



COUNTRY REPORT DENMARK

Izabela Surwillo and Veronika Slakaityte

Energy Without Russia

The Consequences of the Ukraine war and the
EU Sanctions on the Energy Sector in Europe

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About the authors

Izabela Surwillo is a Senior Researcher at the Danish Institute for International Studies. Her research focuses on the complexities of geopolitics and energy security, with a particular emphasis on the Baltic Sea region and Central and Eastern Europe.

Veronika Slakaityte is a Research Assistant at the Danish Institute for International Studies, where she specialises in energy security within the Baltic Sea and Central and Eastern Europe regions. Her research is centred on the intricate relationship between national identity and energy policy, the selection of energy technologies, and the formation of strategic alliances.

Izabela Surwillo and Veronika Slakaityte

Energy Without Russia: The Case of Denmark

The Consequences of the Ukraine War and the EU Sanctions
on the Energy Sector in Europe

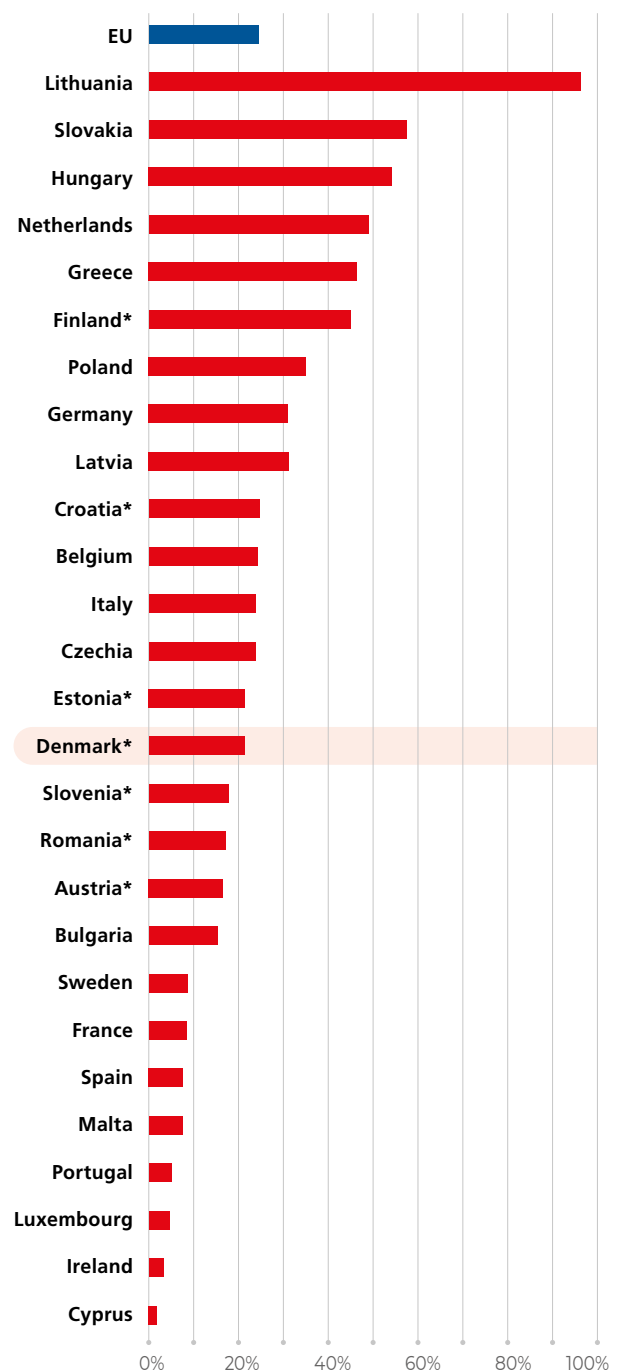
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INTRODUCTION

Prior to the Russian aggression on Ukraine in February 2022 and the subsequent energy crisis, Denmark’s total dependency on Russian energy imports stood at 21.1%, which was below the EU average of 24.4% (European Commission 2022). Notably, Denmark also had one of the EU’s lowest gas import dependencies with only 4% of its total energy consumption covered by Russian gas (McWilliams and Zachmann 2022). Furthermore, Denmark’s strong wind power sector, along with domestic reserves of fossil fuels (including oil and gas industries), resulted in a high level of self-sufficiency, reaching 60% in 2022 (Danish Energy Agency 2022a). Consequently, in comparison to many other EU Member States, Denmark faced fewer challenges in diversifying its energy imports away from Russia. As a result, the impact of the EU’s energy sanction packages against Russia on the Danish energy sector was relatively low, with more immediate effects observed in the substitution of Russian coal and wood pellets.

