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NATURAL GAS AND THE TRANSFORMATION OF THE ENERGY SECTOR IN THE NETHERLANDS

GAZ ZIEMNY A TRANSFORMACJA SEKTORA ENERGII W HOLANDII

The aim of this paper is to discuss the conditions for the modernization of the energy sector in the Netherlands following the discovery of natural gas deposits in the country and a rapidly growing importance of this fuel. Hence the paper presents the essence of the model of transition management in the energy sector. It also shows the nature of changes in the structure of primary energy sources in the Netherlands and the decisive factors that led to the prominent role of natural gas in this country. These considerations formed the basis for discussion on the contemporary energy policy in the Netherlands.

Keywords: modernization of the energy sector, natural gas, natural gas market

Celem opracowania jest omówienie uwarunkowań modernizacji sektora energii w Holandii związanych z odkryciem złóż gazu ziemnego w tym kraju oraz szybkim zwiększeniem znaczenia tego paliwa. Dla realizacji tego celu przedstawiono istotę modelu zarządzania zmianą w sektorze energii. Pokazano istotę zmian struktury źródeł energii pierwotnej w Holandii oraz na czynniki decydujące na zwiększenie znaczenia gazu ziemnego w tym kraju. Rozważania te były podstawą do omówienia współczesnej polityki energetycznej w Holandii.

Słowa kluczowe: modernizacja sektora energii, gaz ziemny, rynek gazu ziemnego

1. Introduction

In the European Union one of the most important factors that determine the direction and extent of modernization of the energy sector is meeting the objectives of the climate and energy

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package, whose aim is to contribute to the energy security of the EU countries[1], protect the climate against the consequences of their energy policies and to improve the competitiveness of their economies. The attainment of the energy and climate package, through long-term, sustained modernization, is expected to contribute to the implementation of EU energy policy based on sustainable development.

Meeting the challenges associated with achieving the objectives of the climate and energy package is particularly difficult for the energy sector in Poland, because in spite of over 20 years of ongoing transformation of the economy, there have been no significant changes in the structure of its energy sources. Due to negligence of the country's energy policy, one characteristic feature of the sector is its preserved structure of primary energy sources – a monoculture based on coal- which is a unique phenomenon in developed economies (Figure 1). In subsequent years, this structure will be subject to significant changes associated with both regaining part of the generating capacity – while satisfying the requirements of the climate and energy package – and with creating new capacities needed to meet the projected increase in demand for electricity[2].

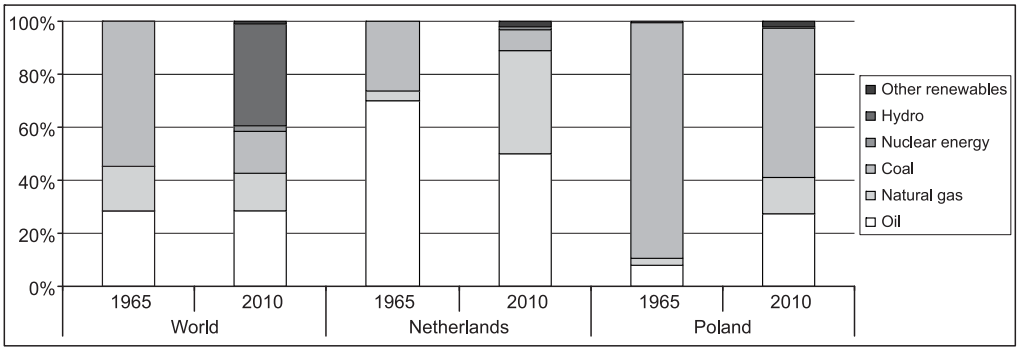

Fig. 1. The structure of primary energy sources in the world, the Netherlands and Poland in 1965 and 2010 (BP, 2010)

One of the options for changes in the national energy sector, free from a negative impact on the environment, is to reduce the importance of coal and at the same time increase the role of natural gas in the energy balance of the country. The use of natural gas does not present environmental problems, hence it is supported by a number of environmental organizations, societies of individual countries and economy decision-makers. The advantages of natural gas led to its 23.8% share in the global primary energy mix in 2010 (BP, 2011). Because of its beneficial properties, and the developed and fast-growing market, natural gas is considered a fuel of the

[1] Energy security today does not only mean the security of energy supplies, but also the reduction of air pollution emissions, the liberalization of the energy market, the integration of the market, fulfilling the international obligations of the country's energy sector and minimizing energy prices (Żmijewski, 2007, 2011).

