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Energy Transformation in Lithuania: Aiming for the Grand Changes

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1 Introduction

For almost two decades after 1990 the main priority of Lithuania’s energy policy was to increase energy security. The diversification of the energy supply (oil and gas mainly) and construction of infrastructure for alternative importing capabilities was the main priority. After the closure of the Chernobyl-type Ignalina nuclear power plant in 2009, Lithuania became an electricity importer as domestic producers became uncompetitive in the regional electricity market. Building new electricity connections with Poland and Sweden became the new strategic task to secure an electricity supply at market price. Together with efforts to disconnect from the Soviet-era electricity grid BRELL (Belarus, Russia, Estonia, Latvia and Lithuania) and to synchronize with the European Continental Power...
Network of the European Network of Transmission System operators (ENTSO-E), a fully-fledged integration into the EU energy markets was declared to be the most important goal.

In 2018 Lithuania adopted a new National Energy Independence Strategy (hereinafter referred to as the National Energy Strategy) that foresees a radical transformation of the country’s energy sector by decreasing the energy dependency rate, which is one of the highest in the EU (all gas and oil is imported, and about 70–80% of electricity comes from foreign countries). As the plans to build a new nuclear power plant were abandoned, a new radical turn towards promoting renewable energy sources has been taken. It is a strategic target set in the strategy to gradually replace electricity imports with local electricity generation: in 2030 electricity generation in Lithuania should account for 70% of total final electricity consumption, and in 2050 the share should be 100%. The main aim is to have 80% of the country’s energy needs generated from non-polluting (zero emissions of greenhouse gases (GHG) as well as other air pollutants) sources by 2050 (National Energy Independence Strategy 2018).

Lithuania’s National Energy Strategy is in line with EU objectives (i.e. to reduce greenhouse gas emissions, increase the share of renewable energy and strive for better energy efficiency) and even exceeds some goals set in EU strategic documents, e.g. the renewable energy target of at least 32% of energy consumption, revised in 2018 from 27% that was set in the 2030 climate and energy framework (2014) of the EU (European Commission 2020a). However, this is only partly related to the pro-EU enthusiasm and genuine efforts to develop a climate-neutral energy system. The strategic turn to renewables in Lithuania stems from a complex of domestic and regional factors. First, a high dependency on external energy sources and nuclear energy phase-off creates a pressure on Lithuania to turn to domestic energy sources; the development of renewables (especially, biomass and wind-powered generation) appears as a natural choice. It is especially visible in the heating sector, where monopolized gas supply from the Russian Gazprom resulted in very high prices for gas (see below for details) and consequently also heat which pushed local heat producers to switch to domestic biomass. Second, no strong domestic energy lobby and no tradition of using high-polluting
fossil fuels (e.g. coal) in industry or energy sector facilitates a competitive environment for producers of renewable energy sources (RES) and provides a good ground for a liberalized market. Thirdly, a bureaucratic approach towards strategic thinking and domestic ambivalence of what national strategic goals should be has led to accept the EU strategic orientation. It was further supported by the political leadership, especially after 2016, when all the main actors (i.e. president, prime minister and minister of energy) agreed on the direction of energy transformation.

However, there are some specific risks that arise from unfinished integration in the EU energy markets and remaining dependency from Russia. Despite some already archived positive results and relative successes of initial programmes supporting a transformation towards RES, political reluctance to act more firmly on supporting clean energy and introduce specific measures dedicated to climate change goals casts a shadow on proposed targets. The transformation of transport and agriculture sectors and energy efficiency are the most lacking ones. Overcoming these challenges requires considerable increase of financial investments and persuasion of specific society groups (for example, farmers benefiting from existing fuel incentives).

2 The Main Directions of Lithuania’s Energy Policy After 1990 and the Current Situation

Lithuania regained its independence in 1990 and was immediately punished by the Soviet Union via an energy blockade. From 20 April until 2 July 1990 Lithuania was completely cut off from oil and natural gas supplies. This had a very disruptive effect on the country’s economy as Lithuania had no domestic resources of gas, oil or coal. Even after an official recognition of independence by the Russian Federation in 1991, energy supplies were repeatedly disrupted. It became clear that diversification of energy supplies was needed urgently. At the same time, the economic downfall and transformation of the market economy resulted in a drastic reduction of energy consumption and production:
i.e. gas consumption decreased from 6 billion cubic metres (bcm) in 1991 to 1.85 bcm in 1993 (Lithuanian Energy Institute 2003) and electricity generation fell from 29.35 TWh in 1991 to 10.01 TWh in 1994 (Šaduikis 2015).

The first large-scale strategic project was the Butingė Oil Terminal. The construction started in 1995 and was finished by the summer of 1999 (Orlen Lietuva 2019). The reversible export and import oil terminal on the Baltic seacoast can export 14 and import up to 8 million tons of oil per year. The oil terminal allowed Lithuania to transform itself from an end-consumer of crude oil to a transit country for Russian oil. As Balmaceda states, “the relatively swift completion of the Butingė project reflect[ed] a consensus and governmental proactivity” (2013, p. 219) at that time as well as a clear understanding that the terminal should remain under the control of the Lithuanian government as an object of strategic importance. As she further underlined, “it is clear that Butingė’s impact was not so much in terms of Lithuania’s day-to-day management of its energy dependency, but in terms of guaranteeing emergency oil supplies, as happened during the post-2006 stoppage of oil supplies from Russia via the Druzhba pipeline” (ibid., p. 219). Until 2006, Russian crude oil was transported from Polotsk to Butingė by a branch of the Druzhba pipeline through the oil refinery Mažeikių Nafta, the only refinery in the Baltic States. In July 2006, Russia cut off the oil supply to Mažeikių Nafta claiming that the oil pipeline needed repairs. For Lithuania it was obvious that the shutdown was a politically motivated action after the country sold Mažeikių Nafta to Poland’s PKN Orlen rather than to a Russian company (Reuters 2008). The pipeline has never been restarted after that. Lithuania had bad experiences with disruptions of the gas supply from Russia as well. On 18 February 2004 gas supply was interrupted for Lithuania because of the Russian-Belarusian conflict concerning gas prices. For two days Lithuania had the possibility to use only 5 mcm of 12 mcm needed through a reserve pipeline from Latvia (Janeliūnas 2009).