This paper assesses the impact of the energy crisis on Denmark. It delves into the specifics of the Danish case by analysing the energy situation of the domestic energy market prior to the war in Ukraine in 2022, the short- and long-term policy responses following its outbreak, the impact of the conflict and the energy sanctions on Denmark’s domestic energy sector, and its alignment with the EU climate goals.

Figure 1
Imports from Russia in gross available energy, EU, 2020



Source: Eurostat, Including estimates for non-reported data for countries with*

1

STATUS QUO ANTE (AS OF FEBRUARY 2022)

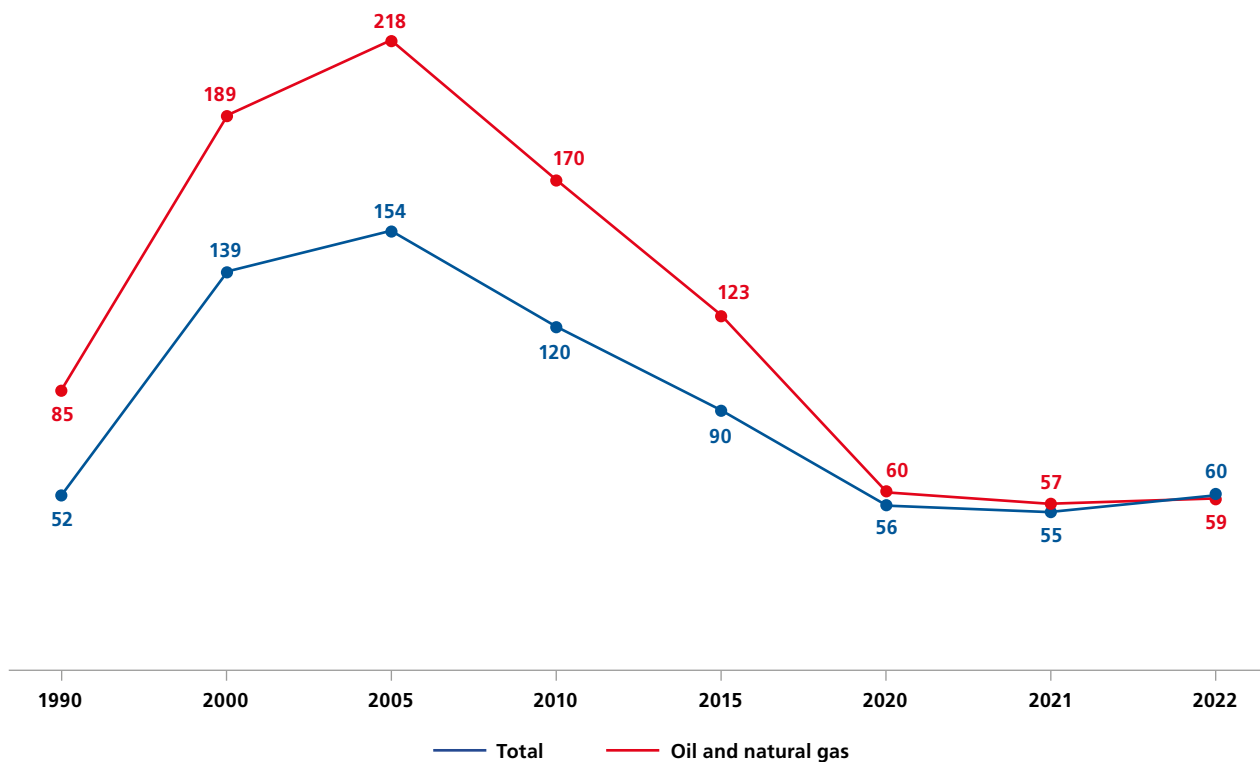
The Russian invasion of Ukraine in February 2022 and the subsequent energy crisis did not have a drastic impact on the Danish energy sector – at least not directly. Due to significant investments in renewable energy, high energy efficiency measures, and a relatively low-carbon economy, Denmark has been a regional leader in energy transition for years. Surrounded by the Baltic and the North Seas, Denmark capitalised on the favourable meteorological conditions for wind power generation, with over half of its domestic electricity generation currently coming from wind (Ritchie and Roser 2023).

