DEVELOPMENT DIRECTIONS OF POLISH ENERGY POLICY

Sylwia SŁUPIK
Faculty of Economics
University of Economics in Katowice
Katowice, Poland
sylwia.slupik@ue.katowice.pl

Abstract

The paper presents a strategic goals of Polish energy policy and its comparison with the European energy regulation. Polish power industry must cope with challenges of power policy of the EU. Especially with stricter emission requirements, implementation of EU rules, stricter competition on the EU market and promoting balanced development, including electrical effectiveness, emission-free technologies, and renewable sources of energy. Energy policy directions, which were set by the government in the document "Polish energy policy until 2030", are aimed at improving national security and maintaining sustainable growth. Those aspirations are supposed to be met through: reduction of electricity losses in transmission and distribution, higher energy savings by end consumers, introduction of mandatory energy characteristics certificates for buildings put into use or to rent, energy markings on devices and products, information campaigns promoting rational energy consumption or supporting research into and development of new technological solutions reducing energy consumption.

Keywords: Poland, energy sector, energy policy, renewable energy sources, strategies, European energy regulations, investments, CCS.
JEL classification: Q48, Q42

1. INTRODUCTION

Poland is faced with challenges related to issues of energy security, development of labour market and economic development, topped with problems of climate change. Joining the European Union is synonymous with gaining access to the common market, what presents domestic business with necessity of fending off international competition by means of cost reduction and setting rational energy prices, electric energy in particular. Polish energy industry, compared to incumbent EU countries, apart from system and functional dissimilarities, differs substantially in factual description. First and foremost the Polish energy sector comprises far larger area of economy – apart from electric energy and gas an important part is played by heat engineering. The structure of primary fuels and the overall efficiency of their consumption are different. Poland has at its disposal considerable resources of solid fuels, whereas hydrocarbon fuels resources are rather modest. Therefore, regardless of changes in extraction and consumption structure of primary energy, coal remains still the

fundamental energy carrier in the Polish economy. The next issue is the market structure, which is not sufficiently adapted to conditions of developing competition. The state of gas engineering is even more distant from the desired one – restructuring of the national monopolist is experiencing major delays. An important entry barrier for new investors (connecting new energy sources) is also the inadequately developed network infrastructure, especially in case of intersystem connections.

In 1989 reforms have been initiated in Poland, aimed at country transformation from authoritarian system with economy dominated by the government and with central control, to democratic system and market economy. Energy policy exercised by the state was also subject to reformation. Over the PRL period, the energy policy was part of RWPG's energy policy, where USSR was distinctively dominant. During fifties of the last century, Poland was bound to supply significant amounts of black coal to USSR, often under far lower prices than in international markets. At the same time, country's restoration and expansion required energy, which back then, could originate only from coal-fired stations. During peak-demand for coal, domestic consumption amounted to about 160m tonnes. It has dropped over the years, in 1989 to 151.2m tonnes, in 2006 to 83.6m tonnes to reach as little as 84.5m tonnes in 2007. Almost halved coal consumption over the years 1990 to 2008 was caused by transformation of broadly defined economy and energy consumption economies, but also by difficulties in extracting the resource due to drastically decreased investment outlays in facilitating access to new coal deposits in black coal mines. In 2006 combined share of black and brown coals in the structure of primary energy amounted to 53.6%, whilst those fuels' share in the structure of electric energy generation amounted to 91.6%. Those are the biggest numbers amongst European Union countries. The dominant share of coal in national fuels balance maintains high level domestic energy security. Such domination, however, particularly in energy generation inherited from PRL has also other side [Ney, 2009, 5-17]:

- → firstly, energy conversion processes involving coal as the primary fuel are less efficient than those based on other fuels, namely crude oil and natural gas. Therefore apart from other factors it has an impact of energy efficiency;
- → secondly, high share of coal in primary fuels structure causes significant natural environment pollution, mainly heavy emission of greenhouse gases. Poland demonstrates definitely the highest in the European Union, emissivity of primary energy and that is not only in comparison to incumbent European Union countries, but also in relation to former RWPG countries.

The problem of refining coal, black coal in particular, and improving efficiency of energy conversion processes utilising that fuel is of top significance. Comparison of rudimentary energy indicators of Poland and the European Union predicated on example of chosen Eastern and Central Europe countries evidently indicates to belated development of Polish energy industry. Over the entire period of political and economic transformations a selection of fundamental issues in Polish energy industries failed to be resolved. Already under changing political and economic conditions certain old problems aggravated and new determinants of energy policy came to existence. Present determinants of energy industry development in Poland are dependent on: fossil resources of energy raw materials, inconsistency of European Union's energy policy, emissivity of primary energy and energy efficiency [Ney, 2009, 5-17].

2. MODERN DETERMINANTS OF POLISH ENERGY POLICY

Poland possess substantial, documented deposits of black and brown coals, which if rationally managed will be sufficient for many years to come. Resources of black coal with adequate investment – currently quite the contrary – in accessing new seams in already operational mines and so far unexploited new deposits, could be capable of satisfying domestic demand for coal for at least 40 year. Black coal should be an input resource for contemporary electric plants, CHP plants and heating plants as well. At the same time, black coal should start to be used in producing synthesis gas, and effort should be made to manufacture synthetic engine fuel. Combined share of black and brown coals in the structure of primary energy amounted to 59%, whilst those fuels' share in electric energy generation amounted to an excess of 90%. Only 8.4% of electric energy is produced from renewable energy (water, wind and biomass). Resources of crude oil and natural gas compared to coal have been deemed insufficient to cater for current demand. Industrial crude oil resources estimated at 14.5m tonnes are allowing extraction of 783 thousand tonnes of oil annually, which in turn allow securing only 3.5% of domestic oil in its general usage. Hence the need for crude oil has to be satisfied with imports. Significantly more favourable situation is in the natural gas sector. At 73.5b m^3 of industrial natural gas resources, 1/3 is covered by the domestic deposits. Once necessary investments are completed in new deposits, 40% of national consumption will be possible to be covered with domestic gas.

Poland as a member of the European Union is responsible for energy policy conforming to Community's standards, and is presented with a task of implementing its most important elements with regard to domestic conditions such as: natural resources, technologies and energy transmission. In passed by the Council of Ministers in November of 2009 document "Polish energy policy until 2030", presented were priority directions of action in terms of national energy policy, expanding on three rudimentary EU strategic objectives [Council of Ministers, 2009]:

- → improvement of energy efficiency,
- → increased security of energy supplies,
- → introduction of nuclear power,
- → development of renewables,
- → development of competitive markets for fuels and energy,
- → limited impact of the energy industry on environment.