The above-mentioned examples of “energy coercion” by Russia were a reminder for Lithuania that energy security through diversification is the greatest priority of the national energy policy. The first decade of independence was marked by the need for a rapid shift towards
a market economy and for learning how to diversify energy imports. The energy situation in the country stabilized as alternative oil imports emerged. Disruptions of the gas supply were rare and did not substantially hinder commercial relations with Russia, as Lithuania was already paying the market price for Russian gas in the 1990s. The energy situation was significantly alleviated by a functioning nuclear power plant (NPP) Ignalina, while Lithuania was a net exporter of electricity until 2009. However, one of the conditions for EU membership was the closure of the Chernobyl-type reactors (RBMK-1500 water-cooled graphite-moderated channel-type power reactors) in Lithuania.

2.1 The End of Nuclear Energy in Lithuania

The membership application of Lithuania to join the European Union (EU) was submitted in 1995. Ignalina NPP received special attention during the negotiations. It was a strategically important asset for Lithuania which ensured energy security for the country otherwise almost devoid of indigenous energy sources. However, the NPP was perceived as unsafe due to the utilization of two Chernobyl-type nuclear reactors.

Lithuania committed itself to shut down the reactors considering that at later stages of the EU accession negotiations the issue of additional financial support for the premature closure of Unit 1 at Ignalina NPP by 2005 and Unit 2 by 2009 was adequately dealt with. The power generation at Ignalina NPP was completely stopped on 31 December 2009 and its decommissioning is estimated to be finished by 2038. The decommissioning process of the Ignalina NPP is expected to cost €3.316 billion (BNS 2019).

Since 2010, due to the shutdown of Ignalina NPP, Lithuania’s electricity generation structure has significantly changed, and Lithuania from a net exporter became a net importer of electricity (IAEA 2018). Electricity production fell nearly three times and imports reached more than 7 TWh per year increasing ever since that (see Table 1). The closure of Ignalina NPP increased the dependence of Lithuania’s energy sector on natural gas since most of the rest of Lithuanian electricity generation
| Year | Electricity generation | Of which Ignalina NPP | Domestic consumption | Export | Import |
|------|------------------------|-----------------------|----------------------|--------|--------|
| 2000 | 11.42                  | 8.42                  | 8.26                 | 1.48   | 0.14   |
| 2002 | 17.71                  | 14.14                 | 9.00                 | 6.79   | 0.30   |
| 2004 | 19.27                  | 15.10                 | 9.79                 | 7.32   | 0.13   |
| 2006 | 12.46                  | 8.65                  | 10.35                | 1.98   | 1.54   |
| 2008 | 13.88                  | 9.89                  | 10.96                | 2.63   | 1.68   |
| 2010 | 5.70                   | 0.00                  | 10.28                | 1.14   | 7.13   |
| 2012 | 4.71                   | 0.00                  | 11.23                | 2.3    | 8.8    |
| 2014 | 4.05                   | 0.00                  | 12.44                | 0.17   | 7.78   |
| 2016 | 3.97                   | 0.00                  | 12.90                | 1.80   | 10.10  |
| 2018 | 3.20                   | 0.00                  | 13.20                | 2.80   | 12.40  |

Source Šaduikis (2015, p. 41) and National Energy Regulatory Council (2019b)
capacities were gas-fired power plants. As a result, the country became highly vulnerable to natural gas price volatility as it affected the prices of electricity generation, which consequently decreased the competitiveness of the Lithuanian economy.

The shutdown of the Ignalina NPP and the increased dependence on Russia as the single gas supplier required a clear strategy which could break Lithuania’s energy isolation and ensure competitive internal capacities of electricity production. Consequently, regional projects such as a new NPP, the electricity interconnections with Sweden and Poland or the liquefied natural gas (LNG) terminal became extremely important on Lithuania’s way to energy independence. The need to promote the development of local renewable energy sources was also recognized. In June 2010, the government approved the National Renewable Energy Sources Development Strategy, which aimed to achieve at least a 23% share in the gross final energy consumption to be produced from RES by 2020 (Government of the Republic of Lithuania 2010). The biggest potential was foreseen in wind energy, hydropower and biomass, mostly for heat production (IAEA 2018).

The construction of a new nuclear power plant was perceived as a possibility to mitigate the negative consequences of the closure of Ignalina NPP. However, building a new NPP seemed too expensive for Lithuania alone and required the involvement of additional regional partners. The discussions regarding the new project started back in 2005 and in 2006 the Declaration of the Prime Ministers of Lithuania, Latvia and Estonia on security of supply in the Baltic States and common European energy policy (2006) was signed. The Declaration foresaw the construction of a new NPP in Lithuania which should have contributed to the security of the energy supply in the Baltic region and to the full integration of the Baltic States into the internal European energy market. Later Poland was also invited to join the project and the Japanese company Hitachi was chosen as a strategic investor. The expectations from the project were extremely high. The Lithuanian National Energy Independence Strategy adopted in 2012, named the NPP “the key strategic project in terms of the development of competitive domestic power generation by 2020” as well as “a project of regional importance
forming an integral part of the Baltic Energy Market Interconnection Plan” (National Energy Independence Strategy 2012, p. 19).

