Lithuania 2021

Energy Policy Review

International Energy Agency

INTERNATIONAL ENERGY AGENCY

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Foreword

The International Energy Agency (IEA) has conducted in-depth peer reviews of its member countries' energy policies since 1976. This process not only supports energy policy development, but also encourages the exchange of and learning from international best practices and experiences. By seeing what has worked – or not – in the "real world," these reviews help to identify policies that deliver concrete results. Since 2017, the IEA has modernised the reviews by focusing on the key challenges in today's rapidly changing energy markets.

The IEA in-depth review of the energy policies of Lithuania was carried out in the framework of Lithuania's request to become a member of the IEA. I welcome the broad alignment of the country's energy policies with the shared goals of the IEA.

Our review provides a range of recommendations to help the government design its future energy and climate policies, in the light of the EU-wide efforts to shift toward climate neutrality and regional ambitions to strengthen energy security.

First, this review offers policy advice on how to seize the opportunity to use EU funds for economic recovery from the Covid-19 pandemic to support clean energy transitions. Electrification will determine the speed of the region's clean energy transition, and our recommendations also emphasise how Lithuania can make modern bioenergy and electricity a pillar for the further decarbonisation of transport, industry and buildings while enhancing resilience and security.

Second, Lithuania is continuously emphasising the importance of energy security in its energy strategy. Amid rising geopolitical tensions in the Baltic region, I commend the government for boosting regional gas security with the Klaipeda LNG terminal and for placing electricity security at the heart of its regional efforts. Security is more important than ever, as threats from extreme weather events or cyber-attacks place ever greater stress on the power system.

It is my hope that this in-depth review will help guide Lithuania in its admirable efforts to accelerate the energy transition toward its ambitious 2050 targets. The IEA is committed to help the Lithuanian government achieve its energy policy goals of providing affordable, secure and clean energy to its people as they adapt to a fast-changing international energy landscape.

Dr Fatih Birol

Executive Director

International Energy Agency

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1. Executive summary

This first review of Lithuania's energy policies by the International Energy Agency (IEA) comes at a momentous time for the country's energy sector, which is undergoing significant reforms and witnessing greater regional integration within the Baltic and European Union (EU) energy markets.

The review was conducted in the context of Lithuania's process of accession to the IEA. Lithuania's energy policy aligns sustainability goals with the objectives of boosting energy security, competitiveness and technology innovation. As such, the country's energy policies are broadly aligned with the IEA Shared Goals (see Annex D).

Over the past decade, Lithuania has witnessed several energy transitions. With the closure of its only nuclear power plant (Ignalina's two reactors shut down in 2004 and 2009), Lithuania switched from the position of a net exporter to one of a net importer of electricity. Since then, the shares of electricity imports, natural gas and bioenergy have increased. Today, Lithuania imports over 70% of its electricity needs, while bioenergy is taking the lead in domestic energy supply. Most of Lithuania's co-generation,[1] district heating and residential heat have switched from natural gas to biomass.

Since Lithuania regained its independence in 1990, its energy policy has continuously emphasised energy security. The 2012 National Energy Independence Strategy, which was updated in 2018, reflects these fundamental goals. Lithuania is commended for its ambitious 2050 targets for emissions reductions, renewables and energy efficiency under the strategy. Lithuania supports the EU climate neutrality goal and is starting to place a greater emphasis on the mitigation of climate change, while boosting economic growth and technology innovation.

Up to 2030, policies and measures are well identified under the integrated National Energy and Climate Plan (NECP), which was adopted and submitted to the European Commission at the end of 2019. The NECP sets ambitious medium-term targets as well as the actions needed to achieve them. The Ministry of Energy, the lead co-ordinator of the NECP, will have to work closely with the Ministry of Environment and the Ministry of Transport and Communications on implementing it. This review suggests it should do so by adopting sectoral strategies, for instance for transport or the bioeconomy. Stronger co-ordination of energy and climate policies and monitoring of progress will be critical to ensure full implementation of the planned measures in the coming years.

The NECP is being implemented at a time when the EU Green Deal promotes new action towards climate neutrality by 2050. EU leaders agreed in 2020 to reduce emissions by 55% by 2030. In 2021, the EU will review its energy and climate targets and policies for 2030. Lithuania has had a long-term vision to 2050 for a decade; however, climate change has not been a key driver of its energy policies to date. While the IEA commends

[1] Co-generation refers to the combined production of heat and power.

Lithuania's achievements in recent years, including the adoption of the NECP, the envisaged medium-term development should be more aligned with a development path towards achieving the long-term vision for 2050. By 2023, Lithuania, like all EU countries, will need to report progress on the implementation of its NECP and provide an updated NECP by 2024, which will have to reflect national progress and the increased climate and energy ambitions at EU level.

With regard to climate action, Lithuania has decoupled greenhouse gas emissions and economic growth, and has met its 2020 targets for the sectors outside of the EU Emissions Trading Scheme. However, meeting the 2030 target will be a challenge, as for the first time, a decrease in emissions (of 9%) is required.

There are several challenges for implementing the NECP. Progress in energy efficiency has slowed down, as in other IEA countries. Lithuania did not meet its 2020 final energy consumption target of 4.3 million tonnes of oil equivalent (Mtoe) and additional measures are needed and envisaged, notably in building renovation and the transport sector. For 2030, the target is 4.5 Mtoe of final energy consumption. All sectoral measures are well identified, but their implementation will depend on public funding and procurement, as the role of energy service companies and private renovation is small to date.

The government had achieved its 2020 renewables target as early as 2014 and sold the surplus credits to Luxembourg. Looking ahead, the government aims to reach a share of renewables of at least 45% in final energy consumption by 2030 and 80% by 2050, with 100% in the electricity mix. Such high levels of renewables will require actions to manage power system security and flexibility, as well as compliance with EU sustainability requirements. Recent auctions have confirmed the interest of investors in Lithuania, with a preference for public purchase agreements rather than subsidies.

Around 75% of all heat is produced by burning woody biomass, of which the largest share is harvested in Lithuania, with some imports coming from the regional Baltpool platform. Imports of woody biomass from Belarus have increased due to large deforestations in that country. The Baltpool platform promotes cheaper imports, which may raise concerns over the sustainability of biomass trade. Modern bioenergy can play an important role in Lithuania's low-carbon future. Lithuania's forests are also a major carbon sink and the government is already counting these towards EU emissions reduction targets up to 2030. Bioenergy can also balance variable electricity generation, mainly wind and solar, and will remain important to match peak load capacity, especially for cold winter days. Biofuels are also key to decrease emissions in the transport sector.

Co-generation and related district heating remain the best ways to boost energy efficiency, advance renewables and link heating with electricity for flexibility. Lithuania is well placed to make the best use of this "sector coupling". Despite comparably low district heating prices, the role and economics of co-generation is changing, with a trend towards heat-only boilers or heat pumps. In support of the 100% renewable electricity target by 2050, the government is encouraged to design a long-term renewable energy strategy for Lithuania, which would analyse the electrification of end-uses, notably heat, and an assessment of system integration needs across sectors.

Without new policy action, emissions will continue to grow, notably in transport. The IEA encourages Lithuania to introduce an annual vehicle tax, create the Sustainable Mobility Fund and phase out tax exemptions (e.g. of agriculture operators from the environmental pollution tax) and update excise duty rates in line with carbon content. The Lithuanian

government has shown leadership in the transport sector with the adoption of the Alternative Fuels Law in March 2021. A holistic approach to mobility is needed to meet its ambitious 2050 vision. The government should prepare a comprehensive strategy for improving vehicle efficiency, rolling out zero-emission vehicles and biofuels blending. Besides subsidies for the roll-out of zero-emission vehicles, a package that combines fiscal instruments and local mobility measures, based on alternative fuels, biofuels and electrification targets, could be very effective.

Important institutional reforms have taken place in the Lithuanian energy sector since the creation of the Ministry of Energy in January 2009, and most recently under the EU Third Energy Package and the accession to the OECD in 2018. As a result of the reforms, independent system operators for gas and electricity, unbundled from supply activities, were created. Lithuania has made progress in gradually opening up its electricity and gas markets. However, amid security concerns, it has increased the level of state ownership in its energy sector in recent years. This may result in entry barriers for private players in its gas/electricity markets and implies that the state will ensure that energy companies can make the needed investments in clean energy. In this context, it is welcome that Lithuania is implementing a step-wise phase out of price regulation for residential consumers in the electricity market. However, Lithuania maintains high market concentration in the residential gas market with regulated prices.

The implementation of the NECP requires around EUR 14 billion of public and private financing in the clean energy transition. In 2021, EU and national recovery funds will be disbursed under the National Resilience and Recovery Plan. Commendably, Lithuania has deployed significant stimulus funding, amounting to around 10% of its gross domestic product. To ensure the best use of EU and national recovery funds in the medium term, policies play a critical role for scaling up private/public investments and allow the private sector to take over. The government could use an auctioning system for clean energy technologies (e.g. renewables, hydrogen and energy storage), and encourage private industry energy service companies to lead the renovation wave.

Boosting investments in clean energy technology innovation is a new and promising area. The IEA welcomes the Action Plan for an Energy Innovation Ecosystem, which is in line with the IEA's technology and innovation framework. The IEA encourages Lithuania to establish a regular tracking process of energy innovation results and funding. In the context of Lithuania's new Innovation Promotion Fund, created by the Ministry of Economy and Innovation, the Ministry of Finance, and the Investment and Business Guarantees (Invega), the action plan is an opportunity for boosting energy sector investments.

Amid rising geopolitical tensions in the Baltic region, energy security remains as important as ever before. At the heart of Lithuania's security policy lies a strong renewables strategy, based on bioenergy and wind energy, as part of a move to reduce electricity imports by half in the horizon to 2030 and towards zero by 2050. Today, rather than independence alone, regional integration underpins energy security. Lithuania is part of the highly interconnected Baltic-Nordic electricity markets. An even greater integration with the EU energy system is a core policy objective, with the milestone of reaching full synchronisation with the European continental electricity grid by 2025. Lithuania also co-ordinates with regional partners on other electricity security issues, notably on the implementation of the Baltic Energy Market Interconnection Plan, and investments in new electricity and gas infrastructure, co-financed under the Connecting Europe Facility.

One of the current major challenges for Lithuania is to ensure that no electricity could enter the Baltic states' market from Belarus, where the Astravets nuclear power plant was commissioned recently. Lithuania's Special Law declares the plant as unsafe, as it poses serious threats to nuclear safety, the environment and national security across the Baltics and notably for Lithuania's capital, Vilnius.

Lithuania's liquefied natural gas (LNG) terminal in Klaipėda has significantly reduced the country's dependence on direct gas imports from the Russian Federation, a declared policy priority for the government. The terminal has also improved the gas market integration and lowered gas prices in the region. A Baltic gas market is emerging, which connects infrastructure and countries in the region: the Klaipėda LNG terminal in Lithuania, the Baltic gas storage in Latvia (Inčukalns) with Estonia's and Finland's gas network through the Balticconnector pipeline, and with Poland through the Gas Interconnection Poland-Lithuania by the end of 2021. Lithuania and its neighbours have an opportunity to access global LNG and use natural gas as a transition fuel to end coal and oil use in the region. The IEA encourages the government to complete the regional gas market, based on regional gas pricing and infrastructure expansion and usage.

Oil security is a core mandate of the IEA. As an EU member state, Lithuania has a solid oil stockholding system in place for national emergencies. Lithuania's oil stocks are well above the IEA's 90-day minimum requirement, totalling 173 days of net imports at the end of 2020. Under the accession process to the IEA, the government has reviewed the national system and made strong progress in adopting legislation, procedures and rules for allowing the country to participate in an international crisis response through a collective IEA action and a national demand restraint programme. The Law on State Stocks of Petroleum Products and Oil was accordingly modified in June 2020. Lithuania has started efforts to update the existing oil demand restraint policy and its emergency handbook to meet the IEA requirement to be able to reduce oil demand quickly by up to 10% in a crisis.

Key recommendations

The government of Lithuania should:

- Mobilise public and private finance, including EU funding, by adopting robust policies such as auction schemes to strengthen Lithuania's economy and meet energy and climate ambitions.
- Complete the opening of the electricity and gas markets, reform energy and environmental taxes and levies, and promote energy technology innovation, with a view to boost competitiveness and accelerate the switch to clean energy technologies.
- Enhance energy and climate governance to continuously review targets and monitor progress and implement the NECP. Update the NECP in the light of EU and national climate neutrality goals.
- Intensify co-ordination with Baltic and Nordic neighbours on the design and implementation of climate and energy policies, including the implications for the security of electricity, gas and oil supply as well as cybersecurity.

2. General energy policy

Key data

(2019)

Total energy supply (TES): 7.61 Mtoe (oil 37.9%, natural gas 24.5%, biofuels and waste 18.8%, electricity trade 10.6%, heat 3.5%, coal 2.2%, wind 1.7%, hydro 0.4%, solar 0.1%), -13.2% since 2009

TES per capita: 2.8 toe/cap (IEA average 3.7 toe/cap, IEA median 3.5 toe/cap)

TES per unit of GDP*: 80 toe/USD million* (IEA average: 85 toe/USD million, IEA median 79 toe/USD million PPP)

Energy production: 1.98 Mtoe (biofuels and waste 75.8%, heat 13.4%, wind 6.5%, oil 2.0%, hydro 1.5%, solar 0.4%, peat 0.4%), -55% since 2009

Total final consumption (TFC): 6.6 Mtoe (oil 36.9%, natural gas 23.4%, heat 12.8%, electricity 13.8%, bioenergy and waste 10.6%, coal 2.5%), +26% since 2009

CO_2 emissions by sector: transport 56.2%, energy industry own use 13.2%, industry 11.4%, electricity and heat generation 7.5%, residential 6.6%, and services and other 5.0%

* GDP is computed in USD 2015 prices and purchasing power parities (PPPs).

Country overview

Situated on the eastern shore of the Baltic Sea, the Republic of Lithuania (Lithuanian: Lietuvos Respublika, hereafter “Lithuania”) is one of the Baltic states. With a mostly flat territory of 65 300 km^2, rich in agricultural and forest resources, Lithuania borders Latvia to the north, Belarus to the east and south, Poland to the south, and has borders with the Russian Federation’s exclave Kaliningrad Oblast (Figure 2.1). Lithuania has a population of 2.8 million inhabitants, with around 580 000 living in the largest city, the capital Vilnius, followed by the cities of Kaunas and Klaipėda. Since 2007, the working-age population (20-64 years old) has decreased by more than 12% (from 1.81 million in 2007 to 1.59 million in 2017) and continues to shrink as emigration has been on the rise.

Lithuania was the first country to declare independence from the Soviet Union in 1990. Since its independence and the transition from a centrally planned economy to a small and open market economy, the country has substantially raised economic growth and the well-being of its citizens. This was supported by Lithuania’s membership to the European Union (EU), the Schengen area, the North Atlantic Treaty Organisation (NATO) and the eurozone since 2014, as well as the Organisation for Economic Co-operation and Development (OECD) since 2018.

Figure 2.1 Map of Lithuania and the region

This and all the maps in this report are without prejudice to the status of or sovereignty over any territory; to the limitation of international frontiers and boundaries; and to the name of any territory, city or area.

Over the past ten years, Lithuania's gross domestic product (GDP) grew faster than in most OECD countries, with real growth rates of 4.2% in 2017, 3.6% in 2018 and 3.9% in 2019 (IMF, 2020). In 2020, GDP stood at USD 38 777 per capita (OECD, 2020). The financial system is resilient, and the fiscal position has stabilised after a long period of deficit and rising debt, thanks to strong exports of energy products, chemicals, machinery and equipment, and textiles.

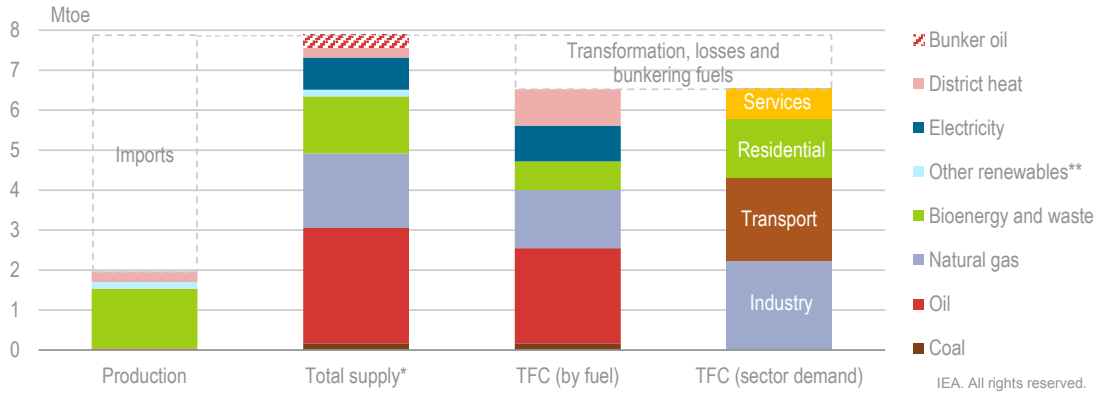
However, the global COVID-19 pandemic led to a 2% contraction in GDP growth in 2020 and is expected to see a recovery of 2.7% in 2021. However, this depends on the evolution of the pandemic, domestic demand, and the shape and speed of the economic recovery of Lithuania's trading partners (OECD, 2020). The IMF expects the Lithuanian economy to rebound even by 4.1% in 2021 (IMF, 2020).

The head of state is President Gitanas Nausėda, who was elected in June 2019 for a five-year term. He took over from Dalia Grybauskaitė, who served as long-standing President of Lithuania from 2009 until 2019. The next presidential elections are scheduled for 2024. Parliamentary elections took place from 11 to 25 October 2020 to elect the 141 members of the Seimas, Lithuania's parliament. A centre-right coalition won the elections made up by the conservative and two liberal parties. Lithuania's Prime Minister Ingrida Šimonytė was appointed by the president and parliament on 25 November 2020. On 9 December 2020, the Šimonytė Cabinet was approved by parliament, with Mr. Dainius Kreivys designated as the new Minister of Energy.

Supply and demand

Lithuania's energy position strongly depends on imports (Figure 2.2), as domestic production in 2019 (1.97 million tonnes of oil equivalent [Mtoe]) covered only one-quarter of total energy supply (TES,[1] 7.61 Mtoe). Two-thirds of TES comes from oil and natural gas and a quarter from renewables. Bioenergy and waste[2] covered more than three-quarters of domestic energy production in 2019, with the remainder coming from heat (13%) and renewables (8.5%) – such as wind, hydro and solar – and oil (2%).

Figure 2.2 Overview of Lithuania's energy system by fuel and sector, 2019



As domestic production is mainly bioenergy, most of total supply is imported. Both energy supply and demand are dominated by fossil fuels, with high shares of bioenergy and waste.

* *Total supply* includes bunker fuels for international aviation and shipping (not part of TES).

** *Other renewables* includes wind power, geothermal, hydro and solar energy.

Note: Mtoe = million tonnes of oil equivalent. TFC = total final consumption.

Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

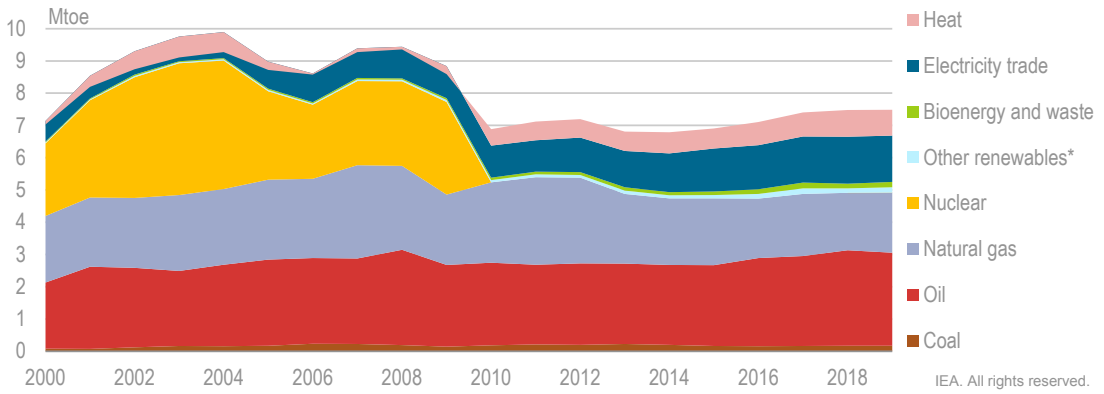
Due to the high level of losses in the energy system, total final consumption (TFC) was 6.6 Mtoe in 2019, of which oil accounted for 37%, natural gas 23%, heat 13%, electricity 14%, bioenergy and waste 11%, and coal 3%. Almost all coal, oil and natural gas was

[1] TES is made up of production + imports – exports – international marine and aviation bunkers ± stock changes. This equals the total supply of energy that is consumed domestically, either in transformation (e.g. power generation and refining) or in final use. Nuclear energy supply in TES includes losses. The primary energy equivalent of nuclear electricity is calculated from the gross electricity generation by assuming a 33% conversion efficiency.

[2] Bioenergy and waste also includes non-renewable municipal and industrial waste.

imported. The transport and industry sectors are the key drivers of consumption, covering one-third of TFC each. The residential sector accounts for less than a quarter of TFC, with services and other sectors (including agriculture) making up the remaining 11%. Taking a closer look at the historic evolution of TES over time, Lithuania's energy system reveals a number of interesting features. The phase-out of nuclear energy, with the closure of the two reactors of the Ignalina nuclear power plant in 2004 and 2009, caused drops in TES in 2005 and 2010 (Figure 2.3).

Figure 2.3 Lithuania's total energy supply by source, 2000-19



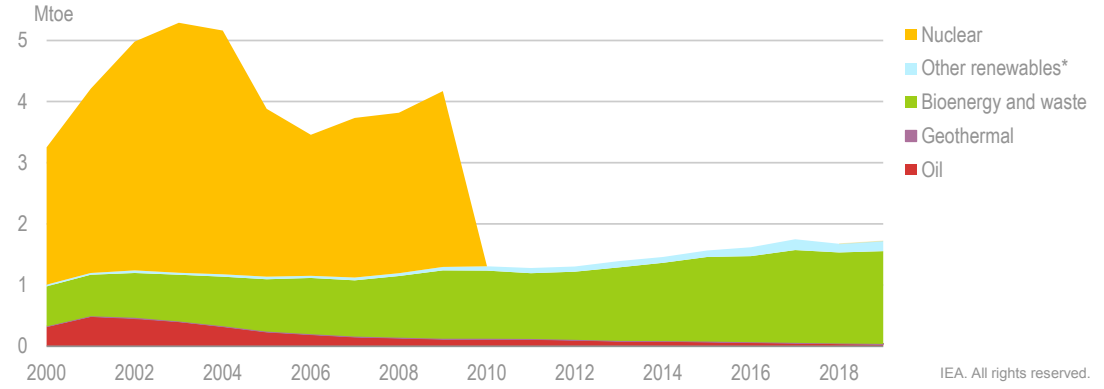
Since the phase-out of nuclear energy, TES is now sourced mainly from oil, natural gas, electricity and heat, with a low share of renewables (mainly bioenergy and wind).

* *Other renewables* includes wind power, geothermal, hydro and solar energy.

Note: Mtoe = million tonnes of oil equivalent.

Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

Figure 2.4 Lithuania's domestic energy production by source, 2000-19



Nuclear energy production stopped in 2010, while bioenergy continued to increase its share.

* *Other renewables* includes wind power, geothermal, hydro and solar energy.

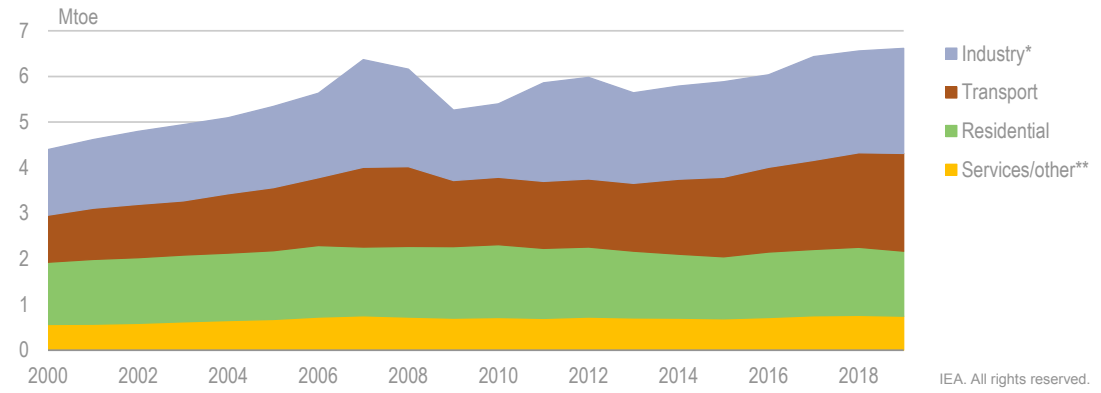
Note: Mtoe = million tonnes of oil equivalent.

Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

After 2010, the share of natural gas and electricity imports initially increased to partially cover the loss in energy supply, while recently bioenergy and waste have continued to grow as has the supply of oil (Figures 2.3 and 2.4).

TFC has increased since 2000, despite a temporary drop due to the financial crisis in 2008-09 (Figure 2.5), which mostly affected industry sector consumption. TFC has increased by 26% since 2009. The industry, transport, residential and services/other sectors accounted for 35%, 32%, 22% and 11% of TFC, respectively, in 2018.

Figure 2.5 Lithuania's total final consumption by sector, 2000-19



The industry and transport sectors dominate TFC, and have both increased in recent years.

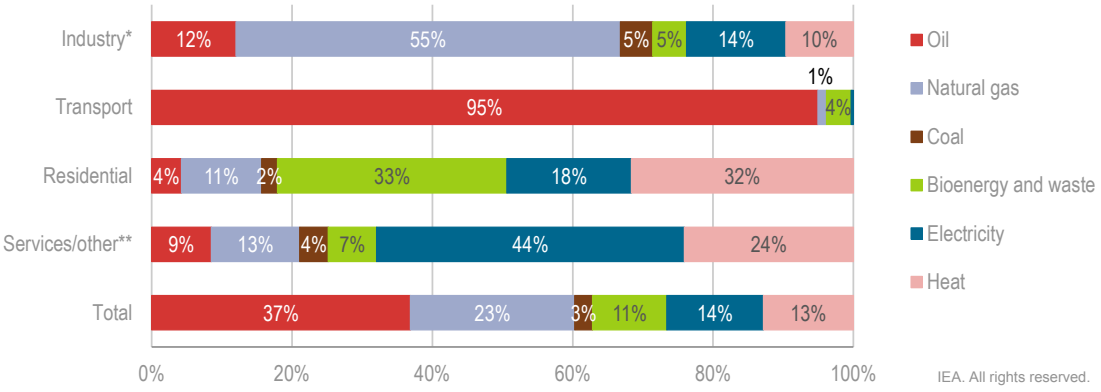
* *Industry* includes non-energy consumption.

** *Services/other* includes commercial and public services, agriculture, forestry, and fishing.

Note: Mtoe = million tonnes of oil equivalent.

Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

Figure 2.6 Lithuania's total final consumption by source and sector, 2019



Oil is the major source of TFC, notably in transport, while natural gas accounts for half of consumption in industry. Bioenergy and waste are used in the residential sector and for heat.

* *Industry* includes non-energy consumption.

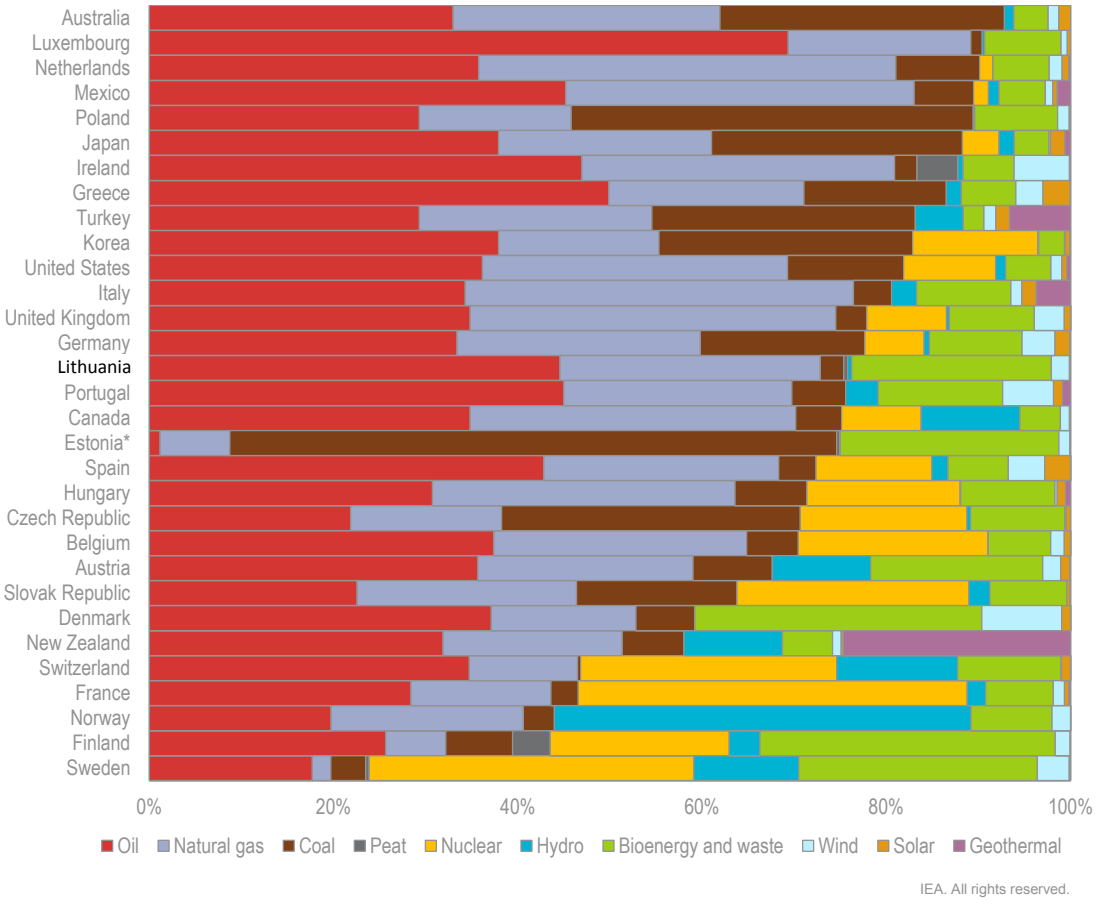
** *Services/others* includes commercial and public services, agriculture, forestry, and fishing.

Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

Oil was the most important fuel in 2019, accounting for 37% of TFC (Figure 2.6), mainly due to the ransport sector. Natural gas plays an important role in industry, accounting for more than half of TFC in this sector. In the residential sector, one-third of energy needs came from bioenergy and waste, and another third from district heating. Heat plays an important role in the services/other sector as well, accounting for 27%, while 41% of the energy consumed in the services/other sector came from electricity.

By international comparison, Lithuania has a fossil-fuel intensive energy supply, but a high share of bioenergy, similar to its Nordic and Baltic neighbours and Austria (Figure 2.7).

Figure 2.7 Breakdown of total energy supply in IEA member countries and Lithuania, 2019



Fossil fuels accounted for three-quarters of TES in 2019, but bioenergy also has a significant share, the fifth-highest compared to other IEA member countries.

* Estonia's coal is represented mainly by oil shale.

Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

Energy policy institutions

Established in 2009, the **Ministry of Energy of the Republic of Lithuania** has led a range of structural reforms of the Lithuanian energy sector. It is responsible for the National Energy Independence Strategy (NEIS), the National Energy and Climate Plan (NECP), and the Action Plan for Strengthening the Energy Innovation Ecosystem, in consultation and co-ordination with other stakeholders. In 2019, the Ministry of Energy created a new section for innovation and internationalisation, which works on energy innovation.

In 2019, Lithuania merged the former State Energy Inspectorate, which fell under the Ministry of Energy, and the National Commission for Energy Control and Prices to create the **National Energy Regulatory Council** (NERC). NERC regulates the market and supervises the actors in the fields of energy (gas, LPG, electricity, district heating, and petroleum products), water and waste water, and transport. In the energy sector, it certifies energy installations (oil, natural gas, and heat) and authorises licenses for electricity generation, export/imports and transmission, heat supply, and wholesale and retail trade of oil products. NERC's main tasks are regulating access to Lithuania's energy infrastructure and the prices of electricity, heat, natural gas and water supplies. This includes the regulation of the transmission and distribution system operators' tariffs on gas and electricity, the implementation of network codes, the approval of methodologies for price setting, and the organisation of renewable energy auctions for the allocation of incentive quotas. NERC is financed by contributions from the market players, not by the state budget.

Statistics Lithuania is the central data agency for most energy data (except for research, development and demonstration and energy efficiency) and reports to the IEA on energy demand/supply data, energy prices and taxes.

The Lithuanian Energy Agency assesses the state of renewable energy and energy efficiency in Lithuania and is mandated to assess progress towards the energy sector targets under the NECP. It is also the competent authority to manage Lithuania's strategic petroleum reserves and to monitor oil market developments.

The **Ministry of Environment** covers a large portfolio ranging from climate change, forest, water, ambient air, nature protection and territorial planning to construction and housing (energy efficiency). It is supported by the Environmental Protection Agency, the Housing Energy Saving Agency, the Public Investment Development Agency and the Environmental Projects Management Agency.

The **Ministry of Transport and Communications** has oversight over all modes of transport (road passenger/freight transport, rail, sea, inland waterways and aviation), including aspects of safety and logistics. The Ministry implements Lithuania's targets on energy efficiency in transport, as set under the Law of Energy Efficiency.

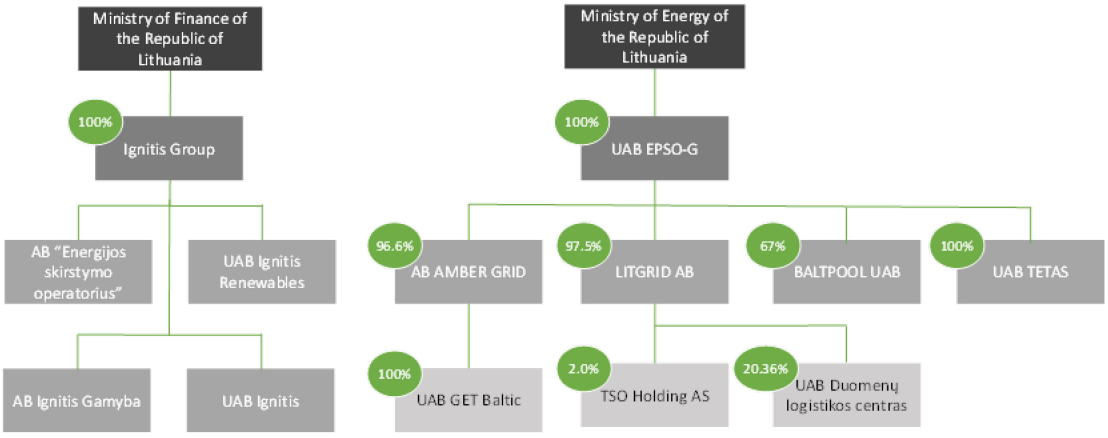
The **Ministry of Economy and Innovation** implements energy policies in the industry sector, including energy efficiency, and leads the innovation policy in Lithuania. The Agency for Science, Innovation and Technology is the administrator of national and international RD&D programmes, clusters in Lithuania, and promotes the commercialisation of results and innovation actions.

The **Lithuanian Energy Institute** carries out fundamental and applied research and advisory work in the field of energy at the international level for Lithuanian and foreign

institutions of science, government and municipalities, and also trains researchers for research and analyses in the field of energy.

Lithuania has restructured its energy sector assets over the past few years (Figure 2.8). The **Ministry of Finance** controls investment in generation and distribution through the Ignitis Group, whose subsidiaries are involved in power and heat generation and distribution, natural gas trade, and electricity/gas distribution (Energijos skirstymo operatorius, ESO) and wind energy generation (Ignitis Renewables). EPSO-G is the state-owned group under the Ministry of Energy that owns the gas and electricity transmission grids and the market operators. Through EPSO-G the government has oversight of Litgrid, the electricity transmission system operator, Amber Grid, the natural gas transmission system operator, the Get Baltic, the gas market operator, and Baltpool, a regional biomass exchange. The oil sector is in private ownership (refinery ORLEN Lietuva), while the government took the decision to purchase the liquefied natural gas (LNG) terminal of Klaipedos Nafta, which will be under state operation and ownership as of 2024.

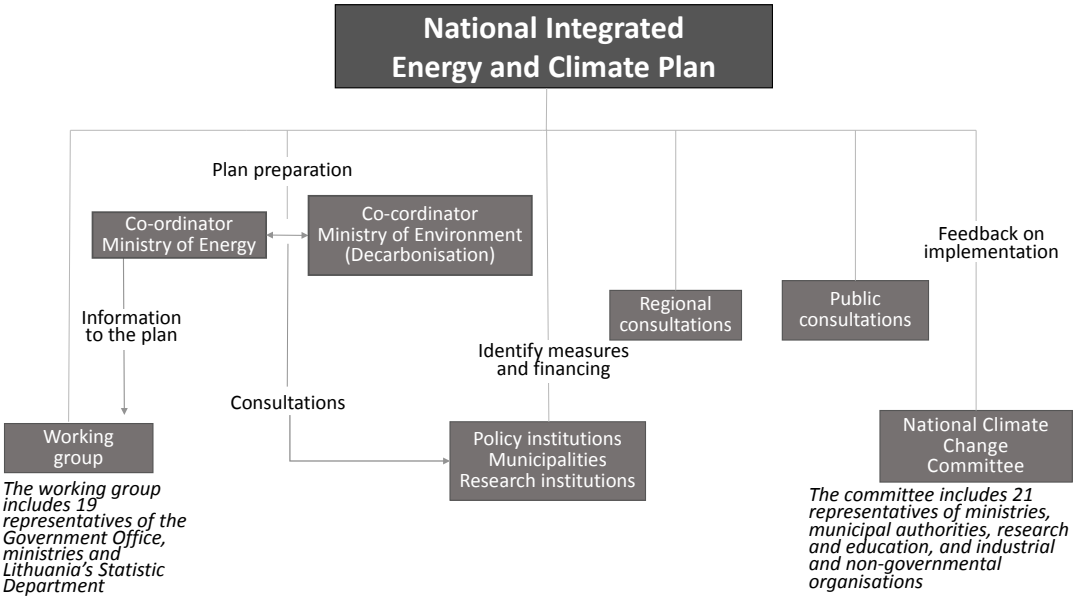
Figure 2.8 Ownership of energy companies and assets in Lithuania



Source: Information provided to the IEA by the Lithuanian government.

The Lithuanian government set in motion a co-ordination process for the preparation of the NECP for the period 2021-30 (Figure 2.9). The Ministry of Energy, in co-ordination with the Ministry of Environment, is working under the framework of the National Progress Plan, which runs in parallel to the NECP. The government evaluates progress towards the overarching Lithuania 2030 Strategy and the NECP under the National Progress Plan (2021-30), based on the United Nations' Sustainable Development Goals indicators and the metrics that are part of the NECP (Republic of Lithuania, 2020). A public consultation on the NECP was held in two phases from December 2018 to May 2019 and in November 2019, including at the regional level within the Baltic Energy Market Interconnection Plan and the Baltic Council of Ministers.

Figure 2.9 Governance of Lithuania's National Energy and Climate Plan



Source: Information provided to the IEA by the Lithuanian government.

Energy strategies and targets

The Lithuania 2030 Strategy promotes a smart society, smart governance and smart economy to place Lithuania among the top ten in Europe on sustainable growth, openness, inclusiveness and well-being. Adopted by the parliament in 2013, the strategy supports sustainable growth in the energy, transport and industry sectors. The Lithuania 2030 Strategy notes that "*A competitive and environmentally sustainable energy sector will be of utmost importance for the national economy: it is necessary to achieve energy independence and sustainable development of environment-friendly use of resources*" (Republic of Lithuania, 2013). The strategy does not contain any specific targets with regards to energy and climate policies except for the Sustainable Development Goals.

Lithuania's energy policy is planned along two time horizons (2020-30 and 2030-50), with medium- and long-term actions. The **National Energy Independence Strategy**, adopted in 2012, has been Lithuania's main energy strategy. In 2018, an updated NEIS was approved by parliament and set out key energy targets and actions for 2020, 2030 and 2050 (Table 2.1). The NEIS aims at completing energy security projects, strengthening competitiveness, reducing the impact on the environment and climate change, and promoting innovation and new technologies (Republic of Lithuania, 2018).

In 2019, Lithuania adopted the final **National Energy and Climate Action Plan** for the period 2021-30 (Governance of the Energy Union Regulation [EU]) 2018/1999), which outlines actions along several policy objectives:

- Decarbonisation: increasing environmental quality and the sustainability of the use of natural resources, climate change mitigation and climate resilience, boosting the consumption of renewables, promoting renewable and alternative fuels in the transport sector, intermodal mobility, and pollution reduction measures.

- Energy efficiency: improving energy efficiency and the use of energy from renewable sources in residential and public buildings.
- Research, innovation and competitiveness: becoming a leader in energy technology innovation, including for exports in the Baltic Sea region.
- Internal energy market: making Lithuania part of the EU single energy market by integrating the Lithuanian natural gas market and interconnecting the Lithuanian power system with the continental European power system in synchronous operation.
- Just transition: reducing the energy poverty of the population.
- Energy security: ensuring the adequacy of the Lithuanian electricity market and system, increasing the share of locally generated electricity, boosting security in the Baltic Sea region, and safely decommissioning the Ignalina nuclear power plant and disposing of radioactive waste (supported by EU funding).

National energy and climate targets

Lithuania's energy and climate targets are set by EU and national policies, and contained in the NEIS and the NECP (see Table 2.1). By 2030, Lithuania wants to reduce its electricity imports by half and produce 70% of its electricity needs from domestic renewable sources, and complete the synchronisation with the continental European power system by 2025. By 2050, all electricity consumed should be generated in Lithuania. There are no targets for the reduction of fossil fuel imports (EC, 2020).

While overall greenhouse gas (GHG) emissions targets are set at the level of the EU, each member state has a target and needs to meet its national objectives for the sectors outside of the EU Emissions Trading System (ETS). By 2020, Lithuania was required to limit non-ETS sector emissions growth to 15%, compared to 2005 levels. By 2030, these emissions will need to be reduced by 9% compared to 2005.

In terms of renewables, Lithuania has ambitions higher than the EU target (for 2030) and is pursuing a very strong renewables strategy, which relies on bioenergy. The goal is to reach a share of 38% of renewable energy sources (RES) in the gross final energy consumption by 2025 and at least 45% by 2030 (broken down into at least 45% electricity, 90% district heating and cooling, 80% residential household heating and cooling, and 15% transport).

By 2050, the share of RES in total gross final energy consumption should reach 80%. This means that 100% of electricity – and all heating in the district heating sector – should be produced from RES, while in the transport sector, the share of RES will amount to 50%. The role of biomass is expected to be significant.

Innovation and research and development in the energy sector are mentioned in the NEIS and NECP. The NECP stipulates a target of 300 innovative energy products and business solutions tested in the regulatory sandbox for energy innovation by 2030. It also envisages start-up funding (grants and loans) until 2022 in the field of energy technology innovation (product manufacturing) and an obligation for public energy undertakings to invest in innovation.

Table 2.1 Lithuania's energy and climate targets*

NEIS targets	Current status	By 2020	By 2030	By 2050
Binding target for greenhouse gas emissions (from 2005 levels) in the non-ETS sectors	+7%	+15%	-9%	-95% (energy and transport)
Share of renewables in gross final energy consumption	25.47%	23% by 2030	45% RES-E: 45% RES-H: 90% RES-T: 15%	80% RES-E: 100% RES-H: 100% RES-T: 50%
National contribution for energy efficiency (in Mtoe)	PEC:* 7.6 FEC:* 6.5	PEC:* 6.5 FEC:* 4.3	PEC:* 5.4 FEC:* 4.5	Reduce primary and final energy intensity by 2.4 times (from 2017 levels)
Level of electricity interconnectivity	62%	79%	111%	NN
Share of research, development and innovation budget in GDP in % (non-energy specific)	0.94%	1.9%	NN	NN

* The definitions of primary energy consumption (PEC) and final energy consumption (FEC) are calculated according to the EU rules set under the EU Directives and do not follow IEA standards.
Note: RES = renewable energy sources. Mtoe = million tonnes of oil equivalent. E = electricity. H = heating. T = transport. NN = no value.

The role of the EU Climate Law and the NECPs

The EU Climate Law sets into legislation the objective of a climate-neutral European Union (EU) by 2050 and creates a system for monitoring progress and adjusting national and EU-wide action, if needed. In line with the Paris Agreement, the EU Climate Law provides for a five-year stock-taking process. The national energy and climate plans (NECPs), which are regulated under the EU Governance Regulation, are at the heart of this process. In 2019/20, the first edition of the NECPs was adopted for ten years up to 2030. The European Commission will assess progress made on them by 2023. By 30 June 2023, member states are required to provide a draft update of the NECP and by 30 June 2024, the final updated NECP.

EU member states are also required to report on the implementation of their NECPs. The first such report (a so-called integrated national energy and climate progress report) is due by 15 March 2023. Any new policies and measures can be included in the progress report.

In mid-2021, the European Commission is set to present a range of proposals for a higher emissions reduction goal with the so-called 'Fit-for-55%' package of legislative proposals, including rules for the reduction of GHG emissions (effort sharing regulation, ETS) and proposals to revise the Energy Efficiency and Renewable Energy Directives, including their target level. The updated NECPs (by 2023/24) will have to reflect these increased climate and energy ambitions at EU level, once negotiations are finalised, as well as the results of the national progress reports.

Box 2.1 The Government's Programme in Energy 2021-24

The government's energy programme for the period 2021-24 confirms actions to promote stronger infrastructure, green energy and higher energy security levels, notably by:

- increasing the amount of domestically produced renewable electricity by 2025 (1.2 GW of wind and 1 GW of solar PV), the flexibility of the electricity system, notably 200 MW of energy storage (with modern balancing services, emergency and other reserves) and the resilience of electricity networks, as well as pursuing the full integration into regional gas markets, notably by completing the gas interconnection Poland-Lithuania (GIPL).
- boosting the share of distributed renewable energy by increasing the share of energy „prosumers" (to every third household by 2025) and energy communities, supporting smart grids and the roll-out of electric charging infrastructure, giving appropriate attention to energy R&D&I while continuing to promote energy start-ups and open-data and prioritising the development of hydrogen, including the blending into the natural gas grid and final energy savings of 20.4 TWh.
- ensuring the swift synchronisation with the European Continental power system before 2025, while continuing the principle of not buying electricity from unsafe nuclear power plants (NPPs) and carrying out the safe decommissioning of the Ignalina NPP.

Energy investments for the transition

The NECP stipulates that the implementation of all of the measures for 2030 would require an overall investment of up to EUR 14.1 billion in the coming decade, with the majority needed in the transport sector (Table 2.2). The decarbonisation of the economy will absorb over 70% of the total investment, which is expected to be leveraged largely by public funds, as illustrated in Table 2.2. No information is available on how the private sector investment will be leveraged, through policy or funding instruments.

Table 2.2 Total investment needs for the implementation of the NECP 2020

EUR million

Sector	Total funding needs	Public funds
Energy: energy efficiency	2 605	976
Energy: renewable energy sources	2 304	1 428
Transport	4 138	2 977
Agriculture and forestry	868	729
Industry (including ETS sectors)	876	342
Waste management	5	5
Total greenhouse gas reduction measures	10 795	6 455
Adaptation to climate change	3 303	3 303
Total	**14 098**	**9 759**

Source: Republic of Lithuania (2019), National Energy and Climate Plan, https://ec.europa.eu/energy/sites/ener/files/documents/lt_final_necp_main_en.pdf.

Lithuania's sustainable recovery plan

In March and May 2020, the government of Lithuania adopted the Economic Stimulus and Coronavirus Mitigation Action Plan with short-term funding allocated to solar energy, building renovation and electricity networks. Under the action plan, the government also allowed the deferment, or payment in instalments, of electricity and natural gas bills from UAB Ignitis, and recommended municipalities to allow deferment or payment in instalments of utilities and heat energy. These were largely relief measures and have ended. At the time of writing, the government is preparing a range of recovery projects as part of its National Recovery and Resilience Plan, which it is expected to submit to the European Commission by 30 April 2021 to confirm EU funding for its projects and support investment up to 2026.

Assessment

Lithuania's energy policy serves the quadruple purposes of energy security, competitiveness, sustainability and innovation. Lithuania's energy policy is the result of its geographical location at the Baltic Sea and geopolitical conditions at the border with Belarus and Russia (Kaliningrad). Since regaining independence in 1990, Lithuania's energy policy has continuously emphasised energy independence and energy security. The NEIS of 2012, which was updated in 2018, reflects these fundamental goals. In March 2021, the new government has confirmed in the energy programme for the period 2021-24 its strong commitment to strengthen energy infrastructure, green energy and energy security.

Lithuania has a unique energy history. It is decommissioning its main electricity production facility, the Ignalina nuclear power plant and its two reactors, under the accession to the EU in 2004. The plant's two reactors were closed in 2004 and 2009, respectively, and are currently undergoing decommissioning by 2038. In 2009, the country switched from being a net exporter to a net importer of electricity. Today, Lithuania imports over 70% of its electricity needs. The share of natural gas increased, but has recently been replaced by biomass, notably in district heating and residential heat.

Overall, the IEA commends the Lithuanian government for the significant progress made through the establishment of an integrated energy and climate framework for 2030. The NECP for 2030 was adopted in December 2019, setting ambitious targets as well as the actions needed to achieve them. Lithuania also has a long-term vision under the NEIS, with 2050 targets for renewables and energy efficiency, very unique by international comparison.

Recent efforts have focused on the actions needed for 2030. An inter-ministerial action plan is in place for implementing the NECP, which will require institutional co-ordination and monitoring of progress. At this point, the National Progress Plan is the key monitoring instrument, which is welcome. The Ministry of Energy, the lead co-ordinator of the NECP, needs to step up the joint implementation with the Ministry of Environment and the Ministry of Transport and Communications, including through sectoral strategies, for instance on transport and inter-ministerial progress reports. The strengthening of the Lithuania Energy Agency is a welcome development. As energy and climate targets are strongly interlinked, the government will need to create a robust and independent governance, which should review progress over periods up to 2030, 2040 and 2050.

This first review of Lithuania's energy policies comes at a time when the EU is implementing the Green Deal, with ambitions to reach climate neutrality by 2050. In 2021, the EU will be discussing higher emissions reductions targets and reviewing its energy and climate targets and policies for 2030. Lithuania has had a long-term vision to 2050 for a decade; however, climate change has not been a key driver of its energy policies to date. In 2019, more than half of the country's energy-related CO_2 emissions came from the transport sector, followed by the energy industry.

The IEA commends Lithuania's achievements in recent years, including its strong renewables strategy, based on bioenergy, solar and wind, as reflected in the NECP. The envisaged medium-term development should, however, be more strongly aligned with a development path towards achieving the long-term vision towards 2050. This relates to the sustainable use of bioenergy and a more flexible electricity system with higher shares of wind and solar. By 2023, Lithuania needs to report progress on the implementation of its NECP and provide an updated plan by 2024, which should reflect any increased climate and energy ambitions at the EU level and national progress.

Important institutional reforms have taken place in the Lithuanian energy sector since the creation of the Ministry of Energy in January 2009. These were most recently boosted by the implementation of the EU's Third Energy Package and accession to the OECD in 2018. These reforms were completed in 2019-20 and led to the creation of independent system operators for gas and electricity, unbundled from supply activities, and the reform of the NERC. Lithuania has made substantial progress in gradually opening up its electricity and gas markets. On 1 January 2021, it started the phase-out of regulated prices, starting with large consumers. However, in natural gas, market concentration remains high and regulated prices persist. Lithuania has increased the level of state ownership in its energy sector, amid energy security concerns. However, this means that the state has to ensure that state-owned companies can make the needed investment in the clean energy transition. Privatisations may be another way to deal with inefficiencies or market concentration, as recommended by the OECD's 2020 *Economic Survey of Lithuania* (OECD, 2020).

To finance the energy transition, Lithuania estimates it will require EUR 14 billion of investments, with the lion's share coming from the public sector and the EU. The decarbonisation of the economy will absorb over 70% of the total investment, which is expected to be leveraged largely by public funds. The government needs to identify private sector investment and create more own resources, as it is largely relying on EU funding for most of its energy sector public spending. As an example, Lithuania was able to create a fund based on the monetisation of its renewable energy surplus under its national RES target. Another opportunity is taxation: the government should consider reforming energy taxation in the coming years, aligning its tax structures to the energy content, CO_2 emissions and other air pollutants. There are plans to introduce an annual vehicle tax, create a Sustainable Mobility Fund and phase out existing exemptions. The IEA underlines the critical importance of this reform and the existing ample opportunities for better aligning taxation to climate and energy objectives (see also Chapter 3).

