

ENERGY SECURITY IN THE BALTIC SEA REGION

Transition within geopolitical constraints

Veronika Slakaityte, Izabela Surwillo and Trine Villumsen Berling

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EXECUTIVE SUMMARY

The Russian attack on Ukraine in February 2022 shook continental geopolitics and led to a major shift in EU energy policy. The necessary speed of the combined diversification away from the Russian energy sources, fossil fuel phase-out and mass scale-up of low-carbon energy and technologies are having a tremendous impact on European national economies and societies. The Baltic Sea Region is no exception. Baltic Sea energy politics currently paints a complicated picture of competing pipeline projects, sprouting new LNG terminals, plans to build nuclear power infrastructure, a race to develop new energy technologies and to increase the interconnectedness, and digitalisation of the electricity grids. These developments will transform the regional energy landscape for decades to come and have important security implications. This policy report provides a comprehensive overview of the energy security situation in the Baltic Sea Region, zooming in on eight country cases (Denmark, Sweden, Finland, Estonia, Latvia, Lithuania, Poland and Germany). By locating the national energy policies in a historical context that shaped choices of energy infrastructure and technology, the analysis investigates how the energy policy and energy mix of each country was affected by cutting the energy ties with the Kremlin following the outbreak of war in 2022. The report looks into future investments in the energy sector that are meant to tackle the dual energy-climate crisis at the Baltic Sea. As the war in Ukraine and the European energy crisis are continuously unfolding, we conclude with five key points moving forward:

Regional interconnectedness of energy infrastructure and the development of a common energy policy approach will be crucial for building resilience in the Baltic Sea energy sector in the face of the unfolding energy crisis.

Short-term versus long-term trade-offs, such as the use of 'black' energy as a quick fix versus investments in green energy sources in line with climate goals, will be faced.

Technological and political lock-ins may be created by putting long-lifecycle energy infrastructure projects in place (eg pipelines, LNG terminals, NPPs) that risk creating new dependencies and hampering the green transition.

Speed, scale and competitiveness are all crucial in tackling the energy crisis and keeping the rise of global temperatures under 1.5°C; however, we may be counting on technology that is not invented or not yet ready for mass roll-out.

Political resilience and possible loss of momentum, as European businesses and consumers alike will increasingly feel the dire impact of the ongoing war in Ukraine and the energy crisis.

ABBREVIATIONS

3EP	Third Energy Package
BCM	Billion cubic meters
BEMIP	Baltic Energy Market Interconnection Plan
BRELL	Belarus, Russia, Estonia, Latvia and Lithuania
BSR	Baltic Sea Region
CEE	Central and Eastern Europe
CFB	Circulating fluidised bed
CHPP	Combined heat and power plant
CO₂	Carbon dioxide
DG	Directorate General
DH	District heating
ELLI	Enhancement of Latvia-Lithuania Interconnector
EU	European Union
FSRU	Floating storage and regasification unit
GHG	Greenhouse gas
GIPL	Gas Interconnection Poland-Lithuania
HPP	Hydropower plant
IEA	International Energy Agency
ITO	Independent transmission operator
LNG	Liquefied natural gas
NPP	Nuclear power plant
NS1	Nord Stream 1
NS2	Nord Stream 2
OU	Ownership unbundling
PCI	Projects of common interest
RES	Renewable energy sources
SMR	Small modular reactor
UGS	Underground gas storage

PREFIXES AND UNITS OF POWER AND ENERGY USED IN THE REPORT

Symbol	Name	Value	
Electricity/Power			
W(h)	Watt (hour)	10 ⁰ W	1 W
kW(h)	Kilowatt (hour)	10 ³ W	1,000 W
MW(h)	Megawatt (hour)	10 ⁶ W	1,000,000 W
GW(h)	Gigawatt (hour)	10 ⁹ W	1,000,000,000 W
TW(h)	Terawatt (hour)	10 ¹² W	1,000,000,000,000 W
Natural gas/LNG			
m³	Cubic meters	10 ⁰ m ³	1 m ³
mcm (/y)	Million cubic meters (/per year)	10 ⁶ m ³	1,000,000 m ³
bcm(/y)	Billion cubic meters (/per year)	10 ⁹ m ³	1,000,000,000 m ³
Expression and comparison of different sources			
toe	Tonne of oil equivalent	10 ⁰ toe	1 toe
ktoe	Kilo-tonne of oil equivalent	10 ³ toe	1,000 toe
mtoe	Mega-tonne of oil equivalent	10 ⁶ toe	1,000,000 toe

INTRODUCTION

The Russian attack on Ukraine in February 2022 shook continental geopolitics and led to a major shift in EU energy policy. It also rapidly realigned the views on energy security across the Union. For many years there had been a discrepancy between Central and Eastern Europe, which largely perceived Moscow's use of fossil fuel exports as an instrument of political pressure, versus Western countries, such as Germany, which insisted on the economic dimension of EU-Russia energy cooperation. The latter appeared to be caught by surprise when Moscow employed energy blackmail and used its gas pipelines instrumentally after the outbreak of war. This time, the EU threat perceptions aligned and triggered a sequence of actions aimed at reducing the Russian war-financing income, especially generated by fossil fuel exports. The unprecedented Nord Stream 1 and 2 pipeline leaks recorded in late September 2022 further highlighted how energy belongs in the security domain. Although pending assessment, the evidence points to deliberate explosions.¹ Consequently, security has been tightened around critical energy infrastructure in several countries in the region. In the recent months, the EU energy policy approach towards Moscow has changed drastically, prioritising the security of energy supply and further complicating the EU green energy transition. The necessary speed of the combined diversification away from Russian energy sources, fossil fuel phase-out and mass scale-up of the low-carbon energy sources and technologies negatively impact European national economies and societies, and the Baltic Sea Region (BSR) is no exception. Here, the diversity of countries with historically shaped energy paths attempts to adjust their national energy plans to the challenging circumstances and strengthen cooperation in a joint bid to enhance regional energy security.

In 2021, the EU committed to a legally binding pledge to become a net-zero emitter by 2050, a goal enshrined in the European Climate Law. A set of policy initiatives approved in 2020 known as the European Green Deal serves as a roadmap leading to climate neutrality. Although labelled as an economic growth strategy, energy occupies centre stage, as energy production and use across economic sectors account for three-fourths of all EU greenhouse gas (GHG) emissions. As noted by Commission President Ursula von der Leyen in October 2021: 'The European Green Deal is in the mid- and long-term a pillar of European energy sovereignty in the 21st century', but the role of natural gas as a transitional fuel alongside speeding up the transition to clean energy is crucial.² Although the classification of gas as a transitional fuel (and later as 'green' in the EU taxonomy) has been widely criticised since,³ numerous European states designed their energy policies with a view to using natural gas in the medium term. The outbreak of war in Ukraine, which necessitated the phasing out of Russian fossil fuels (incl. oil, gas and coal), as well as acceleration of energy transition has complicated this task.

The EU responded with a number of policy moves to the developments in Ukraine and the energy crisis. Already in early March 2022, the International Energy Agency (IEA) published their 10-Point Plan for how to reduce EU dependence on Russian natural gas imports by one-third by the end of the year. Shortly thereafter, the European Commission's 'REPowerEU Communication' document suggested the complete eradication of EU dependence on Russian fossil fuels by 2030, with a particularly strong emphasis on natural gas. The plan states that two-thirds of Russian gas volumes can be replaced by the end of 2022, which is a volume equivalent to 100 bcm, that previously appeared in the 'Fit for 55' package as a target for 2030. It is important to stress that 'REPowerEU' does not suggest a simple replacement of Russian gas with other sources in the short-term, but rather a mix of measures combining other energy sources together with gas of other origins, most notably in a form of liquified natural gas (LNG). In mid-May, the 'REPowerEU Action Plan' further accelerated the deadlines and targets set in the 'Fit for 55' package, despite the initial objectives being criticised as overly ambitious even prior to the outbreak of the war. This meant that the binding energy efficiency measures increased from 9% to 13%, the share of renewables rose from 40% to 45%, whereas the industry and transport sectors, among others, were required to reduce natural gas consumption by an additional 35 bcm on top of the Fit-for-55 objectives.

Apart from the policy changes within the bloc, the EU also targeted Russian energy exports. Russian coal imports were banned from August 2022, while the sixth package of sanctions, adopted in June, bans seaborne oil imports by December 2022 and petroleum products by February 2023. Currently, oil sanctions remain partial, covering 30% of oil imports from Russia, however, once the seaborne oil restrictions come into effect, the coverage will extend to 90%.⁴ Nonetheless, prominent exceptions (eg emergency oil purchases) remain intact due to strong opposition from some landlocked countries highly dependent on Russian oil. This does not bode well for the even more challenging accelerated phase-out and sanctioning of Russian gas imports to be negotiated between the Member States in the near-future.

This report takes stock of the most recent energy policy developments in Denmark, Sweden, Finland, Estonia, Latvia, Lithuania, Poland and Germany, while placing them in the historical context that shaped national choices of energy infrastructure and technology. As energy policy still mostly remains an EU Member State prerogative, the report analyses how the national energy mix of each country was affected by cutting the energy ties with Moscow following the outbreak of war in 2022, and what future investments in the energy sector are meant to tackle the dual energy-climate crisis. The report can be read as a whole or as individual case studies. In the final section, we offer concluding thoughts regarding some of the major dilemmas that must be followed closely in the months and years to come.



**BALTIC SEA REGION UNDER
THE MAGNIFYING GLASS**



Panorama of oil and gas central processing platform.
Photo: Oil and Gas Photographer, Shutterstock.

DENMARK: OIL/GAS SELF-SUFFICIENCY AND A WIND ADVENTURE

Although Denmark is known for high energy efficiency and low-carbon intensity, oil and natural gas has occupied an important part in its recent history. In the 1970s, Denmark was heavily reliant on oil, at peak points (1971-2) accounting for 93% percent of the overall energy mix, and it suffered severely from skyrocketing oil prices during the oil crisis sparked by OPEC in 1973. This shifted the focus towards the extraction of oil and gas in the Danish part of the North Sea.⁵ In 1962, the Danish corporation Maersk was awarded a sole concession with rights to the Danish shelf, as doubts were high as to whether domestic production would be financially viable (Hahn-Petersen 1999). Systematic exploration of the Dan oilfield began in 1972, followed by operations in Gorm (1981), Skjold (1982), Tyra (1984) and Rolf (1986); the remaining oilfields were developed from the 1990s to the early 2000s.⁶ Today, Denmark's oil and gas production is produced by a total of 55 platforms spread over 21 North Sea oil- and gas fields. Maersk sold its exclusive rights to French Total in 2018, marking an end to an era of Danish exclusivity on the Danish shelf.

