



Nordic Energy
Research

Impact assessment of emergency market intervention measures to tackle high energy prices

– with a focus on the Nordic wholesale market

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This publication is also available online in a web-accessible version at:
<https://pub.norden.org/nordicenergyresearch2023-04/>

Preface

The evolution of the common Nordic electricity market is a significant enabler in the implementation of the vision of the Nordic Countries, wherein the Nordic region aims to become the world's most sustainable and integrated region.

Secure, affordable, and clean energy is fundamental to realizing this. As recognized by the Nordic Electricity Market Group, established under the Nordic Council of Ministers, the Nordic electricity market holds significant importance as an essential instrument for ensuring a resilient security of supply and high-quality electricity service to customers, all while maintaining competitive and affordable electricity prices. In addition, energy markets, such as the electricity market, can help to ensure efficient utilization of our resources across the Nordic borders and energy systems.

Yet, in view of the recent year's unprecedented energy prices and geopolitical risk, the electricity prices surged and exposed the need for a review of resilient energy infrastructure measures. As a response, the European Commission created the Just Energy Transition Fund and a toolbox of emergency intervention measures for action and support aimed at consumers and industry.

This report delves into the Nordic approaches to implementing the EU's emergency intervention measures aimed at tackling the energy crisis and high energy prices during the winter of 2022/2023. Simultaneously, readers are presented with a theoretical economic analysis of the implications resulting from these interventions.

The report supplements other studies by Nordic Energy Research. Latest, the reports "*The Nordic Energy Trilemma - Security of Supply, Prices and the Just Transition*" as well as "*Inflation and its social consequences – The case of Nordic and Baltic countries*". All reports analysing the recent years energy price rise, measures, and consequences.

It is my hope that these reports will create knowledge-based foundation for enlightening and sharing of best practices to ensure a resilient, sustainable, and integrated Nordic energy region of tomorrow.

Klaus Skytte

CEO, Nordic Energy Research

Acknowledgements

This publication was funded by the Nordic Council of Ministers. Vista Analyse was commissioned to perform this study by Nordic Energy Research (NER) on behalf of the Electricity Market Group (EMG) under the Nordic Council of Ministers. Maj Dang Trong at Nordic Energy Research was the coordinator of the project.

Team at Vista Analyse

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Steering group

The study was supervised and guided by representatives from the Electricity Market Group.

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Additional materials, press coverage, presentations etc. can be found at www.nordicenergy.org.

Proofreading

The report was proofread by Scribbr.

Disclaimer

The opinions expressed in this publication are those of the consultants. They do not necessarily reflect the views of the Nordic Council of Ministers, Nordic Energy Research, or any entities they represent. The individuals and organizations that contributed to this publication are not responsible for any judgements herein.



Aerial view of windmills in Pori, Finland.
Photo: iStock

Executive Summary

The Council of the EU introduced emergency intervention measures to address high energy prices in October 2022. We describe the implementation of these measures in Denmark, Finland and Sweden and analyse the impact of the measures on the Nordic power market.

Electricity consumption, both during peak hours and in total, was reduced in the winter of 2022–2023 in the three countries. However, we cannot attribute this development solely to the emergency measures. Electricity prices were higher than in previous winters, so it is reasonable to assume that at least part of the reduction is attributable thereto. In addition, the winter was milder than usual. Moreover, it is likely that increased awareness of the situation in the power market also contributed to reducing demand.

The measures targeting electricity producers – the revenue cap in Denmark and Sweden and the profit tax in Finland – do not distort short-term production incentives, though they may distort long-term incentives to invest. To avoid negative impacts on investments, it is important to emphasize that these measures are temporary, one-time measures that were introduced as a response to an extraordinary crisis.

Background and aim of the study

The Council of the EU proposed the Regulation on an emergency intervention to address high energy prices in Europe (hereafter “the CR”) on 14 September 2022. The CR was adopted 6 October 2022 and came into effect 8 October 2022.

The aim of the CR was to mitigate the effects of high energy prices on energy consumers through three exceptional, targeted and time-limited measures:

- Reduction in electricity demand
- Cap on market revenues for inframarginal technologies in electricity generation
- Solidarity contribution from the fossil fuel sector

There was some flexibility in how the measures could be implemented. One aim of this study was to describe how the emergency measures outlined in the CR were implemented in the Nordic countries. Our focus was on Denmark, Finland and Sweden. Iceland and Norway are not EU members and thus did not implement the measures of the CR. Chapter 2 is devoted to a description of the implementation of the measures.

The second aim was to assess the short- and long-term impacts of the measures on the Nordic wholesale power market. The short-term impacts are related to incentives to produce, while the long-term impacts are related to incentives to invest in new capacity. Chapters 3–5 address the impacts of the measures.

Table S.1 summarizes the measures outlined in the CR and how they were implemented in Denmark, Finland and Sweden.

Table S.1. Overview of the implementation of the emergency measures in the Nordic countries

	The Council Regulation	Sweden	Denmark	Finland
Reduction in electricity demand	<p>Mandatory 5% reduction in electricity consumption during peak load hours between 1 December 2022–31 March 2023.</p> <p>Voluntary 10% reduction of total electricity consumption between 1 November 2022–31 March 2023.</p> <p>Flexible implementation and somewhat flexible definition of peak hours.</p>	<ul style="list-style-type: none"> • Consumption flexibility procurement scheme. • Energy savings in 198 public institutions. • Information campaign. 	<ul style="list-style-type: none"> • Energy savings in the state and public sector. • Energy-saving campaigns for households and businesses. 	<ul style="list-style-type: none"> • Voluntary power system support procedure. • Energy-saving campaign "Down a degree".
Cap on market revenues	<p>180 EUR/MWh cap on market revenues obtained from the sale of electricity produced from specific sources between 1 December 2022–30 June 2023.</p>	<p>180 EUR/MWh cap on market revenues obtained from the sale of electricity produced from specific sources between 1 March 2023–30 June 2023.</p> <p>Tax applied to 90% of hourly realized revenues exceeding the cap.</p>	<p>180 EUR/MWh cap on market revenues obtained from the sale of electricity produced from specific sources between 1 December 2022–30 June 2023.</p> <p>Tax applied to 90% of monthly realized revenues exceeding the cap.</p>	<p>Additional 30% tax on electricity companies' profits in 2023 above "ordinary" return on equity.</p> <p>The tax is levied on electricity producers and, under certain conditions, retailers.</p>
Solidarity contribution from the fossil fuel sector	<p>The fossil fuel sector is levied a tax of 33% on taxable profits that exceed the average profits in the four preceding years by 20%.</p> <p>Applies to fiscal year 2022 and/or 2023.</p>	<p>The fossil fuel sector is levied a tax of 33% on taxable profits that exceed the average profits in the four preceding years by 20%.</p>	<p>The fossil fuel sector is levied a tax of 33% on taxable profits that exceed the average profits in the four preceding years by 20%.</p>	<p>The fossil fuel sector is levied a tax of 33% on taxable profits that exceed the average profits in the four preceding years by 20%.</p>

Demand reduction measures in the Nordic countries

The Council Regulation stipulated two demand-reduction measures:

- A mandatory 5% reduction in consumption during peak load hours
- A voluntary 10% reduction target in total electricity consumption

One of the key issues the authorities had to determine was which hours should be considered peak load hours. In Sweden, peak load hours were defined as three hours each morning and three hours each afternoon on weekdays. In Finland and Denmark, peak hours were defined as two hours in the morning and two hours in the afternoon on weekdays. The comparison period for the peak hour consumption reduction was the monthly consumption as forecasted by the transmission system operators (TSOs), while the reference period for the total consumption reduction was the average consumption in the corresponding months in the five-year period 2017–2022.

All three countries introduced measures to reduce demand; however, these were introduced before the CR. Most of these measures can be characterized as command-and-control measures and information campaigns. For instance, public institutions in Sweden and Denmark are required to implement energy-saving measures, such as reducing indoor temperatures in buildings and switching off lights, ventilation, screens, electronic devices, etc., where possible. Moreover, there are information campaigns, such as “Every kilowatt-hour counts” in Sweden and “Down a Degree” in Finland, apprising public institutions, businesses and households about energy saving possibilities.

In addition to information campaigns and command-and-control measures, demand reduction schemes were introduced by the TSOs in Sweden and Finland.

- In Sweden, a flexibility procurement scheme was introduced in November 2022. Under this scheme, large consumers were compensated for shifting their power demand from peak load hours to other periods. In total, 75 MW were procured under the scheme. In spite of its name, the scheme was not particularly flexible: eligible consumers were compensated for reducing consumption during certain hours, regardless of the situation in the power market. The scheme was closed in February 2023, as the total reduction of electricity demand in the rest of the market was sufficient and made the procurement scheme unnecessary.
- In Finland, Fingrid introduced a voluntary power system support procedure. Fingrid entered into agreements with about 50 companies and public entities that agreed to reduce their demand in a power shortage. If the risk of a

blackout or brownout occurs, Fingrid will contact them by text message the day before to warn them about the risk. The companies and public entities will only be asked to activate the emergency measures when there is a real need. They are not compensated for this other than through price effects in the market. Fingrid has pointed out that an important part of the scheme is the identification of potential measures and the education of the employees of the participating companies.

Data have revealed that electricity consumption was reduced in the winter months of 2022–2023 in all three countries. Peak-hour consumption was reduced well beyond the target of 5%: 8.3% in Finland, 9.1% in Sweden and 10.2% in Denmark. Figure S.1 shows the reduction for each month. The reduction of total electricity consumption has also been considerable in all three countries (see Figure S.2), especially in January and February.

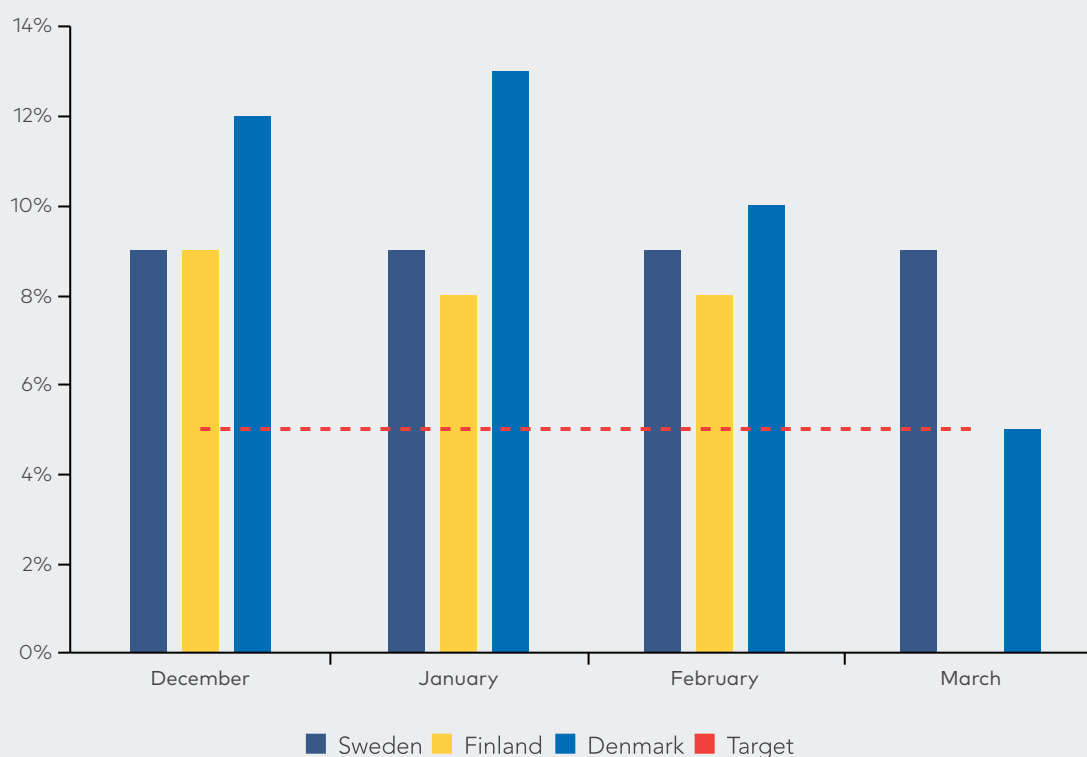


Figure S.1. Average consumption reduction during peak hours, December 2022–February 2023

Source: Vista Analyse, based on reports from the TSOs

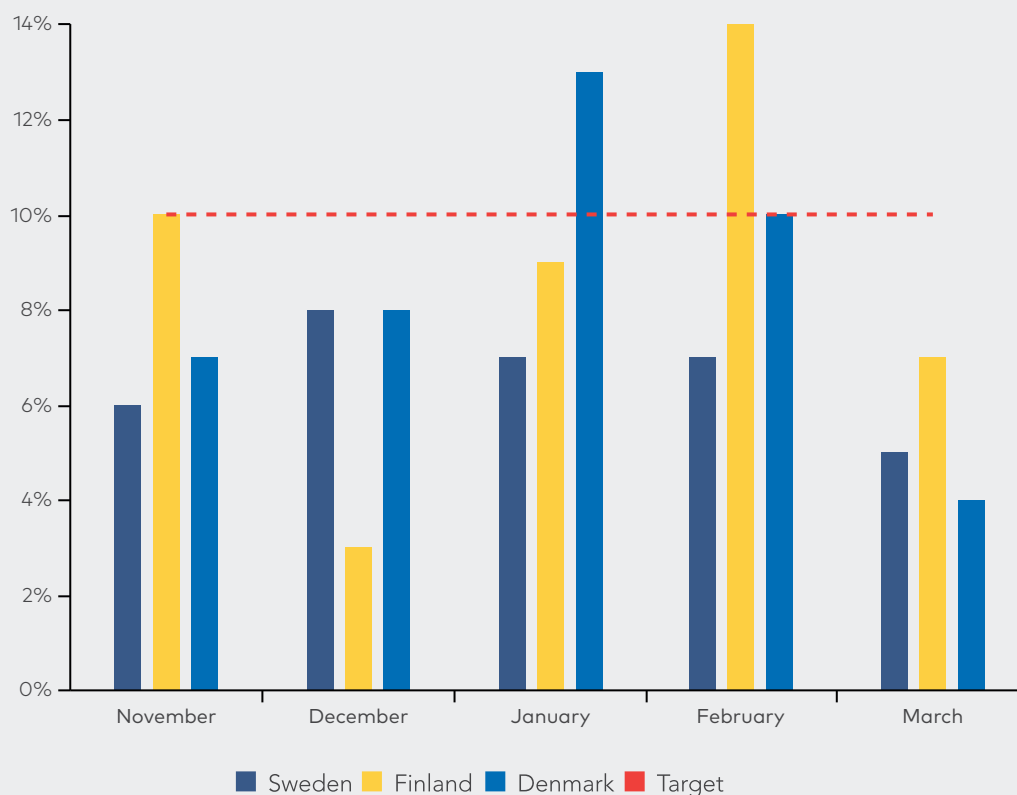


Figure S.2. Total consumption reduction, November 2022–March 2023

Source: Vista Analyse, based on reports from the TSOs

Note: Figures have been temperature-adjusted for Sweden and Finland (December–February).