[2] According to forecasts, by 2020, it will be necessary to build and largely modernize power plants of 12.7 GW (approximately 39.7% of installed capacity in the country in 2006) (*Polityka*.., 2009, *EU Energy*..., 2009). It is expected that as a result of extensive spending on these investments in Poland, in comparison with the level of 2006, by 2030 the price of electricity for industrial customers will have doubled, and the scale of the increase in electricity prices for households will be close to industrial one (*Prognoza*..., 2009).

21st century (Łucki, 2005; Kapron & Wasilewski, 2011). In the coming years the use of gas is expected to increase even more (IEA, 2011). This increase will involve, among others, progressive liberalization of the gas market, which might lead to a reduction of price and to increased security of supply (Frączek & Kaliski, 2009; Staśko & Kaliski, 2006).

Currently in Poland, the share of natural gas in the energy mix is significantly smaller than the average of the EU. One way to increase this proportion in Poland is to continue efforts to increase gas domestic production from conventional reserves, and to begin extracting it from shale deposits (Rychlicki & Siemek, 2011; Nagy & Siemek, 2011). These actions will both increase the share of natural gas in the Polish energy mix, and reduce emissions of air pollutants through creating alternatives to fossil fuels.

To facilitate the modernization of the energy sector in Poland it may be useful to use the experience of the Netherlands, whose energy sector is an example of successful transformation carried out thanks to great efforts of state institutions and public support for these activities. These concerted efforts led to a rapid increase in the importance of natural gas in the energy balance of the country, which helped to establish low-carbon energy economy. With these changes, today, the Netherlands is one of the leaders in the implementation of the concept of sustainable development. Instituting such changes in the sector was associated with the use of transition management model.

The aim of this paper is to discuss the changes in the energy policy of the Netherlands, which took place in the twentieth century, and to analyze the factors which contributed to the modernization of the energy sector in the country. Particular emphasis was placed on discussion of those determinants of the transformation of the Dutch energy sector which took place in the second half of the twentieth century and have led to an increased importance of natural gas in the energy balance of the Netherlands. The study also focused on the role of state institutions in making this transition.

2. Transformation and the model of change management

Transformation is meant as a gradual, continuous process of change leading to structural transformation of the nature of the society or its complex subsystem (such as technology, economy, institutions, culture, and ecology). The concept of transformation is thus linked to major changes in many areas, characterized by different dynamics. It is important to note that these changes do not necessarily occur in all domains at the same time (Rotmans et al., 2001). Difficulties in effecting transition result from the multiplicity of changes, inability to predict the causes of problems or to understand the essence of change, finally from underestimating the scale of difficulties (Kemp, 2005). A major problem is the resistance of many actors associated with concerns about the future consequences of the proposed changes.

Systemic changes taking place in transition occur at three levels (Rotmans et al., 2001; Verbong & Geels, 2007):

1. **Macro** (socio-technical environment). These are the changes occurring at the level of the economies of individual countries, including, amongst others, material infrastructure, political culture, values recognized in society, worldviews and paradigms, macroeconomics, demographics and the natural environment. One feature of the macro-level is a slow response to the changes and the impact of the changes on the meso and micro levels.
2. **Meso** (regimes). Here changes include networking between different actors and social groups, where actors include utility companies, government agencies responsible for the

functioning of the energy sector and large industrial customers. They relate to the dominant practices, rules and shared assumptions (at meso level there are the interests, principles and beliefs that guide private actions and public policy). They are mostly oriented towards optimizing systems rather than their transformation. At this level material resources are essential, such as raw materials, power grids and power plants. Initially, regimes are often factors inhibiting change, because their goal is to improve existing technologies and identify actions to reject new solutions. Later, when the a new technological system gains recognition, the regime may play a catalyzing role by means of large amounts of capital provided and organizational support.

3. **Micro** (niches). Changes relate to individuals or individual actors involved in the transformation (including businesses, environmental organizations) and local practices. At this level, there may be variations and deviations from the status quo, such as new techniques, alternative technologies and social practices.

The dynamics and quality of the changes taking place at all of these levels influence the quality and speed of transformation carried out. It is important that in order to effect transformation, changes which occur on one level coincide with changes at other levels. This means that any acceleration of change will lead to interactions between the various levels.