Although the COVID-19 pandemic did not strongly impact Lithuania's economy during 2020, it did that of its trading partners. The expected impact seems to be limited to a 2% negative growth of GDP in 2020. A consistent recovery in 2021 is expected thanks to a government fiscal stimulus of almost 10% of GDP. Following a EUR 5 billion economic relief package (16 March 2020), Lithuania adopted additional fiscal measures in May 2020.

At the time of writing, Lithuania is preparing its national resilience and recovery plan. Much of the funding is expected to come from EU funds in the perspective up to 2026.

Lessons from the 2008/09 financial crisis have shown that governments withdraw fiscal stimulus too early for the economy to recover and loose impact by designing new complex funding instruments. The Lithuanian government should ensure that the fiscal stimulus kick starts investments that continue for a three- to five-year period or even longer, notably through policies that let the industry take over. In this context, the government should assess which existing policies could be used to scale up private/public investment by the energy market players. As an example, the government could be using auctions for clean energy technologies, like advanced biofuels, hydrogen, storage and large-scale renovation by energy service companies. The government should indeed seize the opportunity of the EU recovery funding to boost the country's clean energy transition, by directing funds to the needed modernisation and renovation of buildings and transport infrastructure.

Boosting investments in clean energy technology innovation is a promising area, including for aligning short-, medium- and long-term goals for 2050. Lithuania hopes to advance strongly in the coming years. The government should adopt an investment-oriented economic policy on innovation, including in the framework of recovery, with a coherent policy framework to support science-business co-operation. A welcome step is the adoption of the Action Plan for an Energy Innovation Ecosystem by the Ministry of Energy. The plan can also boost the performance of the energy sector under the newly created Innovation Fund.

Recommendations

The government of Lithuania should:

- Strengthen the governance of inter-ministerial collaboration on energy and climate issues for the swift implementation of the National Energy and Climate Plan and the EU Clean Energy Package by designing sectoral strategies, monitoring progress and institutionalising co-ordination across government to deliver on the targets.
- Ensure that the fiscal stimulus of the Lithuanian recovery plan remains robust and extends into the future to mobilise citizens, consumers and industry towards meeting sustainability goals and boosting employment, by directing funding to the renovation of buildings, renewables and alternative fuels using existing but scalable policy instruments.
- Mobilise the private and public funding needed for the clean energy transition by completing the opening of the electricity and gas markets, reforming energy taxes and levies, and promoting energy technology innovation, with a view to boost competitiveness and accelerate the switch to clean energy technologies.

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3. Energy and climate change

Key data

(2018/19)

GHG emissions without LULUCF* (2018): 20.3 Mt CO_2-eq, -58% since 1990

GHG emission without LULUCF* by sector (2018): transport 30%, agriculture 21%, and energy supply and use 49%

GHG emissions with LULUCF* (2018): 16.4 Mt CO_2-eq, -60.2% since 1990

Energy-related CO_2 emissions (2019):

CO_2 emissions from fuel combustion: 11.2 Mt CO_2, +9.1% since 2000

CO_2 emissions by fuel: oil 72.2%, natural gas 19.1%, coal 7.1% and other 1.5%

CO_2 emissions by sector: transport 56.2%, energy industry own use 13.2%, industry 11.4%, electricity and heat generation 7.5%, residential 6.6%, and services and other 5.0%

CO_2 intensity per GDP:** 0.12 kg CO_2/USD (IEA average 0.24 kg CO_2/USD)

* Land use, land-use change and forestry (Source: UNFCCC).

** Gross domestic product in 2015 prices and PPP (purchasing power parity).

Overview

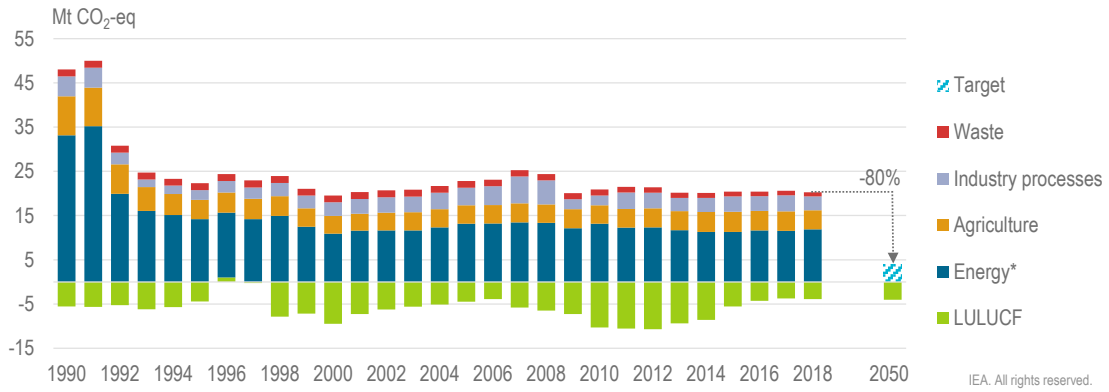
Lithuania has largely decoupled greenhouse gas (GHG) emissions from economic growth and is on track to meet its 2020 targets under the European Union (EU), which allowed an increase of 15% in sectors outside of the EU Emissions Trading System (ETS). However, total energy-related CO_2 emissions have increased by 9% since 2000, notably from transport activities, which account for the lion's share of Lithuania's emissions. Existing measures are not enough to reverse the rise in emissions from transport, agriculture and industrial sectors and decrease emissions by 9% by 2030, compared to 2005 levels.

Under the National Strategy for the Climate Change Management Policy (Republic of Lithuania, 2012), Lithuania has set a target to reduce GHG emissions by 80% by 2050 compared to 1990 levels, and aims to reduce the remaining 20% with negative emissions and forests as carbon sinks. Lithuania is currently reviewing the National Strategy, as it joined other EU countries in supporting a vision for climate neutrality. The National Energy and Climate Plan (NECP) contains a range of climate-related measures for 2030, in line with EU rules, on emissions, renewables and energy efficiency (Republic of Lithuania, 2019). Lithuania relies for their implementation mainly on the availability of EU funding. The NECP has also started a process of integrating energy and climate policies and measures across government.

Emissions trends

In 2018, GHG emissions in Lithuania stood at 20.3 million tonnes of carbon dioxide equivalent (Mt CO_2-eq), excluding land use, land-use change and forestry (LULUCF) (Figure 3.1). Energy-related emissions accounted for 59% of Lithuania's total GHG emissions, as Lithuania has large emissions from agriculture (21%), industry processes (16%) and waste (5%). The role of forests as carbon sinks is important. However, the contribution from removals in forests has declined since 2012, due to active forest management, and accounted for 19% of the total GHG emissions (or 3.9 Mt CO_2-eq) in 2018. Total GHG emissions have stabilised in recent years at 20 Mt CO_2-eq.

Figure 3.1 Greenouse gas emissions in Lithuania by sector, 1990-2018



In 2018, Lithuania's total greenhouse gas emissions excluding LULUCF were 58% lower than 1990 levels, and came largely from the energy sector as well as agriculture and industry.

* *Energy* includes power and heat generation, services, households, industrial energy consumption, and transport, and excludes indirect CO_2.

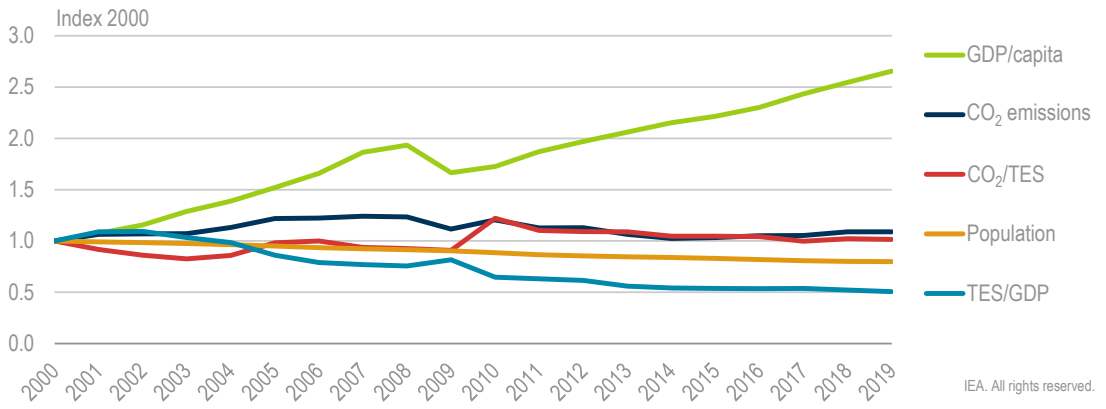
Notes: Mt CO_2-eq = million tonnes of carbon dioxide equivalent. LULUCF = land use, land-use change and forestry.

Source: UNFCCC (2020), *Lithuania 2020 National Inventory Report*, https://unfccc.int/documents/226319.

Lithuania has decoupled GHG emissions from economic growth. During the period 1990-2018, total GHG emissions decreased by 58%, while gross domestic product (GDP)[1] increased by 83%. From 2000 to 2019, Lithuania's total population declined by 20%, while GDP per capita grew rapidly (Figure 3.2). Since 2000, Lithuania's economy (GDP/capita) has grown by 165%, while CO_2 emissions have remained stable. Trends in energy-related CO_2 emissions were impacted by the closure of the Ignalina nuclear power plant in 2010; otherwise, CO_2 emissions would have been flat, in line with the steady decline in the energy intensity of the economy (TPES/GDP). The carbon intensity of the energy supply (CO_2/TPES) increased in 2010 due to the shutdown of the last nuclear reactor and the increased use of natural gas in power generation. The role of biomass has increased since and has largely replaced natural gas, notably in district heating.

[1] Gross domestic product in 2015 prices and PPP (purchasing power parity).

Figure 3.2 Energy-related CO_2 emissions and main drivers in Lithuania, 2000-19



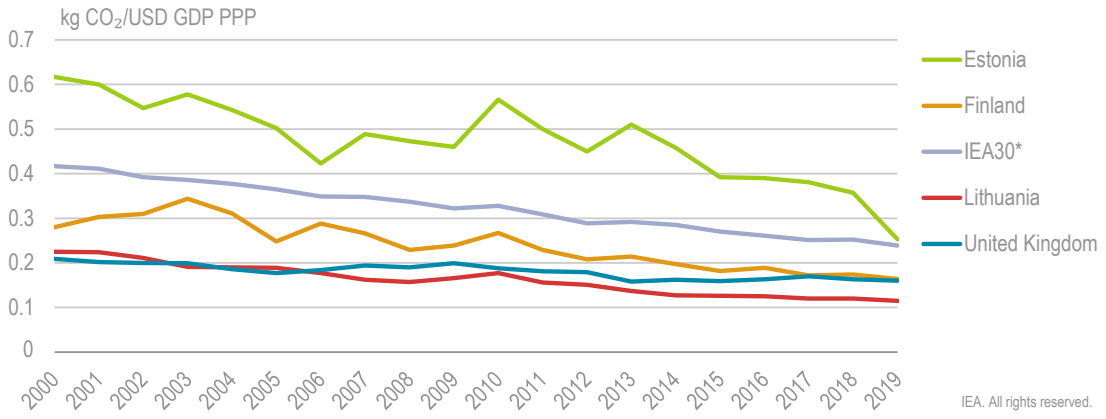
Lithuania's economy has grown by 165% since 2000. Energy-related CO_2 emissions increased after the closure of the Ignalina nuclear power plant in 2010 but have stabilised since.

Notes: TES: total energy supply. Real GDP in USD 2015 prices and purchasing power parities (PPP). Data for 2019 are estimates.

Source: IEA (2020), "CO_2 emissions by product and flow", *CO_2 Emissions from Fuel Combustion Statistics* (database), www.iea.org/statistics.

In 2019, Lithuania's carbon intensity, measured as the ratio of emissions per unit of GDP, was 0.115 kilogrammes of carbon dioxide (kg CO_2) per United States dollar (USD), a 49% decrease from 2000 levels. This is more than twice as low as the weighted average of IEA member countries (0.239 kg CO_2/USD GDP PPP) (Figure 3.3). Lithuania ranked fifth-lowest among IEA countries in 2019.

Figure 3.3 CO_2 intensity per GDP in Lithuania and IEA member countries, 2000-19



The carbon intensity of Lithuania's economy has decreased by 49% since 2000 and is below the average of IEA countries. In recent years, it has plateaued around 0.12 kg CO_2/USD.

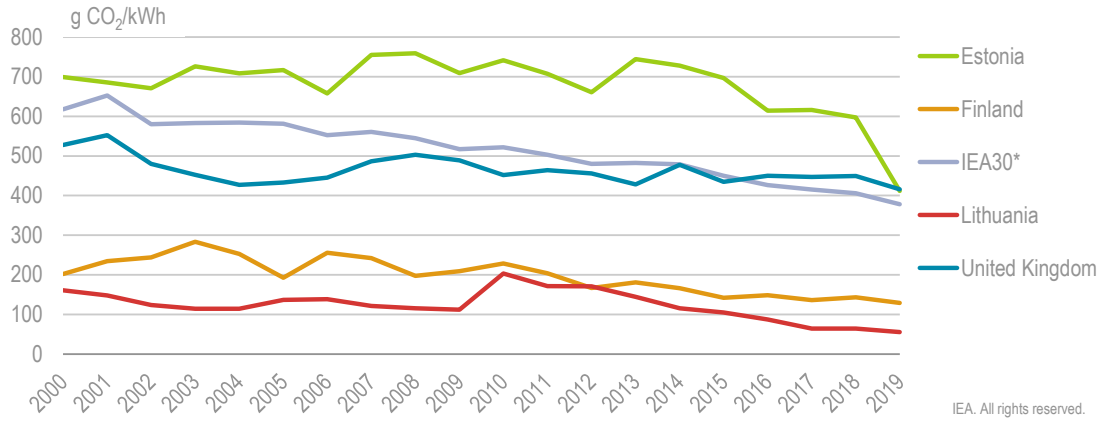
* IEA30 is the equivalent of a weighted average of 30 IEA member countries.

Notes: kg CO_2 = kilogrammes of carbon dioxide. Real GDP in USD 2015 prices and purchasing power parities (PPP). Data for 2019 are estimates.

Source: IEA (2020), "CO_2 emissions by product and flow", *CO_2 Emissions from Fuel Combustion Statistics* (database), www.iea.org/statistics.

CO_2 intensity in electricity and heat generation was 56 g CO_2/kWh in 2019, significantly below the IEA weighted average of 378 g CO_2/kWh (Figure 3.4). In 2019, Lithuania had the fourth-lowest carbon intensity in electricity and heat generation among IEA member countries. From 2010, the carbon intensity began to decrease again, reaching its lowest level since 2000 in 2019, thanks to the expansion of renewables in Lithuania's power mix and the remarkable switch from natural gas to bioenergy in heat generation.

Figure 3.4 CO_2 intensity for electricity and heat generation in Lithuania and selected IEA member countries, 2000-19



Lithuania's electricity and heat generation is low-carbon, with a greater role of renewables since 2010.

* IEA30 is the equivalent of a weighted average of 30 IEA member countries.

Notes: g CO_2/kWh = grammes of carbon dioxide per kilowatt hour. Data for 2019 are estimates.

Source: IEA (2020), "CO_2 emissions by product and flow", *CO_2 Emissions from Fuel Combustion Statistics* (database), www.iea.org/statistics.

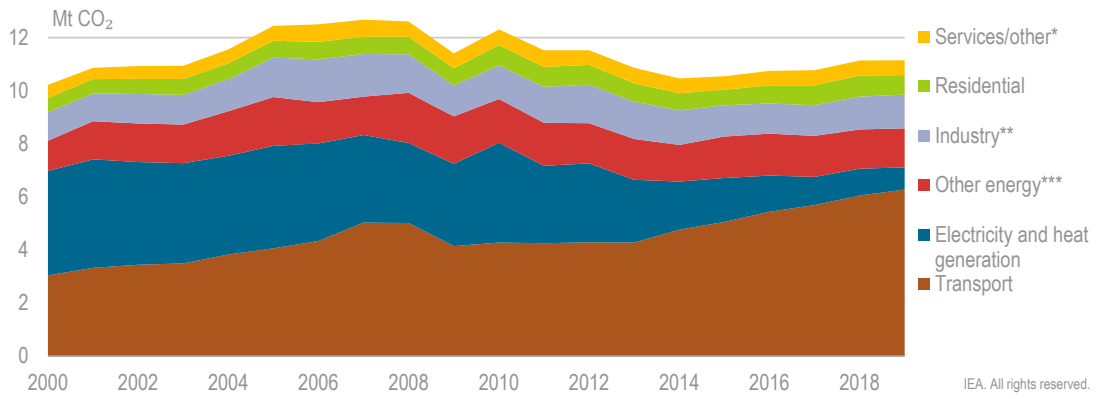
CO_2 emissions by sector

In 2019, Lithuania's energy-related CO_2 emissions were 11.2 Mt CO_2 (Figure 3.5). After peaking in 2007, total emissions began to pick up again in 2014, mainly due to growing emissions in the transport sector, where oil accounted for 95% of the energy demand. Emissions from the transport sector have doubled, from 3.0 Mt CO_2 in 2000 to 6.3 Mt CO_2 in 2019.

In 2019, transport accounted for the largest share of total energy-related carbon emissions, at 56%, followed by other energy (mainly emissions from refining; 13%), industry (11%), electricity and heat generation (8%), residential (7%), and services (5%). In industry, emissions stem from cement, chemicals and energy facilities. Emissions in the industry, services and residential sectors have been stable overall.

In line with the growing share of emissions from the transport sector, the largest source of energy-related CO_2 emissions is from oil combustion (Figure 3.6). In 2019, oil accounted for 72% of total energy-related emissions, followed by 19% from natural gas, 7% from coal and 2% from other emissions. Oil emissions have increased noticeably since 2013, but emissions from natural gas combustion have declined since 2010 as the share of gas in electricity and heat generation has decreased with the switch to bioenergy (Figure 3.6).

Figure 3.5 Energy-related CO_2 emissions in Lithuania by sector, 2000-19



Despite decreasing emissions from electricity generation, total energy-related CO_2 emissions have increased since 2014, due to the growing share of emissions from transport activity.

* *Services/other* includes commercial and public services, agriculture/forestry, and fishing.

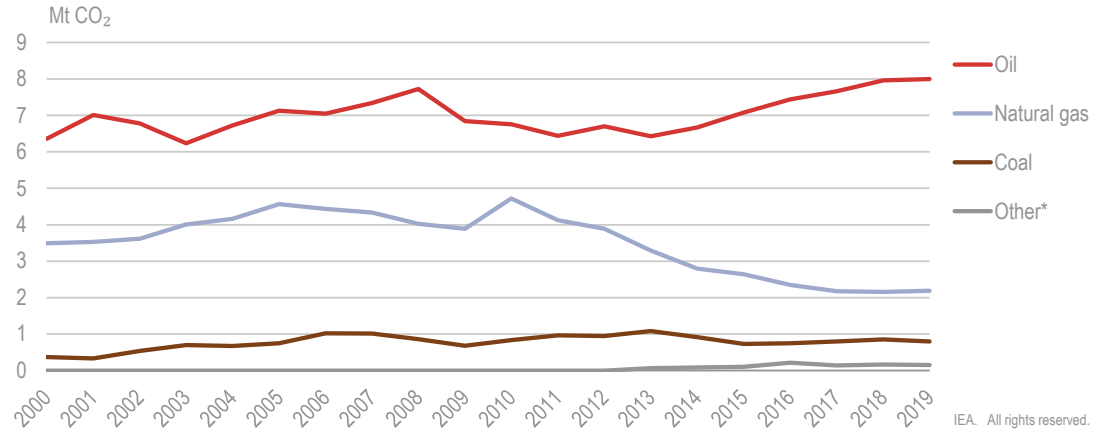
** *Industry* includes CO_2 emissions from combustion at construction and manufacturing industries.

*** *Other energy* includes emissions from refinery gas, petroleum coke, fuel oil, natural gas and diesel oil.

Note: Mt CO_2 = million tonnes of carbon dioxide.

Source: IEA (2020), "CO_2 emissions by product and flow", *CO_2 Emissions from Fuel Combustion Statistics* (database), www.iea.org/statistics.

Figure 3.6 Energy-related CO_2 emissions in Lithuania by energy source, 2000-19



Oil is the largest source of CO_2 emissions. Its share has increased since 2013 with growing energy demand in the transport sector. Meanwhile, emissions from gas combustion have decreased since 2010.

**Other* includes emissions from non-renewable waste.

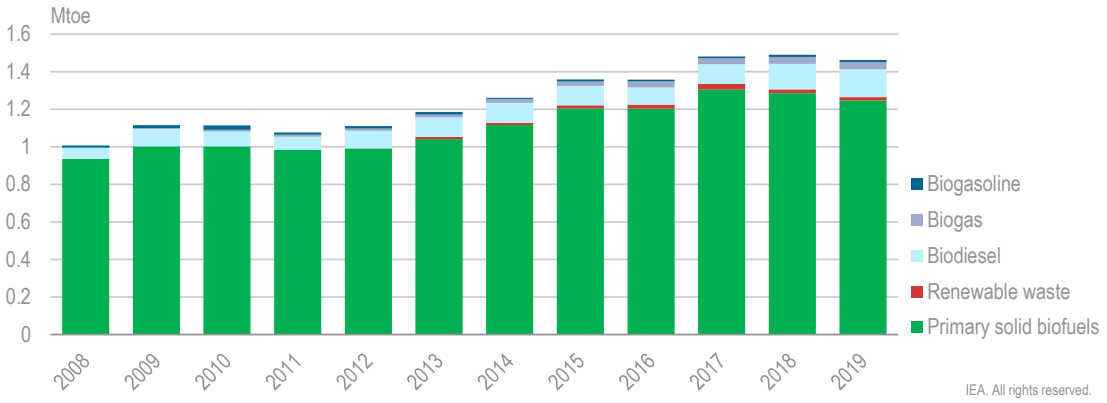
Notes: Mt CO_2 = million tonnes of carbon dioxide. Data for 2019 are estimates.

Source: IEA (2020), "CO_2 emissions by product and flow", *CO_2 Emissions from Fuel Combustion Statistics* (database), www.iea.org/statistics.

Lithuania has large forest resources and agriculture, as well as a furniture and wood processing industry. Lithuania mainly produces solid biomass and first-generation biodiesel (from rapeseed). The country's bioenergy production is both exported and used

in the heating sector in Lithuania. The sustainability of bioenergy production and agriculture are critical, as Lithuania plans to offset 20% of its emissions by land use, forestry and has a strong agriculture sector.

Figure 3.7 Lithuania's bioenergy production, 2008-19

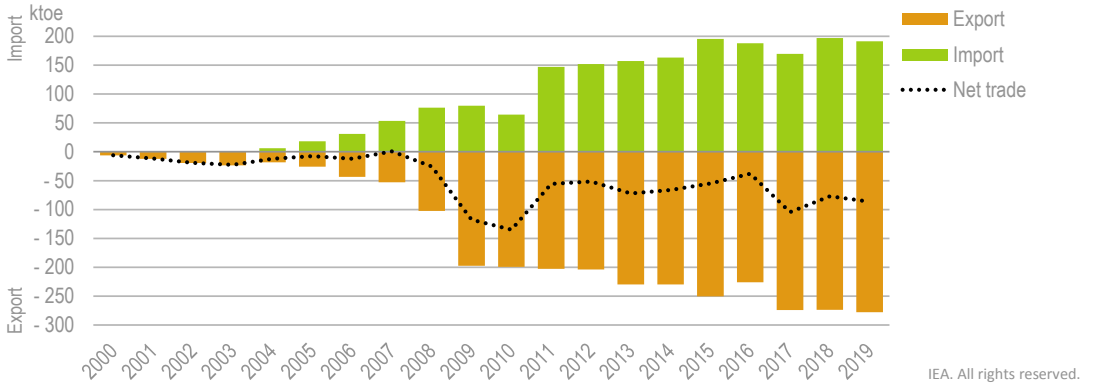


Lithuannia's domestic production of bioenergy consists mainly of primary solid biofuels and biodiesels.

Note: Mtoe = million tonnes of oil equivalent.

Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

Figure 3.8 Bioenergy net trade



Lithuania became a net exporter of bioenergy in 2007 and saw a rise in exports up to 2019.

Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

Climate policies and targets

The National Strategy for the Climate Change Management Policy (2012) describes the framework for climate policies. It contains sectoral targets for transport, agriculture, waste management, industry and others. The strategy sets legally binding short-term (until 2020), indicative mid-term (2030 and 2040) and long-term (until 2050) mitigation and adaptation objectives. Lithuania targets reductions compared to 1990 levels of:

- 70% by 2040 by moving all sectors of the economy toward innovative, low GHG emissions and environmentally friendly technologies and through the deployment of renewable energy
- 80% by 2050, with 20% of emissions covered by absorbents from the forestry sector, as well as by applying environmentally safe carbon capture and utilisation technologies (CCU).

Lithuania has reviewed its Strategy with a view to update and align its binding GHG emissions reductions targets and objectives for the year 2030 with EU targets. The government has decided to join other European countries to achieve a climate-neutral economy by 2050, which will require an industrial transformation of its industry and manufacturing sector. These will be implemented under the National Energy and Climate Plan (NECP). The draft strategy includes a 2050 vision for climate neutrality and is expected to be adopted in 2021 (Republic of Lithuania, 2020). Lithuania notified this draft long-term strategy to the European Commission on 14 January 2020, which requires the notification of sectoral emissions reductions targets in line with Article 15 of the EU Governance Regulation. Under the 2021-24 government programme, the Ministry of Environment has declared an ambitious goal for Lithuania to become a carbon-neutral country with an established circular economy by 2050.

Lithuania relies strongly on energy efficiency and renewable energy policies to meet its climate targets. Many measures require external, mostly EU, public funding. The use of economic instruments and financial mechanisms, including taxation, as well as performance and energy efficiency standards has been secondary to date.

Emissions in the ETS and non-ETS sectors

Around a third of Lithuania's total emissions is regulated under the EU-wide ETS, while the bulk of emissions (71%) falls under national targets for non-ETS emissions. ETS emissions stem mainly from chemical and mineral production (46%), oil refining (26%), public electricity and heat generation (17%), and fuel combustion in industry (11%). Emission-intensive industrial sites in the Kaunas, Telsiai and Siauliai counties are covered under the ETS in Annex I to Directive 2003/87/EC.

Table 3.1 Lithuania's greenhouse gas emissions reductions targets for non-ETS sectors in 2021-30

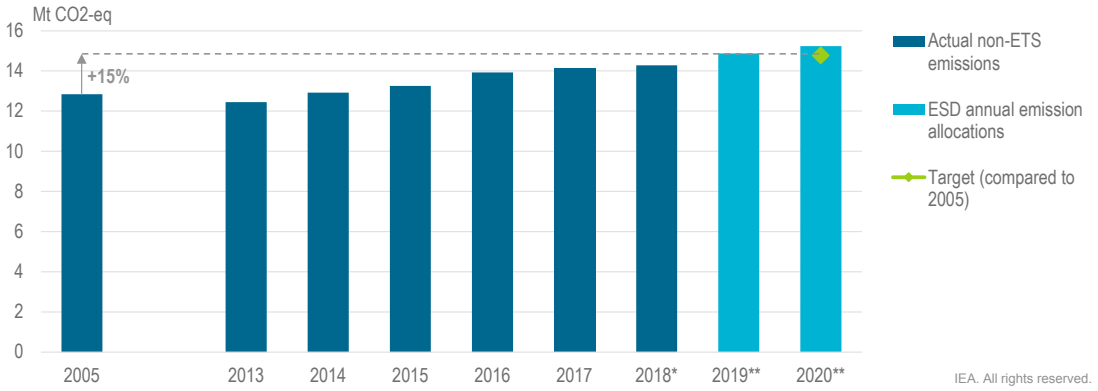
Sector (non-ETS)	Targets (compared to 2005)
Transport	-9%
Agriculture	-9%
Industry (including fuel combustion)	-9%
Waste management	-40%
Non-centralised energy production (small combustion plants) and use (households, services)	-15%
Total non-ETS sector (target)	-9%

Source: Republic of Lithuania (2019), *National Energy and Climate Plan*, https://ec.europa.eu/energy/sites/ener/files/documents/lt_final_necp_main_en.pdf.

The EU Effort Sharing legislation establishes binding annual GHG emissions targets for member states for the periods 2013-20 and 2021-30. These targets concern emissions from most sectors not included in the EU ETS, such as transport, buildings, agriculture and waste. Under the EU Effort Sharing Decision, Lithuania's 2020 target assumes an

increase of up to +15% in non-ETS sectors compared to 2005 levels. The 2030 target is -9% compared to 2005 in line with the Effort Sharing Regulation.

Figure 3.9 Lithuania's non-ETS emissions and EU targets, 2005 and 2013-20



Lithuania's non-ETS emissions have increased by 15% since 2005 in line with its target. The 2030 target requires strong efforts to meet a 9% reduction of emissions compared to 2005 levels.

* Actual emission data for 2018 are provisional.

** Data for 2019-20 are allocations for the ESD annual emissions.

Notes: ETS = Emissions Trading System. ESD = Effort Sharing Decision.

Source: EC (2020) and EEA (2019).

Existing measures are expected to lead to an increase in the non-ETS sectors by 6% compared to 2005. In the horizon up to 2030, the NECP focuses on the emissions reductions in the sectors not covered under the EU ETS (transport, agriculture and non-ETS industry), which require additional national action. The implementation of these measures under the NECP could allow Lithuania to achieve an emissions reduction of -21% by 2030, according to the government. The NECP outlines that GHG removals from LULUCF could amount to 6.2 Mt per year between 2021 and 2025, and 5.3 Mt per year between 2026 and 2030. The NECP states that part of these removals can be used to meet the targets under the Effort Sharing Regulation.

Air quality

Lithuania's air pollutants have decreased since the 1990s. However, according to the latest data from the European Environment Agency (EEA, 2020), a rebound has been depicted for some pollutants in the past five years.

Particulate matter emissions ($PM_{2.5}$) decreased between 2011 and 2014, but have been on the rise since 2016 in residential and services and transport sectors. They are attributed to road transport and residential activities (use of solid biomass in heating). The EEA found that there were around 2 700 premature deaths attributable to fine particulate matter concentrations in 2018. Likewise, nitrogen oxide emissions remain high at a stable level in the transport and agriculture sectors. Energy production and distribution in Lithuania has the highest sulphur dioxide emissions in the EU, which is largely due to Lithuania's old refinery. Lithuania's industrial emissions stem largely from agriculture-related activities (poultry and pigs), but also from the management of the hazardous waste industry and of

non-hazardous waste and energy activities, mainly electricity generation. An increase in pollution is recorded during the summer season and notably in the main cities of Vilnius and Kaunas.

Lithuania's average pollution levels have been above the national pollutants limits under the EU National Emissions Ceilings Directive (2001/81/EC) up to 2020 and allowed standards by the World Health Organization, notably for particulate matter.

Lithuania adopted a National Air Pollution Control Plan in 2019 with commitments up to 2030 under EU Article 6 of Directive (EU) 2016/2284 (National Emission Reduction Commitments Directive or "the NEC Directive"). The NEC Directive obliges EU member states to meet emissions reductions commitments for 2020-29 and 2030 onwards and adopt a national programme. The plan targets the heating and transport sectors and outlines measures to subsidise consumers (EUR 1 000 per car) and municipalities (EUR 30 million) to switch to clean vehicles and clean mobility and phase out solid fuel use in heating. It includes plans to impose a road charge on the cargo industry. Trucks would no longer be able to buy seasonal permits, but will pay according to the distance travelled on Lithuanian roads.

Climate change adaptation and resilience

In Lithuania, the most sensitive sectors for climate change are agriculture, public health, energy, industry, transport and communication infrastructure, forestry, ecosystems, biodiversity, landscape, water resources and coastal areas, and urbanised areas.

The National Strategy for Climate Change Management Policy is a key climate change adaptation strategy, outlining Lithuania's vision, goals and objectives to address climate change up to 2050. The strategic goal of Lithuania's climate change adaptation policy is to reduce the vulnerability of natural ecosystems and domestic economic sectors. The policies and measures are set in Lithuania's Interinstitutional Action Plan for the Implementation of the Goals and Objectives for the Period of 2013-2020 of the Strategy for the National Climate Change Management Policy (Republic of Lithuania, 2013) and in the NECP for the period 2021-30.

The Lithuanian National Risk Analysis, which was updated in 2018, provides an assessment of the risk factors with the greatest impact and likelihood of occurring. This assessment comprises the evaluation of all threats in Lithuania, including those caused by climate change. The government has short-term, indicative medium-term (until 2040) and long-term (until 2050) objectives for climate change adaptation and must further monitor and study the vulnerability of the country's ecosystems and economy, to strengthen the capacity to adapt, plan measures, minimise risks and damage effectively, and maintain and enhance resilience to climate change. Adaptation measures are put in place with regard to flooding, and promote underground cabling for distribution networks and smart networks to withstand more severe weather conditions.

The National Strategy for Climate Change Management Policy emphasises that the transport and agriculture sectors are especially poorly prepared to manage the adaptation challenges. Regional and local impacts can be different. Therefore, the government prioritises engaging municipalities and residents through awareness-raising, co-operation with scientists and strengthening resilience preparedness. Co-ordination of disaster risk management, emergency and natural events management, prevention, warning systems, rescue actions, and adaptation measures are important. The strategy includes quantitative

adaptation targets by 2030. All residents living in flood risk areas should have flood protection measures. With hazardous, natural and catastrophic weather events expected to account for at least 89% of all weather events, the annual cost of climate-related economic losses in GDP should not exceed 0.08%.

Taxation and subsidies

In 2018, revenues from environmental taxes in Lithuania represented 2% of GDP (the EU average was 2.4% of GDP), according to Eurostat data (Eurostat, 2020). Taxes on transport are the second-lowest in the EU. Only 0.3% of total revenues from taxes and social contributions stem from environmental taxes (compared to the EU average of 1.2%). Lithuania has one of the lowest excise duties on petrol and diesel in the OECD. The country also has one of the largest "diesel differentials", i.e. the gap in the tax rate on diesel compared to gasoline. Despite the gradual increase in excise duties imposed on diesel since 2008, an important gap remains between diesel and gasoline taxation, which is subject to a higher excise duty. Excise duties on energy products in Lithuania are regulated by the Law on Excise Duty (No. IX-569, 30 October 2001), as illustrated in Table 3.2, but are not in line with carbon content. Excise duty rates and their structure across energy products have remained stable over time and have many exemptions. The tax on diesel used in agriculture almost tripled from 1 July 2015 to 1 January 2020.

Table 3.2 Excise duty rates in Lithuania, 2004-20 (in EUR)

Product	2004	2007	2008	2009 (Jan)	2009 (Aug)	2010 (Jan)	2010 (April)	2011	2013	2015	2016	2018	2020
Unleaded gasoline	381.72*		323.22	434.43									466.00
Leaded gasoline	560.13*		421.11	579.24									
Diesel	290.20*		274.27	330.17	274.27			302.07	330.17			347.00	372.00
Diesel as heating fuel	25.91*		21.14										
Kerosene	290.20*		274.27	330.17									
Diesel in agriculture										21.00		56.00	60.00
Heavy fuel oil	15.06*												
Liquefied petroleum gas	125.12*			304.10*									
Natural gas as motor fuel	125.12*			304.10*									
							219.53				23.60	0.00	
Natural gas as heating fuel *(per MWh)*											0.54**		
											1.08***		
Coal *(per MWh)*		3.77**											
		7.53***											
Coke and lignite *(per MWh)*		4.63**											
		8.98***											
Electricity *(per MWh)*						0.52**							
						1.01***							

* All rates are per 1 000 litres unless indicated with * for 1 000 kilos.

** Rates applicable for business use.

*** Rates applicable for non-business use.

Notes: MWh = megawatt hour. Prices and taxes prior to 1 January 2015, the date of entry into the Economic and Monetary Union, have been converted from Lithuanian litai using the conversion rate of 3.45280 LTL/EUR.

Source: Ministry of Finance, Lithuania.

Electricity is exempted from excise duty for activities related to generation, distribution and transmission (including for the maintenance and losses in electricity distribution and transmission networks), supply to domestic consumers and aid receivers under the Law on Charity and Aid as well as electricity from renewable sources.

Also exempted from excise duty is the consumption of natural gas as a motor fuel, for co-generation,[2] by households and/or by charitable organisations. Domestic liquefied petroleum gas supplied in cylinders or in bulk is also exempted from excise duties.

Coal, coke and lignite are subject to excise duty since 1 January 2007 and electricity since 1 January 2010. Natural gas for heating is subject to excise duty since 1 January 2016. An excise duty is imposed on diesel used in agriculture since January 2015 (before total excise duty exemption was applied). In April 2010, a separate excise duty rate for natural gas used as motor fuel was introduced (before the same excise duty rate as for liquefied petroleum gas was applied). Since 1 January 2018, natural gas used as motor fuel is exempt from excise duty.

Lithuania levies a general tax on environmental pollution (EC, 2015), which covers pollutants discharged into the environment (NO_x, SO_x and particles), specified goods (tyres, accumulators used in transport vehicles and others) and specified filled packaging (glass, plastic, metal, paper and other packaging). The use of biogas, solid and liquid biomass for heating and transport purposes qualifies for an exemption from the tax. The State Tax Inspectorate under the Ministry of Finance and the Ministry of the Environment administer the tax on pollution. The latest amendments became effective on 1 January 2021. The government has plans to phase out the exemption of bioenergy by 2028.

Under the NECP, Lithuania has outlined plans to phase out exemptions and align excise taxation with the carbon content. The government seeks to abolish the exemptions of agriculture operators from the environmental pollution tax by 2024 and gradually phase out the subsidies (reduced excise tax rates) for heating gas oils, and the commercial use of coal, coke and lignite, and of natural gas as heating fuel. Under the National Air Pollution Plan, the government plans to introduce a road charge for freight which would no longer be a seasonal road usage permit, but a charge for the kilometres travelled.

Lithuania does not have an annual vehicle tax, but imposes a registration tax. Adopted in 2019, the motor vehicle registration tax came into force on 1 July 2020. Based on the CO_2 emissions of motor vehicles as reported by the manufacturer, a registration fee between EUR 13.5 and EUR 540 is levied on vehicles (Table 3.3). The fee is imposed on vehicles emitting more than 130 g/km, making no differentiation between a diesel or gasoline vehicle, taxing from the same threshold but applying different tax rates for diesel, gasoline or gas fueled cars for the same amount of CO_2 and, in such a way, reflecting pollution levels. The tax will apply to around 170 000 newly registered vehicles in Lithuania and 207 000 cars changing owners every year. The expected revenues for the state budget amount to EUR 19-20 million per year.

[2] Co-generation refers to the combined production of heat and power.

Table 3.3 Registration tax for passenger cars in Lithuania (2020)

CO_2 emissions (g/km)		Tax on motor vehicle (EUR)		
From	To	Diesel	Gasoline	Gas
0	115	0	0	0
116	130	0	0	0
131	140	30	15	13.5
141	150	60	30	27
151	160	90	45	40.5
161	170	120	60	54
171	180	150	75	67.5
181	190	180	90	81
191	200	210	105	94.5
201	210	240	120	108
211	220	270	135	121.5
221	230	300	150	135
231	240	330	165	148.5
241	250	360	180	162
251	260	390	195	175.5
261	270	420	210	189
271	280	450	225	202.5
281	290	480	240	216
291	300	510	255	229.5
301 and more		540	270	243

The tax structure does not incentivise low-emission vehicles or efficient driving, and has a number of exemptions (for instance for farmers). The tax aligns with old EU standards (130 g/km) and is far from meeting the latest requirements for passenger cars, which are 95 g/km of CO_2, being phased-in for 95% of vehicles in 2020 with 100% compliance in 2021. The government plans to amend the tax in 2023 to expand its scope.

Climate finance and investment

Around 30% of the revenues collected from the environmental pollution tax are directed to the Lithuanian Environmental Investment Fund, which promotes small-scale projects in all environmental sectors. The Law on Management of Financial Instruments for Climate Change (2009) established the Climate Change Programme in Lithuania under the state budget. Revenues received from auctioned allowances under the EU ETS are directed to the Climate Change Programme.

Lithuania relies on EU Structural and Investment Funds for the period 2014-20; 23% is used for the implementation of climate-related projects. The Alternative Fuels Law, which

was adopted by Parliament in March 2021 and comes into force on 1st July 2021, includes the creation of the Sustainable Mobility Fund for the implementation of the alternative fuels policy. The development of an action plan for e-mobility is part of the Law. A total of EUR 1.8 billion is required to be invested during the period 2021-30 and most of the funds are planned to be raised from the European Recovery Fund, as well as the EU Structural Funds. Pilot measures, worth EUR 56 million, are already funded through the Climate Change Programme.

Assessment

Lithuania has set an ambitious long-term target for climate neutrality, with an envisaged reduction of GHG emissions of -80% by 2050 compared to 1990 levels, requiring offsetting with 20% of emissions under LULUCF.

The most significant source of GHG emissions in Lithuania is the energy sector, with a 58.4% share of the total emissions in 2019. The main contributors in the energy sector are transport (31% in 2019) and the energy industries (11% in 2019). Agriculture is the second most significant source, accounting for 20.8% of total emissions. Emissions from industrial processes and product use contributed 16.7% of the total GHG emissions, and the waste sector 4%. To some extent, this growth was offset by reductions in energy-intensive industries.

GHG emissions in Lithuania have dropped significantly. Emissions in 2018 were 58% lower than in 1990. The bulk of the reductions in emissions occurred between 1990 and 1993. In more recent years, emissions have stabilised at around 20 Mt CO_2-eq per year. As the Lithuanian economy has been growing at a fast rate (~3.5% per year over the last decade), maintaining such a steady emissions level means that the country avoided further growth in emissions and has mostly been able to decouple economic growth from GHG emissions. Transport sector emissions, which made up 56% of the total energy-related CO_2 emissions, have grown fast, also related to the truck transit going through the country.

Reducing GHG emissions from the current levels is the key challenge for the coming years. Among total GHGs, emissions in the transport and agriculture sectors have been increasing for several years, putting at risk the achievement of the 2030 climate change targets. Any net-zero pathway would need significant energy efficiency, renewable energy and technology innovation in the transformation of Lithuania's industry and agriculture sector.

The long-term framework for the climate policies is set in the National Strategy for the Climate Change Management Policy which, in addition to the 2050 vision, sets reduction goals for 2030 and 2040 (40% and 70%, respectively). The update of the National Strategy for the Climate Change Management Policy currently under discussion in the Lithuanian parliament includes the objective of climate neutrality as a vision for 2050. Medium-term goals (up to 2030) are more thoroughly elaborated in the NECP for the period 2021-30 and in the National Progress Programme. Many strategic documents have been reflected in the NECP and the National Progress Programme, for instance the National Energy Independence Strategy, the National Strategy for the Climate Change Management Policy and the National Air Pollution Reduction Plan.

As climate goals are connected with many policy areas, many ministries and government bodies are involved. Under the NECP, climate and energy policy planning have become more interlinked. The National Climate Change Committee, established for consultations on the development of the Lithuanian climate change policy and co-ordination of its implementation, includes 26 representatives of ministries, local authorities, research, and industrial and non-governmental organisations.

As 71% of the GHG emissions in Lithuania stem from non-ETS sectors (including transport), where EU member states have binding national reduction targets, reducing emissions in those sectors will be the biggest challenge for Lithuania in the coming years. The government is sure to be on track with the 2020 goal for non-ETS emissions (+15% higher than 2005 levels). However, by 2030, Lithuania has to reduce emissions from the non-ETS sectors by 9% compared to 2005 levels (a reduction of 31% from today's levels). Lithuania may be able to offset 6.5 Mt CO_2-eq (around 5% of the total non-ETS emissions for the period 2021-30) to meet the GHG emissions reductions target for non-ETS sectors through the LULUCF flexibility for the period 2021-30. The government should pay particular attention to the sustainable use of farmland and forest land as well as a sustainable agricultural policy in order to make use of the LULUCF flexibility.

Transport is the largest emitter of GHGs, followed by industry, and electricity and heat generation. Taxes imposed on transport activities do not sufficiently incentivise energy efficiency, environmental performance or lower consumption of fossil fuels. Biomass use is exempted from the environmental pollution tax and its pricing does not reflect the negative externalities from air pollution when it is used for heating purposes. In transport, the electrification of railways, promotion of alternative fuels and implementation of sustainable urban mobility plans are seen by the government as critical measures for reducing emissions from the transport sector.

The IEA encourages the government to develop a dedicated strategy and road map for addressing transport sector emissions to 2030 and beyond, which will be critical if Lithuania is to meet its long-term emission targets. The draft Alternative Fuel Law is an excellent step in the right direction to promote the industrial supply chain. However, the industrial development will require detailed scenarios and emissions reductions pathways to operationalise targets for the use of different fuels and the needed investment in the enabling infrastructure.

The occurrence of extreme weather conditions is expected to increase in the coming decades. Adaption measures such as updated planning procedures and requirements for renovations and new constructions can be very effective. The IEA emphasises the importance of adapting Lithuania's critical infrastructure to these changes, notably for the climate-proofing of electricity distribution grids.

The main source for financing the measures for mitigation and adaptation to climate change are external/EU public funds. For instance, for the NECP implementation period (2021-30), out of the EUR 14.1 billion needed, EUR 9.8 billion is planned to come from external/EU public funds. At the beginning of the period, the government is relying on available EU funds to finance climate-related measures. However, the amount of available external funds for grants will probably decrease over time and the policies and measures will have to be adapted to make full use of financial instruments and private sector investments.

Lithuania has a large and mostly unexplored potential to use taxes to steer behaviour in the transport and other sectors. Currently, there is no road-use tax levied on private vehicles in Lithuania; there is only a motor vehicle registration tax. Studies show that such taxes, differentiated to CO_2 emissions of cars, could have a strong impact on reducing emissions from the transport sector. Most IEA member countries impose taxes on private combustion vehicles in one way or another, while supporting electric vehicles, and have seen positive impacts on buying and usage behaviour. The IEA encourages the government to closely study the applicability of these measures in Lithuania.

There is no single solution for reaching climate neutrality – this means that there are a lot of new business opportunities to support the transition. Technology and innovation will be critical for this transition. The government should study the role of critical clean energy technologies, notably hydrogen and CCU, to enable negative emissions in meeting long-term decarbonisation efforts.

Recommendations

The government of Lithuania should:

- Adopt and implement an updated National Strategy for the Climate Change Management Policy to scale up policies for reaching climate neutrality, including energy technology and innovation targets.
- Develop a comprehensive set of emissions reduction pathways for the non-ETS sectors towards 2030 and beyond and review them on a regular basis.
- Design sector policy road maps with priority actions in non-ETS sectors, notably in transport, with comprehensive measures, including carbon price signals, to reflect externalities (i.e. annual car taxation, road charges), support to alternative fuels and infrastructure as well as clean mobility.
- Strengthen planning procedures to ensure that risks stemming from climate change (e.g. potential floods, high wind speeds) are alleviated when renovating or constructing new critical infrastructure or buildings.
- Seize the opportunities of the EU Green Deal and transitioning to a climate-neutral economy by developing futureproof energy systems and business models, which will contribute to climate change adaptation and mitigation, security of supply, resilience, and the competitiveness of the Lithuanian economy.
- Accelerate private sector involvement and financing for attaining the climate policy goals, including through taxation reforms.

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4. Energy efficiency

Key data

(2019)

Total final consumption (TFC): 6.6 Mtoe (oil 36.9%, natural gas 23.4%, heat 12.8%, electricity 13.7%, bioenergy and waste 10.8%, coal 2.6%), +26% since 2008

Consumption by sector: industry 34.8%, transport 32.4%, residential 21.5%, services/other* 11.3%

Energy consumption (TFC) per capita: 2.3 toe/capita (2018 IEA average 2.8 toe/capita, 2018 IEA median 2.4 toe/capita)

Energy intensity (TFC/GDP):** 70 toe/USD** million (2018 IEA average 62 toe/USD** million, 2018 IEA median 62 toe/USD** million)

* *Services/other* includes commercial and public services, agriculture, forestry, and fishing.

** *GDP* is computed in USD 2015 prices and purchasing power parities (PPPs).

Overview

Rising industrial and transport activity undermines Lithuania's efforts to progress towards its national savings target for final energy consumption by 2020, which would require a sharp decrease of energy use. COVID-19 impacts may lead to a short-term decline in consumption, but not to a structural change in transport and industry efficiency.

The National Energy and Climate Plan of Lithuania (NECP) set targets for primary and final energy consumption for 2030 and announced a number of policies across all sectors to achieve those quantitative targets. The new Energy Efficiency Law sets out obligations for all ministries in their respective sectors.

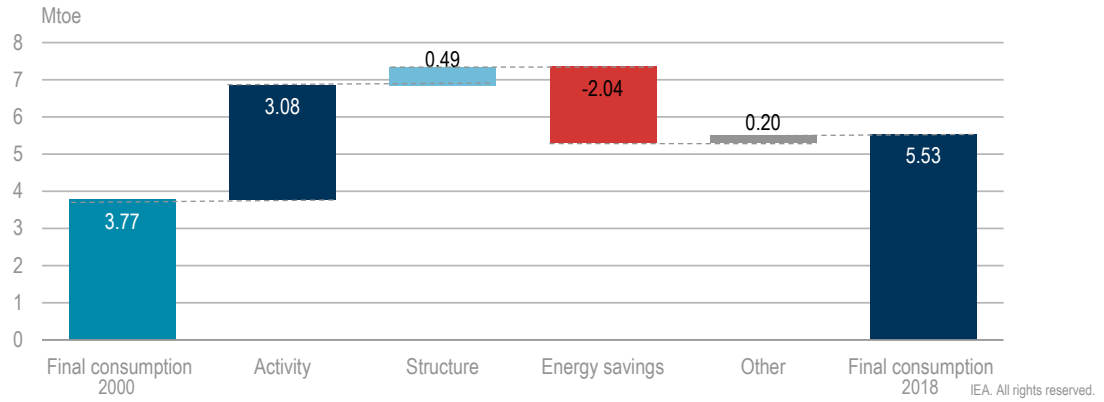
IEA analysis underlines the significant role energy efficiency can play in the short and medium term for mitigating the expected rebound of consumption and emissions as the economy recovers in the coming years. Policies and measures are in place for making progress in public building renovation and the EU Renovation Wave can present an opportunity to boost progress towards the 3% renovation rate per year.

The IEA estimates that energy efficiency will play an instrumental role in achieving the emissions reductions necessary for the climate neutrality of the economy by 2050. Commendably, the National Energy Independence Strategy (NEIS) of 2018 includes an energy savings goal for 2050. In its final assessment of the 2030 targets, the European Commission qualified Lithuania's 2030 target as a modest effort (EC, 2020a).

The role of energy efficiency

Lithuania's economy and energy consumption have continuously grown since 2000, only interrupted by a small drop in 2008 amidst the global financial crisis. The role of energy efficiency has been important. The increasing economic activity (in transport and industry) and changes to the structure of the economy since 2000 would have led to a doubling of final consumption without energy efficiency. As a decomposition analysis shows in Figure 4.1, energy savings allowed the potential increase in final consumption between 2000 and 2018 to be reduced by half.

Figure 4.1 Decomposition of total final energy consumption trends in Lithuania

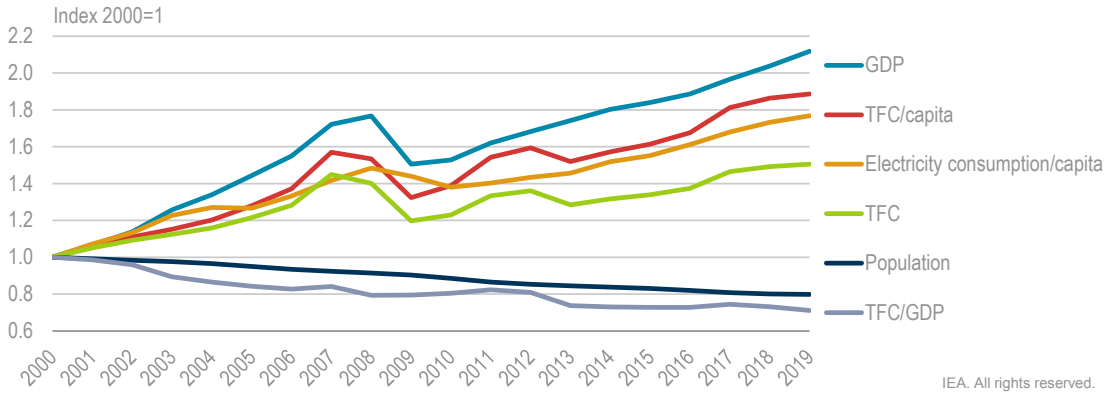


Energy savings allowed to halve the potential rise in consumption from 2000 and 2018.

