

# ENERGY POLICY OF LIECHTENSTEIN

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## Abstract

Liechtenstein is the fourth smallest country in Europe, which determines the low economic importance of this country on the international arena. Therefore, Liechtenstein is usually overlooked in the analysis of economic policies in various countries, including the energy sector. However, the analysis of such a small country brings a valuable complement to researches on potential and challenges with regard to the implementation of energy transformation policy especially taking into account the countries with poor capabilities. It should be emphasised that due to difficult geographical conditions and strong external influences, deepened analysis of the process of formulating energy policy in Liechtenstein should arouse the interest of those countries that suffer geographical disadvantages to strengthen their energy security.

**Keywords:** energy policy, energy transition, Liechtenstein, energy security

## Introduction

Liechtenstein is the fourth smallest country in Europe in terms of surface area, with 160 km<sup>2</sup> (Liechtenstein in Zahlen 2018: 4). Due to its small size, which largely determines its economic importance on the international scene, Liechtenstein is generally disregarded in considerations of the economic policy aspects of various countries, including the power generation sector. There are no studies on Liechtenstein in the scientific literature. Only reports describing selected issues concerning the power generation sector of this country can be found, e.g. the UN Liechtenstein National Climate Report 2005 (Liechtenstein National Climate Report), the VP Bank energy report (Energiebericht 2017), and government documents, which include energy strategies, reports by the Liechtenstein Statistical Office, or government programmes. Nevertheless, the value of an analysis of such a small state is a valuable addition to research into the potential and challenges, but also into the capabilities of individual countries with regard to the implementation of energy transformation policies.

**Map 1. Geographic situation of Liechtenstein in Europe**



Source: <https://www.1843magazine.com/travel/liechtenstein-the-magic-princedom> (access: 31.7.2019).

The aim of this paper is to analyse the formulation of energy policy in Liechtenstein with a view to ensuring national energy security, based on the characteristics of the existing geographical, political and economic opportunities of the country. For this reason, the main part of the paper is divided into three parts, the first of which deals with legal and institutional issues, the second with the economic dimension of energy policy, and the last with social issues. The topics discussed in the paper are based primarily on government documents defining national priorities for the development of the power generation sector and the geopolitical situation of Liechtenstein with particular emphasis on relations with neighbouring countries – Switzerland and Austria.

It should be stressed that due to difficult geographical conditions and strong external influences, the examination of the process of formulating power generation policy in this country should be of particular interest to those countries which are themselves disadvantaged in order to strengthen their energy security, taking into account all the necessary elements to ensure it. However, before discussing Liechtenstein's energy policy, the definition of basic concepts in the form in which they will be used for further analysis should first be clarified.

### ***Definition of a State's energy security***

The definition of energy security reveals differences in the elements it focuses on – some researchers highlight aspects related to security of supply, such as the availability of energy or its price, while others highlight issues related to the impact on economic and social welfare (Choong 2015: 1078).

According to the most common definition, energy security means the ability of the national economy to cover the current and future supply of energy to domestic consumers at socially acceptable prices, while maintaining political independence (Młynarski 2013: 23-24) and environmental and climate protection.

The International Energy Agency defines energy security as the uninterrupted availability of energy sources at an affordable price. At the same time, it points out that this concept has many dimensions. For example, in the long term, it refers primarily to investments in securing energy supplies in line with economic development and environmental sustainability needs (Energy Supply Security: 13). It is therefore recognised that energy security is a chain of inter-related values and economic and political factors (Młynarski 2013: 23-24), which shows the complexity of this concept. Actions to ensure energy security relate to a wide variety of areas affecting sustainable development policies, economic policies, power generation markets, socio-economic changes or technological development (Cziomer, Lasoń 2008: 18). Therefore, energy security has a raw material and product, infrastructural, political, international and human capital dimension (in terms of availability of qualified personnel) (Bojańczyk 2014: 144).

In terms of the subject matter, energy security is an element of the state's national security. It also refers to international security as an element of foreign policy, which is based on the most important interests of the state. It follows from this that the State is the main actor in energy security. However, it operates alongside other participants in the energy security system, such as power generation corporations and end consumers (Młynarski 2013: 23).

Energy security is a component of raw material security because it is based on traditional raw materials: coal and lignite, crude oil, natural gas and uranium. With regard to the latest energy production and storage technologies, raw materials such as lithium, cobalt, magnesium,

silicon, etc. are also becoming crucial. Energy security also refers to economic security, because the area of power generation directly affects the efficiency and competitiveness of the economy (Młynarski 2013: 23-24). Therefore, the task of the state energy policy is to coordinate all these dimensions of security as important elements for the undisturbed functioning of the modern state.

### ***The modern concept of energy policy***

In the definitional sense, the concept of energy policy arises from the definition of raw material, energy and environmental security and the concept of sustainable development. Therefore, the aim of energy policy is to determine the state's activity, which is necessary to secure the current and future needs for raw materials, ensuring sustainable and balanced economic development, based on policies that include such activities as diversification of energy supply sources, creation of reserves of raw materials, limiting the accessibility of foreign entities to the domestic energy market and concluding international agreements (Młynarski 2013: 24).

