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Support for Renewable Energy in Germany as an Example of Effective Public Policy

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Keywords: *renewable energy sources; green growth; sustainable development*

Abstract: *This article aims to analyze the process of energy transformation in Germany and renewable energy state support as an example of a strategic and effective policy. Energy transition in Germany, which leads to replacement of conventional energy with renewable sources and increase of energy efficiency is a long-term project requiring a strong state intervention. This project is supported with European Union green energy policy giving favorable legal and institutional framework for green technologies development. The process of energy transformation in Germany started more than two decades ago, and nowadays this economy benefits from a growing number of new jobs and export of high-tech products. The article analyzes the concept of "green growth" in the EU, which is both determinant and the effect of energy transformation in Germany. It discusses support mechanisms and instruments for German green energy sector, transformation goals in that area, financing sources and the most important economic effects.*

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Introduction

Energy security and ensuring access to raw materials at the lowest possible price should be a priority of every government. It is undoubtedly the task of state energy policy to develop appropriate regulations facilitating the development of domestic energy production. Energy policy should be consistent with general economic policy and form the foundation of stable growth. It must also be "intelligent", meaning that it provides a base for the absorption of modern technologies, is compliant with the principle of sustainability, and incorporates the broadest possible spectrum of entities, including households, in the production of energy (Swora (Ed.), 2014). The role of the state is particularly crucial in respect of renewable energy. Renewable energy is the leading form of energy technology, with significant upside in the future, but is also a significant challenge for the development of modern civilization.

The idea of "green growth" has become one of the EU's leading objectives, and a condition for its achievement is an economy that makes more efficient use of resources, is more environmentally friendly, and is more competitive. Germany is Europe's leader in renewable energy, with a strategy that assumes 80% of its energy needs will be generated by renewable sources by the year 2050. The process of energy transformation in that country has been underway for over two decades, and has proven successful (in 1990, 3.4% of all energy consumed was produced by renewable sources, while in 2013 this number reached 25.4%). Germany has achieved a competitive advantage in the production of renewable energy technologies, which brings them palpable economic benefits and allows them to influence the development of renewable energy strategy in the EU.

Methodology of the Research

The objective of this article is to analyze the process of energy transformation in Germany and support for renewable energy as an example of an effective public policy. This goal will be achieved in the following manner: in the first section, the idea of "green growth" in the EU will be presented, which is both a determinant and an effect of the energy transformation in Germany. Next, the mechanisms and instruments which support the development of renewable energy are discussed, along with German aims in that area. The final section of the paper contains an analysis of the scale of public intervention and the effects generated by support for renewable energy sources in Germany.

The article is intended to be an overview. It is based primarily on German strategic documents regarding energy policy, legislation and statistical data from the German Federal Ministry of Economy and Energy as well as the German Wind Energy Association and German Solar Industry Association.

The Idea of "Green Growth"

In recent years, a large number of states have taken an increasingly active interest in renewable energy sources (RES)[1]. The development of the renewable energy sector is contributing to improvements in environmental quality (by reducing atmospheric pollutants and waste generation, as well as by protecting ecological resources) and strengthening energy security. It is also leading to social and economic benefits associated with the creating of jobs, local growth, the opening of markets for new products and materials, and expanded consumption and investment spending owing to reductions in energy costs. This issue, however, should be examined in a broader context – that of sustainable development. This phrase appeared in the 1970s in conjunction with ecological problems resulting from such factors as economic and non-economic human activity. Sustainable development is interpreted to mean social and economic growth that meets the needs of present generations without hindering the potential for future generations to meet their own (Brundtland, 1987). It is the central point of research in a new economic paradigm – the theory of sustainable development, which accents the ecological and energy-related conditions for economic growth, and also draws attention to the interdependence linking the economic, social and environmental objectives of such growth (Fiedor, 2010). This paradigm stands out in the Europa 2020 strategy, expressed in the concepts of green growth (development), bioeconomy and eco-innovation.