Albeit decreasing in importance, domestic oil and natural gas production has also played an important role. Since the 1970s, Denmark was heavily reliant on oil and natural gas, which were systematically extracted from the Danish North Sea. The extraction volumes have decreased signifi-

cantly since the peak of production in 2005, when Denmark produced 289,163 oil barrels per day and 11.7 bcm/y of natural gas, making the small Scandinavian country not only fully self-sufficient, but also a net exporter of oil and gas in the period of 1997–2018. Ageing infrastructure and gradual depletion of the oil and gas fields led to much lower extraction volumes, with the domestic oil production currently covering 53% and the natural gas around 70% of the country’s needs (Danish Energy Agency 2023c; Eurostat 2022b).

Together, the historically significant and expanding wind power coupled with access to domestic fossil fuel resources made for a high level of Danish self-sufficiency over the years (see Figure 2). This helped Denmark achieve a certain level of energy self-sufficiency and minimise the repercussions of the EU’s energy sanctions on Russia in 2022.

Figure 2
Self-sufficiency degree in Denmark in 1990-2022.



Source: Based on data provided by the Danish Energy Agency

Nevertheless, Danish consumers and businesses were hit by high energy prices resulting from the economic impact of the war. The crisis also drew attention to energy import vulnerabilities, prompting a shift in policy focus.

In 2021, Denmark's total dependency on Russian energy imports amounted to 21.1% (below the EU average of 24.4%) (European Commission 2022). The Danish energy mix has been relatively stable with oil ranking as the first source by consumption, followed by wind energy and natural gas, with the latter being overtaken by renewable energy sources (RES) in recent years. In 2021, oil accounted for 39.77%, wind for 22.49%, other RES for 14.95%, gas for 12.41%, coal for 6.88%, solar for 1.79% and hydro for 0.02% of the total share of energy consumption in Denmark (Ritchie and Roser 2023).

Denmark has one of the lowest gas import dependencies in the EU at 28.7%¹ in 2021 (Eurostat 2023; 2022b). Domestically, gas is used for heating by 380,000 households, and approximately 30,000 small, medium, and large businesses (Danish Energy Agency 2022b).

In 2019 Tyra, Denmark's largest oil and gas field, went under maintenance; its reconstruction was prolonged due to the Covid-19 pandemic, pushing back the field's opening into the winter of 2023–2024 (Energinet 2019). That increased the country's gas dependence. Therefore, approximately one third of gas for domestic use had to be imported, while the rest has been covered by a mix of storage reserves, domestic gas, and biogas production.

With a relatively tight gas network consisting of a feeder pipeline to Sweden, a bidirectional pipeline between Denmark and Germany, and a newly constructed bidirectional connection – the Baltic Pipe – that enabled access to Norwegian gas as of October 2022, the gas import possibilities are limited. Hence, from the closure of Tyra to the opening of the Baltic Pipe, all imports were sourced from Germany (Danmarks Statistik 2022). Estimating how much of that gas was of Russian origin however is challenging; most data is generated under an assumption that half of the net imports from Germany are of Russian origin (see Eurostat 2022a). In a statement issued by the German Ministry of Economic Affairs and Climate Action in 2022, it is noted that prior to the war in Ukraine, 55% of gas imports came from Russia, 30% from Norway and 13% from the Netherlands (Wettengel 2023). Some other unofficial estimates were higher, listing 75% of the 'German transit gas' to be of Russian origin (Global Energy Data 2022). According to the estimates made by Bruegel, only around 4% of the total energy consumption in Denmark in 2021 was made up of Russian gas (McWilliams and Zachmann 2022).

Since 2013, Denmark has experienced a substantial increase in biogas usage. Over the past decade, 51 biogas facilities were integrated into the gas system. By 2021, biogas accounted for about a quarter of domestic gas consumption,

leading to a significant reduction in CO₂ emissions (Energinet 2022). Plans are in place to expand the sector further, aiming to cover 75% of gas demand by 2030 and meet the entire demand by 2034 (Ibid.).