The concept of transformation is used to refer to the modernization that took place in the Netherlands in the second half of the twentieth century and was associated with a rapid increase in the importance of natural gas. Making this transition was possible thanks to the application of such a change management model by state institutions (called transition management), which facilitates solving the persistent problems that require a systematic approach.

The basic elements of the transition management model are (Kemp et al., 2007; Kern & Smith, 2008):

- knowing public expectations, learning how they can be met and adapted to the existing conditions thus allowing for a quick response to change,
- basing the changes on the knowledge of the structure of existing problems,
- identifying long-term goals and vision,
- specifying ways to reach objectives,
- orienting actions in order to achieve the objectives of transformation, and ultimately meeting them to the benefit of the public.

Defining transition goals and vision allows for development of such programs that will contribute to their achievement. At the same time, in the event of difficulties with the implementation of the planned model, thanks to such programs previous assumptions can be modified quickly, therefore making transition possible.

3. Changes in the structure of primary energy in the Netherlands

In the twentieth century, the structure of energy sources in the Netherlands was subject to numerous changes. In the first half of the century it was dominated by coal, peat and biomass derived from the country's own resources, and burnt in inefficient power plants. Reliance of the energy mix on burning solid fuels led to numerous environmental problems. At the same time in

this period, due to the low level of industrial development and the relative poverty of the society, demand for electricity was low in comparison with its modern consumption (TNO, 2010).

A significant change in the structure of primary energy sources in the Netherlands took place in the 1940s and 1950s and was associated with the population getting richer, the country's economic growth and industrial development. These changes led to increased demand for energy. This growing demand gradually increased oil consumption, which mirrored a global trend of the rising popularity of this fuel.

The transition of the energy sector in the Netherlands took place in the 1960s and early 1970s. What provided an impetus for change in the structure of primary energy sources in the Netherlands was the discovery in 1959, of the country's own large natural gas reserves near Groningen, in the north. A low cost of gas production from this source and its high efficiency were significant factors, too. The transition consisted in a fast shift from coal to natural gas, which then became the main source of energy. This, however, was associated with changes that occurred at all levels (Table 1).

TABLE 1

Nature of transition at various levels
(Author's own on the basis of Rotmans et al., 2001)

Level	Nature and conditions for transition
Macro	– recognition of natural gas and oil by the international community as clean energy, – closure of coal mines in the Netherlands due to lack of price competitiveness, – the expectation that the introduction of nuclear power will lead to a decrease in electricity prices, – recognition by the Dutch government of the importance of natural gas as a priority in the energy sector, – active attitude of the government in carrying out measures to enhance the importance of natural gas,
Meso	– public-private ownership of the Dutch gas industry (Gasunie), – preventing fragmentation of the Dutch gas companies, which was linked with the nationalization of the gas companies and their joining in strong capital entities able to finance the necessary investments,
Micro	– a huge potential market in the form of natural gas supplies to households (cooking and heating purposes), poor state of the Dutch housing conditions (houses were uncomfortable, non-insulated and poorly heated), – raising awareness of the benefits of natural gas by advertising campaigns that emphasized the comfort and user-friendly aspect, – society expectations to improve quality of life – natural gas has become a popular, easy-to-use fuel for central heating and hot water, – total reliance on natural gas supply, controlled by Gasunie, in which the government owned shares.

The most important factors which in the 1960s led to a change in the structure of primary energy sources in the Netherlands, include (Rotmans et al., 2001; Slingerland, 1997; Arentsen & Künneke, 2003):

– building, partly before World War II, power plants to produce and distribute coke gas on a large scale – these systems after the discovery of natural gas in the Netherlands were used for its distribution,

- setting clear targets by the government for the transition of the energy sector and state support for the development of gas transport and distribution systems,
- the role of the government acting as change initiator, encouraging the public to learn and use the new solutions, reacting quickly and effectively to problems in the implementation of changes.
- co-ordination by state institutions of the activities related to the development of the gas industry and creating the natural gas market,
- granting support to the government by local authorities regarding ongoing changes, which in turn made it easier to reach the wider public,
- obtaining social support for changes in the sector, thanks to becoming aware of the negative consequences of maintaining the structure of carbon-based energy sources and the promotion of environmental solutions,
- support of environmental organizations for changes in the energy sector, – dissemination in the early 1960s of cheap coal imports from the U.S., which led to a decline in the profitability of the Dutch coal mines, and consequently to their elimination,
- creating public awareness of the benefits of natural gas by means of advertising campaigns, which highlighted the ease of its use and its ecological character,
- co-operation with public and private enterprises on the development of the Dutch gas industry.

