lead to concentrated markets and thus strongly counteract the establishing of a competitive market (Zmijewski and Kassenberg, 2007).

Nevertheless, Zmijewski and Kassenberg (2007) see some signs of a competitive market at work in Poland, like a working power exchange and Internet trading platforms for electricity, as well as (small) independent electricity trading companies and the introduction of trade in emission allowances and green certificates. They conclude: "[T]here are structures necessary for the functioning of the market, but the market itself is absent." (Zmijewski and Kassenberg, 2007:21)

6.1 Most Important Subsidies and Policies

After initial attempts to install a feed-in tariff system in 2000, Poland switched to a quota obligation system during 2001, which has been amended with tradable green certificates (TGC) in 2005/2006 (Michałowska-Knap, 2006). Until 2005, RES prices were negotiated on a case-by-case basis between producers and suppliers/distributors (EREC, 2004), while the penalty for not fulfilling the quota target was initially not strictly defined (Michałowska-Knap, 2006), and set to 130 % of the buy-out price in 2003 (Zmijewski and Kassenberg, 2007). In 2003, TGCs ("Certificates if Origin") were introduced to prove quota achievement, while actual TGC trade was not introduced until 2005, when the penalty was transferred into a "voluntary charge for non-compliance" of 240 PLN/MWh (Michałowska-Knap, 2006).

In effect, the RES producer receives the wholesale price for electricity plus the price for the Certificate of Origin (CoO), which is determined on the market (usually at the POLPX power exchange). In 2006, this led to RES prices of 340 PLN/MWh (= 120 PLN/MWh wholesale price plus 220 PLN/MWh CoO price) (Michałowska-Knap, 2006).

The RES quota to meet is mandated by the Ministry of Economy. Quotas were set at increasing shares until 2010, when it shall meet 10.4 % to be in compliance with the 2001/77/EC directive; this target value allows for co-firing biomass with coal (Michałowska-Knap, 2006). It is, however, not clear, if the substitute charge for not meeting the quota is more strictly enforced than the former penalty, since EC-DGET (2007c) still complains about insufficient enforcement.

A second support mechanism only for RES is their exemption from the excise tax of 0.02 PLN/kWh (0.5 €-cent/kWh), which is obligatory for all other energy forms. This provides a small competitive advantage for RES and a way to support RES investments (EREC, 2004).

Legal support for RES includes regulated access to grid connection. Additionally , there exist various financing mechanisms like soft loans, non-repayable grants, or low interest loans (EC-DGET, 2007c; EREC, 2004). There also exist subsidised funding schemes to support investment in RES by the National Fund for Environmental Protection and Water Management by granting cheap loans (EREC, 2004; Zmijewski and Kassenberg, 2007).

7 Manufacturing and Generation of RES Electricity

Wind energy is the most dynamic RES electricity source at the moment. First wind energy turbines have been built during the 1980s at the Institute for Building, Mechanisation and Electrification of Agriculture (IBMER) in Warsaw, then mainly for use in rural areas without proper grid connection. In the 1990s, still most installed turbines were built by domestic producers: Nowomag, Dr. Zaber, both located in Nowy Sacz (Michałowska-Knap, 2006; energetyka wiatrowa, 2007). These initial attempts ceased after 2000, when turbines bigger than 1 MW entered the market, which had to be imported. In the mid-200s, most projects were designed for Vestas turbines (Michałowska-Knap, 2006), while re-purchasing turbines from other countries and repowering in Poland also grew a common strategy (energetyka wiatrowa, 2007). There is no more significant manufacturing in Poland, while components are still produced for foreign companies like GE Wind (Michałowska-Knap, 2006).

From 2006, foreign investors started to return slowly after they had been expelled around 2003 due to balancing forecasting requests that were hard to meet (Michałowska-Knap, 2006). Currently, most capacity is installed in five wind farms, mainly along the coastline. The increase in capacity has been strong since 2000, in particular 2006 saw an annual growth rate of over 200 % (Michałowska-Knap, 2006). For the future, about 2 GW additional capacity are currently being planned, mainly by foreign investors (BFAI, 2008). The largest Polish utility, BOT, is planning the first offshore wind park with 900 MW, between 20 and 90 km off the coast near Slupsk, close to the HVDC cable that connects Poland and Sweden (BFAI, 2007)

Investments currently start to face increasing obstacles on the financing side, since the previously often used preferential loans and grants are limited and banks do not accept TGCs as securities. Also, equipment from Western Europe is becoming more expensive, locations in favourable sites are getting scarce, and local communities often impose taxes of up to 2 % on the investment value. All these issues make it harder to meet the payback levels requested by equity capital and result in lack of financial resources, even for the project preparation phase (Michałowska-Knap, 2006).

Grid interconnection is also beginning to become a problem: many sites with favourable wind conditions have only weak grids, and in some places, no more interconnections are possible. The northern location of many wind farms could result in a reversal of the usual direction of electricity flow (Michałowska-Knap, 2006).

At the moment, wind energy is still below its possibilities and unable to compete with other technologies, in particular large co-firing plants. However, the market will soon change significantly and attract strong investors, so that there might be a major boost in capacity before 2010. The most important factor remains national policy, namely stability of conditions, public investment support and the will to meet the national emission targets (Michałowska-Knap, 2006).

8 Market Structure

Transformation of the Polish electricity sector was inspired by the wish to make the ownership structure more similar to that of EU member states, but also to generate revenues, and to increase the transition speed and the competition within the overall economy (Ministry of Treasury, 2003). The transformation process comprises all three sub-sectors (generation, distribution, transmission) and entails both consolidation and privatisation. Consolidation was an objective, because initially the electricity sector appeared as rather fragmented with numerous small companies, lacking capital to invest, thus being potential targets of takeovers (Jeziorski, 2006). The consolidation process resulted in strong corporate structures at the regional level (Eurofound, 2006), however, most of them were still state-owned and not privatised. Privatisation was opened in 1999 also to outside investors (USDOW, 2003).