Under Polish conditions increased energy efficiency is top priority not only for the sake of energy efficiency itself, but also to decrease primary energy consumption and emission of greenhouse gases, CO_2 in particular. In the program of executive actions essential actions were enclosed, completion of which will guarantee 20% improvement of energy efficiency by the end of 2020. Average energy efficiency in the European Union in 2005 was for "27" EU countries182 toe/m Euros, for "25" EU countries 177 toe/m Euros and for the "15" 170 toe/m Euros. This comparison clearly demonstrates, that the more contemporary the economy the higher the energy consumption efficiency.

The salient aspect of development of energy industry is decrease of its emissivity. Such requirements are clearly articulated in the European Union, especially in the energy and climate package. Deriving from that is the second important direction for development of Polish energy industry, namely increased utilisation of energy from renewable sources. Efficient following of that direction will result in 18-20% of energy consumed to originate from renewables. In order to achieve that, development of that energy form has to be more effec-

tive than so far, supported not only by material subventions, but also through drawing up renewables-friendly legislative framework facilitating its development.

The third issue is taking more effective action in terms of modernisation and construction of electric energy generating units and broadly defined energy infrastructure as well. Necessary is expansion of both electric engineering and heat engineering, however, hurdles of financial nature are standing in the way. Modernisation would be a rational action, but in fact, in place of the old and obsolete fleet a new one of highly efficient and low emissive generating stations should be built. It especially applies to Silesian Industrial Basin, where some of power stations are so outdated, that they should be swapped for new power plants of 40-45% efficiency or even higher. It is crucial from the perspective of coal consumption, which is mined in that area. Highly efficient heat power station lowers emission of greenhouse gases, CO_2 in particular through lowering coal combustion in favour of higher efficiency. Moreover investment in new generating stations is required, especially nuclear, but gas as well, located in central and northern Poland, where energy is in short supply [Ney, 2009, 5-17].

3. INDICATORS OF ENERGY EFFICIENCY IN POLISH ECONOMY

Pursued in Poland energy policy refers primarily to the generating sector, to a lower extent aims at controlling the demand. Therefore the extraction and refining processes are the biggest contributors to emission of majority of basic pollutants. However, thanks to improved generating techniques, investments in modern facilities and emission reducing equipment, utilisation of clean fuels and decommissioning of the least efficient facilities, the emission levels of pollutants are decreasing, resulting in improvement of natural environment. Nevertheless energy efficiency in Poland is substantially lower compared to Eastern European countries. The energy generated and used currently in Poland originates predominantly from non-renewable energy sources. The structure of energy carriers in Poland has a characteristic nature, shaped over the past five decades and determined by availability of resources and geopolitical considerations [Ministry of Economy, Labour and Social Policy, 2003, 12].

According to the Eurostat data, in 2008 in Poland 59.5% of consumed energy were primary fuels, 27.3% crude oil, 13.6% gas, and 6.1% renewables. In comparison, on average in the EU-27 the proportions shaped as follows: 17.5% solid fuels, 36.5% crude oil, 24.5% gas and 8.4% renewables and over 13% have been contributed by the nuclear energy. That data demonstrates the fundamental discrepancy between Poland and other EU member states, particularly in case of EU-15 in terms of the structure of carriers/sources of primary energy consumed in order to satisfy needs. The dominant primary energy sources in Poland (over 90%) are solid, liquid and gas fossil fuel combustion processes, whereas in EU-27 countries this indicator does not reach 80%. Polish energy sector, despite the lowest level of dependency on energy carriers import, is using primarily solid fuels rendering it among others, one of major air pollution sources in Europe [Ministry of Economy, 2009, 36].

Main commonly used indicators, depicting the level of economic efficiency are: national energy consumption per-capita and total energy consumption per one GDP unit of a given country. The indicator showing total energy consumption per one statistical citizen demonstrates in absolute values the measure of energy consumption, giving the actual image of energy consumption in individual countries. It allows assessment of how much energy

per year (in absolute units) is consumed by a statistical citizen of a given country. An overview of those national indicators is presented in the chart below (Figure no. 1).

The presented data implies that Poland is characterised by one of the lowest unitary energy consumption indictors in the region and among developed countries. I would seem at first glance, Poles are effective energy consumers, but a detailed analysis reveals it is down to the discrepancy in GDP per-capita of different countries. Energy consumption on average by Polish consumers is two thirds of the European average. The indicator will be difficult to maintain at that level due to middle-term perspective of high GDP (about 4% annually) and consumption growth rates. According to the latest available evaluations by the European Environment Agency (EEA) regarding the scope (from 2005), primary energy consumption per-capita in Poland amounted to 2.6 toe per citizen, whereas in EU-27 it was 3.66 toe, and in EU-15 just shy of 3.95 toe [Ministry of Economy, 2009, 42].

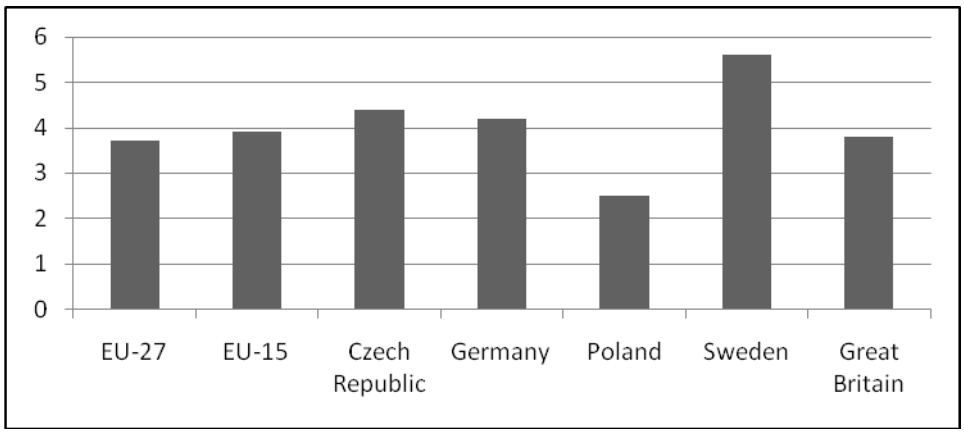

Figure no. 1 Primary energy consumption indicator per citizen in chosen EU countries in 2008 [toe/p]
Source: [Eurostat, 2010]

Eurostat's estimates indicate, that in the EU-15 countries energy consumption indicator per person is greater by approximately 60% and in case of Czech Republic even 85% higher than in Poland. The biggest variation in that area is between Poland and Sweden, where unit energy consumption is almost 2.5 times greater than in Poland (see tab. 1). The table implies that primary energy consumption per-capita in Poland in the past decade was fluctuating between 2.59 toe/per-capita in 1997 via the minimum of 2.35 toe/capita in 2004 to reach 2.58 toe/per capita in 2008.

In years 2004-2008 characterised by high GDP growth figure of 5% annual average, the total energy consumption growth of 9.8% took place, so 2.4% annual average. Particularly swift hike in energy consumption – by almost 4.8% - took place in the last 2007/2008 period. At the same time energy consumption in EU-15 countries slightly fell (by about 1.5% in year 2006-2008), what could be a first indication of a new trend, meaning actual – contrary to gauge only – energy efficiency improvement, thanks to a variety of actions concentrated on energy efficiency.