However, the project of a new NPP (in Visaginas, Lithuania) has become subject to domestic political struggle and controversy. Opposition parties before the 2012 national elections were heavily criticizing the government for the project as economically unjustified and risky. As a consequence of political battles, a consultative referendum concerning the construction of a new NPP was organized in October 2012, where 62.68% of the participants opposed its construction (Lithuania’s Central Electoral Commission 2012). The new government formed after the Parliament election in 2012 had a vague position on the implementation of the project and postponed the decision for several years. Consequently, regional partners were also confused by ambivalent Lithuania’s position on further development of the project and a tacit political consensus was formed around 2015–2016 that the Visaginas NPP would no longer be developed (Energy Research Institute 2019). Though the implementation of Visaginas NPP was cancelled, it became a turning point to focus on renewables as the only real alternative is to boost local energy production.

2.2 Breaking Out of an “Energy Island”

The closure of the Ignalina NPP exposed a high vulnerability of Lithuania’s electricity sector and persisting dependency on Russia. Lithuania’s electricity transmission grid is directly interconnected with the grids of Belarus, Russia, Estonia and Latvia within the so-called BRELL ring. Russia controls the frequency at which electricity flows, the voltage of the lines, and the balance of the grid. This is seen in Lithuania as a factor of risk when it comes to energy security as it prevents the Baltic States from a full integration into the European electricity market (Hoellerbauer 2016). A core objective of Lithuania’s energy strategy since the beginning of the 2000s is integration of its power system into the common European electricity market and synchronous interconnection with the European Continental Power Network. To address these
concerns and objectives, Lithuania and the other Baltic States carried out several strategically important electricity projects.

A marine underwater high voltage cable Estlink I (350 MW), connecting Estonia and Finland, was completed in 2006. Another cable between Estonia and Finland, Estlink II, with a capacity of 650 MW, began operating in 2014. These two projects allowed Nordic electricity to become available for consumers of the Baltic States. Further integration of the Baltic electricity market into the EU electricity market was strengthened by new interconnection lines between Lithuania and Sweden (NordBalt—a 700 MW submarine power cable) and Lithuania and Poland (LitPol Link—a 500 MW electricity link), which were installed at the end of 2015 (IAEA 2018). Both NordBalt and LitPol Link projects provide Lithuania with an access to the Nordic energy market NordPool, allow for keeping electricity prices for consumers at relatively low level, and create preconditions for further synchronization with the continental European network.

The Baltic States share the view that their electricity system must operate synchronously with the continental European network. The importance of the synchronization is also recognized in the framework of EU energy policy—it is included within the European Energy Security Strategy and the EU Energy Union as a Project of Common Interest and of critical importance for EU energy security. In 2015 the European Commission (EC) and the Baltic Sea region countries (Denmark, Germany, Estonia, Latvia, Lithuania, Poland, Finland and Sweden) signed a memorandum of understanding, modernizing and strengthening the Baltic Energy Market Interconnection Plan (BEMIP 2015).

However, to complete the synchronization with continental Europe an additional electricity line (with Poland) and extra electricity generation capacity in the Baltic States may be needed. The so-called Harmony Link is a new Polish-Lithuanian submarine High Voltage Direct Current (HVDC) cable proposed in 2018 as a compromise with Poland instead of the second alternating current (AC) electricity link LitPol Link II. The estimated cost of the Harmony Link is about €650–700 million, a major part of the whole synchronization project. It is planned that 75% of the funding should be provided by the EC (Energy Research Institute 2019).
Another bold step breaking out from an “energy island” (the labelling appeared in 2006, when the EC’s Green Paper on European Strategy for Sustainable, Competitive, and Secure Energy pointed out that the Baltic states remain an “energy island”, largely cut off from the rest of the EU’s energy markets [Švedas 2017]) was the LNG terminal in Lithuania’s port of Klaipėda. The Floating Storage Regasification Unit (FSRU) Independence started operating in 2015 (the first in the region) and increased energy security for all three Baltic States. Until 2015 Lithuania was fully dependent on Russian gas supplies. No alternative emergency gas supply was ensured, and Lithuania had no access to international markets. Such a monopolistic dependence on Russian Gazprom resulted in higher than the market price for gas: for example, Lithuania paid 36% more for Russian gas than the German border price in the first four months of 2014 (Seputytė 2015). In 2011 the Lithuanian Government even launched a complaint (it was supported by the other EU members of the region dissatisfied with Gazprom’s pricing practices) to the EC requesting to investigate the abuse of the dominant position by the Russian gas supplier Gazprom. The EC adopted a decision imposing a set of obligations on Gazprom in 2018 that addressed the Commission’s competition concerns and enabled the free flow of gas at competitive prices in Central and Eastern European (CEE) gas markets, to the benefit of European consumers and businesses (European Commission 2018).

The FSRU Independence helped to reduce gas prices and even before starting operations impacted Gazprom’s price policy—in 2015 Lithuania already got a 23% price reduction for Gazprom’s supplies (Seputytė 2015). However, the cost of the LNG terminal is high—the annual operation cost until 2019 was about €62 million including the lending expenditures (Ministry of Energy of the Republic of Lithuania 2019c). One of the most challenging issues for Lithuania’s energy sector is the task to decrease operational costs of the LNG terminal as it creates a high burden for business consumers while major gas-consuming companies are obliged by law to buy natural gas coming from FSRU. At the end of 2018 the Lithuanian Parliament approved the amendments of laws initiated by the Ministry of Energy, which will reduce the annual costs of the LNG terminal to €23–25 million. The amendments include a plan to acquire the LNG terminal after 2024 and take a long-term
loan with the government’s guarantee to cover the expenses (Ministry of Energy of the Republic of Lithuania 2019c). In 2016, 60% of the natural gas consumed in Lithuania was imported through the Klaipėda LNG terminal. These significant changes in the natural gas sector as well as favourable trends in international markets have led to a 50% decrease in the price of imported natural gas in Lithuania from 36.5 €/MWh in 2012 to 18 €/MWh in 2016 (National Energy Independence Strategy 2018, p. 45).