Since the opening of the fields, the domestic oil production had been gradually increasing, peaking in the early- to mid-2000s; production levels thereafter expectedly fell and have been in sharp decline, dropping from 389,163 barrels per day in 2004 to 65,636 in 2021. The fields are nearly depleted and the infrastructure is aging.⁷ Domestic natural gas production levels follow a similar trajectory: peaking in 2005 at 11.7 bcm/y and falling to 1.4 bcm/y in 2020 (an 88% drop).⁸ While Denmark had been a net exporter of oil and natural gas in the period 1997-2018, it has more recently become a net oil importer. Also in relation to gas: Denmark stopped being self-sustaining in 2019 and became a gas importer due to maintenance work on Tyra, its biggest gas field.⁹

Several international gas pipeline projects have been presented to the Danish authorities over the past 15 years. Denmark was among the first countries in the region to accept the construction of the Nord Stream 1 (NS1) pipeline through the Danish maritime territory around the Baltic island of Bornholm. After the Russian annexation of Crimea in 2014, however, Danish sentiments changed, and the Nord Stream 2 (NS2) pipeline construction permit was stalled for nearly two and a half years. The Baltic Pipe adjoining Norwegian and Polish gas networks was processed more smoothly, despite the pipeline having been built over land across Denmark from Jutland to the island of Zealand. While the construction was delayed due to COVID-19, the interconnector has become operational in October 2022. The majority of gas imports to Denmark are thereafter expected to come from Norway.¹⁰ While

Table 1. Energy consumption by source in Denmark

Source	1990	2009	2021
Nuclear	0.00%	0.00%	0.00%
Gas	10.42%	20.75%	12.41%
Oil	53.24%	44.63%	39.77%
Hydropower	0.04%	0.02%	0.02%
Wind	0.89%	8.50%	22.49%
Other renewables	0.33%	4.80%	14.95%
Coal	35.07%	21.23%	6.88%
Solar	0.00%	0.00%	1.79%

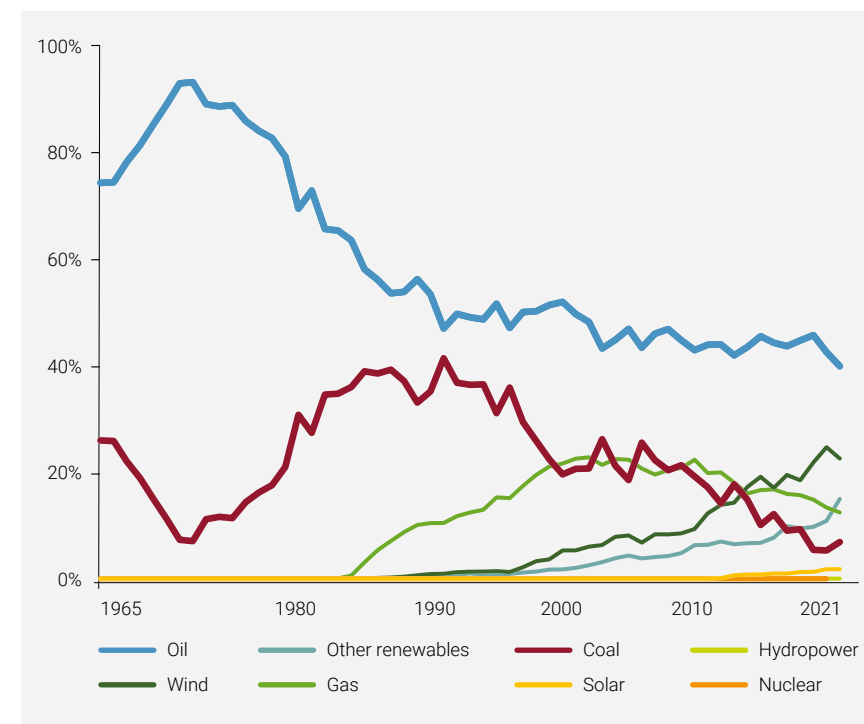
Table 2. Share of electricity production by source in Denmark

Source	1990	2009	2021
Nuclear	0.00%	0.00%	0.00%
Gas	2.66%	18.33%	5.93%
Oil	3.46%	5.39%	3.89%
Hydropower	0.12%	0.06%	0.06%
Wind	2.35%	18.47%	47.84%
Other renewables	0.73%	9.13%	23.17%
Coal	90.69%	48.63%	15.09%
Solar	0.00%	0.00%	4.01%

Rank	Source
Highest percentage	Coal
Second highest percentage	Wind
Third highest percentage	Other renewables
Fourth highest percentage	Gas

this interconnection further improves security of supply, less carbon-intensive forms of energy are prioritised. Notably, Denmark has been boosting biogas production at a staggering +2743% increase since 1990 to today.¹¹ In 2021, a record-high level of biogas was injected into the gas system, covering nearly one-fourth of domestic gas-consumption needs.¹²

Figure 1. Share of coal and oil in the Danish energy consumption



Source: Our World in Data based on BP Statistical Review of World Energy (2022)

Interestingly, the use of oil and coal are inversely correlated in Denmark:¹³ increased oil consumption translates to reduced coal use; and vice versa. Although both have gradually decreased over the past three decades, this interplay continues (Figure 1). Coal had been the main source of energy for electricity generation until 2013 but has since lost out to booming wind energy production. In fact, the falling oil consumption is largely due to improved efficiency measures and an exponentially growing share of renewable energy.¹⁴

Since 2011, Denmark has been a net importer of electricity from Sweden, Norway, Germany and the Netherlands.¹⁵ Domestic electricity generation has been decreasing since the mid-1990s, falling from 10,196 KWh in 1996 to 5,744 KWh in 2021.¹⁶ The total output has fallen following the decarbonisation strategy, yet the share of renewable energy in the mix has blossomed (Table 2). Meanwhile, nuclear energy is practically a taboo in Denmark. Having met substantial popular resistance in the 1970s-80s, the Danish government passed two decisive laws in the spring of 1985 that ruled nuclear energy out of public energy planning, and this sentiment was

cemented further after the Chernobyl disaster the following year (Chr. Sidenius 1986). These decisions have stood to this day. Nevertheless, the eastern part of Denmark imports electricity from Sweden, roughly 40% of which is of nuclear origin.¹⁷

Wind has a long history in Denmark and has arguably become the global brand of the country. The Danish state has subsidised electricity produced by wind turbines since 1976, and state subsidies played a major role in rendering wind energy financially viable.¹⁸ The share of total electricity production from wind has risen from 2.35% in 1990 to 47.84% today (Table 2). While the first turbines were land-based, offshore wind has more recently taken primacy. After the outbreak of war in Ukraine, the Danish government sped up the roll-out of the green transition and is currently planning to increase solar and onshore wind energy fourfold by 2030.¹⁹ This constitutes a major shift.

At the same time, the ambitious Danish mega-project of 'energy islands' in the North and Baltic Seas has been pushed ahead of the original schedule. While the project was largely marketed as part of the green transition, the geopolitical impact is palpable. The first energy island in the North Sea will be an artificially constructed island 100 km off the coast of Jutland, which will serve as a hub for 200 offshore wind turbines with a capacity of 3 GW. Eventually reaching a capacity of 10 GW, the power hub will provide energy for ten million households.²⁰ It will be the biggest construction project in Danish history, costing an estimated EUR 28bn. In late August 2022, cabinet ministers from several BSR countries met in Denmark to plan for an additional energy island on Bornholm in the Baltic Sea.²¹ In the long-term, these offshore energy hubs are envisioned to operate under the power-to-x model, which enables green hydrogen production from surplus wind energy that is not otherwise possible to store (Johansen 2021).

Following the outbreak of the Russo-Ukrainian War, the Danish government presented its vision for how Denmark can simultaneously become less dependent on Russian gas and accelerate the green transition; a vision which formally merges energy/climate and security politics. Denmark will focus on excluding gas from central heating and wean 430,000 households off of Russian natural gas by installing district heating or heat pumps in private houses while boosting gas extraction in the Danish North Sea.²² Land-based wind and solar projects, regional cooperation on energy islands, and major wind parks will further accelerate the green transition. The North Sea Declaration from May 2022 underlined this, stating that the North Sea will become Europe's green battery.²³

Denmark is often addressed as one of the leading countries in the net-zero transition. With strong renewable-energy convictions, Danish climate-change-mitigation policies are driven by both national targets and international climate obligations. Some of the ambitious national projects can be traced to the island of Bornholm, which has been a leader in developing renewable energy. In a similar manner, the City of Copenhagen announced an ambitious target in 2012 of becoming the first carbon-neutral city by 2025.²⁴ However, despite significant improvements in the implementation of renewables and energy efficiency measures, much hope has been invested in carbon capture technology, which has yet to be rolled out. This shortfall has raised questions regarding the attainability of national carbon-neutral targets; not just in the capital region but on the national scale in general. With the phase-out deadline for oil and gas extraction set to 2050, the scepticism has increased especially since the current energy crisis has not only accelerated the sustainable transition but also evoked concerns over increasing oil and gas production volumes, as well as moving some offshore wind projects on-land. Although Denmark is not heavily dependent on Russia, the current energy crisis has repercussions for the Danish energy transition, as it extends its fossil fuel phase-out timeframe and affects the economy and society with record-high energy prices.²⁵ Despite low dependency on Russian fossils, the security dimension of the crisis has been further amplified following the Nord Stream 1 and 2 natural gas pipeline leaks in the Danish and Swedish exclusive economic zones in the Baltic Sea in late September 2022. While the pipelines were not in operation, the suspected sabotage caused by explosions registered by the seismic systems elevated the protection of critical energy infrastructure in Denmark and across Europe in fear of further escalations.²⁶



Downstream Namforsen water power plant with the outlets open.
Photo: Lars Ove Jonsson, Shutterstock.

SWEDEN: FROM OIL TO NUCLEAR AND HYDRO

Despite being an energy-intensive country, Sweden has been pioneering the way towards low-carbon economy for years.²⁷ With a low share of fossil fuels in the primary energy mix (28%), the near-complete decarbonisation of heating and electricity and high energy efficiency has been achieved through electrification and district heating, Sweden is leading the way to climate neutrality.²⁸ However, this has not always been the case. Sweden used to be heavily dependent on oil, which at times accounted for as much as 70% (1970) of the overall energy consumption. Generally, the share of oil has been decreasing from 419 TWh in 1979 to 149 TWh in 2021, which translates to a 64% reduction over 43 years.²⁹

The years 1973-5 mark an important energy policy shift in Sweden, where oil consumption was largely replaced by nuclear energy (Vedung 2001). The development of nuclear energy in Sweden was historically entangled with security considerations related to Sweden's status as a neutral country during the Cold War. The policy stretches back to the decades immediately after the Second World War, when the Swedish government found that acquiring nuclear weapons might be the best solution to ensure national security. The nuclear weaponry plans were abandoned in 1966, and civilian nuclear energy generation took over. At the same time, nuclear energy plans were supported by the parliament without raising significant opposition from society. This can be attributed to two reasons: energy policies at the time were handled by a small circle of experts and a few politicians, which also led to little media coverage and limited public debate (Holmberg and Hedberg 2017). The unity on the nuclear questions ended with the newly elected parliament in 1973, when the nuclear expansion issue was politicised and further intensified by the global oil crisis. This time, the public opposition to nuclear power grew. After a referendum in March 1980, decision was taken not to plan for new reactors and to phase out nuclear energy.³⁰

There were 12 reactors in Sweden before 2005, but two of these reactors (in Barsebäck), were decommissioned in 1999 and 2005, partly in response to pressure from Denmark.³¹ The share of energy generated using nuclear technologies has been gradually decreasing since 2005. Four more reactors were shut down by 2020.³² which furthered the drop in the nuclear share in electricity generation.³³ Today, nuclear energy in Sweden is produced by six operating nuclear reactors in three nuclear power plants: Ringhals, Oskarshamn and Forsmark. The Swedish reactors are owned and operated by Vattenfall (state-owned), and private utilities

include Uniper SE (formerly E.ON Sweden) and Fortum Sweden (majority-state-owned by the Finnish government). Nuclear energy accounts for one third of the electricity generation, corresponding to 53 TWh in 2021.³⁴

Apart from nuclear energy, one of the most notable aspects of the Swedish energy profile is the high share of renewable energy in the final energy consumption (see Table 3). In 2021, nearly half of the energy generated in Sweden came from renewable sources (hydro, wind, solar and other RES).

Table 3. Share of energy consumption by source in Sweden

Source	1990	2009	2021
Nuclear	28.36%	23.84%	21.01%
Gas	0.88%	1.96%	2.06%
Oil	33.38%	31.09%	23.53%
Hydropower	31.42%	31.15%	29.47%
Wind	0.00%	1.18%	11.26%
Other renewables	0.91%	6.24%	6.71%
Coal	5.05%	3.96%	2.48%
Solar	0.00%	0.00%	0.60%

Rank	Source	Percentage
Highest percentage	Oil	23.53%
Second highest percentage	Hydropower	29.47%
Third highest percentage	Coal	2.48%
Fourth highest percentage	Gas	2.06%

Hydropower is especially important in the Swedish energy mix – for the past 30 years, it has steadily stood at around 30% of the overall share – and continues to be a cornerstone of Swedish energy policy.³⁵ Interestingly, the hydro projects were initiated during the two World Wars, which restricted coal imports and pushed the country to seek alternatives (Kander and Stern 2014). Most working hydropower plants were built between 1950 and 1970. Today, Sweden has around 1,800 hydropower plants, some of which produce as much electricity as a nuclear power plant (eg Harsprunget by Luleå). 80% of the hydropower plants are in the northernmost parts of Sweden.

The new National Strategy of 2014 issued a call for improved ecological status for hydropower.³⁶ The primary concern in the new legislation (2019) points to compensation for loss of commercial fishing and restoration of damaged freshwater

ecosystems. The hydropower is increasingly being regulated by national laws, such as the Swedish Environmental Code and Environmental Quality Objectives,³⁷ together with the EU directives that apply to the hydropower plant license reviews (Rudberg et al. 2015). However, the restoration of rivers often reduces the water availability required for power production, which has led to delays in the restorations to date. With the environmental accountability practices being increasingly enforced, the restoration is expected to be accelerated and may further reduce the hydropower generation volumes.