As regards transmission, the strategy was to disentangle the functions and assets of the transmission system operator (TSO) PSE S.A. into smaller and separate entities, which should later be privatised. The TSO itself (PSE-Operator), however, will remain state-owned due to its strategic role in the national energy system (Ministry of Treasury, 2003).

In the areas of generation and distribution, a number of privatisations have occurred, many of them involved investments by Western European utilities: Vattenfall (Sweden), RWE (Germany), EdF (France), EnBW (Germany), Electrabel (Belgium), Suez-Tractebel (Belgium) have all taken the opportunity to enter the Polish market (OECD, 2002; Simpson et al., 2008). Notwithstanding this engagement, the process was not as successful as expected. By 2004, only 6 out of 19 power plants, 9 out of 19 heat and power plants and 2 out of 33 distribution companies had been privatised (polishenergy.com, 2004a).

One main reason for this sluggish progress until mid-2005 was the controversy between the ministries of finance and of economy whether consolidation should proceed along sub-sector boundaries (Horizontal integration) or allow for mixing of generators and distributors (vertical integration) (BFAI, 2006a). For a long time, proponents of horizontal integration determined government's position, thus no mergers between generation and distribution companies were allowed. This approach was a major point of contention. Trade unions were particularly upset as they feared that a power sector restructured in this way would be badly prepared for EU membership and cause massive job losses (Eurofound, 2006). Furthermore, the horizontal integration did not resolve the financial problems of several plants (e.g. the plants in Bytom, Zabrze and Tychy from the Southern Poland Power Company, PKE), which could otherwise have been profitably integrated into industry conglomerates (Eurofound, 2006). In the end, after intensive lobbying efforts, government allowed vertical integration in June 2005.

The second major obstacle to restructuring and liberalising the Polish electricity sector are the long-term power purchase agreements (PPA) between generators and distributors. PPAs were introduced starting in 1994 as pledges for long-term credits to start the overhaul of power stations in order to meet modern efficiency and environmental standards. As a consequence of the politically-dictated electricity prices in the pre-1990 era, utilities did not have the required money at their disposal. The newly established banking sector was too weak to take the risk of such huge investments, as worn-out, obsolete generation assets and plants were insufficient securities. The power grid company PSE was thus obliged to buy specified quantities of capacity and electricity at fixed prices for capacity and electricity. Of the 25 bn PLN (6.5 bn EURtm) invested in the power sector were 17 bn PLN (4.5 bn €) from credits secured by PPAs, essentially passing the responsibility to repay the credits onto final customers (URE, 2007, Szymczak, 2003). While the share of electricity sold according to PPAs was initially 30 %, it reached 75 % in the late 1990s and was at 45 % in 2005 (URE, 2007).

The PPA's main and most obvious shortcoming was that prices were set to cover generation costs without giving incentives to improve efficiency, so that "many contracts became a tool of subsidising inefficient activity" (URE, 2007). Numerous attempts have been made to overcome the PPA system, both because of its obstruction of implementing a fully competitive electricity market (URE, 2007):

- **Voluntary cession** of contracts to distributors failed because prices turned out to be too high,
- **Compensation fees:** all electricity would be sold at market prices, and generators who would suffer losses would be compensated. This scheme failed due to legal and taxation obstacles.
- **Expropriation and compensation** of generators with PPAs, with compensation covered by emission of Eurobonds, whose obligations being paid by a special fee. This scheme involves legal problems related to expropriation. Additionally, the European Commission raised concerns, because compensation for stranded costs might be higher than the real losses caused by the cancellation of the PPA, given the uncertainties in the evolution of electricity price, and thus be considered an illegal governmental aid (Szymczak, 2003).

In July 2007, an act to gradually discharge PPAs by a compensation scheme finally passed Polish legislation and approval by the European Commission. First PPAs will be terminated in the first half of 2008 (Platts, 2007; UCTE, 2007d). The compensation scheme for stranded costs is very much similar to the Competition Transition Costs (CTC) model in Spain. Here,

Table 3: Main players in electricity generation and distribution in Poland, 2005.
Source: "Puls Biznesu", 14.12.2005, quoted in BFAI, 2006a

Generation		**Distribution**	
Company	Share [%]	Company	Share [%]
BOT	40	WGE	20
PKE	17	ENERGA	16
Kozienice	10	Enion	15
		ENEA	14
		Energia-Pro	12
		L-2	8
		Enegetyka Podkarpacka	10
Rest	33	Rest	10

"generators [will] receive compensation on an annual basis and the compensation would be funded by means of fees paid by customers as part of tariffs of transmission and distribution services." (ING Bank, 2006:21).

8.1 Major Market Players

In 2004, there were 7 generating utilities, that each had a market share of more that 5 % (Eurelectric, 2006). The main players in 2005 are listed in Table 3.

After the "Law and Justice" party (PiS) had won the elections in autumn 2005, vertical integration was no longer disputed within government. The Programme for the Electric Energy Industry, adopted by the Polish government in March 2006, features further vertical integration of the electricity sector by creating four major groups (Sroka, 2007; Jeziorski, 2006):

1. The biggest player on the Polish electricity market is the Polish Energy Group (Polska Grupa Energetyczna, PGE), based on the merger of PSE (except the TSO PSE-Operator, which remains fully state-owned) with the BOT holding, the Dolna Odra power plant and eight smaller distribution companies in 2007. It produces 52 TWh per year (some 40 % of national production) and has an installed capacity of 11.8 GW (PSE, 2008a). PGE is the largest company in Poland (BFAI, 2007a). It is considered to be the strategic energy resource of Poland (Sroka, 2007) and is currently one of the largest players in Central and Eastern Europe.

