low-emission
Poland 2050

Poland 2050 — at a carbon crossroads

After twenty years of transformation, the situation of the polish energy sector is difficult and complex. How we solve these dilemmas will influence further social and economic development and quality of life. Therefore, the debate on the future of the polish energy system constitutes one of the keystones in the discussion on policy, quality and development directions for Poland as a whole.

Zbigniew Karaczun

Should this policy react only to current problems and support solutions that yield short-term benefits? Or should it be based on a long-term development vision that will anticipate changes around poland, seeking and strengthening the competitive advantages of our economy?

> from Conclusions

1

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Summary

The approach towards the energy sector has been changing due to industrialisation, rapid economic growth in developing countries, global increase in energy demand, unprecedented technological advances and escalating environmental degradation. Although energy security still focuses on supply security it has started to encompass other factors, such as counteracting fuel poverty and environmental pollution or ensuring stable access to energy in a long term perspective. All this leads to the development of new, innovative technologies that improve energy efficiency and allow for the production of energy from local, renewable resources. According to a majority of forecasts, further development of the global energy sector will be based on gas, renewable energy sources and energy efficiency.

Poland has to face particularly large modernisation investments. Due to the significant investment backlog, the Polish energy sector is considerably degraded. It does not guarantee proper energy security and high quality services. It is not ready to face the challenges of the 21st century, such as reduction of environmental impacts and GHG emissions. Its modernisation is unavoidable if Poland is to retain its fast pace of development.

Many other countries have had to tackle similar problems to the ones Poland is experiencing nowadays. Some of them decided to implement a new energy paradigm. When planning Polish measures, we should learn from their experiences.
The examples of Great Britain and Denmark show that the need to increase energy security served as a stimulus for instigating changes: energy efficiency improvement and the development of energy sources based on local, renewable resources. Moreover, both countries prove that conventional sources can be used as transition technologies facilitating implementation of a new energy model.

There are two other important lessons to be learnt from the British example. First, it shows that yielding to pressure groups delays structural changes in the economy and may lead to a crisis. Second, enterprises find it more important that a stable framework for conducting business is provided rather than that standards and requirements are relaxed (including production quality and safety norms or environmental protection standards).

The example of Denmark proves how crucial it is to ensure political consensus with respect to the most important economic challenges. Transparency of political agreements between the government and the opposition contributes to securing stable conditions for entrepreneurs to make long-term investment decisions.

The third example discussed here is somewhat different. Germany's decision to phase out nuclear energy temporarily decreased the energy security and economic competitiveness of that country. Nevertheless, Angela Merkel argues that it was indispensible to ensure secure development in the long term.

The above countries would not have undergone this transformation if they had not anticipated the changes that occurred on the global energy market. They reached a conclusion that the time of cheap, conventional, energy resources was coming to an end and that the world was entering a stage of fierce competition for depleted resources. Therefore, they decided to alter their energy mix, adjusting it to new, global, economic conditions.

Such reasoning should shape the Polish energy policy as well. Our country will also have to face the challenge of increasingly scarce resources and the danger of becoming dependent on one import direction. Considering this perspective, the need to modernise the Polish degraded energy sector should be perceived as an opportunity rather than a problem. An opportunity to develop knowledge-based society and to introduce innovative technologies and modern energy management systems. The most important benefits resulting from the modernisation of the energy sector include:

- decreasing Poland's dependence on imported energy resources, which will translate into greater energy security and a more advantageous foreign trade balance;
- reducing environmental pollution caused by the energy sector, which will contribute to the country's environmental security;
- improving the efficiency of energy use and broadening end users' knowledge on energy management, which should lower energy costs and, consequently, minimise the threat of fuel poverty;
- developing new markets for small and medium enterprises, which involves social activation and creation of new, stable jobs;
- reducing external costs generated by the energy sector, which will minimise losses resulting from these costs and improve public health.

If this is to become possible, the following steps should be taken.

- As far as the development of the energy sector is concerned, the interest of the state and society has to be clearly defined and differentiated from the interest of industries and other sectors. Explicit specification of social and economic objectives, taking environmental needs into consideration, should facilitate preparation of a long term (until 2050) development strategy for the energy sector seen as a part of the overall economy (and not separate from it).

- New solutions that can serve as transition technologies supporting the development of a low-carbon economy has to be sought (e.g. shale gas exploitation, underground coal gasification). This should go hand in hand with significant decrease of public support for energy technologies with a particularly harmful impact on the environment, public health and economic competitiveness.

- Opening the market of energy generation through compulsory division of production and distribution companies and their privatisation on the stock exchange. Due to vertical integration electricity companies have gained a monopolistic position on the market. This impedes activities of new, smaller and innovative subjects that could significantly contribute to modernisation of the Polish energy sector.

- System support for innovations and eco-innovations (low-carbon products and services) should be guaranteed at the research, development, dissemination and implementation stages.

- Regions and cities that may be temporarily vulnerable to the negative impacts of the low-carbon transition should be also provided with system support (i.e. places that will face the challenge of restructuring their industrial base).

- These changes should be supported through education, developing a society of aware energy consumers and prosumers[1], which will significantly democratise the processes through which energy demands are satisfied. Raising social awareness and energy demand management capabilities should go hand in hand with increasing end users' role in deciding about the future of the Polish energy sector.

1 The term 'prosumer' has been introduced by A. Toffler to describe a person with extensive knowledge about products and services and who is involved in their production. Here it is used to describe people who not only are aware energy consumers but also generate energy in their household micro installations.

Introduction

In the last decade of the 20th century, Polish objectives were clearly defined: ensuring a strong democratic basis, implementing economic transformation and developing a market economy. The goals of Poland's foreign policy were also rather straightforward: NATO and EU membership. These were demanding challenges that required the cooperation of all political forces and wide public support. Now that these objectives have been fulfilled, there are no priorities to unite politicians and society.

Initiating the third wave of modernisation that would be based on innovativeness, creativeness, efficiency and environmentally-friendly economic development may constitute a similar challenge for Poland. As the country's economy has been dynamically developing for last two decades, Poland still constitutes a 'green' economic island. Nevertheless, easy development opportunities are coming to an end. Polish economic development will inevitably slow down without new technological and organisational solutions, without improved management efficiency or innovations. This holds true for every sector of the economy.

Post-1945 industrialisation was facilitated by access to cheap energy generated from domestic hard coal and lignite resources. This is why, and for other political reasons (development of the industrial working class, energy security understood as self-sufficiency, foreign currency revenue from coal export), the energy sector was particularly protected. After 1989 it did not undergo such a thorough modernisation as other economic sectors. Innovative technologies and modern energy management methods have not been introduced. As a consequence, it does not ensure sufficient energy security and, despite maintaining substantial indirect and direct public support, it is increasingly hindering the country's further development.

When deciding possible transformation paths for the Polish energy sector we should not look back at the past nor be hostages to the present. We have to look to the future and respond to new challenges. And the future lies in innovative technologies, energy efficiency, modern energy generation methods and demand-side energy management.

Limiting Poland's dependence on coal and the development of a low-carbon economy are not only feasible, but also desirable. There are several reasons for this: economic – replacing the technologies of the 19th and 20th century with modern technologies that are more suited to the needs of the world with scarce natural resources; financial – applying technologies with low energy costs and social – improving quality of life[2], supporting social involvement and fostering a knowledge-based society. However, the expected benefits can be reaped only if the state plays an active role, i.e. develops a transparent and stable legal and economic framework that favours creativity and innovativeness, supports research, promotes diffusion of innovations and implements innovative solutions.

The low-carbon modernisation of the Polish energy sector will not be an easy task. Therefore, activities will have to be spread over time, so that all stakeholders are able to adjust to new conditions. A strategy for introducing these changes needs to be developed. It should assess economic, macro-economic and social impacts, identify existing barriers and define possible solutions for eliminating them. It has to include an analysis of costs associated with modernisation objectives and the benefits resulting from fulfilling them. It should also consider opportunity costs so that current decisions take into account future economic impacts.

Two independent non-governmental organisations: The Institute for Structural Research and The Institute for Sustainable Development have embarked on the development of such a programme. This text serves as an introduction to the discussion on the directions for the programme, considering the changes occurring around Poland. It is addressed first and foremost to politicians and decision-makers and it attempts to specify the factors that will influence the energy mix in Poland in 2050.