Table 4. Share of electricity production by source in Sweden

Source	1990	2009	2021
Nuclear	46.70%	38.19%	31.24%
Gas	0.29%	1.14%	0.06%
Oil	1.27%	1.87%	1.37%
Hydropower	49.66%	48.21%	42.97%
Wind	0.01%	1.82%	15.96%
Other renewables	1.33%	8.39%	7.79%
Coal	0.74%	0.37%	0.00%
Solar	0.00%	0.01%	0.61%

Rank	Source	Percentage
Highest percentage	Hydropower	42.97%
Second highest percentage	Wind	15.96%
Third highest percentage	Coal	0.00%
Fourth highest percentage	Gas	0.06%

Over the last decade, Sweden has also increased its share of wind-generated electricity to 15.96% in 2021 (Table 4). Between 2019 and 2020 alone, wind-generated electricity increased by 40%.³⁸ The wind farms are mostly land-based, as on at least two occasions offshore wind projects have been rejected by the Swedish armed forces: Taggen, because it was allegedly too close to a shooting range, and Blekinge Offshore AG, because it was in an area of strategic importance. The armed forces cited the growing threat from Russia as reason to refrain from proceeding with the project.³⁹

In 2021, Hydro Rein and Eolus entered a partnership to develop nine onshore wind projects with a combined capacity of 672 MW to be commissioned by 2027-32.⁴⁰ Today, Sweden has six offshore wind farms in operation, and more are planned.⁴¹ In May 2022, the Swedish Government approved Kriegers Flak,⁴² and an application for project Aurora was sent to the Swedish authorities in June.⁴³ This offshore Baltic

Sea wind project is expected to enter commercial operation in 2030. With an expected combined capacity of 5,500 MW, this is potentially the largest wind farm in the world.⁴⁴

In 2020, Sweden was the tenth largest exporter of electricity in the world, with primary destinations including Finland, Denmark, Lithuania, Poland, and Germany.⁴⁵ The liberalisation of the Swedish electricity market proceeded in two stages: in 1992, the transmission system operator (TSO) was unbundled, while the distribution system operator (DSO) finalised unbundling in 1996, at the same time that Sweden became a part of the Nordic electricity market (Wilkens and Johansson 2010). While the legal basis for unbundling was introduced in the Electricity Act of 1998, the Act has since been amended to correspond to the latest EU directives, including the Third Energy Package.⁴⁶

When it comes to fossil fuel energy, Sweden is a net importer. Having no proven oil and gas reserves, the country imports most of its oil from Norway (65%) and fundamentally relies on a single gas pipe connection with Denmark.⁴⁷ Yet gas has not been consistently considered a security issue in Sweden. In fact, during the negotiations over Nord Stream 2 (NS2), the gas pipeline project was not handled in the same way across the country. Gotland – the preferred storage location for pipes for NS2 – refused to let the company use the island for these purposes, citing security concerns. Conversely, Karlshamn, a coastal town further to the south, saw no security issue and signed a deal for the temporary storage of pipeline construction materials. National legislation was later changed.⁴⁸

According to a statement by the Swedish government in March 2022, around half of the imported gas supply may come from Russia.⁴⁹ Ironically, this gas most likely came through Nord Stream 1 (NS1). However, gas only accounts for around 2% of the final energy consumption and oil for around 23% (Table 3). Most of the gas is used in industry (57%), whereas most of the oil is used for transport (58%) and industry (23%).⁵⁰ Although gas represents a low share of the total primary energy supply at the country level, it covers one fifth of the total consumed energy in the west coast area.⁵¹ The gas supply is somewhat diversified through two LNG terminals in Lysekil (built in 2011) and Nynäshamn (2014), owned by Finnish Gasum, with a combined storage capacity of 50,000 m³ of LNG. However, neither of the terminals are connected to the gas network and serve commercial users only. There are plans to introduce four more small-scale LNG terminals in Gävle, Åhus and

Gothenburg.⁵² Since Sweden has a single natural gas storage facility that covers only 8% of the national gas consumption,⁵³ seasonal swings in gas consumption are balanced by the Danish storage facilities.⁵⁴

In an attempt to enhance security of supply, Sweden is also investing in biogas. This is intended to eventually replace gas altogether, as it can be injected into the natural gas pipelines with no technical impact on gas users.⁵⁵ Since the development of biogas is consistent with Swedish decarbonisation objectives, support schemes such as exemptions for energy and CO₂ taxes are offered for biogas use in transport and heating.

Being a net exporter of electricity with a low share of gas in the national energy mix and the majority of oil imports covered by Norway, Sweden's energy sector and policy have not undergone major shifts following the war in Ukraine; with one notable exception. Recently, a series of gigawatt-scale project announcements were issued for offshore wind farm development in the second half of the decade, totalling a combined capacity of 90 GW by 2032.⁵⁶ With the war-affected economy, despite being a net exporter, Sweden is experiencing one of the highest increases in electricity prices. The soaring prices are blamed on the premature phasing out of nuclear power, leading to pre-election proposals to subsidise new nuclear power plants.⁵⁷ With nuclear and hydro power generation falling under the EU green taxonomy and the multiple wind park projects envisioned in the near future, Sweden remains on track to reach its net-zero targets. Nevertheless, access to nuclear fuel and radioactive waste disposal continue to raise questions worth further investigation. Furthermore, dependence on natural gas that is supplied through a single pipeline connection from Denmark raises security of supply concerns related to the physical reliability of the infrastructure and potential failure. In this context, the Nord Stream 1 and 2 natural gas leaks in the Swedish and Danish exclusive economic zones in the Baltic Sea in late September 2022 raised high security alerts and increased security measures to be placed around critical energy infrastructure. In a joint letter to the President of the Security Council, the countries concluded that all evidence points to the explosions being deliberate acts which endanger international security.⁵⁸ These events show a fundamental change in the perception of threat and potential escalation of conflict in Europe. The Russo-Ukrainian War triggered a fundamental shift in the Swedish position, which is best exemplified by the decision to join NATO and to break its neutral status by supplying weapons to Ukraine.



Olkiluoto Nuclear Power Plant.
Photo: Max Sky, Shutterstock.

FINLAND: IMPORT QUAGMIRE AND NUCLEAR FUTURE

Finland's history has been heavily influenced by its eastern neighbour. In the 1940s, Finland and Russia entered into war twice (Gordon Dickinson 2003). In November 1939, the Soviet Union started the Russo-Finnish War (aka. The Winter War), which eventually resulted in the Treaty of Moscow (1940), leading to the construction of a Soviet naval base on Finnish territory and the cession of Western Karelia.⁵⁹ In 1941, Finland entered the Continuation War as a cobelligerent with Germany, which resulted in more lost territories. This Russo-Finnish conflict was settled with the 1947 Paris Peace Treaties. Since then, a pro-Russian Agreement of Friendship, Cooperation, and Mutual Assistance⁶⁰ was signed by the two parties, including a mutual defence clause (Hannikainen 2020). At the same time, Finland distanced itself from neighbouring Sweden while maintaining good trade ties with the Soviet Union, which enabled the country to access cheap energy and raw materials. Consequently, Finland was not hit by the oil crises in the 1970s, whereas it was hit hard by the dissolution of the Soviet Union. Finland became a full EU member in 1995.⁶¹

Finland's cold climate and energy-intensive industry make it one of the most energy-intensive countries in the world (Jääskeläinen et al. 2018). Although the consumption of primary energy is now re-approaching 1990 levels, with annual consumption stabilising at 322 TWh, in the early- to mid-2000s energy consumption rocketed to ±390 TWh.⁶² The recent decline in primary energy consumption can be explained by improved energy efficiency measures and an increasing share of low-carbon and renewable energy sources that currently account for 53% and 34%, respectively (Ibid.). Nevertheless, due to the absence of significant domestic reservoirs of fossil fuels and uranium (used to power the nuclear reactors), Finland remains dependent on imports (Jääskeläinen et al. 2018: 1-2). Russia is a major supplier, covering 34% of the total Finnish energy consumption in 2021 with sources such as wood, oil, nuclear, coal, gas and net electricity. Natural gas, in particular, showcased a high dependence on imports from Russia, standing at 92% in 2021.⁶³

While this high dependency sparked concerns in the Finnish domestic debate about the potential use of energy as an instrument of political pressure by Moscow, the arguments of economic cooperation and increasing interdependence prevailed both in the Finnish public sphere and in strategic energy documents (Jääskeläinen et al. 2018: 10). The economic rationale was appealing, as Finland had not experienced any significant energy supply disruptions prior to the electricity and gas cut-offs in the spring of 2022.⁶⁴ Following the Third Gas Directive (3EP) in 2009, Finland sought derogation, as the country's gas network was not connected with any other Member

State and remained highly dependent on a single (>75%) supplier (Jankauskas 2015). Until 2019, the Finnish natural gas market was restricted to one operator (Gasum) in charge of the transmission and sale of gas on the domestic market, and a sole supplier (Gazprom).⁶⁵ Through a partial demerger⁶⁶ in 2020, GasGrid Finland legally unbundled from Gasum and has been operating the domestic gas system ever since (Zemite et al. 2021). However, the country still lacked sufficient alternative routes of supply and gas storage capacity.⁶⁷ In this respect, the launching of the bidirectional Balticconnector pipeline in 2020 was of crucial significance (Klemetti and Mäkinen 2021). This link, adjoining Finnish and Estonian markets, initiated the creation of a common gas market with the Baltic States and broke Finland's isolation

Table 5. Share of energy consumption by source in Finland

Source	1990	2009	2021
Nuclear	16,77%	18,64%	18,60%
Gas	7,81%	10,93%	6,35%
Oil	41,40%	32,99%	30,23%
Hydropower	9,95%	10,37%	12,77%
Wind	0,00%	0,23%	6,68%
Other renewables	5,10%	8,16%	13,49%
Coal	18,98%	18,27%	10,22%
Solar	<0,01%	<0,01%	0,25%

Table 6. Share of electricity production by source in Finland

Source	1990	2009	2021
Nuclear	35,34%	32,78%	32,75%
Gas	8,57%	13,68%	4,95%
Oil	8,88%	7,80%	5,93%
Hydropower	19,97%	17,68%	21,79%
Wind	0,00%	0,39%	11,37%
Other renewables	9,49%	12,16%	18,79%
Coal	17,76%	15,51%	4,04%
Solar	0,00%	0,00%	0,39%

Highest percentage	Second highest percentage	Third highest percentage	Fourth highest percentage
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by enabling access to the Inčukalns underground gas storage (UGS) in Latvia and the LNG terminal in Lithuania. The GIPL interconnector from 2022 between Poland and Lithuania further extended the diversification possibilities for Finland and the region at large.⁶⁸

The new political context in the aftermath of the Russian invasion of Ukraine also accelerated other gas diversification projects. Finland already had a small commercial LNG terminal, Gasum, opened in Pori in 2016 with a 28,500 m³ capacity LNG, and the Manga terminal in Tornio operational since 2019 with a yearly capacity 50,000 m³ (Klemetti and Mäkinen 2021: 292; Savickis et al. 2021: 53). Both terminals supply industrial consumers and are not connected to the grid (Savickis et al. 2021). Following the outbreak of the Russo-Ukrainian war in 2022, the previously delayed Hamina LNG terminal (with 30,000 m³ LNG storage capacity) is scheduled to start commercial operations in October 2022. The terminal is connected to the Finnish gas transmission system (Ibid.). In April 2022, Finland also announced plans to construct infrastructure for its first floating storage and regasification unit (FSRU) west of Helsinki in proximity to the Balticconnector. The FSRU is to be leased jointly with Estonia in a bid to make both countries more independent of Russian gas. The terminal is scheduled to open in the winter of 2022/3.⁶⁹

On 21 May 2022, Russia cut off the gas supply to Finland after the Finns refused to pay in roubles. The incident was manageable for the Finnish side for several reasons. First, gas amounts to a mere 6.35% of total domestic energy consumption and less than 5% of electricity generation in Finland (Tables 5, 6). The consumption of gas in Finland fell significantly in the last decade (from 41TWh in 2010 to 20 TWh in 2021) due to the increasing taxes on natural gas and less use of gas in electricity production. As opposed to many Central and Eastern European (CEE) states, household gas consumption is marginal in Finland, as gas is mostly used by industrial customers (nearly 60%) and for energy generation (nearly 40%) (Klemetti and Mäkinen 2021: 278). Moreover, after the record-high gas prices in winter 2021-2, many individual consumers in Finland replaced gas with electric heating or wood stoves, while most commercial consumers have kept alternative fuel sources that can be used immediately instead of gas in the case of supply disruptions. As of mid-2022, Finland was importing gas mostly through the Balticconnector, largely supplied by the LNG terminal in Klaipėda, Lithuania.