2. In the south, the PKE concern merged with the Stalowa Wola power plant, and the two distributors (Enion and Energia-Pro) in late 2006 to form "Energetyka Południe" (Bogulski, 2007), and meanwhile changed its name to "Tauron Polska Energia" (TPE). TPE is about to be floated on the Warsaw stock exchange in late 2008/early 2009 (nov-ost.info,2007)

3. A third group would cover the western and central part, based on the ENEA distribution group.

4. In the north, a fourth group shall be formed around the ENERGA distributor.

Despite the advantages of such groups (strong groups have improved credit qualities and thus better financing capacities), it also bears dangers of creating an oligopoly market (ING Bank, 2006). The programme has in fact been criticised heavily, both by business (who preferred

Table 4: Market access for various customer groups in Poland.
Source: ING Bank, 2006 (shortened)

Period	Criterion (GWh)	Market opening Theoretical	Market opening Actual
31.12.1998	>500	9 %	4.1 %
31.12.1999	>100	22 %	5.5 %
2000	>40	30 %	5.9 %
2002	>10	37 %	6.0 %
1st half 2004	>1	52,%	9.5 %
01.07.2004	non-residential	80 %	10 %

to have more market players and higher competition (Jeziorski, 2006)) and by trade unions, fearing job losses from consolidation (Sroka, 2007).

8.2 Market Liberalisation

Like in most other countries, market liberalisation was a stepwise process. The threshold for free grid access was lowered gradually and should have been completed by 2005 (polishenergy.com, 2004b; OECD, 2002), but the actual timetable is given in Table 4. By the end of 2006, only around 20 % of large customers have switched their supplier, while only less than 1 % of smaller businesses and households have done so (EC-DGET, 2007b).

8.3 Market prices

Electricity is traded in three ways (Eurelectric, 2003;2006):

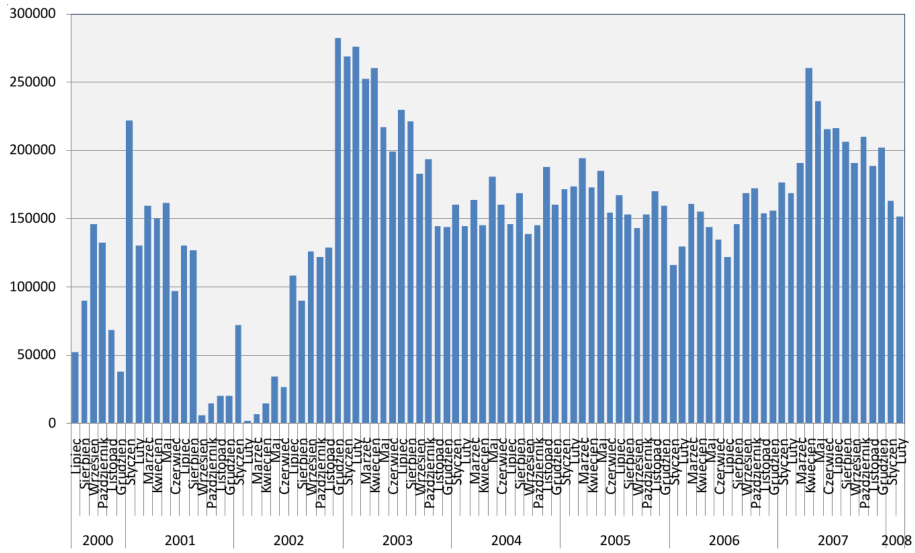
1. On the contract market, electricity is traded base on bilateral agreements between participants. Contract details and prices are only known to the contract parties, and settlements involve only these parties, regardless of settlements in other market segments.
2. On the exchange market, standardised transactions or contracts are concluded at the Polish Power Exchange (POLPX) via auctions, although the number of power exchanges is not limited. Prices are published and available to involved parties and observers. Additionally, there are a number of online trading platforms (BFAI, 2006b).
3. On the balancing market, the transmission system operator PSE-Operator matches transactions made on the exchange and contract market with real demand on a day-ahead basis.

The Polish Power Exchange (Giełda Energii, POLPX) started operation in 2000 as a voluntary pool market, similar to the Nordpool model (OECD, 2002). Actual trade via POLPX is still very limited. Reported physical trade volume on the spot market has remained at roughly 2 TWh since 2004 (see Fig. 7), which is less than 2 % of gross electricity consumption (Giełda Energii, 2008b; Vattenfall, 2005).

This small volume is related to the small degree of third party access (i.e. the small number of customers that have actually changed their supplier, see section 8.2) (OECD, 2002), because most electricity is still traded under bilateral schemes (Kaderják, 2005). Since committed generation is very high – in 2002, only 4 % of electricity was not bound in long term PPAs or direct contracts (OECD, 2002) – liquidity is missing to allow fro functioning free markets (EFET, 2006). Other reasons include high costs imposed by POLPX and high operational risks due to missing emergency schemes. Further obstacles are the quota systems for electricity from CHP and RES, and the limited number of participants (EFET, 2006).