2 Poland has the highest external costs of electricity generation from among all the EU member states – they amount to 5.5-18 eurocents per 1 kWh (data for 2006; after: European Environmental Agency, *EN35 External Costs of Electricity Production*, 2008). This means that electricity prices should be higher by 70-250%. We do not pay these costs in electricity bills but we do cover them as a society – in negative health effects, higher expenditures on health protection, faster degradation of infrastructure, higher water treatment costs, higher pollution of agricultural produce, forest diseases, etc.

1. ENERGY REVOLUTION

1.1 Where is the world heading?

For several years now our world has been undergoing a revolution – the energy revolution. It is not spectacular and does not draw the attention of ordinary people. Media rarely report on it. But it is changing the world as we know it.

It has many causes, e.g.: increasing energy demand, the implementation of innovative energy technologies, the necessity to protect the climate and limit emissions of atmospheric pollutants, the negative political and economic effects of dependence on imported energy resources, the depletion of non-renewable resources, and increasing energy prices.

It is facilitated by technological development that enables the introduction of devices that are more and more energy efficient, better installations for renewable energy generation and utilisation of unconventional deposits: shale gas, oil sands. This is supplemented with demand-side energy management and changes in consumer behaviour.

As with any other revolution, this one will also influence our lives. It will impact the ways in which energy is generated, its prices, the labour market and how households function. It will also change our definition of energy security[3]. We can already observe this impact.

The dynamic development of the renewable energy sources market constitutes one of its effects. New energy installations that were constructed in 2010 had a total capacity of around 194 GW. Half of this is based on RES technologies. It is estimated that since 2011 the increase in the capacity of RES installations will be larger than for installations based on hydrocarbons and nuclear fuel together[4] (see: Frame 1).

All this has had impact on the significance of energy sources in the global energy mix. In 2010, the share of RES in global final energy production and as a transport fuel reached 16%; in electricity generation it was even higher, amounting to 20% (it is estimated that at the beginning of 2011 it reached 25%[5]).

3 Instead of state energy security the notion of regional, local or even individual energy security is used.

4 Fast RES development leads to positive feedback, as it contributes to decreasing investment outlays for new installations and strengthens the conviction that distributed energy, based on local RES resources, improves energy security in the short as well as long term. This, on the other hand, contributes to faster RES development. The future dynamics of this development will largely depend on how fast grid parity is obtained, i.e. when the cost of energy generation from renewable sources becomes equal or even lower than from conventional sources. (Frankfurt School - the UNEP Collaborating Centre for Climate & Sustainable Energy Finance, Bloomberg New Energy Finance, Global trends in renewable energy investment 2011. Analysis of Trends and Issues in the Financing of Renewable Energy, Frankfurt 2012).

5 Ibidem.

Frame 1
The growing significance of RES technologies in selected countries

The following data also confirm the increasing importance of RES[1]:

- in the USA the RES share in primary energy amounts to 10.9% (compared with 11.3% for nuclear energy); in 2010, it increased relative to 2009 by 5.6%;
- in China 9% of final energy comes from RES. The total capacity of RES installations that were connected to the grid in 2010 amounted to 29 GW, which translates into 12% increase relative to 2009;
- in Germany 12.2% of final energy is produced from RES and for electricity consumption the RES share exceeds 20%. In heat production it has reached 10.4% and in transport – 5.6%;
- many EU countries perceive RES as the future of the energy sector and have already started intensive development of renewable energy. RES constitutes a source of 22% of electricity in Denmark, 21% in Portugal, 15.4% in Spain and 10.1% in Ireland.

Utilisation of RES has been growing the fastest in developing countries – this is where over half of new RES capacity was installed in 2010 (these countries are also developing coal and nuclear energy). The largest number of new RES facilities was constructed in China – the global leader in construction of wind, solar and hydro installations. India ranks fifth in wind energy production and is currently preparing a rural development programme based on bio-gas and solar installations. Brazil is the largest producer of energy ethanol and is dynamically developing wind, biomass and solar energy. New installations are also being constructed in Africa and the Middle East.

1 *Global trends in renewable energy investment 2011.* Although the role of large hydro power plants in the RES share still remains significant in respective countries, in recent years this share has been decreasing thanks to development of other renewable technologies, mostly wind farms.

Increased utilisation of unconventional deposits, e.g. shale gas, constitutes another effect of the energy revolution. Shale gas has allowed the USA to stop importing gas. In 2010 the share of this energy carrier in the total gas consumption in the USA amounted to 27% (and is estimated to increase to 50-55% in 2030[6]). Although shale gas is exploited on a wider scale only in North America, new findings show that it can be extracted also in other regions, including Poland. If the preliminary information about the possibilities for the commercial exploitation of shale gas is confirmed, it may become a transition technology that will facilitate development of a low-carbon economy in our country.

6 *BP Statistical Review of the World Energy*, June 2011, available at: www.bp.com/statisticalreview

1.2 The evolution of the energy sector in selected EU countries

In historical terms, the Polish economy's strong dependence on coal is nothing extraordinary. Two to three decades ago, most countries in the world depended to a similar extent on hydrocarbon fuels.

The 1950s saw the first stage of diversification, as various countries started constructing nuclear power plants[7]. As a consequence, in Russia (the USSR at that time), the USA, France, Japan and Germany nuclear technologies became an essential element of the energy mix.

The second stage began in 1990s and is still continuing[8]. It focuses on three objectives:

- increased energy security;
- the development of a more competitive economy through access to relatively cheap energy and innovative technologies;
- the minimisation of threats to public health due to environmental degradation through the enforcement of demanding environmental protection standards, in particular stringent emission reduction norms for GHGs and related pollutants (particulate matter, NOx, SO2, etc.).

7 In most cases such measures were motivated with factors other than energy issues, i.e. obtaining fuel for nuclear weapons. Although this military motivation lost significance with time and most of the current reactors are not suitable for production of plutonium for military purposes, development of nuclear energy in some countries, e.g. Iran, North Korea, still has military objectives.

8 The oil crisis of the 1970s instigated the development of technologies based on renewable resources. Nevertheless, the ensuing slump in oil prices diminished interest in this area and in consequence halted wider application of renewable solutions.

1.2.1 Great Britain

Until the 1960s Great Britain remained dependent on coal. Its combustion generated around 90% of final energy. The remaining 10% was produced mainly from oil combustion. Great Britain started to develop nuclear energy facilities already in the 1950s. Despite this, the share of respective energy carriers remained largely unchanged until 1980: around 75% of energy was produced from coal, 7-10% from oil, 15-18% in nuclear power plants, while the share of natural gas did not exceed 2%.[9] This status quo was maintained mainly to the opposition of trade unions – when in 1972 the government intended to reduce the role of coal it was forced to abandon its plans.

The British solution consists in establishing mid- and long-term objectives of the energy and climate policy, as well as the necessary regulations for meeting the objectives.

On 4 May 1979, Margaret Thatcher came to power. She became the Prime Minister in difficult times – the pace of economic development was nearly zero, inflation exceeded 10%, unemployment was soaring. Implementing her ambitious crisis plan[10], in 1984 she announced the government's plans to close unprofitable hard coal mines and to privatise the remaining ones[11]. In response to this, the National Union of Mineworkers went on strike. After one year the strikers yielded and the government closed all unprofitable mines, privatising the remaining 15. This made it possible to reduce the role of coal in electricity generation.

Although the main reason behind the decision to reduce the significance of coal was to weaken the power of trade unions, Thatcher's speech during the Climate Conference in Geneva shows that she also took into account other objectives: "Many of the precautionary actions that we need to take would be sensible in any event. (...) It's sensible to improve energy efficiency and to develop alternative and sustainable sources of supply; it's sensible to replant the forests which we consume; (...) I understand that the latest vogue is to call them 'no regrets' policies. Certainly we should have none in putting them into effect."[12]

After Thatcher, the following governments continued these processes. The resulting changes in the British energy system are well reflected in the data presented in Figure 1. Utilisation of natural gas made it possible to further reduce the role of coal. Gas is currently used as a transition technology that facilitates faster development of RES installations.