The concept of "green growth" is presently one of the EU's most important aims. Alongside intelligent growth (based on knowledge and innovation) and growth which supports social inclusion (a high employment that ensures social and territorial cohesion), the EU is focused squarely on sustainable development. This implies support for an economy that makes more efficient use of resources, is more environmentally friendly, and more competitive. The measure of a sustainable energy policy is to be reductions in the emission of greenhouse gases by 20% in reference to 1990 levels, an

[1] Energy from renewable sources is understood as energy from renewable non-fossil sources, i.e. wind energy, solar energy, aerothermal, geothermal and hydrothermal energy, as well as ocean and hydroenergy, energy from biomass, gas from waste dumps, wastewater treatment plants and biological sources - biogas (OJ EU L 140/16, 2009, Art. 2).

increase to 20% of the share of renewable energy in general energy consumption, and an increase of energy efficiency by 20%. The EU is striving to be the leader in environmental technologies and environmental protection, and intends to support measures aiming at decoupling economic growth from the consumption of resources as well as the transformation to a low-emission economy (European Commission, 2010).

In setting goals concerning renewable energy and signaling support for "green" technologies, European policy is creating a strong framework for the growth of RES in Germany – the European and world leader in that area. On the other hand, considering their competitive advantage in the production of technologies for generating energy from renewable sources, Germany is the strongest lobbyist on behalf of the European Union's strategy for the growth of RES, and also is responsible for shaping that strategy. The strategic goals of the foreign energy and environmental protection policy pursued by Germany include the construction of a coalition of state pioneers for the development of RES, gradual integration of international greenhouse gas emissions rights trading markets, and establishing more ambitious and binding targets for expanding RES in the EU after 2020. This is to be done through a range of diplomatic campaigns, including joint letters of support for establishing an EU-wide 40% reduction in the emission of greenhouse gases by 2030, and an informal partnership with France which was strengthened in 2013 by a series of intergovernmental pacts intended to enhance cooperation regarding energy policy (Bajczuk, 2014a, pp. 62-64). In 2011, Germany initiated the formation of the international organization IRENA (with over 100 member states), whose objective is the promotion of green technologies and RES. The country is also making intense efforts to create a club of states supporting the energy transformation; one example is the pact signed with the People's Republic of China in 2014 regarding cooperation in the expansion of RES (Bajczuk, 2013). Such extensive German activity benefits both environmental protection and the construction of innovative industry, which in turn allows for achieving the objectives of both domestic and economic policy.

Mechanisms and Instruments Supporting the Growth of Renewable Energy

Levels of green energy use across European countries are very diverse. The smallest share of renewable sources in total gross energy use[2] belongs to Malta (1.1%) and the United Kingdom (4.1%), while the highest is in Sweden (37.2%) and Latvia (36.4%) (Renewable Energy Statistics, 2014). This is, in part, undoubtedly due to geographical conditions, but a more important factor can be identified in the instruments of energy policy applied in those countries. These instruments are highly differentiated, and depend primarily on the mechanism adopted: a quantity-based system (quota) or a system involving shaping the prices of generated energy (feed-in). The former leaves the determination of prices up to market forces and consists in the guaranteed purchase of a given volume of energy from renewable sources. This is done mainly through a system of certificates, which are obligations on market participants to reach target percentages of renewable energy as a portion of total energy sales, or through a bid system consisting in directly fixing the volume of renewable energy needed. Under a quota system, support is provided regardless of the technology, level of market development, location and real need; on the one hand, this facilitates market competition among investors and the development of the most inexpensive technologies, yet on the other hand it may lead to excessive intervention in areas of RES that could grow without public support. The second system, based on price, consists in establishing a fixed tariff for energy from RES, and assumes that the market will generate a desirable volume of that energy. The most important instruments applied within this mechanism include preferential guaranteed prices for renewable sources (over a long term, frequently 10-20 years), guaranteed subsidies (received by entities generating renewable energy regardless of the market price of electric energy), tax relief in areas associated with the production of renewable energy, and investment subsidies (including preferential financing). The flexibility to differentiate tariffs and subsidy rates for particular technologies gives the feed-in system the capacity to achieve governmental priorities in reference to the structure of the energy sector. It is also relatively simple to implement owing to the ability to precisely estimate future income from sale of energy by the investor (Ecofys, 2011, p. 101).