Table no. 1 Gross domestic primary energy consumption [toe]/population [p.]

Countries/years	**1997**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
EU-27	3,47	3,53	3,56	3,62	3,60	3,67	3,70	3,69	3,67
EU-15	3,69	3,84	3,86	3,92	3,88	3,95	3,96	3,96	3,92
Czech Republic	4,04	3,75	3,97	4,07	4,12	4,46	4,48	4,41	4,45
Germany	4,14	4,13	4,14	4,28	4,19	4,23	4,25	4,22	4,24
Poland	**2,59**	**2,45**	**2,38**	**2,38**	**2,35**	**2,41**	**2,42**	**2,46**	**2,58**
Sweden	5,70	5,68	5,38	5,75	5,69	5,6	5,82	5,67	5,54
Great Britain	3,75	3,88	3,92	3,92	3,80	3,85	3,85	3,84	3,75

Source: [Eurostat, 2010]

Statistical data indicate also to a relatively high energy consumption indicator of the Polish economy, describing amount of energy a given country's economy consumes, in order to obtain certain part of GDP (e.g. kilograms of chosen fuel per 1000 Euros of National Income). As the table 2 implies, that indicator was in 2005 in Poland greater by an excess of 120% than the average for EU-15, while in 2007 it dropped down to only 78%. It means, that in the last 2 years only, with energy consumption in Poland raising by 9%, that unfavourable discrepancy fell by over 40 percentage points.

Table no. 2 Gross domestic primary energy consumption [toe]/ GDP [m euro]

Countries/years	**1997**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
EU-27	193,7	169,2	162,5	159,3	150,6	146,1	141,7	138,4	133,9
EU-15	168,1	151,6	146,4	144,4	136,9	133,3	130,3	127,6	123,4
Czech Republic	737,5	475,7	458,9	414,3	370,4	358,8	297,5	272,9	b.d.
Germany	168,7	157,0	154,3	157,4	149,0	143,9	139,4	135,3	132,1
Poland	**636,1**	**489,9**	**445,1**	**372,1**	**329,2**	**298,0**	**246,8**	**227,4**	**b.d.**
Sweden	209,0	183,0	166,5	174,4	162,9	152,1	158,2	152,9	b.d.
Great Britain	154,9	139,1	131,1	127,1	117,0	112,9	124,9	125,2	b.d.

Source: [Eurostat, 2010]

One of the most dynamic in the region, plunges of Polish economy's energy consumption indicator over the past 15 years results predominantly from practical stabilisation of primary energy consumption at the level slightly lower that at the beginning of the 90's,

with GDP growing 3-fold at the same time. Although the substantial reduction rate was achieved in that respect, in years 1995-2005 4.5% annual average (Figure no. 2 and no. 3), one of the highest among new member states, which joined in the last phase of European Union expansion, the indicator is still significantly higher than the average in EU countries.

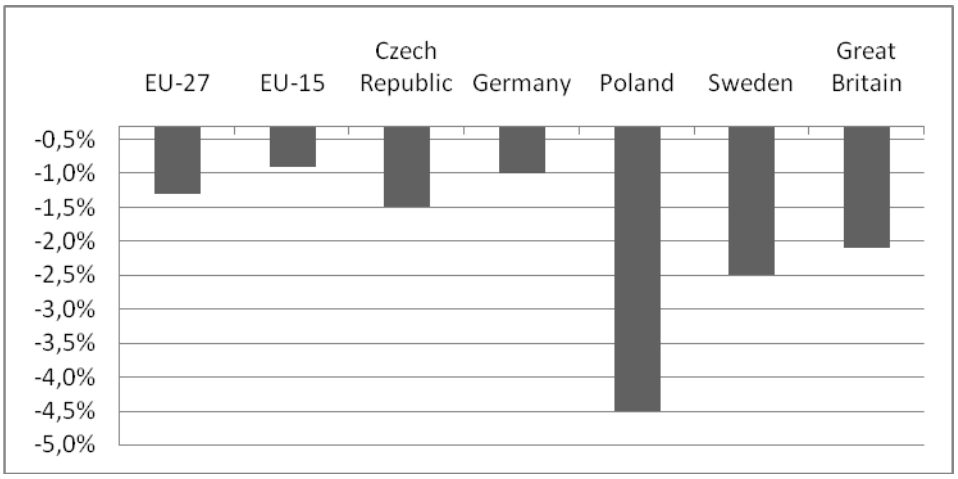

Figure no. 2 Annual average of energy consumption change indicator in chosen EU countries in years 1995-2005
Source: [Eurostat, 2010]

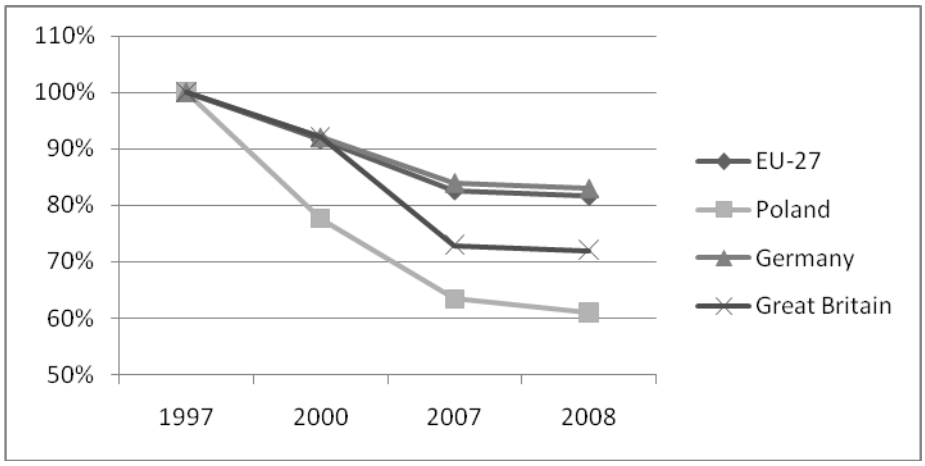

Figure no. 3 Pace of energy intensity decline in chosen EU countries
Source: [Eurostat, 2010]

In analysed years 1997-2008 the total actual primary energy consumption in Poland had tumbled by about 1.9% in real terms (around 11% fall in year 1997-2004 and raise in subsequent year – initially extensive – 1.6% annual average) in years 2004-2007, and then accelerated to around 4.7% in 2008, what is shown in figure no. 4. It is worth mentioning, that the same indicator of absolute primary energy consumption for EU-15 increased over the investigated period by around 12%, and for EU-27 by around 10%. GDP growth at the

same time outstripped energy consumption growth, resulting in energy efficiency indicator in all EU-15 countries decreasing at similar rate, however much slower in Poland.