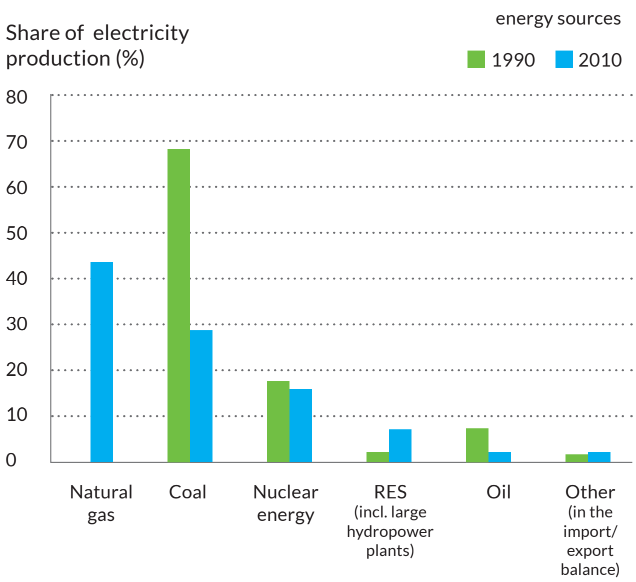

Figure 1. Structure of electricity sources in Great Britain in 1990 and 2010[13].

9 Sharman H., Leyland B., Livermore M., 2011, *Renewable Energy. Vision or Mirage?*, ASI (Research) Limited, London. This share did not increase until as late as 1990 (it was even lower and amounted to only 1.2%). Only after the introduction of the programme *Dash for Gas* at the beginning of the 1990s did the situation change. Subsequent years saw a lot of new gas power plants constructed and the share of this fuel in final energy production increased to 30% in 2002. The total value of the programme within which 40 gas power plants were built in 1991-2002 amounted to £ 11 billion (after: *Digest of United Kingdom Energy Statistics*, 2011. Table 5.11: Power stations in the United Kingdom, May 2011).

10 Encyclopaedia Britannica, available at: http://www.britannica.com/EBchecked/topic/590098/Margaret-Thatcher

11 Nearly all of the several dozen operating coal mines in Great Britain were unprofitable (they were subsidised by the state), poorly mechanised and overstaffed. British coal was much more expensive than coal mined in other countries. At the same time the strength of British trade unions depended on miners.

12 Margaret Thatcher, speech during the second World Climate Conference, Geneva, 6 November 1990.

13 Data for 1990, after: http://www.berr.gov.uk/energy/statistics/publications/dukes/page39771.html. Accessed on: 10.12.2011. Data for 2010, after: http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/fuel_mix/fuel_mix.aspx. Accessed on 2.01.2012

Frame 2
The role of RES development in increasing British energy security

The debate on the development of the British energy sector, which took place at the beginning of the 21st century, was dominated by two main elements: the fact that natural gas deposits in Britain were finishing and the conclusions from the Stern Review[1], which analysed threats to the British economy resulting from climate change.

In August 2009, the UK Energy Research Centre published a report on the depletion of oil deposits[2]. The most important conclusions of this report include:

- 28-56% of global oil resources were exploited by the end of 2010;
- the pace at which production from the existing oil fields is decreasing is considerable and it is growing by 4% annually;
- in order to maintain the current extraction level, over 30% of the existing fields should be replaced;
- most of the exploited fields have passed their peak extraction levels.

The report concluded that oil and natural gas deposits in the North Sea were also shrinking, which jeopardised the stability of the British energy system. Stronger support for RES should help to minimise this threat, as it would reinforce the long-term energy security of Great Britain.

1 Stern N., *The Economics of Climate Change. The Stern Review*, Cambridge University Press, London, 2007. Nicolas Stern, a conservative professor of economics from the famous London School of Economics, was commissioned by the British government to analyse the need to implement active climate protection methods. The report concluded that it was highly probable that climate change was occurring due to anthropogenic impacts and its results would be deeply negative for Great Britain. Prevention measures will be cheaper than later mitigation actions against negative consequences of climate change impacts.

2 Sorrell S., Speirs J., Bentley R., Brandt A., Miller R., *Global Oil Depletion An assessment of the evidence for a near-term peak in global oil production. An assessment of the evidence for a near-term peak in global oil production*, The UK Energy Research Centre, 2009.

In order to strengthen state security, including energy security, in November 2008 the British Parliament adopted the Climate Change Bill[14], which introduces ambitious emission reduction targets – reduction of 80% by 2050 and 28-32% by 2020 (relative to 1990). In April 2009 the British government increased the 2020 reduction target to 34%[15].

The current directions of the British energy policy are set out in the UK Low Carbon Transition Plan[16], which defines how the 34% target should be achieved. Its main objective is to increase the country's energy security (see: Frame 2).

Conclusions

Within the last three decades, Great Britain has made tremendous progress from the "sick" country of Europe to a modern state. Although this process was initiated by other factors than climate change, the fact that Great Britain reduced the role of coal has turned it into a country with the most progressive climate policy within the whole EU. The Conservative Party, which was heading for victory, attacked the governing Labour Party for its excessively passive climate policy. This became one of the main themes of the electoral campaign[17]. Such a situation was possible because the conclusions from the research commissioned by the government were treated seriously. Entrepreneurs were pushing for more stringent reduction targets and a long-term policy in this respect, as they wanted to minimise the risk of having these changes introduced abruptly. Gradual and consulted introduction of environmental objectives, even demanding ones, is less dangerous that unexpected changes in the conditions for conducting business.

Poland could learn from Britain how to define medium and long-term objectives of the energy and climate policy and specify legal measures for the implementation of these objectives. This provides a solid ground for making long-term business and investment decisions.

14 The Climate Change Bill. Available on: http://www.opsi.gov.uk/acts/acts2008/pdf/ukpga_20080027_en.pdf

15 Jowit J., Budget 2009: Darling promises 34 proc. emissions cuts with world's first binding carbon budgets, The Guardian, 22.04.2009

16 HM Government Department of energy and Climate Change, The UK Low Carbon Transition Plan. National Strategy for Climate and Energy, TSO London, 2009.

17 The Conservative Party, *The Low Carbon Economy. Security, Stability and Green Growth Protecting Security. Policy Green Paper No.8*, London, 2009.

1.2.2 Denmark

At the beginning of the 1970s, the Danish economy was nearly totally dependent on imported resources – in 1973, 94% of primary energy was produced from crude oil[18]. As a result, Denmark experienced severe consequences of the first oil crisis. This provided an incentive for a deep restructuring of the Danish energy sector. This process was based on increasing energy efficiency and RES development. These objectives were aimed at strengthening Denmark's energy security by reducing the country's dependence on the import of energy resources.

Denmark serves as an example of consistent implementation of energy policy objectives[19], focused on increasing the share of energy from renewable sources (Figure 2). In 2011, the Danish government, with the support of the opposition, adopted a draft of a new energy policy. It provides for the total elimination of fossil fuels by 2050[20].

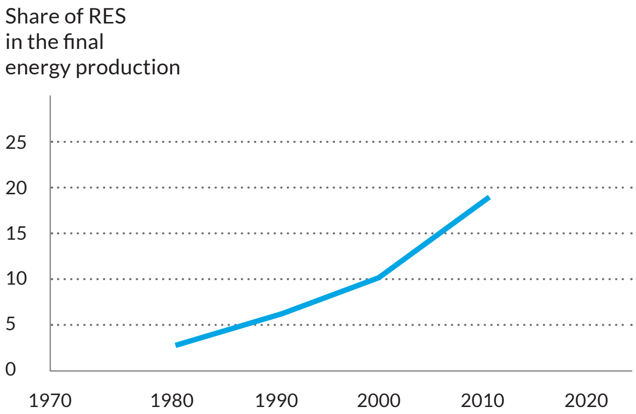

Figure 2. Share of energy from renewable resources in final energy production in Denmark in 1980 - 2010[21]

Danish energy policy is based on state multi-annual investment programmes. The first one, Danish Energy Policy 1976, was adopted in reaction to the oil crisis. It was aimed at decreasing Denmark's dependence on imported energy resources, in particular oil. The next one, Energy 81, served as a basis for fostering energy security through investments in energy efficiency improvement, RES development and large infrastructure projects in exploitation of oil and gas from the North Sea. In 1990, Denmark adopted the document Energy 2000, and in 2001 – Energy 21. Further reduction of the country's dependence on non-renewable resources became even more significant. The main measures to implement this objective included support for RES (subsidies) and the internalisation of costs associated with non-renewable energy through fiscal mechanisms (environmental tariffs and a carbon tax)[22].

The carbon tax was introduced in 1992, first for households and a year later also for industrial emissions[23]. Its rate is still growing. The highest rate is levied on electricity consumption in households and the public sector and heating in all sectors. The lowest rate is imposed on electricity consumption in heavy industry[24]. Thanks to this tax, energy consumption in Denmark is 10% lower than in the reference scenario (without the tax)[25].