A thorough analysis of the different measures' impacts on consumption is outside the scope of this project, as data became available only towards the end of the assignment. Therefore, we cannot distinguish between the effects of individual measures and the effects of prices. On average, electricity prices were slightly below 250 EUR/MWh in Denmark, Finland and Southern Sweden in December 2022 and around 100 EUR/MWh in January 2023. Moreover, the winter of 2022–2023 was relatively mild, contributing to lower demand in Finland and Sweden. However, there are two interesting points to note:

- A large reduction in demand occurred in January, when prices were significantly lower than in December. This may imply a time lag in demand reduction, which may have been due to either more information becoming available and increased awareness of the prices or to more possibilities for reducing demand over time. In addition, total electricity consumption was reduced the most in Denmark, where electricity demand is independent of temperature.

- The reduction of demand in peak hours in Sweden was considerably larger than the 75 MW (corresponding to less than 0.4% of peak demand) procured by the flexibility procurement scheme. Hence, the reduction in electricity consumption in the rest of the economy was significant.

Revenue cap and tax on profits

The second emergency measure in the CR involved a cap on revenues from electricity production: 90% of revenues exceeding 180 EUR/MWh were taxed. This applied to most electricity producers with marginal costs lower than the market price (the so-called inframarginal producers). The revenue cap applied until 30 June 2023.

The implementation of the revenue cap was almost identical in Sweden and Denmark and matched the requirements of the CR. The main difference was that in Sweden, tax was calculated based on the hourly day-ahead price, while in Denmark, the price obtained in the different markets (day-ahead, intraday and balancing markets) was used, and the tax was calculated as a monthly average. Hedging agreements were taken into account in both countries; thus, the actual price that the producer received was the tax base. In addition, in Sweden, the tax applied to revenues obtained between 1 March 2023 and 30 June 2023.

Both countries used the exemption possibilities available in the CR. There was a special cap corresponding to 1.3 times production costs for some high-cost producers in Sweden. In Denmark, the actual fuel prices of high-cost technologies, such as biomass- and oil-fired power plants, were taken into account. Similar to gas prices, the fuel prices of these plants recently increased.

In Finland, a profit tax was implemented instead of a revenue cap. This is a temporary tax of 30% on profits (from electricity sales) exceeding an annualized return of 10% on equity. This tax applies only to 2023; it is to be phased out after 2024.

Impacts of the revenue cap on the Nordic wholesale power market

We assessed the short- and long-term impacts of the revenue cap on the wholesale electricity markets. The main question was whether the revenue cap on inframarginal technologies would affect the incentives of power market participants. The short-term impacts were related to incentives to produce, while the long-term impacts were related to incentives to invest in new capacity.

Short-term impacts

Our main findings related to the **revenue cap** in Sweden and Denmark include the following:

- In principle, inframarginal producers' incentives to produce are not affected by a revenue cap: producers will produce as long as their marginal revenues are larger than their marginal costs. Taxing only 90% of revenues exceeding 180 EUR/MWh contributes to maintaining incentives to produce.
- Special provisions for high-cost producers (biomass and oil-fired power plants) ensure that their incentives are preserved, thus ensuring security of supply.
- The way the tax was implemented in Sweden, with a day-ahead price as a reference price and hourly prices for settlements, does not influence producers' short-term incentives. The impacts of using the monthly average price, as was done in Denmark, are not straightforward, but the incentives were preserved in Denmark as well.
- The actual prices obtained by the producer formed the tax base. Hence, if a producer had hedging agreements or power purchasing agreements (PPAs) and did not earn a market price exceeding 180 EUR/MWh, the tax did not apply. The share of hedging agreements in the Nordic market is relatively high. In particular, wind and solar producers are hedged to a large degree. Therefore, a large share of the production was not influenced by the tax, even when spot prices were high.
- Using the monthly average price as the tax base is likely to reduce the administrative costs of the tax. However, it also reduced tax revenue, as illustrated in Figure S.3. Recall that the tax in Sweden applied only to revenues obtained between March–June 2023.

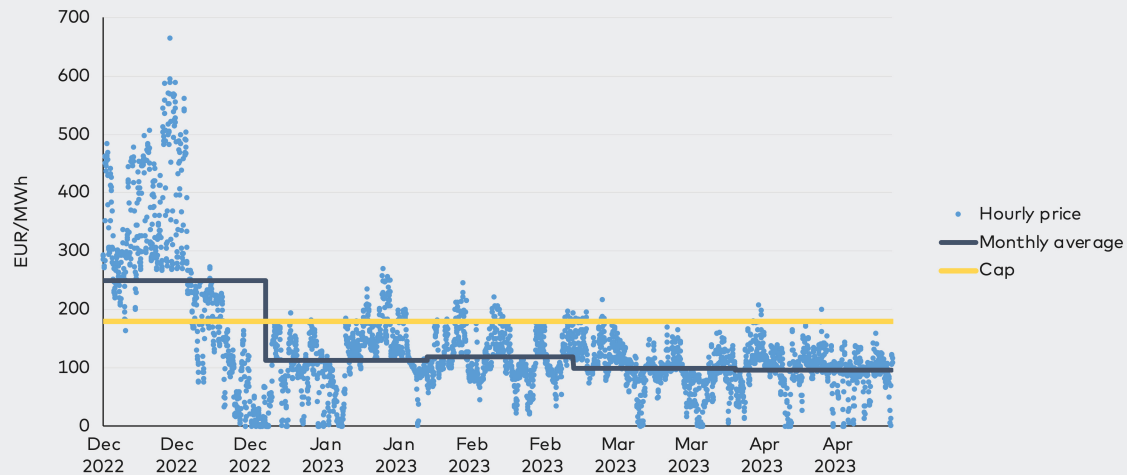


Figure S.3. Hourly and monthly average prices in Denmark (DK1, day-ahead)

Source: Vista Analyse, based on data from ENTSO-E

Our main findings related to the **profit tax** in Finland include the following:

- A profit tax does not distort short-term production incentives. Profit-maximizing firms maintain incentives to maximize profits, even if a share of the profits is taxed. Thus, rational agents in the electricity sector behave as before and offer the same supply in the same markets.
- A profit tax is easier to implement and has lower administrative costs than a revenue cap.
- The present profit tax implies a higher tax level in Finland than the revenue tax in Denmark and Sweden, as the profit tax was calculated to be equivalent to a revenue tax for electricity prices of 280 EUR/MWh and applies to a longer period. While this does not influence short-term incentives, it influences competitiveness and may influence long-term investment decisions.

Long-term impacts

The potential long-term impacts relate to incentives to invest. Investment decisions depend on expectations about future prices and cash flows. Therefore, the main question is how these crisis measures influence expectations about the future - whether investors believe that policymakers will implement a revenue cap or profit tax (or other extraordinary measures) whenever prices are particularly high. If they believe that a similar tax will be introduced in the future, the expected after-tax profitability of new investment projects will be reduced, and investments may be

reduced as well. To maintain incentives to invest, it is important to emphasize that the measures were introduced as a response to an extraordinary crisis and not as regular taxes.

Electricity prices are much higher now than they were prior to 2021. Investments have been planned and carried out at much lower prices than those of today. However, uncertainty about market conditions in general – prices and taxes – may cause some investors to postpone making decisions.

It is worth noting that differences in the implementation of the measures may lead to changes in competitiveness between the countries. This could have long-term impacts, such as investments being “moved” from one country to another. Again, the negative effects on investment can be mitigated by communicating that these crisis measures are unlikely to be used again.

Hence, if investors believe that the current emergency measures are exceptional and time-limited crisis measures indeed, long-term incentives to invest should not be affected. Therefore, it is crucial that the authorities emphasize the temporary, one-time nature of these extraordinary measures.

Solidarity contribution from the fossil fuel sector

The third measure is the solidarity contribution from the fossil fuel sector. This involves a mandatory contribution of at least 33% of the taxable profits in fiscal years 2022 and/or 2023 that are higher than 20% of average profits in the four preceding fiscal years. This applies to companies with activities in the crude oil, natural gas, coal and refinery sectors. This measure appears to be less relevant for the three countries of this study, as no such companies were identified in Finland, and only a few relevant companies were identified in Sweden and Denmark.

The fossil fuel solidarity contribution is, in essence, an extraordinary tax on the profits of fossil fuel companies. A profit tax does not influence short-term incentives to produce, but it may influence long-term incentives to invest if it influences expectations about future net tax revenues. Representatives of the fossil fuel sector have argued that the solidarity contribution may reduce investments in green technologies. However, the profitability of green investments will not change because of the tax on fossil fuel companies. Other companies will invest in green technologies as long as these investments are profitable relative to other investments in the economy. Moreover, as stated, if companies are convinced that the tax is a temporary and extraordinary measure, incentives to invest will not be affected.

Conclusions

The Nordic electricity market has responded relatively well to the current crisis. The increased prices, together with information and awareness campaigns and other measures, resulted in lower demand in the 2022–2023 winter. The reduction in demand during peak hours in Sweden was considerably larger than the 75 MW procured by the flexibility scheme. Hence, the reduction in electricity consumption in the rest of the economy was significant. Based on the current data, it is difficult to distinguish between the effects of the special measures and the effects of prices.

The revenue cap on inframarginal technologies, as implemented in Denmark and Sweden, does not distort short-term incentives to produce to a significant degree. However, administrative costs may be high. Considering that power prices have been much lower in 2023 than they were in the second half of 2022, the actual tax revenue from these measures is relatively low.

A profit tax, as implemented in Finland, is theoretically better than a revenue cap. In addition, the administrative costs of a profit tax are likely to be lower.

Different tax schemes may influence the competitiveness of producers in different countries. In the long term, this could lead to investments being “moved” from one country to another.

The main potential impacts of the emergency measures relate to incentives to invest in new production capacity. If investors believe that the current emergency measures are indeed exceptional, targeted and time-limited, as stated in the Council Regulation, the long-term incentives to invest should not be affected. If, on the other hand, they expect new crisis measures to be implemented whenever prices are exceptionally high, they may hesitate to invest. Hence, it is crucial that the authorities emphasize the temporary, one-time nature of these extraordinary measures – as also stated in the Council Regulation.



Solar panels in Västerås Sweden.

Photo: Hans Berggren / Scandinav / imagebank.sweden.se

1. Introduction

The Council of the EU proposed the Regulation on an emergency intervention to address high energy prices in Europe (hereafter "the CR") on 14 September 2022. The CR was adopted 6 October 2022 and came into effect from 8 October 2022.^[1]

The aim of the CR was to mitigate the effects of high energy prices on energy consumers through exceptional, targeted and time-limited measures. The primary measures to reach this aim were:

- Reduction in electricity demand
- Cap on market revenues for inframarginal technologies in electricity generation
- Solidarity contribution from the fossil fuel sector

1. Source: EUR-Lex - 32022R1854 - EN - EUR-Lex (europa.eu)

The CR also included measures that enable member states to intervene in the price setting of electricity for households and small- and medium-sized enterprises (SMEs).

The CR stipulated the measures that member states were to implement. However, there was some flexibility in how these measures could be implemented. One aim of this study is to describe how the emergency measures outlined in the CR were implemented in the Nordic countries. The second aim is to assess the impact of these measures on the Nordic wholesale power market in the short and long term.

The CR has been implemented in Denmark, Finland and Sweden. Iceland and Norway are not members of the EU, and since the CR is not EEA-relevant (and therefore not compulsory), Iceland and Norway have not implemented the CR.^[2] Hence, Iceland and Norway are outside the scope of this report.

1.1. Organization of the report

This report is organized as follows. We start by describing the three main measures in the CR in greater detail, after which we describe how the CR has been implemented in each country in Chapter 2. Chapter 2 also summarizes the market agents' reactions to the measures.

After describing the measures and how they have been implemented, we turn to the impacts of the measures. We examine the impacts of the revenue cap in Chapter 3, the impacts of the measures to reduce electricity demand in Chapter 4 and the impacts of the fossil fuel solidarity contribution in Chapter 5. Our focus is on the short- and long-term impacts on the Nordic electricity market. Short-term impacts refer to production and consumption decisions, while long-term impacts refer to investment decisions. Finally, Chapter 6 concludes.

2. Norway has introduced measures in response to the high electricity prices (see e.g., [Høyprisbidrag på vind- og vannkraft - regjeringen.no](#) and [Regjeringens strømtiltak - regjeringen.no](#)), but these measures were implemented before the CR.

1.2. Methods

The report is based on the following methods:

- A review of relevant official documents, reports, articles in the media, responses to public consultations in the three countries, etc.
- Interviews with various power market participants, such as representatives of regulators, transmission system operators (TSOs) and producer organizations.
- Data: consumption data has been published by the TSOs and the authorities. However, much of this data was made public just before the finalisation of the report.

1.3. Background: High prices in late summer and early autumn of 2022

The CR was introduced in October 2022 following a couple of months of debate. Power prices had been extraordinarily high for several months, not only during a few peak hours but over a longer period. The price levels were unprecedented, especially for the summer months of June, July and August, and remained high even in September 2022 (see Figure 1.1). This is the background of the CR.

Figure 1.1 shows that power prices dropped considerably in October 2022. Although prices were high in December (slightly below 250 EUR/MWh on average in Denmark, Finland and Southern Sweden), they were much lower than in August. In the first quarter of 2023, the average power price was below 100 EUR/MWh in Finland and Southern Sweden and slightly above 100 EUR/MWh in Denmark. Although this is still considerably higher than the historical price level, it is well below the level of August and September, when the CR was being discussed.

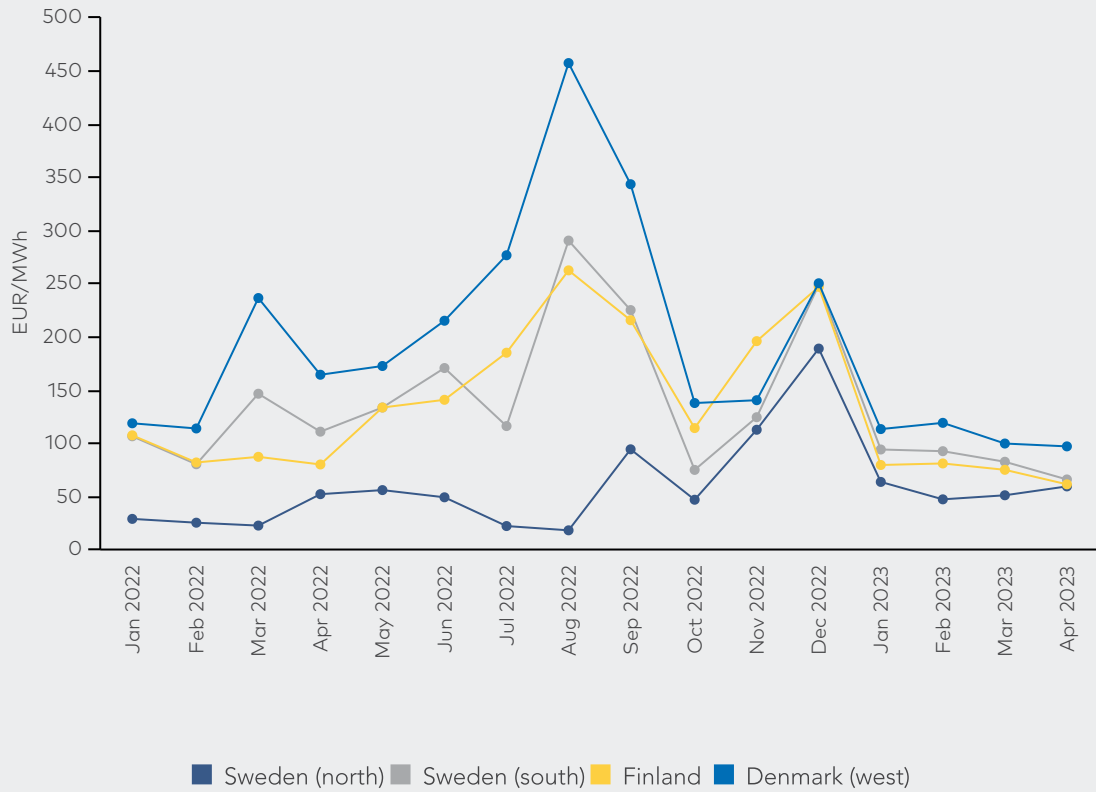


Figure 1.1. Monthly average spot prices (day-ahead), January 2022 – April 2023

Source: Vista Analyse, based on data from ENTSO-E



Amager Bakke. Waste energy plant in Copenhagen, Denmark.
Photo: Hofton&Crow

2. Implementation of emergency measures in the Nordic countries

The CR required EU member states to implement emergency measures in response to high electricity prices. In short, the main measures outlined in the CR were:

- **Reduction in electricity demand** that involved two targets:
 - A mandatory 5% reduction in peak-hour electricity consumption in the period of 1 December 2022–31 March 2023.
 - A voluntary 10% reduction target of total electricity consumption in the period of 1 November 2022–31 March 2023.