Wholesale Prices (see Fig. 8) have been remarkably stable between 2003 and 2007 at 115 PLN per MWh (approx. 30 €/MWh), which is comparable to German and French average spot prices during that period. The hardly visible movement is probably related to the small volumes that have been traded. The price peak in January 2008 (intra-day maximum 602 PLN/MWh, translating into a monthly average of 215 PLN/MWh) was apparently caused by unfortunate weather conditions and a extraordinary high demand (10000 MWh/day compared to a monthly average of ca. 5000 MWh/day) (Giełda Energii, 2008a). Interestingly, the price level remained at

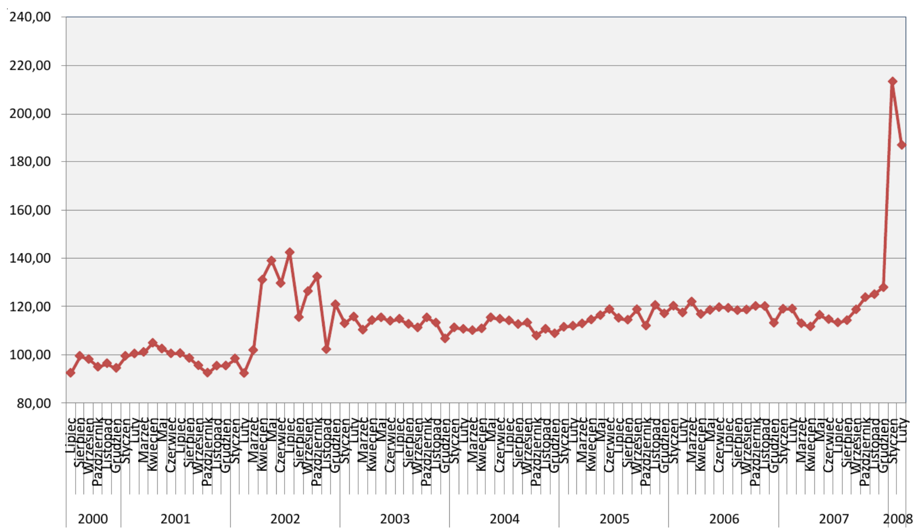
Figure 7: Top: Monthly transaction volumes (in MWh) traded on POLPX spot market.
Source: Giełda Energii, 2008b



190 PLN/MWh also in February and shows only a very weak tendency to fall in March and April – so far, I could not find an explanation for that on the Internet, probably due to my lacking knowledge of Polish.

The Polish Power Exchange started to trade futures in 2001, but trade volumes remained very small, and the futures market is currently suspended (Giełda Energii, 2008c). Again, this appears to be due to the lack of liquidity in the free market (EFET, 2006).

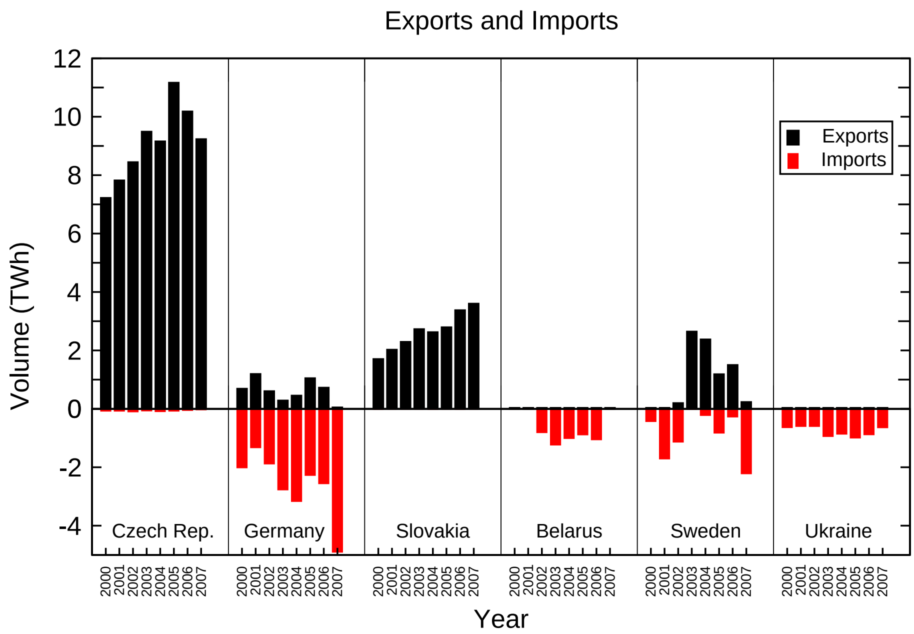
Figure 8: Spot prices (PLN/MWh) at PolPX between July 2000 and February 2008.
Source: Giełda Energii, 2008b



8.4 Imports and Exports

As already mentioned in section 3.3 (see also Fig. 3, right), Poland is a net exporting country with annual net exports in the order of 10 TWh in recent years. Most exports go to the Czech Republic and Slovakia (see Fig. 9. The exchange with Sweden (via a DC connection across the Baltic Sea) is more or less balanced in the long run. Germany, Belarus and the Ukraine export more electricity to Poland than they receive.

Figure 9: Polish physical electricity imports (red) and exports (black) to neighbouring countries, 2000-2007.
Source: UCTE, 2007b



Given the fact that Polish electricity prices are far below German prices the import figures from Germany remain a puzzle – until one recognises that the data in Fig. 9 refer to physical flows. Poland's exports to Germany thus take the detour vial the Czech Republic and Austria, which are slightly less congested (see Section 9).

9 Networks

The Polish transmission network is run by the government-owned transmission system operator PSE operator S.A. It operates 1 line at 75 kV (114 km), 67 lines at 400 kV (4919 km) and 165 lines at 220 kV (7908 km)(Kasprzyk, 2007). Lines below 220 kV belong to the distribution network; part of it (the so-called "coordinated 110 kV network") is also coordinated by PSE Operator (PSE Operator, 2006), the rest by various distribution companies (ING Bank, 2006).