Prior to the war, Denmark primarily imported petroleum from five locations: the United States, Norway, Russia, Nigeria, and Libya (OEC 2023). Total oil and petroleum products (excluding biofuel) import dependency was measured at 55% in 2020; Russian oil accounted for approximately 27.6% of the imports (Eurostat 2022a). With oil being a more palpable commodity – traded on the world market and transportable by multiple means – oil import dependency certainly constituted a lower potential vulnerability, as compared to gas imports, due to vast diversification options. However, the global nature of the oil market presented its own risks. Historical oil crises in 1973–1974, 2000–2001, and 2007–2008 demonstrated that a disruption in one oil exporting country could impact the entire market.

Coal also plays an important part in the Danish energy mix, although its consumption has been gradually decreasing since the 2000s due to the boom in renewables (OECD 2020). Fossil fuel is primarily used for electricity generation and household heating (Danish Energy Agency 2022b). While coal only accounts for 6.88% (2021) of the domestic energy profile, Denmark has been completely dependent on its imports, predominantly from Russia (about 97% of imports), followed by Colombia (European Commission 2022; Danish Energy Agency 2022b; IEA 2017, 70). Among the most notable initiatives to phase out coal is the combined heat and power (CHP) plants' conversion from coal to biomass. What is more, biomass is also used to replace oil and natural gas boilers, in order to reduce greenhouse gas emissions ('Danish Climate Agreement for Energy and Industry 2020'). To speed up the transition to low-carbon technologies, biomass was placed under a zero-taxation scheme, both for district heating and residential use. The rapid roll-out of biomass, however, introduced additional import dependency, especially when it comes to solid biofuels, such as wood chips and pellets. The imports to Denmark have been primarily routed from three locations: Estonia, Latvia, and Russia (IEA 2017). One of the measures in the National Danish Energy Plan (2020–2024) agreed in 2018, enlists a decrease in solid biomass use in CHPs to counter the import dependence of wood (by-)products (Mussatto 2021). In 2021, biomass accounted for 33% of CHP generated heating, followed by waste at 21.2%, coal at 6.5% and natural gas at a mere 3.9% (Danish Energy Agency 2022a).

Denmark's electricity profile is largely dominated by renewables: wind (50%), bioenergy (20%), and solar (4%). However, as renewables constitute a less stable form of power generation that can be affected by weather conditions, e. g., low winds, cloudy conditions, or draughts, it is supplemented with more stable production from coal (15%), gas (6%), and oil (3%) (Table 1).

Over the years, the Danish electricity generation sector has seen significant changes. Coal, dominant in the early 1990s, now constitutes just over 15% of the fuel mix (Ibid.; Table 1).

¹ Calculated as follows: total inland consumption observes=100%; (total imports – total exports) = X; X=28,697608843823236%. Data retrieved from: Eurostat, code NRG_CB_GASM.

Table 1
Electricity mix by source in Denmark

Source/year	five-year avg. 2017-21	2021	2022
Wind	50.70	48.55	55.03
Bioenergy	21.33	26.38	23.10
Coal	15.37	13.22	10.52
Gas	06.40	04.66	02.99
Solar	03.40	03.96	05.78
Oil	03.34	03.18	02.53
Hydropower	00.06	00.06	00.06
Nuclear	00.00	00.00	00.00
Other RES	00.00	00.00	00.00

Source: Ritchie and Roser 2023

The role of biomass has grown substantially, accounting for one fifth of electricity production in 2021, signifying a 109% increase since 1990 (Danish Energy Agency 2022a). Additionally, there has been a shift from large-scale combined heat and power (CHP) plants to smaller-scale generation units.

Renewable electricity generation leads to significant yearly output fluctuations. The Nordic power market at large is strongly correlated with weather conditions, given the dominance of hydropower in Sweden and Norway. Since 2011, Denmark has been a net importer of electricity, with imports varying annually. In 2020 net imports accounted for only 3.6% (Eurostat 2022a), primarily sourced from Norway and Sweden (Danish Energy Agency 2022a), while the export flows are directed to Germany and the Netherlands.

Since 1990, electricity consumption has risen by 11.8%. At present, consumers can be categorised into three main groups: agriculture and industry (34%), households (33%), and commercial and public services (30%). As electrification efforts continue, consumption is expected to grow, while the distribution among the three categories is likely to remain relatively stable.