Notes: Mtoe = million tonnes of oil equivalent. Final consumption in 2018 (5.53 Mtoe) does not correspond with IEA total final consumption (6.5 Mtoe), as IEA data include non-energy use (use of hydrocarbons by chemical and petrochemical industry).

Source: Odyssee (2020), *Decomposition Tool*, www.indicators.odyssee-mure.eu/decomposition.html.

Figure 4.2 Energy consumption and drivers in Lithuania, 2000-19



TFC has increased at a slower rate than GDP in recent years, while TFC/capita has increased, as the total population has declined since 2000.

* *GDP* data are in billion USD 2015 prices and PPPs (purchasing power parities).

Notes: TFC = total final consumption. GDP = gross domestic production.

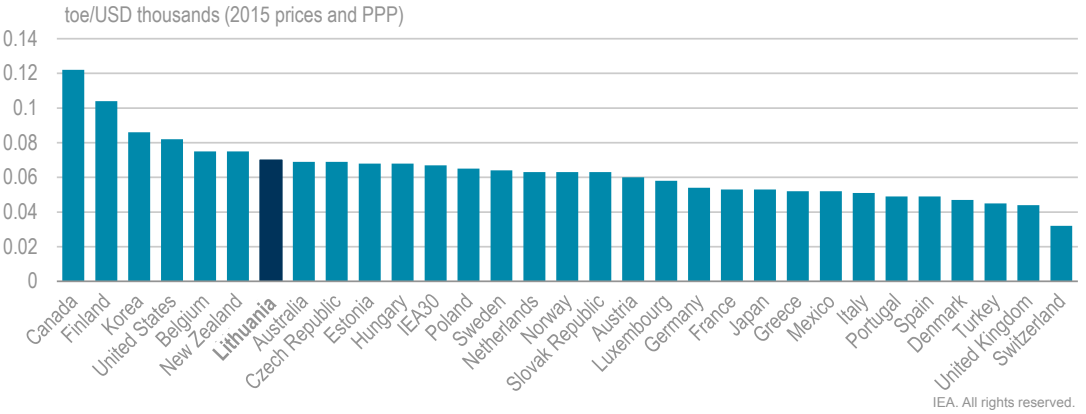
Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

Energy intensity

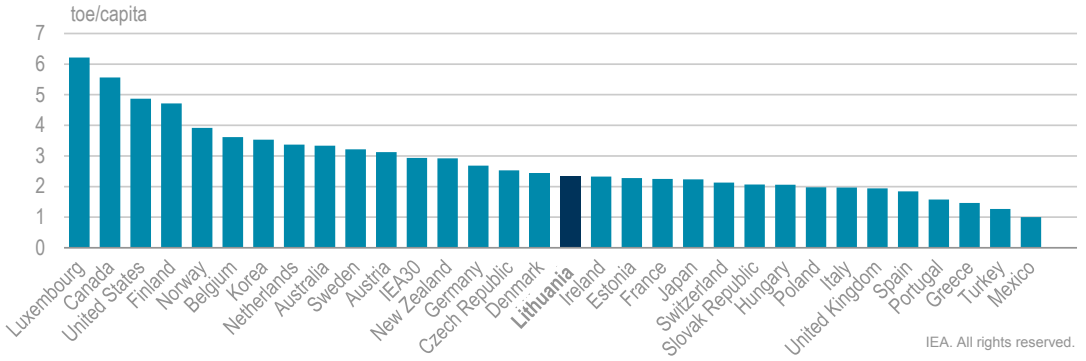
Since 2000, total final consumption (TFC) has increased by 50%, driven by Lithuania's growing economy, whose gross domestic product (GDP) doubled in that time frame. Energy intensity as expressed in TFC/capita has increased after a decrease in 2010, as a result of the increasing TFC and a decreasing population, which has seen large emigration (Figure 4.2). Compared to IEA member countries, Lithuania ranked seventh by TFC/GDP in 2018 (Figure 4.3). The energy intensity of the economy (70 toe/USD million) was 13% higher than the IEA average (62 toe/USD million). It should be noted that Lithuania's GDP per capita (33 USD thousand/capita) is lower than the IEA average (44 000 USD thousand/capita). In terms of TFC/capita, Lithuania ranks below the median of IEA member countries, as TFC/capita for Lithuania (2.3 toe/capita) is 19% lower than the IEA average (2.9 toe/capita).

Figure 4.3 Energy intensity in IEA member countries, 2018

Energy consumption per GDP (TFC/GDP)*



Energy consumption per capita (TFC/capita)



Lithuania had the seventh-highest energy consumption per GDP among IEA countries in 2018 and ranked below the IEA average in energy consumption per capita.

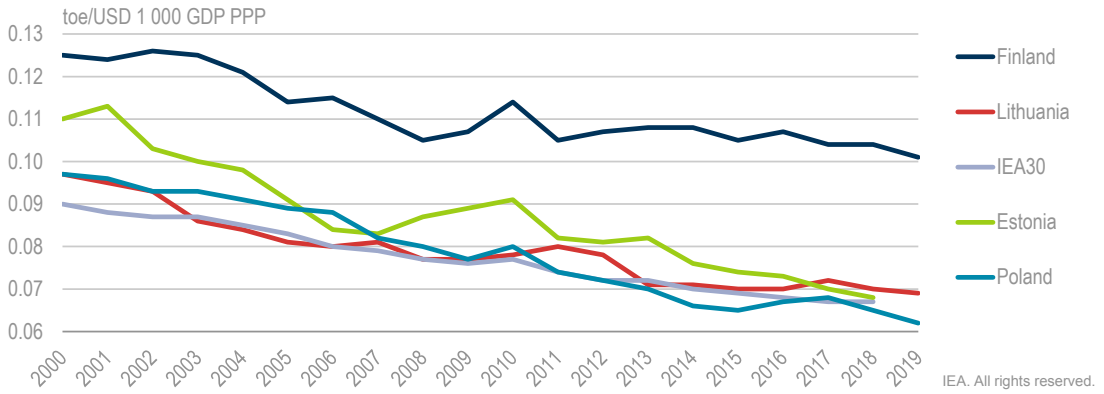
* *GDP* data are in billion USD 2015 prices and PPPs (purchasing power parities).

Note: toe = tonne of oil equivalent.

Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

At the regional level, the decline of the TFC/GDP ratio since 2000 has been weaker than that of IEA member countries in the region (Figure 4.4). Between 2008 and 2018, Lithuania's energy intensity dropped by 9%. This decrease was, on average, more important in IEA member countries (-13%), notably in Poland (-19%) and Estonia (-22%).

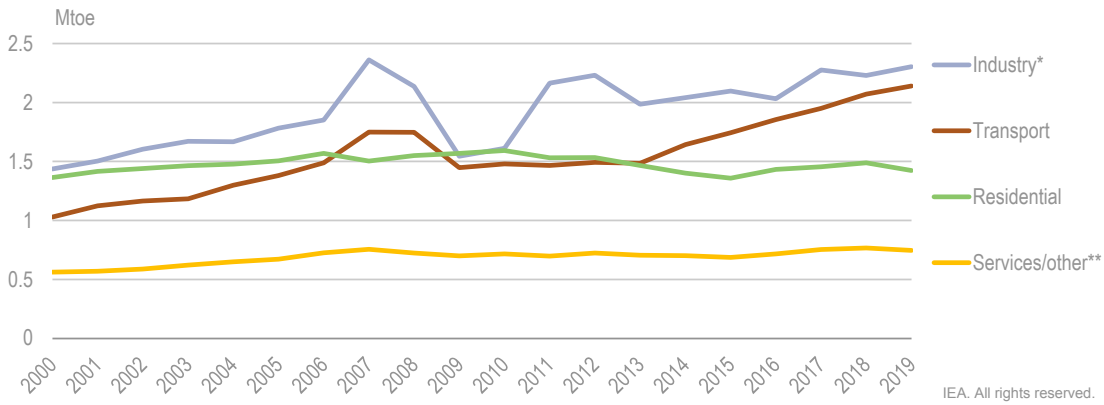
Figure 4.4 Energy intensity in selected IEA member countries, 2000-19



The decline in Lithuania's energy intensity follows trends in IEA member countries and neighbouring countries.

Note: *GDP* data are in billion USD 2015 prices and PPPs (purchasing power parities); toe = tonne of oil equivalent.
Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

Figure 4.5 Total final consumption in Lithuania by sector, 2000-19



The industry sector has been the most energy-intensive sector since 2000. In recent years, however, the transport sector has seen a fast rise in energy consumption.

* *Industry* includes non-energy consumption.

** *Services/other* includes commercial and public services, agriculture, forestry, and fishing.

Note: Mtoe = million tonnes of oil equivalent.
Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

Lithuania's industry sector has had the largest share in final energy demand since 2000, accounting for one-third of TFC (Figure 4.5). Lithuania has export-oriented manufacturing ranging from agriculture and food processing, biotechnology and chemicals to furniture

and wood products, textile and clothing. In 2019, the manufacturing of machinery and equipment made up 7% of the country's GDP and ten new factories were opened in Lithuania in the fields of engineering, high-precision instruments, furniture and medical products.

The transport sector has been catching up, with a 30% increase in the four years from 2014 to 2019, linked to more freight activity, tank tourism due to favourable taxes compared to neighbouring countries and an increase in car ownership. Consumption in residential and services/other sectors has been flat since 2000.

Energy efficiency governance

Energy efficiency policies are designed and implemented by a wide range of stakeholders. In the buildings sector, the Ministry of Environment leads, together with the Ministry of Energy and several agencies. In transport, it is the Ministry of Transport and Communications together with local municipalities; and in agriculture, the Ministry of Agriculture. The Ministry of the Economy and Innovation is responsible for the implementation of mandatory energy savings in industry. Besides policies, the Ministry of Finance, the Environmental Project Management Agency, the Housing Energy Saving Agency and the Public Investment Development Agency offer various subsidies or guarantee programmes. The Lithuanian Energy Agency carries out the monitoring of and reporting on energy efficiency progress.

Lithuania has a unique governance to ensure that energy savings calculated by the Ministry of Energy are implemented across government. The Law on Energy Efficiency Improvements (Republic of Lithuania, 2020) allocates the responsibility to each ministry for achieving the quantified targets in their respective sectors.

Energy efficiency targets and policies

Lithuania's energy strategies recognise the important role of energy efficiency as a fundamental driver for reaching long-term climate targets up to 2030 and 2050. The **NEIS** contains the main national energy efficiency goals. In 2012, the NEIS set the target for 2020, which was geared to a 1.5% annual energy efficiency improvement. Under the updated NEIS of 2018, the government aims to reduce primary and final energy intensity by 1.5 times by 2030 and 2.4 times by 2050 compared to 2017 levels (Republic of Lithuania, 2018a).

The **Law on Energy Efficiency Improvements** contains binding energy saving targets and governs agreements with energy suppliers and industrial facilities (Republic of Lithuania, 2020). Under the law, Lithuania targets a primary energy consumption of 5.4 million tonnes of oil equivalent (Mtoe) and a final energy consumption of 4.5 Mtoe, with the biggest decrease expected from transport (from 2 071 kilotonnes of oil equivalent [ktoe] in 2017 to 1 600 ktoe by 2030), followed by industry (from 1 028 ktoe to 933 ktoe). In line with Article 7 of the Energy Efficiency Directive 2012/27/EU (EED II), as amended by Directive (EU) 2018/2002, cumulative energy savings from energy efficiency improvement measures are expected to amount to at least 27 280 gigawatt hours (GWh). The law also gives priority to energy efficiency improvement measures that reduce energy demand over

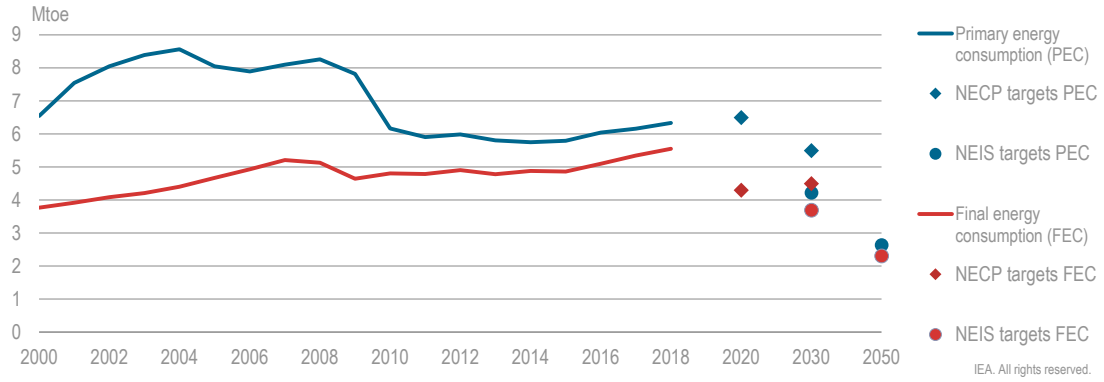
supply-side measures in the investment plans of distribution and transmission networks or systems, provided the former are more cost-effective than relevant energy supply solutions.

The **NECP** reflects the detailed objectives and policies and measures for the next ten years (2021-30), with a priority on building renovation, industry and transport (Republic of Lithuania, 2019). The measures are outlined in Table 4.1 along with the expected savings.

Progress towards energy efficiency targets

For 2020, Lithuania targeted a 17% reduction of its final energy use, compared to 2009 levels, reaching 6.5 Mtoe of primary energy consumption or 4.3 Mtoe of final energy consumption. In 2018, Lithuania's final energy consumption was 5.55 Mtoe[1] (Figure 4.6), much above the target. In terms of primary energy consumption, Lithuania consumed 6.3 Mtoe in 2018, which was in line with its 2020 target of 6.5 Mtoe. Primary energy consumption has increased over the last four years.

Figure 4.6 Lithuania's primary and final energy consumption and targets, 2000-50



Unless structural changes lead to a significant drop of final energy consumption, it will be difficult for Lithuania to achieve its 2020 target for FEC, let alone the 2030 and 2050 targets.

Notes: Mtoe = million tonnes of oil equivalent. NECP = National Energy and Climate Action Plan. NEIS = National Energy Independence Strategy.

Sources: Eurostat (2020), *Complete Energy Balances* (database), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_bal_c; Republic of Lithuania (2019), *National Energy and Climate Plan of the Republic of Lithuania for 2021-2030*, https://ec.europa.eu/energy/sites/ener/files/documents/lt_final_necp_main_en.pdf.

There were no major national energy efficiency measures implemented in the transport sector (outside of tax measures), while effective energy efficiency programmes are in place for industry and buildings. However, progress remains low: the cumulative renovation of public buildings over the past five years only amounts to what would be necessary each year to meet the 2030 target. The following sections will evaluate the different policies and measures in place for each sector and assess their cost-effectiveness.

[1] Primary energy consumption and final energy consumption are calculated according to the EU rules set under the EU Directives and do not follow IEA standards.

Table 4.1 Lithuania's planned energy efficiency policies and measures, 2020-30

Sector	Target	Policies and measures	Estimated savings by 2030
Industry			
Agreements with energy companies on energy saving (notably small and medium-sized enterprises)	Targets per industry for efficiency improvement measures in the end-user equipment (installations, equipment, transport).	Subsidies for energy audits specify measures in transport, processes, buildings, lighting, ventilation, cooling systems, electric motors, etc.	5.5 TWh
Large energy-intensive industry		Public service tax reduction for audits and measures implemented.	5.5 TWh
Transport			
Promotion of efficient vehicles	Increase the energy efficiency of new cars by 42% between 2020 and 2030.	EUR 1 000 subsidy.	0.9 TWh
Promotion of electric vehicles	10% of registered and re-registered passenger cars (M1 class) to be electric cars by 2025 and 50% by 2030.	Subsidy of EUR 4 000 for new and EUR 2 000 for used electric vehicles (5 years).	6 TWh
Public fleet renewal and green procurement of clean vehicles	By 2025, 60% of public fleet (categories M1, M2 and N1) and 80% of buses (category M3) must be clean. By 2030, 100% of the fleet (categories M1, M2, M3) and 16% of heavy-duty vehicles (N2 and N3) and 50% of buses must be clean.	Public procurement.	0.521 TWh
Sustainable urban mobility plans		Reduced car use, walking, cycling, public transport and the use of alternative fuel vehicles.	2.95 TWh
Electrification of rail	Electrification of 814 km of rail (by 2030) with new power lines/substations.	EU funding during 2023-25.	3.36 TWh
Renewal of urban and suburban public vehicle fleet	Purchase of about 150 electric-powered city and commuter buses.	EU funding during 2023-25.	0.393 TWh
Reduction of fossil fuel use	Higher price of petrol (+14.7%), diesel (+5.2%), liquefied petroleum gas (+64.7%).	Higher applicable excise duties and taxes on fuel consumption above EU minimum taxation levels.	6 TWh
Buildings and commercial/residential sector			
Programme for increasing the energy efficiency of public buildings	Renovate 85 public buildings each year to reach least class C.	Subsidies from the state budget, municipal budgets, European Structural Investment Funds, international organisations, private investors.	1.1 TWh
Multi-apartment building renovation (before 1993)	500 multi-apartment buildings per year.	Subsidies	5.5 TWh
Renovation of private homes	1 000 individual houses.	Reimbursement of up to 30% of investment cost.	0.74 TWh

Sector	Target	Policies and measures	Estimated savings by 2030
Modernisation of heating and hot water systems in multi-apartment buildings (after 1993)	250 heating stations per year.	Reimbursement of up to 30% of investment cost.	0.55 TWh
Conversion of boilers to more efficient heat pumps/biofuel boilers	50 000 boilers to be replaced in households not connected to district heating.	Reimbursement of 50% of investment cost.	11 TWh
Modernisation of street lighting	25% of all luminaires in Lithuania, or about 65 000 luminaires by 2030.	Public guarantee, private energy service companies.	0.11 TWh
Consumer education and advice		Agreements with energy suppliers.	3 TWh

Note: TWh = terawatt hour.

Boosting energy efficiency under sustainable recovery

Energy efficiency is also a focus area in the economic recovery measures targeted by the Lithuanian government. The short-term recovery plan adopted by the government in March 2020 includes measures on renovation. Lithuania's medium- to long-term recovery plan, the DNA Plan for the Economy of the Future, adopted in June 2020, also targeted energy efficiency. For the period up to 2030, the NECP 2020 stipulates overall investment needs in energy efficiency of EUR 2.6 billion and public funds are expected to contribute EUR 976 million (Republic of Lithuania, 2019).

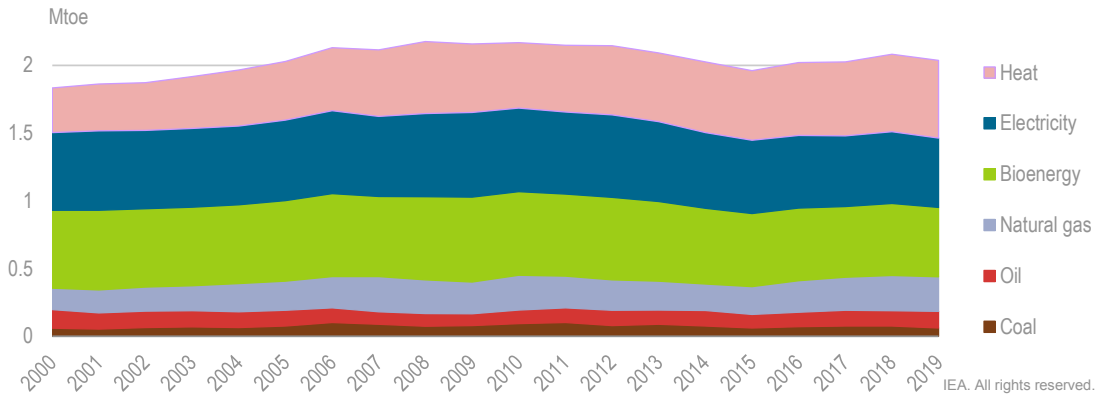
Policies and measures by sector

Residential and services sectors, including buildings

In 2019, the residential and services sectors together consumed 2.2 Mtoe, of which 1.5 Mtoe was in the residential sector and 0.7 Mtoe for services, agriculture and forestry (Figure 4.7). Most of the energy used by the residential and services sectors in 2019 was in the form of district heat (29%) and electricity (26%). Bioenergy and waste also played a major role, accounting for almost a quarter of total energy consumed in these sectors, followed by natural gas (12%). Oil and coal had a share of 6% and 3% respectively. Total energy used by the residential and services sector peaked in 2006 and plateaued in the following years to decrease until 2015. Between 2015 and 2018, TFC in the residential and services sectors increased by almost 10%, then decreased again by 4% in 2019.

Buildings make up a large share of Lithuania's energy consumption in the residential and services sector. There are a total of 1.45 million dwellings in Lithuania, for a total dwelling area of 99.2 million m^2. Only 167 000 (18.6 million m^2) of those were built after 1995. The lion's share are multi-apartment dwellings built between 1945 and 1980. Public buildings only account for a small share. The central government occupies 2.1 million m^2 of buildings and that amount is expected to decrease to 1.8 million m^2 by 2021.

Figure 4.7 Residential and services* energy demand in Lithuania by fuel, 2000-19



The residential sector consumes mainly heat and electricity. Bioenergy also accounts for an important portion of residential and services energy demand.

* *Residential and services* includes residential, commercial and public services, agriculture and forestry.

Note: Mtoe = million tonnes of oil equivalent.

Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

Policies and measures

Since January 2018, minimum energy performance requirements apply to newly constructed buildings with at least an A+ and, as from January 2021, an A++, according to the Technical Construction Regulation STR 2.01.02:2016 "Building energy performance planning and certification". Stricter requirements have been applied since February 2020, following the 2019 amendment of the regulation, setting more rigorous definitions of building envelopes, more robust engineering systems and lower cost-optimal calculation data, and revised energy performance indicators.

In line with Article 5 of the EED II,[2] Lithuania needs to annually renovate 3% of central government buildings by 2030. This amounts to 510 000 m^2 (of the floor area of central government buildings) to be renovated annually by 2030.

By 2020, 470 000 m^2 had been targeted for renovation. Lithuania is among the few EU member states to have achieved its annual renovation target as well as the 2014-19 target for the renovation of public buildings. In the period 2014-19, around 411 251 m^2 of public buildings were demolished, sold and renovated (see also EC, 2020b). Public buildings were renovated mainly thanks to subsidies, and public procurement and renovation benefited from EUR 100 million of EU funds over the period. The renovation of public buildings relies much less on energy service companies than on the availability of financing under state administrative budgets. Besides public buildings, progress in renovation of single-owner apartments has been satisfactory thanks to private energy service companies (ESCOs) and direct subsidies. However, multi-ownership apartment buildings remain a challenge due to shared ownership models.

[2] As amended by Directive (EU) 2018/2002.

As in many countries with a large district heating (DH) infrastructure, the major challenge of the Lithuanian multi-ownership apartment sector is inefficient heat consumption in buildings. Amongst the country's 38 000 apartment buildings, 18 000 are provided with DH. However, only 4 200 are newly built or renovated buildings while 13 800 have poor thermal insulation. The average annual heat consumption is 160 kWh/m², whereas in newly built and renovated multi-apartment buildings it is 80-90 kWh/m². During winter months, families have to spend 30-40% of their income on heating. Low-income households receive compensations. Despite available EU funding, between 2005 and 2019, only 2 200 apartment buildings (out of 38 000) were renovated.

Lithuania could improve the incentives significantly through better heat billing and metering. In line with the EED II, all consumers should be billed on the basis of actual energy consumption or heat cost allocation, except in specific circumstances where it is proven that this is not cost-effective. Newly installed metering devices were to be remotely readable as of 25 October 2020.

Lithuania's final NECP announced that the government is targeting the renovation of existing buildings with a long-term national strategy for the renovation[3] of the public and private residential and non-residential buildings and for new buildings, with an implementation plan to convert all buildings to near zero-energy buildings by 2050. On 31st of March 2021 the Long-term Renovation Strategy has been adopted by the government (Republic of Lithuania, 2021).

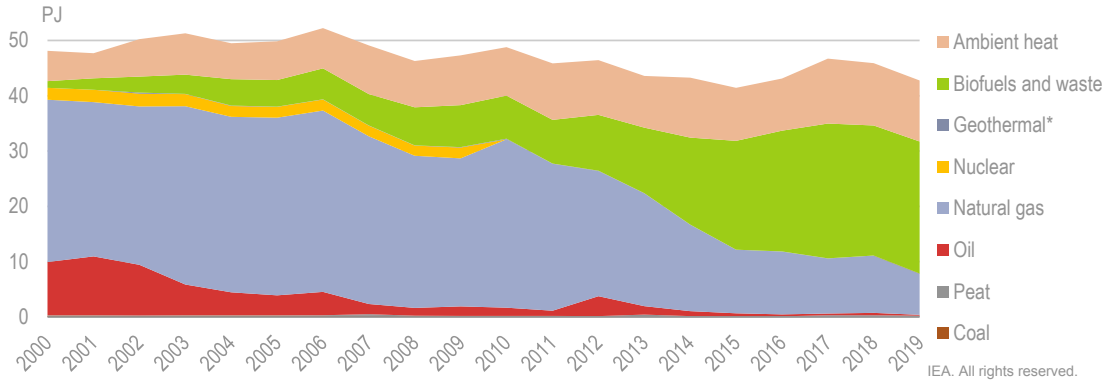
The government estimates that investment of EUR 40 billion would be needed to renovate the 600 000 buildings. The government intends to prioritise an integrated approach to renovation and the reduction of energy poverty, aligned with increasing shares of renewables and smarter energy systems. Up to 2030, the Public Buildings Energy Performance Improvement Programme targets the renovation of public buildings to achieve an energy performance class higher than C. Lithuania also targets individual houses and multi-apartment buildings and wants to renovate around 5 000 buildings, which is the priority focus area and where the needs are the highest.

Heating and cooling

Heat generation in Lithuania has changed its energy sources in recent years (Figure 4.8). The share of renewables and municipal waste in DH doubled, from 43% (2012) to 82% (2019), while the role of natural gas decreased substantially. In the year 2000, most heat was generated from natural gas (61%) and oil (20%), and only 3% from bioenergy and waste. Recently, the roles have switched, and bioenergy and waste became the main source of heat (56%) in 2019, while the shares of natural gas and oil decreased significantly, to 18% and 0.4%, respectively.

[3] The Energy Performance of Buildings Directive required every member state to present a renovation strategy by 10 March 2020.

Figure 4.8 Heat generation in Lithuania by source, 2000-19



Heat generation sources have shifted from fossil fuels to bioenergy and waste.

Notes: PJ = petajoule. Bioenergy includes the direct use of bioenergy, electricity and district heat produced from solid biofuels and renewable waste, liquid biofuels, and biogases.

Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

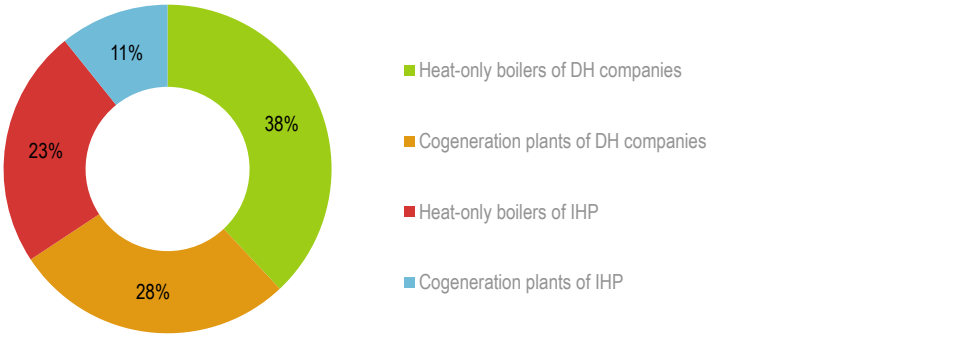
Since 2007, support from EU Structural Funds has made a significant impact on the development of the heat market and in the transition to renewable energy sources. Today, however, in rural areas, heating systems remain outdated and the use of oil results in higher air pollution and energy bills. In 2019, Lithuania put forward a programme to subsidise the replacement of inefficient fossil fuel-based boilers with boiolers fuelled by renewables (biomass and heat pumps) in single family buildings. The subsidy could be up to 50% of the investment cost for a household, depending of the efficiency level of the technology. A total amount of EUR 14 million will be allocated in the period 2019-22.

According to government estimates, the share of district heat in the overall heating sector has been stable at 57% in rural areas and 76% in urban areas, with a DH pipeline network of 2 885 km. Around a third (34%) of the heat delivered to these networks comes from independent producers (44 companies), from both heat only boilers and co-generation[4] power plants (Figure 4.9). Almost three-quarters (73%) of DH consumers are residential consumers, with the remaining shares being municipal institutions (14%) and business organisations (14%).

Amid rising prices of natural gas and fuel oil in recent years, biomass has become by far the most convenient source for DH. In 2019, the price of biomass was less than half the price of oil and natural gas. The price factor together with the technology shift prompted by significant investments under EU funds drove the major fuel switching from natural gas to biomass and a decrease in the average DH price, which dropped by 39%, from 77 EUR/MWh in 2012 to 47 EUR/MWh in 2019 (Figure 4.10).

[4] Co-generation refers to the combined production of heat and power.

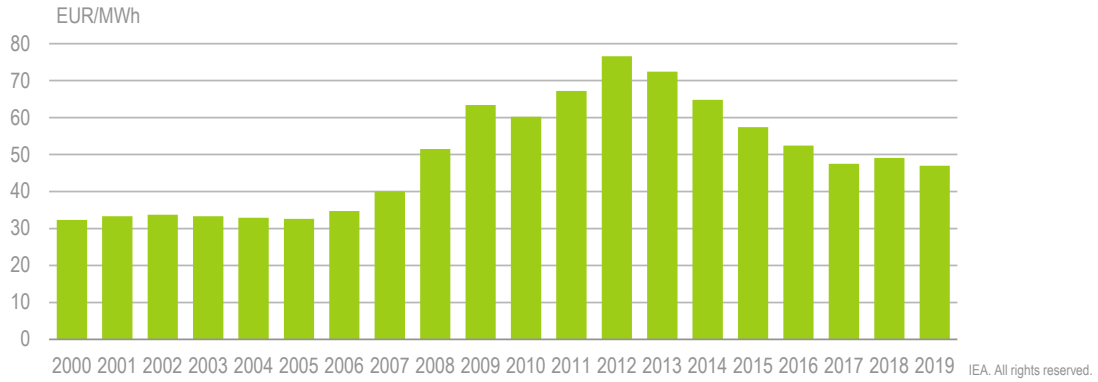
Figure 4.9 Market shares of district heat production in Lithuania, 2019



Independent heat companies provided 34% of the total district heat.

Notes: DH = district heat. CHP = combined heat and power. IHP = independent heat producer.
Source: Ministry of Energy.

Figure 4.10 Average district heating price in Lithuania, 2000-19



The switch from natural gas to biomass fuel has lowered the price of DH in recent years.

Notes: MWh = megawatt hour. The price does not include value-added tax.
Source: Government estimates.

The wider use of biomass boilers has supported the Lithuanian economy. New jobs were created in the increasing boiler and other equipment manufacturing sector, with Lithuanian companies exporting their products to Eastern and Western Europe and beyond.

The building stock is dominated by multi-apartment buildings built in the period 1945-80 with inefficient heat consumption. Buildings often do not have individual heat metering at the apartment level and households do not have incentives and lack awareness for energy savings.

Despite EU law, smart heat meters are not installed at scale. The government is planning to provide subsidies for modernising heating and hot water systems in these dwellings as well as for replacing boilers with more efficient technologies.

Polices and measures

In 2019, Lithuania's DH sector had 49 heat supply companies with annual sales of more than 10 GWh, which are mainly owned by the municipalities in the 60 cities and districts of Lithuania. Out of 49 suppliers, 44 companies are independent heat producers.

In line with the 2018 Law on the Heat Sector (Republic of Lithuania, 2018b), the National Energy Regulatory Council (NERC) regulates these companies based on cost-plus long-term heat prices (over a period of three to five years) for each DH company, which are annually adjusted for actual heat sold, inflation, fuel structure and other factors. For the smaller DH companies (less than 10 GWh of annual production), prices are set by municipalities.

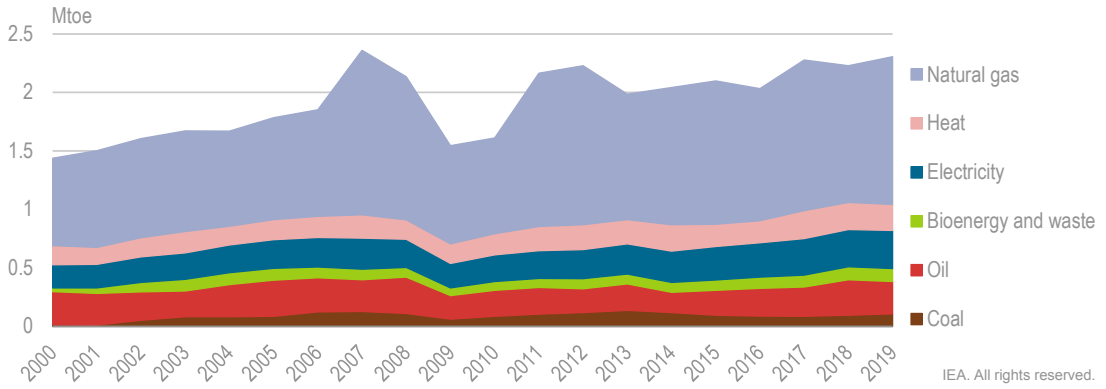
On the heat production side, there has been increased competition from independent heat producers, which now make up 34% (2 869 GWh) of total heat delivered to the DH networks. The new Procedure of Heat Purchase from Independent Heat Producers by NERC in 2018 brought about significant changes in the regulation and pricing in the DH market, with a potential impact on the financial viability of DH companies. The amount of heat purchased from independent heat producers and/or produced by DH companies themselves is determined by a monthly heat auction organised by the operator of the energy exchange (Baltpool). Under the previous regulation, the DH companies received remuneration for the fixed costs of their boilers, whether they were producing heat or not. Under the new regulation, they only receive remuneration (full costs; for the installation and the fuel) when they produce heat and have won the auction in a certain month. The regulatory framework encourages competition; however, it does not incentivise investment in modernisation and new technologies, greater reliability or new flexibility services. The current regulation creates delays in setting basic prices and increases administrative burdens for both NERC itself and for regulated companies.

Co-generation plants operate in all large Lithuanian cities. In 2015, Lithuania abolished the electricity buy-back quota (subsidies for co-generation) and no longer sets the volume of eligible electricity produced from fossil fuel co-generation plants (natural gas, fuel oil). This led to a 60% decrease of electricity delivered to the national network over the period 2015-19. The Vilnius CHP-3 was shut down, while other large natural gas co-generation plants in Kaunas and Panevėžys continue operating on a fragmentary basis only. In November 2020, the Kaunas CHP plant launched commercial operations after getting formal approval to generate electricity.

Industry

Most of the energy used in the industry sector is natural gas, which accounted for 55% of the industrial energy demand in 2019 (Figure 4.11), followed by electricity (14%), oil (12%) and district heat (10%). After a drop in 2008-09, natural gas supply to industry has increased since 2009 (+51% between 2009 and 2018) and is linked to the increase in the production of nitrogen fertilisers and chemical products (by AB Achema).

Figure 4.11 Industry energy demand in Lithuania by fuel, 2000-19



Natural gas is the main fuel used by the industry sector. After dropping in 2008, its use has been increasing again in recent years.

Notes: *Industry* includes non-energy consumption; Mtoe = million tonnes of oil equivalent.
Source: IEA (2021), "World energy balances", *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics.

Policies and measures

Under the Law on Energy Efficiency Improvement (2020), the Ministry of Economy and Innovation is required to achieve at least 5.5 terawatt hours (TWh) of mandatory energy savings in large energy-intensive industry and 5.5 TWh from small and medium-sized entrerprises (SMEs).

The government offers subsidies to help SMEs perform energy consumption audits and implement energy efficiency improvement measures specified in the audits.

For large industries, energy audits are mandatory and agreements are in place for the implementation of saving measures in return for a rebate from the public service tax. Around 30-40 large industrial users have used ISO 50001 certification in the framework of their audits. Eighty per cent of Lithuania's ESCOs are focused on industry energy efficiency upgrades.

Between 2014 and 2020, the Programme for Promotion of Investment and Industrial Development supported a number of industrial projects to promote increased use of renewable sources of energy, more efficient and low-carbon technologies, and the implementation of energy audits and digitalisation (Republic of Lithuania, 2014).

- Around 90 projects (with a total allocation of EUR 20.5 million) were dedicated to the installation of renewable energy production and the use of technologies for more efficient use of renewables in industrial enterprises for own consumption needs and to supply surplus energy to other industrial enterprises or centralised energy networks. Out of 90 projects, 72 were completed for an amount of more than EUR 15 million.
- Energy audits at industrial enterprises (65 projects) were supported with a budget of EUR 0.5 million. Around 20% of the 40 industrial enterprises that had performed energy audits were able to implement the energy efficiency measures recommended after the energy audits.

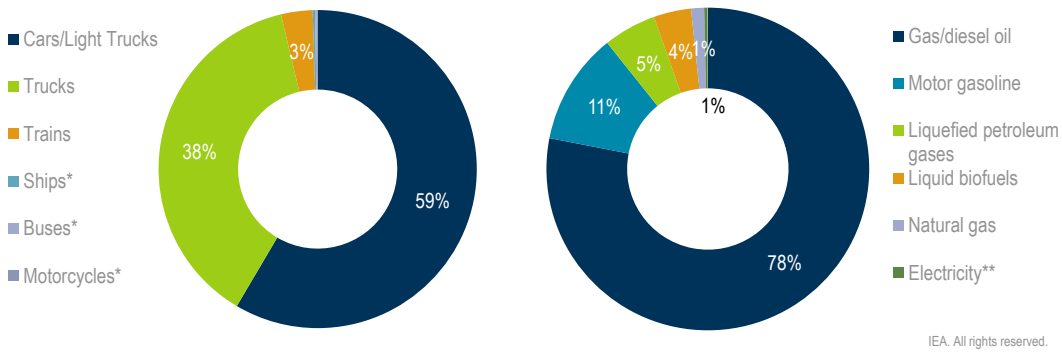
- The programme also supported audits of industrial SMEs (98 projects) with a budget of EUR 53 million in order to assess the possibilities and perspectives of digitalisation of production processes, including the use of equipment with integrated digitalisation technologies, based on the recommendations of the technological audit performed.

Transport

In 2018, road transport accounted for 95% of transport energy consumption, followed by rail with 3%. Cars remain the main mode of transport, representing 59% of total transport energy consumption in 2018, followed by trucks (38%), which is a rather high share by international comparison (Figure 4.12), due to transiting trucks filling up in Lithuania, as its diesel tax is lower than in neighbouring countries. International freight plays an important role in transport consumption and the recent increase in the sector's energy consumption is much linked to this.

Lithuania had around 1.4 million passenger cars in 2020. The share of diesel use is high, supported by a lower excise duty rate on diesel than on gasoline. In 2018, the consumption of diesel represented more than three-quarters of total consumption of the sector, followed by gasoline (11%) and liquefied petroleum gas (LPG) (5%).

Figure 4.12 Transport energy demand in Lithuania by mode and fuel, 2018



Energy consumption in the transport sector consists mainly of consumption of diesel oil by cars and trucks.

* *Ships, buses and motorcycles* are not visible in the chart and represent about 0.2% each.

** *Electricity* is not visible in the chart and represents 0.3% of total consumption.

Source: IEA (2020a), *Energy Efficiency Indicators 2020*, www.iea.org/statistics.

Alternative fuel passenger cars represent less than 1% of total cars despite expanding networks for refuelling and electric charging points (177 points in 2020). Lithuania has a strong market for compressed natural gas and LPG use thanks to exemption of natural gas used as transport fuel from excise duty, but electrification of transport activity has been slow. The installation of recharging points saw a strong rise during 2016-18, but has fallen in recent years (EAFO, 2020).

Public transport (rail and buses) accounts for only 8.9% of passenger travel and its use is decreasing.

Rail electrification increased to 8% of the total network (149 km of electrified railway lines in 2017), which is still one of the lowest in the EU.

Policies and measures

The Ministry of Transport and Communication targets policies for the renewal of vehicles, greater electrification, the promotion of rail and the development of local sustainable mobility plans as well as green public procurement. The government aims to increase fuel taxes (diesel, gasoline and LPG) with an expected savings of 6 TWh (see Table 4.1).

The electrification of rail is a priority for the government, notably along the key artery from Kena to Klaipeda. This includes the electrification of the Vilnius railway junction by connecting it to the already electrified Vilnius-Kaunas section, to electrify Kaišiadorys-Radviliškis (125 km) and Radviliškis-Klaipėda (196 km). In addition, Lithuania, together with other Baltic states, is implementing the Rail Baltica project supported by EU funds. By 2030 the government plans to have electrified 814 km of railway lines.

In line with EU Directive 2019/1161,[5] Lithuania is adapting its legal framework to increase the use of clean vehicles and reduce the number of conventional fuel vehicles by meeting the minimum public procurement targets in 2025. The Alternative Fuels Law, adopted by Parliament in March 2021 sets out a full suite of measures.

The government supports the purchase of electric vehicles (including second hand electric vehicles) with the aim to reach a share of 10% electric cars in passenger car sales by 2025 and 50% by 2030. The share of clean cars (categories M1, M2 and N1) in green procurement must be at least 60% of the total fleet and the number of clean buses (category M3) must be at least 80% of the total fleet. Until 2030, the proportion of non-polluting light vehicles (categories M1, M2 and N1) in green procurement must be 100% of the total fleet, non-polluting heavy vehicles (categories N2 and N3) must be at least 16% of the total fleet, and the number of clean buses (category M3) must be 100% of the total fleet. Half of the target for buses must be zero emissions. The government plans to purchase an urban and suburban public vehicle fleet with the purchase of about 150 electric-powered city and commuter buses during 2023-25 with EU funding.

At the local level, Lithuania has around 20 sustainable urban mobility plans in place. The implementation of these plans is expected to significantly reduce car use, promote walking and double cycling, and increase public transport and the use of alternative fuel vehicles.

Energy efficiency and sustainable recovery

Under the NECP, the investment needs in energy efficiency for the period up to 2030 represent EUR 2.6 bn. Public funds are expected to contribute EUR 976 million. The national Economic Stimulus and Coronavirus Mitigation Action Plan allocates short-term funding to building renovation. Lithuania's medium- to long-term recovery plan is under preparation. At the time of writing, Lithuania is preparing its draft Resilience and Recovery Plan to benefit from the funding under the EU Resilience and Recovery Facility under which investment in building renovation is one of the priority areas. Lithuania is also finalising its operational programme under the EU Cohesion Policy funds for the period 2021-27.

[5] Directive 2019/1161 of the European Parliament and of the Council of 20 June 2019 amending Directive 2009/33/EC on the promotion of clean and energy efficient road transport vehicles.

According to the IEA Sustainable Recovery Plan (IEA, 2020b), energy efficiency measures are not only boosting short-term employment, but are also creating long-term job impacts and economic growth while boosting self-sufficiency, decreasing reliance on supply chain risks and fuel prices, and contributing strongly to climate targets and sustainability. For example, energy efficiency retrofits can often be ramped up quickly, as can projects to install or improve urban transport infrastructure. Both measures will require strong engagement with municipalities and local authorities. The central government can improve the sharing of information and best practice across the country to catalyse learning effects, create scale quickly and help mobilise private capital.

Public funding is important, but private investments will need to contribute to a large extent as well. The energy service companies' market for energy performance contracting in Lithuania (for residential buildings) is still at an early stage, but good experience was found in industry. In order to address market barriers, Lithuania has been successful in using the ELENA Project Development Assistance, managed by the European Investment Bank, and is in the process of finalising preparations for the next period. In terms of green finance, the Lithuanian state-owned company Ignitis, in co-operation with the European Bank for Reconstruction and Development, had a successful initiative resulting in the issuance of EUR 300 million in green bonds. This has brought down interest rates for investments in renewable energy, energy efficiency, clean transport, and pollution prevention and control.

Assessment

Lithuania aims to increase energy efficiency with an objective to ensure that primary and final energy intensity is 1.5 times (-66%) below 2017 levels by 2030 and about 2.4 times (-42%) below 2017 levels by 2050, as part of the NEIS of 2018. With this ambitious and explicit 2050 target, Lithuania leads internationally. Lithuania has decoupled its energy consumption and economic growth for some years, final energy consumption has recorded an increasing trend since 2014. In terms of primary energy consumption, Lithuania reached 6.3 Mtoe in 2018, which is close to its 2020 target of 6.5 Mtoe.

However, Lithuania will need additional measures in order to reach its 2020 target of 4.3 Mtoe for final energy consumption (from the current level of 5.5 Mtoe). Progress in energy efficiency has been lagging behind: buildings renovation is well below the targeted rate, even in public buildings, and results of audits carried out in industry are not always implemented. The transport sector had almost no national energy efficiency measures implemented until 2020 although energy consumption has been on a stark rise in this sector.

The lion's share of savings needs to come from the energy savings obligation, which amount to 27.3 TWh (2 346 ktoe) for the period 2021-30 under the EED II, as amended by Directive (EU) 2018/2002. The buildings and transport sectors are the key areas targeted, whereas cross-cutting measures are also expected to play a role, with projected savings of 6 TWh (516 ktoe). These measures relate to changes in excise duties applicable to fuels, energy savings agreements and consumer consultation agreements.

Energy efficiency policies and measures expand across a range of sectors with the involvement of several ministries and stakeholders. The recently adopted legislation introduces clear responsibilities for each ministry to implement quantified energy saving targets by 2030. It also supports requirements to consider the energy-efficiency-first

principle across the entire energy system. However, it is not clear how this principle will be applied in practice and energy efficiency action is fragmented across government, leaving untapped opportunities to promote investment in energy efficiency and leverage job creation potential under the national recovery efforts.

Buildings

Building on the progress in public buildings, Lithuania is encouraged to further prioritise building renovations more broadly in the recovery context and increase the funds for renovation. Lithuania needs to facilitate the cost-effective transformation of existing buildings into near-zero energy buildings by 2050.

The Long-Term Renovation Strategy sets out indicative milestones for 2030, 2040 and 2050 as well as a list of national financing measures. It is a key planning tool in the context of Lithuania's national recovery plan, to apply for funding to finance concrete projects and frontload investments. Opportunities abound under the EU Renovation Wave, which was presented by the European Commission in October 2020, and the additional support available from the EU under the Next Generation EU and the next Multiannual-Financial Framework.

The government should engage with subnational authorities to scale up renovations of all types of public buildings (beyond central government buildings, like municipality buildings, schools, universities, hospitals, etc.). Providing them with some subsidies is listed as a policy measure under the NECP, but incentives and finance should be combined with information sharing and capacity building. Local authorities are encouraged to promote renovation based on a neighbourhood approach.

As appliances are a major energy consumer in the residential and commercial sectors, the government should continue to support minimum energy performance standards for appliances through mandatory labelling and targeted rebates. An appliance upgrade programme should also be part of the renovation strategy, as a "cash for clunkers" initiative.

Responsibilities for building renovation are shared among several ministries. The government is encouraged to closely monitor the overall progress in the building renovation and modernisation efforts with a clear trajectory built on a comprehensive inventory of its building stock (notably of the public buildings). Continuing and increasing the current financing schemes should be encouraged, including through procurement auctions, grants and rebates, but also by expanding ESCOs, notably for public and service sector buildings and multi-apartment buildings with multiple owners.

Lithuania records the second-highest number of households in the EU affected by energy poverty (27.9% in 2018) and aims to reduce it to 17% by 2030. Support schemes are implemented to partly compensate for energy-related expenditure in energy-poor households. The government could adapt energy efficiency standards and programmes to the energy poor and may wish to review opportunities in this area, as price regulation of final consumers is supposed to be removed in the coming five years (see Chapter 7).

Heating and cooling

Heating and cooling supply switched from fossil fuels (natural gas and oil had shares of 60% and 20% respectively in 2000) to biomass and waste (82% in 2019), thanks to

efficiency upgrades, reforms of the heat market and support from EU Structural Funds. Heating prices have decreased sharply in the past years, as the role of biomass has increased. The lower DH prices are one reason why there are also lower incentives for energy efficiency investment.

Opportunities abound in the heat sector, where energy efficiency could be further improved by modernising outdated heat metering, heat management and adjustment systems. Public funding is particularly critical, as the newly introduced regulation of district heating fails to incentivise such investment in the modernisation, upgrade and smartness of heat production and networks. The long-term renovation strategy and the Resilience and Recovery Plan offer an opportunity to place renovation and heat in the recovery context.

Lithuania needs to promote heat supply diversification away from biomass and boost the use of new technologies, including heat pumps and solar technologies. Lithuania is encouraged to put substantial effort into the preparation of the comprehensive assessment of the potential for efficient heating and cooling, required by the end of 2020 under EU legislation. This assessment can enable effective decision making and should be based on an in-depth evaluation of the energy efficiency potential in the heating and cooling sector. To exploit the identified potential, including for the recovery of waste heat, policies and measures should be identified and interlinked with the Long-term Renovation Strategy.

To further promote the decarbonisation of heating and cooling as well as energy system integration, integration of renewables and the use of waste heat, Lithuania is encouraged to consider promoting smart and modern heating and cooling technologies. Due attention should be given to respecting sustainability requirements for biomass. Lithuania has an ambition to move to fourth-generation DH projects. The new Heat Law is expected to incentivise DH suppliers to switch to innovative and more efficient technologies.

The market regulation establishes remuneration to DH companies only when they produce heat (without separately covering fixed costs). The sector records increased competition from independent heat suppliers, whereas the overall demand in the district heating sector is projected to decline as a result of energy efficiency improvements in buildings. The IEA encourages the government to consider a balanced approach when engaging renovation projects at the district scale, by addressing demand- and supply-side measures together and reviewing whether the regulatory framework provides stability for the operation and remuneration of DH companies under declining heat demand.

Industry

Industry represents the highest share of final energy consumption, accounting for about one-third, followed by transport. It continues to be largely fuelled by natural gas, followed by electricity, oil and heat extracted from the ambient by heat pumps.

Energy efficiency improvements in industry are largely triggered by energy savings obligations or the recommendations from energy audits. Applicable to large enterprises,[6] this obligation is well implemented in Lithuania. Many companies have been certified under ISO 50001 for their energy management systems. The government plans a financial

[6] The audit is obligatory (every four years) only for large companies registered in Lithuania and carrying out economic activities in its territory, i.e. the audit is mandatory only for companies with an annual average number of employees greater than 250, annual revenue exceeding EUR 50 million, and the value of assets shown in the company's balance sheet exceeding EUR 43 million.

instrument to encourage companies to implement energy efficiency measures, focusing on upgrades and the greening of heat, power and gas consumption, identified in the audit as well as a tax rebate available to companies that implement the recommendations of the audits. SMEs are incentivised with grants for the preparation of audits and are reimbursed on the basis of the savings realised. SMEs can also be incentivised to implement efficiency measures through information sharing, which is not yet fully exploited in Lithuania. In the industry sector, Lithuania records a good participation of ESCOs.

Considering the high reliance on fossil fuels and the objectives of smart energy system integration and the circular economy, industry should consider using the untapped potential in recovering waste heat in internal processes, or by selling it to a nearby industrial installation or district heating network. Upgrading key industrial equipment, such as motors, pumps and lighting; better controlling industrial processes; and optimising energy use through innovative digital technologies, might provide some additional opportunities. Recent changes in the national regulatory framework are a welcome development and should be effectively implemented. The industry should also explore entering into power purchase agreements for renewables.

Transport

The IEA commends the government's leadership on public procurement, in line with Directive 2019/1161. It is welcome that the government has significantly expanded energy efficiency measures to infrastructure renewal and electrification, all measures which are new and have not been included in the energy efficiency policies and measures to date.

However, Lithuania has not yet used taxes to steer behaviour and fuel economy. In fact, the planned increase in fuel taxes does not target diesel use, but petrol and LPG. The EU level requirements limiting CO_2 emissions for cars are an important driver for efficiency improvements. The new motor vehicle registration tax, applicable since July 2020, includes a CO_2 component and depends on the fuel type. The tax rate is set for cars whose emissions exceed CO_2 130g/km, which is well above the threshold for emissions for new cars in application in the EU. Current intentions are to introduce an annual car tax. Incentives are provided to encourage the replacement of old vehicles, available even for switching to a less polluting internal combustion engine (ICE) vehicle (diesel fuelled cars are, however, not included).