First support programmes for RES development were also introduced in 1992. Initially this took the form of investment subsidies. Operational support gained significance with time, as more and more RES installations were connected to the grid – a system of tariffs for renewable energy introduced to the grid. Most of this support depends on the energy source type and size. The tariff for large offshore wind farms is individually negotiated between an investor and the government. in 2009-2010 annual support for renewable energy amounted to around EUR 250 million[26], i.e. around 0.075% of Danish GDP.

Increasing energy efficiency constitutes the second main direction of the energy policy (see: Frame 3).

18 European Renewable Energy Council, *Review of Policy Initiatives within the EU. Denmark*, Brussels, 2004

19 Ibidem

20 Richardson K., Dahl-Jansen D., Elmeskov J., Hagem C., Hanningsen J., Korstgard J., Kristensen N.B., Morhorst P.E., Olsen J.E., Wier M., Nielsen M., Karlsson, *Denmark's Road Map for Fossil Fuel Independence*. Solutions 2(4), 2011.

21 European Renewable Energy Council, *Review of Policy.*

22 Ibidem

23 It was introduced as a part of the environmental tax reform, which increased taxes on natural resources and reduced taxes on labour.

24 Danish Environmental Protection Agency, Ministry of Environment and Energy, *Economic Instruments in Environmental Protection in Denmark*, 1999.

25 McCormick K., Neij L., *Experience of Policy Instruments for Energy Efficiency in Buildings in the Nordic Countries*. International Institute for Industrial Environmental Economics, Lund University, 2009.

26 Andersen F., N., Plougmann P., *Policy Paper on Renewable Energy and Energy Efficiency of Residential Housing*, A report to the European Commission Directorate-General Regional Policy. Expert Evaluation Network Delivering Policy Analysis on the Performance of Cohesion Policy 2007 – 2011, Copenhagen.

Frame 3

Energy efficiency as a solution for increasing Danish energy security

The first energy norms for buildings were introduced in the 1960s and since then they have been regularly tightened. The current norms for new buildings are: 120 kWh/m2/year for small buildings and 75 kWh/m2/year for large ones[1].

In 2000, Denmark adopted the act on the promotion of energy efficiency, which was amended in 2005 to fully transpose the Directive 2002/91/EC of the European Parliament and the Council of 16 December 2002 on the energy performance of buildings. Denmark introduced stringent norms for new buildings. Their energy demand in 2015 has to be at least by 50% lower than in 2006 and in 2020 by 75%[2].

Energy consumption in buildings is controlled by energy audits and the energy labelling system for buildings. It had already been introduced in 1979 and since that time it has evolved to reach conformity with the EU requirements. There are two types of certificates: for large buildings (over 1500 m2) and for small buildings (below 1500 m2). Energy labels cannot be older than five years. Every new building as well as any building for sale or rent has to have an energy label[3].

Apart from indicative standards, Denmark has also introduced voluntary systems for the energy certification of construction materials [4]. They are supported by the governmental Centre of Energy Services. It is estimated that around 50% of energy efficiency investments would not be implemented without educational support[5].

Another important measure is the system of support, e.g. subsidies available for owners of private as well as public buildings (up to 30-40% of investment outlays), except for buildings that have already benefited from other forms of public financial support. Between 1993 and 2003 Denmark offered support for energy efficiency improvement in buildings that housed the retired[6].

In 2008, Denmark spent around EUR 86 million (0.015% of GDP) supporting energy efficiency, out of which around EUR 40 million/year for measures targeted on enterprises and EUR 32 million/year for measures in buildings[7].

1 McCormick K., Neij L., *Experience of Policy Instruments*.
2 Danish Ministry of Transport and Energy, *A Visionary Danish Energy Policy 2025*, Copenhagen, 2010.
3 McCormick K., Neij L., *Experience of Policy Instruments.*
4 Ericsonn K., *Evaluation of the Danish Voluntary Agreements on Energy Efficiency in Trade and Industry*, Ecofys, Copenhagen, 2006.
5 Torgeby, M., Dyhr-Mikkelsen, K., Larsen, A., Hansen, M.J. & Bach, P., *Danish energy efficiency policy: revisited and future improvements*, 2009.
6 McCormick K., Neij L., *Experience of Policy Instruments.*
7 Torgeby, M., Dyhr-Mikkelsen, K., Larsen, A., Hansen, M.J. & Bach, P., *Danish energy*.

Conclusions

This progressive energy policy would not be possible if the following two conditions had not been met: political consensus on the necessity to limit emissions and the conviction that the development of the green energy sector will increase energy security and competitiveness of Danish enterprises[27]. This is why Danish industry supports this policy. DONG ENERGY, one of the largest Scandinavian energy companies, may serve as an example here. In 2011 it adopted the 85/15 programme, which states that: "currently DONG ENERGY produces 85% of energy from hydrocarbon fuels. Our aim is to reduce CO2 emissions to 15% of the current level"[28].

In Denmark, energy policy is free from political disagreements. Political parties sign public agreements on selected issues that shape the most significant directions of this policy. On 29 March 2004, Danish parties signed an agreement on the construction of two offshore wind farms with the capacity of 20 MW each. The next agreement, encompassing the period

27 Development of the RES-based energy sector makes it easier to connect the Danish energy system with the neighbouring countries – energy imports are treated as a reserve that stabilises the energy network.

28 DONG owns facilities extracting gas and oil from the North Sea bed (in 2011 it extracted over 9 m barrels of oil and over 17 m barrels of natural gas. The company generates electricity and heat – in 2011 it produced 20.4 TWh of electricity and 42.6 PJ of heat (respectively 54% and 35% of total production in Denmark). For several years now DONG has been investing in renewable energy. In 2011, 20% of its electricity was generated in wind farms. Data available at: http://www.dongenergy.com (accessed on 15.05.2012).

from 2008 to 2011 was also accepted by all the main political forces and signed on 21 February 2008[29]. Its main objectives include: decreasing Denmark's dependence on non-renewable energy sources through ensuring at least a 20% RES share[30] in final energy production in 2011 and energy efficiency improvement by 1.5% annually. The latest action plan, adopted in 2011, assumed that by 2050 Denmark will have based its energy sector solely on renewable sources.

The decision to replace hydrocarbon fuels was grounded in the conviction that ambitious domestic targets will create a new market for innovative technologies, making Denmark an important producer in this sector[31]. These expectations have been to a large extent fulfilled as a Danish company, Vestas Wind Systems A/S is the largest producer of wind turbines in the world – its share in the global market amounted to nearly 15% in 2010[32].

The development of renewable energy sources is directly or indirectly accompanied by an increase in the number of jobs associated with "green energy". The example of Germany shows, on the one hand, the importance of public opinion for political decisions, and on the other hand, that it is possible to make decisions with positive effects that manifest over a long term.

1.2.3 Germany

The example of Germany differs from the other two analysed countries. The decision from March 2011 to close down nuclear power plants by 2021 (three will be able to work to 2022) will temporarily decrease Germany's energy security. Let us not forget that Germany is the second largest nuclear energy producer in the EU – around 30% of electricity consumed in Germany comes from this source.

It seems that this decision results from two basic facts: very strong public opposition to nuclear energy (additionally strengthened by the Fukushima breakdown) and the need of stronger support for green energy. Although implementation of this plan will be costly and, at least temporarily, will partially make the German economy dependent on imported energy, Angela Merkel believes that bearing these costs is indispensable for maintaining the competitiveness of the German economy in the long-term[33].

The RES and energy-efficiency sector already constitutes one of the markets with the fastest growth rate in Germany. This gives Germany the first place in Europe in installed capacity based on RES. In 2010 it amounted to 27.2 GW. Its share in electricity production in the first half of 2011 grew to over 20% - in 2000 it was only 6.3%. In 2010 alone, the investment volume in this sector amounted to EUR 26 billion[34].

RES development brings a growing number of jobs that are directly or indirectly connected with green energy – in 2010 approximately 370 000 people worked in this sector, which is 8% more than in 2009 and over twice as much as in 2004 (160 500 employees). According to German politicians this constitutes an example of the successful integration of economic, social and environmental objectives[35]. Such fast RES development would not have been possible without support for research in this field (see: Frame 4).

29 The agreement between the government (Liberals and Conservatives), Social Democrats, Danish People's Party, Socialist People's Party, Social Liberals and New Alliance on Danish energy policy for the years 2008-2011. Available at: http://www.ens.dk/en-US/policy/danish-climate-and-energy-policy/Documents/Energy proc.20Policy proc.20Agreement proc.2021 proc.20Feb proc.2008_final.pdf. Accessed on: 27.12.2011.