[2] Gross energy consumption is the total demand for energy in a given country and encompasses the use of energy by the energy sector itself, losses from distribution and conversion, final energy use by end users, and statistical differences.

The feed-in system that has been applied in Germany's energy policy. The German Renewable Energy Sources Act is based on the assumption that the energy of "the common man" is given precedence over that produced by corporations. The solutions implemented create incentives not only for energy companies, but also for investors, private individuals and farmers. The foundation rests on guarantees for producers of green energy with reference to its pick-up by network operators and sale at a fixed price. The produce of RES receive a subsidy covering the difference between the market price for energy and an administratively determined reference price (to cover the costs of investment). Tariffs (degressive) are valid for twenty years from the moment of installation, and the reference price remains in effect for a given installation throughout the entire period of subsidies (for more see: Sobolewski, 2006).

Goals for the Expansion of Renewable Energy in Germany

German goals for the development of renewable energy assume that in 2050 renewable energy will cover 60% of final gross energy consumption and 80% of electric energy use, energy efficiency will increase by 50% (compared to 1990), and CO2 emissions will drop by 80–95% (Bajczuk, 2014a, p. 10).

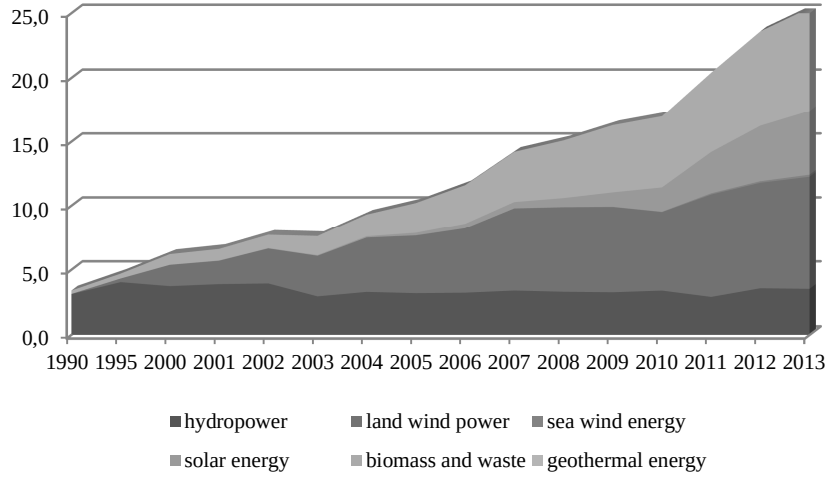
The process of energy transformation in Germany has been in swing for over two decades, and has advanced to the point where those goals are within reach (Klaus *et al*., 2010). In 1991, the first RES Support Act was passed, which guaranteed access for producers to the electrical energy grid and the purchase of ecoelectricity at a fixed price. In 2000, a law was adopted guaranteeing primacy to RES, which led to dramatic growth in the number of wind farms, biogas plants and solar power installations. Since 2007, the Biofuels Act has been in effect (which requires the fuel sector to increase the share of biofuels in fuel compositions by 0.25% per year to 8% by 2015), while since 2009 there has been a law regarding support for RES in the production of heat (assuming a 14% share of RES in the production of heat and cold is reached by 2020). The energy transformation process (*Energiewende*) is to be accelerated by the country's energy strategy through 2050, eight laws passed in 2011[3] and amendments to the RES law

[3] These are: the Act amending the Atomic Energy Act, the Act on support for the production of energy by renewable sources, the Act on measures to boost the speed of construction of distribution networks, the Act on regulations concerning energy management, the Directive amending the public procurement act, the Act establishing the "Energy and Cli-

which went into effect in August 2014. An important element of the *Energiewende* is the shuttering of nuclear power plants (in 2011 the decision was taken to close 8 of 17 atomic energy plants, and to gradually close the remaining ones by 2022). The energy gap is to be closed by energy from RES, and also by efforts to lower consumption (efficiency and thrift). It is worth drawing attention to the overwhelming level of support in German society for the energy transformation, in excess of 80%. *Energiewende* is primarily associated with a broad understanding of safety and protection of the climate. Germans also appreciate the potential to end independence on imported energy raw materials and the role of social engagement in the production of energy (Wunderlich, 2012).