The gas cut-off episode was preceded by Russia also stopping the supply of electricity to Finland, with both events following Finland's announced application for NATO membership.⁷⁰ Yet Finland's security of electricity supply is not at risk,

as sufficient grid interlinks are established with Sweden, Estonia and Norway. Furthermore, while imports covered up to 20% of consumed electricity in Finland prior to the Russian cut-off, the country is expected to become self-sufficient in electricity generation by 2023-4 once the Olkiluoto 3 nuclear power plant is completed later this year and wind capacity is boosted to meet the remaining domestic demand.⁷¹ Wind power generation has grown steadily in Finland in recent years and exceeded 11% in 2021 (Table 6). With many onshore wind projects, the Finnish government also announced in 2021 its plans to build two large-scale offshore wind farms. The expansion of the existing Tahkoluoto wind farm (42 MW) with up to 45 turbines (11-20 MW each) could boost its capacity up to 900MW.

The expansion of nuclear and wind power is also in line with the Finish Parliament decision from 2019 to become carbon-neutral by 2035.⁷² The long-term energy policy envisions a phase-out of coal (by 2029), the commissioning of new nuclear power reactors, and the extension of the operating lifetimes of the existing ones. Currently, Finland has five operating nuclear reactors, while Olkiluoto 3 will start commercial operation in late 2022. The construction of the sixth nuclear reactor, Hanhikivi 1, scheduled for commercial operation by 2029, was cancelled following the Russian invasion of Ukraine. Russian co-ownership of the Fennovoima nuclear power company in charge of the project established jointly by Rosatom and a consortium of Finnish state-owned power and industrial companies was previously criticised by some parliamentarians, environmentalists and general public.⁷³ Nonetheless, the project received parliamentary approval. It was first in March 2021 that the Ministry of Defence called for a risk assessment, including the geopolitical risks associated with the role of the Russian state-owned company.⁷⁴ Furthermore, concerns over supply were risen as the country had planned to purchase uranium from Russia for ten years after the completion of Hanhikivi 1.

Following the outbreak of war in Ukraine, Finland decided not to grant a construction permit to the project, and Fennovoima announced in May 2022 the termination of the engineering, procurement and construction (EPC) contract with Rosatom's RAOS Project subsidiary. Additionally, Finland is also currently exploring the potential use of small modular reactors (SMRs) for district heating and electricity generation.⁷⁵

The outbreak of war in Ukraine radically changed Finland's relations with Russia, as perhaps best illustrated by the decision to join NATO. When it comes to energy, despite being an energy-intensive country, Finland's electricity needs are to be covered in the near future by domestic generation based on nuclear expansion and large-scale wind farm projects that are in line with the national climate neutrality

targets to be achieved by 2035. The war has also accelerated the implementation of a joint LNG terminal project with Estonia, which will cover the marginal domestic natural gas demand by the end of 2022. The increasing gas prices in the winter of 2021/2 had pushed Finns to shift towards wood stoves and electric heating for heating and are expected to further accelerate in the winter to come. With most electricity being generated in nuclear power plants, the security of supply of the nuclear fuels and radioactive waste disposal remain an issue.



An excavator digs into the rock in an open-air mine in Tallinn.
Photo: Raigo Pajula/AFP/Ritzau Scanpix.

ESTONIA: SHALE OIL INDEPENDENCE?

In 1991, the Estonian Soviet Socialist Republic declared independence and started paving the way towards EU and NATO memberships. The general anti-Russian political sentiment has also created friction in the energy sector. Estonia has been subjected to both verbal threats and energy supply disruptions. Russian Minister of Foreign Affairs (1992-4) Vitaly Churkin regarded the supply closures to Estonia in 1993 as a foreign policy instrument, and Director of Foreign Intelligence Service (1991-6) and Prime Minister (1998-9) Yevgeny Primakov threatened halting supply in 1995, 1996 and 1997 (Grigas 2013; Lehotský 2015). The politically driven manipulations of supply occurred in the winter of 1992/3 by limiting oil streams and when the gas supply was curbed in the summer of 1993 (Collins 2017; Grigas 2012). In 1992 and 1993, the former Soviet army was still present in Estonia, and tensions with Moscow were high. Even though natural gas is relatively insignificant in the Estonian energy mix (Table 7), it still played an important role in the relation to Russia. When the national gas company Gas Eesti was undergoing privatisation, 30% of the shares were sold to Gazprom, partly in the hope of cushioning the escalation of further conflicts, while the remaining 70% was held by the Estonian state. The company was further privatised throughout the 1990s, state shares being sold to Ruhrgas, Itera Latvija, Fortum Oil and Gas and other private investors (>2%) (Grigas 2012). Notably, around one quarter of the Estonian population self-identify as ethnic Russians,⁷⁶ and tensions with Moscow therefore intensified further over Estonian language requirements linked to the acquisition of citizenship (Ibid.).

Table 7. Share of energy consumption by source in Estonia

Source	1990	2009	2021
Nuclear	0.00%	0.00%	0.00%
Gas	11.14%	10.40%	7.37%
Oil	32.41%	27.23%	25.86%
Hydropower	0.00%	0.15%	0.12%
Wind	0.00%	0.93%	2.95%
Other renewables	0.00%	1.71%	10.25%
Coal	56.45%	59.55%	51.80%
Solar	0.00%	<0.01%	1.00%

Highest
percentage

Second highest
percentage

Third highest
percentage

Fourth highest
percentage

Although Gazprom's official reasoning addressed the interrupted supply as a reaction to unpaid debts, the cut-off directly coincided with the domestic policy changes (Lehotský 2015).

A significant share of Estonian energy is generated from shale oil, which is often combined with coal in primary energy statistics.⁷⁷ Table 7 illustrates how, in the period 1990-2021, coal and shale oil combined to account for over half of the overall energy consumption. The domestic production of shale oil enabled Estonia to remain relatively self-sufficient, and production increased steadily from the late 1990s until 2018. Notably, the overall domestic energy production levels approached 5.9 Mtoe, which translates to an increase of 39% over one decade: almost entirely from oil shale (72%) and bioenergy from waste (27%) (Brandt, Boak, and Burnham 2010). At the same time, the primary energy consumption levels in the years from 1990 to 2021 dropped by 48%, from 128 to 66 TWh per year.⁷⁸

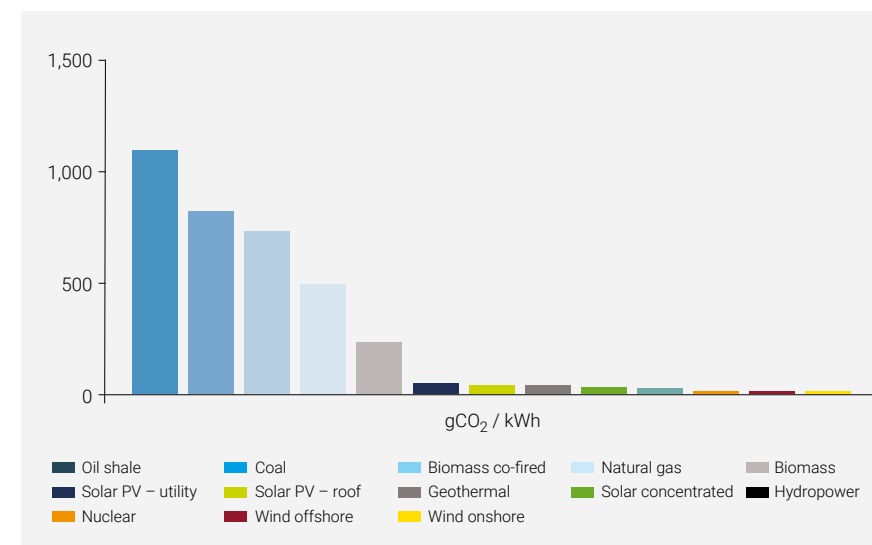
While shale oil serves as a guarantor of energy security, there are significant environmental concerns in relation to its extraction and burning. Mining necessitates an exorbitant use of water that is subsequently difficult to purify due to the chemicals used in the process, resulting in residual air pollution and large amounts of waste.

As for the use of oil shale, around 30% goes to electricity and 70% to heating. The electricity generation from this source discharges more CO₂ than any other primary fuel (Figure 2). The emission factor for shale oil stands at 1,110 g of CO₂ equivalent per kWh, while coal stands at 820, biomass co-firing at 740, natural gas at 490 and biomass at 230 gCO₂/ kWh.⁷⁹ This means that oil shale emits 26% more CO₂ than coal, making it the most polluting source of energy with substantial exhaust of fly ash.

The liberalisation of the electricity market in Estonia was particularly shaped by the two EU Energy Packages (2003 and 2009). While the electricity market deregulation gradually started in 1997, followed by the two packages, Estonia eventually opened the electricity market to all consumers by 2013⁸⁰ (Elere and Loorits 2013). With the interconnectors with Finland-Estlink I completed in 2006, Estlink II operational since 2014, and the third Estonian-Latvian connector completed in 2020, the electricity market is maturing.⁸¹

As most heating in Estonia is produced using oil shale, natural gas represents only 7.37% in the national energy mix (Table 7). Although the share is small, Estonia was until recently 100%-dependent on Russian gas imports, Gazprom being the sole

Figure 2. Emissions in electricity production by source



Sources: <https://www.world-nuclear.org/information-library/energy-and-the-environment/carbon-dioxide-emissions-from-electricity.aspx>
<https://www.iea.org/reports/energy-policies-of-iea-countries-estonia-2019-review>

supplier until 2015. While connected to the Russian and Latvian gas transmission systems, the Estonian gas market was insufficiently linked to other markets and therefore regarded as an 'energy island'. This enabled the country to seek derogation in the Third Energy Package (3EP) like neighbouring Latvia. From 2012, the Estonian energy policy approach leaned towards the full ownership unbundling (OU) model, which separates suppliers and operators in the network. The government passed an amendment to the Natural Gas Act,⁸² which obliged Eesti Gaas to detach the gas distribution utility by 2013 and unbundle the ownership by 2015. Until 2014, however, Estonia sought a derogation from the 3EP through the so-called independent transmission operator (ITO) model. The latter enables gas system ownership and operations to remain integrated but binds the energy companies in charge by a set of rules ensuring that activities are carried out independently.⁸³ This was the most favourable option to Gazprom, and some analysts reported that Estonia was offered discounted gas rates in return for the delay of unbundling procedures (Grigas et al. 2013). The 'energy island' status was lost when operations were initiated from the Lithuanian LNG terminal Independence (operational since 2014) supplying Estonia via Latvia.⁸⁴ The ownership unbundling was completed in March 2016, when the gas transmission system operations were transferred to Elering, a public entity.⁸⁵

Advancing the interconnectedness of the gas network has been a central element in the energy policy agenda for the past decade. Among the most important projects for the national gas market development are the enhancement of the Estonian-Latvian interconnector and the bidirectional Balticconnector,⁸⁶ interlinking the Finnish and Estonian markets.⁸⁷ Other means of opening the national gas market were being discussed as early as in 2007, when the Lithuanian National Energy Strategy indicated a potential feasibility study for a regional LNG terminal together with experts from Estonia, Latvia and Poland. In 2009, the first Baltic Energy Market Interconnection Plan (BEMIP) concluded that the regional scope does not call for more than one terminal and eventually proposed several potential sites for developing the infrastructure.⁸⁹ The negotiations were slow, however, and the LNG Independence became operational in Lithuania in the meantime. Two national LNG projects were proposed to be built by 2015 with an intended capacity of 2.5 bcm, but neither of them came to fruition (Pakalkaitė and Rosaner 2018). Although the general planning of the Paldiski LNG terminal started in 2010,⁹⁰ it was not before the war in Ukraine that the project truly gained momentum. In April 2022, Estonia joined forces with Finland to jointly rent the large-scale floating storage and regasification unit (FSRU). The two-stage construction of the Paldiski LNG terminal requires substantial on-ground preparation and an additional pipeline connection to the Balticconnector (to be completed by November 2022). Eventually, a more permanent FSRU solution is expected.⁹¹ As per the latest cooperation agreement between the two countries, the FSRU may be located on the Estonian side before the necessary infrastructure is completed in Finland. The FSRU Exemplar is leased for ten years and will enable a 5 bcm/y capacity.⁹² Another LNG terminal project, Tallinn LNG, has been under development since 2012, with the principal technical design confirmed in 2015 and full planning procedure completed in 2019. With the planned initial capacity of 0.5 bcm/y and eventual expansion to 4 bcm/y, the project development is currently stalled.⁹³