30 This objective has been fulfilled.

31 European Renewable Energy Council, *Review of Policy*.

32 Jäger-Waldau A., Arantegui L.R., *Snapshot on European Wind Energy*, 2011, available at: http://ec.europa.eu/energy/renewables/studies/doc/wind_energy/2011_wind_snapshot.pdf.

33 Schultz S., Will Nuke Phase-Out Make Offshore Farms Attractive, *Spiegel Online*, 23.03.2011, available at: http://www.spiegel.de/international/germany/0,1518,752791,00.html.

34 Crossing the 20 Percent Mark. Green Energy Use Jumps in Germany, *Spiegel Online*, 30.08.2011, available at: http://www.spiegel.de/international/0,1518,783314,00.html.

35 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BmU), *Renewable Energy Sources in Figures*, Berlin, 2011.

Achievements in energy-efficiency improvement are equally impressive. In 1991-2007, the average GDP growth amounted to 1.5% annually and consumption grew by 1.2% annually[36]. Despite such growth, final energy consumption fell by 8%. This places Germany among the most efficient economies of the world.

Frame 4
Expenditures on research as the basis for RES development in Germany

Germany offers a perfect example of a government policy that combines market push (expenditures for innovations in RES and energy efficiency) with market pull (support for production and sales). The development of innovations is fostered by funding for research. In 2005-2010 alone, the federal government allocated EUR 800 million for studies in this field, which was much more than in any other EU member state. This gives Germany third position among countries with the largest number of patents for clean technologies[1]. Demanding energy policy targets with respect to RES development and energy efficiency improvement are to provide support for production and sales. The German government presented these targets in September 2010[2]:

- RES share in electricity production: 35% in 2020 and 80% in 2050;
- RES share in final energy consumption: 18% in 2020, 30% in 2030 and 60% in 2050;
- energy efficiency – 50% reduction in electricity consumption relative to 2008 in 2050.

1 Taylor Dimsdale, Sanjeev Kumar, Jesse Scott, *EU 30 proc. Emissions Reduction by 2020: Benefits for European Competitiveness, Consumers and Taxpayers*, E3G, 2010.
2 Ibidem.

Conclusions

On one hand, the example of Germany proves that public opinion can exert significant pressure on political decisions (politicians would have looked for other ways to support low-carbon solutions, had it not been for public opposition to nuclear energy). On the other hand, it shows that it is possible to make decisions that will yield positive effects only from a longer perspective[37]. This provides Germany with an opportunity to restructure their energy sector when they can still use non-renewable resources and when they are rather cheap. Electricity that will have to be bought from neighbours is also relatively inexpensive (compared with construction costs of new capacities)[38]. By focusing on energy efficiency and RES, Germany is developing its energy security and access to cheap energy in a longer perspective. Anticipating changes to international markets, Germany is developing more competitive conditions for its companies and is safeguarding its own market against the negative consequences of increasing energy prices due to the depletion of non-renewable energy resources.

36 The economic crisis after 2008 reduced the pace of economic development and contributed to lower energy demand.

37 Nuclear energy phase out may temporarily increase emissions, as nuclear power plants will be replaced (at least at the beginning) by higher generation in coal and gas power plants.

38 More information on this topic can be found in the report: Hewicker Ch., Hogan M., Mogren A., *Power Perspectives 2030. A contributing study to RoadMap 2050*, ECF, Brussels, 2011, available at: http://roadmap2050.eu/attachments/files/PowerPerspectives2030_FullReport.pdf.

2. WHAT FUTURE FOR THE ENERGY SECTOR?

Forecasting the future, especially in the long-term, is a difficult and risky task, as such forecasts are prepared on the basis of earlier trends and changes, while decisions are impacted by current political interests, concerns and economic factors (Figure 3).

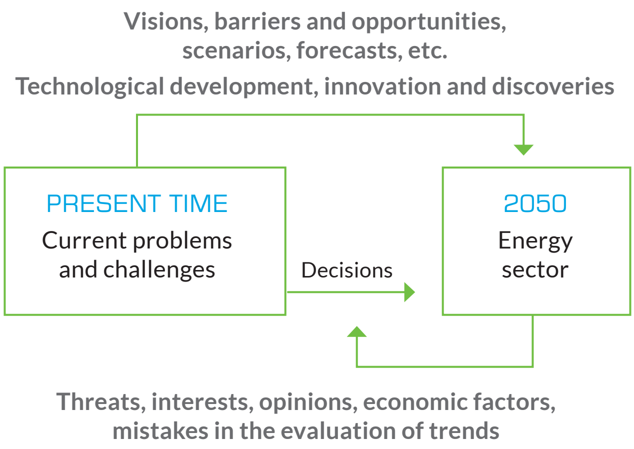

Figure 3. Factors impacting accuracy of forecasts in the energy sector for 2050[39]

The future depends on which new, already available inventions, solutions and technologies will gain a dominant position. In recent years the energy sector has been experiencing rapid technological development in both energy efficiency improvement and energy generation from renewable sources. Work that may result in a true technological leap is in progress, e.g. effective energy storage methods and achieving a positive energy balance in nuclear fusion. The need to stop global climate change and the concern about the depletion of energy resources constitute other significant factors that will have an influence on the future of the energy sector[40].

Given the above, forecasts for energy carrier demand differ significantly from current trends. For example, in its latest study, the International Energy Agency[41] forecasts (Figure 4) that in the 2035 perspective the highest increase in new capacities will occur for RES (increase by 1300 Mtoe[42]) and gas (increase by 1100 Mtoe).

The British fuel concern BP has published similar forecasts[43], which predict that the share of gas and RES in the global energy mix will increase significantly until 2030. The share of oil will decrease substantially, the share of coal will diminish slightly, while the share of hydro and nuclear energy will remain at the current level.

39 Grunwald A., *Energy futures: Diversity and the need for assessment*. Futures 43: 820 – 830 (amended), 2011.

40 Sorrell S., Speirs J., Bentley R., Brandt A., Miller R., *Global Oil Depletion*, 2009. According to BP estimates, conventional natural gas deposits will last around 60 years, while exploitation of unconventional deposits will prolong this period by 30 years. BP argues that due to depletion of oil resources, biofuels will constitute around 40% of transport fuels already in 2020 and 60% in 2030. [after] *BP Energy Outlook 2030*, London, January 2011. See also: Hedberg D., Kullander S., Frank H., *The World Needs a New Energy Paradigm*, Ambio 39: 1 –10, 2010.

41 EA, *World Energy Outlook 2011*, presentation to the press. London 2.11.2011. Available at: http://www.iea.org/weo/docs/weo2011/homepage/WEO2011_Press_Launch_London.pdf

42 Mtoe – million tonnes of oil equivalent. This is an energy unit that is equivalent to million tonnes of fuel oil with the calorific value of 10 000 kcal/kg. 1 Mtoe = 11 630 GWh = 41.868 PJ

43 *BP Energy Outlook 2030*, London, January 2011.

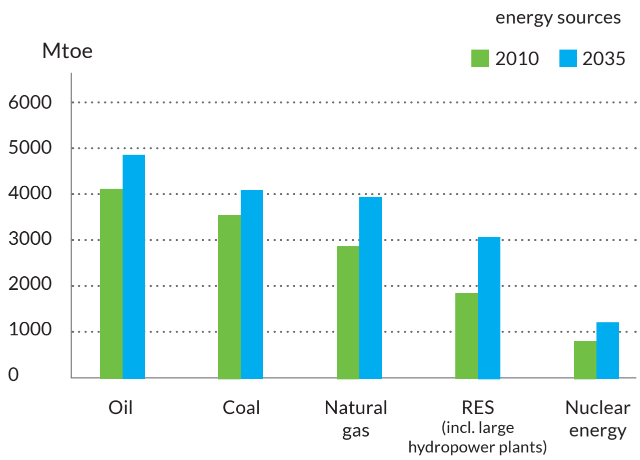

Figure 4. Forecasted growth in the global demand for primary energy carriers in 2035[44]

In October 2009, during the Swedish EU Presidency, the Royal Swedish Academy of Science organised an international conference on development directions for the European and global energy sectors to 2050[45]. The debate resulted in a development scenario for the global energy system to 2050. It assumes that by 2050 primary energy production will have increased from 140 to 170 thousand TWh and the share of non-renewable hydrocarbon resources in primary energy generation will decrease significantly (from 80% in 2007 to 53%)[46].