To sum up, just before the adoption of the new National Energy Independence Strategy in 2018 Lithuania had solved some major issues of energy security that were persistent during the two decades after 1990: the electricity connections with Poland and Sweden allowed integration into European electricity markets; and the FSRU helped to break out from monopolistic Gazprom’s dependence and reduce gas prices for all Baltic States. However, the closure of Ignalina NPP increased the overall energy dependency rate. According to Eurostat (2018), in 2016 Lithuania was one of the most energy dependent states in the EU, with a dependency rate reaching 77.4%. At the same time, the balance of energy consumption in 2017 was still of a “traditional composition” (see Fig. 1).

![Fig. 1 Structure of gross inland fuel and energy consumption in 2017 (in %) (Source Compiled by the author based on data from Statistics Lithuania [2018])](image-url)
The fossil fuels made 69.9% of gross domestic energy consumption, RES at 20.4% and electricity at 9.7% (Statistics Lithuania 2018). In 2017, the share of RES in the country’s total energy balance was 25.8%; 18.3% in the electricity sector, 46.5% in the heating and cooling sector and 3.7% in the transport sector (Ministry of Energy of the Republic of Lithuania 2019a).

The solid biofuels accounted for more than 90% of all RES in Lithuania, and for the most part—especially in the heating sector—replaced natural gas. The dynamics of transformation of the heating sector was impressive—in just ten years, from 2007 to 2017, the share of biofuels in the heating sector increased from 16.2 to 68.7%; accordingly, the share of gas dropped from 77.6 to 29% (Litbioma 2019). The main reason for this transformation is simple—the price for wooden chips (€/toe) is 2–3 times lower compared to gas. Many municipalities have benefited from EU funding to modernize their district heating systems and switched to biofuels—energy efficiency and RES projects have received €89 million in EU funding until 2019 (Esparama 2020).

3 Strategic Transformation of the Energy Sector: More Climate-Friendly, More Efficient, More Self-sustaining

In 2017, a new government, formed after the national elections in 2016, announced its intention to significantly reduce its dependence on fossil fuels and pursue radical changes in the country’s energy sector. The Minister of Energy, Žygimantas Vaičiūnas, presenting the draft of the National Energy Independence Strategy pointed out the need to seek a major transformation:

   Energy in Europe and the whole world is undergoing a remarkable transformation—there is a shift towards new models of energy productions, and consumers are encouraged to change their energy consumption behaviour. The purpose of energy is not only to ensure security but also create a real benefit for every consumer and bring added value for the economy. (Ministry of Energy of the Republic of Lithuania 2017, n.p.)
By 2050, according to the strategic vision, 80% of the country’s energy needs should be generated from non-polluting (zero emissions of GHG and air pollutants) sources. Goals were set to complete the synchronization of the electricity grid by 2025, to connect the natural gas transmission system to the EU market via Poland, to gradually reduce dependency on electricity imports, and to increase energy efficiency and competitiveness relying on principles of sustainable development (National Energy Independence Strategy 2018). The considerably updated strategy has set three stages towards the ambitious vision. The first stage (till 2020) is related to the focus on energy security and advancing the integration of Lithuanian energy systems and markets into the networks and systems of the EU. The second stage (till 2030) is set with a priority to increase competitiveness of the energy sector by focusing on the transition from fossil-fuel-based energy sources to RES and increased energy efficiency. The final stage (until 2050) is associated with the development of effective and non-polluting energy production, supply, storage/accumulation and consumption technologies.

### 3.1 The New National Energy Independence Strategy: The Main Targets

In 2018 Seimas approved the revised National Energy Independence Strategy. According to Minister of Energy Vaičiūnas, the new strategy is progressive and ambitious even in the pan-European context (Ministry of Energy of Republic of Lithuania 2018). The strategy set to end Lithuania’s energy dependency on Russia once and for all. Also, it sought to expand lean, climate-friendly energy, and to develop and introduce innovations that will allow the consumer to save and the economy to grow (Ministry of Energy of the Republic of Lithuania 2018). The main objective of the Strategy in the field of RES is to continue to increase its share in domestic energy production and the total final energy consumption, thus reducing the dependence on fossil fuel imports and increasing local electricity generating capacities. Transformation of the electricity sector is one of the biggest priorities in the Strategy with the most radical
change in Lithuania’s energy policy since the end of the “nuclear era” in the country.

The Strategy projects that by 2025 at least 38% of electricity consumed in Lithuania will be produced from RES and should constitute no less than 5 TWh. It is estimated that at least 50% of the RES-generated electricity could come from wind, 20% from solar, 15% from biofuel, 12% from hydropower, and about 3% from biogas. By 2030, no less than 45% of electricity consumed in Lithuania should be produced from RES and should constitute no less than 7 TWh. By 2050, electricity generated from RES should constitute 100% of power consumed in Lithuania, and the amount of electricity produced from RES should be no less than 18 TWh (National Energy Independence Strategy 2018). Electricity consumers should become proactive participants in the market (i.e. prosumers) and will be given the opportunity to use energy generated from RES for their own needs to receive a reward for surplus energy supplied to the network in line with the market conditions. Prosumers will account for at least 30% of all consumers by 2030 and at least 50% by 2050 (ibid.).