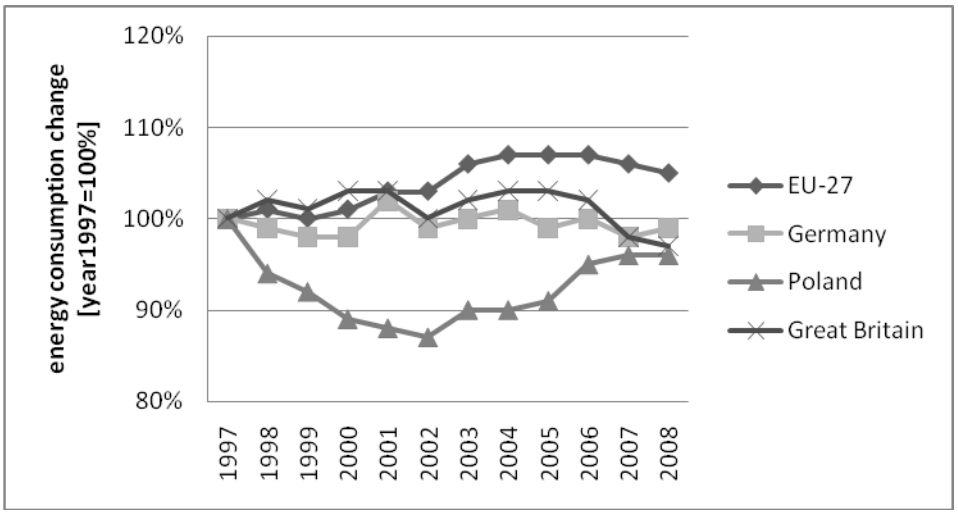

Figure no. 4 Changes in gross primary energy consumption in chosen countries of the European Union in years 1997- 2008 [toe]
Source: [Eurostat, 2010]

Such improvement of energy consumption indicator in Poland over the period of past decade, was possible due to relatively high economy growth figures and maintaining energy consumption indicators – entailing great modernisation efforts virtually in all sectors of the economy, in the public sector and in households sector – at a nearly constant level. Presented in above charts data point towards a very strong trend of energy intensity in Poland being in decline, however its pace in years 2003-2006 had weakened and becomes ever so closer to the EU-15 rate of decrease [Ministry of Economy, 2009, 41].

Poland is estimated to have saved around 15.1 Mtoe in 2006, so in excess of 20% of annual domestic, final energy consumption. It laid foundations, first and foremost, for energy savings in manufacturing and households amounting to 40% and in transport, which contributed 20% of that result. In EU-27 the aggregate energy savings in 2006 amounted to 115Mtoe, of which 40% was saved in manufacturing, 33% in transport and 27% in households. Had those savings not been made, the total energy consumption in 2006 would have been 11% higher [GUS/KAPE, 2008]. It is worth noting, that a substantial part of energy efficiency regulations, including the 2006/32/EC directive concerning effectiveness of final energy consumption and energy services, which back then was not in force yet. Improvement of energy efficiency listed among six fundamental directions of "Polish energy policy until 2030" is prioritised and main objectives in that area are:

- → seeking to maintain zero-energy economic growth,
- → consistent decrease of energy intensity of Polish economy down to the level of EU-15.

Pursuant to provisions of article 14 paragraph 2 of the ESD Directive, Polish Ministry of Economy presented in 2007 National Action Plan concerning energy efficiency. Directive-compliant objective for 2016 was specified, being 53452 GWh in energy savings

corresponding to economies of 4.59 Mtoe magnitude and it was a 9% drop in domestic energy demand compared to current (as at the year 2007). That document features also a so called national indirect objective for energy savings, expected to be achieved by 2010 (11878 GWh), which is an estimate constituting the path towards the goal, forecasted for 2016, allowing assessment of the progress.

Ministry of Economy is intending to stimulate pro-efficiency actions in the area of generating, transmission, distribution and usage of energy. One of proposed support instruments is going to be the system of "white certificates", which guarantees financial benefits to entities displaying the largest energy thrifts. Moreover dynamic development of both electric and thermal energy generation is foreseen through high efficiency cogeneration. The next action planned is introduction of minimum standards for devices and products consuming energy and their energy marking.

Those ambitious goals require implementation of innovative technologies using coal as energy fuel, as well as wide support and financing mechanisms enabling wide-spread use of thermal systems exploiting the potential of local RESs (Renewable Energy Sources). The scope of innovative power systems includes inter alia: new generation energy machines and equipment, RES-based thermal systems, utilisation of nuclear-inclusive CHPs (Combined Heat and Power) for cogeneration of heat and electricity, implementation of carbon capture and storage technologies (CCS). Improvement of energy efficiency is also possible though application of available and proven technologies for thermo-modernisation of buildings and heat distribution networks providing 15-35% energy savings in final thermal energy consumption compared to pre-modernisation state [Chomiak, 2010, 4-5].

In 2007 government came up with guidelines for energy efficiency act applying the 2006/32/EC directive. Still being drawn up act is set to create legislative framework for a system improving energy efficiency, comprising support instruments, aimed at obtaining tangible energy savings. In accordance with article 14 of the draft act, energy companies are going to be obligated to obtain certificates of energy efficiency on a yearly basis, confirming the amount of energy saved as an effect of undertakings rationalising consumption of fuels and energy by equipment, installations and facilities. Completion of those tasks will be supervised and overviewed by Energy Regulatory Office. Best undertakings serving the purpose of improving energy efficiency are going to be chosen through a system of annual tenders. The lowest intended energy savings are equivalent of 10 toe annual average, which should be achieved for the next 15 years [Chomiak, 2010, 4-5].

The scope of energy efficiency act and accompanying legal documents, should in a cohesive and comprehensive manner contain regulations concerning energy efficiency i.a. by [Wnuk, 2009, 8-9]:

1. Introducing voluntary obligations system in manufacturing,
2. Establishing National Energy Efficiency Fund,
3. Creating a governmental body (e.g. Energy Agency), responsible for delivering sustainable energy policy,
4. Arranging an exchange and promotion system for best practices in terms of improving energy efficiency, including participation of energy agencies,
5. State aid favouring and incentivising innovative actions in the scope of energy efficiency and increased productivity through energy economies,
6. Including the energy efficiency criterion when concluding public tenders in order to develop a stable market for energy efficient products,

7. Introduction of tax exemptions for end consumers of energy, using particular measures to increase energy efficiency.

During the last ten-year in Poland a monumental progress has taken place in terms of energy efficiency. It is a consequence of Gross Domestic Product's energy intensity having plummeted by around 1/3. First and foremost our achievements list: thermo-modernisation undertakings completed under the act supporting thermo-modernisation undertakings, modernisation of street lighting and optimisation of industrial processes. Still, however, energy efficiency of Polish economy is about 3 times lower compared to developed European countries and about twice lower than the average for European Union countries. Furthermore, primary energy consumption in Poland, in relation to its population, is practically 40% lower than in "old 15" countries. The aforementioned is indicative of huge dormant potential for energy efficiency in Poland, characteristic for intensively developing economies.