According to other scenarios, the share of respective energy sources in energy production in 2050 will be similar. Some of these scenarios, however, forecast a significant increase in global energy demand. For example, Shell[47] predicts that in 2050 there will be 9.5 billion people in the world and primary energy production will rise to around 310 thousand TWh[48]. The RES share in the energy mix will amount to 50%, while that of coal, oil and gas will decrease, each amounting to around 13.7%. Nuclear power plants will provide around 9% of global primary energy. The authors of the EU Energy Road Map[49] also assume a considerable growth in the RES share and a significant improvement in energy efficiency. The Road Map identifies an optimum path for ambitious CO2 emission reduction by 2050.

There are, however, more progressive scenarios. For example, according to the RIGES[50] scenario, prepared by Energy World Conferences, the RES share in primary energy sources will exceed 60% in 2050. Under the SEE[51] scenario it will amount to as much as 73%[52]. There are also more conservative forecasts, where the high share of hydrocarbon fuels and nuclear energy in primary energy is maintained[53].

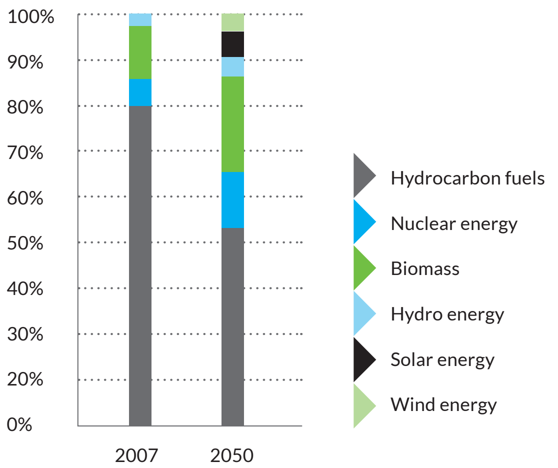

Figure 5. Share of respective energy sources in primary energy generation. 2007 data on the basis of IEA statistics, data for 2050 on the basis of the forecast prepared by the Energy Committee of the Royal Swedish Academy of Science1[54]

All the analysed scenarios recognise that the future shape of the energy sector will depend not only on the changes in energy generation technologies but also on changes in energy management, as even at this very moment we are experiencing an efficiency revolution. Companies already compete trying to make their products as energy efficient as possible. Application of novel solutions can increase efficiency even over ten times (Table 2, Figure 6).

44 IEA, *World Energy Outlook 2011*, presentation to the press, London 2.11.2011, available at: http://www.iea.org/weo/docs/weo2011/homepage/WEO2011_Press_Launch_London.pdf

45 Royal Swedish Academy of Science www.kvsa.se/en. The conference was organised on: 19 - 20.10.2009.

46 Destouni G., Frank H., *Renewable Energy*. Ambio 39:18 – 21, 2010.

47 Grunwald A., *Energy Futures*

48 EJ – exajoule, a unit of electricity generation, 1 EJ = 1018 J = 277 777 GWh = 277 TWh

49 European Commission, *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: The Energy Road Map 2050*, COM (2011) 885/2, 2011.

50 RIGES – Renewable Intensive Global Energy Scenario

51 SEE – Solar Energy Economy

52 Grunwald A., Energy Futures

53 European Commission, *World and European Energy and Environmental Transition Outlook*. WETO-T. EC., Brussels, 2011.

54 Destouni G., Frank H., *Renewable Energy*. Ambio 39:18 – 21, 2010.

Table 2. Changes in energy demand for buildings[55]

Type	Annual demand kWh/m²
Buildings constructed until 1970s	300 – 500
Buildings constructed in 1980s	200 – 350
Contemporary buildings	150 – 200
Requirements of the 2002/91/EC Directive for new buildings	120
Energy sustainable buildings	30
Passive buildings	15

A new term 'zero energy building' has been coined to describe a building that does not require external power as its own demand for energy is covered by its own installations using renewable energy sources.

Despite the significant progress made so far, energy efficiency measures are still at the initial implementation stage. Terms like "zero-energy building" have appeared – these buildings do not require external energy supplies, as their energy demand is covered by the building's installations based on RES. Some of these buildings are connected to the grid not to receive energy but to introduce surplus energy produced in these dedicated installations[56]. A passive consumer becomes a "prosumer", who gains additional income through their own activities. This alters the relation producer – consumer and how energy grids are developed.

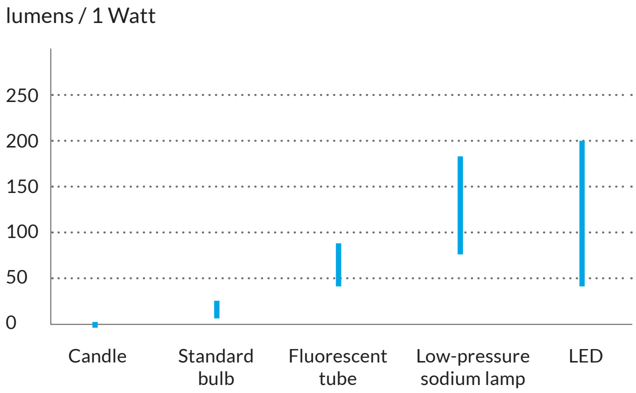

Figure 6. Efficiencies of selected lighting sources (lighting stream size from 1 Watt)[58]

These changes also have an impact on energy management. The construction of new energy generation installations is more and more frequently replaced with measures reducing energy demand. Investments are made in decreasing energy consumption at the level of final users. These savings allow for connecting new customers to the grid. Such a solution is usually two or three times less expensive than the construction of new energy sources[57].

Virtual power plants constitute another new solution. They comprise numerous, distributed local sources, consumers and power accumulators (batteries, hydrogen fuel cells, pump-storage hydro power plants, super-capacitors) as well as energy efficiency improvement and energy management measures at the level of end users. These elements are connected to each other and the energy supply system by means of an IT and energy network that facilitates exchange of information between respective parts of the virtual power plant and communication with the management system[59].

55 Popczyk J., *Energetyka rozproszona. Od dominacji energetyki w gospodarce do zrównoważonego rozwoju, od paliw kopalnych do energii odnawialnej i efektywności energetycznej.* Polish Ecological Club Mazovian Branch and Institute for Sustainable Development, Warsaw, 2011.

56 This is possible with a new type of meters, which measure not only how much energy a particular subject consumed but also how much it introduced to the grid.

57 Hewicker Ch., Hogan M., Mogren A., *Power Perspectives 2030. A contributing study to RoadMap 2050*, ECF, Brussels, 2011, available at: http://roadmap2050.eu/attachments/files/PowerPerspectives2030.

58 Popczyk J., *Energetyka rozproszona.*

59 Szczerbowski R., *Generacja rozproszona oraz sieci Smart Grid – wirtualne elektrownie*, Polityka energetyczna 14(2): 391 – 404. Although these solutions are still at the pilot stage, they offer such a large energy efficiency potential that they are expected to quickly enter into widespread application.

A decentralised management system[60] constitutes the "brain" of a virtual power plant. It sends respective units information to reduce or stop generation or to turn off some devices. Due to the improvement of energy efficiency and energy management at end users, energy demand is significantly reduced. This enables the cooperation of such systems with micro-RES. In consequence, such a power plant can generate energy for an external, local energy grid or can constitute a stable source of energy supply for customers connected to the power plant. Experts argue that virtual energy will develop at a fast pace, as it presents a significant energy efficiency and energy saving potential and contributes to the democratisation of energy generation – instead of one corporation supplying energy in return for revenues, a network of interrelated local energy producers is established[61].

To sum up, an analysis of the current changes justifies the conclusion that the future global energy system will most probably be based on highly efficient equipment, energy management at end users, dispersed sources and a high RES share.

To sum up, it may be assumed that future global energy systems will be based on highly effective equipment, management of energy use by end-consumers, distributed sources and a high proportion of renewable energy sources.

60 Filipowicz M., *Wirtualne elektrownie.* Nafta & Gaz Biznes. July/August, 2004

61 Marc Coroler – Senior Vice President for Central Europe of Schneider Electric. Presentation during the panel: EU 20/20/20 Package. Are we Getting Closer to Creating Cleaner and Energy Sufficient Europe. Energy Forum, Krynica, 9.09.2011

3. QUO VADIS, POLONIA?

Poland has lost its strong position among global coal exporters and will never regain it[62]. In 2008, coal import exceeded its export and has been increasing since then. It grew from around 3.2 million tonnes in 2005 to around 15 million tonnes in 2011 (Figure 7). Further expansion of coal-based energy will create a barrier for fast development[63]. It will divert support from research and innovations to solutions dating back to 19th century (in 2010, state subsidies for the coal sector in Poland amounted to around PLN 2,772 million[64], which is equivalent to around 53% of the total budget expenses for research and development).