Poland is now a member of the CENTREL distribution system, together with the Czech Republic, Slovakia and Hungary. This system is fully integrated into the Western European UCTE. Connections to neighbouring UCTE members have the following net transfer capacities (NTC from/to Poland): Germany 1100 MW/1200 MW; Czech Republic 1660 MW/800 MW; Slovakia 550 MW/550 MW; Sweden: 600 MW/600 MW (ETSO. 2008). Although Poland is physically connected to distribution systems in the Ukraine and Belarus (AEA, 2008b), the president of PSE-Operator (Poland's TSO) announced that the 220 kV line to Belarus and one of the two lines to the Ukraine were out of operation in autumn 2007 – of which only the link to Ukraine is perceived as a "development need" (Kasprzyk, 2007). Much effort is currently devoted in constructing a line to the Baltic countries via Lithuania.

One big problem for electricity interconnection, however, are the insufficient interconnection capacities. In particular, the profitable exchange lines Poland → Germany and Poland → Czech Republic → Germany are almost always congested (Hirschhausen & Zachmann, 2005; UCTE, 2007c). An additional interconnection between Germany an Poland will not be available before 2010 (Hirschhausen & Zachmann, 2005). Even then, some fear that the high level of wind turbines with associated load fluctuations near the German-Polish border could destabilise the Polish grid system (Platts, 2005).

References

AEA (Austrian Energy Agency), 2008a: Energy Profile Poland – Energy Policy. http://www.energyagency.at/enercee/pl/energypolicy.htm (accessed on 25.01.2008)

AEA (Austrian Energy Agency), 2008b: Energy Profile Poland – Supply: Energy Sources. http://www.energyagency.at/enercee/pl/supplybycarrier.htm (accessed on 25.01.2008)

AEA (Austrian Energy Agency), 2008c: Energy Profile Poland – Energy Demand. http://www.energyagency.at/enercee/pl/demand.htm (accessed on 30.01.2008)

BFAI (Bundesagentur für Außenwirtschaft), 2006a: Strukturanpassung in Polens Stromwirtschaft. Länder und Märkte, 03.01.2006. http://www.bfai.de/ext/Einzelsicht-Export/DE/Content/__SharedDocs/Links-Einzeldokumente-Datenbanken/fachdokument,templateId=renderPrint/MKT20060102085751.html (accessed on 12.04.2008)

BFAI (Bundesagentur für Außenwirtschaft), 2006b: Polens liberalisierter Strommarkt stagniert. Länder und Märkte, 27.03.2006. http://www.bfai.de/DE/Content/__SharedDocs/Links-Einzeldokumente-Datenbanken/fachdokument.html?fIdent=MKT20060324104650 (accessed on 12.04.2008)

BFAI (Bundesagentur für Außenwirtschaft), 2006c: Neue Kraftwerksvorhaben in Polen, Länder und Märkte, 02.10.2006. http://www.bfai.de/DE/Content/__SharedDocs/Links-Einzeldokumente-Datenbanken/fachdokument.html?fIdent=MKT20060929103500 (accessed 14.04.2008)

BFAI (Bundesagentur für Außenwirtschaft), 2007: Polen baut erste Windfarmen in der Ostsee. Länder und Märkte, 29.09.2007. http://www.bfai.de/DE/Content/__SharedDocs/Links-Einzeldokumente-Datenbanken/fachdokument.html?fIdent=MKT200709258003

BFAI (Bundesagentur für Außenwirtschaft), 2008: Große Windfarmen in Polen geplant. Länder und Märkte, 03.01.2008. http://www.bfai.de/DE/Content/__SharedDocs/Links-Einzeldokumente-Datenbanken/fachdokument.html?fIdent=MKT200801028004 (accessed 14.04.2008)

BGR (Bundesanstalt für Geowissenschaften und Rohstoffe), 2006: Reserven, Ressourcen und Verfügbarkeit von Energierohstoffen 2005, Kurzstudie, Hannover. http://www.bgr.bund.de

/nn_322848/DE/Themen/Energie/Downloads/Energiestudie__Kurzf__2006,templateId=raw,property=publicationFile.pdf/Energiestudie_Kurzf_2006.pdf (accessed on 26.03.2008)

Bogulski, 2007: Energetyka Południe Established. The Warsaw Voice, 24.01.2007. http://www.warsawvoice.pl/view/13712/

DAA15120: Eurostat dataset 'daa15120': Gross value added - Agriculture, hunting and fishing. Last update: 26.03.2008, accessed via http://epp.eurostat.ec.europa.eu/

ECB (European Central Bank), 2008: Euro exchange rates PLN, http://www.ecb.de/stats/exchange/eurofxref/html/eurofxref-graph-pln.en.html (accessed on 03.04.2008)

EC-DGET (EC Directorate-General for Energy and Transport), 2006a: Unbundling of electricity and gas transmission and distribution system operators – Final Common Report, March 2006. http://ec.europa.eu/energy/electricity/publications/doc/2006_03_08_final_common_report.pdf (accessed on 15.04.2008)

EC-DGET (EC Directorate-General for Energy and Transport), 2006b: Unbundling of electricity and gas transmission and distribution system operators – Annexes (Country Overview), March 2006. http://ec.europa.eu/energy/electricity/publications/doc/2006_03_08_annexes.pdf (accessed on 15.04.2008)

EC-DGET (EC Directorate-General for Energy and Transport), 2007a: POLAND – Energy Mix Fact Sheet, January 2007. http://ec.europa.eu/energy/energy_policy/doc/factsheets/mix/mix_pl_en.pdf (accessed on 28.03.2008)

EC-DGET (EC Directorate-General for Energy and Transport), 2007b: POLAND – Internal Market Fact Sheet, January 2007. http://ec.europa.eu/energy/energy_policy/doc/factsheets/market/market_pl_en.pdf (accessed on 28.03.2008)