In the district heating sector, the share of RES is intended to reach also 100% by 2050, as already by 2020 this share is supposed to be 70%, and 90% by 2030. The goal is to foster the development of high-efficiency solid biomass combined heat and power (CHP) plants and increase efficiency of non-recyclable municipal waste use for energy production. Also, it is projected to incrementally increase efficiency of the district heating sector. It is estimated that as the number of district heating customers grows, accompanied by rapid investments in more efficient energy consumption, district heating systems will supply 8.9 TWh by 2020, 8.5 TWh by 2030, and 8.0 TWh of heat by 2050 (National Energy Independence Strategy 2018). Two high-efficiency biofuel- and municipal waste-fired CHP plants in Vilnius and Kaunas (the two biggest cities in the country) are already under construction. These CHP plants alone are expected to cover around 40% of Vilnius and Kaunas district heating needs (ibid.). The Strategy does not foresee any significant change in cooling needs in the future, which is its one potential shortcoming. The centralized cooling network in Lithuania is not developed. Residential and commercial premises are cooled independently,
using electricity. The preliminary annual cooling demand in Lithuania ranges from 5 to 6 TWh. However, the electricity demand for cooling may increase in the light of rapid climate change and consumers’ growing need for comfort.

The Gas Interconnection Poland–Lithuania (GIPL) project should allow integrating the Baltic States and Finland into the EU’s natural gas market by 2023 and will contribute to the creation of the Energy Union. However, even though the FRSU has increased energy security, it may hinder a faster transition to RES. The strategy states that the natural gas system, “as an integral part of the common energy system, ensures the reliable and competitive fulfilment of RES needs, electricity reserve capacity, and balancing needs, efficient cogeneration as well as industrial and household needs” (National Energy Independence Strategy 2018, p. 48) and the FRSU should be operational until 2044. This could become a serious impediment in the future towards a definitive transition to the carbon-free energy sector.

The increase of energy efficiency is another big target of the Strategy. The main objective in the energy efficiency area is to ensure that the intensity of primary and final energy is 1.5 times lower than in 2018 by 2030, and about 2.4 times lower by 2050 (reaching 80 kgoe/€1000 in 2050) (National Energy Independence Strategy 2018). According to the Strategy, the main directions for achieving the energy efficiency targets are as follows:

i. To promote integrated renovation of residential and public buildings (prioritizing renovation in quarters) and to save about 2.6–3 TWh of energy in the renovated residential and public buildings by 2020 and 5–6 TWh by 2030 (by adding up savings each year).

ii. To promptly develop low-energy-intensive and energy efficiency increasing industries, deploy and acquire the most up-to-date and environmentally friendly technologies and equipment.

iii. To increase energy efficiency in the transport sector by renovating the fleet, switching to modern and efficient public transport, optimising the infrastructure for the use of transport and alternative fuel by electrifying or using alternative fuels (ibid.).
One of the modest parts of the Strategy is related to the transformation of the transport sector and use of fuels. It is claimed, that by 2020, 10% of energy consumption in the transport sector should come from RES, 15% by 2030 and 50% by 2050. It is a goal set to promote the use of electric vehicles, including electric cars, in the transport sector, to create an electric vehicle charging network, and to increase the electrification of rail transport. However, in practical terms there is a lack of specific measures to facilitate this transition towards a cleaner or carbon-free transportation system.

3.2 The Main Drivers of Energy Transformation

The political decision to go for a substantially new model of the energy system was influenced by a complex of domestic and regional factors, ranging from specific constellations of political actors, responsible for energy policy, to geopolitical situation in the region. In this part only the main drivers of the proposed energy transformation are discussed, focusing mostly on the reasons primarily affecting the energy sector and leaving aside the interfering factors.

**Opposition to nuclear energy.** By 2016 a tacit consensus among the main political parties (i.e. the Conservative party, the Social Democrats and the Peasants and Greens Union) has been reached that the project to build a new nuclear power plant in Lithuania has no positive prospects. At the same time the country officially strengthened its opposition to the NPP under construction in Belarus due to safety and environmental concerns. The official Lithuanian position claims that the Belarusian NPP is being developed in violation of the Convention on Nuclear Safety, the Espoo and Aarhus Conventions and other international standards of environmental and nuclear safety (Ministry of Foreign Affairs of the Republic of Lithuania 2018). In 2017 Seimas adopted a law recognizing the NPP under construction in Belarus as an unsafe project which poses a threat to national security, the environment and public health (Seimas of the Republic of Lithuania 2017). An unsafe Belarusian NPP has become part of Lithuania’s political and energy agenda. This position only strengthened the political efforts to seek synchronization with
the continental European electricity system and cutting-off connections with Belarus and Russia (Kaliningrad district). The political rejection of nuclear energy led to the realization that nuclear power could not be a source of electricity in either domestic production or import structure.

**Increasing dependency on electricity imports.** After the closure of the Ignalina NPP the rest of Lithuania’s power generation facilities became almost uncompetitive with the regional suppliers of electricity. The most inefficient producers were gas-fired facilities becoming less and less usable every year. Consequently, the share of renewables in electricity generation was increasing, but mainly due to fallen total production. The electricity import from Russia and Belarus accounted for a significant share, between 30 and 45% during the last few years. Accordingly, eventual disconnection from the BRELL grid can affect Lithuania’s abilities to balance its electricity needs and more local production is needed. As investments in power plants powered by fossil fuels seem to be less and less attractive, the choice to support the RES is the only rational option.