An effect of the priority treatment given to RES is the continual growth in the supply of green energy. The most dynamically growing sector of RES is the production of electricity, and the source of the most rapid growth in power since 1990 has been photovoltaic power plants and biomass power plants.

Figure 1. The share and structure of RES in German's total energy consumption in the period 1990–2013 (in %)



Source: own based on Federal Ministry of Economic Affairs and Energy in Germany (2014).

mate Fund", the Act on tax relief for energy modernization of buildings, and the Act on supporting the climate-friendly development of cities and communes.

In 1990, the share of energy from renewable sources in the total consumption of energy was 3.4%, while in 2013 it reached a level of 25.4%. In 2013, the most green energy was produced by wind power (8.7%) and biomass (8%). Solar power provided 5% of energy consumed, while 3.5% came from hydropower. While at the beginning of the transformation nearly all renewable energy came from biomass, over the course of the last decade Germany has managed not only to expand renewable energy production from other sources, but has also become the world leader in the production and export of solar cells and wind turbines.

The main objective of the German energy transformation is to further increase the share of renewable energy to at least 35% by 2020, 50% by 2030 and 80% by 2050. A key role in the accomplishment of this objective is to be played by wind and solar energy – the two most well-developed and least expensive forms of RES. The most extensive investment is planned for wind energy (its participation in the energy balance will triple by 2020), and efforts are aimed at the construction of more wind farms, modernization of existing facilities (to improve output), and expansion of the grid. The strategy also assumes the building of sea-based wind farms in the Baltic and North Seas, which in the long-term are intended to become the third most important energy source (following land-based wind farms and solar energy). While there are some who claim that the technology remains unpolished and too expensive, the program for development of sea-based wind energy is nevertheless being given priority treatment (GWEA, 2014). *Energiewende* also assumes significant growth in the use of photovoltaic cells, which are to product 19% of green energy by 2020. Photovoltaic cells are solar panels that generate electric energy, while the heat from solar energy can also be used for heating water or rooms. Germany has developed the world's largest market for photovoltaic cells, and also boasts the highest number of solar installations (widespread use of solar systems has led to a significant drop in the cost of installing them – 66% from 2006 to 2012). Photovoltaic technology has allowed Germany to manage the effect of peak demand for energy in the summer, and has even managed to replace a small portion of production for servicing the base load[4] (BSW, 2014).

The only source of renewable energy which the German government plans to restrict the growth of over the long term is biomass[5], which pres-

[4] On the shortest day of the year in 2011, all of the photovoltaic cells installed in Germany produced a total amount of energy equal to that produced in three hours by a large atomic reactor, contributing to meeting peak energy demands (Bajczuk, 2014).

[5] German law includes 47 types of products derived from animals and plants as suitable for producing biomass energy. Biomass in Germany is primarily ethanol from corn,

ently constitutes nearly one-third of RES (Germany is the European leader in the number of biogas plants). In 2020, in spite of a doubling in the amount of biomass, its percentage in RES is slated to drop to around 22%. On the one hand, biomass is the most universal of all RES, as it facilitates the production of electric energy, motor fuels and heat (biomass gives 90% of heat from among all RES). It is also easy to store and to use, and contributes to the development of rural areas (in 2010, 17% of German agricultural land was used for energy production). On the other hand, the cost of producing energy from biomass is relatively high, and it is not without controversy[6]. *Energiewende* also does not assume the further growth of hydropower. Because of its limitations (environmental protection and the lack of appropriate locations), the present output is to remain at current levels, while the proportion of water energy among other forms of production will gradually fall. Analysis of geographic conditions, the level of technological maturity and costs of energy acquisition all indicate that the greatest potential for growth among RES is in land-based wind turbines and photovoltaic technology (Bajczuk, 2014a).