There are still, however, significant barriers hindering improvement of energy efficiency, especially in enterprises. Among the most potent ones are managers lacking awareness, often low contribution of energy costs to total costs incurred by companies and underestimated potential of energy economies. Awareness in that area can be increased by promoting good practice examples (case studies) and energy benchmarking among same-industry facilities. The next hurdle is lack of knowledge about energy efficiency among managers and staff and the fact that core business activities are too absorbing. Good Polish enterprises are striving to find any feasible measures cutting production costs, including energy costs. It applies particularly to companies from energy-intensive industries, which already achieved plenty in that area and on many occasions outperformed foreign competition. Those are exceptions however. Majority of companies fail to approach the matter of energy efficiency methodologically. Somewhat justifying can only be lack of government support for such undertakings. Research into motivation and barriers in respect to energy efficient practices conducted by Polish chamber of commerce confirmed, that predominantly they are implemented with lower energy bills in mind (93% of indications) or as measures deflecting future price rises (78% of responses). Energy efficient actions are viewed as image improving means by 59% of investigated companies, whereas 56% perceived them as an instrument counteracting climate change and helping environmental protection. The research shows, that in staggering 67% of cases actions taken to improve energy efficiency, brought relatively little financial effects. Large profits were obtained in 15% of cases, whereas in 17% of cases no profit was achieved at all. 10% of companies are dismissing the energy issue as not important and 16% is labelling it as insignificant. Energy is a matter of some importance for 28% of investigated companies, and to 46% it is of paramount importance. Despite energy acquisition costs being essential for majority of enterprises, measures improving energy efficiency are scarcely in place.

4. ENERGY SECURITY VS. DEVELOPMENT OF RENEWABLE ENERGY SOURCES

Both indigenous and exogenous factors caused increased interest in issues of energy security in Europe. The former include energy prices on constant rise, decline in generating capacities in Europe (CO2 emissions required to be capped), and divided electric energy market. The latter are in turn constantly changing political and economic backdrop in developing countries. All that put together triggered doubts over Europe's capability to address future energy demand. The shape of Polish energy policy, whose overarching goal should be

to guarantee energy security of the country cannot fail to incorporate actions undertaken by the European Union. On July the 1st 2011 Poland will take over lasting six months presidency of the Council of the European Union. One of top objectives for Poland whilst holding the Presidency will be to provide a fresh incentive to act in the area of delivering continuous development of solid and renewable energy sources, to avoid running the risk of energy crisis within the European Union. The issues of solidarity ask for more attention, including crisis mechanism of the EU, as well as the matter of oil resources and a diverse range of interventionist mechanisms in case of stopped gas supplies. It is also crucial to intensify efforts aimed at improvement of energy efficiency. Investing in solutions improving energy efficiency allows reaching three goals at the same time at the lowest outlays: reduction of greenhouse gasses emission, strengthening of energy security and giving a strong impetus to sustainable economic growth.

"National energy security is a state of economy, where it is capable of meeting current and prospective consumer demand for fuels and energy, in a technically and economically justified manner, at minimised impact of energy sector on natural environment and living standards". Defined in that manner energy security in the "Energy Policy of Poland until 2030" document comprises three main aspects: energetic, economic (market) and ecologic. Energetic aspect comprises balancing demand and supply and technical issues related to technical infrastructure and its management. Energy balance of a country manifests itself in a sustainable act of balancing supply with forecasted demand for energy and fuels at a continuous basis in long-term perspective, bearing in mind economic and ecologic aspects and the possibility of managing demand for energy, without having to tinker with consumer satisfaction in terms of effective energy. Economic (market) aspect of the security boils down primarily to providing effective energy carriers at acceptable by consumers prices, determined in civil-law agreements or in tariffs. Currently the cost of energy supplies security is included in that price, hence the need for market internalisation of energy security costs. This aspect also entails the domestic fuel-energy sector being capable to face the European competition. Ecological aspect of the security touches on issues of preserving the natural environment in a proper state for future generations and requires meeting adequate ecological standards and obligations and other related issues, like development of renewable and associated energy sources and new "clean" generating technologies [Szymczak, 2007].

Liberalisation of the electric energy sector, creation of international links and access to modern techniques and technologies enabling discretion in choosing energy providers, cause the financial and economic aspects of domestic energy system to gain in significance, which as the time goes by will become fundamental parameters of fuel and energy supplies security. The previous level of energy security can change due to forecasted increase in demand for electricity, unavoidably aging fixed assets of electric energy sector and strict requirements of environmental policies. It will take place, given adequate preventive measures are not in place or they are insufficient. In short-term, in the face of energy generating capacities in Poland being increasingly dependent on external deliveries of energy carriers, gaining in significance is also the problem of balance in trade being under strain of fuels purchases and higher economy's vulnerability to exogenous influences related to spikes in crude oil and gas prices.

Ensuring energy security then, requires many actions to be undertaken in the area of generation, transmission and distribution of electricity as well as in the area of consuming electricity, such as:

→ construction of new generating capacities,

- → intensified utilisation of existing power grids,
- → rapid expansion and modernisation of transmission grids,
- → expansion and modernisation of distribution network,
- → quick adoption of legal solutions concerning infrastructural investments aimed at removal of barriers hindering their development,
- → expanding technical possibilities of access to the European market,
- → improvement of economy's energy efficiency.

The most important for functioning of the Polish electricity sector act – Energy Law, features the majority of regulations concerning national energy security. That act has key significance in terms of national energy security. The legislative framework it stipulates concerns: energy supplies security, operating security of both transmission and distribution systems. In accordance with EL and being in force "Polish energy policy until 2030", Ministry of Economy assumes concrete objectives and actions to be undertaken over the next decades in order to create national energy security. Those actions are aimed at decreasing the rate of energy loss as well as maintaining the zero-energy economic growth stripped out of demand for primary energy. Moreover the Polish government puts itself under obligation to lift legal barriers stipulating access to new black and brown coals deposits in order to raise extraction capacities. In the matter of natural gas supplies security, the policy includes the option of Polish enterprises finding their way to access that material's deposits abroad and also planned is construction of a transmission system enabling deliveries of natural gas from north, west and south. The next aspect is plans of building intersystem connections and expansion of reserve storage capacities in case of unexpected crisis. Also featured is intensified oil exploration of Poland and an increase in its extraction. In critical circumstances, the Ministry would expect to build crude oil and liquid fuels storages capable of maintaining continuous supplies. Polish energy policy envisages also introduction of nuclear power before 2020 as an independent and CO_2-free energy generating source. It ties in, however, with preparation of infrastructure for nuclear power and guaranteeing to investors appropriate conditions for building and activating nuclear power plants based on safe technologies. Furthermore, additional investments are planned to incentivise energy generation from renewable sources. Pursuant of that goal, the government commits itself to introduce changes to energy law, facilitating making investment decisions in the RES sector and guarantees to award certificates of energy origin to producers utilising RES energy (ROCs – Renewable Obligation Certificates).