The power generation transformation policy is a detailed specification of the energy policy, and at the same time a guideline for its development and objectives. A narrow and most basic definition of energy transformation means changing the current energy model, which is based on non-renewable energy sources in the form of fossil fuels, to an energy system based on renewable energy sources (Ruszel, Młynarski, Szurlej 2017: 29). The energy transformation policy is strongly based on technological factors, but changes in the economic and social fields are also an important element (Schneidewind, Augenstein, Scheck 2010-2012: 122-123). This is because the subject of the energy transformation is a complex one and relates to many fields and areas far beyond the energy sector. For this reason, four dimensions are mentioned that define the areas of change in the energy transformation process: technological, economic, institutional and sociological (cultural) (Schneidewind, Augenstein, Scheck 2010-2012: 122-123).

Energy transformation is directly identified with the uptake of low or zero carbon energy sources, which are based on appropriate efficient and energy saving energy generation technologies. The elements promoting the development of RES include advanced technologies, increased economic competitiveness, political support, and the education of society. The benefits of the development of renewable sources include reducing the negative environmental impact of the traditional energy sector, supporting the diversification of energy supply, and increasing the energy independence of states. In addition, these activities are combined with the development of the idea of energy saving, which at the same time should be accompanied by an increase in energy efficiency in various industrial and service sectors through such activities as insulation and thermal modernisation, energy efficient lighting, and cogeneration and energy recovery in industrial processes (Ruszel, Młynarski, Szurlej 2017: 29-30).

Society is one of the main pillars of the energy transformation as its initiator and recipient – depending on the perspective adopted. Society, as the payer, bears most of the costs of financing public programmes and investments. Some of the changes can be implemented through social commitment, e.g. electromobility or energy saving. Hence, the importance of educating the society and shaping citizens' awareness of energy issues (Ruszel, Młynarski, Szurlej 2017: 31-32) is emphasized in state energy strategies and programme documents. One

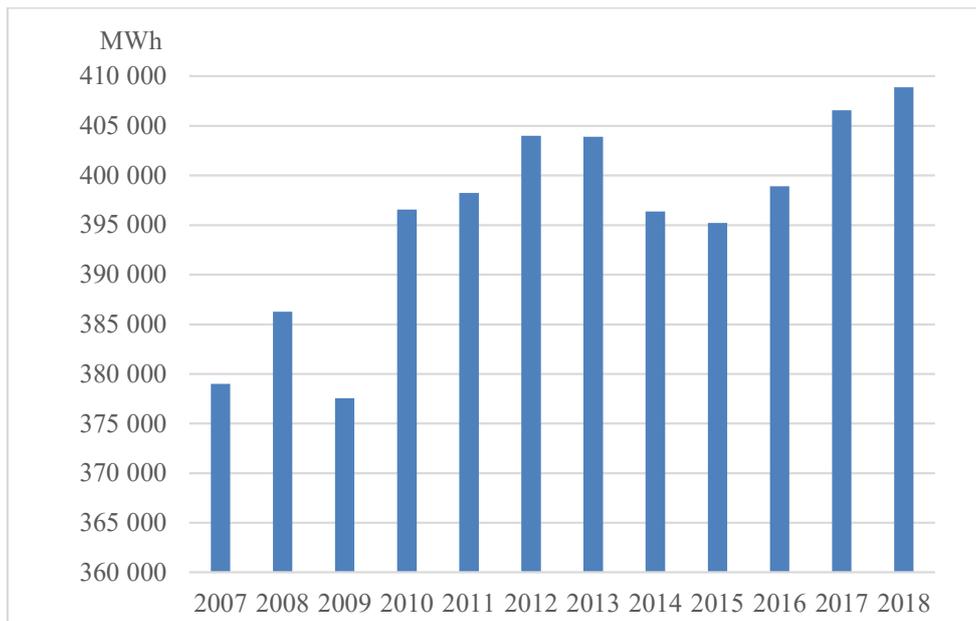
of the challenges in relation to society is consumer activation. The social base is strongly linked to the development and diffusion of new technologies, because on the one hand they enable citizens to raise quality of life, and on the other hand they determine the demand for them and the need to disseminate them. Thanks to the technologies, it was possible to create a new dimension of power generation, defined as prosumer energy. This concept was introduced by Alvin Toffler in his book *The Third Wave* in the 1980s (Toffler 1980: 264-270). The basic definition defines a prosumer as both a producer and a consumer, not only of energy, but of every good (Mirowski, Sornek 2015: 73-81). Prosumer power generation assumes that the hitherto passive consumer will join the production system by generating energy for his own use in a home microinstallation, and any surpluses may be transferred to the grid (Słupik 2014: 129). The role of the state in the context of prosumer power generation is primarily to educate society, promote certain values related to environmental protection, support civic movements focused on caring for the environment, and stimulate civic activity in this field through various incentives, such as subsidies.

### **Liechtenstein's energy policy**

#### ***The structure of Liechtenstein's energy balance***

Energy consumption in Liechtenstein is high – it is almost twice as high as the European average *per capita* (Energy consumption..., <https://www.worlddata.info/europe/liechtenstein/energy-consumption.php>, access: 1.12.2019) – and in 2018 amounted to 1,210,461 MWh and thus the energy consumption decreased by 2.5% compared to 2017. According to data from the Liechtenstein Statistical Office, the largest share of consumption in 2018 was in electricity with a share of 33.8% (Energiestatistik 2018 Liechtenstein, 2019: 6). This information is a little unclear, because the electricity itself also had to be generated from something in the first place. In statistical terms, however, this data should be understood as electricity imported in the form of a finished product into Liechtenstein (Energiestatistik 2018 Liechtenstein, 2019: 15 ). The dominant supplier for Liechtenstein is Switzerland (98% of electricity imports), which in turn produces most of its imported energy from nuclear power plants (Energiestrategie 2020, 2012: 7). The second largest energy carrier in terms of share in consumption is natural gas (20.4%), followed by diesel (12.2%) and heating oil (9.1%) (Energiestatistik 2018 Liechtenstein, 2019: 6).