The German energy transformation programme also assumes limiting energy consumption (by 10% and 25% to 2020 and 2050, respectively) and boosting energy efficiency. Among the seven economies that consume the largest amount of energy, only Germany reduced its consumption in 2013 compared to 1990 (Tab. 1), making the goals which have established realistic objectives.

Table 1. The energy consumption and energy intensity of selected economies in 1990, 2000 and 2013.

year/ country	**Energy Consumption** (Mtoe)*			**Energy Intensity** **		
	1990	2000	2013	1990	2000	2013
US	1910	2269	2187	0,240	0,203	0,158
China	910	1200	3013	0,728	0,345	0,261
Russia	882	619	730	0,471	0,491	0,331

biodiesel from rapeseed, biogas from organic waste, corn and wood granules. A minor source of energy is gas recovered from waste dumps, wastewater treatment plants and liquid biomass.

[6] The use of forest biomass significantly boosts demand for wood, raising its price, and is associated with CO2 emissions, biofarming increases the need for large-area energy plant farms, which is a threat to crop biodiversity and involves the necessity of fertilizers and crop protection chemicals, and the use of grain in energy is ethically controversial while leading to increased food prices around the world (Anton & Steinicke (Eds.), 2013).

Table 1 continued

year/ country	Energy Consumption (Mtoe)*			Energy Intensity **		
	1990	2000	2013	1990	2000	2013
Japan	439	519	455	0,134	0,142	0,112
Germany	335	337	323	0,172	0,135	0,113
India	313	456	819	0,296	0,251	0,191
France	224	255	253	0,159	0,148	0,130

* million tonne of oil equivalent (corresponding to consumption of one million tons of oil)
** GDP per unit of energy use

Source: Enerdata (10.11.2014)

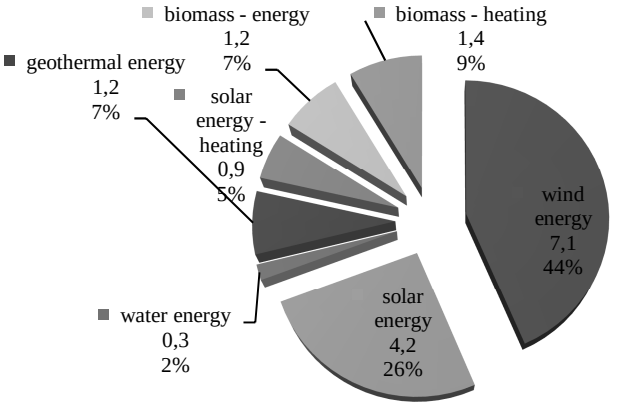
Investments in Renewable Energy in Germany

Investments in the area of renewable energy primarily involve support for producers and receivers of green technologies, as well as expansion, modernization and optimization of existing lines in order to adapt the grid for accommodating greater quantities of renewable energy (such as by facilitating the transmission of energy from land- and sea-based wind farms in the north to centres of consumption in the west and south). An analysis by the German Energy Agency shows that implementation of the plan to boost wind energy output requires investments involving the construction of around 4,500 km of ultra-high tension power lines. The financial programme also assumes support for investments oriented towards boosting the share of renewable heat power in the energy balance (buildings consume as much as 40% of energy, with the majority being energy from oil and gas for heating). Funds are to be provided both to the owners of new buildings, who are under a duty to acquire a portion of heat energy from renewable sources, and to the owners of older buildings who are renovating them. To date, a far more effective policy has been the one towards the owners of new buildings, while the percentage of renovations has been around 1% annually (the German programme assumes a tripling of the amount of renovations). In 2012, the budget for the Market Stimulation Programme, which provides financing for investments aiming at boosting the share of renewable heat in the energy balance, stood at EUR 366M. Calculations show that every euro from the programme has generated a seven-fold return in private investments (Morris & Pehnt, 2014).