With a large share of the Estonian energy mix being covered by fossil fuels that are incompatible with the climate agenda and shall be increasingly phased out to meet CO₂-reduction targets, focus has also turned to renewable energy sources. When it comes to boosting the share of renewables in the national energy mix, the strongest potential lies in bioenergy-based combined heat and power generation, wind energy and biomethane, which can be used to replace natural gas. In support of the latter, a EUR 38.5mn national subsidy scheme has been developed to promote domestic biomethane production. In addition, small-scale hydro and solar energy projects are currently under development.⁹⁴ Solar and wind-energy production are expected to quadruple in the decade to come.⁹⁵ Furthermore, Estonia is planning to include

nuclear in its future energy mix. In 2021, a nuclear energy working group was established by the government, and Estonia and the US signed a strategic cooperation agreement in 2022 to develop nuclear capacity using small modular reactor (SMR) technology.⁹⁶ The project is being developed by a private company, Fermi Energia, claiming that state support is not necessary, although construction of just one reactor amounts to approximately EUR one billion, and the intent is to build four. One such reactor produces 300 MW, which would cover 20-25% of Estonia's electricity needs. Importantly, developing nuclear capacity in Estonia also sets foundations for blue hydrogen production.⁹⁷ The first reactor is expected to become operational in 2032.⁹⁸

The war in Ukraine and the subsequent energy crisis have proven the interconnection plans adjoining Estonian gas and electricity networks extremely timely. With new infrastructure projects (eg the joint LNG terminal with Finland, a national terminal in Tallin), SMRs and mass deployment of solar and wind infrastructure, the Estonian market is shifting towards a green(er) future. As of today, however, shale oil remains the primary source of energy, which places Estonia as the OECD's most carbon-intensive economy.⁹⁹ Although the government has declared plans to phase out oil shale electricity by 2035 and production of shale oil by 2040,¹⁰⁰ drastic changes in the energy sector are needed to reach climate-neutrality targets.



A huge reservoir of water and river Daugava.
Photo: Ingus Kruklitis, Shutterstock.

LATVIA: DISENTANGLING AND UNBUNDLING

Following the collapse of the USSR, Latvia gained full independence in 1991,¹⁰¹ but nevertheless remained dependent on primary energy imports from supply monopolies and locked in old infrastructure, such as the electric power system (BRELL) operated in a synchronous mode with Russia and Belarus.¹⁰² Reducing energy dependence (and, hence, boosting energy security) has been on the political agenda for decades. However, the actual energy policies have been inconsistent (Sprūds 2010). Even though the country experienced several energy blackmail episodes (eg petroleum product delivery disruptions, crude oil supply interruptions via the Russian Druzhba ('Friendship') pipeline since 2006), the measures remained largely reactive.

From the 1990s to mid-2000s, Latvian efforts focused on accession to the EU and NATO. Policy then shifted to increasing energy efficiency measures, which enabled the reduction in net import energy dependence from 90% in 1991 (Sprūds 2010) to 47% in 2016.¹⁰³ While the shares of energy sources consumed in the 1990-2021 period do not display large pattern changes – with oil occupying the primary role and gas a close second (Table 8) – the actual energy consumption dropped from 7414 ktoe in 1991 to 4277 ktoe in 2020, which is a 41% reduction.¹⁰⁴

Although Latvia is short on domestic energy and entirely dependent on imports of sources such as oil and natural gas, one source of energy – hydropower – stands out in the Latvian energy mix (Tables 8, 9). Electricity generation is dominated by large-scale, Soviet-era (operational since 1979) hydropower plants (HPPs) built alongside Daugava, the largest river in Latvia (Kasiulis et al. 2020). Instead of producing negative lock-in effects, the HPPs, classified as one of the greenest energy generation technologies, produce low-cost electricity and align with the climate neutrality agenda. However, reaching Fit-for-55 commitments requires further investments in renewable energy technology. Since no major future hydropower technology investments are envisioned, its overall share in the energy mix will fall as solar, wind and other RES projects are implemented (Tables 8, 9).

A significant share of Latvia's combined electricity and heat capacity has been generated using natural gas. As seen in Tables 8 and 9, this trend has changed little since 1990. Two combined heat and power plants (CHPPs) built in 1955 and 1973 constitute the biggest source of natural gas consumption and represent the second-biggest source of power generation after hydroelectric powerplants.¹⁰⁵ Most Latvian electricity and thermal energy is generated by the three HPPs and two CHPPs, which

account for 58.4% of natural gas and 41.2% of the hydro share in the electricity output.¹⁰⁶ The thermal energy is generated by the two CHPPs (combined capacity of 1710 MW), which are solely operating on natural gas, while a smaller Liepaja plant runs on a combination of woodchips and natural gas.¹⁰⁷ Noting that hydropower generation depends on hydrological conditions affecting water flows (eg spring floods, summer droughts), gas serves as a backup source in case of insufficient hydrological conditions. Over one third of Latvia's domestic electricity production remains to be generated using natural gas (Āboltiņš 2022). With ambitions to boost energy independence and extend the share of green energy, the largest solar

Table 8. Share of energy consumption by source in Latvia

Source	1990	2009	2021
Nuclear	0.00%	0.00%	0.00%
Gas	29.71%	32.98%	27.45%
Oil	45.39%	41.95%	45.86%
Hydropower	15.38%	22.03%	16.81%
Wind	0.00%	0.31%	0.87%
Other renewables	0.00%	0.35%	6.21%
Coal	9.53%	2.27%	0.88%
Solar	0.00%	0.00%	0.03%

Table 9. Share of electricity production by source in Latvia

Source	1990	2009	2021
Nuclear	0.00%	0.00%	0.00%
Gas	26.02%	36.09%	39.30%
Oil	6.32%	6.32%	6.32%
Hydropower	67.63%	62.08%	46.54%
Wind	0.00%	0.86%	2.40%
Other renewables	0.00%	0.86%	14.09%
Coal	0.00%	0.00%	0.00%
Solar	0.00%	0.00%	0.08%

	Highest percentage	Second highest percentage	Third highest percentage	Fourth highest percentage

park in the country is currently being developed in the Ventspils area. Expected to generate 110,000 MWh, the solar park will cover the annual electricity demand for approximately 52,000 households by 2024.¹⁰⁸

Although gas remains an important component in the Latvian energy mix, the country depended until recently on a sole provider: Gazprom. The national gas market situation changed as a consequence of several critical infrastructure projects in the region: the LNG terminal in Lithuania (2014), the Balticconnector pipeline (2020) adjoining Finland and Estonia, and most recently the GIPL pipeline (2022) linking the Lithuanian-Polish gas networks. To better utilise the gas networks, the existing connections are developed further (eg the ELLI gas link between Latvia and Lithuania is under enhancement and will double its bidirectional transmission capacity by 2023).¹⁰⁹ Enhancement of the Latvia-Estonia gas interconnector had also landed on the EU Projects of Common Interest (PCI) list.¹¹⁰ However, Gazprom remains a major shareholder (34%) of the largest national gas trader, Latvijas Gāze, alongside Itera Latvija (with a 16% share package),¹¹¹ which belongs to Areti International and is controlled by the head of Rosneft (Volgina 2015).

Due to close ties with the Russian Federation, the Third Energy Package (3EP) was implemented in Latvia under a derogation for emergent gas markets.¹¹² This meant that the energy companies could retain ownership of the transmission networks while the transmission subsidiaries were turned into legally independent stock companies. Incidentally, this was also the most favourable scenario for Gazprom (Jirušek et al. 2015). The European Commission withdrew Latvia's derogation from the 3EP Gas Directive when the LNG terminal in Lithuania became operational in 2014, which broke the Baltic States' 'energy island' status. Responding to the development of the Lithuanian LNG terminal, the Latvian Parliament approved amendments to its Energy Law and further postponed the liberalisation of the gas market, taking advantage of the exemption option that stretched the unbundling procedures into 2017 (Grigas et al. 2013; Pakalkaitė 2016). Until 2017, Latvijas Gāze had exclusive rights to the Inčukalns UGS. In 2017, Conexus Baltic Grid came under partial ownership of the Latvian state and split from Latvijas Gāze, while the distribution was assigned to a subsidiary: Gaso.¹¹³ In accordance with the 3EP, Conexus Baltic Grid was handed over the gas infrastructure, including transmission systems and the UGS.¹¹⁴ At the same time, the TSO was fully unbundled¹¹⁵ (Grigas et al. 2013). The liberalisation of the Latvian electricity market enabled a functioning market grounded in principles of competition (Bride and Zvaigzne 2016).

Latvia plays an important role in the solidifying regional natural gas market, as it houses a large-scale UGS with 4.47 bcm storage capacity.¹¹⁶ The Inčukalns UGS has gained an increasingly important role in the face of the Russo-Ukrainian war, as adhering to the recently amended EU Regulation (EU) 2017/1938¹¹⁷ and (EC) No 715/2009¹¹⁸ with an introduction of a minimum capacity requirement of 80% for winter of 2022/3 and 90% for the following winter. This ensures the energy security of the neighbouring countries through solidarity agreements.¹¹⁹ Formerly, the UGS was also used to supply north-western Russia during the winter months (Jirušek et al. 2015: 510).

Talks about alternative gas supply routes have been circulating for over a decade, as Latvia could not challenge the prices set above the market value due to the monopolised gas market. In this light, together with its fellow Baltic States, Latvia has called for tighter energy security measures and a regional solution. The call was answered by DG Energy, which identified several sites in the three Baltic States in 2012 for the potential LNG terminal locations (Āboltiņš 2022). By that time, however, the Lithuanian LNG terminal project was already in progress, rendering the regional plans obsolete. Throughout the past decade, the plans for two LNG terminals surfaced in the debate in Latvia: the Kundzinsala Southern Project (Savickis et al. 2021: 49) and the Skulte LNG Terminal Project.¹²⁰ While the former seemed to die out, the latter has been under development since 2016 but is still not complete. Following the outbreak of the Russo-Ukrainian War and the subsequent energy crisis, the Latvian Cabinet of Ministers announced the necessity of the construction of the LNG terminal.¹²¹ The two proposals mentioned above are currently undergoing evaluation.¹²² This includes the assessment of national security, economic, technical, legal and safety compliance. In May 2022, Latvian energy company Virši signed a 20% investment agreement with the Skulte LNG terminal, which is envisioned to speed up the implementation of the project.¹²³ The Minister of Economics noted that while the ongoing evaluation is to determine the feasibility of the terminal project, the developers are encouraged not to delay the implementation if possible.¹²⁴ Considering that the implementation of the projects already has a long history, proceeding without official backing and financing is unlikely. In April 2022, the government mandated the Latvian Ministry of Economy to carry out negotiations regarding the use of the Estonian Paldiski LNG terminal¹²⁵ currently under-construction until the national terminal is built.

While the war in Ukraine has steered the laggard development of the LNG projects, Latvian energy mix composition has undergone few changes since the 1990s. With oil and gas covering most of the domestic energy consumption, climate neutrality targets necessitate the large-scale deployment of low-carbon and renewable energy technologies. Alongside the existing hydro energy generation infrastructure, the development of the new solar farm is a step in the right direction, although attaining climate neutrality by 2050 will call for fundamental changes in the energy sector, including fewer inter-sector ties with Russia.



LNG import terminal FSRU Independence and LNG Tanker ARCTIC PRINCESS in port.
Photo: Vytautas Kielaitis, Shutterstock.

LITHUANIA: SMALL COUNTRY THINKING BIG

Lithuania was the first country to break away from the Soviet Union in 1990. The move from a centrally planned to a market economy proved lonesome and difficult, as the legislative base had to be built from scratch. The 1990s were marked by the development of policy frameworks and ambitions to gain EU and NATO membership. The objective of tackling energy security issues has stretched over the past three decades. Despite political independence, energy infrastructure was inherently Soviet, resulting in dependencies across energy sectors: through gas and oil pipelines with west-bound flows from Russia, Russian fuel-driven RBMK nuclear reactors, and an electricity grid operating synchronously with Russian and Belarussian systems (the BRELL ring).