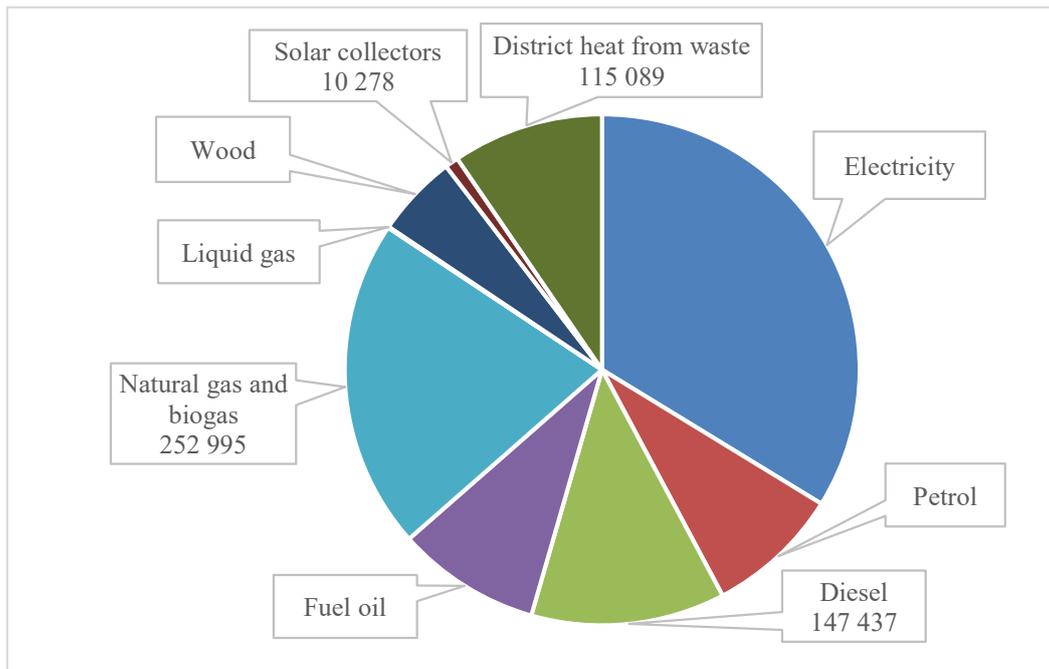
**Graph 1. Electricity consumption in Liechtenstein from 2007 to 2018 [MWh]**



Source: compiled on the basis of: *Energiestatistik 2017 Liechtenstein*, publ. Amt für Statistik, p. 18, *Energiestatistik 2018 Liechtenstein*, publ. Amt für Statistik, state as of July 2019, p. 7.

The share of Liechtenstein’s own energy production in total energy production is low and amounted to 13% in 2018 (12.6% in 2016 and 12.3% in 2017 (*Energiestatistik 2017 Liechtenstein*, 2018: 9)), but electricity production alone has decreased by 5% compared to 2017 (*Energiestatistik 2018 Liechtenstein*, 2019: 6). Domestic electricity sources include hydro-power, cogeneration units for natural gas, and photovoltaics (*Energiestatistik 2017 Liechtenstein*, 2018: 9).

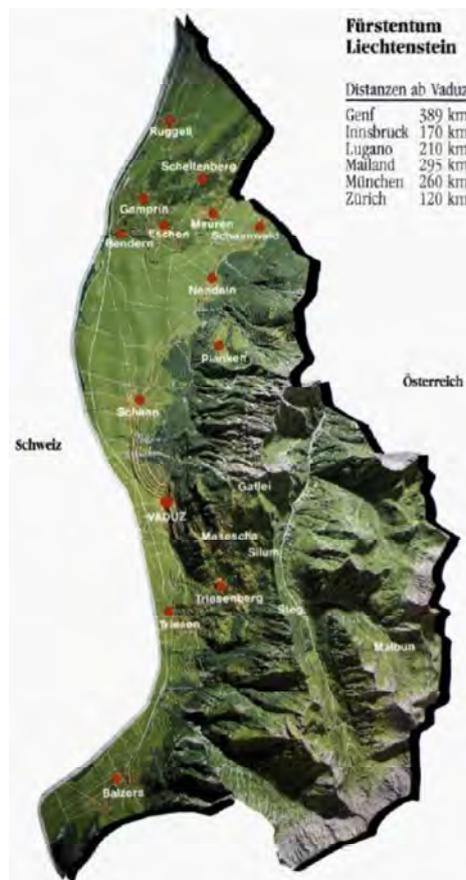
**Graph 2. Overall energy consumption in Liechtenstein in 2018 [MWh]**



Source: compiled on the basis of: *Energiestatistik 2018 Liechtenstein*, publ. Amt für Statistik, state as of July 2019, p. 8.