The government intends to engage important renewal of the urban and suburban public transport fleets, promoting green public procurement, pursuing the electrification of railways (including Rail Baltica, a joint project with Estonia and Latvia) and implementing sustainable urban mobility plans, in co-operation with 22 municipalities to implement a modal shift and reduce CO_2 emissions.

Lithuania has also set ambitious plans for the uptake of electric vehicles, aiming to reach a level of more than 46 000 electric vehicles in circulation by 2025, followed by a fivefold increase by 2030. Subsidies are provided for the purchase of electric vehicles, in addition to measures targeting the public transport fleet. Most of these measures will benefit from EU funding.

The Law on Alternative Fuels presents a framework for achieving the goal of a 15% share of renewable energy sources in the transport sector by 2030, by introducing various

measures and targets. The IEA encourages Lithuania to develop a comprehensive strategy to address decarbonisation and efficiency in the transport sector, including through a Smart Mobility Strategy.

The government has assessed the needs for the charging infrastructure deployment. Considering the projected significant increase in the deployment of electric vehicles, proper attention should be given to electricity grid stability and smart charging. Successful electrification of transport means that the new load must not lead to congestion in an already heavily used electricity system. Smart charging can contribute to addressing these challenges and to limiting costly investments in grid capacity while ensuring cost-efficient integration of electric vehicles and charging points in the electricity system. The government should also secure the deployment of recharging points in buildings, in line with the requirements of the EU Energy Performance of Buildings Directive.

Recommendations

The government of Lithuania should:

- Make energy efficiency a central component of the economic recovery plan to create jobs and economic stimulus by directing available EU, national and other public funding to building renovation and energy efficiency upgrades in heat and transport systems.
- Speed up the implementation of energy efficiency policies and measures in all sectors, notably the NECP actions, and apply the energy-efficiency-first principle by improving co-ordination across government.

Buildings

- Implement the long-term renovation strategy including its financing measures for medium-term recovery of the economy, and monitor the progress of building stock renovation. Work with municipal and local authorities to boost investment in the renovation of public buildings across the country.
- Design effective building renovation schemes that can boost energy performance contracting, private financing and projects on a neighbourhood scale, and address the specific needs of low-income citizens and low-performing buildings in order to alleviate energy poverty.

Heating and cooling

- ☐ Complete a comprehensive assessment of the potential for efficient heating and cooling (district and decentralised), including for the recovery of waste heat. Promote the diversification of the heating and cooling mix, notably by exploring the potential of geothermal, solar and heat pumps.
- ☐ Ensure that the regulatory framework of DH provides sufficient incentives to promote efficient operation of DH companies and adequate investments. In this context, ensure co-ordination between supply- and demand-side measures when carrying out larger building renovation projects, involving all relevant stakeholders, e.g. municipalities, DH companies.

Industry

- ☐ Work with industry on strategies to exploit the use of waste heat and the potential for co-generation and energy efficiency upgrades, like the replacement of motors and equipment.
- ☐ Design a strategy to drive the uptake and implementation of the energy management measures, which were identified in the audits in the SME segment through a suite of policies, including incentives, information sharing and training.

Transport

- ☐ Design a strategy for the decarbonisation of the transport sector that strengthens efficiency and fuel economy and facilitates the shift to alternative fuels and vehicles through a suite of measures, including emissions performance standards, support schemes and taxation measures.
- ☐ Place an emphasis on the role of infrastructure investment (electric vehicle charging points, electrification of rail and others) as a means to create jobs and boost recovery.

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5. Renewable energy

Key data

(2019)

Renewables in total final energy consumption (TFEC)[1] (2019): 1.8 Mtoe or 33.5%, IEA30 (2018): 12.9%

Renewable share by sector TFEC (2019): 75.8% electricity, 53.9% heating, 3.7% transport

Renewables in electricity generation (2019): 2.5 TWh or 76%* (wind 44.5%, bioenergy and waste 18.4%, hydro 10.2%, solar 2.7%), IEA30: 25.4%

* Taking into account that Lithuania imported 70% of its electricity consumption, the share of renewables was 18%.

Overview

Renewable energy is the main pillar of Lithuania's ambition of reaching energy independence and further decarbonising heat and transport. The share of renewables in total final energy consumption[1] (TFEC) increased by 67% between 2009 and 2019 from 20% to 34%, well above the IEA average of 12.9%. In 2018, Lithuania ranked sixth-highest, after Norway, Sweden, Finland, Denmark and Austria and fourth-highest for the share of renewable district heat.

Direct use of bioenergy has been the main source of TFEC and witnessed a further expansion in district heating (DH). Half of the heat demand is covered by bioenergy (including non-renewable waste). In transport, the role of alternative fuels remains small, with only 4% of demand covered by biofuels and renewable electricity. Lithuania's domestic electricity generation is already low-carbon, with 76% of electricity produced from renewable sources (wind, bioenergy and waste, hydro, and solar). Considering that Lithuania imports around 70% of its electricity consumption, the share of renewable electricity in total supply is only 18%.

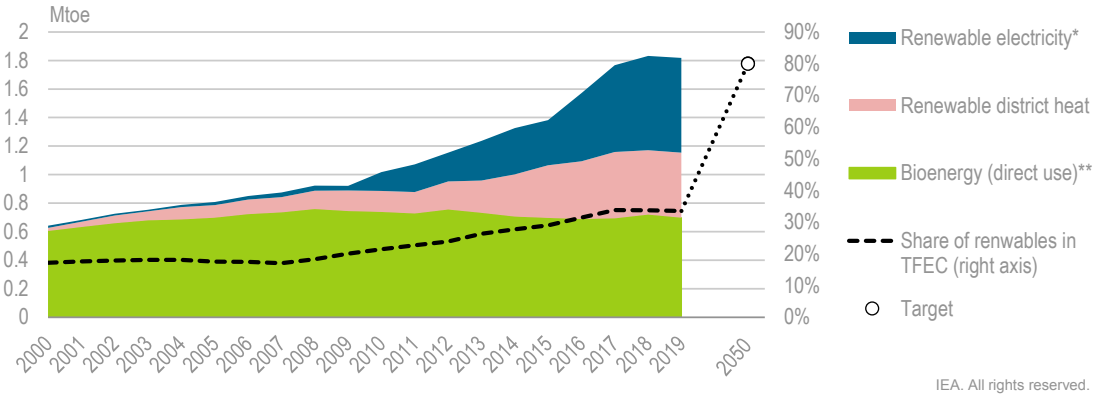
Lithuania has adopted renewable targets up to 2030 and 2050, at which time 100% of electricity is expected to come from renewables. New support schemes (auctions, prosumers and renewable energy communities) are in place and funding from Lithuania's recovery plan targets the deployment of more renewables and energy efficiency alongside system integration (storage and grids), all of which should boost renewable deployment significantly.

[1] Total final energy consumption is the sum of the final energy consumption in the transport, industry and other sectors (also equivalent to total final consumption minus non-energy use). This does not correspond exactly to the Eurostat definition of "gross final energy consumption".

Renewable energy in total final electricity consumption

Direct use of bioenergy[2] historically dominated the renewables sector in Lithuania, but in recent years bioenergy is also increasingly used in DH, and wind energy is growing quickly in renewable electricity production (Figure 5.1). Renewable district heat increased more than threefold, from 144 kilotonnes of oil equivalent (ktoe) in 2009 to 456 ktoe 2019, while renewable electricity experienced even faster growth, from 34 ktoe in 2009 to 664 ktoe in 2019, driven by the increase of wind power and bioenergy use for electricity generation.

Figure 5.1 Renewable energy in total final energy consumption in Lithuania, 2000-19



Bioenergy remains the pillar of TFEC, but electricity and heat generation are increasingly sourced from renewables.

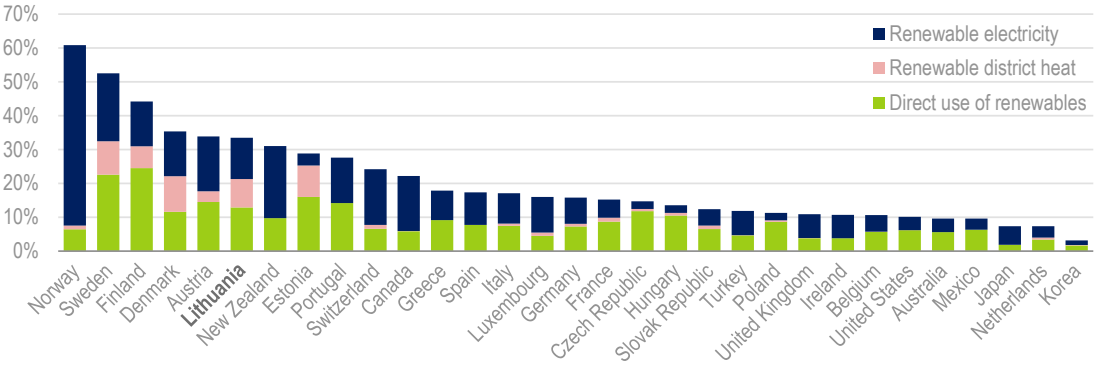
* *Renewable electricity* is computed as the electricity consumption x the share of renewable energy in domestic electricity generation.

** *Bioenergy (direct use)* includes solid biofuels and renewable waste, liquid biofuels, and biogases.

Notes: Mtoe = million tonnes of oil equivalent. TFEC = toal final energy consumption.

Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

Figure 5.2 Share of renewables in total final energy consumption in electricity and heat in Lithuania compared to IEA member countries, 2018



Compared to IEA member countries, Lithuania ranked sixth for the share of renewables in TFEC for electricity and heat.

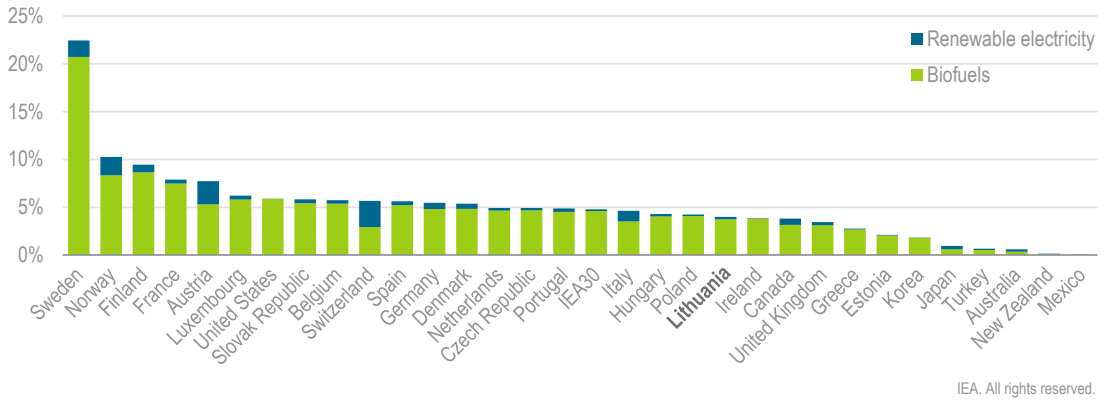
Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

[2] Bioenergy only includes renewable bioenergy sources, excluding non-renewable waste.

Recent growth of renewables in electricity and heat places Lithuania among the leading IEA countries alongside Norway, Sweden, Finland, Denmark and Austria (Figure 5.2).

In contrast to the significant role of renewables in domestic electricity generation (76%) and in heat TFEC (54%), the role of renewables in transport remains low. Only 3.7% of TFEC in the transport sector came from renewables in 2019, with 3.5% from biofuels and 0.2% from renewable electricity. Lithuania performed below the IEA average in 2018 in renewable energy in transport, including the use of electricity (Figures 5.3 and 5.4).

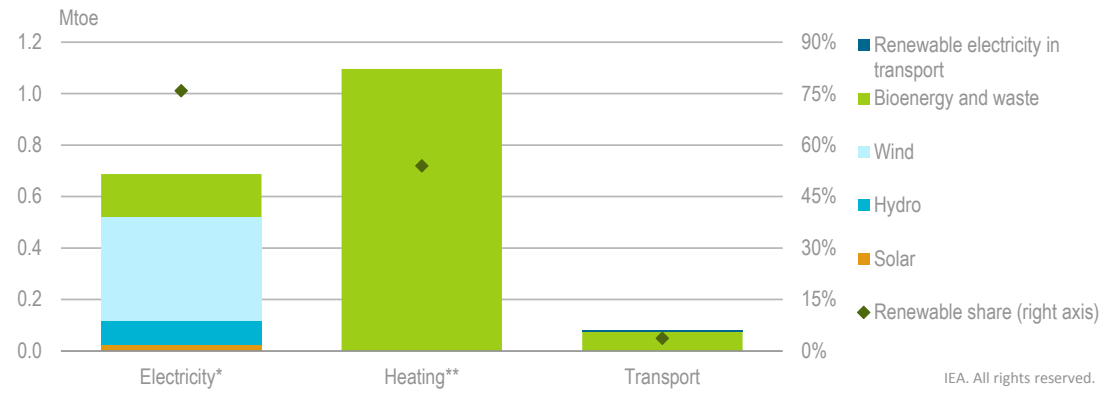
Figure 5.3 Share of renewables in total final energy consumption in transport in Lithuania compared to IEA member countries, 2018



Lithuania was below the IEA median when it comes to the share of renewables in transport.

Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

Figure 5.4 Renewable energy in Lithuania in electricity, heat and transport, 2019



Bioenergy is the largest source of renewable energy for heat and transport, while wind dominates renewable electricity, followed by bioenergy and hydro.

* *Electricity* refers to final electricity consumption, with the breakdown by fuel based on domestic electricity generation. Electricity used for heating is included under electricity due to limitations in statistical data collection.

** *Heating* includes direct use of renewable energy and renewable district heating in industry, residential and service buildings (including agriculture).

Note: Mtoe = million tonnes of oil equivalent.

Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

Renewable energy strategy and targets

Renewable energy is one of the key pillars of Lithuania's long-term energy strategy, the National Energy Independence Strategy (NEIS). The updated NEIS of 2018 makes the case for systematic expansion of renewable energy. Lithuania aims to have at least 45% of its consumption sourced from renewables by 2030. The government also specified a national 2050 target of 80% of renewable energy in overall energy demand and 100% renewables in electricity consumption. At the EU level, Lithuania joined a coalition of five EU countries (Austria, Denmark, Ireland, Luxembourg and Spain) calling for the inclusion of a 100% renewable energy (electricity) scenario in the EU's long-term climate projections.

Under the 2018 NEIS, about 3.8 terawatt hours (TWh) of annual onshore wind generation is envisaged by 2030, which requires a total capacity of 1 300 megawatts (MW) (an additional 400 MW by 2025 and another 370 MW by 2030). In 2050, Lithuania will need around 18 terawatt hours (TWh) of annual electricity generation, more than half of which – about 10 TWh – is expected to be produced from wind both onshore and offshore (Republic of Lithuania, 2018a).

Progress towards renewable targets

In 2014, Lithuania had already achieved its objective to source 23% of its energy consumption from renewable resources by 2020. In 2017, Lithuania agreed to transfer part of its 2018-20 renewable energy production as a statistical surplus to Luxembourg: a minimum of 700 GWh at a revenue of EUR 10 million. These funds are earmarked for investment in renewable energy projects and research in Lithuania.

Deducting this statistical transfer, Lithuania's share of renewables in TFEC reached 24.69% in 2018, placing it among the leading EU member states (behind Sweden and Finland) which source more than 20% of their final energy consumption from renewable sources. Under the EU methodology for the renewable energy targets, the share of renewables in Lithuania stood at 46.2% in heating and cooling, 18.4% in electricity and 4.3% in transport in 2018 (Table 5.1).

Table 5.1 Lithuania's medium- to long-term targets for renewables

	2020 targets	2025 targets	2030 targets	2050 targets	2018
Share of renewable energy sources (RES) in final energy consumption	30%	38%	45%	80%	24.69%*
Share of RES in final energy consumption in the electricity sector	30%	31.48%	45%	100%	18.41%
Share of RES in final energy consumption in the transport sector	10%	9.23%	15%	50%	4.33%
Share of RES in final energy consumption in the heating and cooling sectors	50.9%	63.1%	67.2%	-	46.02%
Of which RES share in district heating	70%	89.3%	90%	100%	67.5%

* After statistical transfer to Luxembourg.

Source: Republic of Lithuania (2019), *National Energy and Climate Plan,* https://ec.europa.eu/energy/sites/ener/files/documents/lt_final_necp_main_en.pdf.

Policies and measures

Lithuania has several support schemes, which have been adjusted over time. In 2018 and 2020, parliament approved amendments to the Law of the Republic of Lithuania on Energy from Renewable Sources, moving to a sliding feed-in premium for renewable electricity (regulated by the National Energy Regulatory Council [NERC] and allocated through auctions), as well as provisions for renewable energy communities (Republic of Lithuania, 2020).

The Alternative Fuels Law was adopted in March 2021. It will form the basis for new support measures for biofuels and alternative fuels, including renewable electricity, hydrogen and biomethane gases (Republic of Lithuania, 2021).

Moreover, the government offers loans and subsidies under the Environmental Project Management Agency's Climate Change Programme. Lithuania also has tax exemptions for bioenergy under the Environmental Pollution Tax and the excise duty.

Bioenergy and sustainability

Lithuania's bioenergy sector generated around EUR 300 million of turnover and employed around 7 500 people in 2019. It is also a major export industry. In 2019, 46 DH companies, 18 independent heat producers and 98 biofuel suppliers were active in the Lithuanian biofuels market.

Almost all bioenergy used in the heating sector is woody biomass, of which the largest share is harvested in Lithuania itself. Depending on the price trends, the country also imports biomass through the Baltpool market (without sustainability certification). In recent years, biomass supply from Belarus to Baltpool increased, as Belarus carried out major deforestations in its territory. Lithuania's Baltpool is the wholesale market for biomass across Denmark, Finland, Sweden and the three Baltic states. Prices of woodchips reached a historic low in May 2020 (EUR 111.99/toe [EUR 9.63/MWh]) and the turnover under half-year contracts increased by 28%, from EUR 5.02 million to EUR 6.42 million and breached the historic peak of EUR 10 million with EUR 13.02 million in April 2021.

To date, Lithuania does not produce domestic second-generation biofuels and most of the liquid biofuels produced and consumed in Lithuania are rapeseed-based first-generation biofuels (Fatty Acid Methyl Esters, FAME). Feedstocks are not commercially available to produce substantial amounts of second-generation biofuels. However, the government wants to move from biogas to biomethane, produced by waste as feedstock, which is abundant.

Sustainability is a critical requirement for the continuous use of bioenergy, notably for Lithuania's bioenergy trade and production, as part of the necessary move towards the import and/or production of second-generation biofuels and related technologies.

Under EU law, sustainability criteria were introduced in 2015 (based on amendments to the Renewable Energy Directive [RED] and the Fuel Quality Directive) in response to concerns about the impacts arising from competition of biofuels with food production (ILUC) (2015/1513). Under the overall EU 10% blending target for biofuels, the EU limited the contribution from biofuels produced from crops that could be used for food production to 7%. This means *de facto* that in Lithuania, biofuels cannot be produced on primary forest, peatlands, wetlands or high biodiversity lands. The EU is also phasing out food-crop

biofuels through a new certification process. RED II promotes shares of advanced biofuels and biogas of 1% in 2025 and at least 3.5% in 2030.

Renewable electricity

Under the Law on Energy from Renewable Sources, the production quota for the period until 2020 was fully achieved in 2015, and the support was suspended, which resulted in a slight slowdown of investment until 2018.

In May 2019, the Lithuanian government introduced a new renewable electricity aid scheme with a total budget of EUR 385 million, following the approval of the state aid scheme by the European Commission. Auctions are run in a technology-neutral manner and let wind, solar, biomass and hydropower installations compete for the premium based on the production cost of the cheapest technology. The government allocates a feed-in premium over 12 years on a competitive basis to reach a total of 5 TWh of electricity produced from renewables up to 2025 and to meet the target of renewable electricity in gross final consumption.

The new scheme started in 2019 and annual auctions are planned until 1 July 2025 or, alternatively, until the 5 TWh target is reached. The allocation is done by auctions for production quotas by bidders that offer the lowest premium tariff. The premium is set as the difference between the electricity market price ("reference price") and the average production costs of the most cost-efficient renewable energy technology ("maximum price"), which today is onshore wind in Lithuania. NERC is in charge of organising the tenders and setting the reference price and the maximum price for each auction. Producers pay 100% of the grid connection costs.

The first auction was held in September 2019 for all renewable energy technologies. Producers bid for a maximum premium of EUR 3.86/MWh during the auction, the difference of the reference price of EUR 45.07/MWh and the maximum price of EUR 48.93/MWh. UAB Windfarm Akmene One won the auction by bidding a premium of EUR 0/MWh for the entire promotion quota proposed for 2019 (0.3 TWh per year). This confirms the attractiveness of the electricity price at the exchange, coupled with the guaranteed priority dispatch for 12 years and the favourable cost of onshore wind, which allows companies to operate under market conditions.

The 2020 auction was declared void by NERC, as less than three bids were submitted for the production quote of 0.7 TWh. The next auction is scheduled for April 2021.

In June 2020, the government released a plan to promote offshore wind in the Baltic Sea with a capacity of up to 700 MW to be constructed by 2030, based on a tender to be held in February 2023. A dedicated offshore wind support scheme is being negotiated with the European Commission and discussed in parliament. The territory in the Baltic Sea for the wind turbines will cover 137.5 km^2, 30 km offshore and at an average water depth of 35 m. The Lithuanian Energy Agency will lead on the approvals of spatial planning and environmental procedures. To connect the offshore wind farm to the Lithuanian transmission network, a 330 kilovolt (kV) substation at sea would be built to connect to a new cable up to the Darbėnai substation and new 330 kV transmission lines along Darbėnai-Mūša-Panevėžys. Lithuania's offshore plans are part of a regional strategy, based on a joint declaration by the European Commission and Lithuania, Denmark, Estonia, Finland, Germany Latvia, Poland and Sweden. The co-operation focuses on

increasing offshore wind power capacity and improving the transmission system in the Baltic Sea within the Baltic Energy Market Interconnection Plan.

As part of the government's strategy to produce all of its electricity supply domestically by 2050 (thus reducing today's import needs from 70% to 0%), Lithuania is actively supporting decentralised energy production through its prosumer scheme. Under this model, energy consumers are becoming energy producers of local electricity generation, including solar PV and wind power facilities, thanks to a combination of different support schemes, including direct subsidies, net metering and virtual power plants (Box 5.1).

Box 5.1 Energy consumers become prosumers in Lithuania

- Lithuania promotes the deployment of small-scale renewable energy installations owned by private energy consumers and renewable energy communities.
- The government invests the revenues received from the statistical transfers to Luxembourg in tenders for decentralised energy production facilities during 2020. Around EUR 7 million are allocated to renewable energy communities, farmers, and small and medium-sized enterprises for small-scale renewable projects. The support funds up to 45% of the investment costs for solar power plants (up to 500 kilowatts [kW]) and wind power plants (up to 3 megawatts [MW]).
- Lithuania targeted a share of 2% of total electricity consumers (1.6 million) to become prosumers by 2020, 30% by 2030 and 50% by 2050. At the end of 2020, Lithuania had 8 473 prosumers with an installed capacity of 80.5 MW, a significant increase from 2015 when it had 63 prosumers with 0.5 MW capacity. This is still below the targeted level for 2020. By 2024, a total of 696 MW of installed capacity is envisaged under the prosumer scheme for small-scale renewable energy facilities.
- Net-metering is in place for electricity production from solar and wind. Net-metering was introduced in 2015, but the design has been reinforced over the years. Net-metering can be used for solar PV and wind installations up to 500 kW by any legal or personal entity: by private households, commercial units, communities. EU funds support prosumers. As of 2019, prosumers received EUR 323 per kW of installed capacity in support. For the coming five years, the government has allocated EUR 23 million from EU funds to the prosumer scheme.
- The prosumer scheme is also facilitated by lower preconditions for development and production permits, a reduced cost for connecting to the networks, a general opening to enterprises, easing of the capacity limitation requirements, modification of financial incentives for solar installations, elimination of control accounting and inclusion of the investments needed for the integration of prosumers in the distribution system operator's investment plan.
- Virtual power plants are being integrated into the prosumer model in Lithuania and will boost the provision of demand- and supply-side system services. It is possible to construct PV power stations in one part of the country and consume its electricity in another; only the electricity transmission will be charged. Individuals can buy or lease part of a big PV facility (for instance 1 000 kW), thereby providing multi-apartment buildings with access to solar power.

Lithuania also has plans to expand the Kruonis pumped storage power plant. The plant was initially planned for 8 units, but only four 225 MW hydro units are operational today. The plant provides energy storage to the grid and significant flexibility for the power system, as it can generate 900 MW for 12 hours. It operates in conjunction with the Kaunas

hydroelectric power plant. The installation of an additional 225 MW unit (with total investment costs of EUR 110 million) is being planned, which would be more efficient than the older units. Lithuanian utility Ignitis is also investing in a small floating solar plant on the upper reservoir of the Kruonis plant with funding of EUR 235 000 from the Lithuanian Business Support Agency.

Chapter 7 examines in detail the opportunities and challenges from operating Lithuania's electricity system with higher shares of variable renewables, including at a distributed level.

Renewable heat

Lithuania's Law on the Heat Sector (Heat Law) of 2018 not only regulates the quality of supply, competition and access to heat networks, but also promotes the use of domestic sources, like biofuels and renewable energy for heat production, all the while mitigating the negative impact of the heat sector on the environment (Republic of Lithuania, 2018b). Lithuania's National Programme for the Development of the Heat Sector builds on municipal heat sector plans, alternative heat sources and the modernisation of the DH sector.

Co-generation[3] supply is a public service in Lithuania, while heat production is organised as a competitive activity with auctions. As cities have large DH networks and co-generation, under the Renewable Law and the Heat Sector Law, municipalities play a critical role in the promotion of heat supply from biofuels, renewable energy sources, waste incineration and geothermal energy. The municipalities have set out heat plans and are obliged to promote the purchase of renewable heat under a public service obligation.

Heat suppliers are obliged to purchase all heat from renewables generated by independent producers when such heat is cheaper than the heat produced by the heat supplier itself and satisfies environmental and quality requirements as well as standards for security of supply. This obligation does not apply when renewable heat generated by independent producers exceeds demand for heat-by-heat consumers (see Chapter 4).

The government supports the conversion of heat installations for households. Since 2011, the Climate Change Programme, through its annual funding envelope of EUR 2-3 million, supported the conversion from fossil fuel heating to biomass boilers. From 2019 to 2022, EU funding of EUR 21.7 million is being allocated to the conversion of inefficient biomass boilers to more efficient renewable heating, including heat pumps and biomass boilers that meet Class 5 efficiency and emissions requirements (under European standard EN 303-5:2012), particularly in areas with high local air pollution. Funding compensates for 50% of the purchase cost of the installation.

Renewable energy in transport

In recent years, the increase of transport has caused rising emissions, energy consumption and particulate matters. Diesel dominates the fuel use in road transport.

The transport sector has the lowest renewable energy penetration and the share of renewables in transport has stagnated at around 4.3% since 2014. In 2018, bioethanol made up 10% of renewable fuels used, of which biodiesel dominates (86.4%) and electricity remains at a very low level (3.6%). To date, there is no domestic second-generation biofuel production in Lithuania; most of the biofuels is rapeseed-based

[3] Co-generation refers to the combined production of heat and power.

first-generation biofuel. Improved infrastructure (refilling stations), vehicles (engines), and political regulations and incentives are needed for biomethane in transport.

In transport, Lithuania uses three main support schemes for biofuels: 1) blending mandates (with quotas) for biodiesel and bioethanol; 2) exemptions from excise duty; and 3) exemptions from the environmental pollution tax.

The National Paying Agency of the Ministry of Agriculture subsidises raw materials for biofuel production (part of the price of rapeseed oil used for the production of rapeseed methyl [ethyl] ester and part of the price of rapeseed and cereal grain purchased for the production of dehydrated ethanol is reimbursed).

To date, fuel traders are obliged to sell gasoline containing 5-10% biofuels and diesel containing at least 7% biofuel. The exemption from excise duty is only available for biofuels that meet the standards EN 14214 and CEN/TS 15293 approved by the European Committee for Standardization. The excise duty rate is reduced by the percentage in proportion to the percentage of additives of biological origin in the product.

The Alternative Fuels Law was adopted by the Parliament in March 2021 and will enter into force on 1 July 2021. It offers new provisions for the support of biofuels, biomethane and hydrogen and promotes the use of electricity for the horizon up to 2030. Lithuania aims to reach a share of 15% of renewable energy in final energy consumption in transport by 2030 through a combination of measures. Lithuania proposes to increase the biofuel blending obligation for fuel suppliers (based on an energy target) up to 16.8% in 2030, with a sub-target of 3.5% of double counted advanced biofuel, and a certificate system for renewable transport fuels.

Fuel suppliers can therefore meet the obligation by physically blending biofuels, using renewable fuel certificates, transferring obligations between fuel suppliers or registering renewable fuels delivered by other non-obligated suppliers (e.g. biomethane producers).

Biomethane, hydrogen and syngas should make up at least 5% of TFEC in the transport sector in 2030. The government plans to shift existing biogas production subsidies (with feed-in tariffs set by NERC) to biomethane production and create a new investment support scheme for biomethane production facilities, using feedstock from wastes and residues. Biomethane production should reach 92 million cubic metres by 2030 (Republic of Lithuania, 2019). In 2020, Lithuania introduced guarantees of origin of gas from renewable sources and a national registry.

A Sustainable Mobility Fund will be created under the law to finance the implementation of the alternative fuels policy. It will need to raise significant revenues. Apart from EU funding, the government will need to examine options for raising fuel, excise and road usage taxes, and phasing out exemptions, as explored in Chapter 3.

With the fund, the government aims to financially support the roll-out of the enabling infrastructure, including 6 000 public electric vehicle charging stations, 30 natural gas filing stations to promote the use of hydrogen or biomethane, and public financial support for the purchase of light-duty electric vehicles. All public transport should run on alternative fuels by 2030 and after 2026 all passenger cars and buses purchased through public procurement procedures will have to be clean vehicles. Municipalities will be required to create low-pollution zones in the main cities, which should encourage the switch to clean vehicles, biking, walking and thus reduce air quality concerns.

Assessment

Renewable energy is the main pillar of Lithuania's energy independence. After the closure of the Ignalina nuclear power plant, Lithuania became a net importer of electricity and as part of its energy security agenda, increasing domestic capacity remains a critical energy policy priority. Today Lithuania imports around 70% of its electricity. The 2018 NEIS stipulates that electricity imports should be replaced by local electricity generation from renewable energy: domestic electricity generation should reach 70% (30% imported) in 2030 and 100% in 2050.

Under the EU targets, Lithuania has substantially increased the share of renewables in gross final energy consumption, reaching 24% in 2018, above the target of 23% in 2020. Lithuania is one of the few countries to have used statistical transfers under the EU Renewable Energy Directive. Revenues from the transfers are reinvested in renewable energy in Lithuania. Two major developments have been the driving forces behind this development: investment in new small-scale capacity for renewable electricity and in research and development of renewable energies.

The launch of new support schemes (feed-in premium with technology-neutral auctions, schemes for prosumers and renewable energy communities, new blending obligations under the Law on Alternative Fuels) are generous polices that will increase the production of renewable energy. Commendably, the recovery programme also aims to promote the system integration of variable renewables with planned investments in grid connection, storage and hydrogen.

Today, Lithuania has targets for renewable energy deployment in electricity, heating (district heating) and transport, in line with EU ambitions, but not yet geared towards 100% renewables. The country has joined a coalition of six EU countries that aim for 100% renewable electricity in 2050. As Lithuania wants to reduce electricity imports to 30% by 2030, the government should indeed implement an ambitious renewable energy strategy.

The role of bioenergy

Today, bioenergy is the largest renewable source (all sectors considered). Bioenergy provides the largest share of Lithuanian renewable energy supply and accounts for around 75% of all heat production in Lithuania. Around 95% of bioenergy is woody biomass, of which the largest share is harvested in Lithuania. Trade of biomass is organised at the Baltpool platform, the regional exchange for biomass. In recent years, imports of woody biomass from Belarus have increased due to large deforestations in Belarus. Without strong certification of sustainability, the platform promotes cheaper imports, which may raise concerns on the sustainability of biomass trade.

Clear and enforceable sustainability requirements for biomass feedstocks (imports and domestic production) would allow Lithuania to continue to rely on and expand the role of bioenergy and avoid sustainability concerns. In order to avoid impacts on biodiversity and other environmental dimensions, a further increase in the use of biomass and intensive forest biomass harvesting must be conditioned to the requirements of sustainable forest management. The implementation of the RED II Directive requires Lithuania to adopt criteria for the sustainability of bioenergy.

Indeed, modern bioenergy can play an important role in Lithuania's low-carbon future. Lithuania's forests are also a major carbon sink and the government is already counting its sinks towards EU emissions reduction targets up to 2030. Bioenergy is also balancing variable electricity production, mainly wind and solar, and will remain important to match peak load capacity, especially for cold winter days. Biofuels are key for decreasing emissions in the transport sector, notably in heavy transport, freight, maritime and aviation.

Lithuania could review its bioenergy support schemes to align them with its neighbouring Nordic countries, which are successfully investing in sustainable bioenergy. For instance, Finland promotes domestic modern bioenergy production by taxing unsustainable use. In Finland, biofuels are classified into three categories: 1) biofuels that fail to meet sustainability criteria are subject to the same CO_2 tax as fossil fuels; 2) sustainable biofuels (first-generation, agricultural origin) are subject to 50% of the CO_2 tax on equivalent fossil fuels; 3) second-generation biofuels (waste, lignin cellulose, etc.) are exempt from CO_2 tax.

Renewables in electricity

The share of RES in domestic electricity production in Lithuania has increased at a rapid pace to reach 76% in 2019 or 18%, taking into account that 70% of electricity consumed annually was imported. This rapid expansion is primarily driven by wind power, but also a rising share of solar PV. The support mechanisms for new RES capacity will support an increase in wind and solar PV capacity.

Like other countries on the Baltic and Nordic Sea shores, Lithuania eyes investment in new RES-E capacity through the auction of 700 MW of off-shore wind in the Baltic Sea, which is expected to bring a step change.

Lithuania has special support mechanisms for small-scale power plants and incentives for self-producing consumers (prosumers), the number of which the government wants to increase significantly in the coming years. Prosumer schemes and renewable energy communities help to engage citizens in financing new capacity, which helps develop awareness of renewable energy, public acceptance and societal involvement on these topics. The total number of prosumers is targeted to grow to around 700 000 by 2050, which is the most significant target in any EU country.

At the distributed level, solar PV will further grow, thanks to the generous support scheme, combining investment support and net metering. The integration of solar PV will require stronger storage and demand-side flexibility, all still under development in Lithuania. As the government is phasing out regulated prices for households, it is timely to assess the potential impacts of the prosumer scheme on the electricity market and cost-reflective pricing, including grid costs.

Growth is expected from onshore wind (today the most cost-efficient technology) and offshore wind in the future. If Lithuania further increases the share of domestic variable renewables, this can impact grid operations, power system stability[4] and strength.[5] Large offshore wind capacities in the western part of the country require investments in the electricity grid, which was developed for imports from the east. Lithuania will need to pay attention to ensuring the flexibility of the system. Moreover, the government aims at the

[4] The ability of the power system to return to its normal or stable conditions after being disturbed is called stability.
[5] System strength relates to the ability of a power system to manage fluctuations in supply or demand while maintaining stable voltage levels.

synchronisation with the European Continental power system by 2025 and to ensure the adequacy of the Lithuanian power system. The system and grid operators are already working actively towards these goals, as the in-depth analysis in Chapter 7 of this report confirms.

The IEA recommends that the Lithuanian government take further steps to accelerate the system integration of renewables, both within Lithuania and as part of its regional electricity interconnection and synchronisation with the EU network (see also Chapter 7). If the government wants to reach the target of 100% renewables by 2050, several critical elements need to be further analysed by the government and the system operator. These include the socio-economic cost, opportunities from innovation, and technology development and demonstration of system services for power system stability.

Renewables in heat

Most of the energy used by the residential and services sectors in 2018 was in the form of district heat and electricity. Bioenergy and waste played a major role, accounting for almost a quarter of the total energy consumed in these sectors, followed by natural gas (12%), while oil and coal had small shares each.

The renewable share of district heating tripled between 2011 and 2018. This was the result of support mechanisms in place since 2011 which promoted a shift from natural gas to biomass. Support is given to biomass heating installations (Class 5) and to heat pumps when shifting from fossil-fuelled heat installations. The public service obligations to purchase renewable heat combined with more expensive natural gas prices led to the switch to biomass, which also lowered the final heat price.

Quite a unique and rare feature among IEA member countries, single-family houses in rural areas mainly use woody biomass for heating. The use of biomass in district heating and in single-family houses, however, negatively impacts local air quality. Besides heat pumps, the government could promote the installation of shallow geothermal energy in buildings, for instance by financially supporting the exploration, in order to avoid putting too much pressure on biomass resources and to mitigate local pollution.

To date, the use of electric driven heat pumps is low in Lithuania. Heat pumps are an energy-efficient technology for heating. Lithuania targets 100% renewables by 2050. As electricity supply shifts entirely to renewable energy, electrification of heating will offer a renewable-based alternative to fossil fuels, and an alternative to biomass. Electrification of the heating sector will be relevant for both decentralised heating and DH.

A successful strategy would rely on partial heat electrification with heat pumps and thermal inertia/storage in buildings. However, this requires a higher level of building insulation (to maximise thermal inertia in buildings). Given the high share of district heating in building consumption, the government should leverage this asset by improving network efficiency and target 100% renewable district heat supplies, thanks to large-scale electric heat pumps (possibly ground source). Despite having already 70% of renewables in district heat, the government should indeed invest in the remaining 30%.

Flexible heat supplies will also contribute to system flexibility. Electrification of the heating sector as well as the industry and transport sectors can contribute to energy system integration, which can potentially increase the system's flexibility and thus improve energy security, reducing the need for interconnections. The government should assess the

perspectives for electrification in general and identify potential barriers and instruments to reduce the overall system costs via flexibility and sector integration.

Renewables in transport

The Alternative Fuels Law promotes a range of alternative fuels (including electricity, hydrogen and biomethane), vehicles and enabling infrastructure. This framework is complemented by a number of urban clean mobility plans targeting biking, walking, and the roll-out of clean vehicles and the enabling infrastructure, alongside planned investment in the electrification of rail, including the Rail Baltica project.

In the area of renewables, Lithuania is promoting the injection of biomethane into the gas system (shifting biogas to biomethane subsidies) to gradually support the decarbonisation of gas infrastructure over time. The government adapted the natural gas quality requirements to ensure their applicability to injected hydrogen gas in December 2020. In the longer term, biomethane and other green gases could provide valuable contributions to a green energy transition. In order to ensure the right framework conditions for investments in the production of green gases and the maintenance of gas distribution infrastructure in a cost-effective way, the government should develop a strategy for the future use of gaseous fuels, notably for energy services that are difficult to electrify. Such a strategy should also analyse the consequences for the gas infrastructure, as natural gas use is decreasing.

A new biofuel blending scheme will be introduced under the Alternative Fuel Law which will raise the blending obligation for fuel suppliers up to 16.8% in 2030 (15% plus the sub-target for advanced biofuel components). There is no domestic second-generation biofuel production in Lithuania. Given the limit on the use of first-generation biofuels for sustainability at 7%, Lithuania needs to invest in supplies of second-generation biodiesel, such as hydrogenation-derived renewable diesel.

Economic opportunities to develop domestic production can be promoted through incentives like reduced taxes or subsidies. Lithuania has recently introduced higher excise duties and value-added tax in order to increase energy efficiency in the transport sector. First-generation biofuel blends (FAME and ethanol) currently benefit from an excise duty exemption. The tax exemption should be modified and applied to second-generation biofuels as well as hydrogenation-derived renewable diesel, which is expected to increase in demand as the country implements its alternative fuel mandate to 2030.

Recommendations

The government of Lithuania should:

- In support of energy independence and the 100% renewable target by 2050, design a long-term renewable energy strategy for Lithuania, including a strategy for the electrification of end-uses, notably heat, and an assessment of system integration needs across sectors.
- Ensure that biomass for energy meets high standards of sustainability, as required under the EU Directive on Renewable Energy (RED II).

- Assess the conditions under which prosumers can produce and consume renewable electricity in order to ensure the proper functioning of the electricity market.
- Develop a strategy for the production and use of green gasses and the continued use of the existing gas infrastructure in order to provide renewable energy sources for those energy services which are difficult to electrify.
- Boost economic opportunities for the production of second-generation biofuels through support measures (tax incentives, subsidies and grants) as well as extending the excise duty or other environmental tax exemptions to those fuels, while considering higher taxes for first-generation biofuels and fossil fuels.

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6. Energy research, development and innovation

Key data

Total energy-related RD&D budget (2020 estimated): EUR 7.64 million

Share of GDP: 0.08 per 1 000 GDP units (IEA average: 0.25)*

Total private RD&D expenditure (2016): EUR 1.3 million (0.03% of GDP)

* Average for Lithuania and eight member countries for which 2019 data are available.

Overview

Lithuania's Ministry of Energy is stepping up the challenge of revitalising its energy innovation policies. The high-level objective of Lithuania's energy innovation policy is to become an energy technology exporter by 2030, based on the goals set out in the National Energy Independence Strategy (NEIS) of 2018 and the actions of the NECP.

The ministry is building on Lithuania's overall robust innovation policy and funding framework, and the ecosystem of technology and science clusters and start-ups in Fintech, eco-innovation and biotechnologies. The government promotes research, development and demonstration mainly through the Smart Specialisation Programme, which includes one priority on sustainability and energy. As the government starts preparing the next programme period of the Innovation Fund and recovery funding, it is timely that the Ministry of Energy adopted in September 2020 the Action Plan for Strengthening the Lithuanian Energy Innovation Ecosystem.

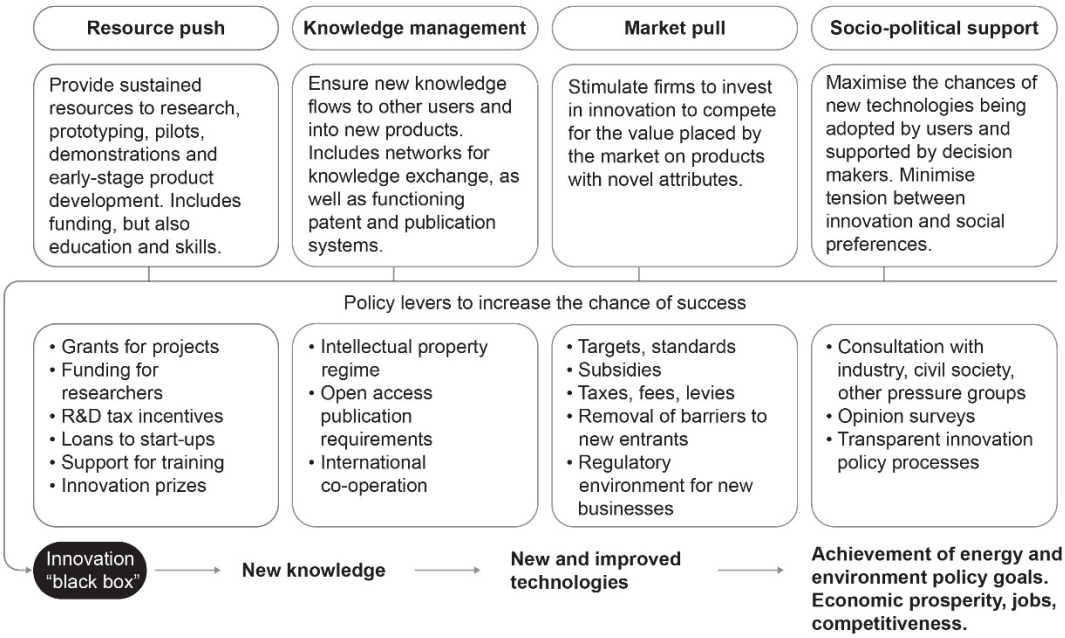
The action plan presents a comprehensive and consistent strategy for innovation of the energy sector, with actions to improve the availability of funding, preparation of energy projects, investments in human resources in the private and public sectors, and boosting collaborative activities, including at EU level under the EU research frameworks, like the SET Plan initiatives.

The government relies on a framework of grant funding, public procurement and regulatory sandbox models for business innovation. Commendably, the action plan will also create a consistent set of indicators for the monitoring and tracking of funding and results.

IEA framework for energy innovation policies

Technology innovation processes are complex and decision makers must pay attention to a variety of elements that characterise successful energy innovation systems (IEA, 2020). The IEA groups these elements into four core functions: 1) resource push; 2) knowledge management; 3) market pull; and 4) socio-political support (Figure 6.1).

Figure 6.1 The IEA's four functions of a successful innovation ecosystem for energy



Source: IEA (2020), Tracking Clean Energy Innovation: A Framework for Using Indicators to Inform Policy, IEA, Paris, www.iea.org/reports/tracking-clean-energy-innovation.

While the appropriate policy measures to address each function can vary widely with the size and structure of a country's economy, the technologies it prioritises and the strength of its existing research and development (R&D) base, successful energy innovation ecosystems can have effective policies in each of the four areas. In some cases, the policies might operate at different levels, such as local, national or municipal levels.

Successful innovation systems involve a wide range of actors with aligned interests and a wide variety of mandates and responsibilities. These actors can be engaged by targeted policy interventions. A comprehensive approach to energy innovation policy, such as through co-ordinated action under each of these four headings instead of a silo approach, can increase the chances of successful technological change.

- **Resource push:** A sustained flow of R&D funding, a skilled workforce (e.g. researchers and engineers) and research infrastructure (laboratories, research institutes and universities) is required. These resources can come from private, public or even charitable sources, and can be directed to specific problems or basic research.
- **Knowledge management:** Knowledge should flow smoothly between researchers, academia, companies, policy makers and international partners, among others.

- **Market pull:** The expected market value of new products or services must be big enough to make the R&D risks worthwhile, and this is often a function of market rules and incentives established by legislation. If the market incentives are high, then much of the risk of developing a new idea can be borne by the private sector.
- **Socio-political support:** There needs to be broad socio-political support for new products or services, despite potential opposition from those whose interests might be threatened.

This report will apply the IEA innovation framework to Lithuania with a view to assess the current state of play and derive concrete recommendations on how to enhance the innovation ecosystem for the clean energy transition. The following sections present the institutional and policy landscape across these four functions.

Energy priorities linked to innovation policy

Lithuania's overarching innovation framework focuses on the energy sector as a priority area. The Lithuania 2030 Strategy and its implementing National Progress Programme focus on boosting incentives for business to invest in green technology development. The Lithuania 2030 Strategy promotes a smart society, smart governance and smart economy, with the goal of placing the country among the top ten in Europe on sustainable growth, openness, inclusiveness and well-being (Republic of Lithuania, 2013).

Adopted in 2019, the National Progress Programme (2021-30) promotes a smart economy in Lithuania by investing in more innovative and higher value-added segments of the economy and by integrating the country more into international clusters and global value chains. The government promotes the competitiveness of the country's industry and aims at better integrating Lithuania's industry into European strategic value chains, such as batteries, hydrogen, low-carbon industries and the circular economy.

The NEIS called for strengthening the Lithuanian energy research and innovation ecosystem. Lithuania's goal is to become the leader in the region in developing and exporting energy innovations. Priorities for innovation in the energy sector include smart electricity networks, digital system and cybersecurity solutions, the development of energy storage, energy efficiency, hydrogen technologies, and alternative fuels production.

Based on the National Progress Programme, Lithuania's main strategy for innovation is the so-called Smart Specialisation Strategy and its related funding programme. During the past programming period (2014-20, extended to 2023), the government supported projects which can help achieve substantial technology and innovation breakthrough in seven identified priority areas: 1) energy and a sustainable environment; 2) smart, clean and intermodal transport; 3) health technologies and biotechnologies; 4) agro-innovation and food technologies; 5) new production processes, materials and technologies; 6) information and communication technologies (ICTs); and 7) an inclusive and creative society. Under the priority of energy and sustainable environment, the government supported projects in biomass, solar PV, waste recycling, energy efficiency, and smart grids and systems.

In the next programming period (2021-27), the Smart Specialisation Programme will be streamlined across three priority areas: 1) health technologies, biotechnologies and safe food; 2) ICTs, inclusive and creative society; and 3) new production processes, materials and energy efficiency. The latter includes the energy sector with four main themes: 1) enhancing the interoperability of the distributed and centralised generation, networks and

energy system efficiency (smart systems); 2) digitalisation; 3) developing the use of renewable biomass and the recycling of waste for energy; and 4) solar energy.

The 2019 National Energy and Climate Plan (NECP) targets the growth of Lithuanian energy exports and the development of new energy technologies in the country, as well as the exploration of innovation opportunities, such as the use of hydrogen in energy, industry and transport, in line with the EU Hydrogen Strategy, and the potential and opportunities for carbon capture utilisation and storage (Republic of Lithuania, 2019).

Lithuania's energy innovation ecosystem

The government is working to boost the Lithuanian energy innovation ecosystem. The Action Plan for Strengthening the Lithuanian Energy Innovation Ecosystem (hereinafter referred to as the action plan) was adopted by the Ministry of Energy in September 2020 (Box 6.1). It aims to achieve the goals established in the NEIS. Under the NEIS, Lithuania aims to develop smart technologies and digitalisation as innovations for the energy sector. In preparing the plan, extensive consultations took place with ministries, higher education and research institutions, energy-related businesses and associations, and other social partners.

The action plan includes 51 actions and important reforms aiming to reduce the fragmentation of programmes, funding mechanisms, and support services for research and innovation; improve innovation skills across businesses and public institutions; and increase innovative and pre-commercial procurement to 20% of total public procurement expenditure by 2027. The plan also sets out targets and actions up to 2030 and progress will be monitored in annual reports (Republic of Lithuania, 2020a; see Box 6.1).

Box 6.1 The Action Plan for Strengthening the Lithuanian Energy Innovation Ecosystem

The action plan is the integrated energy innovation plan in Lithuania for the period 2020-30. A well-functioning energy innovation ecosystem will bring together scientific and business representatives, local producers, and researchers to improve the conditions for further developing and strengthening Lithuania's innovative products. The main objective of the action plan is to strengthen the energy innovation ecosystem in eight specific areas. To successfully develop these areas, the plan established 51 measures, which are planned to be implemented between 2020 and 2023.

Lithuania's action plan focuses on eight areas, including measures as follows;

1. **Financing**

- Specialised funding for innovations in the energy sector (Innovation Promotion Fund).
- Promotion of pre-commercial procurement and public procurement of innovation.
- Participation in the EU Innovation Fund managed by the European Commission's Innovation and Networks Executive Agency.

2. **Human resources**

- Popularisation of the energy profession in Lithuania; increased attractiveness and modernity of energy-related study programmes.

- Promotion of the Lithuanian Energy Agency as a competence centre of energy innovation by providing human and financial resources to perform additional functions.

3. Infrastructure

- An assessment of the availability of energy sector data for the development of new innovative products.
- Demonstration project for the production and storage of energy from renewable sources using hydrogen and other innovative technologies.

4. Products and services

- Promotion of the development of digital energy innovations.
- Creation of the hydrogen technology development and promotion programme in Lithuania, building on the EU Hydrogen Strategy.
- Organisation of regular energy sector hackathons and innovation workshops.

5. Science and technology

- Identification of priorities for enabling energy technologies with a view to clarify the amount of funding for their research and innovation.
- More active engagement with European Union energy research and innovation initiatives, such as the SET-Plan Steering Group, Horizon Europe and other related formats.

6. Regulatory environment

- Creation of a regulatory sandbox by establishing the model in energy sector legislation.
- Feasibility analysis of applying the Open Innovation Test Bed tool in the field of energy.
- Legislation to allow companies engaged in regulated energy activities to direct part of the income from regulated activities to innovation promotion

7. Consumers

- Regular public consultations to identify consumers' needs.

8. Communication and innovation culture

- Development of an indicator system to measure the progress of energy innovation.

The Ministry of Energy is responsible for co-ordinating the implementation of the action plan.

Resource push

Lithuania's main approach to financial support for energy R&D is based on capital grants to university researchers and grants to small and medium-sized entrerprises (SMEs) and start-up companies. Funding has been administered mainly by the Ministry of Economy and Innovation and the Ministry of Education and Science and their related agencies.

The core funding programme is the Smart Specialisation Programme. During the 2014-20 programming period, the programme included a priority "energy and sustainable environment" and promoted R&D and demonstration projects that improve the interoperability of new generation, distribution grids and efficient energy use that strengthen efficient and smart energy use and the development of renewable biomass, solar energy and waste recycling for energy.