The Kremlin had been using energy to send political messages even before the dissolution of the USSR. The first disruptions in Lithuania occurred in April-June 1990, when the oil supply was shut off and gas flows critically restricted. Hereafter, to varying scale and scope, Lithuania experienced politically and economically motivated energy disruptions correlating with political developments in 1992-93, 1998-99, 2006 and 2010-14. Unsurprisingly, energy independence quickly became a central mission for Lithuania. Ever since 1990, the energy policy has maintained consistent emphasis on energy security, and it is now positioned alongside the climate neutrality goals in line with the Fit-for-55 package and 'the European Green Deal'.¹²⁶ Thus far, the mission to achieve energy security has been carried out with the opening of an oil terminal in 1998, an LNG terminal in 2014, enhancement of the Latvia-Lithuania interconnection ELLI (which will double bidirectional flow capacities by 2023), construction of the GIPL interconnector with Poland (2022), an increasing share of renewable energy sources (RES), and synchronisation with the continental grid (to be finalised by 2025). In that sense, the energy independence objective is gradually being met, balancing on two components: diversification and interconnectedness. In the face of the Russian aggressions in Ukraine in 2022, Lithuania was able to pioneer the decision to completely cut off energy ties with Russia in April the same year as a direct consequence of decades-long strategic energy sector development and political determination.

In a country short on domestic energy resources, two sectors were of particular concern: oil and natural gas, Russia being the primary supplier of both. Consequently, diversification of supply routes was prioritised, and efforts focused on finding an alternative oil supply. Already in 1998, the Būtingė oil terminal was erected together with the necessary infrastructure adjoining the terminal with the only oil refinery in

the Baltic States, with a 91.6 km crude pipeline and six oil tanks with a total capacity of 306,000 m³.¹²⁷ Until July 2006, crude oil was delivered to Lithuania in two ways: through the Russian Druzhba ('Friendship') pipeline and the Būtingė terminal. After the refinery was sold to a Polish company over a Russian bidder, however, the Druzhba pipeline was abruptly shut off under the pretence of emergency repair and has never been reopened.¹²⁸ The oil refinery has since been supplied through the Būtingė terminal with a capacity of 14 Mt of crude oil per year, enough to exploit the refining volumes and export the surplus.¹²⁹ Secondly, a natural gas market had to be created. Tied to a sole pipeline delivery system from Russia, Lithuania was exposed to energy insecurity. Plans to build an LNG terminal already started circulating in the parliament in 2006. However, it was first in 2011 that the project made it to the government agenda, largely as a reaction to exceedingly high gas prices. It is worth noting that different plans for the LNG terminal envisioned divergent private/state-owned, small-/large-scale, and national/regional variations. Neither of the options, however, projected a frictionless way out of Gazprom's regional monopoly. Especially because the Russian company was a shareholder in the national gas company in Lithuania, much like in the fellow Baltic States,¹³⁰ and it exerted monopolistic tendencies with its representatives on both the Lithuanian and Russian sides (Grigas 2013). Under immense pressure, Lithuania seized the opportunity to break free by adopting the most stringent form of the EU's Third Energy Package¹³¹ (full ownership unbundling), which laid the foundations for the creation of a national gas market. Battling against the ever-rising gas prices and pressured by time, Lithuania proceeded with an LNG terminal as a project of national importance instead of waiting for EU approval of a regional LNG terminal project. The diversification of natural gas supply was introduced in 2014. Even before the FSRU, symbolically named Independence, docked at the terminal in the coastal town of Klaipėda, debates over its economic viability arose. However, the critical importance of the infrastructure was justified on security rather than economic grounds. Today, the sceptics have mostly gone silent.

Concerns over gas supply security had also pushed towards stronger energy efficiency measures and a move to alternative energy sources. For instance, a mass block-house renovation programme to boost energy efficiency was launched in 2004 (Berling and Bratz 2021), and co-generation, district and residential heating increasingly moved from natural gas to biomass.¹³² This partially tackled insecurity of gas supply through energy-saving measures and the implementation of low-carbon-emission technologies. This trend has been further accelerated in recent years. In fact, the primary energy consumption has decreased from 202 TWh per year in 1990 to 70 TWh per year in 2021, equating to a 65% reduction.¹³³

Unlike the gas sector, the liberalisation of the wholesale electricity market went smoother. In 2002, the national legal framework was established, and the market principles entered into force in 2010 (Švedas 2014). While the efforts were focused on learning the corporate mindset and commercialisation in the period 1997-2010, from 2010 onwards the focus shifted to boosting competitiveness and ensuring fair competition following the objectives of the Third Energy Package (Streimikiene and Siksnyte 2013). In 2015, the new NordBalt¹³⁴ link between Lithuania and Sweden further facilitated the process by establishing a common Baltic-Nordic electricity market. In addition, the LitPol¹³⁵ that linked the Lithuanian and Polish grids the same year furthered access to Western Europe. The retail market liberalisation was laggard, initially expected to be achieved by 2023.¹³⁶ Following the war in Ukraine, however, the proposal to postpone the move from fixed to variable costs resurfaced in the debate and was approved in August 2022 to maintain affordable price levels.¹³⁷

Table 10. Share of electricity production by source in Lithuania

Source	1990	2009	2021
Nuclear	60.05%	75.50%	0.00%
Gas	23.87%	14.61%	32.83%
Oil	14.63%	5.15%	6.31%
Hydropower	1.45%	2.92%	9.34%
Wind	0.00%	1.11%	32.58%
Other renewables	0.00%	0.70%	14.65%
Coal	0.00%	0.00%	0.00%
Solar	0.00%	0.00%	4.29%

	Highest percentage	Second highest percentage	Third highest percentage	Fourth highest percentage

Change in the sources used for electricity generation (Table 10) tell a compelling story about the general shifts in the Lithuanian energy sector. In the period from 1990 to 2009, nuclear power occupied a central role. However, one of the conditions of EU membership was the decommissioning of two Chernobyl-type reactors in Ignalina in 2004 and 2009, respectively.¹³⁸ The closure of the second reactor in 2009 reduced domestic electricity generation from 13,000 to 4,243 GWh in 2010.¹³⁹ This led to a dramatic increase in electricity prices and a search for alternative means of generating power. With the closure of the Ignalina NPP, Lithuania moved from being

a net exporter to a net importer of electricity.¹⁴⁰ In 2021, imported electricity accounted for over 70% of Lithuania's electricity needs. Unsurprisingly, plans to build a new NPP were on the agenda, but they never materialised.

In the decade following the closure of the NPP, the share of RES in the domestic production of electricity increased significantly, reaching 60.86%¹⁴¹ in 2021. This was also apparent in the national energy mix, where wind energy accounted for over 5% of the overall energy consumption in 2021 and a 32.58% share in the domestic electricity production (Tables 10, 11). In June 2020, the Lithuanian government approved a territory for an offshore wind farm of up to 700 MW. The first tender is scheduled for 2023. The offshore park alone will cover over 25% of the national electricity demand.¹⁴² Nonetheless, as evident from the shares of energy consumption (Table 11), oil and gas have steadily become the predominant sources in the Lithuanian energy mix.

Table 11. Share of energy consumption by source in Lithuania

Source	1990	2009	2021
Nuclear	23.91%	32.59%	0.00%
Gas	26.95%	28.44%	31.75%
Oil	43.91%	33.95%	53.70%
Hydropower	0.61%	1.33%	1.44%
Wind	0.00%	0.49%	5.08%
Other renewables	0.00%	0.36%	2.52%
Coal	4.59%	2.19%	3.02%
Solar	0.00%	0.00%	0.46%

Highest percentage	Second highest percentage	Third highest percentage	Fourth highest percentage
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There are plans to develop a national hydrogen strategy and to accelerate pilot projects and hydrogen valleys in the Lithuanian government.¹⁴³ Furthermore, network resilience has been strengthened with a 200MW battery system that enables the grid to operate in an isolated mode (ie independently) before the synchronisation with the continental grid is completed.¹⁴⁴ The self-sufficiency that RES offers is even more appealing today, and the war in Ukraine has accelerated the RES projects and simplified administrative procedures, as noted in the newest Breakthrough Package¹⁴⁵ for renewable energy technology implementation. In

addition, even more emphasis has been placed on self-sufficiency; from 2023, all new commercial buildings are required to ensure the self-generation of energy, and the same requirements are currently being considered for residential buildings from 2024 onwards.¹⁴⁶

The war in Ukraine and the energy crisis have showcased how the investments in national energy security are of crucial importance. With oil and LNG terminals, Lithuania can access the two fossils fuels that occupy a significant role in its energy mix. Furthermore, the interconnections of gas networks and electricity grids ensure the stability of supply. These infrastructures allowed Lithuania to become the first country to sever all energy ties with Russia following the outbreak of war in Ukraine. Whereas prior to 2022, administrative procedures were preventing the energy projects from gaining speed, the energy crisis has triggered a number of policy responses aimed at both improving energy efficiency measures and upscaling renewable energy technologies implementation, both of which are in line with the green agenda. With multiple renewable energy projects in the pipeline, Lithuania is heading towards its climate neutrality targets. However, high shares of oil and natural gas in the national energy mix call for mass substitution, which is going to be both costly and time-intensive.



LNG terminal in Swinoujscie.
Photo: Mike Mareen, Shutterstock.

POLAND: THE CARBON PAST AND NUCLEAR DREAMS

The Polish energy mix can generally be characterised by two opposing trends: a gradual growth in the use of oil, natural gas, wind, solar, hydropower and other RES, and a gradual decline in the use of coal. In a historical perspective, the consumption of coal in the national energy mix fell from 89.14% in 1965 to 42.28% in 2021; the actual energy output declined from 692 TWh to 523 TWh, indicating a 24% drop in the 60-year period.¹⁴⁷ In contrast, natural gas has undergone an upwards trend, rocketing from 17 TWh in 1965 to 232 TWh in 2021. Due to the phasing out of coal, gas is playing an increasingly important role in bridging the Polish transition to decarbonisation by 2050.¹⁴⁸

The collapse of the Soviet Union necessitated the renegotiation of contracts on gas imports from Russia by Poland in the early 1990s. Both sides signed the agreement on building the Yamal-Europe pipeline in 1993 and on gas deliveries to Poland in 1996 (Fischer 2008). The agreement on deliveries was criticised domestically, as the Polish side contracted for higher gas volumes than expected consumption levels for the next 25 years and agreed to an unfavourable 'take or pay rule', which prohibited the re-export of surplus gas (Fischer 2008). In fact, the 1996 contract was breached in April 2022 with Gazprom's unilateral decision to initiate a gas cut-off.¹⁴⁹ The conditioned contract led to the politicisation and diversification of the Polish energy supply, with the subsequent Polish governments considering various gas diversification routes (eg from Denmark, Norway, Germany, Central Asia and Ukraine or the construction of an LNG terminal) (Fischer 2008). These plans lacked consistency, and it was first following the election of President Lech Kaczyński in December 2005 and the Ukrainian gas crisis in January 2006 that energy policy became a matter of urgent national security in Poland. Kaczyński made energy security one of the top priorities of his presidency, and the plans for the construction of the LNG terminal and a gas pipeline from Norway started to crystallise.¹⁵⁰ Both projects had strong political and security dimensions from the start.¹⁵¹ Poland also rejected the construction of the Yamal 2 gas pipeline offered by Russia in 2007.

The construction of the first LNG terminal in Świnoujście, named after deceased President Lech Kaczyński, started in 2011, and the terminal became operational in 2016.¹⁵² In April 2022, the first stage of expansion was completed, boosting the terminal's capacity to 6.3 bcm/y. The capacity is scheduled to be further expanded by the end of 2023, which will further increase the regasification capacity to 8.3 bcm/y.¹⁵³ Furthermore, the plans for a new 6.1 bcm/y floating LNG terminal in Gdansk are in progress, which is expected to be operational by 2028.¹⁵⁴

When it comes to pipeline infrastructure, the strategic Baltic Pipe Project will deliver up to 10 bcm of Norwegian gas per year from the North Sea via Denmark to Poland and is expected to become operational in autumn 2022, reaching full capacity in early 2023.¹⁵⁵ The bidirectional corridor is also suitable to transfer gas from Poland to the Danish market, further adding to the flexibility and security of energy supply in the region. The timing of these initiatives is key, as the expiration of Poland's long-term contract with Gazprom in December 2022 was the primary push to stick to the deadlines. It is also one of the reasons why cutting the gas supply to Poland by Russia in April 2022 did not raise energy security concerns for Poland, which had domestic storage facilities filled up to 80% capacity and diversified gas supply routes in place to meet its future domestic demand.