Liechtenstein is therefore in a very difficult position when it comes to energy self-sufficiency. It does not have its own energy resources, which makes it completely dependent on imports or RES. Renewable energy sources require a lot of space, which this country does not have. In addition, 15% of Liechtenstein's surface area is mountainous, i.e. not usable areas (Droege, Genske 2013: 9) and unusable for renewable installations. In addition, Switzerland, the main exporter of energy to Liechtenstein, has decided to stop producing energy from nuclear power plants, which have hitherto provided it with enough energy to export. Although this will be done gradually over a broad time horizon, Liechtenstein has now been put in a position where the future of its security of energy supply is uncertain.

**Map 2. Topographical map of Liechtenstein**



Source: <http://www.map-library.com/map-library/maps-of-europe/maps-of-liechtenstein/>, (access: 31.7.2019).

Observation of Liechtenstein's energy policy shows that the European Union and Switzerland have the greatest influence. Nuclear power plants can be identified as the main reason why Liechtenstein has a special partnership with Switzerland. As mentioned above, electricity imported by Liechtenstein comes mainly (although not exclusively) from this source (Liechtenstein, <http://de.atomkraftwerkeplag.wikia.com/wiki/Liechtenstein>, access: 31.7.2019). Neighbouring Austria does not have nuclear power (although it is also an importer) and does not have a source of electricity that is at the same time stable in terms of production and sufficient capacity for export. It is therefore interesting in this context to see the decision taken in Switzerland to phase out nuclear power generation altogether.

However, it can be seen that the Swiss decision is generally accepted in Liechtenstein, for several reasons. First of all, Liechtenstein is one of the countries dominated by anti-nuclear

sentiments. In the first decade of the 21st century, it was planned to build a nuclear power plant in Liechtenstein in order to increase national energy independence and guarantee a secure and stable energy supply. However, numerous social protests were raised against the construction plans, the force of which was strengthened after the nuclear power plant accident in Fukushima in 2011 (Liechtenstein: "Das AKW kommt", <https://www.vol.at/liechtenstein-das-akw-kommt/1358032>, access: 31.7.2019). As a result, Liechtenstein has joined the anti-atomic trend, as has Switzerland. Secondly, Switzerland's plan to phase out nuclear energy includes a long-term perspective, until 2034 at this point in time. Liechtenstein therefore considers that it still has time to prepare its energy system for the changes. According to studies carried out by a group of researchers at the University of Liechtenstein, the country is able to reduce its dependence on imports from today's 90% to 50% by 2040, and to achieve energy independence in the next two generations, i.e. by 2070 (Droege, Genske 2013: 5). The last reason is that Liechtenstein relies on the extensive development of renewable energy sources, energy saving and energy efficiency, as well as the further development of transnational transmission networks and the interconnection of energy markets. All these elements are intended, in accordance with the strategy papers, to guarantee the security of Liechtenstein's energy supply in the future.

With regard to Liechtenstein's relations with the European Union, they have been shaped as in the case of Switzerland, i.e. in a natural way due to its location in the central part of Europe, but also due to the similarity of approach to energy, climate and environmental policy, which Liechtenstein places great emphasis on. By signing the agreement on the European Economic Area, Liechtenstein was incorporated into the internal market of the European Union, creating a common area of free movement of goods, services, capital and people, taking into account uniform rules on competition and prohibited state aid. At the same time, a field of cooperation in the field of consumer protection, environment, health and education was opened (So wird EU-Recht zu EWR-Recht, <http://eealaw.efta.int/de/>, access: 31.7.2019). For this reason, the European Union's energy policy is a real factor influencing this area in Liechtenstein.

### ***The legal and institutional dimension of Liechtenstein's energy policy***

Against the backdrop of Europe, Liechtenstein is one of the countries that paid attention to the importance of the energy sector at an early stage. This has been reflected in historically passed legislation. The crisis of the 1970s contributed to the adoption of the first Energy Regulation in Liechtenstein in 1979 as a complement to building regulations. This ordinance regulated issues related to the heating of buildings and the type of heating installations, and its aim was to reduce energy consumption for heating buildings, which at that time represented half of all energy used by the state (Biedermann: Energie, <https://historisches-lexikon.li/Energie>, access: 31.7.2019).

The framework for energy policy-making in Liechtenstein began to take shape in the 1990s, as in most Western European countries. In 1996, the *Energy Saving Act* was adopted in Liechtenstein, the main objective of which was to promote alternative forms of energy production, in particular solar energy. In 1998, Liechtenstein became a signatory to the Kyoto Protocol, which resulted in a commitment to reduce carbon dioxide emissions by 92% by 2012 compared to 1990 levels. The *Energy Concept in Liechtenstein 2013*, adopted in 2004 and the *Energy Efficiency and Renewable Energy Act 2008* (Biedermann: Energie, [68](https://historisches-</a></p></div><div data-bbox=)

lexikon.li/Energie, access: 31.7.2019) were to help achieve this goal. Both documents set out the scope of appropriate measures required for energy saving and support for renewable energy sources (Biedermann: Energie, <https://historisches-lexikon.li/Energie>, access: 31.7.2019).