**Liberal energy market and high regional competition.** By completing the electricity connections with Poland and Sweden and having a common electricity market with the Nordic and the Baltic States, Lithuania became a very liberal and open energy market. At the same time, in Lithuania there are no strong lobbyists pushing the government to maintain the fossil fuel industry. Meanwhile the RES development, supported in the recent years by the EU financing instruments, especially in the biomass and wind sectors, has created a new and booming industry, which is regarded as a potential advantage for Lithuania’s economy (Varnagirytė-Kabašinskienė et al. 2019).

**Willingness to contribute to the EU strategic objectives.** Lithuania is subject to the obligations and privileges of the EU membership as defined within EU legislation common to all members. The Renewable Energy Directive (2009/28/EC) of the European Parliament established an overall policy for the production and promotion of energy from RES in the EU. It requires the EU to fulfil at least 20% of its total energy needs with RES by 2020. Lithuania’s national renewable energy target is 23%. In 2015, Lithuania already achieved a share of 25.8% of RES in its gross final energy consumption (European Commission 2020b). Reaching national renewable energy targets sooner did not slow down
ambitions for the use of RES and Lithuania aims to further develop RES in its economy. Lithuania’s willingness to follow this path can also be explained by the preference of energy ministers for renewable energy—for example, Minister Vaičiūnas was proud to declare that Lithuania is among the five most ambitious countries in the EU in terms of RES targets for 2030 (Ministry of Energy of the Republic of Lithuania 2019b). Furthermore, being among advanced leaders in RES of the EU member states, Lithuania can earn a good reputation in the EC. This could be regarded as a political benefit in pursuing the EC’s support for other energy projects developed by Lithuania such as the synchronization of the electricity network with the European system and a gas pipeline interconnection between Lithuania and Poland (GIPL).

3.3 Strategy Implementation and the Main RES-Support Programmes

The National Energy Strategy of 2018 was met with enthusiasm by local renewable energy producers. However, concrete political decisions were needed to indicate that effective measures and programmes were in place to achieve the objectives set. As with many policy reforms, clear leadership, and the ability of politicians to mobilize the necessary resources have become crucial. Luckily, Lithuania’s energy policy has become one of the few areas where all major policy players—President Grybauskaitė, Prime Minister Skvernelis and Energy Minister Vaičiūnas—have agreed on common goals.

The leadership of the Ministry of Energy has led to the emergence of several important programmes following the adoption of the National Energy Strategy. Most of all it was relevant to the promotion of the local electricity generation from RES and the emergence of prosumers (i.e. consumers, who have abilities to generate electricity for their own needs). In December 2018, the Lithuanian Parliament has approved a new version of the Law on Energy from Renewable Sources (No. XI-1375) where new support schemes for electricity generation from RES are included. Before this decision a state support scheme for RES was set up in 2012 to support producers of electricity from RES, including
wind, solar, hydro, biomass and biogas. Under the old support scheme RES developers were selected via a tender procedure and granted a feed-in premium for a period of twelve years. Small scale electricity plants, i.e. ones below 30 kW, and since 2013 below 10 kW, received a fixed feed-in premium for a period of twelve years. However, this support scheme was small in scale and the last effective auctions were carried out in 2014.

In September 2019, a new technology-neutral support scheme for electricity production from RES was launched with the first auction for distributing the quota of 0.3 TWh. Under the scheme the support should be allocated to new power plants by technology-neutral auctions, with the winner being determined by the smallest premium offered to the electricity market price in the exchange. The procurement scheme has a budget of €385 million and was approved by the EC in spring 2019 (Bellini 2019a). The scheme should help Lithuania to reach its national target share of RES in the gross energy consumption structure set to 38% by 2025. The approved renewable energy support measure will be in effect until 2025 and can be extended if the target is not reached by that date.

In January 2020 it was announced that the winner of the first auction offered a €0/MWh premium to the market price. This means that the project will be developed without state support. “This is a turning point in Lithuania’s renewable energy sector, as for the first time wind farms are being invested in without state support. Lithuania has succeeded in creating a particularly attractive environment for energy investments”, said Minister of Energy Vaičiūnas, when the auction results were announced (Ministry of Energy 2020a, para. 2). The government has approved three more RES auctions until 2022. Each auction provides for the distribution of 0.7 TWh of electricity. As the Ministry of Energy declares, the amount of electricity distributed in scheduled auctions will ensure that by 2025 electricity production from RES will double and reach 5 TWh. This means that no less than 38% of electricity consumed in Lithuania will be produced from RES (Ministry of Energy of the Republic of Lithuania 2020a).

Another success story illustrating the new impetus in promoting RES is related to the support scheme for prosumers. Although a net-metering system (i.e. excess electricity produced by solar, wind and biomass power...
installations can be fed into the electricity grid and sent back to the self-generating customers (prosumers) when electricity is not produced) in Lithuania was launched in 2015, the system was procedurally complex and not very attractive to users. In 2016 only 248 prosumers with 1.9 MW of a total generation capacity were officially registered (Ministry of Energy of the Republic of Lithuania 2020b). However, since 2018 the Ministry of Energy started a new promotion programme (supported by the EU funds) for prosumers planning to install small solar panels. Starting from owners of individual houses, the support programme later included apartment buildings and offered a possibility to geographically separate the solar panel installation and electricity consumption. The scheme is expected to run until 2023 and the planned budget is around €20 million (Bellini 2019b). The support allows homeowners willing to install rooftop solar-panel systems with a capacity of up to 10 kW to receive state support of €323 per kW installed (or about 30% of total instalment costs) (Bellini 2019b). This has led to considerable optimism among household consumers: at the beginning of 2020, the number of prosumers reached 3452 with a total generation capacity of 30.7 MW (Ministry of Energy of the Republic of Lithuania 2020b). Although the number of prosumers is still modest, the dynamics have been impressive and give grounds to the belief that the goals of the National Energy Strategy of rapidly increasing the number of prosumers can be achieved. Faced with the economic slowdown due to the spread of Covid-19, the Lithuanian government even decided to accelerate the provision of this support as a part of an economic incentive programme (Ministry of Energy of the Republic of Lithuania 2020c).