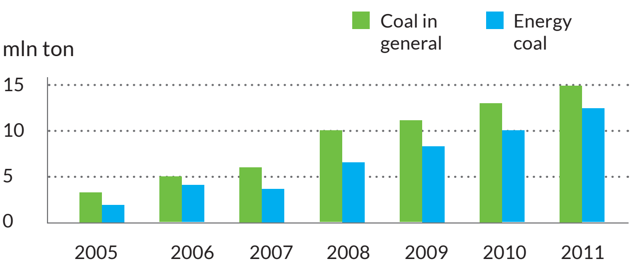

Figure 7. Growth in coal imports to Poland in 2005 - 2011[65]

62 Oklulski T., *Zmiana trendu w handlu polskim węglem*. Polityka energetyczna Tom 13 (2): 365 – 375, 2010.

63 The fact that Polish coal resources are running out will also have a large impact. According to Wilczyński, national lignite resources will finish by 2030 – 2040. It will be difficult to start exploiting new fields, as even now such plans are strongly opposed by the public. Hard coal resources will be exploited slightly longer, but reaching new deposits will be increasingly more difficult and expensive. [after] Michał Wilczyński, Vice Minister of Environment, Chief State Geologist in the government of J. K. Bielecki. Spoken during the conference: Realizacja priorytetów polskiej Prezydencji, a przyszłość polityki energetycznej w UE. Warsaw, 15.12.2011

64 OECD, *Poland: Inventory of estimated budgetary support and tax expenditures for fossil fuels*, OECD, Paris, 2011.

65 Oklulski T., *Zmiana trendu*.

In recent years Poland has been developing at a fast pace, nevertheless its electricity production has not increased (Figure 8). This was possible due to implementing structural changes in the economy and increasing the efficiency of resource and energy management among economic subjects.

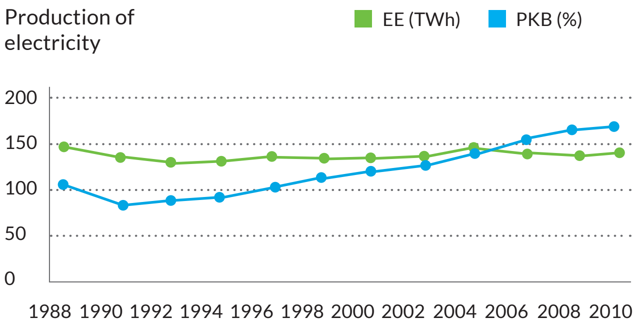

Figure 8. Electricity generation volume (EE) in TWh/year relative to GDP changes (cumulatively) in Poland in 1988 – 2010[66]

Although the cheapest possibilities for increasing energy efficiency have been to a large extent exploited, the Polish economy still possesses considerable potential in this area. In 2010, the energy intensity of the Polish economy was 2.2 times higher than the average for the EU-27[67]. The energy saving potential to 2020 amounts to 26.8 TWh/year for electricity and 512.9 PJ/year for fuels and other types of energy. This level of

66 Own analysis on the basis of statistical data (www.stat.gov.pl) and the announcement of the Minister of Economy of 12 December on the report assessing the progress in increasing the share of electricity from high-efficiency co-generation in the total electricity production. M.P. of 2008, No. 1, and the data of PSE Operator S.A. available at: http://www.pse-operator.pl/index.php?dzid=152&did=842#opis. Accessed on 09.01.2012

67 http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=1&language=en&pcode=tsien020

savings is economically justified and would make it possible to reduce energy consumption by 25%[68].

The benefits from improving energy efficiency are unquestionable[69] and include: economic benefits – reduced energy costs and improved competitiveness, environmental – lower pressure on respective elements of the ecosystem and social – job creation in sectors connected with efficiency improvement, reduced negative health effects of pollutants emitted during coal combustion (SO2, NOx and particulate matter PM10 and PM2.5)[70].

The wide application of passive buildings and micro-generation, developed as a response to increasing energy prices, and the reduction of costs associated with such solutions constitute other factors that should be considered in forecasting the future energy mix[71]. Even if the state does not provide system support for promotion of micro-sources based on local, renewable resources, property owners will invest in them (without system solutions, however, these new sources will be used for their own needs and will not be connected to the grid). This will have an additional impact on energy demand reduction.

Even if no systemic actions are taken for the promotion of micro-sources using local renewable resources, property owners will invest in them anyway.

These factors show that the estimates conducted for the future energy mix should to a larger extent take into account the possibility of maintaining the high economic growth rate at stable energy consumption or its slight growth. This is a significant issue, as Poland will have to make a decision on the development direction of the energy sector and the whole economy. This stems from the crisis in the energy sector and from EU measures – introduction of obligatory energy saving objectives, new requirements on energy efficiency (inter alia with relation to new buildings) and RES share in energy supply as well as higher prices for CO2 emissions.

Before the final choice is made, the costs and benefits of all available options should be thoroughly analysed. This is crucial, as current analyses ignore the fact that simple modernisation of this sector, with coal as the dominating resource, will be equally expensive, and in the long term even more expensive (Figure 9), than diversification. If the sector is not thoroughly transformed, potential benefits will be lost, e.g. minimised external costs, reduced transport intensity, job creation, social activation, innovations. All these issues should be taken into account so that the cost and benefit analysis includes all the aspects that are important from the social, economic and environmental points of view.

These factors, however, do not determine the direction to be chosen. Poland may continue its drifting policy, trying to avoid making tough choices. In the short term, such a strategy eliminates the necessity to take unpopular decisions. In the medium term, however, it will reduce competitiveness and will leave important social and environmental challenges unaddressed. If the drifting policy is chosen, significant social groups will continue to be marginalised, unemployment will grow and social stratification will deepen.

68 Technical potential is estimated at 50% [after] *Potencjał efektywności energetycznej i redukcji emisji w wybranych grupach użytkowania energii*, Polish Ecological Club Mazovian Branch, Polish Foundation for Energy Efficiency, Katowice, 2009.

69 Implementation of a wide energy efficiency improvement programme will also bring positive budget results, as the increase in budget revenues (PIT, CIT, VAT) from the implementation of additional investments will be higher than losses due to reduced energy production and sales. [after] Berbeka K., *Konsekwencje wprowadzenia białych certyfikatów jako instrumentu poprawy efektywności energetycznej*, Polish Ecological Club Mazovian Branch, Warsaw, 2010. According to the above estimates, the implementation of an energy efficiency programme will increase tax revenues by PLN 350 - 400 million net annually.

70 According to Żylicz, GHG emission reduction can be justified by co-benefits of decreasing other pollutants. [after] Żylicz T., *Współkorzyści przeciwdziałania ociepleniu klimatu. Presentation during the conference: Przygotowanie społeczeństwa do zagrożeń powodowanych zmianami klimatu*, Climate Coalition, Warsaw, 30.09.2009. Therefore, an additional 10% GHG emission reduction would bring Poland annual savings in healthcare of PLN 5.3–15.2 billion [after] *The co-benefits to health of a strong EU climate change policy*. http://www.climnet.org/Co-benefits proc.20to proc.20health proc.20report proc.20-september proc.202008.pdf

71 Competition from Chinese companies that offer cheaper products is already becoming a problem for enterprises from highly developed countries. See e.g.: Upadł kolejny z czołowych producentów paneli PV w USA. Available at: http://www.gramwzielone.pl/zielone/artykul/Upad-kolejny-z-czoowych-producentw-paneli-PV-w-USA. Accessed on: 23.12.2011

Poland may also choose an active policy. It may evolve in two directions. Poland may continue to protect the interests of the coal sector and the energy sector that is based on the monopoly of large state corporations. In this scenario it will mechanically transpose the provisions of the new EU directives with regard to energy efficiency and RES development (implementation of legislation and not the spirit behind it)[72] and prefer cost intensive and large scale investments.

However, a coal-based energy sector will not ensure inexpensive energy. Energy infrastructure is slowly becoming degraded. Replacement costs for this infrastructure – even for coal-based installations – are estimated at around PLN 200 billion until 2020[73]. In order to repay these investments, energy prices for final consumers will have to increase. Climate policy measures and the necessity to incorporate external costs in energy prices will further increase the cost of coal-based energy.