The transformation of the Dutch energy sector would not have been possible without a change in the attitude as to the government's role in the energy sector. Even in the middle of the twentieth century, the major institutions affecting the energy policy were local utility companies (called public utilities) and local governments. During this period the state government had a limited influence on the area of the economy.

An increased involvement in shaping the government's energy policy in the Netherlands took place in the 1960s after the discovery of natural gas reserves and their use. The Dutch government, recognizing the vital importance of this discovery for the future economic situation of the country's energy security and the quality of life of the society, took steps to improve the status of the fuel in the national structure of primary energy sources. This commitment led to the transformation of the energy sector in the Netherlands, as it was associated with an active conduct by the government and other state bodies, which provided a system of incentives necessary to change the structure of energy sources. Thanks to the commitment of the government, local authorities and public support, the makeover of the energy sector in the Netherlands lasted only six years. It should be emphasized however that the change phase was preceded by decades of preparatory actions, without which it would be impossible to transform the structure of energy sources in the Netherlands. For the ever richer Dutch population the use of natural gas meant a chance to improve the quality of life, which was associated with the properties of the fuel[3].

The responsibility for gas delivery rested on Gasunie, which was established in 1963 and whose shares were held by private oil companies (25% Royal Dutch Shell and ExxonMobil each) and the Dutch government (50%). To enable the sale of natural gas to numerous groups of

[3] One of the negative consequences of changes in energy policy was the occurrence of the so-called Dutch disease associated with the changes caused by the discovery of natural gas deposits. This discovery led to a rapid influx of capital, which led to the destabilization of the Dutch economy. A manifestation of this was the increase in public spending and household consumption combined with a sharp price rise. In consequence, there was an increase in wealth indicators and at the same time a decline in industrial production (Hjort, 2006).

households and industrial customers, Gasunie, a monopolist in gas extraction, also coordinated work to extend the system of gas pipelines in the Netherlands. The basis for this development was formed by the already existing network (including pipelines distributing coke gas – later to become part of a grid for natural gas distribution), and investments carried out to build new pipelines. These investments enabled a fast distribution of gas to households and industrial customers, which contributed to a rapidly developing natural gas market in the Netherlands. Owing to such consistent efforts, gas network in this country was completed in 1970 (Künneke & Arentsen, 2003). With such an extensive grid, competitive pricing of the fuel and its ease of use, gas has become the predominant source of heat for households. This group of customers generated a significant income in the country's budget.

That is why the sector of electrical energy in its initial stage (right after the discovery of gas deposits) was excluded from the purchase of natural gas. This meant focusing on the supply of gas to domestic customers as the most profitable segment of the energy market. Since 1968 there started large-scale sales of gas to power plants. With competitive gas prices, and its approval as a fuel, gas-fired power plants gained a dominant share in electricity production (about 80% in the mid-1970s), weakening the position of coal and oil (Verbong & Geels, 2007). What enabled the dissemination of natural gas turbines was the relatively small size of this type of installation, a brief period of construction, a proportionately small investment (compared with high-cost power plants run on solid fuel), and the possibility of their rapid start-up, thus reducing the risk of power outages .

The widespread use of natural gas was also a result of offering preferential prices to industrial customers, which contributed to the development of energy-intensive industries in the Netherlands. Industrial customers gradually became the largest consumers of gas in the Netherlands, which has contributed to the development of the gas market.

The development of the Dutch gas market also benefitted from starting natural gas exports to other European countries in the 1960s. As a result of these exports, the Dutch gas industry is one of the most important suppliers of natural gas to customers in European countries. The development of gas exports from the Netherlands involved integrating the Dutch gas system with similar systems in other countries. As a result of these actions, the Netherlands has become both a major consumer and exporter of natural gas.

What greatly shook the energy policy in the Netherlands was the oil crisis in 1973, followed by a subsequent surge in oil prices. It reminded the public and decision-makers that conventional energy resources are finite and it is necessary to adopt a long-term policy which would ensure the continuity of supply and competitive energy prices for end-users.