The *Liechtenstein Energy Concept 2013* stressed in particular the need for the technological development of the energy sector to ensure security of energy supply without the need to expand access to raw materials for future energy production. At the same time, technological innovations in the energy sector were intended in the *Energy Concept...* to support climate protection by reducing harmful emissions from the combustion of fossil fuels. The document stresses the need for rational energy production and extending it to renewable sources (Energiekonzept Liechtenstein 2013 der Regierung des Fürstentums Liechtenstein, [http://cdn1.vol.at/2009/06/sm\\_fl\\_energie.pdf](http://cdn1.vol.at/2009/06/sm_fl_energie.pdf), access: 31.7.2019). The *Energy Concept...* had the following objectives:

- reduction of carbon dioxide emissions by 10% by 2010 compared to 1990 levels;
- increasing the share of RES in total energy consumption to 10% by 2013, mainly through the use of domestic biomass, biofuels and solar energy, whose share in energy production in the next decade was planned to triple;
- reduction of energy losses both in transmission (through modernisation of infrastructure and buildings) and in its production, through the construction of cogeneration (blocks for the production of electricity and heat);
- stepping up information policy and public incentives (Energiekonzept Liechtenstein 2013 der Regierung des Fürstentums Liechtenstein, [http://cdn1.vol.at/2009/06/sm\\_fl\\_energie.pdf](http://cdn1.vol.at/2009/06/sm_fl_energie.pdf), access: 31.7.2019).

The document also provided for appropriate financial resources to support the actions and objectives outlined. Interestingly, the *Concept...* also assumed a greater use of wood and wood processing waste (e.g. sawdust) for heating purposes, considering this energy source to be carbon-neutral and taking into account the national potential (Energiekonzept Liechtenstein 2013 der Regierung des Fürstentums Liechtenstein, [http://cdn1.vol.at/2009/06/sm\\_fl\\_energie.pdf](http://cdn1.vol.at/2009/06/sm_fl_energie.pdf), access: 31.7.2019).

The *Act on Support for Energy Efficiency and Renewable Energy*, adopted in 2008, regulated issues related to the provision of financing for the improvement of energy efficiency and the strengthening of the use of RES, while maintaining the objectives related to environmental protection. The Act directly referred to Directive 2004/8/EG of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market (LGBI-Nr. 2008/116: 1).

In accordance with Article 22 of the *Energy Efficiency and Renewable Energy Act*, an Energy Office was established, which is an advisory body to the National Economy Office (*Amt für Volkswirtschaft*, acting under the Ministry of Infrastructure, Economy and Sport – *Ministerium für Infrastruktur, Wirtschaft und Sport* (Ministerium für Infrastruktur, Wirtschaft und Sport, <https://www.regierung.li/ministerien/ministerium-fuer-infrastruktur-wirtschaft-und-sport/amtsstellen>, access: 31.7.2019) in the field of energy policy. Its job covers:

- advising private entities, municipalities and institutions on issues related to energy policy and possibilities of support;
- development and implementation of concepts resulting from the national energy policy;
- preparation of a plan for financial support for measures to implement energy objectives;

- issuing construction certificates in accordance with the Swiss Minergie<sup>5</sup> standards;
- develop an Energy Action Plan in line with EEA objectives (Energiefachstelle im Amt für Volkswirtschaft, <https://www.energiebuendel.li/Akteure/Energiefachstelle.aspx>, access: 31.7.2019).

Article 20 of the Act establishes the Energy Commission as an advisory body to the government and defines its tasks and powers (LGBI-Nr. 2008/116: 1). In addition to the Energy Commission, there are currently two specialised committees to advise the government. The tasks of these bodies are defined as follows:

1. Energy Commission – advises the government on all matters concerning energy policy. It monitors the process of implementation of the energy policy and technological development of this sector, as well as supervising ongoing activities related to the implementation of the provisions of the Energy Efficiency Act. In addition, it is responsible for providing and developing financial support for the construction of demonstration plants. The Power Generation Committee conducts campaigns to disseminate energy information and raise public awareness on these issues, in particular with regard to the use of energy-efficient lighting and household appliances.
2. The Energy Market Supervision Commission – is one of the governmental regulatory authorities. The scope of its activities is limited to issues related to energy market supervision in accordance with national and international regulations on the subject. In accordance with its respective competences, the Commission provides advice to the government, in particular on matters relating to electricity and natural gas market law.
3. Board of Appeal in Administrative Matters – an appeal body in matters of management and decisions concerning construction, road and rail transport, electronic communication, housing, environmental protection, agriculture, etc. (Auszug aus dem Staatskalender des Fürstentums Liechtenstein, <https://www.energiebuendel.li/Akteure/Kommissionen.aspx>, access: 31.7.2019).

In May 2012 the *Energy Strategy 2020* was adopted in Liechtenstein, which outlined the objectives of the national energy policy and the transformation of the sector. The *Energy Strategy 2020* replaced the previous *Energy Concept 2013* and constituted its superstructure (Energiesstrategie 2020, <https://www.energiebuendel.li/EnergiepolitikFL/Energiesstrategie2020.aspx>, access: 31.7.2019). The newly adopted *Strategy...* set four basic objectives, including security of energy supply, economic profitability of energy production, as well as maintaining it at a level favourable to consumers, not hindering social development and environmental protection (Energiesstrategie Liechtenstein 2020, 2012: 12-15). Apart from these objectives, the objectives directly from EU documents concerning the increase of energy efficiency by 20%, as well as the increase of RES share in electricity generation by 20% and the reduction of carbon dioxide emissions by 20% by 2020 compared to 1990 levels were also accepted (Energiesstrategie 2020, <https://www.energiebuendel.li/EnergiepolitikFL/Energiesstrategie2020.aspx>, access: 31.7.2019).

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<sup>5</sup> Minergie includes a set of standards for low energy consumption, ecological and energy-efficient buildings, recognised in Switzerland and Liechtenstein.