An important source of financing for the energy transformation is the Energy and Climate Fund, which is financed by such sources as the tax on the use of atomic power stations and the sale of CO2 emission rights. *Ener-*

giewende is also financed by funds for environmental protection policy in the budgets of three ministries. That said, it should be noted that the greatest proportion of subsidies in the RES sector comes directly from individual consumers of energy and enterprises, which pay the appropriate fee calculated as a portion of the final cost of energy. This fee serves to balance the market price of energy and the legislatively guaranteed price of energy from RES. In 2011, the total sum of additional fees charged to electricity bills borne by non-privileged users of energy amounted to over EUR 12 billion (Kwiatkowska-Drożdż, ed., 2012).

Figure 2. Investments' value in RES in Germany in 2013 (billion euro)



Source: Federal Ministry of Economic Affairs and Energy in Germany (2014).

Germany provides a greater amount of public resources than any other country to the development of energy production. In the period 2008-2012 it spent EUR 25.5 billion (the next country on the list was the United Kingdom, which spend EUR 13.3 billion), 80% of which was earmarked for expanding RES and boosting energy efficiency. During the same period Poland spent EUR 970 M, with over 90% on energy from extractable sources (primarily coal in Poland). In 2013, German investment in renewable energy amounted to EUR 16.3 billion, with EUR 7.1 billion going to develop the wind power sector and EUR 4.2 billion to the solar power sector (Alberici *et al*., 2014).

Effects of Support for Renewable Energy in Germany

The German economy reaps a significant number of benefits from the energy policy being pursued:

- Germany supports the natural environment and adheres to the restrictions it has agreed to concerning emissions of carbon dioxide. The country is among an elite group of states which have not only reached the Kyoto protocol targets, but even exceeded them. The German government assumed that by the end of 2012, CO2 emissions would fall by 21% (compared to 1990), while the final result was in fact 26.5%. By way of comparison, during the same period the United Kingdom reduced its CO2 emissions by 12.5%, while France posted a figure of 0% (Climatico, 2012).
- transformations on the energy market in Germany are consistent with the directions of European Union strategy (Europa 2020) and constitute a significant stimulant for the growth of innovative technologies (environmentally friendly). The EU provides particularly strong support for 'ecoinnovation', meaning forms of innovation which are intended to generate meaningful and observable progress in the area of sustainable development through reducing environmental impact or through more efficient and responsible management of natural resources, including energy (European Commission, 2010). The German model of energy transformation is also a point of reference for programmes designed to expand the use of renewable energy in many other countries, such as Japan and India.
- the energy transformation is contributing to jobs growth. Energy is one of the ten largest industries in Germany, employing over 600,000 people. In 2013, the RES sector had a workforce of around 370,000 (in 2004 it was 160,000), and by 2020 this number may grow to 500,000. The most jobs are generated by the solar, wind and biomass energy sector (O'Sullivan *et al*., 2014).
- Germans are becoming more resistant to the impact of growing fossil fuel prices and the policies of foreign suppliers, which is having a positive impact on the state budget. Germany imports 98% of the crude oil, 86% of natural gas and 100% of uranium that it consumes (EIA, 2014). Renewable energy sources and increased energy efficiency are significant factors in reducing imports (in 2012 the costs of importing raw materials for the production of energy constituted 11% of total import expenditures), and by the same token they are contributing to increased energy security for Germany and improved balance of payments.