2

AD HOC RESPONSES AFTER FEBRUARY 2022

The outbreak of war in Ukraine and the subsequent shift in the EU's energy policy towards Moscow have affected Denmark's domestic energy sector despite its low reliance on Russian energy sources.

The energy crisis made Danish society acutely aware of the dire consequences of the war in Ukraine, as the economic and geopolitical repercussions were brought to its doorstep, influencing public perception of European energy and security politics more broadly. Record-high energy prices affected Danish businesses and society (The Local 2022) and the security dimension of the crisis became blatantly obvious with the explosions along the Nord Stream 1 and 2 natural gas pipelines in late September 2022. These acts of sabotage, just outside of Danish territorial waters, heightened the protection of critical energy infrastructure in Denmark in fear of further escalations.

In terms of immediate policy responses, Denmark has introduced various energy saving measures, encouraging its population to conserve energy to support sufficient energy supply on the domestic market and aid in protecting consumers from high energy bills. Some of the recommended measures for citizens included turning down the heat in buildings, limiting the use of hot water, saving electricity (turning off appliances when not in use, switching off lights if/when not necessary), or using electricity when it is produced domestically, and tracking energy prices. Consequently, apps such as *Min El* that show electricity prices in real time have become hugely popular (Danish Authority of Information 2023). Moreover, a country-wide program aimed at reducing energy consumption across all public buildings was launched on 8 September 2022. The project included measures, such as lowering the heating temperature to 19°C in public buildings, switching off unnecessary lighting (e.g., the logo sign on the building, decorative lights, etc.), and reducing the heating season by 14 days at each end (Danish Authority of Information 2023).

Despite the relatively mild winter season of 2022/2023, low dependency on gas imports, and all the implemented measures, Danish consumers were still hit by the energy price rise, largely due to the closely linked gas markets with Germany. The year 2022 averaged at a gas price of EUR 125/MWh which is five to six times higher than the historical average (Energinet 2023). The government sought to

mitigate the impact with several initiatives along the way. From 1 October 2022, the general electricity tax was reduced (by 4 øre² per kWh), and the measure extends to the first half of 2023 with the tax rate being temporarily lowered to the EU minimum (from 69.7 øre per kWh to 0.8 øre per kWh). Electricity tax reduction is also being considered for heat pumps. Other discussed measures include diverting some of the windfall revenues from higher energy prices back to consumers.

Diverse financial support schemes were introduced for the most vulnerable consumers affected by rising energy prices in Denmark, including one-time payments in August 2022 for the most disadvantaged households, financial support for pensioners receiving supplementary pension contributions, a possibility for a temporary deferral scheme for the share of household and business costs for electricity, gas and district heating that exceeded the prices in the first quarter of 2021, an increase in the maximum employment allowance for 2022/2023 income years, and a temporary increase of the child and youth benefit paid out in January 2023 (Danish Authority of Information 2023). Approximately 419,000 low-income families have benefited from the one-time compensation for rising energy costs in heating. The government also allocated €13.3 million to municipalities to further distribute the funds to those in need (European Commission 2022).

Concrete policy initiatives were taken to alleviate the energy crisis: For instance, the subsidies for disconnecting from the gas network in 2023 have been increased further by DKK³ 35 million (€4.7 million), the fund pool for the roll-out of district heating was increased by DKK 150 million (€20.1 million) in 2022 and by additional DKK 100 million (€13.4 million) in 2023, measures have been implemented to enhance the supply of wood pellets, while the scheme that supports switching to subscription heat pumps by providing grants for the scrapping of oil and gas boilers was increased by DKK 10 million (€1.3 million) in 2022 and extended to include pellet boilers from 1 December 2022 (Danish Authority of Information 2023).

² øre is the centesimal subdivision of the Danish krone (DKK); 1 øre is equal to approximately €0.001.

³ Danish krone: DKK 1 = €0.134078

The solidarity with the EU's shift in energy policy was also visible on the business side. The Danish company Ørsted gradually decreased its energy cooperation with Russia in the months following the outbreak of war. First, Ørsted stopped using the Russian coal and biomass supplies, then it declared that it would ensure none of its direct suppliers for the construction of renewable energy are going to be Russian, and finally the company refused to pay for Russian gas in rubles (Joanteguy 2022). In response to the latter, Russia cut off the gas supply (O'Neill 2022).