Out of a total public budget of EUR 679 million over the period across all priorities, EUR 150 million had been spent by the end of 2019, with EUR 31.43 million granted in the

energy and sustainable environment priority and EUR 40.36 million for smart and clean transport. The lion's share of the programme (EUR 398 million) is administered by the Ministry of Economy and Innovation and covers all R&D, not only in the energy sector. There is strong competition between the different priority fields and projects have to compete for funding. The Ministry of Energy has no lever to direct R&D to energy-related priorities or sub-priorities.

Lithuania's Agency for Science, Innovation and Technology supports start-ups by offering innovation vouchers for scientists (up to EUR 76 000), innovation patents (with funding up to EUR 30 000 to protect intellectual property) and innovation start funding for SMEs (up to EUR 52 000 for development or the recruitment of researchers).

The Industrial Development Programme and its funding instrument, the 2014-2020 Programme for Promotion of Investment and Industrial Development, also support energy efficiency and increasing the use of renewables in industry. The programme mainly focuses on the implementation of the audit results on energy efficiency and less on research, development, demonstration or commercialisation activities.

In June 2020, the Lithuanian parliament adopted the legal basis for the creation of an overarching Innovation Promotion Fund whose aim is to promote fundamental and applied scientific research, development and innovations. For the period 2020-40, a budget of EUR 900 million is intended to be allocated. Around 20% is expected to come from European Union funds. It remains to be seen how energy innovation projects can be financed out of this fund, whether there can be earmarking for funding and how competitive calls will be organised.

The Innovation Promotion Fund started its activities at the beginning of 2021. It was founded by the Ministry of Economy and Innovations, the Ministry of Finance, and the JSC "Investment and Business Guarantees" (Invega). The fund has two main financial instruments: 1) "Perspective", which is planned to be implemented in the first quarter of 2021; and 2) "Accelerator 2", which is planned to be implemented not earlier than in 2022.

"Perspective" aims to promote innovation by providing favorable financing conditions for businesses in the form of loans provided directly by Invega. EUR 1 million is dedicated to this instrument. "Accelerator 2" is a venture capital instrument covering acceleration and investment activities, with an allocation of up to EUR 20 million from the state budget. This financial instrument would promote the development of the start-up ecosystem and entrepreneurship.

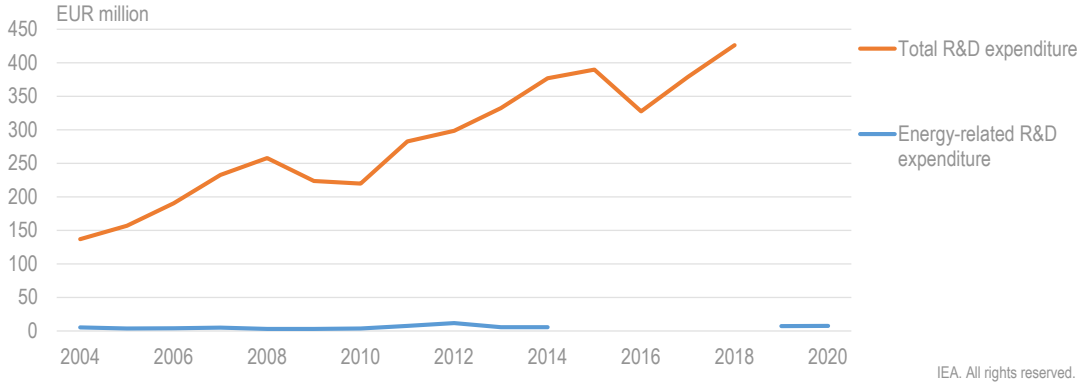
The fund was created by the Ministry of Economy and Innovation and is managed by Invega. The fund may be enlarged to others, as they implement financial instruments for the promotion of innovation through the fund.

Public spending on energy research and development

In 2018, Lithuania's total public expenditure on R&D amounted to EUR 426.3 million, up from EUR 379 million in 2017 and more than a threefold increase since 2004 (Figure 6.2). Total R&D spending peaked in 2015 at around EUR 390 million. In 2018, it amounted to 0.94% of GDP, well below the 2023 target of 1.9% set in the updated National Progress Programme; that programme continues to require funding for innovation at a minimum of 1.9% of GDP until 2030 (Republic of Lithuania, 2020b). In terms of energy-related public R&D expenditure, spending levels remained flat and at relatively low levels. The Ministry

of Energy reported to the IEA R&D database for the first time in 2020 and informed that the government spent EUR 7.3 million in 2019 and expected to spend EUR 7.6 million in 2020. However, historic data collection and evaluation of energy sector trends by the government remain incomplete.

Figure 6.2 Lithuania's gross domestic expenditure on total R&D, 2004-20

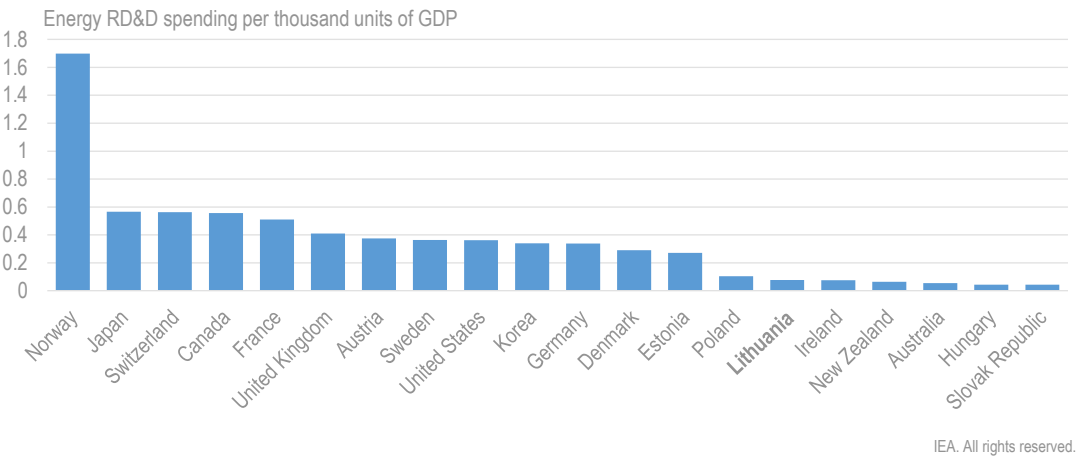


Notes: Since 2020, the Ministry of Energy reports energy-related R&D expenditure to the IEA, with data for 2020 being estimated. There are no data on energy R&D reported to the OECD after 2014.

Source: OECD (2020a), *Gross Domestic Expenditure on R&D*, https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm.

In 2019, Lithuania was among the low performers of IEA member countries when it comes to energy-related public R&D spending per GDP (Figure 6.3). Lithuania spends less than its Nordic or Baltic neighbours but more than Hungary and the Slovak Republic.

Figure 6.3 Energy-related public RD&D budget per GDP in selected IEA countries, 2019



The public budget for energy-sector RD&D in Lithuania is below the level of neighbouring IEA member countries.

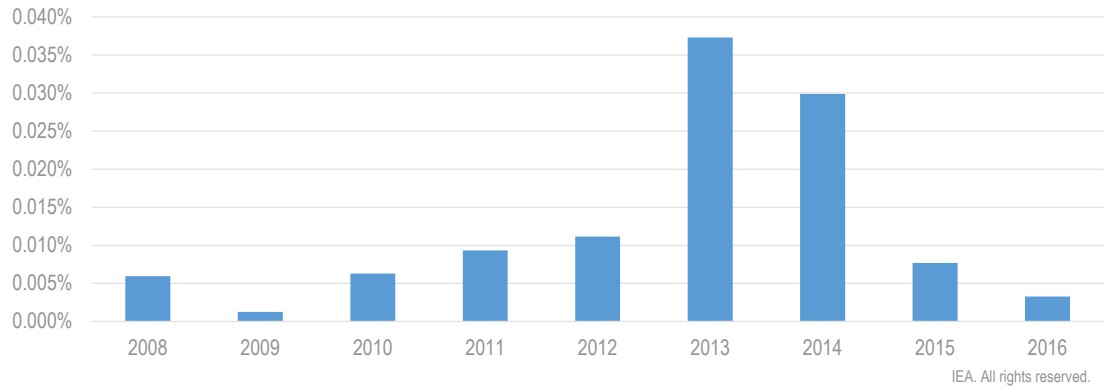
Note: 2019 data are not yet available for all IEA member countries.

Source: IEA (2021), *Energy Technology RD&D Budgets*, www.iea.org/statistics.

Private spending on energy research and development

Lithuania spent 0.03% on private sector energy R&D and demonstration in 2016 (Figure 6.4) according to the latest available data from the European Commission's Energy Union tracking. Up to 2017, the European Commission evaluated member states' performance with regard to the Energy Union, the EU's flagship initiative in the energy sector. One of the Energy Union's key priorities is research, innovation and competitiveness. Indicators examine the number of patents and the share of energy R&D spending in GDP, including public and private spending on the Energy Union's priorities, which include renewable energy, smart systems, energy efficiency, sustainable transport, carbon capture and storage, and nuclear energy.

Figure 6.4 Lithuania's private sector spending on R&D per GDP, 2008-16



Note: Energy Union priorities include renewable energy, smart systems, energy efficiency, sustainable transport, carbon capture and storage, and nuclear energy.

Source: EC (2020a), *Energy Union Indicators,* https://ec.europa.eu/energy/data-analysis/energy-union-indicators/scoreboard_en?dimension=Research%2C+innovation+and+competitiveness.

Knowledge management

At the international level, Lithuania's research organisations participate in EU and IEA research networks. The Lithuanian Energy Institute (LEI) joined the IEA hydrogen Technology Collaboration Programme (TCP) in 1999. Lithuania is not part of Mission Innovation or the Clean Energy Ministerial.

The LEI and the country's universities are active partners under the EU Horizon 2020 programme, notably Kaunas University of Technology (KTU), Vilnius University, the Vilnius Gediminas Technical University, Vytautas Magnus University and the Research Council of Lithuania (RCL), to name the most active ones. The RCL focuses mostly on research issues on a national level and covers programmes and basic research financing.

The Agency for Science, Innovation and Technology, which started in 2010 and replaced the Agency for International Science and Technology Development Programs, plays an important role in co-ordinating national activities and international programmes on innovation as the major governmental institution. It supports collaborative activities between business and science, encouraging various Lithuanian universities, institutes and the private sector to accelerate knowledge and technology transfer. The agency co-ordinates several clusters on energy and construction across Lithuania, including with

regional partners. It provides advice and co-ordinates the participation of Lithuanian stakeholders in EU programmes, such as Structural Funds, Horizon 2020 and EUREKA Eurostars.

The LEI performs research in the energy field for the government, the industry and the public at large and is part the Research and Technology Organization, which brings together non-university research and technology organisations in Lithuania. The LEI collaborates internationally on nuclear energy and is active in the European Energy Research Alliance. The LEI provided inputs to the National Energy Independence Strategies with the Ministry of Energy and prepared together with the Vytautas Magnus University (Kaunas, Lithuania) the Lithuanian and Baltic states' energy security reviews (2011-16). The LEI has notified 15 patents, most of them in the area of hydrogen (Republic of Lithuania, 2019).

In December 2020, the Ministry of Energy created the Lithuanian Hydrogen Platform by bringing together ministries (Energy, Economy and Innovation, and Transport and Communications), the National Energy Regulatory Council (NERC), energy companies (EPSO-G, Ignitis Group, Klaipėdos Nafta, Amber Grid, ORLEN Lietuva, Achema, SG Dujos, Contrarian Ventures I and others), business associations (the Lithuanian Confederation of Industrialists, the Association of Lithuanian Chemical Industry Enterprises, the Hydrogen Energy Association, the Lithuanian National Road Carriers' Association LINAVA, the Lithuanian Employers' Confederation), the Lithuanian Autoentrepreneurs Association, the Smart Energy Digital Innovation Hub, the LEI, the Center for Physical Sciences and Technology (FTMC) and the Lithuanian Maritime Cluster. The platform shall implement innovative projects and help develop a long-term hydrogen strategy for Lithuania in line with the EU Hydrogen Strategy and with the goal to achieve a breakthrough in these technologies in Lithuania (Ministry of Energy, 2020).

Market pull

Lithuania's biomass energy industry is focusing on the production of advanced biofuel technologies and the manufacturing of biomass combustion equipment, thanks to active science and technology co-operation. Companies operating in Lithuania also produce and export innovative solar modules. A nascent industry is evolving in industrial biotechnology and energy efficient materials, alongside eco-innovation and the circular economy.

Until August 2020, the innovator seeking to test a pilot innovative product or service in the energy area needed a permit. Obtaining such a permit required time and effort and demonstration activities are not always possible. To stimulate innovation and R&D in Lithuania's energy sector, the government decided to rely on a regulatory sandbox approach to create a space for the demonstration and commercialisation of new energy technologies, notably in the area of smarter energy systems and demand response. A regulatory sandbox is a safe environment in which to experiment and collect experiences without having to face the strict rules otherwise applicable to the sector, while certain consumer safeguards are still being established. Amendments to the Law on Energy were adopted in 2020 in favour of a regulatory sandbox for the testing of energy innovations by regulated public companies, Lithuania's state-owned enterprises, which make up the lion's share in the country's energy market, and other interested local or international

companies. The amendments to the Law on Energy establish the main principles and criteria and the rights and obligations of participants in this approach, which will be supervised by NERC.

For example, Lithuania's electricity distribution system operator (ESO) is putting in place a number of instruments to develop innovative grid and system services at the distribution level, including the prosumers and data hub. The investment is recognised under ESO's regulated assets base by the regulator. ESO is also a major investor in energy efficiency services in industry.

As stipulated above, the regulatory sandbox for the testing of energy innovation is available for all companies, public entities and privately owned players, including in the oil industry, manufacturing of renewable energy components and the bioenergy sector. NERC may additionally incentivise regulated public entities by financial means (e.g. by recognising a bigger share of innovative investment as suitable to be financed from the tarriff). Other advantages of the sandbox could relate to the waiver of energy-specific permits.

International experience among IEA member countries suggests that provisions to specifically encourage the use of the latest technologies can be built into policies such as auctions, purchase incentives and contracts-for-difference. Public procurement can also be used to create new markets for products that are ready to be commercialised for the first time, while co-funding for large-scale demonstration projects can attract private investment at an earlier stage.

Lithuania has a very active start-up sector, notably in ICT and Fintech, supported by the Start-up Lithuania initiative, a one-stop shop facility for matchmaking between entrepreneurs and investors, with pre-seed and seed stage investment schemes, accelerator programmes, and mentorship services. Success stories have been recorded in IT-related clean technologies – such as start-ups developing digital platforms for car sharing (Citybee), green energy procurement (WePower Network) or textile exchange (Vinted) that successfully raised up to EUR 140 million in single deals. However, venture capital activity in energy technologies remains limited. A handful of deals can be observed every year overall, and few involve hardware technologies, despite recent investments in electric vehicle charging infrastructure (start-up Inbalance Grid).

Universities, like the Kaunas University of Technology (KTU), also promote entrepreneurship and technology development through science and technology centres and technology business incubators. The Kaunas region with the KTU is developing an innovation ecosystem which encompasses industry, business and university institutions – the National Innovation and Entrepreneurship Centre, eight research institutes, six accredited laboratories and the KTU start-up space. However, the attractiveness of public institutions and businesses for researchers and engineers remains insufficient.

Lithuania has several clusters bringing together industry and science, including the Biopower Plants Development Cluster (development of modern, innovative biofuel equipment and technologies for efficient use of biomass) and the Photovoltaic Technology Cluster (development of environmental energy technologies), and the newly created Smart Green City Cluster (promoting the use of new technologies for environmentally friendly solutions), the Cleantech Cluster Lithuania and the Circular Economy Cluster.

Lithuania's innovation performance has improved over the past decade. It moved up by 27.8% points in the European Innovation Scoreboard 2020 between 2012 and 2019. The

index takes into account investments, patents, human capital and other innovation factors (EC, 2020c). Lithuania saw the best improvement among the EU27 and belongs to the group of moderate innovators with other 13 EU member states. Lithuania's strengths are an innovation-friendly environment, small and medium-sized enterprises, science-to-business relations, and the number of higher education graduates. However, it ranks lower on the attractiveness of the research system, employment in the knowledge-intensive sector and intellectual property indicators.

Socio-political support

Institutional governance

The Ministry of Education and Science and the Ministry of Economy and Innovation are the main government entities responsible for policy making, implementation and funding of innovation strategies, including for energy R&D and demonstration. The Ministry of Education and Science is in charge of financial and other resources to manage national research policies. The Ministry of Economy and Innovation covers the development and implementation of research and innovation policies related to the business sector. The Ministry of Energy has recently adopted a dedicated action plan for developing an energy innovation ecosystem which is expected to build the institutional framework for energy technology development and commercialisation.

The latest OECD *Economic Survey of Lithuania* suggests that there can be efficiency gains in the organisation of policies and funding by consolidating the number of innovation agencies in Lithuania (OECD, 2020b). Similarly, the European Commission noted in the European Semester country report 2020 that Lithuania should improve the governance for public sector R&D and innovation (EC, 2020b). The government decided that Ministry of Economy and Innovation will be in charge of implementing the Smart Specialisation Programme for the upcoming programme period 2021-27 (previously it was split between the Ministry of Education and Science and the Ministry of Economy and Innovation).

The Ministry of Energy does not direct funding, but has indeed started to develop the engagement of energy sector stakeholders. For the development of the Action Plan for Strengthening the Energy Innovation Ecosystem, it held extensive and wide-ranging consultations during 2019-20 with ministries, higher education and research institutions, energy undertakings and associations, and other social partners.

Monitoring, evaluation and tracking of results

The monitoring and evaluation of outcomes of Lithuania's overall innovation policy and programmes is limited to a few indicators, which do not include specific energy sector indicators. The overarching National Progress Programme for the period 2021-30 includes overall indicators for creating a "smart economy" in Lithuania, which are the Innovation Index, business R&D expenditure and the number of patents.

The government set a number of overall targets under the Smart Specialisation Strategy and Programme across sectors and priorities: increase public spending on R&D and demonstration to 1.9% of GDP by 2023 (up from 1.04% of GDP in 2015); boost employment in knowledge-based sectors to 13.6% (up from 9.7% in 2017); and double the

number of patent applications (150 in 2023), the number of SMEs using new products or processes (40% in 2023) as well as double the number of innovative SMEs (35% in 2023).

Historically, the Ministry of Energy does not monitor R&D and demonstration investments in the sector and does not track the outcomes of energy sector performance in public funding programmes. In 2020, linked to the accession process to the IEA, the Ministry of Energy started collecting and monitoring public expenditure across the energy sector with a view to contribute to the IEA energy R&D database. This also renders Lithuania's capacity to actively contribute to tracking and monitoring under the Energy Union, the Innovation Scoreboard and the NECP.

The Smart Specialisation Programme was reviewed ahead of the next programming period. In its 2018 interim evaluation of the Smart Specialisation Strategy, the government think tank Strata found that the energy sector had the best absorption capacity thanks to active participation from the industry. However, outcomes were low in digitalisation, bio-refining and solar energy. This evaluation formed the basis for updating the priorities in the smart specialisation programme for the coming period, which also involved consultations with representatives from research, businesses, the non-governmental sector, technology experts and the government. With a view to updating the priorities of the research programmes, experts from science and industry were invited to several rounds to contribute to the priority setting. More than 100 participants were from business and academia.

Assessment

Lithuania's Ministry of Energy is taking the lead in aligning innovation policy and funding with energy and climate priorities, as reflected in the 2018 NEIS and the NECP of 2019.

The Action Plan for Strengthening the Energy Innovation Ecosystem, adopted by the Ministry of Energy in 2020, is an excellent achievement and has the capacity to promote Lithuania's energy technology leadership. Based on eight pillars, the action plan relates to the innovation objective of the NECP and targets growth of energy exports and the development of new types of business, including the use of hydrogen in energy, industry and transport, and the potential and opportunities for carbon capture, utilisation and storage in Lithuania, as set out by the NEIS.

The action plan covers several key components of successful energy innovation systems – as laid out in the IEA innovation framework. It seeks to improve governance, better align funding with the financing needs of innovators as well as energy-climate priorities, and embed monitoring of progress over time, all of which are aspects of good policy practice.

The action plan provides a strong basis for strengthening energy innovation capabilities in Lithuania. The country's smart specialisation approach with its policy strategy and seven-year funding programme is well aligned with the country's energy strategies and fully supports the development and demonstration of clean energy technologies, an area where Lithuania may have a competitive edge and technology export leadership. At the same time, the government is now looking to develop and demonstrate new enabling innovative clean energy technologies, such as hydrogen and storage, which will be much

costlier and require different funding and regulatory instruments. Lithuania may also evaluate new opportunities for technology leadership, including on digital technologies for efficiency and the bio-economy.

Clear whole-of-government priority setting can help improve and strengthen the priority setting. The priorities should be subject to updates over time, based on the newly proposed evaluation procedures. Although the action plan is based on the priority fields of the Smart Specialisation Programme, it could be further enhanced in the coming years, with a commonly agreed on, cross-ministerial energy-related R&D strategy. Aligning research priorities with new clean energy transition challenges is essential to ensure that the various measures and programmes under the action plan are effective.

Better defined priorities for the energy sector will also allow the government to identify targets relative to a to-be-defined baseline, against which the government can monitor outcomes. It will be critical that the Ministry of Energy work on the indicators and targets with the Ministry of Economy and Innovation for the forthcoming programme period of the Smart Specialisation Programme, which does not yet have any specific indicators or targets established for the new period.

Lithuania's energy innovation action plan is a critical framework to boost the energy sector's participation in the future Innovation Fund and the Smart Specialisation Programme in the next period (2021-27). The newly created Innovation Promotion Fund would be the main source of funding. The action plan can allow the government to better identify and quantify funding needs and possible allocation to the energy industries.

However, Lithuania's public expenditure on energy R&D, with EUR 7 million in 2019 carried out mainly under the Smart Specialisation Programme and by publicly owned companies, remains well below the median of IEA member countries. Lithuania's recovery plan and future EU funding present an opportunity for the government to increase funding, including in new areas such as hydrogen and energy storage. There are also opportunities for Lithuanian companies under the future EU programmes to receive funds for demonstration and commercialisation, including the Connecting Europe Facility, Just Transition Fund, Innovation Fund and Modernisation Fund, and InvestEU guarantees. However, that requires a project pipeline across a range of clean energy technologies and the mobilisation of the private sector. The action plan has the capacity to mobilise stakeholders to create such a project pipeline.

Boosting private sector investment in clean energy technology innovation is a relatively new area and Lithuania hopes to advance quickly in this regard in the coming years. The action plan aims to strengthen knowledge transfers of the energy innovation ecosystem and boost ties with industry in order to best leverage publicly funded R&D. A number of regulatory barriers and the low level of available public matching funding present hurdles for regulated and private companies from pushing innovative solutions towards commercialisation.

An investment-oriented economic policy could boost innovation in the areas of resource efficiency, sustainable transport and low-carbon industry technologies. The latest trends in the start-up sector suggest that investors are confident in Lithuania's digital sector and associated clean technologies, and in the ability of domestic talents and start-ups to develop new services – rather than hardware technologies – and bring these to domestic and international markets. Decision makers may learn from these experiences – both success stories and failures – to promote further investments in clean energy start-ups,

strengthen activity in the digital sector but also diversify into other technology areas, if relevant. For instance, the use of regulatory sandboxes has proven to be successful in the Fintech sector.

The promotion of regulatory sandboxes under the action plan is a helpful approach and should be available to all public and private companies. Such an approach can even promote competitive energy markets in Lithuania, which still have barriers to entry for new companies. Innovation incentives need to also consider private investors' capabilities and needs. International experience in IEA countries suggests that auctions or contracts for difference can help produce scale and competition, thus bringing down the costs for costlier clean energy technologies, such as hydrogen and carbon capture, utilisation and storage.

The IEA commends the creation and publication of an energy metrics for tracking progress over time under the new action plan. The availability of data on energy-related public and private R&D funding and use of it is thus far limited. For the energy sector, Lithuania also needs to define targets for public or private R&D funding. A clear methodology for assessing government and private sector expenditure in clean energy technologies will help to set adequate targets and benchmarks. It is excellent news that the action plan intends to expand the competencies of the Lithuanian Energy Agency to establish a methodology to continuously monitor the implementation and performance of the energy innovation ecosystem. The collected data will allow adjusting the action plan's measures and the priority areas and will provide the quantitative basis for the annual reporting to the IEA.

Lithuania's accession to the IEA will facilitate its participation in the IEA Energy Technology Network and EU energy technology and innovation partnerships (IEA, 2019) and allow international co-operation in key priority areas to be extended. Today, the Lithuanian Energy Institute is the only institution in Lithuania participating in an IEA Technology Collaboration Programme (Hydrogen TCP). Lithuania has an opportunity to participate in more networks under the IEA, but also under the EU SET Plan.

Equally, there are many regional opportunities for the Ministry of Energy to increase partnerships. Lithuania is highly interconnected with the Baltic and Nordic countries and is part of the Baltic-Nordic electricity market. It is working with neighbours on digital and Fintech activities, including Estonia and Finland. Regional collaboration and sharing good practice can help highlight similarities and common challenges. Progress could be expanded further through engagement in the Baltic Energy Market Interconnection Plan and the Nordic Council of Ministers in energy technology and innovation. This in return will enable the government and private sector stakeholders, including universities and business, to share lessons and learn from other countries' experience and build human resources and capacity in Lithuania in line with its ambitious energy and climate priorities.

Recommendations

The government of Lithuania should:

- Develop and regularly adjust a cross-ministerial energy-related R&D strategy to support the national energy and climate policy objectives, identify funding needs, and align key priority areas across government.
- Establish a methodology to continuously monitor the performance of the energy innovation ecosystem along the action plan, including public and private energy-related R&D expenditure, and to adjust the implementation accordingly.
- Increase the level of public funding as share of the GDP in order to further develop national core competencies and strengthen and direct energy-related R&D.
- Incentivise private investments by identifying and removing regulatory barriers, creating regulatory sandboxes and providing matching public funding through auctions, contracts-for-difference or public procurement.
- Introduce appropriate institutional and human resource capacity to accelerate knowledge and technology transfer within the energy innovation ecosystem and to the business sector in order to make best possible use of the outcomes of publicly funded R&D and increase international collaboration activities.

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7. Electricity

Key data

(2019)

Electricity generation: 3.6 TWh (wind 44.5%, biofuels and waste 18.4%, natural gas 15.6%, hydro 10.2%, heat 6.6%, solar 2.7%, oil 2.0%) -78% since 2009

Electricity net imports: 9.3 TWh (imports 13.3 TWh, exports 3.9 TWh)

Electricity import dependency: 70% of total electricity supply

Installed capacity: 3.7 GW

Electricity consumption: 11.4 TWh (industry 33.3%, services/other 32.9%, residential 25.5%, energy 7.6%, transport 0.7%)

Electricity peak demand (2019): 2.0 GW

Overview

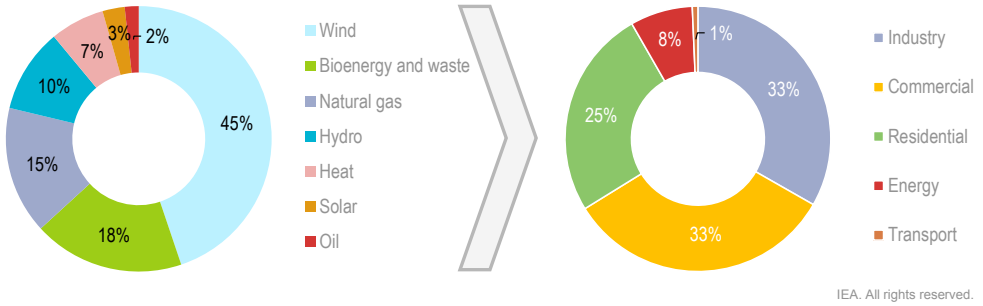
Lithuania imports around three-quarters of its electricity needs, as domestic electricity generation is fairly small, with only 3.6 terawatt hours (TWh) in 2019, following a 78% decrease since the end of 2009, when the country shut down its second (and last) nuclear reactor. In 2019, renewable energy dominated domestic electricity generation, accounting for 76% (Figure 7.1). Wind power makes up almost half of the total and biomass has increased its role considerably. Net imports of 9 TWh play an important role to satisfy a consumption of 11 TWh, which is largely driven by the industry and services sectors.

The government has set ambitious targets for reaching 80% renewables in final energy demand by 2050. In the electricity mix, the country aims for a renewables share of 45% by 2030 and 100% by 2050. A unique feature of Lithuania's market relates to the fast increase of prosumers, which should reach 30% of total electricity consumers by 2030 (see Box 5.1).

Lithuania's electricity sector has embarked on three major transitions: 1) rapidly reduce import dependency with significant investments in domestic renewable capacity; 2) increase interconnectivity and synchronisation with the European network; and 3) open its market towards competition and choice for final consumers. Thanks to reforms of the electricity sector governance and investments in major new interconnectors with Poland and Sweden, Lithuania's electricity market is increasingly integrated into the Baltic and Nordic electricity markets. In November 2020, together with neighbouring Estonia and Latvia, Lithuania ceased imports from Belarus, responding to the start of the Astravets nuclear power plant in neighbouring Belarus.

In the coming years, Lithuania will need to adapt rules and regulations to make the market fit for these three transitions to ensure the efficient development of the country's electricity sector. The government aims to boost the medium-term power system adequacy and considers the introduction of an appropriate capacity remuneration mechanism, while boosting regional co-operation, and increasing flexibility to adapt the power system operation for higher shares of variable renewable energy, implementing the synchronisation with the European network. This will require new balancing and reserve markets at the regional level, while phasing out regulated prices, promoting competition and choice for retail electricity consumers.

Figure 7.1 Electricity generation by fuel and consumption by sector, Lithuania (2019)



Renewables accounted for 76% of domestic electricity generation, with 45% from wind energy in 2019.

* *Services/other* includes commercial and public services, agriculture, forestry, and fishing.

Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

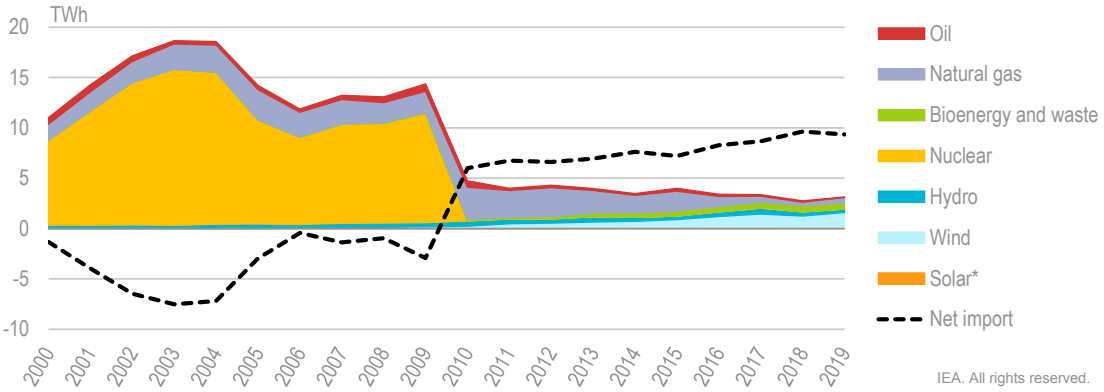
Electricity supply

Until 2009, Lithuania relied on nuclear energy as a primary energy source of electricity generation. With the closing of the Ignalina nuclear power plant in 2009, it switched from being a net exporter to being a net importer of electricity (Figure 7.2). Electricity imports and natural gas use in electricity generation have compensated and filled the gap left by the shut-down of nuclear. Natural gas quickly became the main source of electricity generation, increasing from 14% in electricity generation in 2009 to 63% in 2010 (around 2 TWh).

With the rise of wind power and the switch to bioenergy in power and heat, however, the share of natural gas fell to 47% (or 1.8 TWh) in 2014 and 16% (0.52 TWh) in 2019. Wind power has increased both in relative and absolute terms in the electricity mix, from 5% in 2010 to reach 45% in 2019. Bioenergy steadily increased its role and reached 16% in 2019. The contribution of bioenergy to electricity production increased from 69 megawatt hours (MWh) in 2008 to 533 MWh in 2019. Hydro plays an important role in Lithuania's electricity mix and hydro sources have been constant at around 400 MWh over the last decades. Solar power deployment is still small at 3%, barely reaching 0.1 TWh in 2019, but growing rapidly. Between 2018 and 2020, the installed capacity of solar power increased by 50%.

There is potential for further development in solar, particularly given Lithuania's extended exposure to daylight during the summer months. Taking a closer look at electricity produced from renewables, the growth of wind power can be better appreciated (Figure 7.3).

Figure 7.2 Lithuania's electricity supply by source, 2000-19



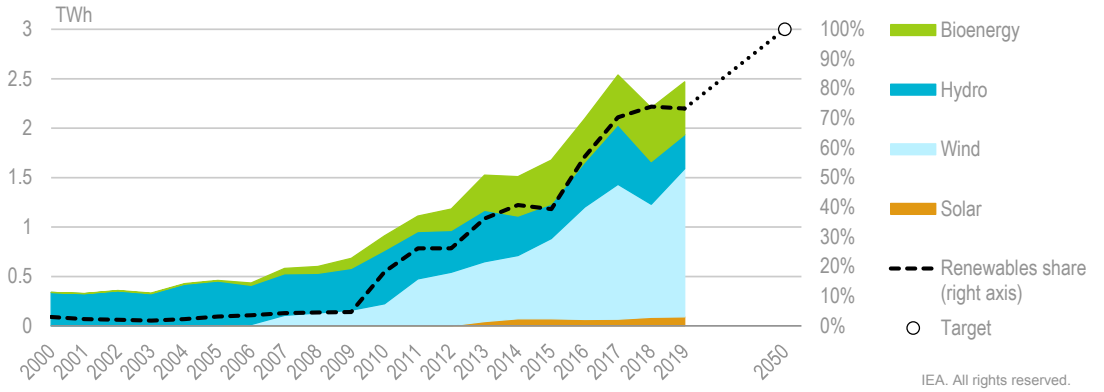
Nuclear ceased to be the main domestic electricity supply source after 2009. Today, natural gas, electricity imports and rising shares of renewable energies meet electricity demand.

* Not visible on this scale, increasing from 0 megawatt hours (MWh) in 2011 to 0.09 MWh in 2019.

Note: TWh = terwatt hour.

Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

Figure 7.3 Renewable electricity generation in Lithuania, 2000-19



Wind power has seen the highest increase since 2012 and became the largest source of renewable electricity in Lithuania in 2019.

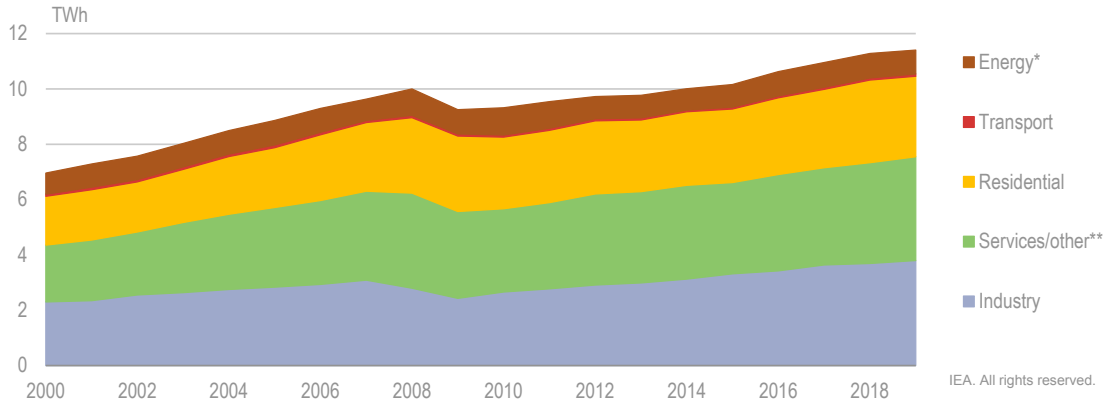
Note: TWh = terwatt hour.

Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

Electricity demand

Lithuania's electricity consumption was 11.4 TWh in 2019 and has grown at constant levels over the past decades, except for during the global financial crisis, which led to a decrease in electricity consumption in 2009 (Figure 7.4).

Figure 7.4 Electricity consumption (total final consumption) in Lithuania by sector, 2000-19



Electricity consumption has seen a steady increase, mainly driven by the industry sector.

* *Energy* includes petroleum refineries, coal mines, oil and gas extraction, coke ovens, and blast furnaces.

** *Services/other* includes commercial and public services, agriculture, forestry, and fishing.

Note: TWh = terwatt hour.

Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

In 2019, the industry and services sectors were the largest electricity consumers, accounting for 33% (3.8 TWh) and 33% (3.8 TWh), respectively, followed by the residential sector (26% or 2.9 TWh), energy transformation (8% or 0.9 TWh) and the transport sector (1% or 0.1 TWh). Electricity demand in the industry sector has increased by 56% over ten years, followed by the residential and services sectors at 7% and 20%. The transport sector demand increased by less than 1%, while the energy sector decreased by 2%.

Electricity generation capacity, imports and exports

Electricity generation capacity

In 2020, Lithuania had around 3.6 gigawatts (GW) of installed power generation capacity, mainly natural gas and renewables (hydro, wind, biofuels), as illustrated in Table 7.1. Lithuania has important hydro power resources. The Kruonis Pumped Storage Plant provides energy storage with a total capacity of 900 MW (4 units, 225 MW each). The Kaunas Hydroelectric Power Plant has 99 MW of capacity and supplies about 3% of the electrical demand in Lithuania. In 2021, Lithuania adopted new solar PV, hydro and wind power targets: 1 GW of solar PV and 1.2 GW of wind power by 2025, with 700 MW of offshore wind and the increase in the capacity of the Kruonis pumped storage hydro plant by 110 MW with a fifth unit. These have not been included in the projections for net generating capacity for 2025 of 4.8 GW.

Table 7.1 Outlook of installed net generating capacity in Lithuania (in MW)

	Fuel	2020	2021	2022	2023	2024	2025	Comments
Fossil fuel capacity								
Lietuvos E	Gas	1 018	1 018	1 018	1 018	881	881	
Vilniaus E3	Gas	282	141	141	141	141	141	Mothballed power plant
Kauno E	Gas	148	148	148	148	0	0	Including 53 MW mothballed unit
Panevezio E	Gas	32	32	32	32	32	32	
Mazeikiu E	Oil	150	150	150	150	150	150	
Other small	Gas	112	112	109	109	109	109	TSO and DSO connected
Renewable capacity								
Kaunas HE (RoR)		99	99	99	99	99	99	
Small HE (RoR)		27	27	27	27	27	27	
Wind (on shore)		540	610	927	1 215	1 406	1 506	TSO and DSO connected
Solar		169	172	250	376	511	676	
Biomass and biogas		89	89	89	89	89	89	
Biomass new			0	63	63	63	63	
Kruonis HPSPP		900	900	900	900	900	900	
Kruonis HPSPP new							110	Project of common interest
Waste		43	44	44	44	44	44	Municipal waste
Waste new			16	16	16	16	16	Municipal waste
TOTAL		**3 610**	**3 622**	**4 013**	**4 427**	**4 468**	**4 843**	

Notes: MW – megawatts. HPSPP = hydro pumped storage power plant. RoR = run-of-river plant. TSO = transmission system operator. DSO = distribution system operator.

Source: Litgrid 2020

Co-generation

The role of co-generation[1] has decreased since 2015, with a 60% decrease of electricity delivered to the national network over the period 2015-19. This is linked to the fact that Lithuania abolished the electricity buy-back quota (subsidies for co-generation) and no longer sets the volume of eligible electricity produced from fossil fuel co-generation plants (natural gas, fuel oil). Several plants have been mothballed during the past years. The Vilnius CHP-3 has not been operating since 2016; other large natural gas co-generation plants in Kaunas and Panevėžys continue operating on a short-term basis.

Nuclear energy

Lithuania was an exporter of electricity to Belarus, Latvia and the Russian Federation during the 1990s. The Ignalina nuclear power plant was once the pillar of Lithuania's

[1] Co-generation refers to the combined production of heat and power.

energy supply. It consisted of two Soviet-designed RBMK (*reaktor bolshoy moshchnosti kanalnyy*, or "high-power channel-type reactor") reactors of 1 300 megawatt electrical (MW_e) each. Units 1 and 2 came online in December 1983 and August 1987 respectively. A third reactor was planned and construction started in 1985, but it was suspended and demolished in 1989. A design flaw of Unit 1 was noted first in 1983, with no official consequence.

Following the Chernobyl disaster in 1986, and as part of the accession process to the European Union (EU), Lithuania agreed to close the Ignalina nuclear power plant given the similarity in both reactors' design and lack of a robust containment building. The EU financed the decommissioning with EUR 820 million, and Units 1 and 2 were closed respectively in 2004 and 2009. The safe decommissiong by 2038 is a priority for the government.

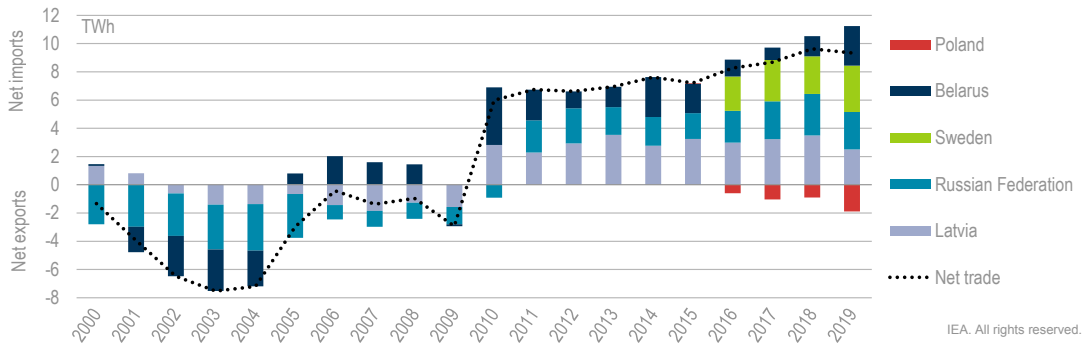
Lithuania discussed options for building a new nuclear power plant close to Visaginas. However, the project was cancelled following the 2012 referendum, showing the electorate's opposition at 62.7%.

Electricity imports and exports

Since the closure of the Ignalina nuclear power plant, Lithuania has been importing electricity from Belarus, Latvia, Russia and Sweden. Electricity imports covered around 70%[2] of its electricity supply in 2019.

Lithuania started importing electricity from Russia (including Kaliningrad) in 2011 (2.3 TWh), and from Latvia in 2010 (2.8 TWh). In 2018, imports reached 3.3 TWh for Latvia and 2.8 TWh for Russia (Figure 7.5). After the commissioning of the NordBalt sea cable in 2015, Lithuania started importing electricity from Sweden in 2016, ranging between 2.4 TWh in 2016 and 3.6 TWh in 2019. Overall net trade in electricity was 9.3 TWh in 2019. Lithuania has been exporting some electricity again since 2016.

Figure 7.5 Lithuania's electricity net imports and exports by country, 2000-19



A net exporter up to 2009, Lithuania has been importing increasing levels of electricity since.

Note: There may be discrepancies between IEA and Litgrid data with regard to electricity reciprocal commercial and physical trade flows reported by Russia and some of the Baltic states.

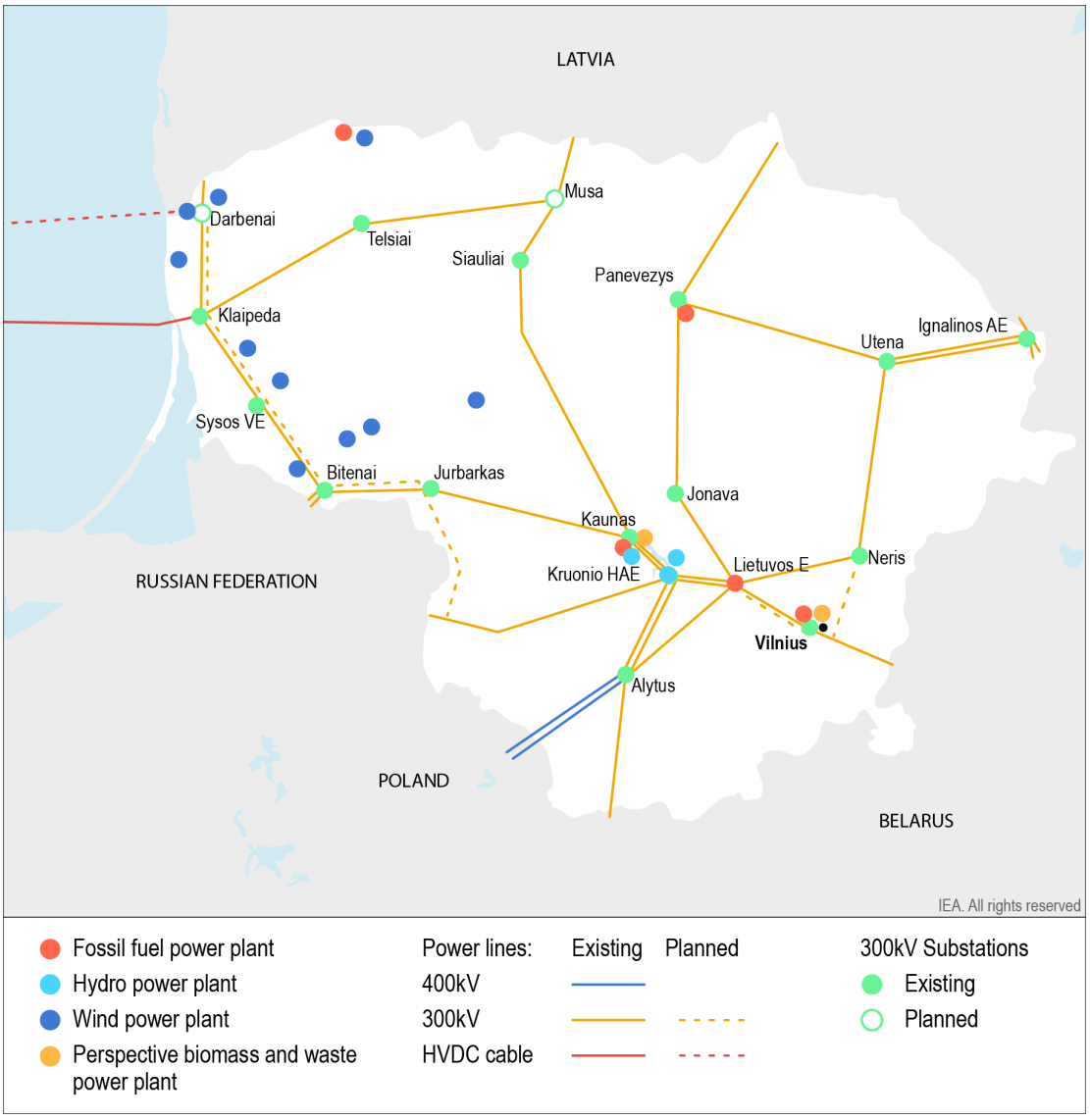
Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

[2] Electricity import dependency is computed here as the share of net imports over the total electricity supply (net imports + electricity generation).

Electricity grids and interconnections

In 2019, Lithuania's power grid consisted of around 7 190 kilometres (km) of high-voltage lines of 110 kilovolt (kV), 330 kV and 400 kV power transmission lines, including about 134 km of undersea cables (under the Baltic Sea). The electricity distribution grid of 126 600 km is operated by 5 distribution system operators (DSOs) (with one DSO in charge of the lion's share of the grid).

Figure 7.6 Map of Lithuania's power system



Notes: HVDC = high-voltage direct current. This map is without prejudice to the status of or sovereignty over any territory; to the delimitation of international frontiers and boundaries; and to the name of any territory, city or area.

Lithuania targets 23% of interconnectivity with the EU by 2030 (well above the EU-wide target of 15%), which it has already achieved. By 2030, it is expected that Lithuania will rely even more on interconnections to the European Continental System, with an interconnectivity level of 111%. As illustrated in Figure 7.6 and Table 7.2, Lithuania is well-interconnected to its neighbouring countries, with existing net transfer capacity to Belarus (1 800 MW import/and 1 350 MW export), Sweden (700 MW in both directions, NordBalt Link), Latvia (684 MW export and 1 234 MW imports), Russia/Kaliningrad (680 MW export and 600 MW import) and Poland (500 MW in both directions, LitPolLink). The Harmony Link will increase the LitPolLink capacity with Poland by 700 MW when it comes online in 2025.

Synchronisation with the Continental Europe Grid

The Baltic states' power system is currently asynchronously connected to Continental Europe through the LitPolLink between Lithuania and Poland and to the Nordic Synchronous Area through NordBalt between Lithuania and Sweden and Estlink 1 and 2 between Estonia and Finland.

Despite being a member of the EU since 2004 and integrated in the Nordic market, to date, the power system operation remains separate, as Lithuania forms part of the BRELL (Belarus, Russia, Estonia, Latvia and Lithuania) and the Russian Unified Power System. The synchronously operating joint system BRELL covers Belarus, Russia, Estonia, Latvia and Lithuania. Lithuania has access to the joint Baltic countries' power reserves and participates in dispatch and regulation.

The synchronisation of the Baltic states with continental Europe has been under preparation since 2009, starting with the signing of a joint declaration of principles. In June 2018, the Prime Ministers of Estonia, Latvia and Poland and the Presidents of Lithuania and of the European Commission signed a joint political road map, which plans to synchronise the Baltic states with the continental European network through Poland by 2025. The countries agreed to analyse options for synchronisation. Based on this agreement, a formal merger procedure was initiated – on 21 September 2018, the Polish transmission network operator submitted an application to the relevant regional group of the European Network of Transmission System Operators (ENTSO-E) for extension of the Continental European networks to the Baltic states. The agreement for accession to the Continental European electrical system entered into force on 27 May 2019. A first test of the Baltic states to unplug themselves from the Russian grid was postponed in 2018 and no new date has been agreed. Russia was to conduct its own test first by temporarily unplugging Kaliningrad from its neighbouring states in May 2019, but no results have been published.

The implementation of the road map in June 2019 requires reinforcing the internal grids of the three Baltic states and developing cross-border infrastructure. These include the construction of a 330 kV power transmission line Bitėnai-Kruonis PSP, a 330 kV line Darbėnai-Bitėnai, a 330 kV switch yard "Darbėnai" and connecting a new offshore cable to it, as well as a 330 kV switch yard "Mūša".

Synchronisation will take place through Poland, notably via the existing link between Poland and Lithuania, together with a new high-voltage direct current line between Lithuania and Poland (Harmony Link). Grid optimisation measures will also be carried out. All of these actions will involve significant investments in the coming years.

In April 2020, the second stage of the electricity network investment was completed with the cross-border cost allocation decided by the four regulators (Estonia, Latvia, Lithuania and Poland), which will also open the possibility to receive EU funding under the Connecting Europe Facility.

The road map's main milestones towards synchronisation include:

- ensuring an adequate amount of system services (inertia) in the Baltics, including via an adequate number of synchronous condensers by 2024
- commissioning of 400/330 kV autotransformers in Alytus by 2021
- completion of the investment request and submission of a financing proposal for the Connecting Europe Facility call in 2020 for the high-voltage submarine Harmony Link cable and related internal grid reinforcements in Lithuania and Poland
- launch of tendering and start of construction of the Harmony Link in 2021 and 2023
- elaboration of principles of operation of the high-voltage submarine cables between the Nordic and Baltic regions
- implementation of a number of measures under the Connection Agreement ensuring frequency stability in the Baltic states.

The total cost of synchronisation amounts to EUR 1.6 billion, and up to 75% will be covered by EU funding under the Connecting Europe Facility. Synchronisation with the EU continental power system will change imports/exports and net transfer capacities at the Lithuanian borders.