In order to mitigate the effects of the oil crisis, the Dutch government took measures to create an active energy policy and change the direction of the policy. As adopted in 1974 Energy White Paper document, the emphasis was on increasing the diversification of energy sources, making it easier to reduce dependence on individual types of energy, and boosting efficiency in the energy sector, thus reducing the impact of the energy sector on the environment (Verbong & Geels, 2007). In order to reduce the depletion of natural resources and to minimize the effects of rising oil prices in the Netherlands, measures were taken to promote cogeneration facilities, which maximized combustion efficiency and reduced air emissions. The guidelines for the Dutch energy policy changes resulting from the first and subsequent documents of Energy White Paper are presented in Table 2.

The next oil crisis (in 1979) resulted in changes in the second document of the Energy White Paper, where the new goals of energy were to reduce energy consumption, diminish the role of oil,

increase nuclear energy and re-introduce coal. The plans for the development of nuclear energy, due to its controversial nature, however, have as yet not materialized, thus the Netherlands retains a small share of nuclear power in the energy balance. Using coal again was considered a less sensitive social issue than building new nuclear reactors. It was also expected that in a short time clean coal burning technology could be widely introduced. However, it quickly became evident that a commercial scale implementation of CCS technology in a few years' perspective, which could eliminate the environmental consequences of burning coal, was not possible.

TABLE 2

Changes in direction of the Dutch energy policy
(Author's own based on Verbong & Geels, 2007; de Jong, 2006)

	Nature of planned changes
The First Energy White Paper (1974)	– increased diversification of energy sources, which helps reducing dependence on particular types of energy, – higher efficiency the energy sector, helping to reduce the impact of the energy sector on the environment,
The Second Energy White Paper (1979)	– reduced energy consumption, – diminished role of oil, – an increase in the importance of nuclear energy, – reintroduction of coal,
The Third Energy White Paper (1996)	– increased efficiency by a third in the next 25 years, – increasing the share of renewables in the energy mix of the country to 10% by 2020, – leaving the issue of the future role of nuclear power in the Dutch energy policy open, – the use of tax instruments, appropriate tariffs and the development of appropriate development standards in order to increase the importance of renewable energy, – increasing the importance of market forces in the energy sector in line with the principle („markets wherever possible, government wherever needed"), – recognition that there is no significant risk of energy supply,
The Fourth Energy White Paper (2001)	– 40-60% reduction of CO2 emissions by 2030 compared to 1990 levels, – application of the principles of sustainable development in energy policy.

An important consequence of the energy crisis of the 1970s was the decision to increase production of natural gas in the Netherlands. This involved not only extraction of gas from Groningen (Groningen field), but also from smaller deposits, which was imposed on Gasunie by the so-called Gas Act. To increase the interest of potential investors in looking for natural gas, Gas Act obliged Gasunie to purchase natural gas from all small deposits of this fuel. This solution helps to increase the security of gas supply and strengthens the position of the Dutch gas industry in the European market.

Significant changes in the functioning of the Dutch gas market are related to the adoption of the third Energy White Paper. Prior to its publication in the Netherlands, there had been a strong opposition to the liberalization of the energy sector, including the natural gas market. Following the document's publication, emphasis was placed on increasing the role of market mechanisms in the sector as well as the issue of security of supply of clean and affordable energy (Hesen,

2006). By taking these actions, the Dutch government sought both to maintain the role of natural gas in the Dutch gas market, and to preserve a significant role of the Netherlands in the European market for this fuel (Arentsen & Künneke, 2003, p. 104).

The orientation of liberalization was to a large extent determined by the requirements of EU directives and regulations adopted in the Netherlands' Gas Law. The essence of the reform was associated with the introduction of the principle of *third party access* (TPA), separation (*unboundling*) of transportation from the sale of natural gas and the opening of the natural gas market. The Gas Law enabled large industrial customers to choose their suppliers. Since 2002 medium sized customers have also got this right, and since 2007 also households (EZ, 1998).

To speed up the liberalization of the sector in 2002, Gasunie was split into trade and distribution companies, which meant a legal separation of that company (legal unboundling). With the liberalization of the gas market in the Netherlands, the position of Gasunie in the market has weakened, which was mainly due to gas imports to the country. Still, however, Gasunie is the dominant supplier of gas on the Dutch market.

An important change was to allow energy companies to produce electricity on a small scale (Verbong & Geels, 2007). Under this law, Dutch energy companies formed joint ventures with large industrial enterprises to produce electricity and cogeneration power. One of the results of this cooperation was the development of distributed energy resource systems in the 1990's for generation of power. The development of cogeneration based on highly efficient, centralized system helps to increase the efficiency of fuel combustion and to reduce both the energy intensity of the Dutch economy as well as air pollution emissions.