Poland plans to increase contribution of renewables to final energy consumption to 15% by 2020 and further 5% by 2030. There are also plans to raise consumption of biofuels to 10% in the market of transport fuels. It intends to supplement Polish energy mix i.e. diversification of energy resources used in energy and fuels production. Apart from introducing nuclear energy to energy balance and reinforcing it with more energy from renewables, Poland also sees a possibility to improve energy security in unconventional natural gas deposits. It is estimated, that deposits of shale gas in Poland can reach as much as 3 trillion cubic metres. Polish extraction potential compared to EU countries' is substantial. If the estimates were confirmed, it would mean a significant improvement of national energy security, because those deposits would satisfy demand for the resource over several hundred years.

One of the tools to deliver Polish energy policy is active engagement with the European Union seeking to draw up common EU energy policy. Poland has presented a few important to it issues concerning European Union's energy policy, which was supposed to

take into account energy considerations of new member states. They were inter alia: introduction of mandatory gas reserves, obligation to inform about planned strategic investments in the energy sector, co-funding by the European Union transmission infrastructure and change of "supply disruption" definition concerning mutual assistance of EU states.

Poland was in favour of tightening solidarity in EU actions taken in case of emergencies (common plans in case of such eventualities) and stocking up common gas reserves. Under previous provisions EU countries had to unite only when there was a 20% gas supply gap for the entire Union. Those are important for Poland postulates; they were supposed to be beneficial to new member states' interests in terms of common approach to Russia and other gas exporters. Development of renewables is to contribute to independence of a single energy resources provider. Becoming independent of import has now been elevated to the rank the most critical issue. Utilisation of renewables has a positive impact on local energy security and decreases transmission losses, on top of that, it is an energy emitting no detrimental to environment pollution and conforms to the European environment protection trend.

5. INVESTMENTS REQUIRED IN THE ENERGY INDUSTRY AND DETERMINANTS OF CCS IMPLEMENTATION

In Poland on one hand the economic transformation caused fall of energy-intensive branches of industry, but on the other hand it exerted pressure on improvement of energy efficiency. As a consequence, demand for electricity practically remained unchanged, hence sufficient power reserves could be maintained, and thus decisions about investments were belated in time. Over the course of coming decade, however, energy companies will have to face challenges resulting from the necessity of building new generating capacities. Poland will have been faced with investment risk, which it will have to be capable of evaluating and minimising [Ciepiela, 2011].

The most essential distinguishing mark of investments in the energy sector is long-term, complicated investment process and long lifecycle of energy facilities and generally longer, than in other branches of manufacturing, period of achieving return on investment. Higher, than in other sectors are capital outlays, similarly to financial costs of investment. Currently being built large energy facilities (excluding wind farms) are going to be operational for at least 40 years. Even regardless of uncertainty resulting from possible legal changes, it is very difficult to make assumptions about future energy prices, fuel prices or improvements of CO2 emissions.

Unfavourable age structure of energy infrastructure, deteriorating technical condition and hardships impeding realisation of indispensible investment tasks by energy companies are fuelling the need to guarantee quick completion of infrastructural investments. Inadequate intensity of those investments can create the risk of inability of those energy companies to ensure undisrupted and reliable electricity supplies. Additionally, environment protection requirements stipulated by the European Union and the structure of electricity generating are causing extra costs of those investments.

Investments of Polish energy groups have to be divided into several areas. The first is the energy generating segment. The next investment-requiring area is the transmission and distribution system, which needs modernisation and construction of new lines and stations. The third area is cross-border connections. Due to under-performing and low in number connections, Poland currently can be neither a significant importer nor exporter of energy.

In Poland investments in new generating capacities are realised too slow compared to the needs. Polish energy policy until 2030 assumes, that energy consumption will increase from 150.7 TWh in 2006 to 217 TWh in 2030. It means a surge in demand by 44%. At the same time aging generating capacities and increasingly restrictive norms for greenhouse gases emissions through the prism of 2020 translate into necessity of fundamentally modernised 12 000 MW by that time as well as new-build 12 000 MW. The scale of required investment in the generating sector is monumental, because of indications pointing to the need of about 45 GW of installed capacities by 2030 with simultaneously decommissioning 15 GW of already installed capacities by that time. It requires power plants to be built using a diverse range of technologies: modern, high-performance both black and brown coals-fired units; combined cycle units; distributed energy resources of average and low capacity combined with generating electricity and heat; nuclear energy and power plants utilising renewable energy sources (mainly: biomass fired power stations, wind turbines).

Building new power lines, especially in case of transmission grids is very difficult and time-consuming under current legislation. If the government failed to make a quick change-over, building new power lines would get increasingly challenging. Therefore efforts should be made to intensify utilisation of already operational lines. Modernisation actions aimed at replacing transmission wires should be the driver behind that intensification.

National transmission grid is adapted to typical for the time being, conditions of demand for electricity and completion of internal transmission tasks under normal circumstances. There are, however, local threats causing power difficulties under extreme weather conditions, both during summer and winter. In the anticipated timeframe electricity supplies security can be undermined in large urban agglomerations. Already now, a significantly higher than average demand for electricity is observed during summertime, moreover it seems to concentrate in large urban agglomerations [Kasprzyk, 2007]. Those premises are indicative of necessity to expand and modernise the transmission grid. Development of strategically important transmission grids, from the point of view of energy security should be additionally supported financially by the state as part of instituted special systems or support funds. In the context of forecasted increase in demand for electricity in the future, the current transmission infrastructure may prove to be insufficient. Therefore expansion and modernisation of 110 kV grids as well as medium-voltage networks will be required. Especially important will be modernisation and upgrade of transmission grids in rural areas to an extent guaranteeing adequate quality of the energy supplied. Negligence in that area can cause future disruptions in energy supplies to end consumers [Dołęga, 2009,2-3].

Polish energy sector is operating currently in a very changeable economic and legal climate, where to an increasing extent the factor determining the profitability of an investment are the political decisions. Hence, when realising long-term energy projects taken into account have to be regulations, which will have to be observed in the future. Forthcoming legal solutions, however, in the area of energy and environment protection are still unclear, therefore making any concrete investment decisions for the time being, involves substantial risk. Instability and unpredictability of regulations as well as lacking consistent, long-term government policy, which would tie administrative authorities with the targets set out, are becoming the prohibitive barriers for investment in the energy sector.

Without a stable legal framework and implementation of stimulus-response mechanisms for new low-emission investments, construction of new generating capacities will be vacillated. Those stimuli have to be designed in a fashion allowing compensating the trade off between contemporary technologies competing with obsolete, exhausted generating

units, claiming their free CO2 emissions allowance. Also required is coordination of actions of individual resorts, allowing investors to take advantage of the synergy effect in form of concurrent realisation of objectives resulting from both the climate package (reduction of CO2 emissions) and regulations concerning environment protection (reduction of SO2 and NOx emissions, dusts) [Lewiatan, 2010, 35].