- Energiewende is a major contribution to GDP growth (in 2011 green technologies accounted for 11% of Germany's GDP) and enhances export of technologically advanced products ("made in Germany"). Renewable energy is doubtlessly a leading energy technology with a bright future, and as the world leader in this area Germany can reap significant long-term benefits. It is estimated that 60% of German photovoltaic panels are produced for export (in 2004, foreign sales amounted to 14%, while in 2020 they will account for 80%), and Germany's share in the global solar panel market is 46% (BSW, 2014). Germany also exports 65-70% of wind turbine components produced, and the gross value of the wind energy sector is nearly EUR 11 billion (BWE, 2014). It is estimated that the German green technology sector will retain its 15% share in the global market until at least 2025, and its value will double to almost EUR 4.5 billion (Bundesministerium fur Umwelt, 2012).
- the development of RES is contributing to "democratization" of the energy sector. German citizens can not only change their energy supplier, but they also have the freedom to act as energy producers, including sale of energy. The ownership structure is diffuse and composed of a range of entities, both local residents and enterprises: 47% of installed RES power belongs to private individuals and farmers, 41% to institutional investors, and only 12% to energy suppliers – the four largest energy firms hold only
- 5% of installed RES capacity (Morris & Pehnt, 2014).
- in the long run, investments in RES are intended to contribute to achieving social objectives of economic policy. The cost of acquiring energy from renewable sources is continually dropping and is independent of fluctuating international conditions. This has a beneficial effect on household budgets – particularly of the less well-off – in which a significant chunk of spending goes towards basic maintenance needs. So far, the achievement of this objective is turning out to be the most difficult, as the end price of energy has been growing (in 1998 the average price of one kilowatt hour of electric energy for German individual customers was approx. 17 cents while for industrial customers it was 9 cents; in 2013, these prices were around 28 and 15 cents, respectively). This negative phenomenon is the result of the structure of the subsidy system in place for the production of renewable energy, which is based on the RES fee that comprises an element of the final energy price. This fee helps to balance the market price of energy and the legally guaranteed price for energy from RES. The German energy market features a fixed guaranteed tariff for OZE (which is too high when compared to the rapidly falling costs of green energy production, particularly photovoltaic

energy). This fact, in conjunction with declining market energy prices and the gradual exemption of industrial clients from a portion of the RES fee (particularly energy-intensive ones) is leading to rising final energy prices (Kwiatkowska-Drożdż (Ed.), 2012). In August 2014, amendments to the Renewable Energy Sources Act went into effect that are designed to halt this process and to solve other problems related to the energy transformation. There is, of course, no shortage of problems, including economic (financing the RES sector), legal (such as expanding the transmission grid) and organizational (muddled division of tasks across ministries). Considering the revolutionary pace of the energy transformation in Germany, these seem quite natural problems which the government is addressing in a logical and consistent manner.

Conclusions

The energy transformation in Germany is essentially an irreversible process, and is supported by a significant portion of society, as well as the political and scientific establishment[7]. What is more, Germany is influencing the direction of energy and ecological policy in the EU, which reinforces political decisions and helps them remain consistent with EU strategy. The political dispute essentially concerns the schedule for expanding RES, the architecture of the energy market and the subsidy system. Numerous interest groups have appeared (such as small producers of energy from RES – prosumers, private individuals, farmers and cooperatives, as well as the green technology lobby), which, on the one hand, support the rapid growth of RES, while on the other strive to shape the structure of the renewable energy market in a way that benefits them.

Germany views climate policy as a chance to develop a low-emissions economic system featuring a significant level of energy independence. An important role in the German economic transformation is assigned to stimulating the development of modern technologies for the use of renewable energy, through both financial and legal means couples with incentives for society to assume responsibility for satisfying its own needs. Renewable energy is without doubt a leading energy technology with massive upside potential, and the public intervention practiced by Germany should be con-

[7] In a study from 2011, 65% of Germans supported the energy transformation, 79% of respondents said that high energy efficiency and combating climate change had a positive effect on economic growth and can contribute to the creation of new jobs (Morris & Pehnt, 2012, p. 8).

sidered a success. Considering that *Energiewende* is a long-term strategic project of German policy, it required strong state intervention. This is particularly facilitated by a common EU energy policy with a beneficial legal and institutional framework that supports the growth of green technologies.

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