In the early twenty-first century, thanks to the growing public awareness of the impact of energy management on climate change, the Dutch put more emphasis on the reduction of air pollution and the need for the concept of sustainable development, which was reflected in the fourth document of the Energy White Paper. However, despite the awareness of the importance of these issues, the position of RES in the energy balance of the country still has not changed much. Innovative actions aimed at promoting RES encountered a number of obstacles, which prevented the achievement of the objectives of energy policy in this area (Verbong et al., 2008). As a result, the Dutch energy sector is characterized by a relatively small share of RES in the energy balance.

4. The modern structure of energy sources in the Netherlands

Today, the structure of primary energy sources in the Netherlands is dominated by natural gas and crude oil; together they have 83.5% share in the primary energy sources (Table 3). Thanks to its deposits, the Netherlands is also a major exporter of natural gas. At the same time imports include oil, coal and electricity[4].

In the current energy balance of the country, coal is a major source of electricity. In 2007, coal generated 24% of electricity produced in the Netherlands. Through the use of modern power systems based on cogeneration and centralized burning, coal does not have such an adverse impact on ecology. Despite this, the public and economy decision makers increasingly support moving away from coal-fired plants (van Foreest, 2010), which could lead in the near future

[4] The Netherlands also imports a small amount of electricity, which is related to the possibility of obtaining cheaper energy from France (nuclear power plants) or Germany (coal) (Kemp & Rotmans, 2004).

to the cancellation of the construction of new coal power plants and, consequently, to a lower participation of coal in the energy mix of the country. The introduction of CCS technology might change public expectations in this area, so far, however, this technology has not been used on an industrial scale, therefore it is difficult to assess its potential impact on the future role of coal in the energy balance of the Netherlands.

TABLE 3

Selected data on the structure of energy sources in the Netherlands in 2007 (EU, 2010)

	Primary energy consumption	**Primary energy production**	**Primary energy imports**	**Final energy consumption**	**Power production [TWh]**
Solid fuels	8.36	-	8.81	1.47	24.92
Crude oil	37.17	3.35	49.40	18.56	2.22
Natural gas	33.40	54.76	-21.46	18.96	62.58
Nuclear energy	1.08	1.08	-	-	4.20
Electricity	-	-	1.51	9.19	-
Renewables	3.02	2.50	1.51	0.76	9.15
Other	1.51			2.39	0.18
Total	84.54	61.69	38.78	51.33	103.24

Although much attention has been given to the environmental issue and the fact that since 1970s efforts have been made to increase the share of renewables in the energy mix, their representation is small and growing very slowly (Rooijen & Wees, 2006). On the other hand, despite their insignificant proportion in the structure of primary energy sources, they are an important source for electricity production. Their promotion is associated with the support of the Dutch society for this kind of energy sources (*Europeans*.., 2007).

It would be hard, however, to expect that in the coming years, renewable energy will play an important role in meeting the requirements of the climate policy. The current economic crisis has led to a partial change of the eco-friendly attitude of state institutions. Due to the high cost of energy from wind power, the Dutch government decided to stop subsidizing the construction of new wind farms, hydroelectric and biogas plants. As a result of this change in the energy policy, it will be easier to improve energy efficiency (Gassmann, 2011). An important element of energy policy in this regard was also a decision to reduce the share of renewables in the Dutch energy mix from 20% to 14% by 2020.

Despite the relatively small share of nuclear energy in the energy balance of the country, it is a significant source of electricity. There is only one nuclear power plant located in Borselle. Its construction was associated with the efforts of the Dutch government, which materialized in creating the basis for the future construction of nuclear power plants. In the early 1980s measures were taken to increase public support to build more nuclear reactors. Yet, public opposition to this type of investment after the disaster in Chernobyl in 1986 led to postponement of work on this type of project.

A change in the attitude to nuclear power was observed in the early twenty-first century. After the energy crisis caused by the Russia-Ukraine gas conflict, the Netherlands turned to nuclear energy again. Before the nuclear disaster in the Japanese power plant in Fukushima, the Dutch government had intended to build another one or two new nuclear reactors at the nuclear

power plant operating in Borselle. This solution would increase the importance of this source of cheap and low-carbon electricity.