The strategy paper presented for the first time data on the level of energy consumption in particular sectors. On this basis, the success of the action groups has been identified, including concrete measures aimed at directly achieving the objectives set out in the *Strategy...* by 2020. These include the building sector, the transport sector, the energy efficiency area, electricity generation, education for raising energy awareness, and laying the foundations for appropriate national energy policy planning, in particular to identify areas for improvement. The *Strategy...* embraces a variety of methods for achieving the objectives set and implementing specific measures on a voluntary basis. In order to create incentives to increase motivation to act, the *Strategy...* foresees the creation of appropriate financial support and emphasises better access to information and education (Energiestrategie 2020, <https://www.energiebuendel.li/EnergiepolitikFL/Energiestrategie2020.aspx>, access: 31.7.2019).

The current actions based on the assumptions of the *Energy Strategy 2020* are evaluated satisfactorily. Thanks to the financial means for the support of RES and energy efficiency, it was possible to save about 6 million litres of heating oil and reduce carbon dioxide emissions by about 12 thousand tonnes. In terms of photovoltaic development, 285 Wp (i.e. peak capacity) per capita were installed in Liechtenstein by the end of 2012, making Liechtenstein the world's second largest producer of photovoltaic services per capita. These installations provide electricity for 3,000 households (Energiepolitische Ziele in Liechtenstein, <https://www.energiebuendel.li/EnergiepolitikFL.aspx>, access: 31.7.2019). According to the French RES development ranking, in mid-2015 Liechtenstein was already the world's first in terms of the number of photovoltaic installations per capita (Renewables 2016 Global Status Report: 212).

The Liechtenstein Energy Union (German: *Energiebündel Liechtenstein*) was established with the main task of creating a platform bringing together all participants in the energy area in order to achieve a level of cooperation for them, as well as to highlight the presence of each of them. The Liechtenstein Energy Union constitutes a response to the European debate on energy and climate challenges and supports national energy policymaking, referring to the energy policy of the European Union and neighbouring Switzerland. The Liechtenstein Energy Union considers it necessary to take measures to reduce energy consumption through the efficient production and use of energy. As well as increasing activity to improve the security of energy supply, which is to be supported by the development of renewable energy sources (Akteure im Energiebereich, <https://www.energiebuendel.li/Akteure.aspx>, access: 31.7.2019).

**Table 1. Legal regulations concerning energy policy in Liechtenstein**

Regulatory area	Legal act	Legal act in original
Support for the energy transition	Law of 24 April 2008 on the Support of the Energy Efficiency and Renewable Energies	Gesetz vom 24. April 2008 über die Förderung der Energieeffizienz und der erneuerbaren Energien (Energieeffizienzgesetz; EEG)
Support for the energy transition	Regulation of 27 May 2008 on Support of the Energy Efficiency and Renewable Energies	Verordnung vom 27. Mai 2008 über die Förderung der Energieeffizienz und der erneuerbaren Energien (Energieeffizienzverordnung; EEV)
Construction law	Construction Law of 11 December 2008	Baugesetz (BauG) vom 11. Dezember 2008
Construction law	Building Regulation of 22 September 2007	Bauverordnung (BauV) vom 22. September 2009
Construction law	Energy Ordinance of 21 August 2007	Energieverordnung (EnV) vom 21. August 2007
Construction law	Law of 23 May 2007 on the energy performance certificate for buildings	Gesetz vom 23. Mai 2007 betreffend den Ausweis über die Gesamtenergieeffizienz von Gebäuden (Energieausweisgesetz, EnAG)

Source: *Energiebündel Liechtenstein*, <https://www.energiebuen-del.li/EnergiepolitikFL/RechtGrundlagen.aspx>, (access: 31.7.2019).

### ***Economic dimension of Liechtenstein's energy policy***

In its strategy paper on energy policy, Liechtenstein draws attention to the growing global demand for energy, which goes hand in hand with the use of fossil fuels. Today, global energy production is based on non-renewable, coal, hydrogen or nuclear energy raw materials. Therefore, in relation to the policy of energy sector transformation, which is gaining increasing popularity in the world, the key challenge of the 21st century is to break the global trend in which the traditional energy system is based on hydrocarbons and coal and to switch the entire economy to renewable energy sources (Energiestrategie Liechtenstein 2020, 2012: 53). For this reason, more and more emphasis is placed on the nature of the energy sector, which corresponds to the pro-environmental policy. Thus, the importance of the origin and method of energy production is growing, which is reflected in the structure of the domestic energy mix and the form of production abroad (due to imports) (Energiestrategie Liechtenstein 2020. Rück- und..., 2017: 37).

In its energy policy, Liechtenstein has adopted three pillars to ensure that energy consumption and its consequences in terms of reducing existing natural resources, emissions of environmentally and climate-damaging gases and dependence on locally unavailable energy sources are as little harmful to the economy and society as possible. These three key elements are: increased energy efficiency, increased use of renewable energy sources and measures to reduce energy consumption as well as energy-related products and services (in line with the principle of *sufficiency*). The first two pillars, energy efficiency and increasing RES production, are strongly popularised and usually treated as key elements for solutions to energy policy challenges across Europe. The reason for this is the fact that increasing energy efficiency and enhancing the use of RES is not in principle related to the reduction of the level of comfort (in terms of industrial production dimension and quality of life of the society). In practice, both these areas require concrete action, including careful analysis of the economic, social and technical feasibility of their implementation. Liechtenstein assesses its potential very positively in all these areas and assumes that it is possible to implement these tasks in conjunction with the implementation of economic objectives and the maintenance of social acceptance for them. This assessment is based, inter alia, on studies published in the report *Renewable Sources of Liechtenstein* (German: *Erneuerbares Liechtenstein*), which show that by 2070 full self-sufficiency of the country based on RES is possible with simultaneous minimisation of greenhouse gas emissions, if the previous efforts in this aspect are maintained with a focus on the energy policy objectives adopted (Energierstrategie Liechtenstein 2020, 2012: 53).