The most important element heightening the regulatory risk is currently the uncertainty referring to CO2 emissions trading system after 2012. Especially no specifics on allocating free allowances, methods of consuming trading proceeds and their amount, criteria for installation classification and the pace of decreasing number of free allowances over the 2013 – 2019 period are all influencing the investment decisions made. The remaining investment barriers in the energy sector include[Lewiatan, 2010, 22-23]:

- → maintaining price control over energy for end consumers in households, what distorts the market and impedes reliable forecasting of energy prices in perspective of several years, because the exact date of lifting the regulation remains unknown. The following direct effect is subsidising some users by other users, and among indirect effects – higher funding costs of new investments,
- → bad structure, lack of liquidity and transparency of the energy wholesale market, and also flawed functional model based on the concept of so called "copperplate", rendering impossible to properly evaluate goods and shipping. One of effects is incorrect method of rewarding producers for commissioned by the system operator work, which poses a threat to ability to recoup fixed investments in low-emissions technologies,
- → uncertainty about possible implementation of the cap-and-trade scheme concerning SO2 and NOx,
- → uncertainty about possible implementation of CCS technologies in Poland.

In accordance with assumptions of the second energy package, coal will remain one of the fundamental energy sources in the European Union and an all-important alternative to natural gas and crude oil. It stems from the fact that it is available in enormous quantities at multiple suppliers worldwide and is easily stored. The current century brought observable all over the globe increase in the amount of energy generated from black and brown coals. Higher carbon dioxide emissions during coal combustion processes compared to other energy resources constitute, however, a major hurdle for its further utilisation for energy-generating purposes. Hence indispensible are highly productive capture and storage installations for greenhouse gases and serving that purpose research is advanced. Development of CCS technologies in the European Union and other regions is dependent on adopting adequate legal regulations, coal prices and availability of new technologies and processes. According to the International Energy Agency, that technology stands in for a chance to contribute to lower global CO2 emissions by about 20%. It can be particularly promising for Poland – a country where in excess of 90% of energy is generated from fossil fuels.

Successful implementation of the CCS technology can yield Poland over a distant time horizon a range of benefits, not only of prestige nature but also financial. CCS can play a key role in increasing the potential of Polish research centres and R&D centres as well as assisting Poland in finding its niche in the worldwide market. It will be possible, however, only in case of scrupulous processes of development and distribution of the CCS technology. In order to do so, CCS should gain renown and potency at the governmental level, which would bestow on CCS the rank of being one of the crucial tools in climate and energy politics.

By the end of 2008 the European Union passed the climate and energy package, containing several legal acts, which are currently being implemented into the legislation of the member states. One of those legal acts is directive concerning geological carbon dioxide storage, stipulating the following guidelines [Gąsiorowska, 2010, 241]:

- → rules for locating CO2 storages in deep geological layers,
- → rules for using such storages and their closure, in particular very important are regulations concerning storing safety,
- → financial reserves in case of CO2 leaking into the environment,
- → rules for granting access to CO2 transmission networks and storages of that gas,
- → the issue of appropriate governmental bodies,
- → issues of cross-border collaboration.

Geo-sequestering of CO2 in geological layers will be preceded with detailed analysis of a potential reservoir, conducted only under condition of appropriate concession having been granted. If the conducted analysis proved, that the storage complies with conditions of safe and permanent CO2 storage, one would be able to apply for an appropriate concession, this time for carbon dioxide storage in an eligible reservoir. After adequate injection and storage monitoring installations were built-in and the usage commenced, the operator would become responsible for safety of the storage and it monitoring. The regulations stipulate that in case of CO2 leakage or significant irregularities occurring, the operator has to inform the competent authority and carry out adequate repair works. There are relevant procedures in place for closing the storage and controlling it afterwards. Passing on the responsibility for the storage to the competent authority will take place up to 20 years after storage closure, provided predetermined conditions are satisfied, and for the following 30 years the storage will be monitored in order to reassure that the storage process is fully safe.

There is work in progress In Poland on transposition of the CCS directive into the national law. In November of 2009 the Ministry of the Environment presented draft guidelines for the bill determining rules of injecting CO2 into geological layers, propositions of solutions concerning storage monitoring and closure, and also propositions of solutions concerning issues of inherent responsibility related to CCS. Proposed by the Ministry of the Environment legal solution involves introducing legislation regulating transport and storage of CO2 to the act – Geological and Mining Law, as well as other acts such as: the act – Energy Law, the freedom of economic activity act, act – environment protection Law, Law on provision of information on environment and its protection, society's contribution to its protection and acts about environmental impact assessment. It seems reasonable the stance, that the planned CCS regulation was consistent with other regulations, implementing provisions of the climate and energy package. It is also necessary to prepare a comprehensive review of impact the regulation of legal acts applying that package has made (SEA - Service Efforts and Accomplishments). Taken into account have to be also financial implications of introducing new rules of trading with allowances for greenhouse gases emissions within the Community after 2013, including aftermath of possible failure to introduce CCS in Poland and all related increased costs, which would have to incurred by enterprises in case of mandatory purchases of emission permits. It is worth noting, that the CCS matter is a fresh one and should be comprehensively regulated, so that the entire CCS process was legislated: capturing, transport and storage of CO2 in geological reservoirs [Gąsiorowska, 2010, 242-243].

It can be expected, that the CCS will be a technology used for decades, until other technologies will have been invented allowing low-emission electricity generation from coal. Hence CCS in some respect is a support technology assisting the process of reducing CO2 emissions into the atmosphere. Especially in case of Poland, the possibility of developing and implementing the CCS is a golden opportunity to avoid the necessity of incurring increasing charges for CO2 emissions. Because the CCS technology is currently in the phase of demonstration projects, then due to very high cost of such installations on the industrial scale, significant subsidies from public funds are required to finance the process of developing the technology. The EU will subsidise the first few demonstration plants with the amount of 7-10 billion Euros.