In 2012 it was decided to postpone the decision on building a new reactor by 2-3 years, which was associated with considerable uncertainty as to the future operating conditions of the energy market, in particular the issue of changing the emissions trading scheme and the allocation of emission allowances[5] (*Decyzja*.., (http)). According to the assumptions of the said power plant investor, after those 2-3 years it will be possible to return to the planned investment. As expected, taking into account the assumed period of delay, the plant will be operating around 2020 (Rzeczpospolita, 2012).

An important feature of the Dutch energy sector is also the country's high energy security associated with its own natural gas resources. This is reflected in a high level of energy independence ratio (Table 4). It is important that this ratio was achieved mainly due to the specific structure of energy mix, which is dominated by environmentally friendly fuels.

TABLE 4

Energy independence ratios for the Netherlands, Poland and EU [%] (EU, 2010)

	1990	**1995**	**2000**	**2005**	**2006**	**2007**
The Netherlands	23.2	20	39.2	38.7	38	38.6
EU-27	44.5	43.5	46.8	52.6	53.8	53.1
Poland	2.2	-0.2	11.2	17.7	19.8	25.5

The future of energy policy and energy security in the Netherlands will also significantly depend on gas co-operation with Russia and the reliability of supplies from that country. It should be noted that Gasunie is one of the shareholders of the Nordstream gas pipeline, which may later become a source of natural gas for customers in the country and generate income from the transit of this fuel to other EU countries. This appears to be a long-term plan aimed to ensure the security of gas supplies to customers in the Netherlands and to maintain the transit of gas through the Dutch network to other European countries. The Dutch-Russian co-operation is expected to further enhance the already strong position of the Dutch gas industry in the European market. The Dutch expect that by means of Russian gas deliveries, the Netherlands will become the center of gas distribution in north-western Europe.

5. Energy intensity of the Dutch economy

One important consequence of changes in the energy policy of the Netherlands was a dramatic increase in energy consumption. In particular, there was a surge in demand in the years 1950-1973, when the average rate was 1.7%, while for the rest of the world, this increase was of 0.8%. Starting from 1974, we have been experiencing a gradual decline in the average energy consumption, but the level is still very high (van der Helm et al., 2010).

An important element of energy policy aimed at reducing energy consumption is work geared towards the development, implementation and continuous improvement of energy policy

[5] Of high importance was probably a kind of aversion to nuclear energy, which occurred after the disaster at the Japanese power plant in Fukushima. It is difficult to assess today the impact of this disaster on the future role of nuclear power in the global structure of primary energy sources (Kaliski & Frączek, 2012).

instruments, the use of which will inevitably lead to higher energy efficiency. The efforts to reduce energy consumption are dictated by the global challenges of combating climate change. Reducing energy consumption can help to decrease the impact of energy policy on the environment. As a result of these actions, energy intensity of the Netherlands is lower compared to other EU countries (Table 5).

TABLE 5

Selected data on economy efficiency in EU in 2007 (toe)
(Author's own based on Eurogaz, 2010)

Country	PEC	FEC	PEC/person	PEC/GDP
Austria	33.44	26.11	4.03	0.14
Belgium	58.54	43.55	5.53	0.2
Bulgaria	20.4	10.95	2.66	1.02
Czech Republic	44.9	27.06	4.36	0.54
Denmark	20.4	15.9	3.75	0.1
Estonia	5.62	2.63	4.19	0.54
Finland	35.37	27.14	6.7	0.22
France	270.67	175.21	4.27	0.17
Germany	334.3	218.4	4.06	0.15
Greece	30.81	21.4	2.76	0.17
Hungary	26.86	20.58	2.67	0.4
Ireland	15.94	13.4	3.7	0.1
Italy	194.45	145.66	3.29	0.15
Latvia	5.04	4.29	2.21	0.32
Lithuania	9.35	5.55	2.76	0.44
Luxembourg	4.73	4.43	9.93	0.16
Netherlands	77.4	61.2	4.73	0.16
Poland	90.86	59.4	2.38	0.37
Portugal	25.39	20.44	2.4	0.19
Romania	39.7	26.16	1.84	0.65
Slovakia	18.07	11.43	3.35	0.54
Slovenia	7.49	7.36	3.73	0.26
Spain	147.02	101.68	3.31	0.18
Sweden	53.5	34.8	5.87	0.17
United Kingdom	225.7	157.9	3.71	0.12
EU 27	1795.94	1242.63	3.57	0.17

PEC – primary energy consumption, FEC final energy consumption, GDP – Gross Domestic Product

In the years 1990-2007 energy intensity of the Dutch economy fell by 20% (EU, 2010). This decrease was largely related to the economic growth in the country that was observed in the 1990s, and with the ongoing actions taken to reduce energy intensity. Still, despite the decline in energy intensity in the Netherlands, its level is relatively high, due to the structure of the industry and the country's geographical in-transit position, which necessitates a significant energy consumption by the industrial and transport companies. The current level of energy intensity in the Dutch economy is close to the EU average.