EC-DGET (EC Directorate-General for Energy and Transport), 2007c: POLAND – Renewable Energy Fact Sheet, January 2007. hhtp://ec.europa.eu/energy/energy_policy/doc/factsheets/renewables/renewables_pl_en.pdf (accessed on 15.04.2008)

EFET (European Foundation of Energy Traders), 2006: Towards a well-functioning electricity wholesale market in Poland. Electricity Position Paper, 14.06.2006. http://www.efet.org/Download.asp?File=9112 (accessed on 10.04.2006)

EIA (Energy Information Administration), 2006: Country Analysis Briefs - North Central Europe. http://www.eia.doe.gov/emeu/cabs/NC_Europe/Background.html (accessed on 10.01.2008)

EGL (Elektrizitäts-Gesellschaft Laufenburg AG), 2006: Europas Strommärkte. http://staticweb.egl.ch/eglgb/0506/download/EGL_d_Europas_Strommaerkte.pdf (accessed on 27.01.2008)

energetyka wiatrowa, 2007: Wind turbines in Poland. http://oen.dydaktyka.agh.edu.pl/dydaktyka/inzynieria_srodowiska/c_odnaw_zrodla_en/en_version/files/elektrownie_polska_en.htm (accessed on 16.04.2008)

ENV_AIR_EMIS: Eurostat dataset 'env_air_emis': Air pollutant/greenhouse gas. Last update: 08.11.2007, accessed via http://epp.eurostat.ec.europa.eu/

EREC (European Renewable Energy Council), 2004: Renewable Energy Policy review Poland, May 2004. http://www.erec.org/fileadmin/erec_docs/Projcet_Documents/RES_in_EU_and_CC/Poland.pdf (accessed on 27.03.2008)

ETSO (European Transmission System Operators), 2008: Indicative values for Net Transfer Capacities (NTC), Working day, peak hours (Non binding values), Winter 2007-2008. http://www.etso-net.org/NTC_Info/map/e_default.asp (accessed on 14.04.2008)

Eurelectric (ed.), 2002: Statistics and prospects for the European electricity sector (1980-1990, 2000-2020) (Eurprog 2002), 30th ed., Sept. 2002. Brussels. http://www.eurelectric.org/CatPub/Document.aspx?FolderID=1540&DocumentID=10134 (acessed on 18.01.2008)

Eurelectric (ed.), 2003: Electricity Sector Reform: the pan-European, CIS and Mediterranean dimension. June 2003. Brussels.

Eurelectric (ed.), 2006: Statistics and prospects for the European electricity sector (1980-1990, 2000-2030) (Eurprog 2006), 34th ed., Dec. 2006. Brussels. http://www.eurelectric.org/CatPub/Document.aspx?FolderID=1540&DocumentID=21615 (accessed on 09.04.2008)

Eurofound, 2006: Restructuring in the electrical energy industry, EIROnline, 14.03.2006. http://www.eurofound.europa.eu/eiro/2006/01/feature/pl0601107f.htm (accessed on 08.04.2008)

Eurostat, 2007: Electricity prices - Price systems 2006, 2007 edition. Office for Official Publications of the European Communities, Luxembourg. http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-ER-07-001/EN/KS-ER-07-001-EN.PDF (accessed on 30.01.2008)

EWEA (European Wind Energy Association), 2006: Powering Change – EWEA 2006 Annual Report. Brussels. http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/ewea-report2006.pdf (Accessed on 28.03.2008)

EWEA (European Wind Energy Association), 2007: Delivering Energy And Climate Solutions – EWEA 2007 Annual Report. Brussels. http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/ar07-ewea.pdf (Accessed on 28.03.2008)

EWG (Energy Watch Group), 2006: Uranium Resources and Nuclear Energy. EWG-Series No 1/2006. Ottobrunn/Aachen. http://www.energywatchgroup.org/fileadmin/global/pdf/EWG_Uraniumreport_12-2006.pdf (accessed on 26.03.2008)

Giełda Energii (Polish Power Exchange), 2008a: POLPX monthly report, January 2008 (Raport miesieczny, Styczeń 2008). http://www.tge.pl/documents/200803202148320.TGE_Raport_publiczny_styczen_2008.pdf (accessed on 10.04.2008)

Giełda Energii (Polish Power Exchange), 2008b: POLPX monthly report, February 2008 (Raport miesieczny, Luty 2008). http://www.tge.pl/documents/200804090031570.TGE_Raport_publiczny_luty_2008.pdf (accessed on 10.04.2008)

Giełda Energii (Polish Power Exchange), 2008c: About POLPX – Markets. http://www.polpx.pl/main.php?index=202&show=40&lang=en (accessed on 10.04.2008)

GENI (Global Energy Network Institute), 2007: National Energy Grid of Poland. http://www.geni.org/globalenergy/library/national_energy_grid/poland/index.shtml (accessed on 21.10.2008)

GUS (Główny Urząd Statystyczny - Central Statistical Office), 2007: Statistical yearbook of agriculture and rural areas, 2007 (Table 1). Warsaw. http://www.stat.gov.pl/cps/rde/xbcr/gus/PUBL_Statiscical_yarebook_of_agriculture_rural_areas_07.pdf.pdf (accessed on 26.03.2008)

IAEA CNPP (International Atomic Energy Agency Country Nuclear Power Profiles), 2004. available at http://www.iaea.org/OurWork/ST/NE/NENP/NPES/Downloads/CNPP2004_CD/pages/countryprofiles.htm (accessed on 28.01.2008)

IEA (International Energy Agency), 1990: Energy Policies of Poland 1990 Review. OECD/IEA, Paris.

IEA (International Energy Agency), 1994: Electricity in European Economies in Transition. OECD/IEA, Paris.