The scale of necessary adaptation works and the magnitude of expected investment outlays in forthcoming years, require the government to approach the issue in a systematic and planned manner. It is required to develop an emissions reduction program, promoting i.a. high efficiency cogeneration, low-emission technologies, micro cogeneration, individual renewable energy sources and also utilisation of natural gas, liquid fuels and WTE (waste-to-energy) fuels to power units of generating capacity < 100MW. Without transparent and robust legislative framework and a funding system supporting realisation of investment undertakings, decisions about building new capacities will not be made. Coordination of government actions related to implementation of individual directives: IED, ETS and CCS is required. It should be emphasized, that still one of the barriers, investors have to overcome in the energy sector, is the ubiquitous state interventionism and lack of confidence in the market and competition. The fundamental recommendation would be for the government to gradually withdraw from the electric energy sector (an exception would be to maintain the state ownership of transmission grid) through privatisation and adequately drawn up legal regulations. Immeasurable objectives and incorrectly chosen measures for their completion are indicative of legal system's weakness in the area of energetics. Tools realising some objectives are creating a barrier for realising other ones. For instance, retaining by the state control over energy groups in order to guarantee energy security prevents competition from developing and proper evaluation of investments' profitability. Primary objectives have to be determined – without a shadow of a doubt it should be the competition in domestic energy market with limited scope of state interventions. Furthermore it is recommended, that collaboration between governmental bodies and enterprises improves in order to exchange information and refine quality of the law. Manual control over energy prices should also be moved away from as it restrains the ability to evaluate costs of funding investments. Limitation of the legislative scope to the necessary minimum: network tariffs, enforcement of network access, rules for changing seller, endorsement of connection fees, validation of balancing market rules, support system for renewables and cogeneration, will cause investment barriers to decrease in Poland. Investment processes are also going to be influenced by implementation of mechanisms facilitating decision making in terms of investment in new generating capacities, which are listed in the 2005/89/CE directive concerning electricity supplies security, including apart from robust legislative framework also[Lewiatan, 2010, 33-34]:

- → guaranteeing an adequate level of power reserves, based on market solutions, such as energy market,
- → construction of a liquid wholesale market, producing price signals for generating and consumption and lifting administrative barriers to infrastructure and generating investments.

6. CONCLUSION

Energy policy directions, which were set by the government in the document "Polish energy policy until 2030", are aimed at improving national security and maintaining sustainable growth. They also have to guarantee satisfied demand for energy of the current generation, but at the same time they cannot pose threat to energy supplies for future generations. Poland intends to achieve increasing energy efficiency through efforts oriented towards economic growth devoid of simultaneous raise in energy demand and decreased energy intensity of the Polish economy to the level of EU's "old fifteen" countries. Those aspirations are supposed to be met through: reduction of electricity losses in transmission and distribution, higher energy savings by end consumers, introduction of mandatory energy characteristics certificates for buildings put into use or to rent, energy markings on devices and products, information campaigns promoting rational energy consumption or supporting research into and development of new technological solutions reducing energy consumption. It is forecasted, that all those actions will translate into substantial energy savings and reinforced Polish energy security.

There are many challenges facing Poland, if it was to become a respectable part of the European energy market. First and foremost subject to changes has to be the structure of energy prices for end consumers. Several years ago by the virtue of ERO (Energy Regulatory Office) Chairman's decision, energy prices for all consumers were deregulated apart from individual consumers (households). Energy prices for individual consumers are still subject to tariffs (G tariff) i.e. endorsement by ERO President. It was dictated by the need to protect the most vulnerable group of consumers from threats resulting from inadequate development of competition in the Polish energy market and lack of its transparency. At the moment vast majority of those market flaws have been removed, owing to which a complete price deregulation can be expected for all consumer groups in Poland. It is a crucial matter predominantly for the Polish economy. Maintaining tariffs for individual consumers is a driver for incorrect structure of energy prices for individual consumer groups, manifesting itself in higher energy prices for industrial consumers compared to households. In Poland that discrepancy amounts to over a dozen percent. The second vital challenge, with which the Polish energy market is faced, is inadequate scale of investments in new generating capacities, which is capable of producing in forthcoming years energy shortfalls. Average age of Polish power stations is among the highest in Europe, causing on one hand an urgent need to refurbish existing generating capacities of low efficiency and high failure frequency, and on the other hand construction of new-build generating capacities, which will meet future demand for energy.

Refurbishment of existing obsolete generating capacities as well as investment in additional new-build generating sources in Poland ties in tightly with the European CO2 emissions allowance system (since 2013 CO2 emissions allowances will have to be predominantly paid for). Electricity is generated in Poland in over 90% from combustion of domestic fossil fuels resources (black and brown coals) i.e. the most CO2 emissive technologies. Ensuing consequence is that over the next several decades those technologies will be dominant in Polish energetics, as that is the technology lifecycle. Forecasted hike in energy prices, which stems from the need to build new generating capacities and high CO2 emissions, can be the highest in Poland compared to other European countries. Partial alternative capable of alleviating the surge in energy prices is expansion of cross-border transmission connections with neighbouring electric power systems. It will cause on one hand increased

access to energy from abroad, which should be cheaper than energy generated in Poland, and on the other hand will decrease need for investment in new energy sources in Poland.

All those actions – construction of new generating sources, emissions reduction, expansion of cross-border transmission networks – have to take place in a harmonised manner, so that their joint impact would limit to the maximum extent future energy price increases. An efficiently functioning, competitive energy market will play a huge role in all those actions, rationalising energy prices through market mechanisms.

References

[1] Analiza trendów rozwoju branży energetycznej, *Raport Związku Pracodawców Prywatnych Energetyki*, Lewiatan, 2010

[2] Chomiak, A., Krajowy system poprawy efektywności energetycznej jako realizacja zadań wynikających z Dyrektywy 2006/32/WE (ESD), *Energia i Budynek*, nr. 1, 2010

[3] Ciepiela, D., Dużo deklaracji, mało czynów, *ABC Efektywności energetycznej, Poradnik dla firm*, www.wnp.pl, accessed on April 20, 2011

[4] Dołęga, W., Zapewnienie bezpieczeństwa elektroenergetycznego, *Energetyka cieplna i zawodowa* nr. 11/2009

[5] *Energy efficiency trends by sectors in the EU-27*, GUS/KAPE, Warszawa, 2008

[6] Gąsiorowska, E., Technologia CCS - szansa czy ślepa uliczka?, *Polityka energetyczna* ed. M. Sobolewski, Studia BAS nr. 1 (21) 2010

[7] Kasprzyk, S., Nad bezpieczeństwem energetycznym trzeba stale pracować, *Wokół Energetyk*i, August 2007

[8] Ney, R., Niektóre uwarunkowania polskiej polityki energetycznej, *Polityka energetyczna* tom 12 (2009), zeszyt 2/1

[9] *Polish energy policy until 2030*. Document passed by the Council of Ministers 10 November 2009

[10] *Service Efforts and Accomplishments of the document Polish energy policy until 2030 (Final report)*, Ministry of Economy, Warszawa, 2009

[11] *Strategia zmian wzorców produkcji i konsumpcji na sprzyjające realizacji zasad zrównoważonego rozwoju*. Ministry of Economy, Labour and Social Policy, Warszawa, 2003

[12] Szymczak, W., Sposoby monitoringu stanu bieżącego systemu dystrybucji energii elektrycznej, Konferencja *Bezpieczeństwo Energetyczne Dolnego Śląska - Stan obecny i perspektywy*, Karpacz, September 2007

[13] Wnuk, R., Efektywność energetyczna polskiej gospodarki- szanse i zagrożenia, *Energetyka cieplna i zawodowa*, nr. 5, 2009