The Liechtenstein energy economy is growing in importance, in particular in the field of renewable energy sources, the consulting industry for the optimisation of energy processes, and also energy supply. The energy sector in turn is influenced by the recommendations stemming directly from the Liechtenstein energy strategy and the accompanying debates, which refer to past energy policy making plans. For this reason, Liechtenstein places emphasis on the monitoring and control of the currently implemented measures so that the effects of the strategic document can be coordinated on an ongoing basis (Energierstrategie Liechtenstein 2020. Rück- und..., 2017: 37). For this reason, in the first half of 2017 an evaluation document for the *Energy Strategy 2020* was prepared. The evaluation document entitled *Energy Strategy Liechtenstein 2020. Retrospection and perspectives for the future in the medium term* (German *Energierstrategie Liechtenstein 2020. Rück- und Ausblick zur Halbzeit*) was developed in the middle of the outlined time horizon of the *Energy Strategy 2020*. The evaluation document emphasises that nowadays important economic elements of the planned actions are often omitted when making decisions concerning the energy sector. The basic errors made in the strategic planning process included, first of all, the omission of external costs of maintaining power installations in readiness to provide services and costs related to the operation of infrastructure and energy consumption. Secondly, it was pointed out that investment decisions were often based on too short a time horizon, which meant that in the assumed period it was not possible to fully realise all the planned measures within their full implementation cycle. This made it necessary to take a decision – based on environmental criteria and economic benefits – on which of the planned tasks could not be carried out. Hence, the evaluation document advised that at the stage of investment planning, costs should be included in the full life cycles of the implemented processes. An additional difficulty in this respect is the worldwide trend of rising energy prices (Energierstrategie Liechtenstein 2020. Rück- und..., 2017: 13-14).

By demonstrating in government documents the awareness of the challenges posed by the energy transformation, Liechtenstein assesses current trends in the energy sector as an opportunity for its economy, provided that the actions taken are based on a well-established analysis of economic benefits. Liechtenstein is in a good starting position for the implementation of the energy transformation policy. This is possible, *inter alia*, thanks to the potential of high-tech companies or developed educational institutions, which in the wave of the global trend of changes in the energy sector have a chance to increase their benefits (Energiestrategie Liechtenstein 2020. Rück- und..., 2017: 13-14). The energy transformation requires the cooperation of both science and industry in the development and implementation of technological innovations. Meanwhile, Liechtenstein is a highly industrialised country with a particular focus on high-tech industry (Liechtenstein - the business location, 2017: 2), hence the importance of energy as a factor building the competitiveness of the national economy is strongly emphasised in its strategy document. It assesses that this aspect is dominated by the continued availability of energy in the form of certain supplies, which should be accompanied by competitive prices, taking into account the situation on foreign markets (due to the interdependence of markets). In this respect, a special role is played by power generators and distributors, which in the case of Liechtenstein are two State-owned companies: Liechtenstein Power Stations (German: *Liechtensteinischen Kraftwerke* – LKW) and Liechtenstein Gas Supply Company (German: *Liechtensteinische Gasversorgung* – LGV). These companies play an important role in Liechtenstein's energy policy, *inter alia* by contributing to the definition of general principles and guidelines for future energy supplies (Energiestrategie Liechtenstein 2020. Rück- und..., 2017: 37) and the framework conditions for an action strategy for the future development of energy policy (Energiestrategie Liechtenstein 2020. Rück- und..., 2017: 37).

### ***The social dimension of Liechtenstein's energy policy***

Economic development, employment, and social development are strongly interlinked. The projections for economic development in Liechtenstein were presented in the Strittmatter Partner AG survey, based, among others, on the values of the Liechtenstein Statistical Office, and assume a progressive growth, and the individual scenarios differ only in the expression of its degree (Energiestrategie Liechtenstein 2020. Rück- und..., 2017: 52). Such prospects are a positive stimulus for the power generation sector, which, particularly with regard to the concept of energy transition, requires numerous and costly investments. Of course, state subsidies are important in order to stimulate investments in measures aimed at the practical implementation of national energy and climate policy. In this respect, Liechtenstein has developed a support programme for each of the eleven municipalities with a view to achieving climate objectives, including in particular financial assistance to reduce energy demand and increase the use of RES (Die 11 Gemeinden in Liechtenstein, <https://www.energiebuendel.li/Akteure/Gemeinden.aspx>, access: 31.7.2019). It should be remembered, and this is also pointed out in Liechtenstein's energy strategy, that social and economic development determines the exponential growth of energy consumption. In order to break this link between energy development and consumption, efforts are needed to carry out comprehensive tasks in all the social and economic areas that affect the energy sector. This aspect is a central challenge for the future energy policy of Liechtenstein (Energiestrategie Liechtenstein 2020, 2012: 52).