IEA (International Energy Agency), 1995: Energy Policies of Poland 1994 Survey. OECD/IEA, Paris.

Hirschhausen, C. von, Zachmann, G., 2005: Perspectives and Challenges of EU Electricity Enlargement – Benchmarking the Reforms of the Electricity Sector in the New Member States. WP 5 Report of the SESSA Project1, revised, May 2005. http://www.sessa.eu.com/documents/wp/D33_4_Hirschhausen-Zachmann_final.pdf (accessed on 14.04.2008)

INFORSE 2005. Vision for a sustainable energy development for EU 25, 2000–2050, http://www.inforse.org/europe/word_docs/EU-note.doc (accessed on 30.01.2008)

ING Bank., 2006: Electricity Market in Poland – Changes on the horizon. Report, April 2006. http://www3.ingbank.pl/_itemserver/wholesale/raporty/ING_Raport_Energetyczny_eng.pdf (accessed on 14.04.2008)

Jeziorski, M., 2006: Polish Energy Sector. The Warsaw Voice, special section – Economic Forum in Krynica, 30.08.2006. http://www.warsawvoice.pl/view/12130/ (accessed on 09.04.2008)

Kaderják, P., 2005: A Comparison of Electricity Market Models of CEE New Member States, Budapest, Background paper for SESSA Work Package "Ensuring Sustainable Electricity Enlargement". http://www.sessa.eu.com/documents/wp/D33_1_Kaderjak_final.pdf (accessed on 23.01.2008)

KAPE (Krajowa Agencja Poszanowania Energii/Polish National Energy Conservation Agency), 2004: Regulatory road map for Poland. SUSTELNET workpackage 5, January 2004. http://www.ecn.nl/fileadmin/ecn/units/bs/SUSTELNET/wp5_poland.pdf (accessed on 14.04.2008)

Kasprzyk, S., 2007: Polish Transmission System Development Trends. Presentation at International Seminar “Prospects for the co-operation between Poland, Lithuania, Latvia and Estonia in the process connection of Baltic States’ power systems with the UCTE system”, Vilnius, 05.10.2007. http://www.mg.gov.pl/NR/rdonlyres/6EF4B51E-AC68-4927-B353-7C606CA676CF/38345/PSEOperatorStefaniaKasprzyk.pdf (accessed on 14.04.2008)

Latek, S., 2005: Nuclear News from Poland. ENS News, 8, spring 2005. http://www.euronuclear.org/e-news/e-news-8/newsfrompoland.htm (accessed on 28.03.2008)

LFSI_GRT_A: Eurostat dataset 'lfsi_grt_a': Employment growth and activity branches - Annual averages. Last update: 31.01.2008, accessed via http://epp.eurostat.ec.europa.eu/

Michałowska-Knap, K., 2006: Wind Energy Development in Poland: History, Main Influencing Factors and Future Prospects. Presentation given at conference "Wind Energy in Western and Eastern European Countries - the interaction of driving forces in the process of innovation", 23./24.11.2006, Berlin. http://www.ieo.pl/downloads/23112006/Michalowska_Poland.pdf (accessed on 16.04.2008)

Ministry of Treasury, 2003: Privatization Lines for Treasury Assets in 2004, 28.08.2003, Warsaw. http://www.msp.gov.pl/download.php?s=3&id=13

Nagayama, H., Kashiwagi, T., 2007: Evaluating electricity sector reforms in Argentina: lessons for developing countries? Journal of Cleaner Production 15, 115–130.

NRG 105a: Eurostat dataset NRG_105a: Supply, transformation, consumption - electricity - annual data. Last update: 06.12.2007, accessed via http://epp.eurostat.ec.europa.eu/

NRG 113a: Eurostat dataset 'nrg_113a': Infrastructure - electricity - annual data. Last update: 06.12.2007, accessed via http://epp.eurostat.ec.europa.eu/

NRG 204: Eurostat dataset 'nrg_pc_204': Electricity - domestic consumers - half-yearly prices. Last update: 03.12.2007, accessed via http://epp.eurostat.ec.europa.eu/

NRG 205: Eurostat dataset NRG_PC_205: Electricity - industrial consumers - half-yearly prices. Last update: 02.12.2007, accessed via http://epp.eurostat.ec.europa.eu/

nov-ost.info, 2007: Aus Energetyka Południe wird Tauron Polska Energia, 24.10.2007. Google-Cache (12.02.2008) of page http://www.nov-ost.info/index/Article/1055200_Aus_Energetyka_Po322_udnie_w.html, at http://209.85.129.104/search?q=cache:_2f2pnmq2gwJ:www.nov-ost.info/index/Article/1055200_Aus_Energetyka_Po322_udnie_w.html (accessed 12.02.2008)

OECD, 2002: The Postal And Energy Sectors. OECD Reviews of Regulatory Reform – Regulatory Reform in Poland – From Transition to new Regulatory Challenges, Paris. http://www.oecd.org/dataoecd/50/47/1940173.pdf (accessed on 07.04.2008)

OECD-NEA (Nuclear Energy Agency), 2005: Uranium 2005: Resources, Production and Demand. Paris. http://213.253.134.43/oecd/pdfs/browseit/6606031E.PDF (accessed on 6.03.2008)

Platts, 2005: Polish elections mark turning point for the energy sector. 29.06.2005. http://www.platts.com/Electric%20Power/Resources/News%20Features/polishpower/index.xml (accessed on 14.04.2008)

Platts, 2007: platts EU Energy, Issue 172-172, 14.12.2007. http://www.platts.com/Electric%20Power/Newsletters%20&%20Reports/EU%20Energy/See%20A%20Sample/index.pdf?o=v (accessed on 14.04.2008)

polishenergy.com, 2004a: Assumptions to Privatisation of Power Engineering Sector, http://polishenergy.cire.pl/prywatyzacja.html (accessed on 08.04.2008)

polishenergy.com, 2004b: Polish Energy Market, http://polishenergy.cire.pl/market.html (accessed on 07.04.2008)