Table 12. Share of electricity production by source in Poland

Source	1990	2009	2021
Nuclear	0,00%	0,00%	0,00%
Gas	0,10%	3,17%	9,69%
Oil	1,83%	2,80%	2,84%
Hydropower	1,07%	1,57%	1,32%
Wind	0,00%	0,71%	8,97%
Other renewables	0,04%	3,46%	4,63%
Coal	96,97%	88,28%	70,34%
Solar	0,00%	0,00%	2,21%

Table 13. Share of energy consumption by source in Poland

Source	1990	2009	2021
Nuclear	0,00%	0,00%	0,00%
Gas	8,59%	13,80%	18,84%
Oil	15,68%	28,00%	31,02%
Hydropower	0,35%	0,61%	0,50%
Wind	0,00%	0,28%	3,44%
Other renewables	0,01%	1,53%	1,97%
Coal	75,37%	55,13%	42,38%
Solar	0,00%	0,00%	0,84%

Highest percentage

Second highest percentage

Third highest percentage

Fourth highest percentage

Polish gas infrastructure is also increasingly linked to the regional energy market through multiple cross-border interconnectors. The GIPL interconnector linking Poland and Lithuania started commercial operations in May 2022. Importantly, it adjoins the LNG terminals in Klaipėda and Świnoujście while also adjusting the gas transits to the shifting demand-supply dynamic in the region due to bidirectional flows.¹⁵⁶ The Polish system is also integrated further with the Central and Eastern Europe (CEE) gas infrastructure through an interconnector with Slovakia¹⁵⁷ (2022), and plans for a Czech-Polish interconnector¹⁵⁸ are on the table. While the latter has been repeatedly postponed from 2021 to 2023 and then again to 2027, considering the current geopolitical context, this timetable is likely to be accelerated. Despite infrastructural developments, the Polish natural gas market remains highly concentrated, with the state-owned company PGNiG in a lead position with exclusive rights to using the LNG terminal, full coverage contract for regasification capacity, as well as the control over a long-term 'take or pay' contract with Gazprom (to expire in December 2022). Furthermore, the domestic production of natural gas of approximately 4 bcm/y is also controlled by PGNiG subsidiaries.¹⁵⁹ The distribution system operator (DSO) PSG is 100% PGNiG-owned and is the largest retail natural gas supplier, although legally unbundled from distribution activities.¹⁶⁰ The liberalisation of the gas market had been postponed previously, in 2010, following the Third Gas Directive (3EP) and remains incomplete to this day.¹⁶¹ The slow implementation of the 3EP provisions dragged Poland to the EU Court of Justice in 2012 for failing to transpose the Directive 2009/73/EC into the Polish natural gas market (Gawlikowska-Fyk 2013). In particular, the price regulation; the retail price regulation clause has been prolonged to 2027 from the initial plan to end tariff protection in 2023 over price volatility concerns.¹⁶²

Following the Russian invasion of Ukraine in February 2022, the largest state-owned Polish refiner, Orlen, also stopped buying Russian oil on the spot market and started importing from alternative routes. Prior to the outbreak of the COVID-19 pandemic in 2019, Russia supplied Poland with about 365,000 barrels of oil per day, accounting for 70% of the country's total crude imports.¹⁶³

The new geopolitical situation coupled with the need for accelerated energy transition also has repercussions for the country's coal sector. Coal is especially important to Poland, as over two-thirds of electricity is still generated from coal (Table 12). Although the share of coal in the general energy consumption has been declining over the last three decades, the domestic electricity consumption has increased from 133.31 TWh in 1990 to 180.00 TWh in 2021.¹⁶⁴ Nevertheless, the share of coal has been increasingly replaced by gas, wind and other RES sources (Table 12).

Despite the EU climate agenda and the overall decarbonisation policy, the Polish government signed a 'societal agreement' in April 2021 with the representatives of the coalminer unions, which extended the timeline for phasing out coal to 2049 and envisaged investments in clean coal technologies. In recent years, Poland has also been a foot-dragger on EU climate action. Together with the other Visegrad states (Czechia, Slovakia and Hungary), Poland has undermined the ambitious EU climate agenda on several occasions by protesting significant GHG emissions cuts or blocking the EU 2050 carbon-neutral target.¹⁶⁵ Since the outbreak of the Russo-Ukrainian War and the increase in prices and the demand for coal, Poland has been considering increasing coal mining and extending coal mine lifetimes. Quick investments in the coal sector are currently difficult, however, due to EU decarbonisation policy.¹⁶⁶ Regardless of the short-term policy fluctuations, coal will remain a decisive element in the Polish energy mix for the foreseeable future.

The domestic electricity production has approached record highs of 179.4 TWh in 2021, which was 99.5% of the total demand of 180.3 TWh.¹⁶⁷ Poland is also well connected with high-voltage links to Czech Republic, Germany, Slovakia, Ukraine, Sweden and Lithuania.¹⁶⁸ The interconnectors ensure an overall transmission capacity of 11.8GW, which is expected to be further increased to 12.5GW by 2025. Although the pace of modernisation and decarbonisation is insufficient, several large-scale projects, including nuclear reactors and windfarms, are expected to mediate the energy balance. The need to phase out coal to meet the EU climate protection goals has also served as a key driver behind the development of the domestic nuclear energy programme. Poland has planned the construction of six 1.0-1.5 GW units, with the first nuclear power plant to be in operation by 2033 and each successive unit to follow every two years (PEP 2040¹⁶⁹). The six reactors built by 2043 could cover around 20% of the domestic demand for electricity. Several energy-intensive industrial companies in Poland, including Unimot and Synthos Green Energy, have also been exploring the possibility to invest in SMRs to replace the coal-fired power plants since 2021.¹⁷⁰ The war strengthened the determination to proceed with the NPP programme despite the delays, while the gathering of Russian forces at the Ukrainian border in early February 2022 coincided with the signing of the agreement with the US company NuScale Power and Polish copper and silver producer KGHM Polska Miedź SA to deploy the first SMRs in Poland as early as 2029 in a bid to further increase energy security.¹⁷¹

Poland is also increasingly developing RES, most notably wind power. In 2021, almost 9% of Polish electricity was wind-generated (Table 12). There are currently over 50 onshore wind farms in the country, and this number will increase, especially

after the government amended the previous unfavourable regulations in July 2022 that had stalled the development of land-based wind energy for several years.¹⁷² Although Poland does not yet have offshore wind, Polish energy companies, together with foreign investors, are planning several offshore wind projects on the Baltic Sea starting in the next few years (2022-9).¹⁷³ According to the Polish energy strategy looking ahead to 2040, the country plans to reach 5.9 GW from offshore by 2030 and up to 11 GW by 2040.¹⁷⁴ Given the new geopolitical context, these project timelines will likely accelerate further.

The outbreak of the Russo-Ukrainian War has highlighted the importance of the diversification strategy that Poland has employed for decades, resulting in LNG infrastructure, multiple bidirectional gas interconnectors as well as the electricity grid interconnections. With natural gas treated as a transition fuel, this pipeline nexus is of crucial importance to enabling the move towards a more carbon-neutral economy. The planned multiple projects in renewable energy and the development of nuclear energy are also in line with the climate agenda. However, the long timeframe of the NPP project's completion (2033-45) raises questions regarding the extent to which it will aid the low-carbon energy transition in the medium term. The soaring prices of fossil fuels have also triggered a backlash regarding the phase-out of coal. With the deadline extended to 2049, attaining Fit-for-55 objectives and reaching climate neutrality goals by 2050 became highly questionable.



Inspection at steel long pipes and pipe elbow in station oil factory.
Photo: noomcpk, Shutterstock.

GERMANY: CAUGHT IN GAS PIPELINES

Over the past three decades, the German energy mix has undergone two transitions: firstly, coal has been increasingly replaced by gas; particularly in electricity generation, where its usage fell from 311.70 TWh in 1990 to 162.60 TWh in 2021.¹⁷⁵ And, secondly, nuclear energy has gradually been replaced by renewables following the initial plan to phase out nuclear electricity production by the end of 2022.¹⁷⁶ However, the outbreak of war in Ukraine has altered the course of decarbonisation in the short term, posing challenges for the current nuclear phase-out timeline.¹⁷⁷

In the 1990s and 2000s, the issue of security of supply in Germany was mostly left to private sector energy companies.¹⁷⁸ Before 2005, the domestic debate on energy security revolved around the nuclear phase-out, climate change and price stability (Surwillo 2019). While the Ukrainian gas crisis of 2006 raised energy security questions for the first time in Germany, the German-Russian energy cooperation continued. Even the Ukrainian-Russian conflict in 2014 and the Russian annexation of Crimea and the eastern Ukrainian territories did not change that. In fact, the Russian-Ukrainian gas dispute from January 2006 served to justify the construction of the Nord Stream 1 (NS1) gas pipeline further,¹⁷⁹ as it was seen as bypassing the potentially unstable transit states and hence minimising the possibilities of supply disruptions (Ibid.). In the German context, NS1 was considered a Russian-European project (Surwillo 2019), and the prevailing rationale was one of 'mutual dependence', which viewed the increase of interdependencies between Europe and Russia as a way of democratising the latter and contributing to the overall security on the continent. Despite the criticism directed at Germany for not consulting with its eastern neighbours and undermining the European solidarity clause,¹⁸⁰ the project continued, and the 55 bcm/y pipeline was commissioned in November 2011.¹⁸¹ Similarly, the construction of the Nord Stream 2 (NS2) pipeline already in the aftermath of the 2014 conflict in Ukraine was justified on the grounds of European energy security and economic prosperity.¹⁸² At the time, alternatives like LNG imports were dismissed as too costly, and energy businesses pointed to the EUR 4bn stake already invested in the project.¹⁸³ The pipeline construction was completed in 2021, but its certification was suspended following Russian 'recognition' of the break-away regions of Luhansk and Donetsk just days prior to the invasion of Ukraine on 24 February 2022. Since the outbreak of war, Germany had to radically reconsider its (energy) cooperation with Moscow; not only was the NS2 project put on hold, but the German government announced its intention to build two LNG terminals, previously disregarded in 2020 due to a 'lack of market response'.¹⁸⁴ Further, plans for the creation of strategic coal and gas reserves have emerged.¹⁸⁵

The share of coal in electricity generation has waned over the past 30 years (-30%), increasingly replaced by natural gas (+10%).¹⁸⁶ However, with only a fraction of natural gas being covered by domestic production, Germany is highly dependent on imports. Although the German gas market was fully unbundled following the Third Energy Package (3EP), Gazprom continued to supply Germany under a revised long-term contract together with participation in a spot-market (Westphal 2014).

Table 14. Share of energy consumption by source in Germany

Source	1990	2009	2021 (2020)
Nuclear	10,32%	9,79%	4,93% (4,73%)
Gas	15,19%	22,87%	25,78%
Oil	36,67%	36,29%	33,10%
Hydropower	1,22%	1,44%	1,42%
Wind	<0,01%	2,98%	8,77% (10,11%)
Other renewables	0,11%	2,67%	4,62%
Coal	36,49%	22,60%	16,74% (14,62%)
Solar	<0,01%	0,51%	3,65%

All gas imports currently come through pipelines. Germany is one of the largest importers of natural gas in the world, with 95% of domestic gas demand being satisfied by imports. Natural gas amounted to over 25% of Germany's domestic energy consumption in 2021, making it the second most important energy source after oil (see Table 14). According to a 2022 statement issued by the German Ministry of Economy and Climate, 55% of the country's gas imports came from Russia, 30% from Norway and 13% from the Netherlands.¹⁸⁷

Similarly, nearly all of Germany's primary oil consumption must be covered by imports,¹⁸⁸ and in 2021 alone over one third of all crude oil (corresponding to 80 Mt) came from Russia.¹⁸⁹ While oil remains Germany's primary energy source (Table 14), it is largely used as fuel for transport, and electricity is generated mostly from coal, wind and gas, respectively (Table 15). While oil is a more palpable resource, easily transportable by rail, road and sea, the diversification of gas constitutes a major challenge for two reasons. First, the country's high gas import dependency is coupled with the lack of sufficient alternative gas infrastructure, which is costly and

takes years to build. Second, the problem is magnified by gas being the 'bridge fuel' in, Energiewende, the ambitious German green energy transition that rules out both the use of coal and nuclear energy long-term.