Table 7.2 Net transfer capacity at Lithuania's borders

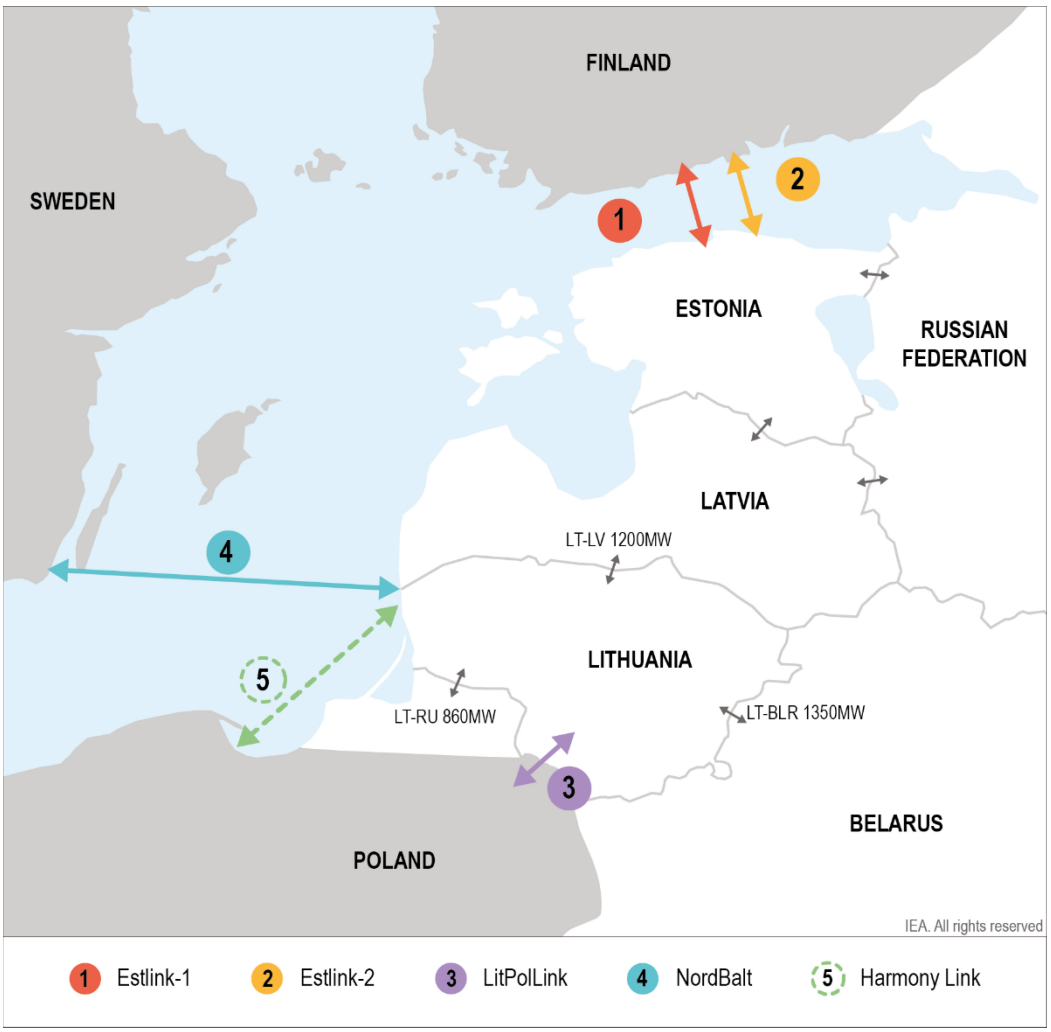
Net transfer capacity	2019	2020-24	2025-30
Latvia-Lithuania (AC OHL)	684 MW	950 MW	950 MW
Lithuania-Latvia (AC OHL)	1 234 MW		800 MW
Sweden-Lithuania (Nordbalt HVDC)	700 MW	700 MW	700 MW
Poland-Lithuania (LitPolLink HVDC, Harmony Link)	500 MW	500 MW	700 MW
Third countries Belarus	1 800 MW import and 1 350 MW export	0 MW*	0 MW
Third countries Russian Federation (Kaliningrad)	680 MW export and 600 MW import		

* Baltic states ended imports of electricity from Belarus.

Note: MW – megawatts. HVDC = high-voltage direct current.

Source: Litgrid 2020

Figure 7.7 Map of Lithuania's electricity connections



Notes: HVDC = high-voltage direct current. This map is without prejudice to the status of or sovereignty over any territory; to the delimitation of international frontiers and boundaries; and to the name of any territory, city or area.

Lithuania is of special importance for Russia to access its exclave Kaliningrad. The Russian power company Rosatom's INTER RAO has been building a nuclear power plant in Kaliningrad (Baltiskaya NPP) since 2010, arguably to supply Kaliningrad (which today exports to Lithuania). However, given the low electricity consumption needs of the exclave (Kaliningrad is self-sufficient thanks to a new natural gas-fired station and coal plants), it has been suggested that Russia would build the nuclear power plant with a view to supply the Baltic states (thus reasserting its influence) and the EU, and getting market access to the EU grid this way. Russia's Rosatom has started the construction of three natural gas plants and one coal-fired plant in Kaliningrad and of electricity networks in Russia and Belarus. Network developments in Russia, Belarus and the Kaliningrad area as well as the construction of the Astravets nuclear power plant in Belarus have accelerated plans for synchronisation.

In November 2020 Belarus has started operations at the Astravets nuclear power plant, which is supposed to start its full commercial operation activity in May 2021. The development of nuclear power in Belarus close to Lithuania's capital Vilnius, without consultation with the Baltic countries, has raised concerns around nuclear safety already during the construction phase. Amid safety concerns after the Chernobyl accident the three

Baltic states collectively opposed the construction and commissioning of the new nuclear power plant. Lithuania considers it not safe and dangerous for the close by capital Vilnius. It has ceased imports from Belarus in November 2020 together with neighbouring countries. The start was postponed from March 2021 in the light of the safety concerns raised by the European Nuclear Safety Regulators Group.

Lithuania adopted a law that allows it to suspend commercial flows with Belarus and the regulator, the National Energy Regulatory Council (NERC), to revoke the licences for power trading with Belarus. In early November 2020, Belarus started operations of the Astravets nuclear power plant and the Baltic states collectively initiated a series of pre-agreed actions including:

- Cease commercial flows between Belarus and Lithuania (physical flows will remain as they are determined by laws of physics).
- Trade continues (with reduced amounts) only between Russia and its enclave Kaliningrad. Corridors for trade are maintained from Russia to Latvia and Kaliningrad to Lithuania.
- Introduction of proof of origins of Russian trade to ensure that no Belarusian electricity enters the Baltics through Russia.

There are no immediate supply security risks for the Baltic states linked to the cease of imports from Belarus. There are increased import flows from Latvia, notably during periods of low wind availability and significant imports from Sweden via NordBalt. The new regime is expected to remain in place until the desynchronisation of Baltic electricity systems from the Russian/Belarusian power system in late 2025.

Electricity market reforms

Lithuania's power sector is the result of a decade of reforms. In recent years, Lithuania has carried out a major restructuring of its electricity sector, in line with the EU Third Energy Package. A range of critical reforms are being implemented based on the Lithuanian Electricity Market Development and Implementation Plan (Republic of Lithuania, 2018). The government unbundled supply and transmission and market operation activities (Litgrid, AmberGas, EPSO-G, Ignitis), third-party access to transmission and distribution, and access to power trading within the Nord Pool market area, and established NERC.

The Ministry of Energy is the sole shareholder of the gas and electricity transmission networks and the gas and electricity exchanges. As of 31 December 2018, EPSO-G group consisted of the holding company EPSO-G and four subsidiaries – Litgrid, Amber Grid, BALTPOOL and TETAS – and indirectly controlled GET Baltic. Lithuania has one major electricity (and gas) DSO, Energijos skirstymo operatorius (ESO), fully owned by Lithuania's utility Ignitis Group. There are also four smaller DSOs.

There are 1 668 licensed electricity producers (2 502 licenses), the majority of which are small renewable energy producers (up to 30 kW). In total, around 59 companies supply electricity to final consumers (households plus industry). Created in 2016 as a merger of AB LESTO and AB Lietuvos Dujos, ESO operates around 130 000 km of electricity lines, 71% of which are overhead and 29% cable, with around 9 000 km of natural gas distribution pipelines.

A common Nordic electricity market including the Baltic states has been the objective of the Baltic Energy Market Interconnection Plan, initiated by the European Commission

in 2009 with a view to end the isolation of the Baltic region from the EU. The integration is based on both interconnections of physical infrastructures and the electricity (and gas) markets. Progress has been made on both fronts. In 2012, Nord Pool Spot established a bidding area in Lithuania which allows market access to Nord Pool. A second milestone was the completion of the Lithuania-Poland interconnection (500 MW, LitPol Link) and the commissioning of NordBalt (700 MW Lithuania-Sweden link) in 2015. Since then, the Baltic region has full price convergence with the Nordic market, except for when there is congestion on the interconnectors.

Lithuania is undertaking a major reform of the electricity retail market, which has started in 2021. The 2015 Baltic Energy Market Interconnection Plan had called for the phase out of regulated prices by 2020. The May 2020 amendments to the Electricity Law bring about the opening of the retail market. The government decided on steps to implement the gradual phase-out of regulated prices at stages of the consumption levels. As of January 2021, regulated prices ended for households with an annual consumption above 5 000 kWh.

Wholesale electricity market and prices

Lithuania has its own price zone in the Nordic electricity market, with electricity prices differing from the Nordic system price at times of congestion on the interconnectors.

Thanks to the integration in the Nordic electricity market, wholesale electricity prices have been declining since 2015. In 2017, the wholesale electricity price was EUR 35.13/MWh, a decrease of 13% since 2015. In 2018, electricity prices within the Lithuanian price zone increased again (43.48 EUR/MWh), which was the result of lower hydro power production in Norway and Sweden due to drought, the increase in the EU ETS price (on 1 January 2017 – EUR 5, on 1 November 2018 – EUR 15.85) and repairs of the NordBalt electricity connection between Lithuania and Sweden (NERC, 2019). When importing power from Russia, Lithuania pays a higher price, due to a capacity payment in the Russian power market.

Instances of congestion lasting for three hours were determined in 2018 on the Latvian-Lithuanian interconnection, with the physical flow exceeding the established capacity limit by 101-108%. Congestion on the Russian-Lithuanian interconnection in 2018 lasted for 480 hours. Capacity during these hours was 300-600 MW, whereas the physical flow exceeded the established capacity limit by 101-116%. No customers have been disconnected or limited due to a lack of network capacity.

Electricity retail market and prices

Retail market competition exists for both households and industrial consumers. Since 2013, users can choose to purchase electricity from a public supplier or buy directly in the market. Five suppliers have the status of public supplier in Lithuania. Industrial consumers pay market prices, while household consumers can choose to pay market or regulated prices. In 2018, consumption of the consumers who buy electricity at wholesale market prices accounted for 2.96 TWh, which is largely industry consumption, as households have largely chosen to remain with regulated prices. In 2019, the Lithuanian retail market had around 1.6 million household consumers. Starting in 2021, regulated prices for household consumers will gradually be phased out.

Lithuania had planned to phase out regulated prices for several years. Under the Lithuanian Electricity Market Development and Implementation Plan (Republic of Lithuania, 2018), the phase out of regulated prices is now envisaged by 2025 in several phases. A critical step will be the identification of vulnerable consumers or energy poor. The government wants to maintain regulated prices for those consumers. From 1 January 2021 to 1 January 2023, the monopoly services of the public supplier will be gradually terminated and conditions will be created for active engagement of electricity suppliers. Several steps are envisaged for the gradual opening by the end of 2024 (Table 7.3). Households consuming more than 5 MWh per year no longer pay regulated prices as of January 2021.

Table 7.3 Lithuaia's three-stage phase out of retail electricity price regulation

Stage	Start date	Annual consumption (by consumer in kWh)	Total market consumption	Number of consumers	Share
Stage I	1 January 2021	>5 000	32.40%	138 814	8.40%
Stage II	1 January 2022	1 000-5 000	56.50%	760 484	45.70%
Stage III	1 January 2023	<1 000	11.10%	762 013	45.90%
Total				1 661 311*	

* Vulnerable consumers represent about 6% (or 101 000) of all household consumers.

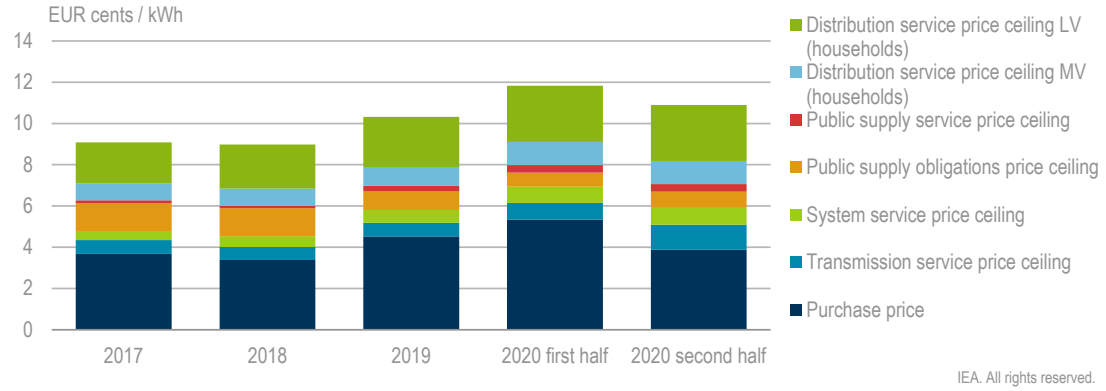
Source: Republic of Lithuania (2018), Lithuanian Electricity Market Development and Implementation Plan.

A major milestone of the process of market opening is the roll-out of smart meters. The objective is to install 1 million smart meters between 2020 and 2023, covering 70% of those consumers for whom smart meters are the most cost-effective. In 2016, 3 000 consumers were equipped with smart meters. The implementation of smart metering starts with all commercial users and those household consumers who consume more than 1 000 kWh per year. Smart meters will not be systematically deployed for customers consuming less than 1 000 kWh per year to be completed until the end of 2023. All remaining consumers will be provided with smart meters after 2024 at their own cost. The metering time resolution will be aligned to the imbalance settlement period, which will be shifted from 60-minute to 15-minute intervals. ESO also has plans for a data collection and sharing platform (data hub) through which data will be available for market processes.

Lithuania's electricity market remains concentrated, despite a large number of licensed suppliers. In 2018, there were four main suppliers in the wholesale electricity market: AB "INTER RAO Lietuva", UAB "Energijos kodas", AB "Lietuvos energijos gamyba" and UAB "Scener". More than 90% of all electricity sales on the power exchange in 2018 came from AB "INTER RAO Lietuva". In the past years, two companies – AB "INTER RAO Lietuva" and UAB "Energijos tiekimas" – purchased about two-thirds of all electricity traded on the power exchange (NERC, 2019).

Electricity retail prices have been on the rise since 2017, with an increase in the electricity purchase price. Retail prices include a number of public service charges, which together with rising network charges made up more than 50% of the final price in 2020 (Figure 7.8).

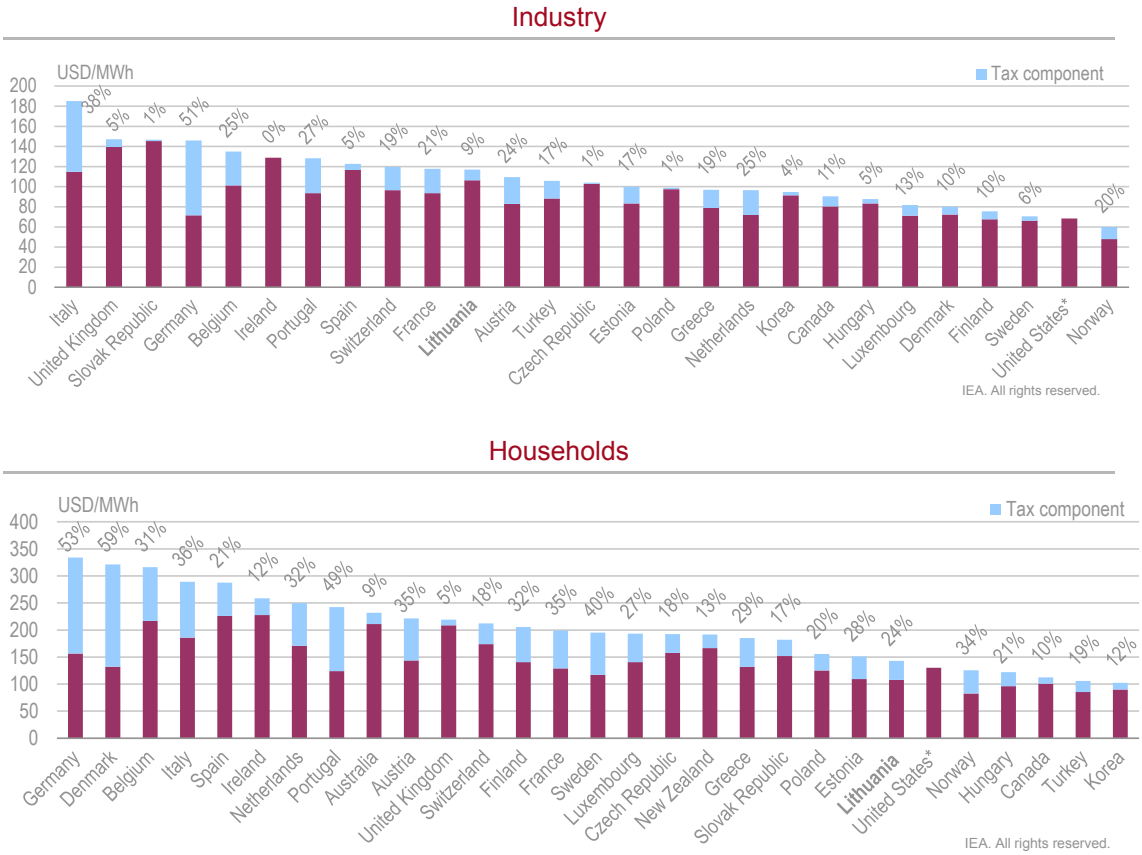
Figure 7.8 Composition of the electricity retail price in Lithuania, 2017-20



Notes: LV = low volt. MV = medium volt.

Source: NERC 2020.

Figure 7.9 Industry and household electricity prices in Lithuania and selected IEA countries, 2019



Lithuania's industry electricity prices are above those of sneighbouring Estonia and Poland. Household electricity prices are at the lower range among IEA member countries.

* Tax Information is not available for the United States.

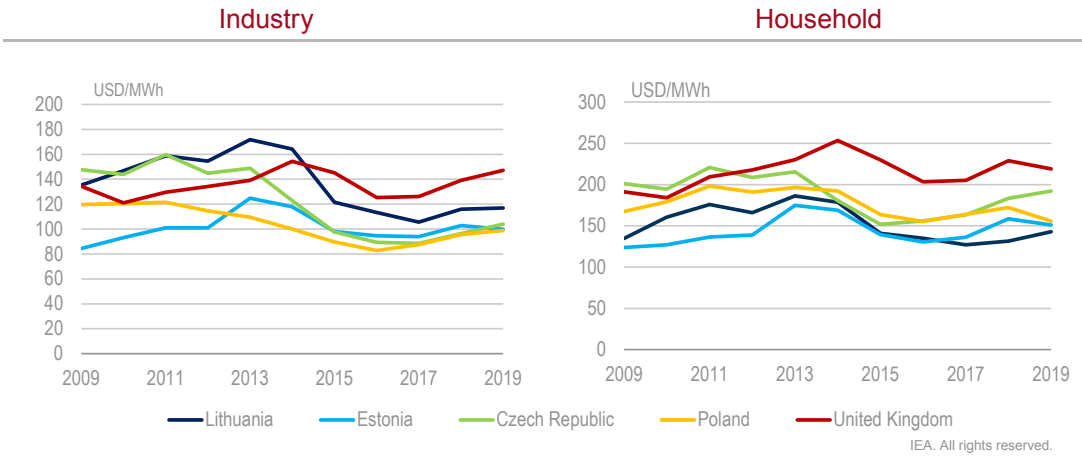
Notes: MWH = megawatt hour. Industry price data are not available for Australia, Japan, Mexico or New Zealand.

Source: IEA (2020), *Energy Prices and Taxes 2020*, www.iea.org/statistics.

Since their peak in 2013 at 171.7 USD/MWh, industry prices have decreased, reaching 116.9 USD/MWh in 2019, and included a tax component of 9% (Figure 7.9). Lithuania's industry prices were above the regional price levels depicted in Poland (98.9 USD/MWh) and Estonia (99.8 USD/MWh) (Figure 7.10) in 2019.

Conversely, household electricity prices in Lithuania, at 142.9 USD/MWh, were one of the lowest in 2019, compared to IEA member and neighbouring countries. Estonia's household electricity price levels stood at 151.2 USD/MWh and Poland's at 155.8 USD/MWh (Figure 7.10). In contrast to industry, the tax share for household electricity prices accounted for 24%, which was above the IEA average (Figure 7.9).

Figure 7.10 Electricity prices in Lithuania and selected IEA countries, 2009-19



Lithuania's electricity prices for households are the lowest across the region, while industry prices are above prices in neighbouring countries.

Note: MWH = megawatt hour.

Source: IEA (2020), *Energy Prices and Taxes 2020*, www.iea.org/statistics.

Security of supply

The Ministry of Energy is formally responsible for security of electricity supply, while the regulator NERC sets standards for the quality of service and reliability with minimum requirements for transmission and distribution.

Lithuania's Energy Independence Strategy places a major emphasis on creating self-sufficiency in power generation, with a target of reducing electricity imports by 30% by 2030 by two means: 1) investing in local generation – mainly renewables – to cover 70% of electricity consumption by 2030 on the path towards 100% by 2050; and 2) fostering the market integration with the EU (and desynchronisation from the Russian power system) by 2025.

At the transmission level, Lithuania uses electricity security standards, such as energy non-supplied and the average interruption time. At the distribution level, two key indicators (SAIDI/SAIFI) measure the performance of the reliability of the Lithuanian electricity supply. In 2018, the average duration of electricity supply interruption for consumers (SAIDI) was not allowed to be longer than 52.12 minutes per year, and the average number

of interruptions per consumer per year (SAIFI) when caused by the DSOs not greater than 0.72 times. Following an inquiry in 2019, NERC found that these key indicators were incorrectly calculated by the main DSO and the available data for 2012-18 are therefore not reliable.

Emergency response policy

The Law on Electricity establishes the statutory basis for emergency response policies with regard to the generation, transmission, distribution and supply of electricity. The supply of electricity in the event of an emergency is limited or suspended in accordance with the Rules of Electricity Supply and Use (Order No 1-38 of 11 February 2010). The Emergency Situation Operations Centre, within the Ministry of Energy, is also responsible for overseeing emergency response in the electricity sector.

NERC is responsible for monitoring the reliability of the electricity system and reporting annually to the government. Article 76(1) (2) of the law stipulates that NERC should co-operate with foreign national energy regulators to ensure that the transmission system operator (TSO) has one or more integrated system(s) at the regional level covering two or more EU member states for capacity allocation and for ensuring the security of the electricity network.

Litgrid, as Lithuania's TSO, is responsible under the law to maintain stable and reliable operations of the electricity system through national balancing and the provision of system services. Litgrid is responsible for the maintenance and management of the network, including the development of interconnections with the electricity systems of other countries, and for reducing the capacity constraints in the transmission network, taking into account the needs of the electricity system and electricity grid users.

The Lithuanian Ministry of Energy and other national institutions are given the authority to request information about energy enterprise activities. A draft of a Government Resolution will be passed early in 2021 which will clearly define electricity enterprises' obligations to provide information during an emergency. The procedure is foreseen as follows: in the case of an emergency within the electricity sector, the TSO and the DSO should, on a daily basis or at a greater frequency (i.e. a few hours), submit information to the Ministry of Energy about the causes for the electricity disruption at hand and the planned measures to mitigate emergency situations, as well as any assistance expected from other member states.

Once the state of emergency is over, the Ministry of Energy would be obliged to provide a report to the European Commission within three months, which would then be presented to the EU's Electricity Coordination Group. The *ex post* report would include all actions undertaken and its respective evaluation.

In an emergency, Litgrid relies on secondary reserves to ensure electricity supply and has plans in place for restricting or disconnecting consumers should a power shortage occur. The Kruonis Pumped Storage Plant serves as a tertiary power reserve, which can be activated during peak power consumption periods when there is a lack of offers in the electricity market. Litgrid holds contracts with the power plants in the Lithuanian electricity system and with BRELL operators for the jointly maintained secondary reserve. The direct current (DC) connections management contracts with the Polish and Swedish TSOs also provide an opportunity for receiving emergency assistance from neighbouring countries. The DC connections LitPol and NordBalt therefore offer emergency supply arrangements to Lithuania.

Litgrid is now part of ENTSO-E and the regional TSO collaboration. Under the ENTSO-E framework of regional security co-ordinators, the Baltic TSOs (Elering, AST, Litgrid) signed the Baltic Regional Security Coordinator Agreement in 2016 to support the common operation of the electricity transmission systems of the Baltic states and the common electricity market. The Baltic Regional Security Co-ordinators set up the framework for regional security co-ordination among the Baltic TSOs, including short-term regional resource adequacy assessments under the new EU Electricity Regulation.

Power system adequacy

Power system adequacy is challenged with higher peak demand (+15% by 2025) and major retirements in Lithuania and the Baltic region more broadly (due to EU environmental rules) (-38% of capacity up to 2025). Peak demand is expected to increase from 2 GW to 2.46 GW by 2029, as electrification of the economy progresses, according to Litgrid's Network Development Plan 2020-29. ENTSO-E expects that in 2025, the loss of load expectation in Lithuania could increase to 29.5 hours per year.

Lithuania planned to address this situation by introducing a capacity mechanism with state support by 2025. During 2019-20, Lithuania adopted amendments to the Law on Electricity to implement a market-wide capacity mechanism to maintain a sufficient level of security of power supply by the time the desynchronisation of the Lithuanian power system from the IPS/UPS system occurs.

However, ENTSO-E will perform the European resource adequacy assessment in 2021 according to the new European Resource Adequacy Assessment methodology approved by ACER with different criteria, so results could significantly influence next steps towards safeguarding of the Lithuanian power system adequacy.

Based on the amended Law on Electricity, Lithuania aims to limit loss of load expectation to a maximum of eight hours per year. It was planned for the market-wide capacity mechanism to be implemented through technology-neutral auctions for existing generation facilities, storage facilities (such as batteries), equipment operated by independent demand-response aggregators and new facilities to be operational by 2025 (to replace old, inefficient and non-compliant facilities). The European Commission needed to approve the latter mechanism under the state aid rules. However, based on the results of the power system adequacy assessment to be performed in 2021, decisions on the most appropriate capacity mechanism model will be reviewed and implemented.

System integration of variable renewables

Renewable energy dominates Lithuania's electricity generation, accounting for 75% in 2019. Wind power makes up almost half of total power generation. With a view to increase independence from imports, the government has ambitious targets for renewable electricity: 45% of electricity consumption is to be covered by renewable generation in 2030. The government also specified a national 2050 target of 80% of renewable energy in overall energy demand and 100% renewables in electricity consumption.

Today, the system benefits from biomass use in co-generation and hydro power, which are dispatchable and a source of flexibility for balancing, inaddition to the spinning reserves provided by synchronous operation with Russia. Wind energy is expected to be the main source of electricity generation, accounting for at least 70%, while solar energy is estimated to account for 3%, biofuels 9%, hydropower 8% and biogas 2% by 2030

(Republic of Lithuania, 2019). The government is also looking at hydrogen to store offshore wind energy in the horizon up to 2030.

With the rise in wind and solar power, system integration will become a priority and the system operator needs to adjust to operations with higher shares of variable renewables. Litgrid has carried out work to identify potential challenges and solutions for better integration of variable renewables and rising peak demand. This is particularly challenging as Lithuania will also have to integrate rising shares of distributed variable renewables (prosumers) at the same time. During the coming years, Lithuania will need to increase the flexibility of the system and its resources.

Much of the future renewable energy will come from distributed levels and prosumers will play an increasing role to meet the targets established by the government. Between 2015 and 2020, the capacity of prosumers increased rapidly: from 0.5 MW (63 prosumers) to 80.5 MW (around 8473 prosumers). Lithuania targets a share of 2% of total electricity consumers (1.6 million) to become prosumers by 2020, 30% by 2030 and 50% by 2050.

In Lithuania, electricity from renewable energy sources is priority dispatched. The power system operator currently does not use countertrading or redispatching at the national level, but it is implementing tools for redispatching or countertrading at the regional level through the introduction of the All Baltic Capacity Calculation Region (Estonia, Finland, Latvia, Lithuania, Poland and Sweden). The distribution system operator ESO and the TSO also collaborate to identify curtailment needs.

Work is ongoing to enhance system flexibility by grid investments using smart technologies, which could ensure inertia of the system and fast response (ramp up/down capacity) as well as demand response. The introduction of smart metering is ongoing with a deadline for 2024, which will offer more flexibility services for peak and off-peak periods.

The distribution system operator ESO is working to support active users (prosumers, deregulation, smart metering and a data hub), system services for flexibility and storage as well as innovative solutions (demand response, cybersecurity, smart grids and cable solutions). The data hub will evolve with the roll-out of smart meters and become a centralised information exchange platform for market participants by 2023.

Grid investments are part of the solution and Litgrid's Network Development Plan for 2020-29 includes EUR 1.25 billion investments at transmission level. Litgrid is regulated by NERC under price cap regulation for five-year periods (2016-20), with a one-year extension with a weighted average of 5.34% capital (2021). NERC applies the same regulatory framework for ESO as it does for Litgrid.

Demand response is available at wholesale level in the Nordic market, which provides great flexibility. TSOs in the Baltic region have worked together to harmonise demand response across the region. In June 2020, it was appointed independent aggregator for demand response. Litgrid publically consults on baseline methodology, implementation of balancing service contract, and imbalance purchase and sales contract.

Litgrid aims at creating a load frequency control block in the Baltic region together with the other Baltic TSOs, taking the necessary steps to enter into a frequency restoration reserve (FRR) exchange and sharing agreements with the TSOs of neighbouring load frequency control blocks.

The synchronisation of the Baltic region will require the countries' power systems to comply with frequency quality and balance control in Eastern Europe. To that end, the creation of an automatic FRR is necessary. Together with the Baltic TSOs, Litgrid will be implementing the design of European platforms for both manual and automatic FRRs in the coming years up to 2023.

Litgrid's future efforts will focus on implementing a 15-minute imbalance settlement period in line with the Nordic market. Litgrid is considering introducing a scarcity pricing function in the common Baltic balancing market, applied not only to balancing responsible parties, but also to balancing supplier parties. To date, the maximum price for the manual frequency restoration reserve (mFRR) to balance the energy market is set in the Baltic balancing market at 345 EUR/MWh. In line with the Electricity Balancing Guideline and European standard mFRR balancing energy products, the Baltic TSOs are considering removing the energy price limit. Baltic balancing service providers could compete with European balancing service providers without predefined limits for mFRR balancing energy prices. Litgrid evaluates the possibilities of an increase in balancing energy prices to the value of lost load, when the system runs out of reserves. These will be essential prerequisites for the synchronisation and integration of higher shares of variable renewables.

To reach the target of 100% renewables by 2050, the government and the system operator need to further analyse several critical elements. There is no theoretical barrier to the stability of a power system without conventional generation; however, emerging technology solutions are only proven at small-scale and in mini-grids to date. More research and demonstration projects will therefore be needed to learn from experience, understand and test system stability in large-scale applications. The deployment of solar and wind must go hand in hand with the promotion of a social licence, the adaptation and upgrade of transmission and distribution grids which requires long-term planning and investment, and stakeholder involvement. Last but not least, the costs of technical conditions for renewables integration and socio-economic implications will need to be assessed, notably the impact of the prosumer scheme on the electricity market, the cost for consumers, and the future of biomass and its sustainability.

Assessment

Lithuania shifted from being a net exporter of electricity to a net importer with the closing of the Ignalina nuclear power plant in 2009. In 2019, 70% of its electricity supply was imported, mainly from Sweden, Russia and Latvia. Lithuania has an installed capacity of 3.7 GW and a peak demand of 2 GW. Its electricity consumption was 11.4 TWh in 2019, with domestic production of 3.6 TWh. Three-quarters of domestic power generation was covered by renewables, primarily wind, solar and hydro.

Over the past decade, Lithuania's Ministry of Energy has adopted critical reforms, which have restructured the institutional governance of the electricity sector, more closely integrated it into the Baltic and Nordic electricity markets, and set out plans for a competitive retail market. The commissioning in 2016 of two HVDC interconnectors with Poland and Sweden allowed diversification of import sources and Lithuania is now well interconnected, which will increase even more with the new subsea cable connecting Lithuania and Poland (Harmony Link).

In the coming five years, Lithuania faces a major implementation period with three key priorities:

- boosting medium-term electricity adequacy in Lithuania and adapting the power system operation to higher shares of variable renewable energy
- implementing the synchronisation with the European network and related balancing and reserve markets at the regional level
- phasing out regulated prices, promoting competition and smart metering of household consumers.

Wholesale electricity market

Lithuania has carried out a massive restructuring of its electricity market in the past years. Lithuania forms a single price area within the joint Nordic and Baltic wholesale market. Due to integration in the Nordic electricity market, wholesale electricity prices have been on a decline since 2015. Transmission and distribution are unbundled from generation and supply. There is one TSO, five DSOs, five large producers and a number of small renewable energy producers.

Renewable energy dominates Lithuania's electricity generation, accounting for 76% in 2019. Wind power made up 44% total generation. Considering that the country imports around 70% of its electricity, Lithuania is commended for its highly ambitious targets for renewable electricity: 45% of electricity consumption is to be covered by renewable generation in 2030 and 100% in 2050.

Large capacities of onshore and offshore wind power as well as solar are expected to be connected to the power system in the coming years. This new generation capacity, together with the synchronisation of the Baltic power system with the Central European network, requires massive investments in the networks in a short time. Together with the TSO and DSOs, the government should secure the necessary financing for critical investments in the internal grid and interconnectors.

With relatively low electricity wholesale prices, co-generation is struggling with its profitability and capacity is mothballed. With an increasing share of variable renewable generation, co-generation remains a very important technology for the power system, in particular for the power balance and peak load. Flexible renewable co-generation plants replacing old gas power plants could be a viable option in the future for electricity grid balancing and other system services.

Renewable generation is priority dispatched. Future support schemes and market regulation for RES should be designed so that the need for redispatch, countertrade and possible curtailment is minimised, hence reducing system costs.

Lithuania aims to increase the number of renewable decentralised prosumers significantly. The ambition is for 30% of all consumers to be prosumers in 2030. Prosumers invest in local generation and thereby reduce the country's dependency on imported electricity. Prosumers gain advantage from net-metering, meaning that they can "store" electricity generated at one moment in the grid and use it later the same year. Consequently, the prosumer has no incentive to use electricity during times of high production or to use less when there is a shortage in the market and prices are high, unless smart meters and dynamic prices offer such incentives.

Lithuania puts a lot of effort into increasing investments in new generation capacity by implementing support schemes for different sizes and forms of generation. With the increase in renewable energy in the coming years, the focus needs to shift to boosting full power system flexibility. Lithuania already benefits from interconnections and hydro power capacity; however, demand-side response is not yet promoted to a similar extent. The demand side most likely has unused potential for relieving the challenge of meeting peak load as well as for facilitating the integration of rapidly increasing volumes of variable generation. The roll-out of smart meters and the opening of the electricity retail market for all customers creates an opportunity for demand-side response and should be a target for development.

Retail electricity markets and smart energy systems

According to the energy regulator, NERC, there are 5 public suppliers and 59 independent suppliers in the retail market. Since 2013, all commercial users can choose to purchase electricity from a public supplier at regulated prices or to buy directly in the market with a bilateral contract. The market remains concentrated for household customers, as public suppliers supply over 99% of the demand, despite the possibility for households to change supplier.

According to the Baltic Energy Market Interconnection Plan, price regulation mechanisms were to be abolished by 2020. Market opening has been delayed for households, but a stepwise phase-out is now in progress. Lithuania seeks to achieve the full deregulation of electricity prices for households and the regulated prices are terminated for the last group of customers (those with an annual consumption below 1 000 kWh) as of 1 January 2023. All customers, including vulnerable consumers, will then have to select an independent supplier.

The phase-out of regulated prices needs to be understood as the cornerstone of a functioning electricity market. Regulated prices limit incentives for consumers to switch suppliers or independent providers to enter the private consumer market, which remains very concentrated. The government could also choose to phase prices out for all and opt for social aid or energy vouchers to support poorer consumers directly.

The DSO ESO plans to deploy smart meters between 2020 and the end of 2023 for household consumers who consume more than 1 000 kWh per year. Thus, almost half of the customers, covering together around 90% of the electricity consumption, would have a smart meter installed. Rolling out smart meters enables dynamic price contracts and raises awareness of energy saving among consumers. In addition, smart meters provide the DSO with a wide variety of metering point data and technical functions, such as remote reading and switching capability. Lithuania has one large DSO for gas and electricity and a few very small ones. This should be favourable for developing demand-side mechanisms, rolling out smart meters and developing the data hub. The government should ensure that the DSOs foster a transparent and non-discriminatory environment for new demand-side services. They should be encouraged to install smart meters also for small customers. A complete roll-out would also enable a maximum benefit of the data hub when it is put into use.

Litgrid's ten-year Network Development Plan forecasts electricity consumption to increase by 1.9% per year. Considering the electrification of the society, Litgrid expects the peak load to increase from 2 032 MW to 2 466 MW within ten years. Demand response and

smart systems such as smart charging of vehicles, can smoothen the demand profile and reduce the need of costly investments in the distribution and transmission networks.

In 2020, Lithuania planned to put in place a capacity mechanism to secure new investment by 2025, the moment when the power system will be synchronised with the EU. In the coming years, Lithuania will also increase the flexibility from demand response (which will be implemented by Litgrid) and smart meters, as well as the use of its interconnections. There is one critical enabler for demand-side flexibility: dynamic retail pricing. Lithuania's retail price reform will be also important for the system integration of variable renewables. Lithuania will need to assess how to use the synchronised interconnections with the EU (after 2025) for the system integration of higher shares of wind and solar energy. New opportunities for system integration may also come from sector integration (coupling of electricity, heat, gas and transport) and the use of hydrogen in Lithuania. The government may need to design a strategy for hydrogen production and use and assess the value for system integration (which may be limited if there are no other uses for it).

Electricity security

Lithuania has a peak load reserve consisting of gas- and oil-fired production units with a total installed capacity of approximately 1 100 MW. FRRs are provided by the Kruonis Power Plant and by electricity from neighbouring countries. There is currently no operational FCR capacity market in Lithuania. This service is provided by the IPS/UPS system. A major part of the installed capacity are old generating units, which are likely to be phased out by 2025. In order to ensure the Lithuanian power system adequacy going forward, a capacity mechanism (market-wide model) was explored. However, based on the results of the power system adequacy assessment to be performed in 2021, decisions on the most appropriate capacity mechanism model will be reviewed and implemented later.

A fundamental objective of the energy strategies of the Baltic states – including Lithuania – is the integration of their energy systems into the common European electricity market and the start of synchronised operations with the European Continental Network by 2025. Lithuania ceased importing power from Belarus in late 2020, and will do so from Russia following the synchronisation with Europe.

The Emergency Situation Operations Centre, within the Ministry of Energy, is responsible for overseeing emergency response in the electricity sector. The regulator, NERC, is responsible for monitoring the reliability of the electricity system, including setting minimum requirements for the transmission and distribution grids. A new improved methodology for assessments and reporting of the reliability of the Lithuanian electricity grids will be implemented in 2021. Litgrid, Lithuania's TSO, is responsible under the law to maintain stable and reliable operations of the electricity system through national balancing and the provision of system services. Lithuania is currently in the process of drafting primary and secondary legislation to meet EU requirements concerning emergency situations in the electricity sector, including preparing national electricity crisis scenarios and related national risk-preparedness plans, as well as meeting power system operation requirements, such as developing system defence and restoration plans.

Lithuania is part of the Baltic Regional Security Coordinator, which is a grid security co-operation initiative set up by the three Baltic TSOs. The Regional Security Coordinator *inter alia* identifies risks of operational security in areas close to national borders and the

most efficient remedial actions. It also makes short-term adequacy assessments. Lithuania is also striving to establish a Regional Coordination Centre in accordance with the Electricity Regulation (EU) 2019/943 by 1 July 2022.

The IEA's overall assessment is that Lithuania is currently in a good position in terms of emergency response and crisis management in the electricity sector. The recommendations for the government therefore aim at a medium-term perspective, where some challenges can be identified in relation to the phase-out of installed dispatchable capacity while variable renewable generation is on the rise, and the continued preparation for the system synchronisation with Continental Europe. Nevertheless, some more immediate electricity security concerns should also be addressed. Lithuania, together with the two other Baltic countries, stopped importing electricity from Belarus when the nuclear power plant in that country became operational in November 2020.

At the same time, the ever-increasing digitalisation of the electricity sector raises the importance of assessing and taking steps to address cybersecurity risks specific to the power system. In 2018, Lithuania established the National Cyber Security Centre at the Ministry of National Defence, with responsibility for unified management of cyber incidents, monitoring and control of the implementation of cybersecurity requirements, and accreditation of information resources. Lithuania should now seek to establish energy sector specific cybersecurity policies, including in the electricity sector.

Recommendations

Electricity markets

The government of Lithuania should:

- Keep the announced schedule for the phase-out of regulated prices, promote a fast roll-out of smart meters to all customers (including those with a consumption of less than 1 000 kWh) and engage customers of all sizes in the electricity market either directly or through aggregators and other service providers. Ensure that DSOs are neutral facilitators of market opening.
- In this context, adjust renewable electricity support schemes, such as net-metering for prosumers, to bring them in conformity with an open and market-based electricity market.
- Foster the deployment of demand-side response and the uptake of energy storage services in wholesale and retail markets in order to ease peak load situations and facilitate the integration of increasing volumes of variable renewable energy.
- Ensure that co-generation plants have the operational and financial capacity to provide grid balancing and other system services, and satisfy security of supply of the electricity system and heat sector needs.

Electricity security

The government of Lithuania should:

- Ensure that market participants maintain resource adequacy amid rising distributed variable renewable electricity production and decreasing imports from third countries. Swiftly implement the Lithuanian Electricity Market Development and Implementation Plan.
- Carefully prepare for the synchronisation with the EU electricity market in terms of infrastructure capacity and operational security issues, e.g. balancing market processes (frequency response) and updating risk preparedness plans, system defence plans and restoration plans.

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8. Natural gas

Key data

(2019)

Domestic production: none

Net imports: 2.2 bcm (2.7 bcm imports, 0.5 bcm exports)

Share of gas: 24% of TES, 16% of electricity generation, 22% of TFC

Gas consumption by sector: industry 68%, electricity and power generation 14%, residential 9%, commercial 5%, transport 1%, other energy 4%

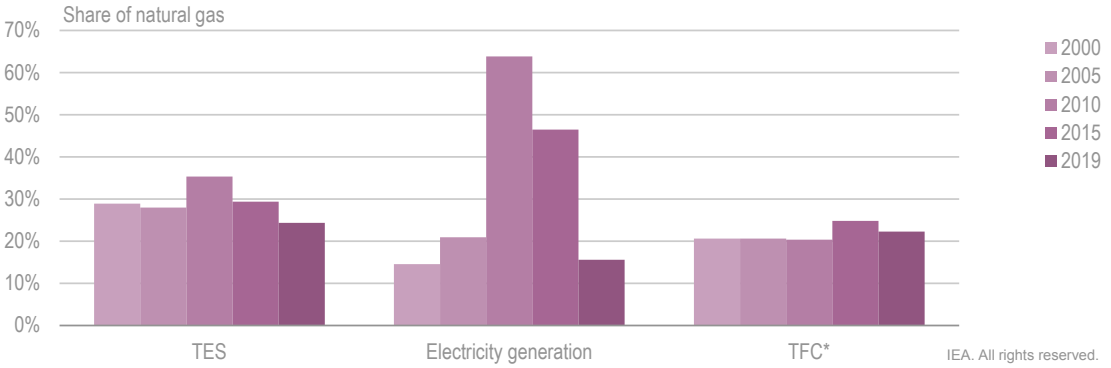
Overview

Natural gas has been a pillar of Lithuania's energy mix as the country decommissioned its nuclear plant. In recent years, the role of natural gas has decreased in the wake of increasing investments in renewable energies, the closure of older gas-fired combined and heating plants, and the increased use of biomass for district heating. In 2010, natural gas accounted for 54% of electricity generation and 62% of heat production, but it has since declined substantially, respectively to 16% and 18% in 2019. Natural gas had made up 35% of TES in 2010, but decreased to 24% in 2019 (Figure 8.1). Russian imports saw a steady decline. However, with 22% of total final consumption (TFC), natural gas is the second most prominent fuel in Lithuania, after oil. Natural gas is now mostly used by industry, including over 50% of the country's gas consumption by the region's largest fertiliser and chemicals company, Achema.

Lithuania is entirely dependent on natural gas imports as the country has no domestic gas production. Until 2014, Lithuania was fully dependent on imports of Russian gas, either directly through interconnection with the Russian Federation or from its connection to the Incukalns storage facility in neighbouring Latvia, where Russian gas is typically stored in the summer for use in the winter. Thanks to the commissioning of the Klaipeda LNG Terminal at the end of 2014, Lithuania diversified its gas supply in support of national and regional security of supply. In 2019, the total volume of imported natural gas amounted to 2.75 billion cubic metres (bcm), of which 0.5 bcm was exported to neighbouring Latvia, leaving Lithuania with an inland consumption of 2.23 bcm. In 2019, the utilisation rate of the liquefied natural gas (LNG) terminal in 2019 was at 49.3%, the highest since its construction. Lithuania is not yet connected to the European gas pipeline network. The Gas Interconnection Poland-Lithuania (GIPL), when completed by the end of 2021, will enable Lithuania, Estonia and Latvia, as well as Finland, to trade natural gas with continental Europe. At the same time, Lithuania's supply to the gas retail market for households is highly concentrated and governed by regulated prices.

Lithuania is committed to a sustainable transition towards climate neutrality. During the transition towards a low-carbon economy, natural gas is expected to have a role to play. Gas-fired power plants will continue to provide flexibility for the integration of rising renewable energy sources in coming years. The government is also planning on promoting LNG and compressed natural gas use as alternative fuel in the transport sector along with green gases. Work has started on scaling up current biogas to biomethane production and promoting the production and transportation of hydrogen in Lithuania.

Figure 8.1 Share of natural gas in total energy supply, electricity generation and total final consumption in Lithuania, 2000-19



Natural gas was the key transition fuel to support electricity generation after the end of nuclear energy production in 2010, but its role has diminished over the last decade as renewable energy has grown strongly.

* Latest data refer to 2018.

Notes: TES = total energy supply. TFC = total final consumption.

Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

Supply and demand

With no domestic gas production, Lithuania is fully reliant on imports. The country's gas network has three entry points: Belarus, Latvia, and the liquefied natural gas (LNG) floating storage and regasification unit (FSRU) in Klaipeda. The largest of these entry points to Lithuania's gas network is the interconnection from Russia through Belarus, which also serves to transit gas to the Russian exclave of Kaliningrad. The interconnection with Latvia provides Lithuania access to the Incukalns underground gas storage facility in Latvia, in the absence of a dedicated gas storage in Lithuania.

Lithuania's natural gas imports reached 2.7 bcm in 2019, of which 0.5 bcm was exported to Latvia. More than half of Lithuania's gas imports in 2019 (or 1.41 bcm) were sourced via the LNG terminal, mostly from Norway (82.8%), Russia (12.7%) and the United States (4.5%). The other half (1.21 bcm) was sourced from Russia via pipeline. Since 2010, gas imports to Lithuania have declined by 17% and Russian deliveries have decreased by 61%, from 3.1 bcm in 2010 (Figure 8.2).

With the start of the Balticconnector in January 2020, the new bidirectional gas pipeline between Estonia and Finland, the connectivity between the Baltic states' and the Finnish gas markets has improved the region's gas supply security. Estonian and Finnish industries gained access to Lithuania's LNG terminal, as reflected in the signature of several short-

term deals, and more remarkably, an increase in exit flows from Latvia to Estonia, which coincided with higher imports from the Lithuanian LNG terminal (up by 37% year-on-year in 2020). Gazprom's exports to Estonia fell by 10% in the first three quarters of 2020.

Figure 8.2 Lithuania's natural gas imports, 2000-19

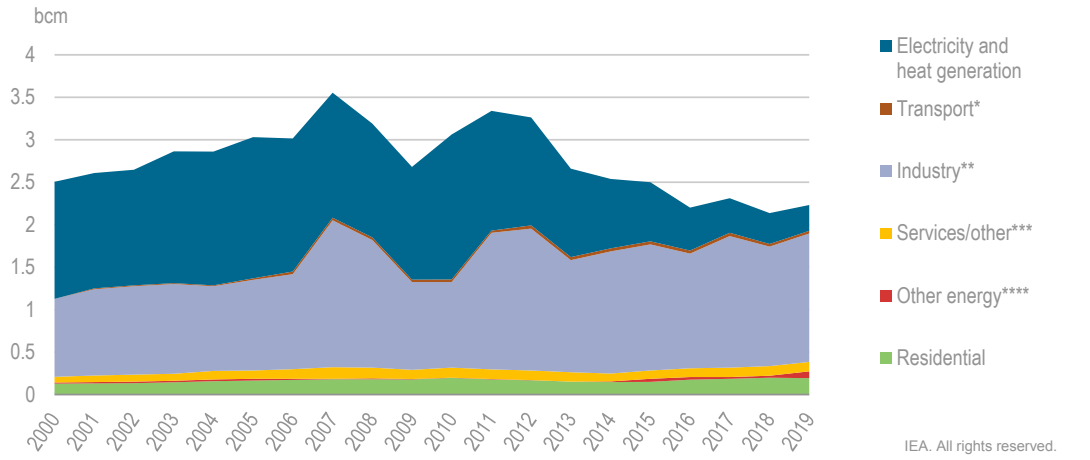
Lithuania's total net imports of natural gas have decreased progressively since 2011.

Note: bcm = billion cubic metres.

Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

Two-thirds of natural gas consumption in Lithuania in 2019 was consumed by industry for non-energy use, which saw a 47% increase from 2010 (1.5 bcm in 2019). AB Achema, a fertiliser company, is responsible for more than half of the gas consumption in Lithuania. Gas consumption for electricity and heat generation has fallen sharply in recent years (from 1.7 bcm in 2010 to 0.3 bcm in 2019), to reach 14% of generation in 2019.

Figure 8.3 Lithuania's natural gas consumption by sector, 2000-19



Natural gas consumption has decreased over the last decade, from 3.1 bcm in 2010 to 2.2 bcm in 2019, driven by the phasing out of gas-fired power plants and switching to renewables.

* *Industry* and *other energy* include non-energy use (oil and gas extraction).

** *Services/other* includes public and commercial services, agriculture, forestry, and fishing.

Note: bcm = billion cubic metres.

Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

Gas-fired co-generation plants are being retired and are largely being replaced by biomass. Residential gas consumption is relatively small (9% of the total), as it is predominantly used for cooking, not heating. The commercial sector is responsible for a 5% share of Lithuania's natural gas consumption (Figure 8.3).

Natural gas infrastructure

Lithuania's gas transmission and distribution network consists of 2 113 km of gas transmission pipelines and around 9 573 km of distribution grids. It has 2 gas compressor stations, 3 gas metering stations and 65 gas distribution stations. A major supply pipeline from Russia enters Lithuania in Kotlovka at the Belarusian-Lithuanian border and is unidirectional. There is also a connection with Latvia's gas systems through a bidirectional pipeline which provides Lithuania with access to the Incukalns underground gas storage facility and to the Latvian and Estonian gas markets, and gives these countries access to the LNG terminal in Klaipeda (Table 8.1). Lithuania also serves as a transit country for Russian gas flowing to the Kaliningrad Region upon a long-term transit contract with Gazprom, extended in 2015 until December 2025 (Amber Grid, 2015).