Countries could decide on appropriate measures to meet these targets.

- **Cap on market revenues for inframarginal technologies in electricity generation:** the revenues of some electricity generators were capped at 180 EUR/MWh. This applied to the inframarginal technologies, i.e., those with marginal costs lower than the market price. The cap applied until 30 June 2023.
- **Solidarity levy from the fossil fuel sector:** companies active in the petroleum, gas, coal and refinery sectors had to make a mandatory solidarity contribution of at least 33% of their taxable profits that exceed the previous four fiscal years' average profits by 20%.

Although these measures were outlined in the CR, the specific implementation was left to the member states, and there was some flexibility regarding the practical implementation of the measures.

Sections 2.1–2.3 provide more detail about the requirements of the CR and their implementation in each country. Table 2.1 summarizes the requirements of the CR and the implementation of the measures in the Nordic countries.

We also present a short overview of the reactions from the market agents in each country based on responses to public consultations on the law and interviews with market agents and authorities.

Table 2.1. Overview of the implementation of the emergency measures in the Nordic countries

	The Council Regulation	Sweden	Denmark	Finland
Reduction in electricity demand	<p>Mandatory 5% reduction in electricity consumption during peak load hours between 1 December 2022–31 March 2023.</p> <p>Voluntary 10% reduction of total electricity consumption between 1 November 2022–31 March 2023.</p> <p>Flexible implementation and somewhat flexible definition of peak hours.</p>	<ul style="list-style-type: none"> • Consumption flexibility procurement scheme. • Energy savings in 198 public institutions. • Information campaign. 	<ul style="list-style-type: none"> • Energy savings in the state and public sectors. • Energy-saving campaigns for households and businesses. 	<ul style="list-style-type: none"> • Voluntary power system support procedure. • Energy-saving campaign "Down a degree".
Cap on market revenues	<p>180 EUR/MWh cap on market revenues obtained from the sale of electricity produced from specific sources between 1 December 2022–30 June 2023.</p>	<p>180 EUR/MWh cap on market revenues obtained from the sale of electricity produced from specific sources between 1 March 2023–30 June 2023.</p> <p>Tax applied to 90% of hourly realized revenues exceeding the cap.</p>	<p>180 EUR/MWh cap on market revenues obtained from the sale of electricity produced from specific sources between 1 December 2022–30 June 2023.</p> <p>Tax applied to 90% of monthly realized revenues exceeding the cap.</p>	<p>Additional 30% tax on electricity companies' profits in 2023, above "ordinary" return on equity.</p> <p>The tax is levied on electricity producers and, under certain conditions, retailers.</p>
Solidarity contribution from fossil fuel sector	<p>The fossil fuel sector is levied a tax of 33% on taxable profits that exceed the average profits in the four preceding years by 20%.</p> <p>Applies to fiscal year 2022 and/or 2023.</p>	<p>The fossil fuel sector is levied a tax of 33% on taxable profits that exceed the average profits in the four preceding years by 20%.</p>	<p>The fossil fuel sector is levied a tax of 33% on taxable profits that exceed the average profits in the four preceding years by 20%.</p>	<p>The fossil fuel sector is levied a tax of 33% on taxable profits that exceed the average profits in the four preceding years by 20%.</p>

Source: Vista Analyse

2.1. Measure 1: Reduction in electricity consumption

We start by describing how the CR stipulated the demand reduction measures (Section 2.1.1) before explaining how Sweden, Finland and Denmark implemented the measures (Sections 2.1.2 to 2.1.4).

2.1.1. The Council Regulation: Electricity consumption reduction

The Council Regulation stipulated two demand reduction measures:

- A mandatory 5% reduction in electricity consumption during peak load hours.
- A voluntary 10% reduction target in total electricity consumption.

2.1.1.1. A mandatory 5% reduction in electricity consumption during peak hours

The Council explained the motivation to introduce a peak hour demand reduction as follows:

To preserve fuel stocks for electricity generation and to specifically target the hours with highest price or consumption of electricity, when gas-fired power generation has a particularly significant impact on the marginal price, each Member State should reduce its gross electricity consumption during identified peak hours.

Recital 17, the CR

In addition, according to Article 4 of the CR, each member state was to identify the expected peak hours for 1 December 2022–31 March 2023 and reduce electricity consumption by an average of at least 5% per hour during these hours. The peak hour demand reduction was calculated as follows:

... the difference between the actual gross electricity consumption for the identified peak hours and the gross electricity consumption forecasted by the transmission system operators [...] without taking into account the effect of the measures put in place to reach the target set in this Article.

Article 4.1, the CR

Member states had some flexibility in defining peak hours, as long as the energy saved was at least equal to the amount implied by the parameters in the CR; however, at least 10% of the hours needed to be covered.

The CR outlined three ways to define peak load hours (Article 2.4):

- Hours with the highest expected prices according to forecasts.
- Hours with the highest expected consumption.
- Hours with the highest expected non-renewable consumption.

The CR did not specify which measures should be used to achieve consumption reduction. However, the CR asked member states to consider market-based measures, such as auctions and tender schemes, in particular.

2.1.1.2. A voluntary 10% reduction in total monthly gross electricity consumption

According to Article 3.1 of the CR, member states were to endeavour to implement measures that would reduce total electricity consumption by 10%. The *comparison period* was the average consumption in the corresponding month (November–March) of the reference period. The *reference period* was defined as the same months in the five years before the 2022–2023 winter, beginning with the winter of 2017–2018.

2.1.1.3. Flexibility in the implementation of demand reduction measures

The CR suggested that demand reduction measures include national awareness-raising campaigns, publishing targeted information about the forecasted electricity system situation, regulatory measures limiting non-essential energy consumption, and targeted incentives to reduce electricity consumption (see Recital 19 of the CR). Member states were free to choose how to reach the demand reduction targets set by the Council and could extend existing national measures. However, the implemented measures stipulated the following conditions (Article 5):

1. Where financial compensation is paid in addition to market revenues, the amount of that compensation shall be established through an open competitive process.
2. Only involve financial compensation when such compensation is paid for additional electricity not consumed compared to the expected consumption in the hour concerned without the tender.
3. Not unduly distort competition or the proper functioning of the internal market in electricity.
4. Not be unduly limited to specific customers or customer groups, including independent aggregators, in accordance with Article 17 of Directive (EU) 2019/944.
5. Not unduly prevent the process of replacing fossil fuel technologies with technologies using electricity.

2.1.2. Sweden: Consumption reduction implementation and reactions

Key features of the implementation of demand reduction measures in Sweden

- Public institutions were required to implement energy-saving measures.
- The information campaign "Every kilowatt-hour counts".
- Svenska kraftnät introduced a procurement scheme to reduce peak load consumption.
- Peak hours were defined as three hours each weekday morning and afternoon.

Some initiatives to reduce power consumption were enacted before the CR was adopted. For instance, public institutions were required to implement energy-saving measures, and an information campaign aiming to inform the public about possible measures to reduce consumption and shift consumption away from peak load hours was launched. In addition, in September 2022 the Swedish government asked the Swedish TSO Svenska kraftnät to consider measures to reduce demand and increase demand flexibility.

2.1.2.1. Definition of peak hours

In Sweden, peak hours were defined as three hours in the morning (8:00–10:59) and three hours in the afternoon (16:00–18:59) every weekday.^[3] The minimum requirement of the CR was one hour per day. The Swedish definition corresponds to approximately 18% of all hours during the period of 1 December 2022–31 March 2023, i.e., a higher share of all hours than required in the CR (10%). The highest expected consumption interpretation was used to identify the peak load hours.^[4]

2.1.2.2. Svenska kraftnät considered several models for procuring flexibility

In September 2022, the Swedish government tasked Svenska kraftnät with preparing further procurement of consumption and production flexibility in Southern Sweden.^[5] After the CR was adopted, Svenska kraftnät made sure that the consumption procurement alternatives were designed to correspond with the CR.

3. Svk report 2022/3283, 30 November 2022

4. Redovisning av fastställda höglasstimmor i samband med regeringsuppdrag att genomföra upphandling av förbrukningsflexibilitet under höglasstimmor (I2022/0204310 November 2022)

5. Uppdrag att förbereda ytterligare upphandling av förbrukningsflexibilitet och planerbar elproduktion i södra Sverige (I2022/01721, 8 September 2022)

Svenska kraftnät considered several consumption procurement models and production procurement models (see Text Frame 2.1). In the end, a consumption flexibility procurement model was chosen that compensated consumers who shifted consumption away from peak hours.

Agents could pre-qualify beginning in November 2022, and the procurement documents were published before Christmas 2022, with tenders being continuously evaluated thereafter. The procurement was conditional on the EU Commission's approval, as the compensation for the consumption reduction constituted state aid; Sweden received this approval on 6 February 2023. The first procurement agreement entered into force a few days after the European Commission's approval. The total flexibility procured under the scheme was 75 MW per peak load hour.

However, the high prices in December 2022 and January 2023, together with the information campaign and other measures, led to a sufficient reduction of electricity consumption, making the procurement scheme redundant. For instance, consumption was reduced by almost 2,000 MW in peak hours on average in December, January and February (see Section 4.2). The weakness of the scheme was that the selected consumers had to reduce their electricity consumption regardless of prices or whether there was a risk of power shortage. On 28 February 2023, Svenska kraftnät announced the closure of the flexibility procurement scheme.^[6] Agreements already made were valid until 31 March 2023.

2.1.2.3. Other consumption reduction measures

Other measures implemented in Sweden to reduce power demand include the following:

- Energy-saving measures in public institutions.^[7] This measure was implemented before the CR. The ordinance required that 198 public institutions take possible and appropriate energy-saving measures from October 2022–March 2023. On an ongoing basis, institutions with 10 or more employees must report their energy consumption and which measures they have introduced to reduce their electricity use.
- The public information campaign "Every kilowatt-hour counts" (*Varje kilowattimme (kWh) räknas*), which aims to inform the public about possible measures to reduce consumption and shift consumption away from peak hours.^[8]

6. Redovisning av fastställda höglasstimmor i samband med regeringsuppdrag att genomföra upphandling av förbrukningsflexibilitet under höglasstimmor (I2022/0204310 November 2022)

7. Uppdrag att vidta energibesparingsåtgärder inom den statliga förvaltningen (Fi2022/02571, 8 September 2022)

8. Varje kilowattimme (kWh) räknas (energimyndigheten.se)

Text Frame 2.1. Procurement schemes considered by Svenska kraftnät

Svenska kraftnät identified three models for consumption procurement and two models for flexible production capacity procurement, all of which were suggested to be financed by surplus congestion rents. According to Svenska kraftnät, the alternative models would benefit different agents and could therefore be used in combination for maximum effect.

The three consumption flexibility procurement models considered were:

- Alternative 1: Increase the use of price-dependent bids (hourly bids, block bids and flexible block bids with a price cap) in the spot market. The authorities would compensate consumers when they refrained from consumption, either per MW made price-dependent or based on the cost of lost output (due to reduced electricity consumption).
- Alternative 2: Compensation for shifting consumption from peak hours. Consumers move a certain volume of power purchases from expected peak load hours to other periods and receive compensation, for example, for higher production costs resulting from the shift. All else equal, the shift would decrease peak prices and increase other prices, levelling the price curve.
- Alternative 3: Compensation for the net reduction of power consumption. Consumers refrain from purchasing a certain volume of power without increasing consumption in other hours.

Alternative 2 was chosen, as it was considered to have a larger price-reducing effect than Alternative 1, especially during peak-load hours, while Alternative 3 would have a continuous price-reducing effect during the contract period.

The two flexible production procurement models entailed that Svenska kraftnät compensated producers who submitted additional bids to the spot market during peak load hours. The main difference was the compensation scheme. However, the schemes may have distorted competition because some agents received compensation from the procurement scheme and others did not.

The report also mentions the possibility of procuring larger production facilities with the aim of using these for remedial measures (countertrade and redirection) and the potential for using power reserves in the spot market to reduce prices.

Source: Uppdrag att förbereda ytterligare upphandling av förbrukningsflexibilitet och planerbar elproduktion i södra Sverige (svk.se)

2.1.3. Denmark: Consumption reduction implementation and reactions

Key features of the implementation of demand reduction measures in Denmark

- Mandatory energy-saving measures for central authorities.
- Voluntary energy-saving measures for local authorities.
- Energy-saving campaigns for households and businesses.

Denmark did not implement any new consumption reduction measures after the CR entered into force. A large-scale national energy-saving campaign targeting households, public authorities and private companies was established in June 2022 with the aim of reducing energy consumption, including gas, specifically, and electricity consumption in general, along with moving energy consumption away from peak hours.^[9]

In addition, there are four pre-existing subsidy schemes with a primary focus of phasing out fossil fuels in the heating of private buildings:^[10]

- The Building Pool (*Bygningspuljen*)
- The Scrapping Scheme (*Skrotningsordningen*)
- The District Heating Pool (*Fjernvarmepuljen*)
- The Phasing-Out Scheme (*Afkoblingsordningen*)

2.1.3.1. Energy-saving measures in the public sector

The government issued instructions to all ministries, departments and public agencies (including agencies, councils and boards) to implement (mandatory) measures to save energy by 1 October 2022.^[11] The recommendations were incorporated into regulations that also implemented Article 5 of the current Energy efficiency directive (EED). The implementation and control thereof have been allocated to the responsible ministries. Exceptions are possible if measures are not feasible or technically possible to comply with, e.g., in hospitals.

9. Source: Answer to fulfilling monitoring obligations according to Article 19 of the Council Regulation (EU) 2022/1854, Danish Energy Agency, 23 January 2023.

10. Source: Description of heating subsidy schemes, Energistyrelsen, 21 April 2023.

11. Regeringen, Danske Regioner og KL er enige om at spare på energien i det offentlige (kefm.dk).

The four recommendations include the following:

- Decreasing the indoor temperature to 19° C
- Reducing the operating time of ventilation and heating systems in buildings
- Turning off unnecessary outdoor lighting
- Distributing information material to employees

Furthermore, local authorities promote the (voluntary) adoption of initiatives similar to those implemented by the ministries. Some municipalities have decided to go even further, for example, by reducing the water temperature of public indoor pools, closing saunas, reducing the use of public lighting and/or promoting working from home.