Therefore, development of distributed energy[74], based on local, mainly renewable resources, constitutes another viable option. This will foster technological and organisational innovations, job creation and social activation (establishment of small and medium enterprises on the developing energy efficiency and RES markets and wide promotion of the prosument approach). As energy generation will be dispersed, so will be the revenues associated with it, which will also contribute to minimisation of income differences. Development of distributed energy should be connected with construction of energy effective spatial structures that will utilise renewable energy sources.[75]

Poland may choose to be an active policy-maker. It can have two directions. Poland may continue defending the interests of the coal sector and the energy sector based on the monopoly of large state corporations. Another way may consist of the construction of a distributed energy sector, based on the use of local and mainly renewable resources.

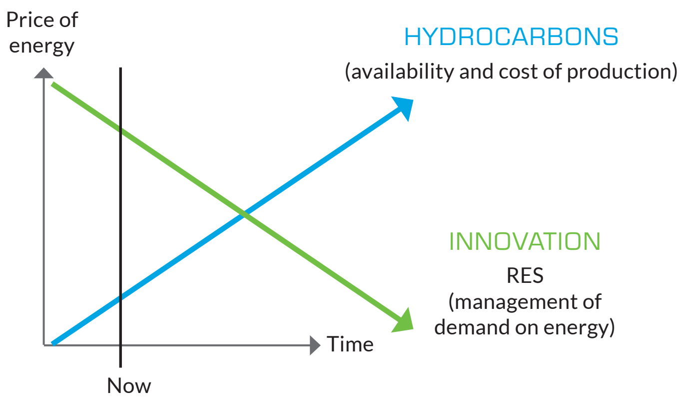

Figure 9.. Forecasted changes in prices of energy from non-renewable fuels and RES[76]

72 This is the current approach that is exemplified e.g. by the Energy Efficiency Act that transposes the Directive 2006/32/EC of the European Parliament and Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC (OJ L 114 of 27.04.2006, p. 64) or by the draft RES Act, presented on 22.12.2011, that transposes the Directive 2009/28/EC of the European Parliament and Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing the Directives 2001/77/EC and 2003/30/EC.

73 Żmijewski K., Statement during the debate: "Plan Marshala dla infrastruktury – finansowanie strategicznych inwestycji", 2011, [after] http://www.kurier365.pl/biznes-kurier-365/gospodarka/item/3426-200-miliardow-na-odbudowe-infrastruktury-energetycznej.html

74 Distributed energy is not the only innovation area in this sector. Large RES installations, e.g. wind or solar farms, in good locations may prove less expensive, more efficient and effective than a large number of less efficient wind turbines in wrong locations that generate the same amount of energy – due to economic reasons as well as landscape protection.

75 Jan Popczyk, *Energetyka rozproszona*.

76 Matthews R., *High Oil Stimulate Renewable Energy*. The Green Market, 15.05.2011

Conclusions

After twenty years of transformation, the situation of the Polish energy sector is difficult and complex. How we solve these dilemmas will influence further social and economic development and quality of life. Therefore, the debate on the future of the Polish energy system constitutes one of the keystones in the discussion on policy quality and development directions for Poland as a whole. Should this policy react only to current problems and support solutions that yield short-term benefits? Or should it be based on a long-term development vision that will anticipate changes around Poland, seeking and strengthening the competitive advantages of our economy? The authors of this text support the latter option. We are convinced that ensuring energy security should constitute the overriding state priority in the energy sector. This energy security should be understood as:

- security of supplies – ensuring continuity and quality of energy supplies so as to meet social and economic needs. At the national level this involves reducing the country's dependence on imported energy resources;
- economic security – ensuring that energy prices will not hinder economic development and will not lead to fuel poverty;
- environmental security – ensuring that energy generation does not lead to excessive environmental pollution and irreversible changes (including resource depletion).

Despite protection and strong financial support from the state, the energy sector in Poland does not fulfil any of the abovementioned criteria to a satisfactory extent. The low quality of energy services constitutes a barrier for the development of innovative technologies and the implementation of new investments, especially within rural areas. At the same time Poland is becoming increasingly dependent on imported energy resources – we are importing not only oil and natural gas but also growing amounts of hard coal. The share of energy prices in the economic balance of enterprises and household budgets is one of the highest in Europe. The fuel and energy sector constitutes the main source of environmental degradation in Poland. Therefore, Polish energy policy requires a thoroughly different approach. It should include the following key elements:

- adjusting energy generation volume to the available environmental space (ecosystems' capacity to receive pollutants and regenerate resources);
- equal priority for investments in energy management structure (efficiency, needs management) and in the development of new energy sources;
- the gradual distribution of energy generation sources and capacity based on the increasing level of education and IT development;
- avoiding excessive emission of pollutants through internalisation of external costs associated with energy production.

A rational choice of the direction in which the Polish energy sector will develop should lead to a synergy of benefits from various areas: support for economic development as well as solutions to social and environmental protection problems. Only this can ensure that these benefits are advantageous for the whole of society and not only select interest groups. The most significant ones include:

- decreasing Poland's dependence on imported energy resources, which will translate into greater energy security and a more advantageous foreign trade balance;
- reducing environmental pollution caused by the energy sector, which will contribute to the country's environmental security;
- improving efficiency of energy use, broadening end users' knowledge of energy management, which should lower energy costs and, consequently, minimise the threat of fuel poverty;
- developing new markets for small and medium enterprises, which involves social activation and creation of new, stable jobs;
- reducing the external costs generated by the energy sector, which will minimise losses resulting from these costs and improve public health.

In order to obtain these benefits, the solutions which are chosen should also anticipate the most probable changes that will occur in Poland and around it. In the coming years, the global energy market will see the beginning of a period characterised by resource depletion and growing prices of energy and its carriers. This is the aftermath of the fast development observed in emerging Asian economies, which due to their large populations will exert strong demand pressure on resource markets. In order to adjust to this new situation, OECD countries, including Poland, will have to undertake or support a number of tasks within their public policies. The most important ones include[77]:

77 Hille. E., *Propozycja harmonogramu wdrażania Alternatywnej Polityki Energetycznej* (in:) *Instrument realizacji Alternatywnej Polityki Energetycznej Polski do 2030 roku (wybrane zagadnienia)*, Institute for Sustainable Development,Warsaw, 2012.

1. Clear identification and differentiation of state and social interests and these of the fuel and energy sector in future development of the energy system. The public needs to become aware that the interests of energy corporations and trade unions do not have to coincide with the needs of society in general or state interest.
2. Reduced support for declining energy technologies. Conventional energy systems benefit from state aid, including assistance that should be allocated to RES development[78]. Instead, funding should be targeted at research and development of innovative technologies (see point 4 below).
3. Real liberalisation of energy generation. Through the process of vertical integration, electricity companies have gained a monopolistic position. This hinders smaller, distributed sources from entering the market. This is why energy generation and distribution companies should be separated and privatised on the stock exchange.
4. The introduction of system support for innovative players on the energy market: companies that invest in energy efficiency improvement, energy management at end users and energy generation based on local, distributed and renewable energy resources. Internalisation of external costs associated with coal-based energy and financing of implementation research should support development of energy storage technologies (pump and storage hydro power plants, highly efficient batteries and electric vehicles) and intelligent grids that are able to transfer energy in two directions.
5. The introduction of system support for regions dominated by coal-based energy companies. The transformation process should be spread over several decades and changes should be introduced gradually, based on negotiated social compromise.
6. The application of educational measures to support the changes. These measures should include the development of university specialisations in innovative energy technologies and organisation of training to shape desired consumer behaviour. Training should be available for people who want to invest in micro-sources.

Although these measures are urgent, they should not be initiated without a strategy that would define the necessary changes, proposing a desirable energy mix in the 2050 perspective and specifying a schedule for implementation of respective instruments to reach the proposed mix in the most effective way. The choice of the most advantageous energy mix should be based on an analysis of social, economic and environmental effects for various scenarios in the development of the Polish energy sector.

78 In 2010, 47% of support for RES development went to coal installations with biomass co-combustion. Depreciated hydro power plants (most of which were constructed prior to 1989) received 23% of this support. [after] Wiśniewski G., Michałowska – Knapp K., Arcipowska A., *O niezrównoważonym wykorzystaniu odnawialnych zasobów energii w Polsce i patologii w systemie wsparcia OZE*, Institute for Renewable Energy, Warsaw, 2012.

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