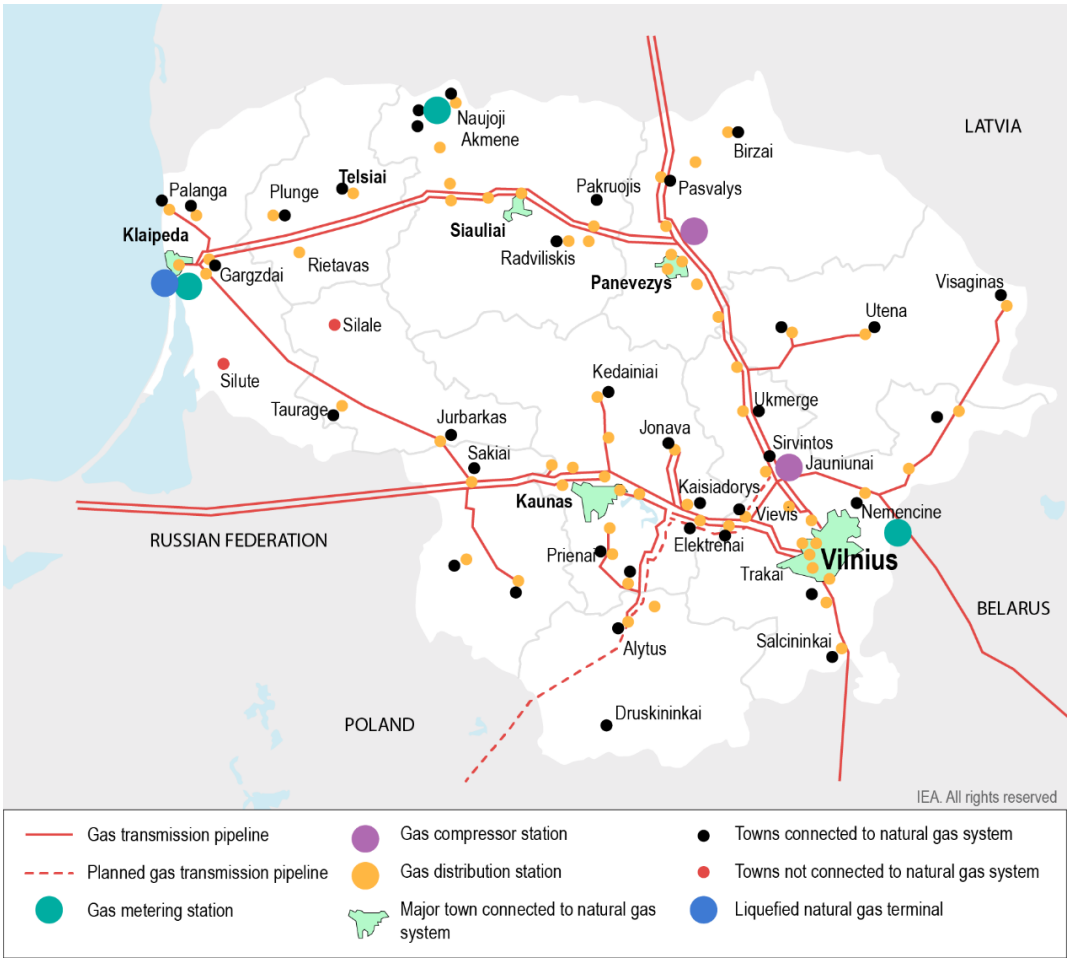
The Klaipeda LNG terminal started operating in December 2014 and consists of an FSRU, named "Independence", with a total capacity of up to 10.25 mcm/d and has LNG storage for 170 000 m^3, a berth and an 18-kilometre gas pipeline connecting it to the transmission system. The FSRU was built by Hyundai Heavy Industries Co., Ltd. and is owned by Leigh Höegh LNG (Norway). It is permanently moored to a berth in the Klaipeda seaport. Since 1 April 2020, PGNIG S.A., the biggest Polish gas company, has the exclusive right to use the LNG reloading station located in the sea port of Klaipeda, becoming its sole user (PGNiG, 2020).

Table 8.1 Lithuania's natural gas pipeline network capacities

Interconnector	Import capacity	Export capacity	Comments
Latvia (Kiemenai)	6.0 mcm/d (65.1 GWh/d)	6.5 mcm/d (67.6 GWh/d)	Interconnector gives Lithuanian companies access to the Latvian and Estonian markets, as well as to the Incukalns storage facility
Belarus (Kotlovka)	29.9 mcm/d (325.4 GWh/d)	Not reversible	The biggest N-1 entry point in the region (Baltics and Finland)
Russian Federation (Kaliningrad Region)	Not reversible	10.5 mcm/d (109.2 GWh/d)	Transit of Russian gas through Lithuania to the Kaliningrad exclave

Notes: mcm/d = million cubic metres per day. GHw/d = gigawatt hours per day.
Source: Ministry of Energy 2020.

Figure 8.4 Map of natural gas infrastructure in Lithuania



Notes: HVDC = high-voltage direct current. This map is without prejudice to the status of or sovereignty over any territory; to the delimitation of international frontiers and boundaries; and to the name of any territory, city or area.

Gas market structure

In 2019, there were 603 000 natural gas consumers in Lithuania, mostly household consumers; 7 700 were non-household consumers. This number is growing steadily. In 2018, there were 587 600 household gas consumers and 7 400 non-household consumers. In 2019, household consumers accounted for 98.72% of the gas retail market, but they consumed only 36% of the natural gas supplied; non-household consumers purchased 64% of the volume of natural gas supplied. UAB Ignitis[1] remains the main supplier of natural gas to household consumers with a market share of 99.89% of total sales in 2019 (NERC, 2020). There is hardly any competition at retail level in Lithuania. In theory, consumers have the option to switch natural gas suppliers, but in practice the market structure is not favourable for this option. Natural gas prices for large consumers were deregulated, but the prices for household consumers remain regulated under the supervision of the regulator. As a result, the Lithuanian market still remains highly

[1] In 2019, Ignitis, an energy service company, inherited all the rights and obligations of Lietuvos Energija. Lietuvos Energijos Tiekimas, Energijos Tiekimas, Gilė and Litgas were also merged into Ignitis, which is the largest supplier of electricity and gas in Lithuania, providing more than 1.6 million people with energy services.

concentrated, with Ignitis supplying 99% of the retail market and Achema being responsible for 89% of supplies on the wholesale market.

All companies in charge of the transmission and market operations of natural gas in Lithuania are state owned. The network's pipelines belong to the transmission system operator (TSO) and the distribution system operators (DSOs).

AB Amber Grid is the designated operator of Lithuania's natural gas transmission system and is in charge of transmission of natural gas via high-pressure pipelines to system users. Amber Grid's customers are large companies (power plants, district heating plants and industrial companies), as well as medium-sized companies operating in Lithuania and gas supply companies. The company operates 65 gas distribution stations and 2 gas compressor stations and all gas transmission pipelines. Amber Grid is 96.58% owned by UAB EPSO-G, with the remaining shares owned by minority investors. UAB EPSO-G is fully controlled by the Lithuanian Ministry of Energy and serves as a holding company through which the ministry manages the entire energy transmission sector. Amber Grid also owns 66% of GET Baltic – the operator of the regional Baltic-Finnish gas exchange which administrates the electronic trading system for spot and forward natural gas products with physical delivery in Estonia, Finland, Latvia and Lithuania. On 1 December 2020, GET Baltic launched a dedicated secondary capacity trading platform for Finnish customers.

The largest gas and electricity DSO in Lithuania is ESO, which serves 99% of Lithuanian consumers. Established on 1 January 2016 through the merger of the Lithuanian electricity distribution network operator LESTO AB and gas company Lietuvos Dujos AB, ESO is controlled by the state-owned Ignitis, which owns 97.66% of its shares.

The Klaipeda LNG terminal is operated by AB Klaipedos Nafta, majority owned by the state (72.3%), represented by the Ministry of Energy, with 10.41% ownership held by Achema Group, a private company, and the remaining ownership shares traded on Nasdaq Vilnius. In 2019, the Lithuanian parliament decided that the LNG terminal will also be needed beyond 2024. The Lithuanian government decided to purchase an FSRU, either the one currently operating or another, one in order to decrease the long-term price of natural gas to final consumers. In November 2020, the European Commission approved, under EU state aid rules, a Lithuanian measure to issue a state guarantee for securing a loan for AB Klaipedos Nafta to finance the FSRU purchase. The initial construction and operation of the LNG terminal was supported by state aid approved in November 2013 by the European Commission. In particular, the Commission found that the measure was necessary to ensure security of gas supply in Lithuania. Under the 2013 decision, the leasing costs connected to the construction and operation of the terminal were exclusively financed through a fee levied on Lithuanian gas consumers, the so-called LNG supplement. In order to reduce the financial burden on consumers, Lithuania replaced part of the LNG supplement with a loan guaranteed by the Lithuanian state, which was approved by the Commission in September 2019. Lithuania intends to organise a public procurement process in the second half of 2021 for selecting the most advantageous loan offer. The state guarantee is necessary to obtain a loan, which cannot exceed EUR 160 million from a private financial institution, as this amount should cover the costs of the FSRU (EC, 2020).

Gas market reforms

The implementation of the EU Third Energy Package in the Lithuanian gas sector was accomplished in November 2014. The unbundling of supply activities from transmission and the breaking up of the dominant vertically integrated monopoly has helped increase transparency in the natural gas market, contributing to the creation of a functioning regional gas market in the Baltic states.

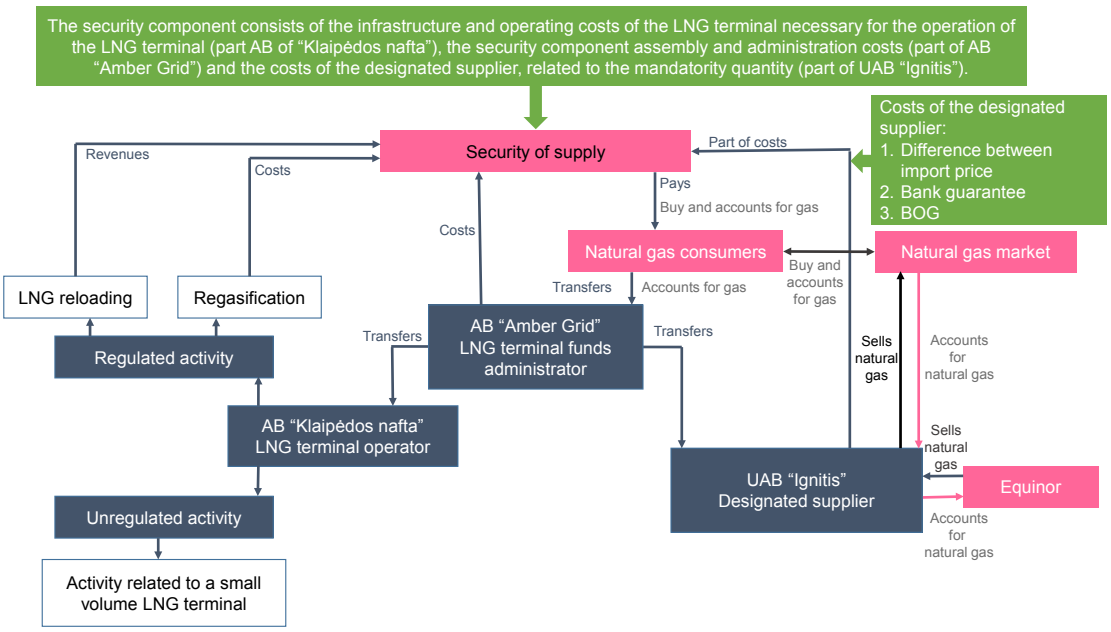
Legislation was passed to ensure the unbundling of then Lietuvos Dujos gas transmission activity by 31 July 2013 and the unbundling of the company's natural gas distribution activity by 31 October 2014. On 1 August 2013, Amber Grid, which was unbundled from Lietuvos Dujos, started gas transmission activity, and on 1 November 2014, Lietuvos Dujų Tiekimas UAB started gas distribution activity.

Before the start of the Klaipeda LNG terminal operation, all of the natural gas supplied to Lithuania was sourced from the Russian company Gazprom pursuant to a long‑term supply contract with Lietuvos Dujos. Negotiations with Statoil/Equinor were completed in August 2014 and a first five-year LNG supply contract was signed for supplying LNG to the terminal in Klaipeda. In 2019, another five-year LNG supply contract with Equinor was signed, but according to media reports, the Ministry of Energy wants to renegotiate and halve deliveries in 2021 amid lower gas demand in Lithuania and elevated cost (Baltic Course, 2020).

Under the EU Baltic Energy Market Interconnection Plan, market reforms in gas have focused on reducing the region's reliance on a single supplier and ensuring greater energy security and market integration with neighbouring countries. The plan is one of the priority corridors identified by TEN-E (Trans-European Network for Energy). In October 2018, the TSOs of Estonia, Finland and Latvia signed a memorandum of understanding, in line with the EU's strategic priorities for its TEN-E programme. The memorandum of understanding sets out the principles of an inter-TSO compensation mechanism (ITC) and a single entry/exit zone encompassing all the participating states (FINESTLAT), establishing the same entry tariff on each entry point to the single entry/exit zone and removing tariffs on country borders. The TSOs of Estonia, Finland and Latvia signed the final ITC agreement on 14 February 2019. The arrangements have been in place since 1 January 2020, with a single entry tariff set at EUR 142.77 MWh/day/year. However, the Lithuanian TSO, despite its active participation in market merger planning and ITC discussions, could not reach an agreement with the three other TSOs and did not sign the memorandum of understanding, nor the ITC agreement, and Lithuania remains a fully separate entry-exit area.

In April 2020, energy ministries, regulators and the TSOs from Estonia, Finland, Latvia and Lithuania agreed on a road map establishing a process for the future regional gas market integration of their respective countries. The first action set out by the road map, which is to be carried out by all TSOs, is to undertake, with the assistance of an external contractor, an analysis to support the ITC design and the emergence of a co-ordinated position on tariffs. Based on the Baltic Energy Market Interconnection Plan, discussions are ongoing to enlarge this common gas market to include Lithuania, based on a cost-benefit analysis, along the "Roadmap on regional gas market integration between Estonia, Finland, Latvia, and Lithuania" for the years 2020-22. From 2022 onwards, a common price zone should be established by abolishing all cross-border tariffs. Lithuania is evaluating the costs and benefits of a common tariff and pricing zone and alternatives for a regional market merger.

Figure 8.5 Lithuania's security of supply ligqufied natural gas financing model



Notes: BOG = Boil-off gas. LNG = liquefied natural gas.

Source: CEER (2019), *How to Foster LNG Markets in Europe*, www.ceer.eu/documents/104400/-/-/57d62db2-db0a-e611-2a49-85703d1d54d6.

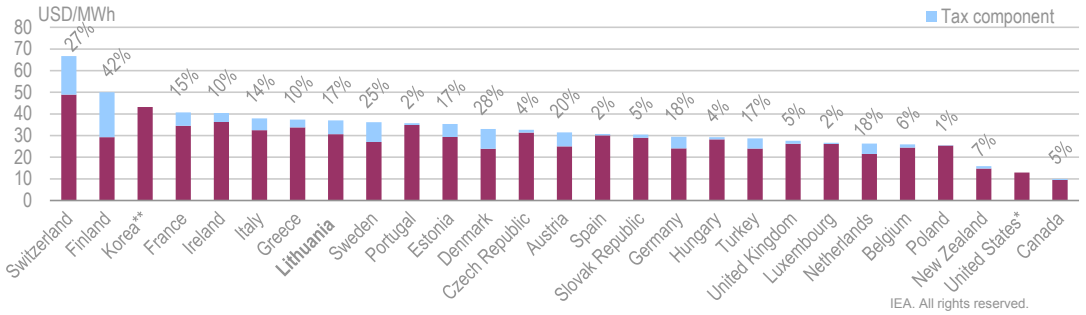
In Lithuania, natural gas prices for household consumers are regulated with price caps. The National Energy Regulatory Council (NERC) is responsible for approving tariffs; prices for non-household customers are not regulated. The gas market is small, with only one major supplier. Households in Lithuania account for one-third of total gas consumption. Unlike in electricity, in the gas retail market, Lithuania has no plans to phase out regulated prices for household consumers. Natural gas companies propose tariffs for household consumers every six months. The tariff consists of the sum of the forecasted specific transmission, distribution, storage, regasification and supply prices of natural gas, and the difference between the forecasted and actual natural gas prices of the previous tariff period. Natural gas suppliers must submit specific tariffs for approval to NERC.

Under the Law on the LNG Terminal, the financing scheme of the terminal is based on a security of supply model with three components: 1) LNG terminal infrastructure and operating costs (of Klaipedos Nafta); 2) costs of the designated supplier of a mandatory quantity (Ignitis); and 3) administrative costs incurred by the TSO Amber Grid (Figure 8.5). According to NERC, the system creates a level playing field for all gas suppliers.

Natural gas prices

In 2019, Lithuania's natural gas industry prices were 37.0 USD/MWh, ranking it the eighth-highest in comparison to IEA member countries. The tax share in industry prices amounted to 17% (Figure 8.6). In 2019, Lithuania's natural gas household prices were 47.9 USD/MWh, the sixth-lowest among IEA member countries. The tax share in household prices was 29% (Figure 8.7).

Figure 8.6 Natural gas industry prices in IEA member countries, 2019



Lithuania's industry prices are the eighth-highest in an IEA comparison.

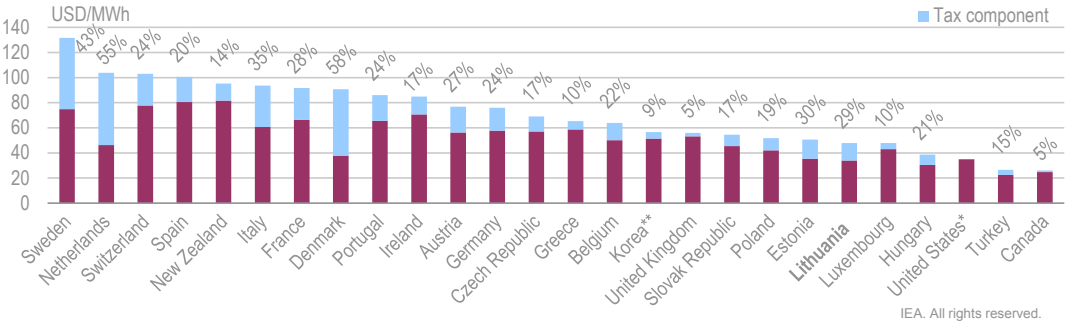
* Tax information not available for the United States.

** Korea's natural gas prices include the individual consumption tax.

Notes: MWh = megawatt hour. Industry price data are not available for Australia, Japan, Mexico or Norway.

Source: IEA (2020), *Energy Prices and Taxes 2020*, www.iea.org/statistics.

Figure 8.7 Natural gas household prices in Lithuania and IEA member countries, 2019



Lithuania's household natural gas prices are the sixth-lowest in an IEA comparison.

* Tax information not available for the United States.

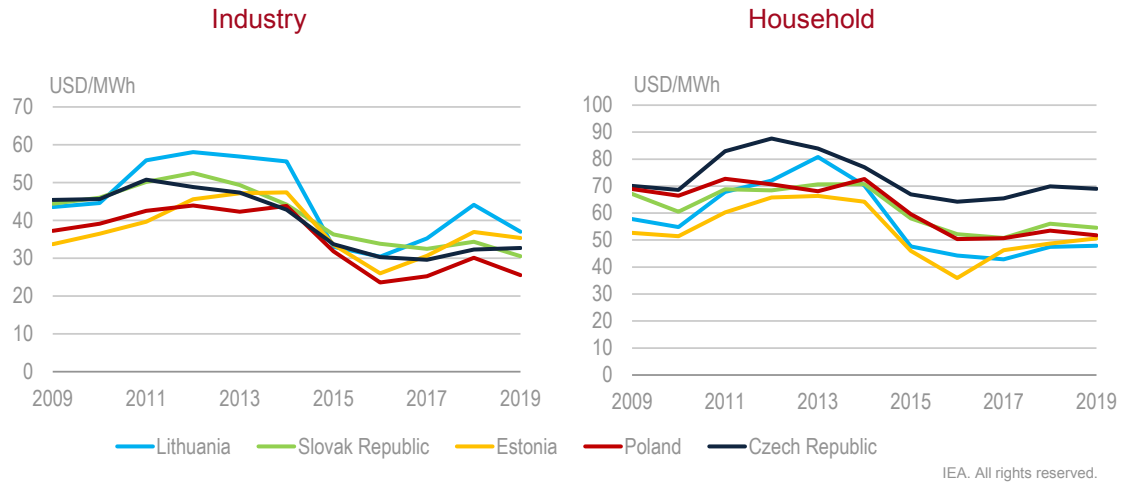
Notes: MWh = megawatt hour. Data not available for Australia, Finland, Japan, Mexico or Norway.

Source: IEA (2020), *Energy Prices and Taxes 2020*, www.iea.org/statistics.

Since 2013, starting around the time of the commissioning of the LNG terminal, natural gas prices have decreased significantly. Compared to Eastern European countries, Lithuania's industry prices have been, on average, higher over the last decade (2009-19). In 2019, Lithuania's natural gas industry prices were 37.0 USD/MWh, while Estonian prices were 35.4 USD/MWh and prices in the Czech Republic were 32.7 USD/MWh.

However, Lithuania's household prices over the same period, compared to the same countries, were amongst the lowest in that group. In 2019, Lithuania's household prices were 47.9 USD/MWh, the Slovak Republic's 54.5 USD/MWh and Poland's 51.8 USD/MWh (Figure 8.8).

Figure 8.8 Natural gas prices in Lithuania and selected IEA countries, 2009-19



Lithuania's natural gas prices have followed trends similar to those in other Eastern European countries over the past decade.

Note: MWh = megawatt hour.

Source: IEA (2020), *Energy Prices and Taxes 2020*, www.iea.org/statistics.

Security of supply

Security of gas supply through supply diversification has been a policy priority of the Lithuanian government for more than a decade. Under the 2018 National Energy Independence Strategy (NEIS), the government prioritised the investment in new gas infrastructure, regional interconnections and lower gas prices as well as alternative gaseous fuels (Republic of Lithuania, 2018).

Overall responsibility for security of gas supply in Lithuania is divided between the Ministry of Energy, the TSO Amber Grid and the energy regulatory authority (NERC, an independent national regulatory authority regulating activities of entities in the field of energy and supervision of the state energy sector). The State Consumer Rights Protection Authority handles complaints from household customers in relation to unfair application of terms and conditions of contracts for the purchase and supply of natural gas or provision of services. It also handles complaints and disputes from household customers with respect to unfair commercial activities of natural gas suppliers under the Law on Natural Gas of 2016 (Republic of Lithuania, 2016).

As Lithuania does not have natural gas storage facilities, it uses the Incukalns underground gas storage site in Latvia, which also supplies gas to major consumers in Estonia, Latvia, and north-west Russia (Pskov). The facility is owned by JSC Conexus Baltic Grid and is made available to customers upon commercial conditions (Conexus Baltic Grid, 2020). It is the only natural gas underground storage facility in the Baltic states and has a total technical capacity of 4.47 bcm, of which 2.32 bcm was working volume in 2019. It has a withdrawal capacity of 30 mcm/d. According to the owner of the facility, it is possible to increase the active capacity to 3.2 bcm to ensure the Baltic region's needs for natural gas, or to expand it even further to store natural gas volumes required by Finland since the completion of the Balticconnector. Traditionally, the Incukalns reserve is filled in the summer with Russian gas, using compressor injection, and used in the winter, primarily for heat generation.

The development of the Klaipeda LNG terminal has had a positive impact on energy security since its start of operations in 2014, by ending the reliance on a single supplier and supply route (i.e. Russian pipeline gas). Further investment in the terminal, including purchasing a floating storage and regasification unit (storage tank), will ensure its longer term contribution to regional security of supply.

Two major projects are underway in Lithuania's gas infrastructure to improve regional interconnectivity and security of supply.

The Gas Interconnection Poland–Lithuania (GIPL) project, expected to be operational as of 1 January 2022, will connect Lithuania, the other Baltic states and Finland with the single EU gas market. In addition, through the southern section of the GIPL in Poland, it will give direct access to the Ukrainian market. The project will have bidirectional capacity between Lithuania and Poland, with 7.11 mcm/d capacity of gas entering Lithuania and 5.57 mcm/d capacity of gas exiting Lithuania. The GIPL is being implemented by the Lithuanian and Polish TSOs, Amber Grid and GAZ-SYSTEM respectively. It is one of the European Commission's declared projects of common interest towards improving gas supply security and creating an integrated European energy market. The total costs of the GIPL project is estimated at EUR 500 million and over 60% of the project costs are financed by the European Commission. The Latvian and Estonian gas TSOs are also co-financing the GIPL interconnection.

The enhancement of the Latvia-Lithuania Interconnection is the second-largest infrastructure project to improve regional interconnectivity. It will modernise the gas pipelines on Latvian territory, increase the pressure to 50 bar (now 40 bar) and expand the Kiemenai gas monitoring station in Lithuania as well as facilitate the use of the Latvian underground gas storage facility at Incukalns. The interconnection is being implemented by the Lithuanian and Latvian TSOs, Amber Grid and AS Conexus Baltic Grid, and is also one of the European Commission's projects of common interest. The project will double the capacity of the gas transmission system between Lithuania and Latvia, in both directions (from 5.91 mcm/d to 11.63 mcm/d entry capacity from Latvia and from 6.5 mcm/d to 12.5 mcm/d for exit capacity to Latvia).

Under EU rules, Lithuania is required to meet the infrastructure standard in line with Article 5 of the EU Gas Security of Supply Regulation 2017/1938. The EU infrastructure standard is met where the N-1 value is greater than or equal to 100%. According to the Ministry of Energy, a risk assessment of the Lithuanian gas sector confirmed that the existing infrastructure is sufficient to ensure safe and secure gas supply with an N-1 of 153.4%. Therefore, even under critical conditions, Lithuania's protected gas consumers will not be impacted. Both gas network projects will further increase security and resiliency in the gas sector, elevating Lithuania's N-1 to more than 200%.

Green gases

Lithuania has also committed to developing a market for green gases in the country. The National Energy Independency Strategy has set a target of up to 5% of biogas in all renewable energy source-generated electricity consumed in the country, and 2% of biogases in the gas network in 2030 (Republic of Lithuania, 2018). Forty-two companies are already active in producing biogases in Lithuania and the first biomethane plant will be connected to the gas grid in 2021. On 30 November 2020, the Ministry of Energy, together with 19 Lithuanian public and business organisations, established the Lithuanian

Hydrogen Platform, with the aim of co-operating in the creation and development of hydrogen technologies. The agreement provides for the mobilisation of Lithuania's science institutions, businesses and public sector bodies in developing innovative hydrogen technologies, and for the establishment of a programme for the development and promotion of clean hydrogen technologies (Ministry of Energy, 2020). This initiative was also joined by the gas TSO Amber Grid, which will have a key role in adapting the transmission system to the transportation of green gases. Since autumn 2020, Amber Grid has also been participating in the European Clean Hydrogen Alliance. The operator is currently analysing the application of power-to-gas technology to extract hydrogen and transfer it to the gas grid. Co-operation with TSOs from other Baltic countries and Finland is also ongoing in this regard: joint research is planned on gas quality and technical application of systems to the hydrogen mixture. At the same time, initiatives to develop standards for hydrogen will be co-ordinated amongst the Baltics and Finland (Amber Grid, 2020).

Emergency response policy

The Emergency Situation Operations Centre under the Ministry of Energy has competence over the state's natural gas security of supply in Lithuania. The Ministry of Energy has an emergency centre for crisis management, involving 16 different specialists, with 3 gas experts and additional members potentially invoked in times of crisis.

Lithuanian emergency gas policy, which relies on market-based instruments even in the event of most serious crises scenarios, reflects the specific structure of its domestic gas consumption, with protected gas consumers (consisting of households and essential services) representing only a small portion of overall natural gas use, primarily using the fuel for cooking rather than heating.

According to the National Emergency Plan, in case of an emergency, Amber Grid, as TSO, is the "crisis manager" responsible for system balancing, gathering and transmitting critical information, and making recommendations to the ministry on crisis response. The DSO is responsible for security of the distribution system and guaranteeing gas supply to protected consumers, while the LNG terminal operator is responsible for providing information about technical LNG terminal capacities.

All companies participating in the gas market are obliged to have their own emergency response plans. In an emergency, these companies are obliged to provide information to the TSO, which in turn provides it to the ministry. The National Emergency Plan details schemes for the frequency and type of information that must be provided under crisis situations, including forecasts on available supply through all entry points, gas storage volumes held in pipelines at the LNG facility and in the Incukalns storage facility, the number of days' cover that such storages provide for vulnerable consumers and uninterruptible contracts, and information on the volumes of gas being consumed for the production of electricity and heat. The TSO would provide instructions to suppliers on the application of any restrictions or phasing out of gas supplies, with pre-established priorities for the transportation and delivery of available gas supplies.

The "Description of the Measures to Safeguard the Reliability of Natural Gas Supply" (Republic of Lithuania [2008], Resolution No 163 of 26 February 2008), designates priority consumers in cases of major or partial gas supply disruptions, taking into account the

amount of gas available in the pipelines and in gas storage facilities and the technical possibilities of the gas system. In line with EU gas security rules (Regulation 2017/1938), natural gas storage must be maintained at a level sufficient to supply vulnerable consumers under the following cases: a 30-day period of exceptionally high gas demand (coldest period); or extreme temperatures in a peak period of 7 days, which occurs once every 20 years based on statistical probability; or a period of at least 30 days in average winter conditions in the event of disruption of one of the largest gas infrastructures (Republic of Lithuania, 2019).

Supply companies are responsible for the uninterruptible supply of gas to vulnerable consumers and must accumulate and store gas reserves for such consumers as well as for any consumers with whom uninterruptible contracts have been concluded. The majority of gas held for this purpose is stored in the Incukalns facilities in Latvia, about 38 mcm in 2019. The gas suppliers must provide a security report to the Ministry of Energy every year, including information about the volume and location of their gas in storage; instances of not fulfilling their storage obligations could result in the suspension of their supply permits.

Assessment

Lithuania has no domestic natural gas production and is thus fully dependent on imports. Its gas network has three entry points, including with Belarus and Latvia and from an FSRU in Klaipeda. The largest of these entry points to Lithuania's gas network is the interconnection with Belarus, which also serves to transit gas to the Russian exclave of Kaliningrad. The interconnection with Latvia provides Lithuania access to the Incukalns underground gas storage facility in Latvia, as there is no underground gas storage in Lithuania.

The share of natural gas in the country's total energy supply remains significant, at 24% in 2019, although its role and share in the overall energy mix has declined from 35% in 2010 following increasing investments in renewable energy sources and the decommissioning of aging gas-fired power plants. In 2019, household consumers accounted for over 98% of all gas users, but residential gas consumption is relatively small, as it is predominantly used for cooking, not heating.

Lithuania has committed to a sustainable transition towards climate neutrality. According to available forecasts, natural gas consumption will remain stable with a slight upward trend until 2050, depending on future EU climate goals and the share of renewable energy sources in the country's energy mix. Until reaching goals regarding a low-carbon economy, natural gas will have an important role to play. Gas-fired power plants will continue to provide backup for renewable energy sources in the coming years. The government is also planning on promoting LNG and compressed natural gas use as alternative fuels in the transport sector.

Work has already started on introducing green gases (biomethane, hydrogen) into the natural gas grids, supported by the Alternative Fuels Law, adopted in parliament in March 2021, and the creation of the Lithuanian Hydrogen Platform by the Ministry of Energy in November 2020. The first biomethane plant will be connected to the gas grid in 2021. Power-to-gas will be essential to implement the NEIS' goals for 2030 and 2050. The TSO Amber Grid is conducting analytical work on hydrogen injection into the Lithuanian gas grid and deployment of power-to-gas facilities. Pilot programmes and tests to define

operational conditions and technical requirements are already planned, in order to enable the deployment of power-to-gas projects.

Lithuania is working on regional gas market integration with its neighbouring countries, which aims at reducing the region's reliance on a single supplier and to ensure greater energy security. The Baltic Energy Market Interconnection Plan in gas is one of the priority corridors identified by TEN-E. However, Lithuania is still not a full member of this regional gas market, remaining outside the common entry-exit tariff zone between Estonia, Finland and Latvia. In April 2020, the government elaborated a road map which will allow Lithuania to join this mechanism and extend a common balancing zone to include all Baltic states and Finland.

The conditions created on the Lithuanian market should enable competition to develop and grow. The LNG terminal not only improved security of gas supply in Lithuania and the whole Baltic region, it also provides the country with access to global LNG markets. Lithuania has joined the regional Baltic-Finnish gas exchange and natural gas volumes traded on the platform are rapidly increasing. An ambitious goal of a churn ratio reaching 30% was set. Moreover, gas supply contracts are predominantly concluded by the market participants on a short-term basis (one year or spot).

There is hardly any competition at retail level in Lithuania. Consumers are provided with the opportunity to switch natural gas supplier, but thus far no other suppliers have entered the market. The natural gas prices for large consumers were deregulated, but the prices for household consumers remain under the supervision of the regulator. Unlike in electricity, the government has not put forward plans to phase out regulated gas prices. As a result, the Lithuanian market still remains highly concentrated, with Ignitis supplying 99% of the retail market (6.4 TWh/y), and Achema being responsible for 89% of supplies on the wholesale market. The government will need to look for ways to enhance competition. Phasing out regulated prices and joining the common regional gas market zone could also help open the gas market.

The Klaipeda LNG terminal has been of primary importance for the gas security of the country as well as for the whole Baltic region, providing access to global LNG markets, and ending the total reliance on Russian pipeline gas that previously existed. With regasification capacity of 10.3 mcm/d, the terminal exceeds Lithuanian gas needs (6.1 mcm/d) and ensures flexibility in balancing gas supplies in a wide range of crisis scenarios in the domestic gas market. After the terminal's start of operations in December 2014 and following the installation of a second line of the Klaipeda-Kursenai pipeline, the infrastructure standard (N-1) in Lithuania reached well over 100%. Further investment in the terminal will ensure its longer term contribution to regional security of supply. In December 2019, the Lithuanian parliament (the Seimas) approved the granting of a state loan guarantee to the terminal's operator, Klaipedos Nafta, to purchase an FSRU (either the existing one or a replacement), to ensure the terminal's operations until 2044.

Two major infrastructure projects are underway. The construction of the GIPL and the increase in capacity of the gas interconnector with Latvia will create greater integration of the Baltic gas systems and connect these and Finland with the EU single gas market, contributing both to improved gas security of the region and to the creation of the Baltic gas market. The completion of these projects will result in Lithuania's N-1 infrastructure standard reaching over 200%, while for the Baltic region including Finland, the standard is expected to reach over 100%. In order to achieve the optimal security benefits from the implementation of these projects, solidarity agreements between all countries of the region will have to be reached.

The Emergency Situation Operations Centre within the Ministry of Energy is responsible for natural gas emergency response, while the TSO, Amber Grid, is the "crisis manager" responsible for balancing the system and preparing recommendations on crisis measures to be implemented. All companies participating in the gas market are obliged to have their own emergency response plans. In an emergency, these companies are obliged to provide information to the TSO, which in turn provides it to the ministry.

Lithuanian emergency gas policy, which relies on market-based instruments even in the event of the most serious crises scenarios, reflects the specific structure of its domestic gas consumption, with protected gas consumers (households and essential services) representing only a small portion of overall gas use (approximately 0.2 bcm/y), primarily used for cooking rather than heating. Under crises scenarios, Amber Grid would be able to balance the market using market-based measures and restore supplies to normal levels within a maximum of a few days, while in more severe crises scenarios, the consumption of protected consumers and consumers with uninterruptible contracts would be balanced with stocks maintained in the Incukalns storage facility in Latvia.

Lithuania's gas security of supply policy is well established. As a member of the EU, Lithuania has established an emergency management structure and emergency planning procedures required by EU legislation on gas security. It has also made significant investment efforts to improve the resilience of its gas supply system, and the projects currently underway will improve this further. Natural gas supply in Lithuania can be sustained even in the most serious crises of the Lithuanian gas market. Emergency legislation and procedures are sufficient to ensure effective crisis management. At the same time, Lithuania must ensure coherence in its energy security policies across fuel sources. In particular, ensuring gas supplies to district heating systems and to gas power plants where idle generation capacity is used as a critical back up for electricity security.

Recommendations

Natural gas market

The government of Lithuania should:

- Ensure timely implementation of ongoing infrastructure projects, including the expansion of interconnection capacity with Latvia and the construction of an interconnector with Poland, to enhance regional market integration with neighbouring countries. Join the entry-exit zone between Estonia, Finland and Latvia resulting in a common entry-exit tariff.
- Seek ways to promote competition and reduce gas market concentration by eliminating barriers to competition in the Lithuanian market, phasing out regulated natural gas prices and enabling gas consumers to choose their supplier.
- Ensure long-term access for Lithuanian traders and consumers to global LNG markets and contribute to regional security of supply by finalising the purchase of the LNG terminal.

Natural gas security

The government of Lithuania should:

- ☐ Finalise a regional risk assessment (with Estonia, Finland and Latvia) and adopt measures for an effective and smooth implementation of the solidarity mechanism.
- ☐ Ensure coherent emergency response policies across energy sectors, including ensuring that gas-fired power plants whose idle capacity is used to back up electricity security do not rely on interruptible contracts.
- ☐ Organise regular exercises and training sessions on gas market functioning under crisis conditions through the Emergency Situation Operations Centre and the TSO in order to test and improve national emergency measures (market-based and non-market based) and test regional co-ordination of emergency response with NESOs of other Baltic Sea countries.

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9. Oil

Key data

(2019)

Net imports of crude oil: 196.9 kb/d, +13% since 2009

Domestic crude oil production: 1 kb/d (2019)

Domestic oil products production: 204 kb/d (2019)

Net export of oil products: 138.1 kb/d, +5% since 2009

Share of oil: 40% of total energy supply (TES), 2% of electricity generation, 37% of total final consumption (TFC)

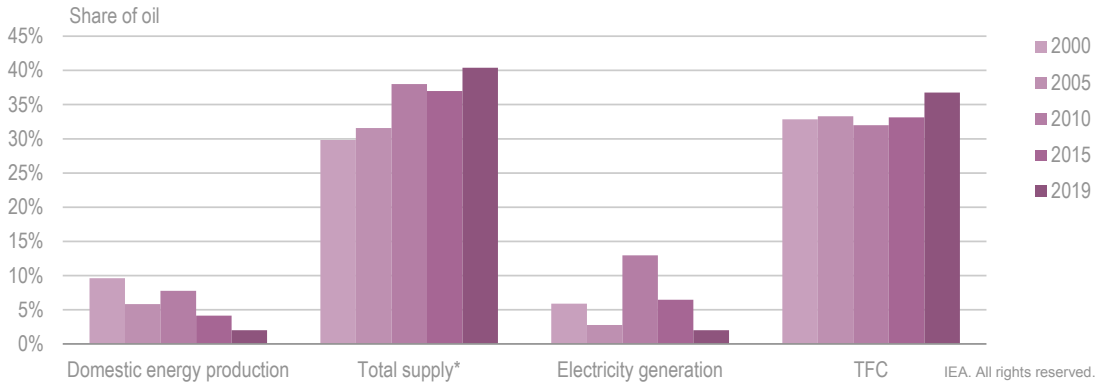
Consumption by sector: 58.8 kb/d (domestic transport 75%, international bunkers 11%, industry 8%, residential 3%, services 2%, electricity and heat generation 1%, other energy <1%)

Overview

Oil is Lithuania's dominant energy source in terms of both total energy supply (TES) and total final consumption (TFC). The share of oil in total supply, total energy supply with international bunkers, increased from 30% in 2000 to 40% in 2019, while its share in TFC reached 37% in 2019, up from 33% in 2000 (Figure 9.1). The role of oil in domestic electricity production is minimal, with a share fluctuating between 2% and 6% since 2000 (with the exception of 2010, the year after the closure of nuclear power in Lithuania, when oil accounted for 13% of total power generation).

Lithuania is entirely dependent on crude oil imports through a single sea terminal, as domestic oil production is marginal. However, security of supply in the country is rather high thanks to a robust supply infrastructure relative to domestic demand. This includes a modern refinery, with an operating capacity to produce three times Lithuania's oil needs and which, as the region's only refinery, serves as a key supplier of finished products to the other Baltic states.

Figure 9.1 Share of oil in energy production, total energy supply, electricity and total final consumption in Lithuania, 2000-19



The share of oil in Lithuania's energy production has been declining, while its supplies increased between 2000 and 2019.

* Share of oil in total energy supply + international bunker fuels.

Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

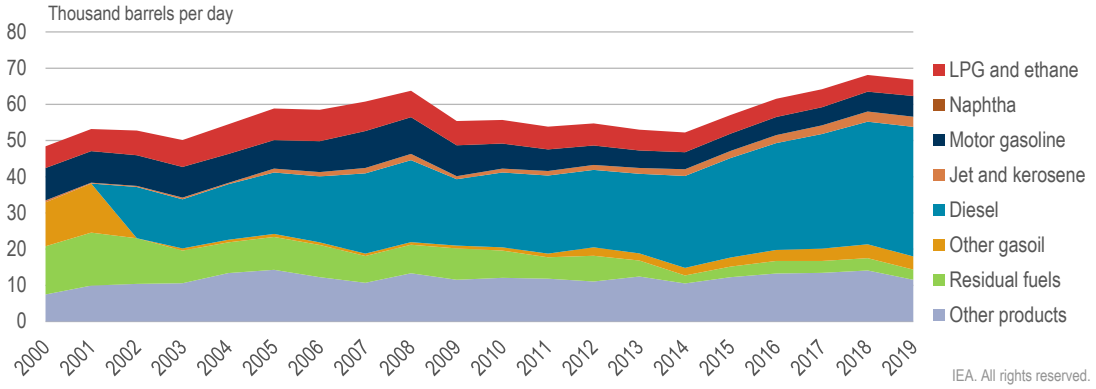
Supply and demand

Lithuania has a very small level of crude oil production, which is used entirely in the domestic chemical industry. Production in 2019 was 50 000 tonnes (less than 1 thousand barrels per day [kb/d]) produced from 14 onshore oil fields. This was 13.5% lower than the previous year, reflecting the progressive decline in production since its peak in 2001 at 575 000 tonnes (10 kb/d). Oil exploration in Lithuania has no prospects for new discoveries and domestic producers instead seek to use advanced technologies to maximise production from depleting fields (LOTOS Geonafta, 2020).

Although fully reliant on crude oil imports, Lithuania's domestic refinery has the capacity to produce oil products well in excess of domestic demand, making Lithuania a net exporter of refined products, principally to regional neighbours (Estonia, Latvia, Poland and Ukraine) but also further afield (the United States). In 2019, Lithuania's net exports of refined products averaged 139.8 kb/d and was more than twice as much as inland consumption.

Lithuania's total oil demand has grown over the decades since 2000, with two periods of gradual increase from 2003 (50 kb/d) to 2008 (64 kb/d), and from 2014 (52 kb/d) to 2019 (67 kb/d) (Figure 9.2).

Figure 9.2 Lithuania's oil demand by product in Lithuania, 2000-19



Demand for transport diesel, propelled by transit freight transport and personal car use, has continued to drive total oil demand growth again since 2014.

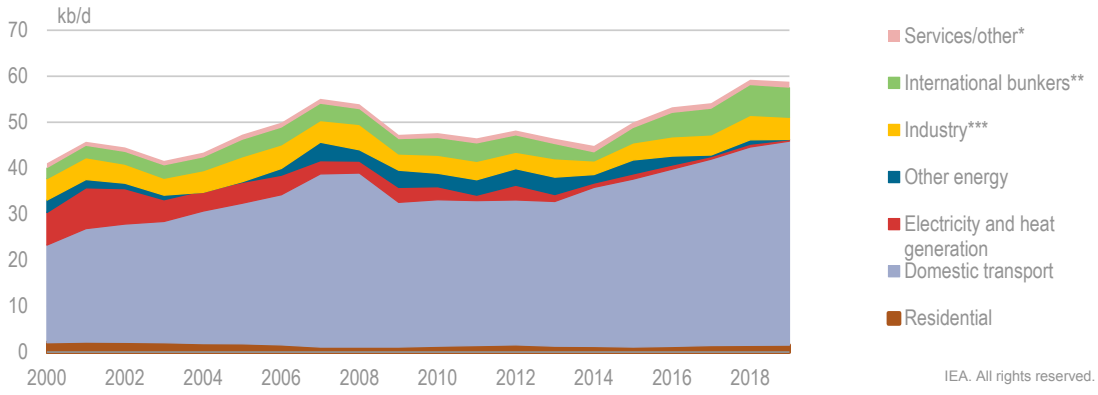
Notes: kb/d = thousand barrels per day. LPG = liquid petroleum gas.
Source: IEA (2020), *Monthly Oil Data Service*, www.iea.org/statistics.

Demand growth has been driven by diesel use, which together with gas oil reached 39 kb/d in 2019, compared to 23 kb/d just prior to the global 2008 financial crisis. One-fifth of diesel use in Lithuania (7 kb/d) is consumed by transit freight transport, benefiting from lower fuel prices in comparison to neighbouring countries. Gasoline consumption in Lithuania is much lower than that of diesel, and stood at 6 kb/d in 2019, while LPG and ethane totalled 5 kb/d and consumption of both aviation and residual fuels amounted to 3 kb/d each.

While total oil consumption in Lithuania slightly decreased in 2019 compared to 2018 (by 1.4%, to 67 kb/d), diesel consumption continued to increase (by 2.6%, to 35 kb/d), and together with gas oil (4 kb/d) accounted for 57% of total oil product demand in the country (Figure 9.3). Since 2017, diesel oil use in Lithuania has increased by 9.3%, underlining the importance of both the dieselisation of the domestic fleet and the role of transit freight refuelling in the country.

Over the last ten years, oil use has diminished only in the sectors of power and heat generation (by 90%) and other energy usage (by 99%). In all other sectors, oil consumption has grown, with the transport sector representing an increasing share of total oil demand, accounting for just under half of all oil consumption in 2000 and reaching 72% in 2018. Passenger cars account for roughly 55% of Lithuanians' daily modal transport, compared to 13% from public transport (Ministry of Transport and Communications, 2020).

Figure 9.3 Trends in oil demand by sector in Lithuania, 2000-19



Oil consumption in the transport sector accounts for a growing majority of Lithuania's oil use.

* *Services/other* includes commercial and public services, agriculture, forestry, and fishing.

** *Industry* includes non-energy consumption.

*** *International bunkers* include bunker fuels for international navigation and aviation bunkers.

Note: kb/d = thousand barrels per day.

Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

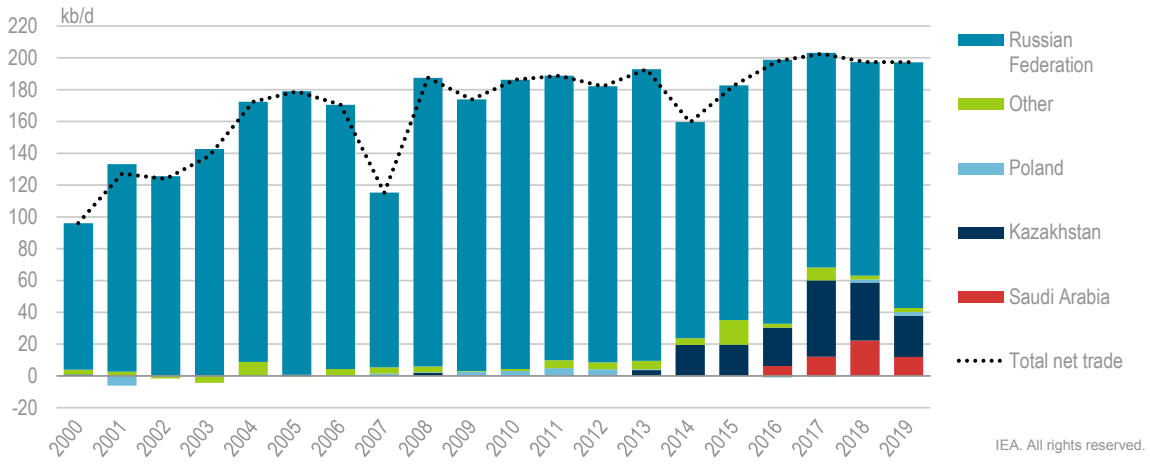
In January 2020, the biofuel blending requirement set on oil product suppliers was increased from 5% to 10% and is applied throughout the year since the removal (as of April 2020) of an exemption on blending in winter months. Lithuania anticipates raising the requirement to 16.8% by 2030, including setting blending requirements on advanced biofuel components (the Alternative Fuels Law, adopted in 2021 by the Parliament). There is no second-generation biofuel production in Lithuania. For diesel, supplies of second-generation biofuels as well as hydrogenation derived renewable diesel or hydrotreated vegetable oil (HVO) will need to be ensured, given the region's colder climate and weather constraints on the use of fatty acid methyl esters (FAME).

Trade

Lithuania is fully reliant on imports of crude oil, as the relatively small amount of domestic production is used directly in the chemical industry. At the same time, with refinery capacity by far exceeding domestic demand, Lithuania is a net exporter of refined products.

Total net crude oil imports in 2019 reached 196.9 kb/d, with the vast majority imported from the Russian Federation (Figure 9.4). However, Lithuania has progressively diversified its oil imports over the last decade, with imports rising substantially from Kazakhstan, from 3.6 kb/d in 2013 to as high as 48 kb/d in 2017, and from Saudi Arabia, starting at 6.2 kb/d in 2016 and reaching 22.2 kb/d in 2018. This diversification has led to the share of Russian imports declining from 98% in 2010 to a low of 68% in 2018, before rising again in 2019 to 78% of total crude imports. The PKN Orlen S.A. Group, the owner of the Mazeikiai Refinery, has a strategic objective to diversify its crude oil supplies to all of its six refineries in the region, with a 30% share of non-Russian supplies. PKN Orlen S.A. purchases about 32.5 million tonnes per year (475 kb/d), which allows the company to negotiate flexibly with suppliers. Since 2019, it has also started buying lighter crude oil from the United States for the Mazeikiai Refinery, striving to obtain an optimal crude blend in order to maximise the yield of diesel oil and gasoline (PKN Orlen, 2020).

Figure 9.4 Lithuania's crude oil net trade by country, 2000-19

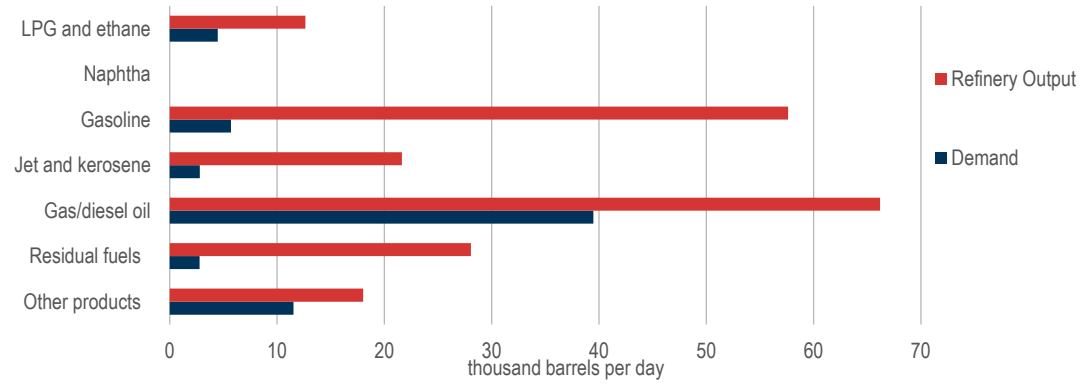


Lithuania is heavily reliant on Russia for its crude oil imports, although there has been increasing diversification in recent years.

Note: kb/d = thousand barrels per day.
Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

Refinery output of finished oil products largely exceeds domestic demand. In 2019, the refinery produced 66 kb/d of gas/diesel oil (compared to 39 kb/d in demand), 58 kb/d of gasoline (versus 6 kb/d in demand) and 22 kb/d of kerosene (3 kb/d in demand) (Figure 9.5).

Figure 9.5 Lithuania's refinery output, 2019



Lithuania's refinery output largely surpasses its domestic oil product demand.

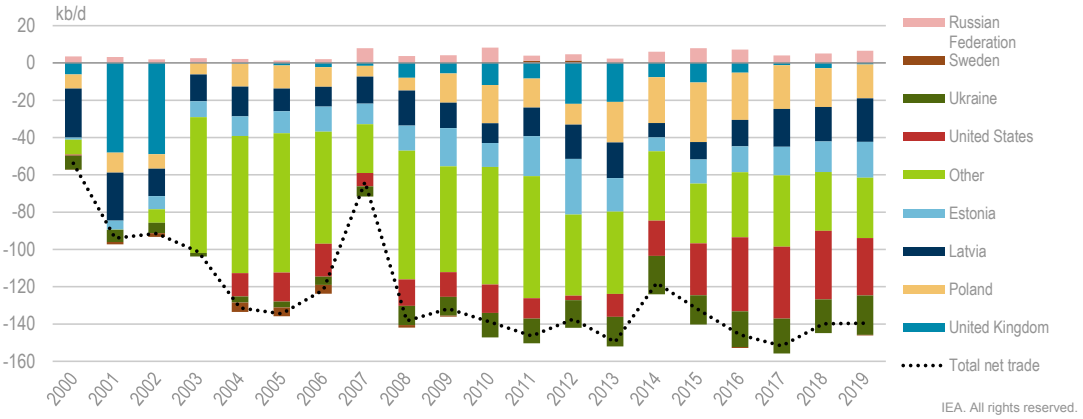
Notes: kb/d = thousand barrels per day.
Refinery outputs exclude refinery losses.
Source: IEA (2020a), *Monthly Oil Data Service*, www.iea.org/statistics.

Lithuania's total oil product exports stood at 158.6 kb/d in 2019, with imports of 19 kb/d, resulting in a net export of 138.1 kb/d (Figure 9.6). The bulk of Lithuania's product exports go to neighbouring and nearby countries of Estonia, Latvia, Poland and Ukraine, which collectively accounted for nearly 60% of total net exports in 2019 (83.8 kb/d), primarily consisting of diesel (50 kb/d) and motor gasoline (17 kb/d). The United States accounts

for a substantial share of Lithuania's net exports, which in 2019 totalled 30.8 kb/d, consisting of motor gasoline (27 kb/d) and residual fuel oil (3.8 kb/d).