The Danish Energy Agency (DEA) also launched an information campaign to encourage civil servants to take local initiatives for energy conservation, such as turning off lights and computer screens in unused meeting rooms (see Chapter 2.1.3.3).

2.1.3.2. Energy-saving campaign for households

In June 2022, the DEA launched a national campaign with the objective of reducing energy use in Danish households. In particular, the campaign emphasizes reducing electricity consumption during peak hours and shifting consumption to cheaper (and greener) hours of the day.^[12]

The campaign includes information on energy consumption, advice on energy saving possibilities and encouragement to save energy via several different channels, such as outdoor posters, campaign videos on national TV, social media and the website SparEnergi.dk.

Furthermore, a number of information meetings for Danish gas customers and households in general have been held both online and locally around the country, and a hotline where Danish households can receive advice on energy consumption and energy-efficient solutions was established.

2.1.3.3. Energy-saving campaign for private companies

The DEA introduced a national energy-saving campaign targeting businesses with the goal of reducing energy consumption (both electricity and natural gas use).^[13] The campaign is aimed at trade and service industries, educational and cultural institutions, care facilities and smaller manufacturing companies, with the aim of moving some of the energy consumption away from peak hours.

12. Spareråd til hjemmet (spareenergi.dk).

13. Spareråd på arbejdspladsen | Energistyrelsen (spareenergi.dk).

The campaign website, SparEnergi.dk, features information and campaign material. Furthermore, the DEA has issued a catalogue with advice, guidance and calculations on energy savings in workplaces aimed at employees and operational managers in office buildings, etc.

The DEA has also engaged the public in general through outdoor posters, campaign videos on national TV and social media to encourage local energy-efficient behaviours, such as turning off lights, screens, computers and other electronic devices when leaving a room or workspace, as well as switching to LED lights.

2.1.3.4. The Building Pool (Bygningspuljen)

The Building Pool is an application-based subsidy scheme where individuals and households can apply for grants subsidising the installation of an electric heat pump when converting from gas, oil or pellet boilers or electrical heating. The scheme also offers grants for general energy-efficiency measures, such as insulation, ventilation and energy-efficient windows.

The subsidy is variable, based on a fixed percentage of the estimated market cost of the measure. The subsidy is 15% for most measures and is paid out after the measure has been documented as completed within the requirements established in the legal framework. The demand for the subsidy has exceeded the allotted funds every year since its introduction in late 2020.

Beginning in 2023, the Building Pool was divided into two separate schemes: one focusing on heat pumps and the other on energy efficiency measures.

2.1.3.5. The Scrapping Scheme (Skrotningsordningen)

The Scrapping Scheme is an application-based subsidy scheme targeting private companies that sell heat pumps with an accompanying service agreement subscription, including installation of the heat pump. The scheme provides grants for converting away from gas, oil and pellet boilers to an electric heat pump. The grant covers a maximum of 45% of the eligible costs for conversion from gas- and oil-fired boilers and 30% for conversion from a pellet boiler. The maximum amount of the subsidy is 25,000 DKK. The scheme has not achieved full disbursement of the allocated funds since its implementation in late 2020.

2.1.3.6. The District Heating Pool (Fjernvarmepuljen)

The District Heating Pool is an application-based subsidy scheme targeted at district heating companies that roll out district heating in new areas. The scheme provides subsidies for conversions from gas- or oil-fired boilers to district heating. The district heating companies can receive a subsidy of up to 20,000 DKK per converted gas- or oil-fired boiler. The demand for funding through the District Heating Pool has been high and steadily increasing over the last year.

2.1.3.7. The Phasing-Out Scheme (Afkoblingsordningen)

The Phasing-Out Scheme is a fee-waiver scheme targeted at individual gas consumers who use gas for heating. When an individual gas consumer sends a decoupling request from the gas grid to the distribution system operator (Evida), they normally have to pay a decoupling fee; however, this scheme covers the cost of the decoupling for individual gas consumers. The scheme has a limited budget for each year. The amount covered by the scheme is between 7,000–8,200 DKK, depending on the area in which the gas consumer lives. The fee is disbursed by the DEA to Evida. The scheme was so popular among individual gas consumers that it received additional funding in 2022 and 2023.

2.1.4. Finland: Consumption reduction implementation and reactions

Key features of the implementation of demand reduction measures in Finland

- Voluntary power system support procedure.
- The energy saving campaign "Down a Degree".
- Peak hours were defined as two hours every morning and three hours every afternoon on weekdays.

2.1.4.1. Definition of peak hours

Peak hours in Finland were defined only for December 2022–February 2023: every weekday from 8:00–10:00 and 17:00–20:00, excluding holidays.

2.1.4.2. Voluntary power system support procedure

At the beginning of December 2022, the TSO Fingrid introduced a new scheme to avoid electricity outages. The aim of the scheme is to engage companies and public entities who can reduce demand or increase electricity production (for example, by starting back-up power generators) but do not participate in the day-ahead or balancing markets.^[14] If there is risk of a power shortage, Fingrid contacts the agents directly by text message, informing them about the risk and asking them to be prepared. This typically happens a day ahead. The agents are only asked to activate the emergency measures when there is a real need.^[15]

Fingrid has entered into agreements with about 50 companies and public entities (e.g., the Helsinki-region water supplier, Yara, SSAB and Metsä). The minimum contribution from an agent is 1 MW. At the time of this writing, the total capacity acquired through the scheme is over 500 MW.

The companies are not compensated for this other than through price effects on the market.^[16] Fingrid has pointed out that an important part of the scheme is the identification of potential measures and the education of participating companies' employees in how to reduce electricity consumption should the risk of a blackout or a brownout occur.

In April 2022, the scheme was extended to spring 2024.^[17]

14. Sähkönsäästö jatkunut marraskuussa - sähköjärjestelmän tuki -menetelmän operatiivinen käyttö alkaa - Fingrid.

15. Good preparations for electricity shortages - Fingrid-lehti (fingridlehti.fi).

16. Sähköjärjestelmän tuki - Fingrid.

17. Sähköjärjestelmän tuki -menettelyä jatketaan keväälle 2024 - Fingrid.

2.1.4.3. Energy-saving campaign "Down a Degree"

The Finnish energy saving campaign "Down a Degree" (*Astetta Alemmas*) began on 10 October 2022 and has the following goals:

- All Finns take specific energy-saving measures with the aim of producing quick results.
- Everyone voluntarily limits their electricity consumption during the hours of the day when consumption is highest – on weekdays from 8:00–10:00 and 16:00–18:00 – by moving the use and charging of electrical devices to other times.^[18]
- Energy consumption is reduced throughout society, including in homes and housing companies, businesses, municipalities, organizations and educational institutions.

In addition, the campaign's web page in English lists the following goals:

- Short-term goal: "To get over 95% of Finnish households to save energy and cut down on their consumption by 5% during peak hours."
- Long-term goal: "To permanently lower energy consumption and reduce electricity consumption peaks."

The campaign encourages everyone to limit their electricity consumption during peak hours. Consumers are also provided energy-saving advice and help with energy issues related to housing. The campaign is organized by the Energy Authority, Motiva, the Ministry of Economic Affairs and Employment of Finland, the Ministry of the Environment, the Prime Minister's Office and the Finnish Innovation Fund Sitra, and it is financed by the Energy Agency (Energiavirasto).

2.1.4.4. Information and education

Energy experts and representatives of the authorities have been active in the media, informing the public about the situation and possible measures to reduce energy and electricity consumption. This has contributed to increased awareness among the general public.

18. The peak hours defined by this campaign are different from the peak hours defined by the TSO when calculating peak hour consumption reduction.

2.2. Measure 2: Cap on market revenues

2.2.1. The Council Regulation: Market revenue cap on the sale of electricity

The Council explained the motivation to introduce a market revenue cap as follows:

The recent surge in the price of gas and hard coal has translated into an exceptional and lasting increase of the prices at which the gas and coal-fired power generation facilities bid in the day-ahead wholesale market. That in turn has led to exceptionally high prices in the day-ahead market [...] In a situation where consumers are exposed to extremely high prices which also harm the Union's economy, it is necessary to limit, on a temporary basis, the extraordinary market revenues of producers with lower marginal costs by way of application of the cap on market revenues achieved through the sale of electricity. [...] The cap on market revenues should apply to technologies with marginal costs lower than the cap on market revenues, such as for instance wind, solar, nuclear energy or lignite.

From recitals 23, 25 and 32, the CR

According to Article 7.1, the cap applied to the market revenues obtained from the sale of electricity produced between 1 December 2022–30 June 2023 from the following sources:

- Wind and solar (thermal and PV)
- Geothermal
- Hydropower without storage
- Biofuels, except for biomethane
- Waste
- Nuclear
- Lignite and crude petroleum products
- Peat

The market revenues from electricity generation from these sources were capped at a maximum of 180 EUR/MWh of electricity produced.

According to Article 6.2, the cap on market revenues targeted all the market revenues of producers, regardless of the market in which a transaction took place. In the Nordic region, there were three relevant wholesale power markets with different time frames: the day-ahead market, the intraday market and the balancing market. Nord Pool is the main power exchange for electricity in the Nordic countries. In addition to Nord Pool, physical electricity is traded bilaterally through power purchasing agreements (PPAs).^[19]

Table 2.2 summarizes the main features of the CR as it was implemented in the Nordic countries. Sections 2.2.1 to 2.2.4 below provide more details.

19. There are also markets for trading financial derivatives used for hedging and/or speculation, such as the financial power futures markets on Nasdaq OMX.

Table 2.2. Cap on market revenues: Summary of implementation in the Nordic countries

Option	Sweden	Denmark	Finland
Type	Revenue cap	Revenue cap	Profit tax 30% on profits over 10% annualized ROE
Generation technologies included	Same as in the CR - Hydropower with storage < 24 hours included - Crude oil included, but fuel oil exempt	Same as in the CR	Tax applies to all producers
The cap level	1957 SEK/MWh (Equivalent to 180 EUR/MWh)	180 EUR/MWh	Intended to be equivalent to an average power price of 280 EUR/MWh
Cap applied to 90% of excess revenues?	Yes	Yes	Intended to be equivalent
Special cap for high-cost producers?	Yes 1.3 times variable costs	Yes Fixed amount on top of costs	No Tax applies to all producers
All wholesale markets covered (day-ahead, intraday and balancing market)?	Yes	Yes	Yes
Reference prices?	Yes Day-ahead price used as a reference for all wholesale markets	No Actual price for all wholesale markets	N/A
Hedging agreements and PPAs taken into account?	Yes	Yes	Yes
Settlement (hourly, monthly, yearly)	Hourly, with monthly corrections for hedging positions	Monthly	Yearly (tax year 2023)
Duration	1 March 2023 – 30 June 2023	1 December 2022 – 30 June 2023	The tax year 2023

Source: Vista Analyse

2.2.2. Sweden: Revenue cap implementation and reactions

Key features of the implementation of the revenue cap in Sweden

- The cap applied to 90% of revenues from electricity sales with prices above 180 EUR/MWh.
- The tax base was calculated as the sum of electricity sales in each hour multiplied by the corresponding day-ahead price, which was used as a reference price for all markets.
- Hedging agreements and long-term contracts were taken into account when calculating the tax base (i.e., the actual price obtained by the producer).
- High-cost technologies had a special revenue cap of 1.3 times the operating costs.
- Duration: 1 March 2023–30 June 2023.

The Swedish government issued a memorandum on 12 December 2022, with supplementary provisions to the CR on the market revenue cap.^[20] The memorandum was submitted for public consultation in Sweden. Following the feedback from the public consultation, the government adjusted the memorandum and provided clarifying comments to certain provisions before submitting it to the Council on Legislation for consultation, after which a final bill was submitted to the Swedish Parliament (Riksdag).^[21] The Riksdag passed the bill, and the new law entered into force 1 March 2023.^[22]

The main difference between the Swedish implementation and the CR is that the legislation took effect on 1 March 2023 and not 1 December 2022. The government explained the postponement as the need to politically process the bill through both the Council on Legislation and the Riksdag.

Other than the implementation date, the provisions of the bill were similar to those of the CR. The tax applied to 90% of revenues obtained from the sale of electricity that exceeded the price cap produced by the technologies listed in the CR.^[23] The cap was set at 1,957 SEK/MWh, which corresponded to the minimum level stipulated in the CR (180 EUR/MWh).

20. Tillfällig skatt på vissa elproducenters överintäkter Fi2022/03328 (12 December 2022).

21. Extra ändringsbudget för 2023 – Tillfällig skatt på vissa elproducenters överintäkter - Regeringen.se.

22. Extra ändringsbudget för 2023 – Tillfällig skatt på vissa elproducenters överintäkter (Betänkande 2022/23:FIU33 Finansutskottet) | Sveriges riksdag (riksdagen.se).

23. Electricity generated from crude petroleum products were taxed, but fuel oil generators were exempt.

The day-ahead market price was used as a reference price for all market revenues. Revenues from all wholesale markets were included in the tax base, but price differences between the markets were not taken into account.

The tax base was adjusted for hedging positions and long-term contracts (such as power purchasing agreements).

A special revenue cap applied to production technologies with high operating costs. For those producers, the cap was 1.3 times the operating costs.

2.2.2.1. Reactions from market agents and the general public in Sweden

The government invited private and public organizations to give feedback on the proposal. The final bill included relevant feedback from the public consultation and the government's explanations for each provision.^[24]

Most responses endorsed (or at least did not object to) the general intentions of the proposed implementation of the CR. Many of the responses requested clarification on how certain terms should be understood or the practical implementation of certain provisions. There were also some warnings about excessive administrative burdens of practical implementation. It was mostly energy producers who argued against the proposal.

The feedback about impacts on wholesale markets can be summarized as follows:

- There were no objections to limiting the revenue cap to 90% of excess income (instead of 100%).
- Some consumer organizations (e.g., Villaägarnas Riksförbund) believed that the tax should be applied retroactively from 1 December 2022. Producers endorsed the planned application for 1 March 2023.
- Some agents (Svenska kraftnät, Nord Pool AB and Finansinspektionen) indicated that using the day-ahead market price as a reference for all markets could influence incentives towards supplying intraday and balancing markets, which often have higher prices. This could increase prices on day-ahead and derivatives markets. However, Svenska kraftnät assessed this risk to be less critical than the risk of decreased liquidity in balancing markets.
- Producers advocated that the tax should be based on a monthly average price, not an hourly price.
- There were no objections to a special revenue cap for producers with high operating costs. However, there were several requests for clarification.

A more complete overview, including government clarifications, is available in the bill text.

24. Remiss av promemorian Tillfällig skatt på vissa elproducenters överintäkter - Regeringen.se.

2.2.3. Denmark: Revenue cap implementation and reactions

Key features of the implementation of the revenue cap in Denmark

- The cap applied to 90% of revenues from electricity sales for prices above 180 EUR/MWh.
- The tax base was calculated based on average monthly prices (not daily or hourly).
- Hedging agreements and long-term contracts were taken into account when calculating the tax base.
- High-cost technologies (biomass- and oil-fired power plants) had a special revenue cap depending on fuel prices.
- Duration: 1 December 2022 – 30 June 2023.

Denmark had a general election in late 2022, which delayed the political treatment of the national supplementary provisions to the Council Regulation. To ensure security of supply while awaiting the government's implementation proposal, the Danish Energy Agency informed the relevant stakeholders about the possible implementation and that the Danish implementation was likely to be similar to the provisions stipulated by the EU.