PSE (Polskie Sieci Elektroenergetyczne) 2008a: Polish Energy Group. http://www.pse.pl/en/01/?branch=0109 (accessed on 25.01.2008)

PSE (Polskie Sieci Elektroenergetyczne) 2008b: About the Company. http://www.pse.pl/en/01/ (accessed on 26.01.2008)

PSE (Polskie Sieci Elektroenergetyczne) 2008c: New Technologies. http://www.pse.pl/en/02/?branch=0204/ (accessed on 26.01.2008)

PSE Operator, 2006: Annual Report 2006, Warsaw. http://www.pse-operator.pl/uploads/kontener/raport_roczny_2006_ANG.pdf (accessed on 14.04.2006)

Simpson, J., Bilousenko, O., Piovesana, V., 2005: Developments in central and eastern Europe's energy markets, International Financial Law Review, Supplement - Energy, September 2005, http://www.iflr.com/?Page=17&ISS=20255&SID=579083 (accessed on 04.04.2008)

Sroka, J., 2007: Trade unions opposed to consolidation in energy sector. EIROnline, 12.03.2007. http://www.eurofound.europa.eu/eiro/2007/01/articles/pl0701029i.htm (accessed on 09.04.2008)

Szymczak, R., 2003: Power to the People. The Warsaw Voice online, 25.09.2003. http://www.warsawvoice.pl/printArticle.php?a=3573 (accessed on 07.04.2008)

Tahirov, T., 2005: Energy Reforms In Transition Countries: What Are The Main Problems Of Domestic Energy Pricing? CAR (Centre for Energy, Petroleum, and Mineral Law and Policy (CEPMLP) Annual Review) 9, Dundee. http://www.dundee.ac.uk/cepmlp/car/html/CAR9_ARTICLE18.pdf (accessed on 18.01.2008

UCTE (Union for the Coordination and Transmission of Electricity), 2003: UCTE System Adequacy Forecast 2004 - 2010, Draft December 2003. http://www.ucte.org/_library/systemadequacy/saf/UCTE_SAF_2004-2010.pdf (accesed on 28.01.2008)

UCTE, 2007a: Memo 2006, provisional values as of 15 April 2007. http://www.ucte.org/_library/memos/memo_2006.pdf (accessed on 28.01.2008)

UCTE, 2007b: Country Data Package – Production, Consumption, Exchange Package for Poland 2000-2007. http://www.ucte.org/scripts/frameset/e_frameset.asp?ms=/services/onlinedatabase/packages/pce_package/default.asp (accessed on 10.04.2008)

UCTE, 2007c: System Adequacy Retrospect 2006. 18.07.2007, Brussels. http://www.ucte.org/_library/systemadequacy/saf/UCTE_SAF_2008-2020_scenarios.zip (accessed on 14.04.2008)

UCTE, 2007d: Living Grid 2007 – Poland. http://www.ucte.org/scripts/frameset/e_frameset.asp?ms=/_action/popup.asp&param=/services/livinggrid/2007/gridinformation/pl.xml (accessed on 14.04.2008)

URE (Urzedu Regulacji Energetyki/Energy Regulation Office), 2006: Statement of the President of the Energy Regulatory Office on the approval of the electricity tariffs for 2007 for: Polish Power Grid company (PSE SA), Polish Transmission System Operator (PSE-Operator SA) and distribution companies, 28.12.2006. http://www.ure.gov.pl/portal/en/1/16/Statement_of_the_President_of_the_Energy_Regulatory_Office_on_the_approval_of_th.html (accessed on 30.01.2008)

URE (Urzedu Regulacji Energetyki/Energy Regulation Office), 2007: Long Term Contracts in the Polish power sector Origins, present situation, perspectives of solution, 29.05.2007. http://www.www.ure.gov.pl/portal/en/1/14/Long_Term_Contracts_in_the_Polish_power _sector_Origins_present_situation_perspec.html (accessed on 08.04.2008)

USDOE (United States Department of Energy), 2003: An Energy Overview of the Republic of Poland. http://www.fossil.energy.gov/international/plndover.html (URL no longer available, version of Jan. 07, 2003 is mirrored at http://www.geni.org/globalenergy/library/nati onal_energy_grid/poland/EnergyOverviewofPoland.shtml, accessed on 10.01.2008)

Vattenfall, 2005: Vattenfall's views on the electricity market 2005. http://www.vattenfall.com/ www/vf_com/vf_com/Gemeinsame_Inhalte/DOCUMENT/360168vatt/397946elec/2005-ElectricityMarketReport.pdf (accessed on 10.04.2008)

WEC (World Energy Council), 2007: Survey of Energy Resources 2007. London. http://www. worldenergy.org/documents/ser2007_final_online_version_1.pdf (accessed 26.03.2008)

WISE (World Information Service on Energy), 1991: Regional Reports - Poland. Wise News Communique 362-363 Uranium Special Edition, 06/12/1991. http://www10.antenna.nl/ wise/362-3/region.html#poland (accessed on 26.03.2008)

Zmijewski, K., Kassenberg, A., 2007: The Energy Sector in Poland in the Context of EU Energy Policy. A paper prepared for the Friedrich-Ebert-Stftung (FES). Instytut na Rzecz Ekorozwoju (Institute for Sustainable Development), February 2007, Warsaw. http://www .feswar.org.pl/pdf_doc/ENERGY_SECTOR_IN_POLAND.pdf (accessed on 14.04.2008)