With reference to the challenge outlined above, Liechtenstein has directly taken over from the Swiss Energy Strategy 2050 the concept of "Society 2000-Watt", which focuses primarily on strengthening actions in the field of energy efficiency and RES (Energierstrategie Liechtenstein 2020, 2012: 53). This concept is a vision of long-term development for a climate-neutral, energy-efficient and equitable energy distribution society. Building a "2000-Watt Society" has three long-term objectives:

- reduction of energy demand to 2000 watts of continuous power per capita;
- reducing greenhouse gas emissions to 1 tonne of CO<sub>2</sub> eq per capita;
- justice in energy consumption.

In the light of these objectives, the concept aims to ensure the long-term sustainable use of energy and the equitable distribution of available resources, which, in line with the ambition of the creators of the "2000-Watt Society", should cover all regions of the world. The central point is the reduction of the share of fossil fuels through the increase of energy efficiency in all areas of energy consumption, with simultaneous development of RES as substitutes for fossil fuels. In Switzerland, pilot projects are being carried out to implement this concept in the form of "Energy Cities". (including Zürich, Basel and Buchs) (Energierstrategie Liechtenstein 2020. Rück- und..., 2017: 16). These measures not only serve the objectives of the process of shaping a specific model of society, but are also part of the construction sector, which in Liechtenstein has a strong emphasis on the implementation of energy objectives due to its high potential for improvement. One of the concepts for the development in this area was the elaboration of an "Energy City" certificate, which status can be obtained by individual cities or municipalities meeting the objectives set out in the *Energy Strategy 2020*. These objectives include long-term implementation of tasks such as support for the construction of RES installations, development of environmentally friendly transport and efficient use of energy sources (of any origin). The certificate is issued by the independent Association of "Energy Cities", which carries out an evaluation every four years, which may extend the validity of the certificate or withdraw it (EnergieLand Liechtenstein, <https://www.energiebuendel.li/EnergiestadtLabel.aspx>, access: 31.7.2019).

The specificity of this country is the labour force, more than half of which are workers living abroad, mainly Swiss (55.1%) and Austrians (40.8%). In 2017, 19,398 employees lived permanently in Liechtenstein and 21,299 employees commuted from abroad to work (Liechtenstein in Zahlen 2019, 2019: 26-28). This fact has certain consequences: Liechtenstein must remain an attractive economy in order to secure workers. For this reason, it places emphasis on environmentally friendly energy production, but only if it takes place under economically advantageous conditions (Energierstrategie Liechtenstein 2020. Rück- und..., 2017: 13-14). In view of the generally accepted definitions of energy security, which include an element of economic efficiency in energy production, it should be stressed that this is a question of the degree of social and economic burden that may be incurred in a given country. This burden in Germany is far beyond what Liechtenstein can afford, as it emphasises in its strategic documents. Therefore, the *Energy Strategy 2020* adopted in Liechtenstein outlines general assumptions and objectives, but their achievement will depend to a large extent on how much the citizens, entrepreneurs and the state budget cope with the financial burden of the energy transformation (Energierstrategie Liechtenstein 2020. Rück- und..., 2017: 13-14).

Liechtenstein, like many other European countries, has difficulty in accelerating the development of electromobility. The *Energy Strategy 2020* set the goal of increasing the number of newly registered electric vehicles to 1,250 between 2012 and 2015, whereas in that period there were only 400. The evaluation document for the *Strategy...* pointed out that the estimates for the development of electromobility in Liechtenstein were overestimated. Hence, its originally planned development was reduced to 20% of its baseline level. Such a revision of the *Energy Strategy 2020* has led to a similar need to adjust energy efficiency and greenhouse gas emissions targets for 2020 (Energierstrategie Liechtenstein 2020. Rück- und..., 2017: 30), given the importance of transport for all these elements. The realism of the objectives based on practical experience has changed expectations for the development of electromobility in Liechtenstein. It is now assumed that there will be further technical progress in the field of electric vehicles and batteries, but significant development of electromobility will start in 2025. In order to support it, a programme has been initiated in Liechtenstein for the extension of charging stations for electric vehicles, in particular fast charging stations. In June 2016, the Energy Committee adopted the objective of building at least one publicly accessible fast-charging station in each municipality, with state funding of 20% of the investment (with a maximum of CHF 10,000). The subsidy is conditional on the guarantee that the station will be supplied with ecologically produced electricity (Schnellladestation/Elektromobilität, <https://www.energiebuen-del.li/ElektroGasMobilit%C3%A4t/Schnellladestation.aspx>, access 31.7.2019).

### **Summary and conclusions**

The analysis of actual activities undertaken so far in the field of the energy transformation shows a strong correlation of geographical conditions, which unequivocally determine the shape of energy policy and the transformation of the sector in this country.

This is important for the energy transformation policy, because as a result of the formation of energy, environmental and climate awareness, the social needs on which consumer decisions are based are unified. On the one hand, this justifies active measures in power generation policy and, on the other, the potential to implement various tasks, develop innovative solutions and develop technologies that will secure, reduce and appropriately shape this demand.

The following important aspects of the energy transformation policy can be deduced from the analysis of programmes and activities undertaken within the framework of cooperation between the DACH countries:

- strong emphasis is placed on technological development and innovation, which stimulate the economy and help to build the competitiveness and economic strength of the state on a macro scale;
- the latest technologies, which are still under development, are issues with particular potential not only in terms of predictable applications and improvements in the power generation sector and beyond, but above all in terms of building a leading position in the international arena;
- dissemination of knowledge and interest of citizens in environmental issues (grass-roots work) is a core activity for the social energy transformation.

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