The Danish government sent a proposal of the bill for public consultation on 27 January 2023.^[25] The bill, along with public consultation feedback, was presented to the Danish Parliament (Folketinget) on 22 March 2023, and it was adopted on 27 April 2023.^[26]

The purpose of the bill was to supplement and implement the provisions on a mandatory cap on market revenue of 180 EUR/MWh. Those liable were electricity producers with income from the production and sale of electricity from 1 December 2022–30 June 2023. Those liable for the tax had to pay 90% of their realized market income above the income cap. Hedging agreements and long-term contracts (PPAs) were taken into account when calculating market income.

Power plants producing electricity from crude oil products and solid biomass fuels had a higher revenue cap to account for operating costs above the revenue cap. Furthermore, a number of production facilities were exempt for other reasons, such as security of supply, effects on heating prices for consumers and administrative burdens for smaller producers.

25. L 68 - Forslag til lov om et loft over indtægter fra elproduktionen | Skatteministeriet (skm.dk).

26. Lov om et loft over indtægter fra elproduktion (retsinformation.dk).

The final bill was passed by the Folketinget on 27 April 2023. The law was effective retroactively from December 2022.

Explanation for using a monthly average price rather than hourly prices

The government assessed that a calculation of the actual income on a shorter term (daily or hourly basis) would entail significant administrative costs for producers, as many only received a monthly settlement from their balance responsible parties. Therefore, it was proposed to use a calculation method that was based on actual monthly production and income.

The government believed that in order to ensure security of supply, it was important that producers continued to have incentives to participate in all markets, including intraday and balancing markets. The Danish government explained in the bill that the preservation of these incentives required that prices on intraday and balancing markets were able to exceed the day-ahead price, which could have been at risk if the cap was binding. By calculating realized income on a monthly basis, producers had the opportunity to offset any high income from times of high intraday prices by balancing market prices with periods when their income was lower. Therefore, the proposed calculation method was considered to reduce disturbances in market incentives.

2.2.3.1. Reaction to the revenue cap in Denmark

The Danish government published public consultation statements on 22 March 2023. We present the most relevant feedback:^[27]

- Some argued that the revenue cap would reduce green investments and thus should not be prolonged (Dansk Erhverv, Eurowind, Green Power Denmark).
- European Energy noted that the regulation created challenges for producers of renewable energy, as it taxed green electricity instead of harmonizing taxation between all forms of energy. European Energy noted that Finland taxes all energy companies' excessive profits, which the Danish government should recognize.
- Several statements criticized that power brokers were exempt (Dansk Metal, FH, Forbrukerrådet Tænk). Dansk Erhverv supported the exemption. The government pointed out that independent brokers were not taxed per the CR but that "connected brokers" (e.g., through a group) were taxed to avoid within-group adaptations.^[28]
- Eurowind noted that prices had fallen since the adoption of the regulation and that the current price level could no longer justify the introduction of the revenue cap. Eurowind and Landbrug & Fødevarer noted that the proceeds of

27. For a complete list of statements, see [here](#).

28. There has also been an ongoing debate in Danish media about power brokers' extraordinary profits. See, for example <https://ekstrabladet.dk/nyheder/samfund/12-milliarder-til-danskerne-men-de-slipper/9607582>.

the proposal were not proportional to the administrative costs for electricity producers. European Energy and Green Power Denmark also pointed out the administrative burden.

- FH noted that the proposal resulted in limited proceeds and considered it unreasonable that only the minimum cap level was implemented.
- Dansk Erhverv, European Energy, Eurowind, Green Power Denmark and Landbrug & Fødevarer found it problematic that the legislation had a retroactive effect and pointed to Sweden, where the cap was effective beginning 1 March 2023. FH, however, recognized the need to implement the cap retroactively.

2.2.4. Finland: Tax on profits

Key features of the implementation of the profit tax in Finland

- Finland implemented an additional temporary tax on profits instead of a revenue cap.
- The tax applies to profits exceeding an annualized return of 10% on equity.
- The tax level is 30%, which was intended to provide at least as much tax revenue as a revenue cap given a certain average spot price level.
- The tax is levied on companies that produce and sell electricity, with some exceptions.
- The tax applies to the income year 2023.

The Finnish government submitted a bill to Eduskunta (the Parliament of Finland) on 29 December 2022, with supplementary provisions to the CR on the market revenue cap.^[29] The Eduskunta passed the bill with some changes to the original proposal at the end of February 2023.^[30]

The law includes provisions for a new temporary tax that applies to electricity companies' profits for the 2023 tax year. This profit tax is in addition to the ordinary corporate income tax. Profits exceeding a 10% annualized return on adjusted equity in taxpayers' electricity business activities are taxed at 30%. The purpose of the 10% threshold is to enable a tax-free income that corresponds to the capital cost of productive investments and thus avoid negative incentives in terms of investments in electricity production.

The tax is levied on companies that operate in the wholesale markets and produce electricity or supply electricity for consumption or resale if the company has revenues from such activities that exceed 500,000 EUR or is not already covered by the mandatory solidarity contribution on the fossil fuel sector.^[31] Electricity retailers are also exempt as long as they do not produce electricity, are part of a group producing electricity or own shares of a company that entitles them to purchase electricity below market price. For details related to other considerations and exceptions, see the law text.^[32]

29. Regeringens proposition RP 320/2022 rd.

30. Ärendets behandlingsinfo RP 320/2022 rd.

31. See § 3 of the law.

32. The Riksdag's response RSv 324 /2022 rd.

The Finnish profit tax is different from the provisions in the CR because it is on profits and not on (gross) revenues. The government explained the motivation for taxing profits as follows:^[33]

The basic idea of the proposed taxes is that they should apply to the agents' net income, that is, the difference between income and expenditure. The tax to be paid by the companies on the electricity market then takes into account the differences in production costs for different forms of production better than the revenue ceiling according to the EU regulation. Since the tax is to be imposed on the basis of the net income of the agents in the electricity market, it can be applied in a more natural way than a revenue cap to all forms of electricity production and all electricity marketplaces. The tax thus treats different agents in a more equal way than a revenue cap, which to a greater extent covers the forms of production whose production costs are higher.

RP 320/2022 rd

2.2.4.1. Reactions from market agents and the general public in Finland

The bill includes a summary of the 60 responses from the public consultation of the bill draft. The relevant feedback from the public consultation to the bill draft can be summarized as follows:^[34]

- Some statements supported the profit tax (instead of a revenue cap), while others disagreed, arguing that the tax should be implemented as described in the CR.
- Several statements warned that the tax could cause a reduction in investment in renewables. However, other statements pointed out that the previous investment decisions were based on lower expected prices than the actual current prices, that the tax applies only for one year and that the consequences for investments would therefore be small.
- Attention was drawn to Finland's international competitiveness in a situation where Sweden, for example, intended to introduce a revenue cap for a shorter period (1 March–30 June 2023) than required by the EU regulation.
- Regarding the details of the tax base calculation, the consultation responses highlighted in particular that the 5% cap is too low^[35]; that the tax covers a longer period than the income cap according to the EU regulation; that the

33. For a thorough discussion of the relationship of the tax to the CR, see Report FiUB 44/2022 from the Finance Committee.

34. For the summary in its entirety, see the bill. For the individual consultation statements, see the Finnish Ministry of Finance's web page: <https://vm.fi/sv/projekt?tunnus=VM160:00/2022>.

35. The final bill changed the income limit from 5% to 10%, which was then passed.

tax should not apply to pure retailers; that losses should be considered; that the tax should be limited to the results of the electricity business; and that group situations should be considered.

After receiving the bill, the Finance Committee conducted an additional hearing with power sector stakeholders and experts^[36]

- According to the Finance Committee, experts were critical of the proposed regulatory approach and its relationship to the underlying EU regulation. The Finance Committee pointed out that the implementation of the regulation via the proposed profit tax could lead to a significantly higher revenue calculation than the EU regulation required in terms of the part exceeding the upper limit for market revenue. Experts also criticized the fact that the profit tax proposed in the bill was significantly harsher than measures in neighbouring countries. In particular, it was criticized that the tax was stricter than the revenue-cap model in Sweden.
- The ongoing energy transition and the current energy crisis highlight the importance of a well-functioning and stable investment environment in the energy sector. The proposed regulation was seen as reducing the predictability of the tax system and thereby lessening companies' investment incentives. From this point of view, it is important to compare the chosen model with regulations in other countries. The Finance Committee emphasized that, in view of the acceptability of the regulation, it was essential that the proposed model be temporary so that it would not delay or hinder investments in the energy sector.
- Given the predictability of the investment and business environment, it was deemed important that the chosen regulatory solutions supported a level playing field for businesses. The Finance Committee proposed that they further assess whether the model proposed in the bill sufficiently considered the different structures for electricity production so that the system would not unjustifiably discriminate against certain types of company structures.

The tax delegation of the Finance Committee also conducted a hearing with experts on taxation, finance and law, as well as power sector stakeholders:^[37]

- Many believed that it was justified to collect extra profits from companies in the electricity industry and that the proposed model was a reasonable solution given the exceptional situation.
- The business community and in particular the electricity industry did not support the proposed temporary tax on the profits of electricity companies

36. EkUU 72/2022 rd (eduskunta.fi).

37. FiUB 44/2022 rd (eduskunta.fi).

for the 2023 tax year and thought that Finnish stakeholders received worse competitive conditions than agents in other countries. Here, it was pointed out that the proposed model deviated in many parts from the model for a market revenue cap established in the CR, and that the proposed model was extensive and stricter than the model specified in the CR. At the hearing, it was also considered a problem that the tax would not only apply to excess income. The proposed tax-free share of 10% of the return on equity was considered too low. Furthermore, criticism was directed at the fact that foreign capital was not considered. However, others considered the annual tax-free return of 5% on equity (in the original draft bill) sufficient and thought it was not necessary to increase the rate to 10%. The reduction of the tax rate from 33% to 30%, according to the draft, was criticized. In addition, it was pointed out that a tax rate of 30% should ensure that excess profits were used for investments in renewable energy and the green transition and not for increased return on capital or rewards for company management.

- Many stressed that the proposed tax should be of a one-time nature. This was considered important to avoid negative investment effects. In a situation where the tax would be permanent or there was a prospect of it being reintroduced, the tax was considered to have negative consequences for investment.
- It was argued that the tax would treat companies differently depending on their capital structure.

2.3. Measure 3: Solidarity contribution from the fossil fuel sector

2.3.1. The Council Regulation: Solidarity contribution from the fossil fuel sector

The Council's motivation to introduce mandatory solidarity consumption from the fossil fuel sector was explained as follows:

[Companies in] the crude petroleum, natural gas, coal and refinery sectors, have seen their profits spike due to the sudden and unpredictable circumstances of Russia's war of aggression against Ukraine, reduced supply of energy and increasing demand due to record high temperatures. [...] The temporary solidarity contribution should act as a redistributing measure to ensure that the companies concerned which have earned surplus profits as a result of the unexpected circumstances, contribute in proportion to the improvement of the energy crisis in the internal market.

From recitals 50 and 51, the CR

Companies with activities in the crude petroleum, natural gas, coal and refinery sectors are levied a mandatory temporary solidarity contribution. The contribution shall be at least 33% of the taxable profits in fiscal years 2022 and/or 2023 that are more than a 20% increase over the average profits of the four preceding fiscal years.

2.3.2. Sweden: Fossil fuel solidarity contribution implementation and reactions

Key features of the implementation of the mandatory solidarity contribution in Sweden

- The mandatory contribution is set to 33% of profits in 2023 that exceed 120% of the average of before-tax profits from 2018–2021.
- The tax applies to companies where at least 75% of the taxable revenue in the 2023 income year derives from economic activities within the crude oil, natural gas, coal and refinery sectors.

The Swedish government sent a bill to the Riksdagen on 17 November 2022 proposing a new temporary tax on extraordinary profits for certain companies in 2023.^[38] The Riksdagen passed the bill on 21 December 2022.^[39]

The temporary tax applies to companies whose net revenues during the 2023 tax year are at least 75% attributable to operations in the fossil fuel sector. The tax is levied on the part of the companies' taxable profits in 2023 that exceeds 120% of the average taxable profit for 2018–2021. The temporary tax amounts to 33% and is levied in addition to the ordinary 20.6% corporate tax.

2.3.2.1. Reactions from market agents and the general public in Sweden

The government invited 10 private and public organizations to give feedback on the proposal.^[40] The final bill included relevant consultation feedback and a government explanation for each provision.

A majority of the responses endorsed (or did not object to) the general intentions of the proposed implementation of the CR. Those who argued against it were energy producers in the fossil fuel industry.

A summary of the feedback, focusing on the impacts on investments and prices, is as follows:

38. En tillfällig skatt på extraordinära vinster för vissa företag under 2023 - Regeringen.se

39. En tillfällig skatt på extraordinära vinster för vissa företag under 2023 Skatteutskottets Betänkande 2022/23:SkU9 - Riksdagen.

40. Remiss av promemorian En tillfällig skatt på extraordinära vinster för vissa företag under 2023 - Regeringen.se

- Drivkraft Sverige argued that such sudden and unexpected taxes may harm the green transition. Drivkraft Sverige argued that the tax may increase investment costs, resulting in price increases.
- Drivkraft Sverige argued that instead of the tax, companies that carry out a green transition could earmark an equivalent amount for sustainable investments.
- Some public institutions pointed out that companies may be able to use Swedish tax rules to neutralize the tax.

For a more complete overview, including the government's clarifications, see the bill text.

2.3.3. Denmark: Fossil fuel solidarity contribution implementation and reactions

Key features of the implementation of the mandatory solidarity contribution in Denmark

- The mandatory contribution is set to 33% of profits in 2023 that exceed 120% of the average of before-tax profits from 2018–2021.
- The tax applies to companies where at least 75% of the taxable revenue in the 2023 income year derives from economic activities within the crude oil, natural gas, coal and refinery sectors.

Denmark had a general election in late 2022, which delayed the political treatment of national supplementary provisions to the CR. The Danish government sent a bill proposal for public consultation on 27 January 2023.^[41] The bill was presented to the Folketinget on 22 March 2023, along with public consultation feedback.^[42]

The purpose of the bill is to supplement and implement the provisions on a mandatory temporary solidarity contribution from companies in the crude oil, natural gas, coal and refinery sectors. Those liable are companies where at least 75% of the taxable revenue in the 2023 income year derives from economic activities within the crude oil, natural gas, coal and refinery sectors. The liable profit is only the part of the company's taxable profit that is 20% higher than the average taxable profit before tax in the first four income years starting on 1 January 2018 or later.

The solidarity contribution rate is set at 33%.

41. L 69 - Forslag til lov om midlertidigt solidaritetsbidrag | Skatteministeriet (skm.dk)

42. L 69 - 2022-23 (2. samling) (oversigt): Forslag til lov om et midlertidigt solidaritetsbidrag. / Folketinget (ft.dk).

2.3.3.1. Reactions from the public consultation in Denmark

A short summary of the public consultation responses (ignoring responses that opposed the CR itself or the provisions stated in the CR) is as follows:

- Some criticized that the minimum tax level was chosen and that only 2023 (and not 2022) would be covered (Oxfam, FH, 92-gruppen). Others, such as Drivkraft Danmark, supported the minimum implementation. The government replied that more than 33% would trigger compensation for the DUC partners following the compensation agreement entered into in connection with the North Sea Agreement of 2003.
- Some argued that the tax would have negative effects on green investments, particularly those aimed at reducing emissions in fossil fuel operations and CCS/CCU (Kalundborg Refinery, Drivkraft Danmark).