The German strategy for an energy pathway to 2050 sets a deadline for a nuclear phase-out by 2022.¹⁹⁰ In 2021, the plans also included phasing out coal by 2038 and covering half of the domestic electricity supply from renewable energy sources by 2030, with the increased targets of 20GW of offshore wind by 2030 (and 40GW by 2040) and investments in 5GW of hydrogen production by the same year.¹⁹¹ Following the outbreak of war in Ukraine and the resulting energy crisis, the German government pledged to further accelerate the development of renewable energy sources to diminish the country's energy import dependency by reducing emissions by 65% and achieving a share of 80% renewables in electricity consumption by 2030.¹⁹² Additionally, Germany has adopted a new Offshore Wind Law that further accelerated its wind capacity building, now aiming at 40 GW by 2035 and 70 GW by 2045.¹⁹³ These are very ambitious tasks. Wind power was Germany's greatest single source of electricity in 2020, but it already lost that ranking after coal-fired plants supplied most of the power to the electricity grid in the first half of 2021, triggering concerns about meeting the ambitious 2030 targets (Table 15). Weather conditions causing wind-energy shortfalls and the increased demand for natural gas in the post-COVID-19 pandemic recovery led to power price spikes across Europe and were partly to blame for the increased coal use at the time.¹⁹⁴

Table 15. Share of electricity production by source in Germany

Source	1990	2009	2021 (2020)
Nuclear	27,88%	22,91%	12,00% (11,40%)
Gas	7,40%	14,02%	14,68% (16,89%)
Oil	4,53%	3,75%	3,85%
Hydropower	3,19%	3,23%	3,00%
Wind	0,01%	6,69%	20,20% (23,40%)
Other renewables	0,29%	5,25%	8,84%
Coal	56,70%	43,03%	28,82% (23,66%)
Solar	0,00%	1,12%	8,61%

With an annual consumption of 503 TWh (2021), Germany generates enough electricity to make it a net exporter in commercial foreign trade, in 2021 balancing at 17.4 TWh of surplus exchange.¹⁹⁵ The inbound flows primarily come from the Nordic countries and Poland, while the outbound flows were directed to Western Europe.¹⁹⁶ Generally, the German electricity market is matured, with full liberalisation achieved in 1998 and third-party access and unbundling achieved under the National Energy Act of 2005.¹⁹⁷ Now, following the Russo-Ukrainian war, Germany declared its commitment to stick to the initial phase-out of coal by the end of the decade while at the same time reactivating some coal-fired power plants in response to recent gas shortages. Consequently, questions over meeting the national climate goals have been raised once again, even though the German authorities assure that these solutions are temporary.¹⁹⁸

Moreover, the current energy crisis made Germany start reconsidering its nuclear phase-out plans. Energiewende gained new impetus after the decision to accelerate the nuclear phase-out following the Fukushima nuclear disaster in 2011. The post-Fukushima 'moratorium' took the seven (of 17) oldest German nuclear power plants off the grid, and the political parties agreed to shut down all of the remaining nuclear plants by 2022,¹⁹⁹ which further reduced the share of nuclear in electricity generation to under 12% (Table 15). In the present context, the German government signalled in late July 2022 that the operation times of the three remaining nuclear power plants might be extended, depending on the results of the planned stress test on the electric grid to assess power supply capacity in the case of severe disruptions (eg gas cut-off from Russia).²⁰⁰ In September 2022, the Minister of the Economy announced that two nuclear power plants (Neckarwestheim in Baden Württemberg and Isar 2 in Bavaria) will remain 'on standby until mid-April 2023, in order, if necessary, to provide an additional contribution to the electricity grid in southern Germany'.²⁰¹ The potential extension is not without pitfalls, though, as the nuclear reactor operators only have enough uranium fuel storage to keep operations running until the end of 2022 (following the original phase-out timeline), and the production of new elements takes 12-15 months.²⁰²

Overall, cutting off energy ties with Russia and manoeuvring around different energy supply sources to be able to stick to the green energy transition will place a high strain on the German energy policy goals, its economy and society. The continuous societal support is one of the decisive factors in the success of Energiewende, yet the projected gas price increase (which could possibly triple by the end of 2023²⁰³) might have a drastic impact on German consumers and the German energy transition alike.

KEY DILEMMAS MOVING FORWARD

DILEMMA I: INTERCONNECTEDNESS IN POLICY AND INFRASTRUCTURE

In the current context, the most important factor to consider is the level of interconnectedness, both in terms of policy and infrastructure development. With Russia being taken off the 'reliable suppliers' list, common regional projects have become a centre of attention. For some (namely, the Baltics and Poland), questions of reliability are not new, while for others (eg the Nordics and Germany), the war in Ukraine has brought about a major shift in perception.

The region passed the first test by agreeing to several EU-encompassing sanction packages and plans for how to wean off energy dependence on Russian fossil fuels. Here, some countries have taken a firmer stand as a sign of support for Ukraine by cutting off energy ties with Russia completely; largely because of their own experience under the Soviet sphere of influence. However, the region did not act in unison regarding the Russian requirement to pay for gas deliveries in roubles, as Germany allowed the companies to comply.

When it comes to infrastructural interconnectedness, there is no quick or easy fix, and the upcoming winter will again put us to a test. However, with several key critical energy infrastructure projects that have recently materialised (eg the Balticconnector, Baltic Pipe, GIPL), the region is more ready to withstand what(ever) is coming next. Yet not without new conundrums: How will the countries fare when gas supplies run low? How strong will the solidarity be when industries must scale down and gas prices soar through the roof? Will we see an increase in 'my country first' policies and energy isolationism? Or will the political interconnectedness hold?

DILEMMA II: GREEN VS BLACK ENERGY

Searching for a fix to the immediate problem caused by the sudden fall in gas supply from Russia, countries have been trawling through both black and green solutions. Some black solutions even landed on the IEA's short-term solutions list, such as burning coal to replace gas in electricity generation, which countries like Poland and Germany have followed. Meanwhile, the efforts to secure new sources of gas that are meant as a 'bridge fuel' in the EU green transition are ongoing. The plans for new LNG infrastructure are mushrooming in the BSR, including in Germany, Latvia, Estonia, Finland and Poland.

The EU is also sweeping the global LNG market. This task is complicated, as the global LNG market is characterised by long-term (10+ year) contracts that cover around 70% of total volume. Another issue points to the possibility of increasing capacities on the market. The major LNG suppliers (the US, Australia and Qatar) are already operating at near-full capacity. In the near-term, accessing cargoes destined for other destinations might be the best solution for the EU. It comes at an increasingly high price, however, simultaneously depriving other parts of the globe of LNG. However, countries in the region also look to low-carbon solutions, such as nuclear energy. While Sweden and Finland continue with their nuclear power generation, Poland plans its first NPPs, and Germany has prolonged life of its nuclear power plants to secure electricity in short term. The plans for small nuclear reactors are also taking shape in Finland, Estonia and Poland. Together with new wind and solar projects, the low-carbon energy solutions will gradually speed up the energy transition and help to replace fossil fuel generation in the medium- to long-term. In the near future, however, there is a risk that the ambitious climate agenda might get side-tracked, overshadowed by a more pressing issue of affordable and available black energy supply.

DILEMMA III: TECHNOLOGICAL AND POLITICAL LOCK-INS

The eastern part of the BSR learned the hard way that technology is political. After independence in the early 1990s, the countries remained locked into energy dependence on Russia through gas and oil pipelines and electricity grids. Today, with the rapid responses to the crisis, we are risking new technological lock-ins that may produce new dependencies and hamper the green transition.

The overall trend in the region has been to consider long-term mega-projects: offshore wind parks with and without hydrogen production (power-to-x technology), nuclear energy projects, and gas interconnectors; to name but a few. But energy infrastructure is long-term: once in place, it stays for decades. The arguably hasty investments in multiple LNG infrastructure projects should therefore raise questions over scenarios when we can no longer rely on fossil fuels and must prepare the technology for green(er) sources. Additionally, the questions of whether the LNG suppliers are reliable and whether the operations are carried out in an ethical manner should be considered. Becoming dependent on large quantities of LNG from industrial competitors (eg the US) might also impact the competitiveness of EU industry long-term, as LNG exporters can always source their energy domestically at a lower price. With several countries in the BSR currently calling for speedy implementation of multiple LNG terminals, seemingly without coordinated action, there is also risk of them locking themselves in a political 'my own way' isolation. The costly infrastructure may end up being a mere sunk cost with no option to extract the value in our green future and a testimony to failed cooperation.

Nuclear energy poses different questions to consider. Although labelled green in the EU taxonomy, nuclear energy comes with long-term quandaries for radioactive waste storage and disposal. Another important question points to suppliers of uranium and plutonium used for fuelling the conventional as well as the small nuclear reactors. Today's dream may turn into tomorrow's nightmare.

The extensions of the operational life of infrastructure in place should also be considered. Apart from the obvious hazards (eg safety, endurance), one must consider the servicing and maintenance of such objects. Are the parts produced by reliable partners or are they further extending the dependencies through bolts, turbines and engines?

DILEMMA IV: SPEED, SCALE AND COMPETITIVENESS

While managing the demand side of energy consumption via improved energy efficiency is the fastest and the cheapest policy option to aid the low-carbon transition, the relative costs, scalability, and timeframe of different low-carbon energy projects need to be weighed against each other while making future investment decisions.

However, the cost estimates of different energy generation infrastructures vary. For instance, while some argue that nuclear energy offers one of the lowest costs per MWh, others see renewables as a much cheaper source of energy. One of the most prominent debates also concerns the deployment of both renewable and nuclear energy generators. When employed together, nuclear energy might cushion the weather-influenced swings in RES energy generation and hence ensure energy security. However, the critiques of this solution highlight that NPPs (much like coal- and gas-fired plants) operate as baseload power plants. This means that instead of producing more electricity from nuclear when the weather conditions are not suitable for RES is not plausible, as the capacity regulation for NPPs is limited. Hence, building new NPPs means keeping a stable share of nuclear in the national mix for decades, rather than using nuclear energy as a bridging mechanism before renewables take over. The lack of flexibility casts a shadow.

Another notable issue relates to electricity generation at large, as to date, the storage of electricity is too expensive to be rolled out on a large scale. With promising hydrogen projects to utilize electricity surplus and improvements in batteries, the future might be brighter. However, much of the technology, that the net zero goals rely upon currently remains in theoretical or testing stages, while human activity continues to drive climate change, and energy prices are skyrocketing.

DILEMMA V: POLITICAL RESILIENCE AND LOSS OF MOMENTUM

The coming winter will test the resilience of the Baltic Sea Region and the EU. The burden of the high energy prices has already taken a toll on European consumers and businesses alike, leaving policymakers hesitant to implement stronger measures. The oil sanctions imposed on Russia in June 2022 are marked by exemptions (exclude one third of piped oil deliveries and allow for emergency seaborne oil purchases), and a long timeframe (a ban on seaborne imports by December 2022 and on petroleum products by February 2023). Although they target the main source of Russian energy export revenues (10% of yearly GDP), their gradual implementation raises doubts about the extent to which they will harm the Russian economy and its ongoing war efforts. Moreover, the EU energy sanction regime lacks urgency moving forward. Currently, no clear date has been set for the total ban on Russian oil and it is likely that countries like Hungary would veto any moves in that direction. Imposing gas sanctions will be even more challenging. The timeline for a total phase-out of Russian gas imports as outlined in the REPowerEU plan stretches until 2030, and there is a real chance of political support waning

before that; especially if the war in Ukraine should end before then. The Nord Stream 2 pipeline has already been mentioned recently as a possible solution to the acute gas crisis by voices both in Europe²⁰⁴ and in Russia.²⁰⁵ Crucially, the public moods are also shifting: Some recent surveys show that due to high economic costs, the mood is changing towards accepting a Russia-Ukraine ceasefire to get a quick fix to the energy problem, rather than insisting on Ukraine's right to its whole territory, which would risk a long-term energy crisis.²⁰⁶ These are all early symptoms of a loss of political momentum. While strengthening European contingency plans to better protect consumers could partially address this issue, the increasingly high economic costs in the months and years to come are undeniable and might cause social unrest across the Baltic Sea Region and throughout Europe.

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