At the same time due to a high standard of living resulting from the ever richer Dutch society, the level of energy consumption per capita remains high. It should be noted that in recent years energy consumption of households has gone down. This was because of both the improved insulation of buildings and the spread of modern heating appliances (ECN, 2009).

Technological development and climate change are important factors affecting the change in the structure of primary energy sources. With more efficient heating devices and climate warming, the share of natural gas in the energy mix of the final energy consumption has been limited, as less gas is needed for heating purposes (ECN, 2009). At the same time, the Netherlands notes an increase in the share of electricity in the final energy consumption structure, which is inevitably linked to the society becoming richer.

The average level of prices of electricity and natural gas offered to industrial customers is one of the lowest in the world. At the same time, prices of electricity and natural gas for households are relatively high (IEA, 2011). The high effectiveness of the Dutch gas companies is very important in reducing prices for consumer (Table 6).

TABLE 6

Selected data illustrating gas markets in EU
(Author's own based on Eurogaz, 2010)

Country	Network length per worker	Number of customers per worker	Sales per worker
Austria	14.18	501.23	0.12
Belgium	17.85	728.33	0.18
Bulgaria	2.58	16.77	0.06
Czech Republic	15.06	578.12	0.07
Denmark	12.29	256.12	0.10
Estonia	7.71	182.23	0.12
Finland	8.29	104.49	0.51
France	7.11	369.28	0.06
Germany	12.51	548.57	0.09
Greece	6.25	195.08	0.16
Hungary	15.78	638.87	0.09
Ireland	15.08	735.31	0.25
Italy	9.07	713.20	0.11
Latvia	4.26	315.88	0.04
Lithuania	5.33	300.71	0.07
Luxembourg	12.76	400.00	0.24
Netherlands	18.12	807.32	0.20
Poland	3.76	198.70	0.02
Portugal	24.51	1 722.36	0.31
Romania	1.62	94.83	0.02
Slovakia	7.79	335.29	0.05
Slovenia	8.14	316.17	0.08
Spain	11.05	1 121.90	0.26
Sweden	14.00	275.00	0.21
United Kingdom	5.48	430.60	0.08
EU 27	7.78	440.81	0.08

In subsequent years, the energy sector in the Netherlands must make a number of investments to reduce CO_2 emissions, meet the growing demand for electricity and replace worn power plants.

6. Summary

The analysis of the modernization of the energy sector in the Netherlands points to the important role of state institutions in initiating and implementing changes in the sector. Thanks to active involvement of these institutions it was possible to change the structure of primary energy sources in the Netherlands, which has ultimately improved the standard of living in the society and reduced the environmental impact of the country's energy management. Initially this change meant a transition from coal to oil, and then – after the discovery of the Groningen gas field – an increased role of natural gas at the expense of coal and oil.

The transformation was based on consistent performance of state institutions, which saw the benefits of promoting natural gas to customers in the Netherlands also realizing the financial advantages to the country's budget. An active role played by these institutions significantly accelerated the transformation of the energy sector and affected not only the structure of primary energy sources, but also increased the importance of the Netherlands as gas exporter in the European energy market. The country's own gas reserves also played an important role in the development of industry in the Netherlands. Gas from the Dutch deposits provided an opportunity for its exports, which translates into significant budget revenues.

The fast transformation of the Dutch energy sector was possible thanks to transition management. It was also important that the changes were consistently made and took place on all levels. The success of the transformation of the energy sector in the Netherlands, to a large extent, depended on the existence of gas and coke gas pipelines, which were built up after the discovery of natural gas deposits. This made natural gas popular in households and boosted the country revenues.

In the following years the Dutch can expect significant changes in their energy policy associated with a better climate protection from the negative impact of the energy sector companies. They will also continue with efforts to reduce the energy intensity of their economy.

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