2.3.4. Finland: Fossil fuel solidarity contribution implementation and reactions

Key features of the implementation of the mandatory solidarity contribution in Finland

- The mandatory contribution is set to 33% of profits in 2023 that exceed 120% of the average of before-tax profits from 2018–2021.
- The tax applies to companies where at least 75% of the taxable revenue in the 2023 income year derives from economic activities within the crude oil, natural gas, coal and refinery sectors.
- No companies were identified that would be liable to the proposed temporary tax for companies in the fossil fuel sector in Finland.

The Finnish government sent a bill to the Eduskunta on 29 December 2022 proposing a temporary tax on profits in the fossil fuel industry.^[43] The Eduskunta passed the bill in late February 2023.^[44]

The temporary tax on profits in the fossil fuel sector includes companies covered by the scope of the solidarity grant according to the CR; more than 75% of the turnover consists of the extraction of crude oil and natural gas, the production of refined oil products from crude oil and the manufacture of coal products.

The result of the business activity must, in accordance with the solidarity contribution according to the CR, be compared with the average result of the business activity for the tax years 2018–2021, and the result of the business activity during the tax year must be taxable to the extent that it is higher than 120% of the average result of the business activity during the comparison period. According to the CR, the taxable profit for 2023 determined in this way is subject to a tax rate of 33%.

2.3.4.1. Reactions from market agents and the general public in Finland

According to the Finance Committee, no companies in Finland were identified that would be liable for the proposed temporary tax for companies in the fossil fuel sector. The government did not include any public consultation responses to this tax in the proposition's summary. Furthermore, the Finance Committee of the Finnish Parliament had no objections to the proposed temporary tax for companies in the fossil fuel sector,^[45] nor were any objections raised during the hearing of experts.

43. RP 320/2022 rd; Laki sähköalan ja fossiilisten polttoaineiden... 363/2023 - Säädökset alkuperäisinä - FINLEX ®; Lag om tillfällig skatt på vinster inom... 363/2023 - Uppdaterad lagstiftning - FINLEX ®.

44. Ärendets behandlingsinfo RP 320/2022 rd.

45. FiUB 44/2022 rd (eduskunta.fi).



Aerial view of skyline Helsinki. Coal for Hanasaari Power Plant
Photo: iStock

3. Impacts of the revenue cap

The aim of the revenue cap was to collect extraordinary revenues from power producers and redistribute them to consumers in order to compensate for high electricity prices. However, if the tax were to lead to reduced electricity supply, the result could be even higher prices and/or problems with security of supply. We analysed how a revenue cap on inframarginal power production technologies may affect the incentives of power producers and market outcomes and assessed the short- and long-term impacts of the revenue cap on the wholesale electricity markets. The short-term impacts are related to incentives to produce, while the long-term impacts are related to incentives to invest in new capacity.

The focus of this report is the wholesale markets for electricity, i.e., the markets for the physical electricity trade. There are three such markets with different time frames: the day-ahead market, the intraday market and the balancing market. Nord Pool is the main power exchange for electricity in the Nordic

countries.^[46]

In this chapter, we start with an analysis of the impacts of the revenue cap as it was implemented in Sweden and Denmark (Sections 3.1 and 3.2). Finland implemented a temporary tax on profits for electricity producers instead of a revenue cap, which we analyse in Section 3.3. Furthermore, we discuss the impacts on competitiveness in the different countries in Section 3.4. Section 3.5 summarizes and concludes the chapter.

Main takeaways:

- The revenue cap, as implemented in Sweden and Denmark, does not affect short-term incentives for inframarginal producers, i.e., producers whose marginal costs are lower than the market price.
- Using a special revenue cap for producers with high marginal costs, as in Sweden and Denmark, ensures that incentives are preserved for these producers as well.
- The way the tax was implemented in Sweden, with day-ahead price as the reference price and using hourly prices for settlements, does not influence producers' short-term incentives. The impacts of using the monthly average price, as in Denmark, are not straightforward, but the incentives were preserved in Denmark as well.
- Accounting for hedging agreements and PPAs ensures that the tax is based on actual realized income. This reduces the risk of potential distortions. Since a large share of production is hedged, many producers are not influenced by the tax, even when spot prices are high.
- Profit taxes, as in Finland, do not influence short-run production incentives. However, the profit tax in Finland is likely to be higher than the revenue taxes in Sweden and Denmark.
- Administrative costs are likely to be lower with profit tax than revenue cap. Administrative costs are likely to be lower when using the monthly average price as a tax base.
- In order to maintain the incentives to invest in new capacity, the authorities should emphasize the temporary and extraordinary nature of the emergency measures.

46. In addition to Nord Pool, physical electricity is traded bilaterally through power purchasing agreements (PPAs). There are also markets for trading financial derivatives used for hedging and/or speculation, such as the futures markets on Nasdaq OMX.

3.1. Short-term impacts of revenue cap: Incentives to produce

The supply curve in the power market can be depicted by a merit order curve, which is a stepwise curve of different producers' marginal costs in increasing order. Figure 3.1 shows a stylised version of the merit order curve for the Nordic power market. Marginal costs include fuel and operation and maintenance (O&M) costs of production.^[47]

Which technology is market-clearing (i.e., marginal) at any given time depends on several things, such as demand (which depends on day, time of day, weather, etc.), fuel and CO₂ prices, the alternative value of water in hydropower reservoirs, wind and solar conditions, maintenance schedules, and more. In addition, transmission capacity between different geographical areas may be congested, leading to different prices in different areas. In low-demand periods, wind power or nuclear power may be the marginal technologies, while in high-demand periods, gas-fired power plants are often the marginal technologies; other plants are inframarginal.

The day-ahead market uses so-called marginal pricing.^[48] This means that all producers with accepted bids get the same price – the spot price – and all consumers pay the spot price. The spot price is the market-clearing price that ensures that demand equals supply at any given time.

47. For hydropower, the actual operation costs are very low, but the marginal costs include the opportunity cost (water value). The opportunity cost reflects the trade-off between producing now and postponing production until later. The opportunity cost of producing now is to lose the option to produce later.

48. Also called pay-as-clear or uniform pricing.

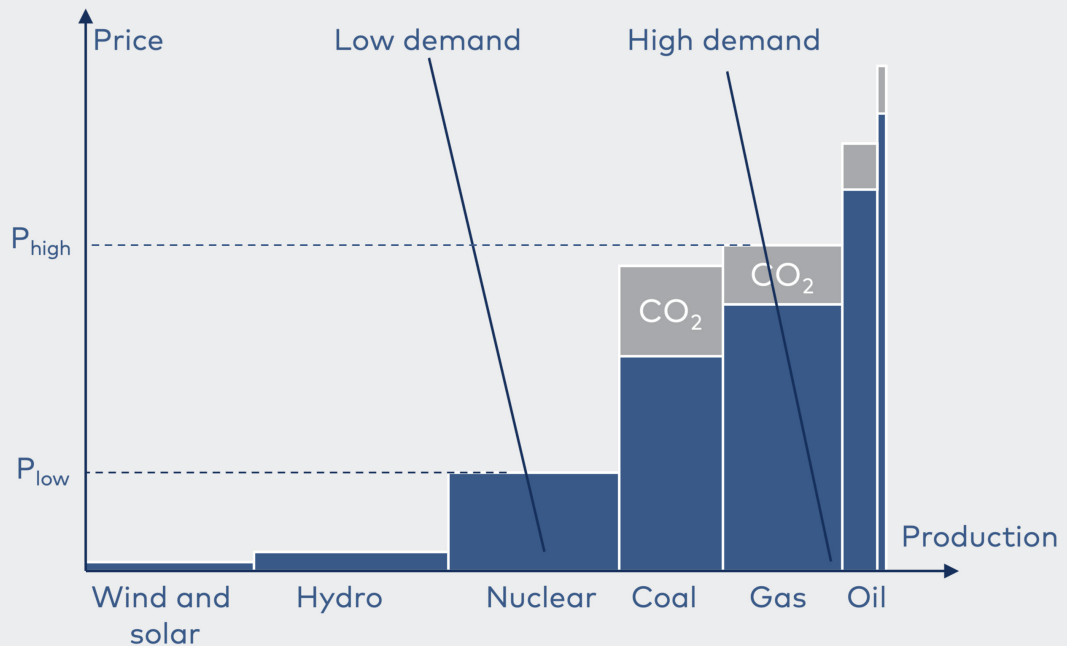


Figure 3.1. Merit order curve and determination of spot price in the Nordic power market

Source: Vista Analyse

Due to uniform marginal pricing, all producers whose marginal costs are lower than the spot price (i.e., the inframarginal producers) collect rent, which is indicated as "standard rent" in Figure 3.2. This rent covers fixed costs and the return on investments for the owners. The increase in gas prices in 2022–2023 have increased the marginal costs of gas power production. This has led to higher spot prices and additional inframarginal rents for all other producers (see Figure 3.2). It is this extra rent that the authorities seek to collect from inframarginal producers. Note that the revenue cap is a tax of 90% on additional rents; the producers keep 10%.

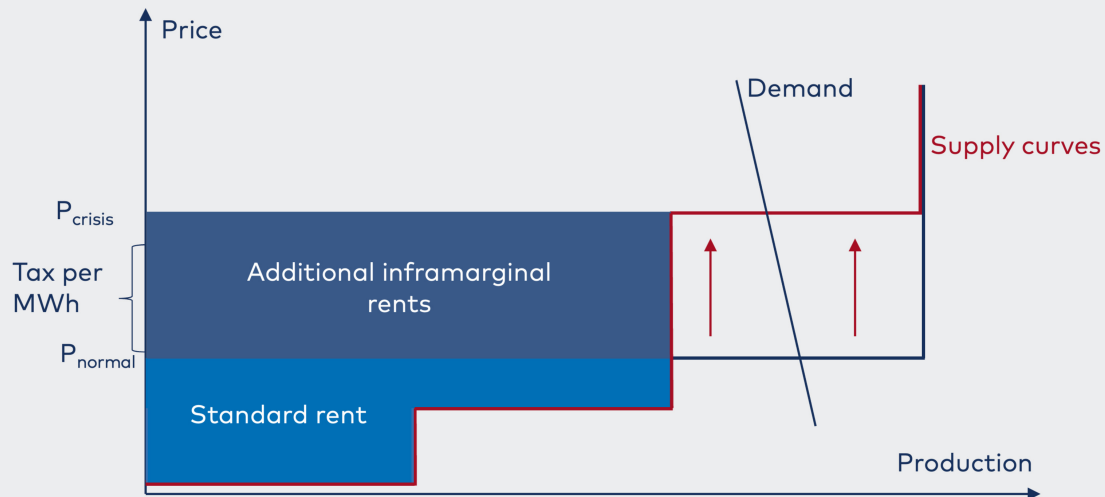


Figure 3.2. Standard rent and additional inframarginal rents due to increased power prices, and revenue tax

Source: Vista Analyse, based on Pollitt et al. (2022)^[49]

In principle, a revenue cap does not affect inframarginal producers' incentives to produce; the producers' marginal net income from production will still be positive whenever it would have been positive without the tax. The behaviour of the producers and their bids to the market do not change. The incentive to produce is governed by a single rule: produce whenever the revenues of an additional unit (kWh) are higher than the costs of producing that unit, i.e., when marginal revenues are larger than marginal costs. Since all inframarginal producers receive the uniform price independent of their own bids, it is not rational to bid above or below the marginal costs.^[50] On the contrary, by bidding anything other than marginal costs, the producer risks not activating profitable production (if the bid is too high) or operating at a loss (if the bid is too low). Thus, bid functions depend only on the producer's own marginal costs, even with the revenue cap.

The technologies listed in the CR and those liable to the tax in Sweden and Denmark were all inframarginal technologies in periods when gas-fired power plants are price setting. Marginal producers (gas-fired power plants) were exempt from the tax. Other potentially marginal producers, such as hydropower plants with storage, were also exempt. The bid function of hydropower producers depends on expectations of future prices, and a revenue tax could affect their production

49. Pollitt, M., von der Fehr, N., Banet, C., Le Coq, C., Willems, B., Bennato, A.R. and Navia, D. (2022): Recommendations for a Future-Proof Electricity Market Design, Centre on Regulation in Europe (CERRE), December 2022.

50. Note that this mechanism is different in markets that use pay-as-bid models, such as the intra-day market.

incentives. There were special provisions for other high-cost producers (details in Section 3.1.1).

To conclude: in principle, a revenue cap does not change inframarginal producers' incentives to produce. As long as the incentives to produce in the short term are preserved, the supply side will function as before. However, the devil is in the details – the specific implementation of the revenue cap may lead to changes in incentives. Therefore, we turn to an analysis of the specific details of the revenue cap in Sweden and Denmark: the special adjustments for high-cost producers, the settlement periods and the use of reference prices. The main question is whether a revenue cap, as implemented in Sweden and Denmark, influences producers' incentives to produce and bid in the different markets.

3.1.1. Impacts of special adjustments for high-cost producers

Some of the technologies listed in the CR have high marginal costs; they are normally profitable only when prices are high. Furthermore, gas prices have not only been extremely high in the past year but fuel costs for biomass and oil have increased considerably.

Special rules were permitted for these technologies (Article 8.1b in the CR). Both Denmark and Sweden used this possibility. In Denmark, biomass- and oil-fired power plants had a special provision: the revenue cap was set as a fixed amount on top of marginal costs.^[51] In Sweden, the special cap for high-cost producers was set at 1.3 times the operation costs for producers using crude oil.^[52]

In both cases, these special caps ensured that marginal revenues exceeded marginal costs. Furthermore, only 90% of revenues exceeding the threshold price were taxed. These adjustments maintained the incentives to produce and contributed to the security of supply.

However, these special adjustments are an example of the regulation being administratively complicated and demanding.

51. L 68 - 2022-23 (2. samling) (oversigt): Forslag til lov om et loft over indtægter fra elproduktion. / Folketinget.

52. The Swedish government clarified that crude oil-fired generation plants would be taxed, but fuel oil-fired generators would not.

3.1.2. Impacts of the settlement periods (hourly vs. monthly)

Sweden and Denmark used different settlement intervals to calculate the tax base. This had different impacts on marginal revenues and thus also on producers' incentives. The main difference between the two settlement methods was:

- **The Swedish tax applied to realized revenues based on hourly prices.** While the tax was calculated on a monthly basis, the revenues that formed the tax base were the sum of realized hourly earnings in so-called qualified hours (i.e., hours when the price is above the cap level), less the number of qualified hours multiplied by the cap level (see Text Frame 3.2 for the calculation). Recall that the actual revenues formed the tax base since hedging agreements and long-term contracts (PPAs) were considered. This method implies that companies were taxed for every MWh they sold at a price above the cap.
- **The Danish tax applied to realized revenues based on average monthly prices,** which implies a monthly realized average "net price" per MWh (revenue per MWh). The tax base was calculated as 90% of total monthly revenues less 180 EUR/MWh for each MWh sold. As in Sweden, hedging agreements and long-term contracts (PPAs) are taken into account. This method implies that companies were only taxed if their realized average revenue per MWh was above the cap.

Administrative costs are likely to be lower when the monthly average price is used as the tax base, as pointed out by the Danish authorities (see Chapter 2.2.3).