4 Challenges and Risks

Lithuanian energy transition aims to create a brand-new energy system when compared to the previous type. The Lithuanian energy sector formed during the Soviet era was deeply integrated into the energy system of the whole Soviet Union, and there was no need to think about energy diversification, security or efficiency. The current energy transformation is very ambitious. Lithuania has almost fulfilled its key energy
security and diversification targets during the last decade and is aiming for the EU energy agenda priorities: moving fast RES, CO₂ reduction, energy efficiency and promoting green energy and innovations. However, this process is full of challenges and risks connected to financial, technical, socio-economic and political issues. Additionally, the increasing regional competition and dynamics of geopolitical challenges may cause difficulties for Lithuania to achieve its goals.

**Financial and technical risks.** The promotion of RES is the most advanced in the electricity sector. However, Lithuania still does not have sufficient back-up generation capacity that would be needed in the cases of increasing share of RES generation. In 2018, the share of RES in the overall installed capacity amounted to only 22.8% (National Energy Regulatory Council 2019a). According to the strategic goals, all electricity produced for Lithuania needs to be generated by RES by 2050; however, the necessary secondary and tertiary back-up generation is not planned yet.

The EU is basically refusing to support fossil fuel projects (such as the construction of new power plants), so it is difficult to expect new power plants (i.e. gas-fired power plants) in Lithuania that can provide a stable energy supply. This prospect is further diminished by the current situation in the electricity sector: the paradox is that the LNG terminal does not facilitate operation of the Lithuanian gas-fired power plants even in periods of low gas prices. Due to high terminal operational costs, gas-fired power plants avoid becoming LNG consumers—they would have to pay a “security tax” (introduced to all Lithuanian corporate gas consumers since 2015 to compensate for the upkeep cost of FRSU Independence) which would increase the price of electricity. Therefore, the combined cycle unit of the Elektrėnai Complex that was commenced at the end of 2012 and cost €376 million (Ignitis 2018), has been generating only very limited amounts of electricity in the last few years, even though Lithuania has invested hundreds of millions of euros into its modernization. It was planned that a new 445 MW Combined Cycle Gas Turbine (CCGT) would produce sufficient electricity to cover 20–25% of Lithuanian domestic demand and the amount of natural gas used to produce the same amount of energy will be reduced by up to 30%. However, Lithuania is even more reliant on electricity imports and does
not have the financial motivation to invest in reliable electricity generating capacities that could serve as a back-up for RES. In the future, the lack or absence of secondary and tertiary electricity reserve capacity may slow down the development of RES.

One of the potential solutions could be investments in large electricity storage systems. For example, Lithuanian Energy Group (the largest state-owned company in the Lithuanian energy sector) plans to install a 1 MW energy battery storage system in the Kaunas Hydroelectric Power Plant during upcoming years. “If the project of synergy of the hydroelectric power plant and the battery was implemented successfully, it would be the first innovation of such type and the battery would be among the biggest in the Baltic States”, states the company (Ignitis 2019, p. 35). However, the investments in the energy battery storage systems are still very expensive and cannot fully replace traditional power generation units.

Another big technical (and financial) challenge is related to the completion of the synchronization project and the issue of the eventual Belarusian NPP, especially its effect on the regional electricity market. Both issues are interrelated. Lithuania seeks to desynchronize from the BRELL system by 2025 and foresees the physical dismantling of the connections with Belarus. Due to the safety issues of the Belarusian NPP, Lithuania has decided not to import electricity from Belarus after the commencement of the Belarusian NPP. Lithuania was attempting to secure support from the other Baltic States and Poland for a boycott of Belarusian electricity. However, Latvia’s transmission system operator, Augstsprieguma Tikls AS (AST), is seeking to mitigate the risks of a possible decrease in electricity flow or negative tariff fluctuations and looking for opportunities to buy Belarusian electricity (Istrate 2019). This is mainly related to Latvia’s concern that the fall in imports could lead to a significant increase in electricity prices. As in Lithuania, the domestic electricity output in Latvia is suffering from a rapid fall; in 2018 power generation at Latvian hydropower plants plunged 44.1% compared to 2017 (Jegelavičius 2019). Regional disagreements over the position towards the Belarusian NPP may force Latvia to strengthen its electricity connections with Russia or Belarus, which in turn may lead to delayed disconnection from the BRELL system. Furthermore, there are
so far no clear technical conditions or requirements on how the desynchronisation from BRELL should look like. Lithuania hopes that these conditions will be set in technical terms only, but there is a risk that some political demand from Russia and Belarus could be included. If cheap Belarusian electricity enters the Baltic electricity market after the start of the operation of the Belarusian NPP, Lithuanian electricity producers may lose interest in investing in new RES.

**Socio-economic and political risks.** Transformation of the energy system in Lithuania is aimed not only at rapidly growing the use of RES but also at much better energy efficiency and reducing CO$_2$ emissions in non-electricity sectors. The transformation of the electricity and heat sectors is already underway and is showing quite good results. This is primarily due to the absence of traditional-source generation infrastructure in the Lithuanian electricity sector (some old and mostly inefficient power plants are already closed) and the open electricity market between the Baltic and Nordic countries, and Poland allowing to import electricity without any substantial costs. In the heat sector, the transition to RES was fostered by the rational need to reduce costs. The period of monopolistic dependence on Russian gas served as an impetus for transforming the heating sector and increasing the use of local biofuels.