Orlen Lietuva trades 40% of its production across the sea to more distant customers, while the remainder is distributed to the nearby countries via road and rail transport or via a product pipeline (diesel) to Latvia.

Figure 9.6 Lithuania's oil products net trade by country, 2000-19



Lithuania exports its oil products to its neighbouring countries, including Estonia, Latvia and Poland. Around 40% of production is exported via a sea terminal to more distant customers.

Note: kb/d = thousand barrels per day.

Source: IEA (2021), *IEA World Energy Statistics and Balances* (database), www.iea.org/statistics/.

Oil industry structure

Upstream

Lithuanian oil production commenced in 1964 but only reached larger scale output after 1990. Production, drawn exclusively from onshore fields, peaked in 2001 and all fields are now in their final stages of production.

In 2019, five companies were producing crude oil in Lithuania. AB LOTOS Geonafta (owned by the second biggest Polish oil company, Grupa LOTOS) performed upstream activities and participated in the management of three other upstream companies in Lithuania, as owner of 50% of UAB Minijos Nafta and 100% of both UAB Gencių Nafta and UAB Manifoldas. The fifth upstream company, LL Investicijos, is privately owned (LL Investicijos, n.d.; LOTOS Geonafta, 2020).

Downstream

Orlen Lietuva is central to Lithuania's downstream oil sector, as it owns and operates a substantial portion of the supply infrastructure, including the country's only refinery (at Mazeikiai), the only crude oil import terminal (Butinge Terminal) and a pipeline connecting the two. The Orlen Lietuva Refinery is a key part of Lithuania's and the Baltic region's energy infrastructure.

Orlen Lietuva is a major contributor to the domestic economy as the country's largest taxpayer, Lithuania's biggest exporting company, with a 12% share of the country's overall exports, and, as it is owned by the largest Polish oil company, PKN ORLEN, it represents the biggest historic foreign direct investor in Lithuania. However, the refinery is facing competitive pressures from refineries in other jurisdictions and tightening EU regulations. The refinery is making efforts to improve energy efficiency, diversify into petrochemicals and expand the production of higher value light products (Orlen Lietuva, 2020).

Wholesale and retail

The Lithuanian oil sector has been operating under open market conditions for more than two decades; there are no legal restrictions on the import of liquid fuels and the prices of petroleum products are not regulated by the state. For petroleum products, only the rates of excise duty and the value-added tax are fixed by the state. Mandatory quality indicators for petroleum products have been established within the framework of the EU regulations, but there are no entry or import quotas.

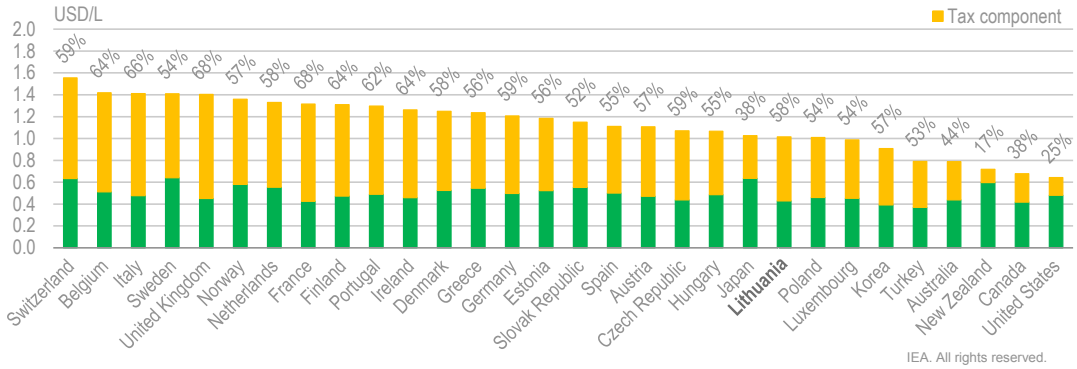
The main participants in Lithuania's wholesale market are Orlen Lietuva, Viada Lietuva, Circle K Lietuva, Neste Lietuva and Baltic Petroleum. Orlen Lietuva, with its Inland Wholesale Department based in Vilnius, is the biggest player on the wholesale market, responsible for supplying up to 80% of the oil products consumed in Lithuania.

There are approximately 300 companies engaged in oil product retail sales and approximately 900 petrol stations (of which 29 belong to Orlen Lietuva) (Furman, 2020). The domestic retail network is supplied by rail and road shipments, with supply dominated by petroleum products of Orlen Lietuva.

Oil prices and taxation

Lithuania's automotive diesel price is the ninth-lowest when compared to IEA member countries and the third-lowest in the European Union (after Luxembourg and Poland), at a price of 1.0 USD/L, with a tax rate of 58%, which is around the median value of IEA countries (Figure 9.7). Prices are lower than in its neighbouring countries, resulting in transiting freight trucks filling up in Lithuania and thus adding some 20% to the country's diesel demand. Carbon taxes are not levied on any fuel in Lithuania. Lithuania does not supply data on gasoline prices to the IEA.

Figure 9.7 Price comparison for automotive diesel in the IEA, 2Q 2020



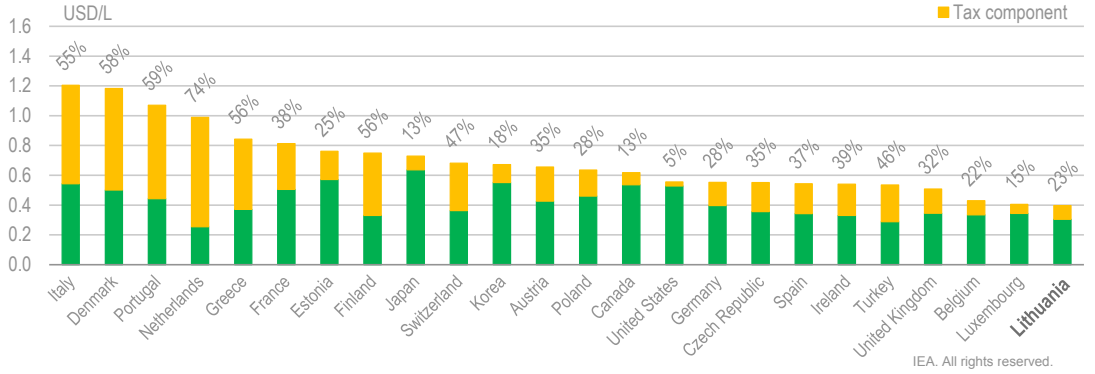
Automotive diesel prices in Lithuania are the ninth-lowest in an IEA comparison.

Note: Automotive diesel is not available for Mexico.

Source: IEA (2020b), *Energy Prices and Taxes Second Quarter 2020*, www.iea.org/statistics.

Lithuania's light fuel oil is priced at 0.4 USD/L, the lowest among IEA countries, with a tax rate of 23%, also the lowest among IEA countries (Figure 9.8).

Figure 9.8 Price comparison for light fuel oil in the IEA, 2Q 2020



Light fuel oil prices in Lithuania are the lowest of all IEA member countries.

Note: Data for light fuel oil are not available for Australia, Hungary, Mexico, New Zealand, Norway, the Slovak Republic or Sweden.

Source: IEA (2020b), *Energy Prices and Taxes Second Quarter 2020*, www.iea.org/statistics.

Oil infrastructure

Refining

Lithuania's Orlen Lietuva Refinery is the only refinery in the Baltic states. Owned by PKN Orlen, the biggest Polish oil company, it is located in northwestern Lithuania, close to the city of Mazeikiai, 90 kilometres from Lithuanian terminals in Butinge, Klaipeda and

Latvian Ventspils. The refinery was put into operation in 1980 with a design capacity of 15 million tonnes of crude oil per year; however, its current maximum capacity is 10.4 million tonnes per year, or 205 kb/d.

The refinery's design and location were based on the decision of the State Oil and Chemical Industry Committee of what was at the time the USSR, with construction beginning in 1972. The refinery remained fully state controlled until 1995 when state-owned company Nafta reorganised into joint-stock company Mazeikiu Nafta, with around 90% of shares remaining in the government's hands and the other 10% distributed among employees. In 1998, the Lithuanian government, Mazeikiu Nafta, and Williams International signed an agreement under which Williams International became a 33% owner and operator of the refinery. In 2002, the Russian company Yukos became a majority stakeholder and operator of the plant until 2006, when the refinery was bought by Polish PKN Orlen S.A. and subsequently renamed Orlen Lietuva in September 2009 (Orlen Lietuva, 2020).

Until 2006, the refinery's feedstock was almost exclusively Russian crude oil shipped by the northern strand of the trunk pipeline system Druzhba, supplemented by crude oil and other feedstocks delivered by railway as well as truck shipments of domestically produced crude oil. Currently, the main deliveries of crude oil come via the Butinge Oil Terminal and a dedicated Butinge-Mazeikiai pipeline (both owned and operated by Orlen Lietuva).

Modern processes and technologies applied by the refinery have allowed it to produce a wide and flexible range of high-quality refined products that meet regional standards, with light refined product yields currently at 72.5%. In 2019, in order to reduce particulate emissions, an electrostatic precipitator was installed in the fluid catalytic cracking unit and in 2020 a PPF splitter installation for the production of propylene was commissioned (PKN Orlen, 2020b). PKN Orlen is planning for the largest investment in the Mazeikiai Refinery since its purchase in 2006 – investment in a bottom-of-the-barrel processing upgrade, which would increase the refinery's diesel, gasoline and jet fuel yield by around 10 percentage points.

The COVID-19 pandemic has had a significant impact on Orlen Lietuva Refinery. In the first half of 2020, the plant's revenues were 45% lower than in the same period the year before. The main reason for that was a significant decrease in consumption of road fuels in Orlen Lietuva's main export markets – Estonia, Latvia, Lithuania, Poland and Ukraine. Although the refinery had net profits between 2016 and 2019 of about USD 200 million per year on average, the future investments may be challenged and PKN Orlen is discussing possible co-financing of the bottom-of-the-barrel upgrade project with the government (Furman, 2020).

Oil ports

Lithuania's Butinge Oil Terminal is exclusively dedicated for importing crude oil for the domestic refinery. The terminal is owned and operated by Orlen Lietuva and situated in the western part of Lithuania near Palanga. It is a single point mooring terminal with a design capacity of 14 million tonnes per year (283 kb/d). Since 2006, the terminal operates as a crude oil import terminal. In the 2015-19 period, the average import volume amounted to 9.4 million tonnes per year (190 kb/d).

Klaipedos Nafta, or “KN Oil Terminal”, located in the central part of the Lithuanian Baltic Sea coast, is the northernmost ice-free port on the eastern coast of the Baltic Sea. It is the most important and biggest Lithuanian transport hub and fulfils the important role of importing and exporting petroleum products. The port is majority owned by the state (72.3%), represented by the Ministry of Energy, and a 10.41% shareholding is held by Achemos Group, a private company, with the remaining ownership shares traded on Nasdaq Vilnius (Klaipedos Nafta, 2020). The terminal is able to handle both crude and refined products, offering loading and discharging services between tankers and rail cars and tanker truck loading for regional diesel and gasoline supplies. Its total annual import/export capacity is 8 million tonnes (160 kb/d).

Additionally, the Krovinių terminal, adjacent to the KN Oil Terminal, specialises in handling oil products and petrochemicals, with a capacity to handle up to 2 million tonnes per year (40 kb/d). The terminal can handle and discharge products from both rail-tanks and tankers and offers mooring services, cargo forwarding and transportation by rail within Lithuania, Belarus and Latvia.

Pipelines

There are two main crude oil pipelines in Lithuania; however, only one remains in operation, connecting the Butinge Oil Terminal and Mazeikiai Refinery (92 km long). This line is owned and operated by Orlen Lietuva and has a design capacity (import/export) of 14 million tonnes per year (283 kb/d). Since 2006, the pipeline is working only in import mode (from the Butinge Oil Terminal to the Mazeikiai Refinery). Over the 2015-19 period, the average import volume amounted to 9.4 million tonnes per year (190 kb/d). The other pipeline connecting Lithuania’s refinery to Russian crude supplies, Polock-Birzai-Mazeikiai (Belarus-Lithuania), was designated to supply 16 million tonnes per year (323 kb/d); however, this branch of the Druzhba has not been in operation since July 2006 due to a reported technical malfunction.

Lithuania’s only product pipeline is the Ilukste-Birzai-Ventspils (Latvia-Lithuania-Latvia), transporting diesel into the northern region of the country. The pipeline length in Lithuania is 87 km and annual throughput capacity is 6 million tonnes of petroleum products (123 kb/d). In 2015-19, the average transported volume of diesel was 3.4 million tonnes per year (70 kb/d).

Storage

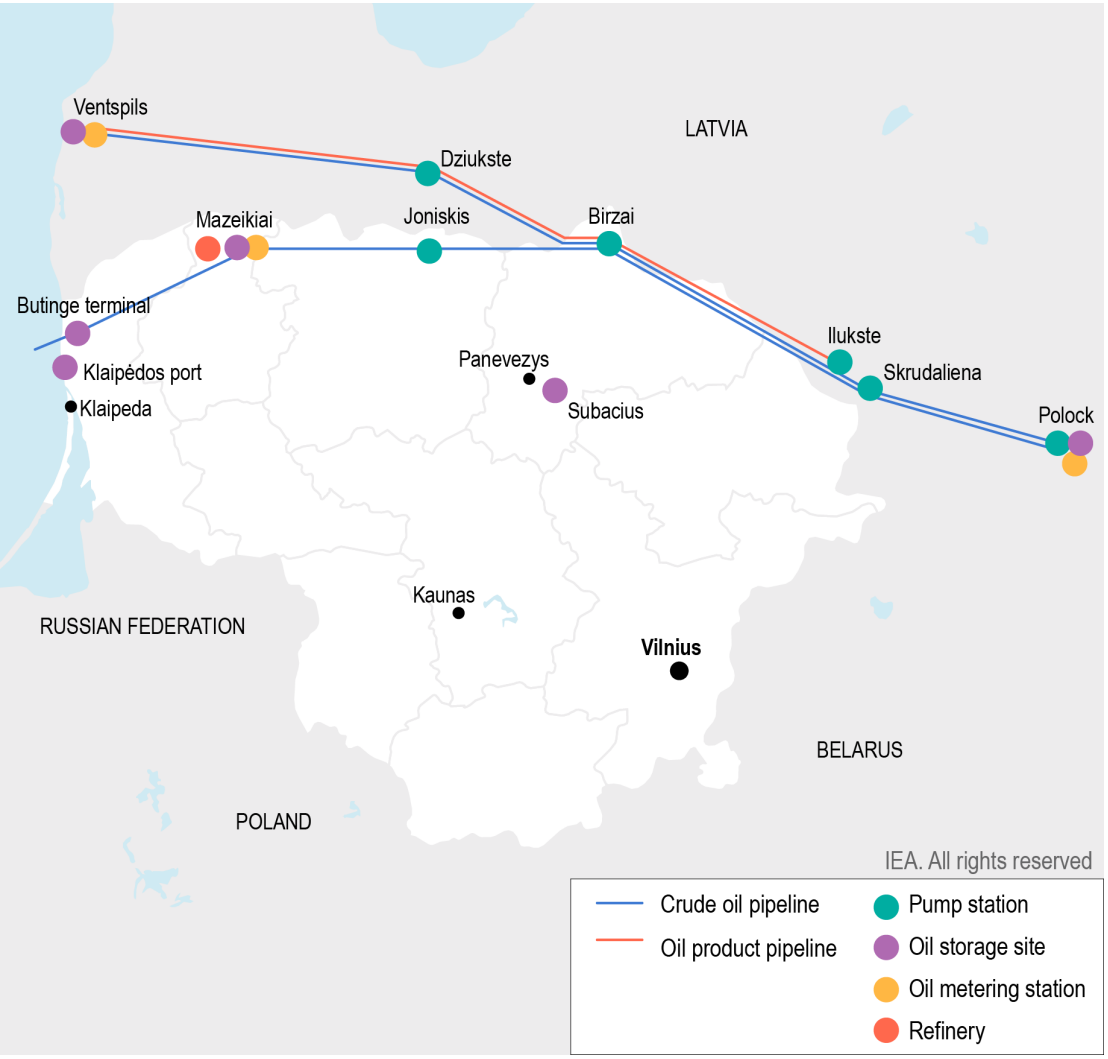
Lithuania’s total oil storage capacity amounts to 2.88 million m^3 (18.1 million barrels [mb]), entirely consisting of above ground tanks as there are no oil caverns in the country.

Storage capacities for crude oil accounts for a fifth of the total (3.89 mb) and are located at the Butinge Oil Terminal (1.93 mb), the Orlen Lietuva Refinery (1.26 mb), terminals of Klaipedos Nafta and Kroviniu Terminalas (0.7 mb).

Storages for refined products amount to 14.2 mb and are primarily located at the Orlen Lietuva Refinery (3.27 mb), the Klaipedos Nafta Oil Terminal (3.18 mb) and the Subacius Oil Terminal (2.25 mb). The Subacius Oil Terminal, located 150 kilometres north of Vilnius, is an inland oil product storage facility that provides both long-term storage for Lithuania’s emergency stocks and short-term storage and handling for commercial stocks. The majority of the facility’s capacity (1.63 mb) is dedicated to emergency stocks. Built

in 1964, the terminal has been upgraded regularly and since 2012 is operated by Klaipedos Nafta. The terminal receives and dispatches oil products via tanker trucks and also provides services for blending bio-additives.

Figure 9.9 Map of Lithuania's regional oil infrastructure



Notes: HVDC = high-voltage direct current. This map is without prejudice to the status of or sovereignty over any territory; to the delimitation of international frontiers and boundaries; and to the name of any territory, city or area.

Oil emergency policies and organisation

Emergency response for oil crises has a legal basis in the Law on State Stocks of Petroleum Products and Oil (Law on Stocks). The law establishes the level and manner in which emergency oil stocks are to be held and provides the legal powers for activating emergency response measures. This law transposes the EU Directive on Oil Stocks (2009/119/EC). On 25 June 2020 the Lithuanian parliament (the Seimas) adopted amendments to the Law on Stocks which allow Lithuania to activate emergency measures in order to participate in an IEA collective action.

Under the Law on Stocks, Council of Ministers' Resolution No. 12 of 2003 lays out the procedures for co-ordinating emergency response in the event of an energy supply disruption. The Resolution requires all energy "undertakings" (i.e. producers, suppliers/importers, storage and transportation operators, etc.), to maintain emergency plans which ensure operations in a crisis, while maintaining optimal energy supplies to consumers through the use of alternative energy sources, reducing consumption and/or limiting supplies. The Resolution places responsibility on the Ministry of Energy for overseeing national emergency preparedness and for proposing specific response measures in a crisis for approval by the Council of Ministers. The Lithuanian Energy Agency is responsible for overseeing emergency oil stockholding as well as advising the ministry on a national energy strategy, including the development of demand restraint measures, renewable energy sources and the implementation of energy efficiency measures.

Within the Ministry of Energy, the Emergency Situation Operations Centre (ESOC) is responsible for co-ordinating energy crises, including for oil. In the case of an oil crisis, ESOC would prepare an assessment and recommendations for emergency response to the Minister of Energy, who could decide to lower the stockholding obligation of industry. In order to use the specific stocks of the Lithuanian Energy Agency or to activate the legal basis for implementing oil demand restraint measures, the minister would submit a proposal to the Council of Ministers for decision.

Ministerial Order No 1-107 forms the basis for the administration's plan for implementing restrictions on the supply and use of oil products in addition to the release of emergency stocks. When activated, the plan allows the Council of Ministers to stabilise the supply and/or consumption of petroleum products when an energy emergency is declared. The ministry is preparing a revised plan in order to be in line with the IEA's requirement to be able to reduce oil consumption by up to 10% in case of a disruption.

Emergency oil stocks

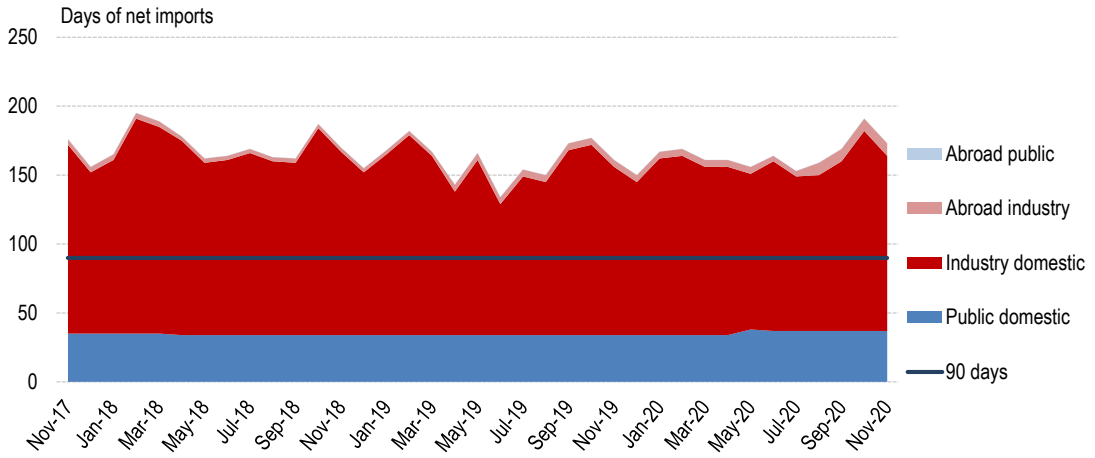
According to the Law on Stocks, Lithuania's oil stockpiles must be sufficient to cover 90 days of average daily net imports or 61 days of average daily inland consumption in the previous year, whichever is greater.

This is consistent with the EU stockholding requirement (Council Directive 2009/119/EC imposing an obligation on member states to maintain minimum stocks of crude oil and/or petroleum products), and in the case of Lithuania, the relevant obligation level is 90 days of net imports. Under this law, the Lithuanian Energy Agency is responsible for maintaining 30 days of publicly held emergency oil stocks and an obligation is set on industry to maintain the remaining 60 days. When including industry's commercial and operational stockholdings, Lithuania's total level of oil stocks is well above the IEA 90-day minimum requirement, totalling 173 days at the end of November 2020. All of the Lithuanian Energy Agency's emergency stocks are held in the Subacius Oil Terminal and all are in the form of refined oil products.

Separate from the emergency oil stocks described above, a stockholding obligation is also placed on heat and electricity generators with over 5 megawatts (MW) capacity, to maintain backup reserves during the cold season sufficient to cover 10 days of operations (Law on Energy, Article 29). The most common stocks to meet this requirement are

biofuels, heavy fuel oil, shale oil and diesel (natural gas is not considered as a backup fuel in any of the companies required to hold these backup fuels). During the warm period of the year (1 April to 31 October), the energy backup requirements and quantities are determined by the energy companies themselves.

Figure 9.10 Lithuania's oil stock level in days of net imports, as of November 2020



Lithuania's oil stock level has consistently been above the 90-day obligation threshold.

Source: IEA (2020c), *Monthly Oil Statistics*, www.iea.org/statistics.

Assessment

Lithuania has only a small level of domestic oil production and is therefore nearly fully reliant on oil imports to meet demand. At the same time, its domestic refinery has the capacity to produce oil products well in excess of domestic demand, making Lithuania a net exporter of refined products, principally to regional neighbours (Estonia, Latvia, Poland and Ukraine) but also further afield (the Netherlands and the United States). In 2019, Lithuania's net exports were more than twice its inland consumption.

Lithuania's oil supply infrastructure is robust relative to its domestic oil demand, reflecting the role of its refinery as the only one in the Baltic region. Orlen Lietuva owns and operates the Mazeikiai Refinery (205 kb/d capacity) as well as the crude oil pipeline (242 kb/d capacity) which connects with the Butinge Sea Terminal (280 kb/d import/export capacity). The Butinge Terminal has been operating as an import terminal since 2006, following the closure of another crude pipeline connecting the refinery to the Druzhba trunk pipeline system through Belarus. As a result, Lithuania has diversified its crude oil import sources. Russian crude imports, which used to account for nearly 100% of total imports until 2013, have since declined to less than 70% in 2018, with imports from Saudi Arabia and Kazakhstan accounting for most of the remaining imports.

The Orlen Mazeikiai Refinery is a key part of Lithuania's and the Baltic region's energy infrastructure and a major contributor to the domestic economy. The refinery is facing competitive pressures from refineries in other jurisdictions and tightening EU regulation. While the refinery is making efforts to improve energy efficiency, diversify into

petrochemicals and expand the production of higher value light products, it will be challenged to adapt to increasing mandates for alternative fuels which displace demand for traditional fuel products.

Orlen Lietuva supplies approximately 80% of domestic oil demand while the remaining volumes of oil products consumed in Lithuania are imported via the other two seaport terminals that together have the capacity to import volumes well in excess of domestic demand.

The biofuel blending requirement set on oil product suppliers was increased from 5% to 10% as of January 2020, and is applied throughout the year since the removal (since April 2020) of an exemption on blending in winter months. Under the new Alternative Fuels Act, Lithuania anticipates raising the requirement to 16.8% by 2030, including setting blending requirements on advanced biofuel components. There is no second-generation biofuel production in Lithuania and in the case of diesel, given the region's colder climate and weather constraints on the use of FAME, supplies of second-generation biofuels as well as hydrogenation derived renewable diesel will need to be ensured.

Lithuania has lower excise duty rates on energy products compared to neighbouring countries, which attracts fuel tourism as diesel trucks are transiting through the country. Diesel has also benefited from a lower excise duty rate compared to gasoline, although the differential has narrowed in recent years (now at less than 10% difference). The country has recently introduced higher excise duties and value-added tax in order to increase energy efficiency in the transport sector.

Oil emergency response

Emergency response for oil crises has a legal basis in the Law on State Stocks of Petroleum Products and Oil, which was modified in June 2020 in order to permit Lithuania to participate in an IEA collective action. Under this law, the Lithuanian Energy Agency is responsible for maintaining 30 days of net imports of publicly held emergency oil stocks and an obligation is set on industry to maintain the remaining 60 days. When including industry's commercial and operational stockholdings, Lithuania's oil stocks are well above the IEA 90-day-minimum requirement, totalling 173 days of net imports at the end of November 2020.

Within the Ministry of Energy, ESOC is responsible for co-ordinating energy crises including for oil. In the case of an oil crisis, ESOC would prepare assessments and recommendations for emergency response to the Minister of Energy, who could in the case of an IEA collective action decide to lower the stockholding obligation on industry. In order to use the public stocks of the Lithuanian Energy Agency or to activate the legal basis for implementing oil demand restraint measures, the minister would submit a proposal to the Council of Ministers for decision.

Lithuania's oil security of supply is well developed and the ESOC team, working closely with the minister, provides a strong basis for maintaining dynamic and flexible emergency response, including reviewing and improving response policies where needed. Lithuania's accession to the IEA has necessitated such a review, and ESOC has taken significant steps in this regard, including updating its existing oil demand restraint regulation to meet the requirement under the IEA's treaty, the Agreement on an International Energy Program (IEP Agreement), to be able to reduce oil demand quickly by up to 10% in a crisis

Recommendations

Oil markets

The government of Lithuania should:

- Promote business growth and competition in the wholesale product market (including for liquid biofuels) by encouraging investment in new storage and blending infrastructure and encouraging new entrants.
- Broaden the Lithuanian Energy Agency's market monitoring activities to include wholesale product markets to ensure proper market functioning and make retail and wholesale price data available through a public website to increase price transparency.
- Consider all viable pathways to meeting renewable targets in transport, including allowing for co-processing of renewable feedstocks (synthetic fuels, green hydrogen and others) at refineries to qualify for generating credits in line with the EU RED II Directive.

Oil security

The government of Lithuania should:

- Conduct regular emergency exercises based on the emergency response handbook to ensure well-functioning communication channels and strong familiarity of emergency procedures within the country's emergency response team, the decision-making hierarchy, and industry participants.

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ANNEX A: Organisations visited

Agency for Science, Innovation and Technology (MITA)

Amber Grid

Energijos Skirstymo Operatorius AB (ESO)

EPSO-G

Get Baltic

Government strategic analysis center (STRATA)

Ignitis Group

Kaunas University of Technology

Klaipedos nafta

Lithuanian Biomass Energy Association

Lithuanian District Heating Association

Lithuanian Energy Agency (LEA)

Lithuanian Energy Institute (LEI)

Lithuanian Solar Energy Association

Lithuanian Wind Power Association

Litgrid

Ministry of the Economy and Innovation

Ministry of Education, Science and Sports

Ministry of Energy

Ministry of Environment

Ministry of Finance

Ministry of Transport and Communications

National Energy Regulatory Council (NERC)

ORLEN Lietuva

Public Institution for Housing Energy Saving Agency

Research Council of Lithuania (RCL)

ANNEX B: Review team and preparation of the report

The in-depth review team visited Lithuania virtually from 1 to 12 September 2020. The review team met with government officials, energy suppliers, market participants, interest groups in the public and private sectors, associations, research institutions, and other organisations and stakeholders. The report was drafted on the basis of the information obtained during these meetings, the review team's preliminary assessment of Lithaunia's energy policy, the government's response to the IEA energy policy questionnaire, and information on subsequent policy developments from the government and private sector sources. The members of the team were:

IEA member countries

Mr Bo Diczfalusy, Sweden (team leader)

Mr Jesper Lorentzen, Denmark

Mr Dennis Trigylidas, Canada

Ms Bettina Lemström, Finland

Mr Jaanus Uiga, Estonia

Mr Michael Moser, Switzerland

Ms Aleksandra Swiderska, Poland

Ms Agnija Rasa, European Commission

International Energy Agency

Mr Aad van Bohemen, Head of Energy Policy and Security Division

Ms Sylvia Beyer, Senior Energy Policy Analyst (review co-ordinator)

Mr Jason Elliott, Senior Energy Analyst

Ms Rachael Boyd, Legal Counsel

Ms Erica Robin, Head of Section 2

Mr Joerg Husar, Programme Officer, Accession Co-ordinator

The team is grateful for the co-operation and assistance of the many people it met with during the visit. Thanks to their kind hospitality, openness and willingness to share information, the visit was highly informative, productive and enjoyable. The team thanks the Minister of Energy, Mr Žygimantas Vaičiūnas, for his participation in the opening and closing sessions of the review, and for the insightful review meetings organised by his team in the ministry. Thanks to the co-operation of the many people the team met throughout the visit, their engagement, openness and willingness to share information, the discussions were informative, productive and enjoyable. The review team wishes to express its gratitude

to the organising team at the Ministry of Energy, in particular Mr Daumantas Kerežis and Mr Dainius Bražiūnas, as well as the many people the team met for their tireless efforts and support to the review.

The review was prepared under the guidance of Aad van Bohemen, Head of the Energy Policy and Security Division at the IEA. Sylvia Beyer managed the review and is the main author and co-ordinator of the report. Milosz Karpinski and Jason Elliott wrote the chapters on oil and natural gas. Alessio Scanziani and Clémence Lizé drafted the sections relating to energy data contained in each chapter, supported by Bomi Kim and Dahyeon Yu, who together ensured the preparation of the report with figures, tables and maps.

Helpful comments, chapter reviews and updates were provided by the following IEA staff: Heymi Behar, Francois Briens, Sara Moarif, Simone Landolina, Jean-Baptiste le Marois, Simon Bennett, Grergely Molnar, César Aljeandro Hernández, Peter Fraser and Carlos Fernández Alvarez.

Special thanks to the IEA Secretariat with regard to the data, publication and editing. Erica Robin, Roberta Quadrelli and Domenico Lattanzio provided support on statistics. Therese Walsh managed the editing process and Astrid Dumond managed the production process. Isabelle Nonain-Semelin finalised the layout. Tanya Dyhin managed the design process. Jad Mouawad and Jethro Mullen supported the press launch. The report was edited by Jennifer Allain.

The Shared Goals, which were adopted by the International Energy Agency (IEA) ministers at their 4 June 1993 meeting in Paris, provide the evaluation criteria for the in-depth reviews conducted by the IEA. The Shared Goals are presented in Annex D.

ANNEX C: Energy balances and key statistical data

Unit: Mtoe

SUPPLY		1990	2000	2010	2016	2017	2018	2019
TOTAL PRODUCTION		**4.94**	**3.40**	**1.52**	**1.85**	**2.04**	**1.99**	**1.98**
Coal		-	-	-	-	-	-	-
Peat		0.01	0.01	0.01	0.01	0.01	0.01	0.01
Oil		0.01	0.33	0.12	0.07	0.06	0.05	0.04
Natural gas		-	-	-	-	-	-	-
Biofuels and waste[1]		0.29	0.65	1.12	1.41	1.52	1.53	1.50
Nuclear		4.50	2.25	-	-	-	-	-
Hydro		0.04	0.03	0.05	0.04	0.05	0.04	0.03
Wind		-	-	0.02	0.10	0.12	0.10	0.13
Geothermal		-	-	0.01	0.00	0.00	-	-
Solar/other[2]		0.09	0.13	0.21	0.23	0.29	0.28	0.27
TOTAL NET IMPORTS[3]		**11.41**	**4.11**	**5.59**	**5.37**	**5.39**	**5.62**	**5.70**
Coal	Exports	-	-	0.02	-	-	-	-
	Imports	0.76	0.08	0.20	0.15	0.18	0.17	0.18
	Net imports	0.76	0.08	0.17	0.15	0.18	0.17	0.18
Oil	Exports	9.56	3.17	7.53	8.66	8.39	7.66	7.57
	Imports	16.78	5.37	10.25	11.60	11.31	10.90	10.81
	Int'l marine and aviation bunkers	-0.23	-0.12	-0.19	-0.26	-0.28	-0.33	-0.32
	Net imports	7.00	2.08	2.54	2.68	2.64	2.91	2.92
Natural gas	Exports	0.15	-	-	0.04	0.17	0.15	0.43
	Imports	4.82	2.07	2.49	1.89	2.08	1.91	2.30
	Net imports	4.68	2.07	2.49	1.85	1.91	1.76	1.86
Electricity	Exports	1.42	0.56	0.19	0.24	0.28	0.28	0.34
	Imports	0.39	0.44	0.70	0.96	1.03	1.11	1.14
	Net imports	-1.03	-0.12	0.52	0.71	0.75	0.83	0.80
TOTAL STOCK CHANGES		**-0.28**	**-0.36**	**-0.06**	**-0.01**	**0.12**	**0.04**	**-0.07**
TOTAL SUPPLY (TES)[4]		**16.07**	**7.14**	**7.05**	**7.21**	**7.54**	**7.64**	**7.61**
Coal		0.78	0.08	0.18	0.16	0.16	0.17	0.17
Peat		0.02	0.01	0.02	0.03	0.03	0.04	0.03
Oil		6.71	2.05	2.56	2.73	2.79	2.96	2.88
Natural gas		4.68	2.06	2.49	1.84	1.92	1.78	1.86
Biofuels and waste[1]		0.29	0.65	1.00	1.37	1.43	1.46	1.43
Nuclear		4.50	2.25	-	-	-	-	-
Hydro		0.04	0.03	0.05	0.04	0.05	0.04	0.03
Wind		-	-	0.02	0.10	0.12	0.10	0.13
Geothermal		-	-	0.01	0.00	0.00	-	-
Solar/other[2]		0.09	0.13	0.21	0.23	0.29	0.28	0.27
Electricity trade[5]		-1.03	-0.12	0.52	0.71	0.75	0.83	0.80
Shares in TES (%)								
Coal		*4.9*	*1.1*	*2.6*	*2.2*	*2.2*	*2.3*	*2.2*
Peat		*0.1*	*0.2*	*0.3*	*0.3*	*0.5*	*0.5*	*0.4*
Oil		*41.8*	*28.7*	*36.4*	*37.9*	*37.0*	*38.7*	*37.9*
Natural gas		*29.1*	*28.9*	*35.3*	*25.6*	*25.5*	*23.2*	*24.5*
Biofuels and waste[1]		*1.8*	*9.0*	*14.1*	*19.0*	*19.0*	*19.1*	*18.8*
Nuclear		*28.0*	*31.4*	*-*	*-*	*-*	*-*	*-*
Hydro		*0.2*	*0.4*	*0.7*	*0.5*	*0.7*	*0.5*	*0.4*
Wind		*-*	*-*	*0.3*	*1.4*	*1.6*	*1.3*	*1.7*
Geothermal		*-*	*-*	*0.1*	*0.0*	*0.0*	*-*	*-*
Solar/other[2]		*0.5*	*1.8*	*3.0*	*3.2*	*3.8*	*3.6*	*3.6*
Electricity trade[5]		*-6.4*	*-1.6*	*7.3*	*9.9*	*9.9*	*10.8*	*10.6*

0 is negligible, - is nil, .. is not available, x is not applicable. Please note: rounding may cause totals to differ from the sum of the elements.

Unit: Mtoe

DEMAND							
FINAL CONSUMPTION	**1990**	**2000**	**2010**	**2016**	**2017**	**2018**	**2019**
TFC	**10.41**	**4.40**	**5.40**	**6.04**	**6.44**	**6.56**	**6.62**
Coal	0.74	0.07	0.18	0.16	0.16	0.17	0.17
Peat	0.01	0.01	0.02	0.02	0.02	0.03	0.02
Oil	4.15	1.44	1.73	2.11	2.21	2.38	2.43
Natural gas	2.13	0.91	1.10	1.39	1.57	1.46	1.54
Biofuels and waste[1]	0.27	0.61	0.74	0.69	0.69	0.72	0.70
Geothermal	-	-	-	-	-	-	-
Solar/other[2]	-	-	-	-	-	-	-
Electricity	1.03	0.53	0.72	0.84	0.87	0.89	0.91
Heat	2.08	0.83	0.92	0.83	0.92	0.91	0.85
Shares in TFC (%)							
Coal	*7.1*	*1.7*	*3.3*	*2.6*	*2.5*	*2.6*	*2.5*
Peat	*0.1*	*0.2*	*0.4*	*0.4*	*0.4*	*0.4*	*0.3*
Oil	*39.9*	*32.8*	*32.0*	*34.9*	*34.3*	*36.3*	*36.8*
Natural gas	*20.4*	*20.6*	*20.4*	*23.1*	*24.3*	*22.2*	*23.3*
Biofuels and waste[1]	*2.6*	*13.8*	*13.6*	*11.4*	*10.8*	*11.0*	*10.6*
Geothermal	-	-	-	-	-	-	-
Solar/other[2]	-	-	-	-	-	-	-
Electricity	*9.9*	*12.1*	*13.3*	*13.9*	*13.4*	*13.6*	*13.7*
Heat	*20.0*	*18.8*	*17.1*	*13.8*	*14.3*	*13.9*	*12.8*
TOTAL INDUSTRY[6]	**4.19**	**1.44**	**1.61**	**2.03**	**2.28**	**2.23**	**2.30**
Coal	0.04	0.01	0.09	0.09	0.09	0.10	0.11
Peat	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oil	1.42	0.28	0.22	0.24	0.25	0.30	0.28
Natural gas	1.53	0.75	0.82	1.13	1.29	1.17	1.26
Biofuels and waste[1]	0.01	0.03	0.08	0.10	0.10	0.11	0.11
Geothermal	-	-	-	-	-	-	-
Solar/other[2]	-	-	-	-	-	-	-
Electricity	0.47	0.20	0.23	0.29	0.31	0.32	0.33
Heat	0.72	0.16	0.18	0.19	0.24	0.23	0.22
Shares in total industry (%)							
Coal	*1.0*	*0.9*	*5.3*	*4.3*	*3.7*	*4.3*	*4.6*
Peat	*0.1*	*0.1*	*0.1*	*0.1*	-	*0.1*	-
Oil	*33.8*	*19.8*	*13.8*	*11.7*	*11.0*	*13.6*	*12.0*
Natural gas	*36.5*	*52.0*	*50.8*	*55.6*	*56.6*	*52.4*	*54.8*
Biofuels and waste[1]	*0.3*	*2.2*	*4.7*	*4.7*	*4.4*	*5.0*	*4.8*
Geothermal	-	-	-	-	-	-	-
Solar/other[2]	-	-	-	-	-	-	-
Electricity	*11.2*	*13.7*	*14.2*	*14.5*	*13.8*	*14.2*	*14.1*
Heat	*17.1*	*11.4*	*11.2*	*9.3*	*10.5*	*10.4*	*9.6*
TRANSPORT[4]	**1.86**	**1.03**	**1.48**	**1.86**	**1.95**	**2.07**	**2.14**
OTHER[7]	**4.36**	**1.93**	**2.31**	**2.15**	**2.21**	**2.26**	**2.17**
Coal	0.70	0.06	0.09	0.07	0.08	0.08	0.06
Peat	0.01	0.01	0.02	0.02	0.02	0.03	0.02
Oil	0.89	0.14	0.10	0.11	0.12	0.11	0.12
Natural gas	0.60	0.16	0.26	0.23	0.24	0.26	0.25
Biofuels and waste[1]	0.26	0.57	0.62	0.54	0.52	0.53	0.51
Geothermal	-	-	-	-	-	-	-
Solar/other[2]	-	-	-	-	-	-	-
Electricity	0.55	0.33	0.48	0.54	0.55	0.57	0.57
Heat	1.36	0.66	0.74	0.65	0.68	0.68	0.62
Shares in other (%)							
Coal	*16.0*	*3.2*	*4.1*	*3.3*	*3.5*	*3.4*	*2.9*
Peat	*0.1*	*0.3*	*0.9*	*1.0*	*1.0*	*1.2*	*1.0*
Oil	*20.4*	*7.1*	*4.4*	*5.0*	*5.3*	*5.0*	*5.7*
Natural gas	*13.7*	*8.2*	*11.1*	*10.8*	*11.1*	*11.5*	*11.7*
Biofuels and waste[1]	*6.0*	*29.8*	*26.7*	*24.9*	*23.6*	*23.5*	*23.6*
Geothermal	-	-	-	-	-	-	-
Solar/other[2]	-	-	-	-	-	-	-
Electricity	*12.5*	*17.1*	*20.9*	*25.0*	*24.7*	*25.3*	*26.4*
Heat	*31.3*	*34.4*	*32.1*	*30.0*	*30.9*	*30.1*	*28.7*

0 is negligible, - is nil, .. is not available, x is not applicable. Please note: rounding may cause totals to differ from the sum of the elements.

Unit: Mtoe

DEMAND							
ENERGY TRANSFORMATION AND LOSSES	**1990**	**2000**	**2010**	**2016**	**2017**	**2018**	**2019**
ELECTRICITY GENERATION[8]							
Input (Mtoe)	8.97	3.83	1.87	1.29	1.30	1.22	1.17
Output (Mtoe)	2.44	0.96	0.43	0.32	0.31	0.26	0.29
Output (TWh)	28.41	11.12	4.99	3.68	3.61	2.98	3.37
Output shares (%)							
Coal	-	-	-	-	-	-	-
Peat	-	-	-	-	-	-	-
Oil	*14.6*	*5.9*	*13.0*	*6.0*	*3.9*	*4.4*	*2.0*
Natural gas	*23.8*	*14.5*	*63.8*	*26.8*	*16.6*	*11.1*	*15.6*
Biofuels and waste[1]	-	-	*2.9*	*14.8*	*16.3*	*21.1*	*18.4*
Nuclear	*60.0*	*75.7*	-	-	-	-	-
Hydro	*1.5*	*3.1*	*10.8*	*12.4*	*16.7*	*14.4*	*10.2*
Wind	-	-	*4.5*	*30.9*	*37.8*	*38.4*	*44.5*
Geothermal	-	-	-	-	-	-	-
Solar/other[2]	-	-	-	*1.8*	*1.9*	*2.9*	*2.7*
TOTAL LOSSES	**5.66**	**2.99**	**1.65**	**1.17**	**1.12**	**1.09**	**1.00**
of which:							
Electricity and heat generation[9]	4.20	1.88	0.55	0.25	0.23	0.20	0.19
Other transformation	0.12	0.08	0.11	0.04	0.01	0.03	-0.03
Own use and transmission/distribution losses	1.33	1.03	0.99	0.89	0.89	0.85	0.85
Statistical differences	**-**	**-0.24**	**-**	**-**	**-0.01**	**-**	**-0.01**
INDICATORS	**1990**	**2000**	**2010**	**2016**	**2017**	**2018**	**2019**
GDP (billion 2015 USD)	25.02	22.52	34.39	42.47	44.27	45.89	47.69
Population (millions)	3.70	3.50	3.10	2.87	2.83	2.80	2.79
TES/GDP (toe/1000 USD)[10]	..	..	..	..	..	..	..
Energy production/TES	0.31	0.48	0.22	0.26	0.27	0.26	0.26
Per capita TES (toe/capita)	4.35	2.04	2.28	2.51	2.67	2.73	2.72
Oil supply/GDP (toe/1000 USD)[10]	0.27	0.09	0.07	0.06	0.06	0.06	0.06
TFC/GDP (toe/1000 USD)[10]	0.42	0.20	0.16	0.14	0.15	0.14	0.14
Per capita TFC (toe/capita)	2.82	1.26	1.74	2.11	2.28	2.34	2.37
CO_2 emissions from fuel combustion ($MtCO_2$)[11]	32.2	10.2	12.3	10.8	10.8	11.1	-
CO_2 emissions from bunkers ($MtCO_2$)[11]	0.7	0.4	0.6	0.8	0.9	1.0	-
GROWTH RATES (% per year)	**90-00**	**00-10**	**10-15**	**15-16**	**16-17**	**17-18**	**18-19**
TES	-7.8	-0.1	-0.0	2.3	4.6	1.3	-0.4
Coal	-20.3	8.4	-2.5	-0.6	2.5	6.1	-2.3
Peat	-3.7	8.1	-3.6	25.0	36.0	8.8	-27.0
Oil	-11.2	2.3	-0.4	8.9	2.2	6.1	-2.6
Natural gas	-7.9	1.9	-3.7	-10.9	4.3	-7.5	5.0
Biofuels and waste[1]	8.5	4.4	6.0	2.6	4.5	1.8	-1.8
Nuclear	-6.7	-100.0	-	-	-	-	-
Hydro	-2.1	4.7	-8.2	30.0	33.3	-28.8	-18.9
Wind	-	-	29.8	40.0	19.4	-16.2	31.6
Geothermal	-	-	-16.7	-	-50.0	-100.0	-
Solar/other[2]	4.3	4.9	2.4	-1.3	23.7	-3.8	-1.4
TFC	-8.3	2.1	1.7	2.6	6.6	1.9	0.9
Electricity consumption	-6.4	3.0	2.3	4.4	3.2	3.4	1.3
Energy production	-3.7	-7.7	3.6	1.8	10.2	-2.1	-0.9
Net oil imports	-11.4	2.0	-0.0	5.6	-1.3	10.3	0.2
GDP	-1.0	4.3	3.8	2.6	4.2	3.6	3.9
TES/GDP	-6.8	-4.3	-3.7	-0.3	0.4	-2.2	-4.2
TFC/GDP	-7.3	-2.2	-2.0	0.1	2.3	-1.7	-2.9

0 is negligible, - is nil, .. is not available, x is not applicable. Please note: rounding may cause totals to differ from the sum of the elements.

Footnotes to energy balances and key statistical data

[1] *Biofuels and waste* comprise solid biofuels, liquid biofuels, biogases, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.

[2] *Other* includes tide, wave and ambient heat used in heat pumps.

[3] In addition to coal, oil, natural gas and electricity, total net imports also include biofuels.

[4] Excludes international marine bunkers and international aviation bunkers.

[5] *Industry* includes non-energy use.

[6] *Other* includes residential, commercial and public services, agriculture/forestry, fishing, and other non-specified.

[7] Inputs to electricity generation include inputs to electricity, co-generation and heat plants. Output refers only to electricity generation.

[8] Losses arising in the production of electricity and heat at main activity producer utilities and autoproducers. For non-fossil fuel electricity generation, theoretical losses are shown based on plant efficiencies of approximately 33% for nuclear and 100% for hydro, wind and solar photovoltaic.

[9] Tonnes of oil equivalent per thousand US dollars at 2015 prices and exchange rates.

[10] "CO_2 emissions from fuel combustion" have been estimated using the IPCC Tier I Sectoral Approach methodology from the 2006 IPCC Guidelines. Emissions from international marine and aviation bunkers are not included in national totals.

ANNEX D: International Energy Agency "Shared Goals"

The member countries* of the International Energy Agency (IEA) seek to create conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and to the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants. In order to secure their objectives, member countries therefore aim to create a policy framework consistent with the following goals:

1. Diversity, efficiency and flexibility within the energy sector are basic conditions for longer term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group.

2. Energy systems should have **the ability to respond promptly and flexibly to energy emergencies.** In some cases, this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.

3. The environmentally sustainable provision and use of energy are central to the achievement of these shared goals. Decision makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should respect the polluter pays principle where practicable.

4. More environmentally acceptable energy sources need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA member countries wish to retain and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5. Improved energy efficiency can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle, from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6. Continued **research, development and market deployment of new and improved energy technologies** make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

7. Undistorted energy prices enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8. Free and open trade and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9. Co-operation among all energy market participants helps to improve information and understanding, and encourages the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA ministers at the meeting of 4 June 1993 in Paris, France.)

* Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

ANNEX E: Glossary and list of abbreviations

In this report, abbreviations and acronyms are substituted for a number of terms used within the International Energy Agency. While these terms generally have been written out on first mention, this glossary provides a quick and central reference for the abbreviations used.

Acronyms and abbreviations

BRELL	Belarus, Russia, Estonia, Latvia and Lithuania
CCU	carbon capture and utilisation
CO_2	carbon dioxideDC
DC	direct current
DH	district heating
DSO	distribution system operator
EED	Energy Efficiency Directive
ESCO	energy service company
ESD	Effort Sharing Decision
ESOC	Emergency Situation Operations Centre
ETS	Emissions Trading System
EU	European Union
EV	electric vehicle
FAME	fatty acid methyl esters
FRR	frequency restoration reserve
FSRU	floating storage and regasification unit
GDP	gross domestic product
GDP PPP	gross domestic product in purchasing power parity
GHG	greenhouse gas
GIPL	Gas Interconnection Poland-Lithuania
HVDC	high-voltage direct current
ICT	information and communications technology
IEA	International Energy Agency
Invega	Investment and Business Guarantees
ITC	inter-TSO compensation
KTU	Kaunas University of Technology
LEI	Lithuanian Energy Institute
LNG	liquefied natural gas
LPG	liquefied petroleum gas
LULUCF	land use, land-use change and forestry
NECP	National Energy and Climate Plan
NEIS	National Energy Independence Strategy
NERC	National Energy Regulatory Council
OECD	Organisation for Economic Co-operation and Development
PM	particulate matter
PPP	purchasing power parity
PV	photovoltaic
R&D	research and development

RED	Renewable Energy Directive
RES	renewable energy source
SME	small and medium-sized enterprise
TCP	technology collaboration programme
TEN-E	Trans-European Network for Energy
TES	total energy supply
TFC	total final consumption
TPES	total primary energy supply
TSO	transmission system operator
USD	United States dollar

Units of measure

bcm	billion cubic metres
CO_2-eq	carbon dioxide equivalent
GW	gigawatt
GW_e	gigawatt electrical
GWh	gigawatt hour
kb/d	thousand barrels per day
kg	kilogramme
km	kilometre
ktoe	kilotonne of oil equivalent
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
mb	million barrels
mBtu	million British thermal units
mcm	million cubic metres
Mt CO_2	million tonnes carbon dioxide
Mt CO_2-eq	million tonnes carbon dioxide equivalent
Mtoe	million tonnes of oil equivalent
MW	megawatt
MW_e	megawatt electrical
MWh	megawatt hour
PJ	petajoule
toe/cap	tonne of oil equivalent per capita
TWh	terawatt hour

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Lithuania 2021

Energy Policy Review

The International Energy Agency (IEA) regularly conducts in-depth peer reviews of the energy policies of its member, partner and accession countries. This process supports energy policy development and encourages the exchange of international best practices and experiences.

Lithuania has made strong progress towards realising its vision of a secure, competitive, sustainable and innovative energy system in the Baltic region.

The government supported major reforms of the electricity and natural gas markets, and further integrated with the EU energy system and markets. Thanks to the expansion of renewable energy sources, notably bioenergy and wind, the carbon intensity of the power and heat sector has decreased over the past decade.

Nevertheless, emissions have been on the rise, notably in the transport sector. Lithuania will need to make energy efficiency a priority, design a strong renewable strategy, and reform energy taxes to underpin its ambitious targets. This kind of clean energy leadership can drive emissions reductions up to 2050.

In this report, the IEA provides energy policy recommendations to help Lithuania accelerate its energy transition towards its ambitious 2050 targets for for climate neutrality.