The differences between the two methods are illustrated in Figures 3.3 and 3.4. Both figures show a hypothetical hourly spot price in a month. This represents the potential marginal gross revenue per MWh for the non-hedged production of a hypothetical producer. Figure 3.3 shows that Swedish producers were taxed for all hours when the hourly price exceeded the cap level (represented by the shaded area between the price curve and the revenue cap). Danish producers, in contrast, were taxed only when the monthly average price was above the cap level, as shown in Figure 3.4. The average price is found where the light blue and dark blue areas are balanced. In Figure 3.4, the average price is below the cap; thus, the producer did not pay any tax in this case.

Figure 3.3. Swedish model: Hourly price

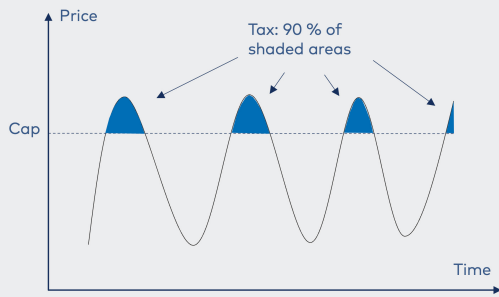


Figure 3.4. Danish model: Monthly average price

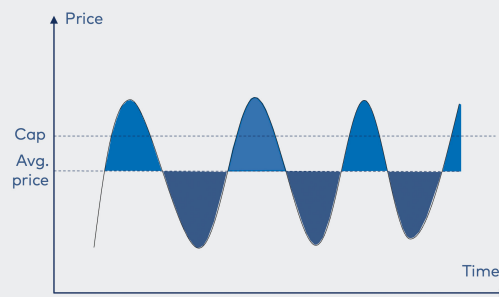
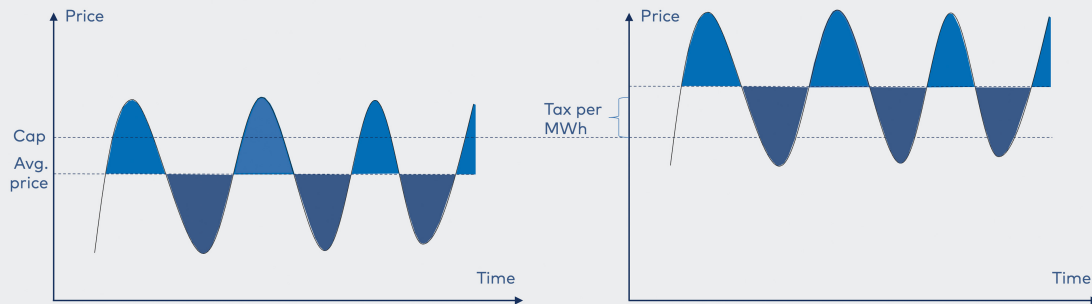


Figure 3.5. Danish model with low and high average spot prices



Source: Vista Analyse

Figure 3.5 illustrates the Danish model in more detail. The left panel shows a situation with low average prices, and the right panel shows a situation with high average prices. The revenue cap level is indicated by the dotted line crossing both panels. Producers in the left panel were not tax-liable because the average price was lower than the cap. However, the average price in the right panel is above the cap, which means that producers paid a tax of 90% for every MWh produced that month.

Note that the average prices, as shown in Figures 3.4 and 3.5, are simple averages of all hourly prices in a month, which implies that our hypothetical producer had identical production in each hour. In reality, Danish producers were taxed based on a volume-weighted average, which means that the average revenue for all producers was not necessarily equal to the simple average of hourly prices. We discuss this further below.

There are two main implications of the different schemes:

- First, it is significantly less likely that the average spot price during a month is above 180 EUR/MWh than that any hours in a month will have a price exceeding 180 EUR/MWh. As shown in Figure 3.6, average spot prices in Denmark were above the cap only in December 2022 (although prices exceeded the cap in some hours every month).^[53] Prices were significantly lower in spring 2023 than in summer and early autumn of 2023 (as shown in Figure 1.1). However, it is not evident which system could provide the highest government revenues or tax burden in reality since the Swedish tax only applied until March 2023.
- Second, Swedish short-term production incentives were less complicated than the incentives of Danish producers, who had to consider the effect marginal production would have on their monthly unit revenue. However, short-term production incentives were generally preserved in both countries. For a mathematical presentation of marginal net revenue calculations in the two countries, see Text Frame 3.1.

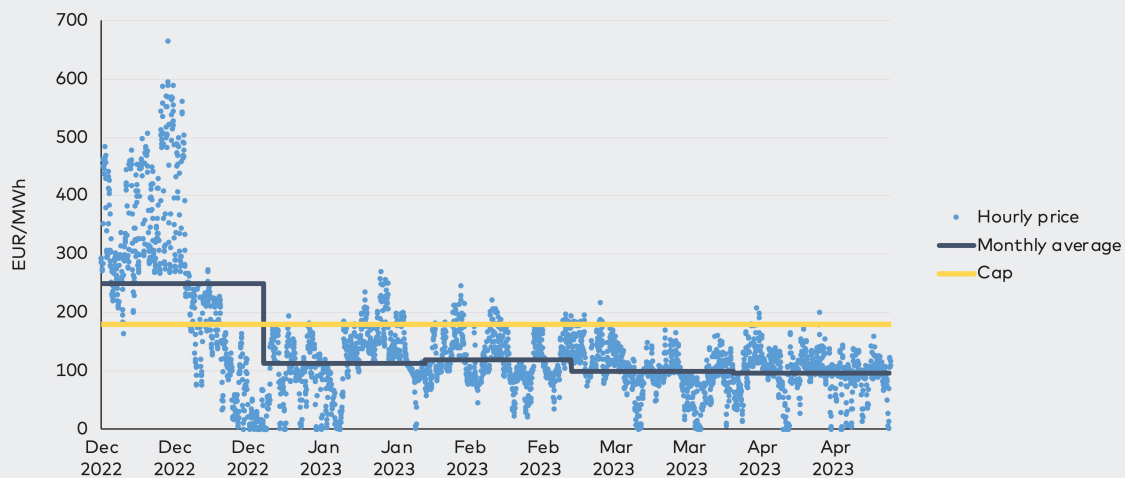


Figure 3.6. Hourly versus monthly average prices in Denmark (DK1, day-ahead)

Source: Vista Analyse, based on data from ENTSO-E

53. The Danish government has calculated expected tax revenues using different settlement periods for December 2022–January 2023. Based on actual spot prices in the period, they showed that using monthly settlement reduced tax revenues, compared to using shorter settlement periods. Source: <https://www.ft.dk/samling/20222/lovforslag/L68/spm/3/index.htm>.

Below, we explain why short-term production incentives were preserved in general.

The short-term **production incentives for Swedish inframarginal producers were unchanged** because it is rational to produce, even for prices above the cap level, as long as the price covers marginal costs. Even if most of the marginal revenue above the cap level is taxed, a producer will still have a marginal income of 180 EUR/MWh plus 10% of the exceeding price. Furthermore, even if all of the revenues above 180 EUR/MWh are taxed (instead of 90%), the incentives of inframarginal producers will not be affected since marginal revenues at 180 EUR/MWh would cover marginal costs. An exception is hydropower plants with a storage capacity of less than 24 hours, which are tax liable in Sweden.^[54] A tax level of 90% (instead of 100%) would preserve correct incentives for these plants in situations where prices fluctuate at a level above 180 EUR/MWh within a day and it is possible to shift production between hours. Finally, setting the tax at 100% could have worsened incentives to produce for high-cost technologies in some situations; the special adjustments described in Chapter 3.1.1 ensure that incentives are maintained.

As mentioned, **Danish short-term production incentives are not as straightforward as in Sweden, but incentives were preserved in Denmark as well.** However, this is not immediately evident, though, because producers face a trade-off in some situations and spot price levels.

There are two main cases to consider. One is when the expected average unit revenue is below the cap. In this case, producers are not tax liable, and the incentives to produce are therefore identical to those in the non-tax case.

The other case is when the expected unit revenue is above the cap. In this case, producers must consider two effects of the revenue cap on their marginal revenues:

- **The direct effect** is the marginal revenue in the hour in question, net of tax. As long as the spot price is higher than the tax payment per MWh, this effect is positive. However, in situations with high expected unit prices and low hourly prices, this effect could give producers an incentive to stop production. Consider, for example, a producer who, due to very high prices so far that month, expects to be tax liable, i.e., their unit revenue is above 180 EUR/MWh. For simplicity, we disregard any start and stop costs and other non-linearities. Then comes a period of expected low prices. Assume for simplicity that the implied average price that month is expected to be 280 EUR/MWh. This implies that producers must pay a revenue tax of 90 EUR/MWh that month on each unit sold: $(280 \text{ EUR/MWh} - 180 \text{ EUR/MWh}) \times 0.9 = 90 \text{ EUR/MWh}$. In hours where the spot price is below 90

54. Chapter 5.4 of the Swedish bill.

EUR/MWh, for example 80 EUR/MWh, the net marginal revenue of producing electricity that hour is -10 EUR/MWh, which is negative, even if gross marginal revenue is positive. Thus, the direct tax effect in this example gives the producer an incentive to stop production altogether.^[55]

- **The indirect effect** on marginal revenue works through unit price. Producing in an hour with low prices will reduce the (monthly average) unit price and thus reduce the tax liability not only for current production but also for all previous production that month. Thus, the indirect effect gives producers incentives to increase production (if possible), i.e., the opposite of the direct effect in low-price situations.^[56]

Our numerical calculations indicated that **the positive indirect effect is likely to be stronger than the negative direct effect** in low-price situations. The reason for this is that the indirect effect affects all production hours, while the direct effect only affects a single hour.

55. We have seen this kind of behaviour by consumers in Norway, where the household electricity price subsidy was calculated on the basis of monthly average price. Consumers were, in effect, paid to consume electricity in hours where the price was positive but where the expected subsidy made consumers' "net price" negative. An important difference here is that the average price in Norway is not volume-weighted but completely exogenous to any single consumer. Therefore, Norwegian households faced only the direct effect and not the indirect effect.

56. Note that production incentives are preserved also in cases where the expected price is above the expected unit price. For an additional MWh supplied, tax payment increases, but gross revenue increases even more, resulting in a net positive.

Text Frame 3.1. Difference between Swedish and Danish short-term production incentives

In both countries, total monthly net revenues from production are given by the expression

$$R = \underbrace{\sum_t (p_t x_t)}_{\text{Gross revenue}} - \underbrace{\sum_t C_t x_t + 0.9(\pi - \tau) \sum_t x_t}_{\text{Tax}}$$

where p is the spot price, x is production, C is unit production cost, 0.9 captures that 90% of revenues above the cap are liable to tax, π is the settlement price, τ is the cap level in EUR/MWh and subscript t indicates hour.

In Sweden, $\pi = p_t$, since the tax was determined by the hourly spot price. In Denmark, $\pi = \bar{p}$, which is the average realized price per unit sold during the month (average unit revenue). This is a volume-weighted average, so $\bar{p} = \sum_t (p_t x_t) / \sum_t x_t$, which depends on x_t .

We suppress the time subscripts t in the following.

In Sweden, the marginal net revenue (i.e., the revenue gained or lost from producing another unit after tax) in any given hour is thus:

$$\text{Marginal Net Revenue}^{SE} = p - C - 0.9(p - 180)$$

if the price is above the cap, and $p - C$ if the price is below the cap. Swedish producers thus only consider the direct effect on revenue production at any given time.

In Denmark, the marginal net revenue is more complicated because producers also had to consider how production (x) at any time would affect the average unit revenue (\bar{p}):

$$\text{Marginal Net Revenue}^{DK} = \underbrace{p - C - 0.9(\bar{p} - 180)}_{\text{Direct}} - \underbrace{0.9 \frac{d\bar{p}}{dx} \sum x}_{\text{Indirect}}$$

where $d\bar{p}/dx < 0$ for spot prices below the expected monthly unit revenue. The direct effect is the marginal revenue for the specific hour, net of tax. This expression looks similar to the Swedish model but note that the tax term includes average unit revenue and not hourly price. The indirect effect is the impact on marginal net revenues resulting from the marginal change in unit revenue from current production applied to all monthly production.

3.1.3. Impacts of using the day-ahead price as a reference price on incentives to shift supply between markets

In Sweden, the day-ahead price was used as a reference when calculating revenue from all markets (adjusted for hedging agreements). For example, if the day-ahead price was 190 EUR/MWh for a given hour and a producer received 210 EUR/MWh from supplying to the intraday market for the same hour, this producer was taxed according to 190 EUR/MWh, even if the realized revenue per MWh on the intraday market was higher. The same applied if the price on the intraday market was lower – producers were taxed according to the day-ahead price.

In Denmark, however, the actual price on the relevant market was used as the tax base (adjusted for hedging agreements). This was directly stated in the provisions and was an implication of the monthly settlement interval chosen in Denmark. Since the average revenue per MWh during a month was the tax base, revenue from markets with relatively higher prices increased producers' average revenues and thus the tax base.

Some Swedish public consultation statements argued that using the day-ahead price as a reference could have reduced liquidity in day-ahead markets and increased liquidity in markets closer to real time because expected prices are often higher in these markets.^[57] Since the day-ahead price was used as a reference, suppliers could withdraw supply from the day-ahead market, hoping to increase actual revenues while the tax base stayed the same. Prices on the day-ahead market could increase due to reduced supply or increased opportunity cost of supplying on the day-ahead market because of higher expected returns on the intraday and balancing markets.

However, producers' incentives will not differ from those before the tax, regardless of whether a reference price is used. A producer has an incentive to produce in Market B if the expected marginal net revenue in Market B is higher than in Market D ($MR_B > MR_D$) If the price from Market D is used as a reference, the producers have incentives to shift production to Market B if

$$p_B - 0.9(p_D - 180) > p_D - 0.9(p_D - 180)$$
$$p_B > p_D$$

Because the tax term cancels out, it is clear that producers shift production only if the gross price is higher in Market B.

57. See, for example, the consultations statement from Nord Pool.

If actual prices are used to calculate the tax in both markets, the decision rule is:

$$\begin{aligned}p_B - 0.9(p_B - 180) &> p_D - 0.9(p_D - 180) \\p_B - 0.9p_B &> p_D - 0.9p_D \\0.1p_B &> 0.1p_D \\p_B &> p_D\end{aligned}$$

By comparing the two scenarios, one can see that the incentives depend only on (gross) price. Producers shift supply between markets only if the price in one market is higher than in the other.

These results apply even if only one market price is above 180 EUR/MWh while the other is below. If a reference price is used, the tax term on each side of the inequality either cancels out (if the reference price is above the cap) or does not enter at all (if the reference price is below the cap). In both cases, the gross spot price determines production incentives.

If, on the other hand, actual market prices are used, we have (for $p_B > 180$ and $p_D < 180$):

$$\begin{aligned}p_B - 0.9(p_B - 180) &> p_D \\0.1p_B + 162 &> p_D\end{aligned}$$

This inequality holds for all situations where $p_B > 180$ and $p_D < 180$, which means that incentives are maintained even in situations where one market is taxed and the other is not.^[58]

Hence, using the day-ahead price as a reference price for all markets does not affect incentives to shift supply between wholesale markets (from day-ahead to intraday).

However, government tax revenues are affected by the choice of reference price. If the day-ahead market on average has the lowest prices of the three wholesale markets, using the day-ahead price as a reference price will, all else being equal, give a lower government tax income than using actual prices.