3

MAIN CONSEQUENCES OF THE CONFLICT AND SANCTIONS SO FAR

Following the outbreak of war in Ukraine, and the vast array of measures implemented to enhance Danish energy security, several changes are noticeable. First, the gross energy consumption has decreased from 729 PJ in 2021 to 709 PJ in 2022 (preliminary) (Danish Energy Agency 2023c). Secondly, due to favourable weather conditions, the degree of self-sufficiency rose from 55% to 60%, and hence the net electricity imports amounted to only 5 PJ (18 PJ in 2021, and 25 PJ in 2020) (Danish Energy Agency 2022a). Thirdly, due to the international nature of the energy markets and coincidental good timing of the Baltic Pipe's opening (autumn 2022), energy imports from Russia have been replaced with sources originating elsewhere – although alas, often at a higher price due to the global nature of the energy market. Lastly, the energy sources used in energy generation have been altered: for instance, electricity production from fossils fell from 21.05% in 2021, to 16.04% in 2022; the generation from low-carbon sources has instead undergone an upwards trend, peaking at 83.96% in 2022 (Ritchie and Roser 2023). Although high self-sufficiency in oil, natural gas and electricity production places Denmark among the least energy import dependent states in the EU, the sanction packages also affected the share of fossil fuels in Denmark's domestic power generation in 2022, with the shares of coal (–2.7%), gas (–1.67%) and oil (–0.65%) all decreasing.

Denmark also joined the EU Member States that called for stringent sanction measures against Moscow. The list of sanctioned energy products includes crude oil (from December 2022) and refined petroleum products (from February 2023) (with some exceptions), coal (August 2022), and other solid fossil fuels (European Commission 2023). While limited economic ties with Russia minimised the effect of the EU's new sanction regime on the Danish energy profile, there is one notable exception. Namely, the import of wood chips and pellets from the Baltic States and Russia which were affected by the sanctions is having both direct and indirect effects on energy generation of biomass in Denmark (K. B. Olsen forthcoming). Although wood did not surface in the headlines as another 'energy commodity ban', it occupies a significant share in the Danish heating and electricity generation sectors. The fifth sanction package included the prohibition of wood products (July 2022), alongside cement, asphalt, paper, plastics, and synthetic rubber (European Commission 2023). Largely overlooked, 'wood as a source of energy' was therefore directly affected by the sanctions (K. B. Olsen forthcoming). Moreover, the imports

of wood from Latvia and Estonia were primarily in a form of a by-product – a residue from the domestic furniture production. However, as both countries used to rely on wood imports from Russia, Belarus, and Ukraine, the EU sanctions and the war in Ukraine affected this chain, thereby also further exposing Denmark to secondary effects of sanctions (IEA 2017).

The energy sanctions are also indirectly affecting the Danish businesses and society – perhaps most notably as reflected in the high rates of inflation. As it will take time for the (energy) markets to stabilise following the shocks induced by the combined impact of the war, sanctions, energy, and climate crises, the true effects of the current sanction regime against Russia can only be evaluated in the years ahead.

4

MEDIUM- AND LONG-TERM ANSWERS

When it comes to a wider policy outlook in the medium to long term, the clearest energy policy shift in Denmark amid the outbreak of war concerned the acceleration of energy transition in order to boost self-sufficiency, with plans pointing to increased development of biogas, and a phase-out of fossil fuels over the long term, coupled with increased generation of green energy (State of Green 2022). The latter is to be achieved through a fourfold increase in the solar and onshore wind energy by 2030 announced by the Danish government in April 2022, as well as the ambitious offshore projects on the North and Baltic Seas. Denmark envisions a construction of the world's first artificial 'energy islands' that will serve as hubs connecting energy generated from offshore wind with the energy systems. This is the largest construction project in Danish history, costing an estimated €28 billion. The pilot energy island will be located 15 km southwest of the Danish Island of Bornholm in the Baltic Sea with a capacity of 3 GW to be established by 2030 (Danish Energy Agency 2023a). The subsequent energy island project will be erected in the North Sea – approximately 80 km off the coast of Jutland. The initial capacity of 3 GW is expected to become operational by 2033, gradually building up the amplitude leading to 10 GW by 2040 with a possibility of expansion up to 40 GW (Danish Energy Agency 2023b). The islands are envisioned to operate under the Power-to-X technology, which will enable the production of green hydrogen from surplus wind energy that is not possible to be stored in large quantities otherwise (Johansen 2021)