However, in other sectors the situation is much worse. It is particularly difficult to expect to achieve strategic targets in terms of energy savings and decarbonization. The energy efficiency issue is one of the most problematic aspects. According to the strategic goals, the primary and final energy intensity should be 1.5 times lower by 2030, and about 2.4 times lower by 2050 compared to 2018. However, as the EC reported, providing the assessment of the National Energy and Climate Plan of Lithuania, the methodology of calculating the supposed changes in energy efficiency is flawed, and “the proposed energy efficiency contributions are of very low ambition” (European Commission 2019b, p. 8). Only a small part of the calculations is provided, specifying how energy efficiency will be specifically targeted (European Commission 2019b). The ambition to save energy by increasing the renovation of apartments and public buildings is maybe the most specific, but far from realistic. As the National Audit Office of Lithuania (2020) reported, the renovation programme is also lagging behind set targets. Still, the final National
Energy and Climate Plan of Lithuania (European Commission 2020b) provided some controversial data on the energy efficiency scenarios, as it claims that “the final energy consumption, compared to the level of 2018, will be 22.8 per cent lower in 2030 and 30.9 per cent lower in 2040” (p. 224), but in the energy consumption forecasts using existing energy efficiency policies, measures, and programmes, the decrease of final energy consumption is much more moderate. This only confirms a suspicion that estimates of potential impact of energy efficiency policies are ungrounded and flawed.

Another potential failed target is related to the reduction of GHG emissions. Lithuania’s 2030 target for GHG emissions not covered by the EU Emissions Trading System (non-ETS), is minus 9% compared to 2005, as set in the Effort Sharing Regulation (ESR). However, the tendency so far is opposed: GHG emissions are growing and by 2020 should reach a 15% increase compared to 2005. According to EC’s estimates, given the existing policies Lithuania may miss the 2030 target by 15% (European Commission 2019b). Among other issues that are not timely addressed are political actions aimed at reducing GHG in the transport sector. Lithuania has done little to reverse the existing negative trends in the transport sector. For instance, the very first attempt to introduce a pollution tax on cars was met with harsh resistance by Parliament in October 2019 (Balčiūnaitė 2019). This resulted in postponing even modest attempts by the government to transform the transportation sector to a less-polluting one. An additional tax on internal combustion cars, with a higher registration fee, should start in July 2020.

It is important to stress that the majority of politicians in Parliament and society still do not give priority to energy transition and climate change. For example, in an attempt to reconcile the 2020 national budget, it was decided to cut funding for the Climate Change Programme by €18 million and there was no opposition in Parliament to this move. Society is still very economically sensitive when it comes to extra taxation or changing habits. This could be a major problem in ensuring sustainable energy transformation because political strategies are not supported by increased public awareness on climate change and the need to save energy. Lithuanian society pays little attention to energy, environment and climate issues. The Eurobarometer survey (as of 2019
June) indicated that only 4% of Lithuanians pointed to ‘the environmental, climate, and energy issues’ as the most important issues facing Lithuania today. The EU average was 20%, placing this topic among the top four most trending threats (European Commission 2019a). In 2020 after the Covid-19 outbreak and the quarantine effects on the economy, society has to focus further on the economic needs by relegating climate change measures to the background. A sharp fall in oil prices could also slow down the development of RES, although the government intends to encourage the development of this sector.

5 Conclusions

The restoration of Lithuania’s political sovereignty went hand in hand with the development of a functional, and as much as possible independent, energy sector. Due to the lack of oil, gas and electricity interconnections with other EU member states and an extremely high dependency on energy resources supplies from Russia, Lithuania used to be compared to an “energy island” which was exceptionally vulnerable from supply interruptions and large-scale fluctuations of fossil fuel prices. Therefore, Lithuania’s energy security has become an integral part of national security. This has led to major energy projects that would fundamentally change Lithuania’s energy balance.

There have been both failures and breakthroughs in the transformation process of Lithuania’s energy sector. Although some energy projects, such as the new NPP, have failed due to lack of political coordination, Lithuania managed to get rid of its “energy island” status. The electricity connections with Poland and Sweden, the ongoing synchronization project, the FRSU, as well as development of oil and gas infrastructures significantly improved Lithuania’s energy security by creating access to international markets, eliminating decades of monopoly in the energy sector and making Lithuania self-sufficient.

Lithuania’s energy transformation from fossil fuels to renewable energy was only possible after Lithuania reduced its reliance on its single energy supplier and ensured diversification of energy imports. Lithuania was
forced to undertake regional energy projects which opened the international energy market. Lithuania’s commitment to RES is the next reasonable step in moving the Baltic region away from their energy dependency on Russia. A renewable-driven energy policy is targeted to increase the competitiveness of the country’s energy sector and its efficiency by promoting branches of industry that decrease energy intensity. The goal of the transformation is to improve energy security and self-sufficiency by increasing domestic production and reducing imports. The National Energy Strategy reflects a more mature approach to energy security and contributes to Lithuania’s transition to a low carbon and sustainable energy supply following the EU and global energy and climate objectives.

However, the practical implementation of the energy transition is crucial. Although several ambitious programmes have already started, there are many challenges ahead that will not be solved without persistency in political efforts and even some transformation of societal habits. So far, there is a lack of political will to make the decisions potentially affecting some groups of society (e.g. car owners, farmers, etc.) and there are too few active players in Lithuanian politics supporting the genuine reorientation towards a carbon-free economy.

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