The reduction of Russian gas supplies and the resulting uncertainty of energy supply in Europe have increased the risk of power shortages and has had consequences for the heating of buildings, street lighting, and energy consumption all over the EU, and Denmark is no exception (Danish Authority of Information 2023). Boosting the production of green energy serves Denmark's double policy goal of staying on track in the sustainable energy transition while ensuring stable energy supply within a changed geopolitical context. Green energy sources and technologies are particularly important to replace the domestic use of natural gas. In 2022, approximately 400,000 Danish households relied on fossil fuel heating. To reduce the consumption of natural gas, current plans envision the expansion of the district heating grid to allow more households to access green heat in the future – with the last district heating projects to be completed by 2028. Those households who cannot install district heating are either to replace furnaces with green heat pumps, or switch to biogas.

5

FORESEEABLE CONSEQUENCES WITH REGARD TO EU CLIMATE GOALS/TARGETS?

Despite the high mobilisation of the Danish government, business, and society amid the ongoing energy crisis, several issues remain. To start with, the planned scale-up of renewable energy generation requires additional regulatory and policy support, as the 2030 targets are quite infeasible given current installation ceilings for onshore wind turbines (State of Green 2022). Moreover, moving some offshore wind projects on-land is problematic, as there are numerous barriers in accessing necessary areas. Although many economic and technological barriers to the development of big wind power projects have been addressed (Nyvold 2019), Denmark often struggles with social resistance to both onshore and offshore wind projects (B. E. Olsen 2022). The majority of local protests come from holiday homeowners concerned with the landscape aesthetics and the drop in their holiday property value once the wind farms are developed in the proximity (Nyvold 2019). This constitutes a major challenge going forward with the ambitious plans to scale-up wind energy fourfold amid the ongoing energy and climate crisis.

The energy crisis also impacted Danish energy transition in other terms, extending the fossil fuel phase-out timeframe and raising concerns over increasing oil and gas production volumes (Slakaityte, Surwillo, and Villumsen 2022, 19). Although that increase is meant to be temporary, the Danish future energy mix rests on the success of the accelerated rollout of renewables, as well as on the energy technologies which are still in the stage of infancy, e.g., industrial carbon capture and storage, carbon recycling, etc. This raises the question of whether Denmark can achieve carbon neutrality by 2050. Nevertheless, Denmark is one of the leading countries in the net-zero transition in Europe and it will retain that position in the future, with wind power expected to play an increasingly important role in the country's path to green future, as outlined in the Danish strategy for carbon neutrality by 2050.

CONCLUSION

Due to the specifics of its energy mix and low import dependency, the direct effects of the energy crisis in Denmark were limited. Tighter energy-saving measures, favourable meteorological conditions, and reduced fossil fuel use in domestic power generation in 2022 played a role. As such, the main effects of the crisis – although less obvious – owe to the interconnectedness of energy markets and the general cost of living crisis across Europe.

Set to be one of the frontrunners in sustainable energy transition in Europe, Denmark did not shift its main energy policy course during 2022. The geopolitical consequences of the war further accelerated the deployment of low-carbon energy technologies. In response to the ongoing energy crisis, the country implemented various measures to reduce energy demand and improve efficiency in both public and private sectors. Therefore, whereas many other EU states had to redirect large resources to rapidly diversify their energy imports away from Russia, the Danish drive towards energy security continues to rely on increasing self-sufficiency.

Despite the crippling of the energy crisis, Denmark remains steadfast in its green transition agenda and long-term decarbonisation goals. As the country forges ahead with ambitious large-scale renewable projects, the development of new technologies and the evolving landscape of international energy markets will further shape Denmark's path towards a sustainable future in the decades to come.

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Email: fesbp@fesbp.hu

Responsible for content and editing:

Ernst Hillebrand, Head, European Economies of the East

ernst.hillebrand@fes.de

Orders/Contact: fesbp@fesbp.hu

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