3.1.4. Impacts of incentives on the intraday market

In contrast to the day-ahead market, which uses marginal pricing, the intraday market uses a pay-as-bid model (see Text Frame 3.2). In the intraday market, suppliers face a trade-off when submitting their bids because they are paid their bids and not the market-clearing price. On the one hand, sellers are tempted to bid above their marginal costs since they are paid their bids. On the other hand, bidding too high involves the risk of not being dispatched and gaining

58. The opposite case, with $p_B < 180$ and $p_D > 180$, gives the equivalent inequality as the first case, only with subscripts switched around (remember that the no-tax incentive is still to supply to the market with the highest price). Therefore, the result holds the other way as well.

nothing.^[59] The marginal revenues of producers thus depend on their bids and their marginal costs, and their bids depend on expected average prices (and marginal costs).

As implemented in Sweden, a revenue cap uses the day-ahead market price as the reference price. Thus, the revenue cap will not affect behaviour in the intraday market because the optimal bid functions are not affected by the day-ahead price, or the day-ahead price affects the expected prices on the intraday market in the same way for all agents, and this price is common knowledge to all bidders.

The Danish implementation did not have an hourly settlement but used total revenues to calculate the tax base. Thus, it was still optimal to maximize revenues for given marginal costs, which implies that behaviour was unaffected by the tax.

Hence, the implementations in Denmark and Sweden ensured that incentives in the intraday market were not affected.

Text Frame 3.2. What is the intraday market?

The intraday market is a market of physical power delivery where participants adjust their positions between the closing of the day-ahead market and the time of delivery. In the Nordic countries, the intraday market is called Elbas (Electricity Balance Adjustment System) and is operated by Nord Pool. Elbas is used for trading internally in a country and across borders.

The intraday market continually connects buyers and sellers who make bilateral trades. Market participants place buy and sell orders for energy and price combinations for certain time periods (e.g., sell 50 MWh for 47 EUR/MWh at 12:00–13:00 CET).

The intraday market settles orders using a pay-as-bid model: sellers are paid their asking price, and buyers are paid their bidding price. Nord Pool matches orders that intersect (i.e., where the price limit of the sell order is not higher than the price limit of the buy order), and the settlement price for each trade is determined by the order first placed (i.e., the asking price if the sell bid came first, and the bid price if the buy bid came first). Intraday auctions (or “batch matching”) are used in certain cases.^[60]

59. With complete information, pay-as-bid markets are equivalent to pay-as-clear markets. However, in reality, information is incomplete, which may distort the merit order as a result of information asymmetry.

60. See <https://www.nordpoolgroup.com/48fa80/globalassets/download-center/cacm-regulation/public-description-of-the-continuous-trading-matching-algorithm.pdf>

3.2. Long-term impacts of revenue cap: Incentives to invest

Main takeaways:

- Investment decisions depend on expectations about future prices and future cash flows.
- A revenue cap may influence expectations about future taxes, which may reduce the net present value of investments.
- Setting the revenue cap level above expected peak prices contributes to preserving incentives to invest.
- It is vital that authorities emphasize the temporary and one-time nature of such taxes in order to maintain investment incentives.

Many inframarginal technologies have low operation costs but high capital costs. Capital costs are recouped through profits earned in periods when the spot price is higher than the marginal cost. This is shown as standard and additional inframarginal rents in Figure 3.2. A revenue cap reduces the revenue of inframarginal producers by capturing part of the additional inframarginal rents. This reduces the after-tax profitability of investments and might make some projects unprofitable.

Investors find it profitable to invest if the net present value of a project is positive. Future cash flows are uncertain, however, and investors form expectations about future cash flows based on their beliefs about the future. Therefore, the main question is whether features of the current crisis and governments' responses thereto may significantly alter expectations about the future.

In general, uncertainty about the future is a cost that investors include in their calculations, effectively raising the required yield. Sudden, unexpected taxes may increase the general uncertainty about future income and cost streams. This raises the discount rate used in net present value calculation, as investors prefer a more certain income in the near future over a more uncertain income in the distant future. Hence, a revenue cap may lead to a higher discount rate and fewer investments. This uncertainty is not unique to the electricity industry but applies to all industries in the economy. There is always a risk that new policies and taxes will be implemented, for example, after an election.

A related question is at which level the cap is set, i.e., which price level is perceived as "extraordinary". The revenue cap implemented in Sweden and Denmark was set

at levels exceeding expected peak prices before Russia's invasion of Ukraine, according to the CR and an impact analysis by the Swedish government.^[61] ^[62] This implies that the actual marginal revenues after tax are higher now than what was expected before the war and sufficient to generate profitability for investments. Thus, one may induce revenues to cover capital costs, and only windfall profits are collected by emergency measures, not ordinary return on investments.

Electricity prices have been much higher in 2022–2023 than in previous years and will be higher than expected in the future. It is unlikely that any investor would invest solely on the basis of the present extraordinary high prices, as investors consider long-term expectations about prices. The present uncertainty about prices and taxes may cause some investors to postpone making decisions.

To conclude, the main question is whether investors believe that policymakers will implement revenue caps or other extraordinary measures again whenever prices are extraordinarily high, or whether they perceive these measures as temporary, one-time measures due to an extraordinary situation. The CR was introduced as an exceptional, targeted and time-limited measure. The authorities can avoid negative impacts on investments by emphasizing that these measures are extraordinary indeed, that they were introduced as a response to a crisis, and that they are unlikely to be used again.

61. The CR, recital 28.

62. Tillfällig skatt på vissa elproducenters överintäkter Fi2022/03328 (12 December 2022).

3.3. Impacts of the temporary tax on profits in Finland

Main takeaways:

- Profit taxes do not affect short-run production incentives.
- The profit taxes in Finland apply to all power production technologies. Hence, administrative costs are lower than in Sweden and Denmark.
- The Finnish tax is ex post higher than the revenue tax in Sweden and Denmark; average spot prices have been below the equivalence level of 280 EUR/MWh.
- The profit tax does not influence the relative profitability of different investments in electricity industry but may influence the allocation of capital between different sectors of the economy.
- The authorities should emphasize the temporary and extraordinary nature of the tax to reduce negative effects on investments.

Finland implemented a tax on profits instead of a tax on revenues. In Finland, 30% of power producers' profits exceeding an annualized return of 10% on equity are taxed. The profit tax was calculated to be equivalent to a revenue cap for average spot prices of 280 EUR/MWh from December 2022–June 2023.

The law does not discriminate between generation technologies but applies to all technologies. The tax is to be levied on profits during the 2022 and 2023 tax years, in addition to the ordinary corporate income tax.^[63]

A profit tax is easier to implement than a revenue cap. Therefore, administrative costs are lower.

3.3.1. The Finnish profit tax will not affect wholesale markets in the short run

Profit taxes do not affect short-run behaviour. Profit-maximizing firms have incentives to maximize profits even if a share of profits is taxed. Behaving otherwise, for example, by shifting production schedules or shutting down, would reduce profits if pre-tax activities were optimal. Thus, rational agents in the electricity sector behave as before and offer the same supply in the same markets as before. Hence, wholesale markets are likely to be unaffected by a temporary profit tax in the short run.

63. For further details, see Chapter 5.1.2 of the Finnish bill.

3.3.2. Will the Finnish profit tax affect investments in the long run?

The tax on profits has reduced the expected after-tax net present value of investment projects in the electricity sector. This alone does not affect the relative profitability between different projects or different electricity generation technologies, but it may affect the allocation of (scarce) capital between different sectors of the economy and foreign investments.

The effect on investments depends on expectations, as discussed in Section 3.2. If the tax is believed to be a temporary measure due to an extraordinary crisis, investments are not affected. However, if the crisis has altered investors' expectations about future prices, profits and government reactions, investments may be affected.

Expectations of similar taxes in the future are tied to agents' expectations about future prices: if investors believe that no extraordinary taxes are introduced when prices and profits are "ordinary", incentives to invest will not change. If some, but not all, of the excess profits in "extraordinary" periods are expected to be taxed, investments may decrease compared to the same situation without taxes because investors may use scarce capital in other sectors.

3.4. Impacts on competitiveness between countries

It is relevant to consider whether the differences in the implementation of the tax impacts the competitiveness of the Nordic countries.

In contrast to electricity producers in Sweden and Denmark, where the tax was implemented as a revenue cap, electricity producers in Finland are taxed at 30% of profits that exceed a 10% return on equity. The profit tax in Finland was calculated to be equivalent to a revenue cap for average spot prices of 280 EUR/MWh in the period December 2022–June 2023. All else being equal, when actual average spot prices are lower than 280 EUR/MWh, the tax burden on companies (and government proceeds) would be higher in Finland than in Denmark and Sweden, given that Finnish producers earn profits that are above 10% return on equity. However, average spot prices have been significantly lower than 280 EUR/MWh since January 2023 (see Figure 1.1). Thus, on average, Finnish producers are likely to be taxed at a higher rate than producers in Sweden and Denmark.

Figure 3.7 illustrates the differences between the two tax systems. The figure shows how profit per unit after tax varies with spot prices, given that the producer is expected to exceed a 10% return on equity. We also assume that marginal costs are covered (which they must be for production to be profitable) and constant (which is a minor simplification).

- The kinked line illustrates profits under the revenue cap system. For prices below the cap (180 EUR/MWh), marginal profits increase in a one-to-one relationship with the spot price. For prices above the cap level, the profit line is less steep since a share of the revenues is taxed.
- The straight line illustrates profits under the profit tax system. The relationship between price and profits is less than one-to-one because a share of profits is taxed.
- The two systems yield the same result when the average spot price is 280 EUR/MWh. For average prices below this, profits after tax are lower in the profit tax system than in the revenue cap system. The opposite is true for an average price higher than 280 EUR/MWh.

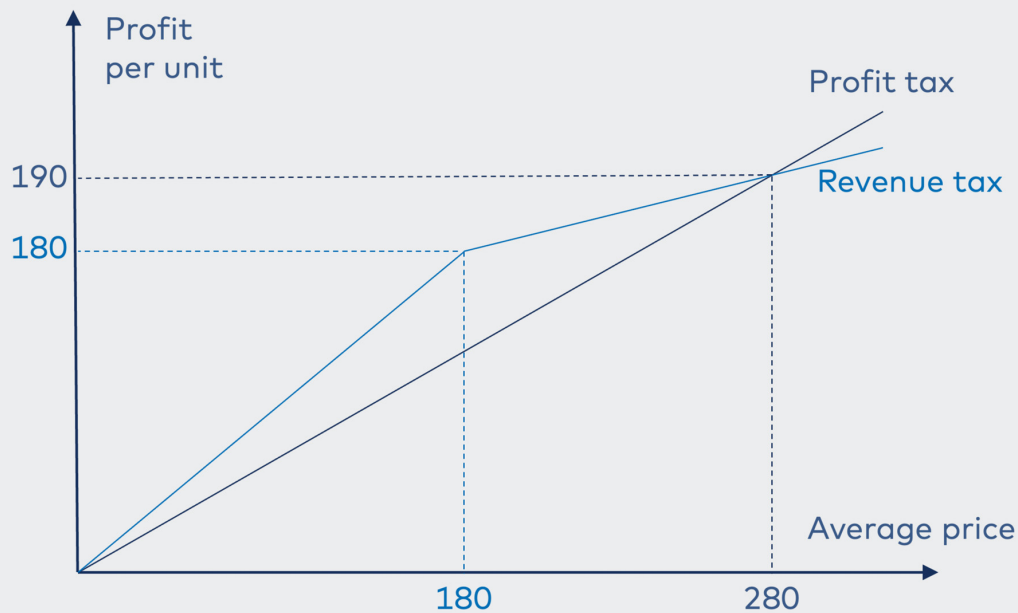


Figure 3.7. Profits per unit and prices under different tax systems

Source: Vista Analyse

It is important to note that profit per unit strictly increases with electricity prices in both systems. This means that the short-term incentives to produce are maintained for both systems. Producers cannot choose where to supply their power; incentives are therefore maintained even with cross-border power trade since producers get the price in their own bidding zone.

The potential long-term impacts of different tax systems relate to investments. Both the revenue cap and the profit tax are temporary and extraordinary measures, and it is not clear to what extent these measures may influence investments. In general, having different tax systems in the Nordic countries may introduce wedges between expected after-tax profitability, which could affect how competitive the countries are in attracting investment capital. Hence, similar tax systems would avoid changes in competitiveness.

3.5. Concluding remarks about the revenue cap and the profit tax

We assessed the short- and long-term impacts of the revenue cap on wholesale electricity markets. The main question was whether the revenue cap on inframarginal technologies will affect the incentives of power market participants. The short-term impacts are related to incentives to produce, while the long-term impacts are related to incentives to invest in new capacity.

3.5.1. Short-term impacts

Our main findings related to the **revenue cap** in Sweden and Denmark include the following:

- In principle, the inframarginal producers' incentives to produce are not affected by a revenue cap: producers will produce as long as their marginal revenues are higher than their marginal costs.
- The way the tax was implemented in Sweden, with the day-ahead price as the reference price and hourly prices for settlements, does not influence producers' short-term incentives. The short-term incentives for Danish producers are more complicated, but incentives are preserved here as well.
- The actual prices obtained by the producer form the tax base. Hence, if a producer has hedging agreements or power purchasing agreements (PPAs) and does not earn a market price exceeding 180 EUR/MWh, the tax does not apply. The share of hedging agreements in the Nordic market is relatively high, especially for wind and solar power producers, which are hedged to a large degree; therefore, a large share of production is not influenced by the tax.
- Administrative costs are likely to be lower with the monthly average price as the tax base.
- Special provisions for high-cost producers (biomass- and oil-fired power plants) ensure that their incentives are preserved as well, thus ensuring security of supply.

Our main findings about the **profit tax** in Finland are as follows:

- A profit tax does not distort short-term production incentives. Profit-maximizing firms will still have incentives to maximize profits even if a share of profits is taxed. Thus, rational agents in the electricity industry behave as before and offer the same supply in the same markets as before.
- A profit tax is easier to implement and has lower administrative costs than a revenue cap.
- The present profit tax implies a higher tax level in Finland than the revenue tax in Denmark and Sweden. While this does not influence short-term incentives, it influences competitiveness and may influence long-term investment decisions.

3.5.2. Long-term impacts

The potential long-term impacts relate to incentives to invest. Investment decisions depend on expectations about future prices and cash flows. Therefore, the main question is how these crisis measures may influence expectations about the future – whether investors believe that policymakers will implement a revenue cap or a profit tax (or other extraordinary measures) whenever prices are extraordinarily high. If they believe that a similar tax will be introduced in the future, the expected after-tax profitability of new investment projects will be reduced, and investments may be reduced as well. In order to maintain incentives to invest, it is important to emphasize that the measures were introduced as a response to an extraordinary crisis and not as regular taxes.

Electricity prices are much higher now than they were before 2021. One may note that investments have been planned and carried out at much lower prices than those of today. However, uncertainty about market conditions in general – prices and taxes – may cause investors to postpone making decisions.

It is also worth noting that the differences in the implementation of the measures may lead to changes in competitiveness between countries. This could have long-term impacts, such as investments being “moved” from one country to another. The negative effects on investment can be mitigated by communicating that these crisis measures are unlikely to be used again.

Hence, we conclude that if investors believe that the current crisis measures are indeed exceptional, targeted and time-limited, as is stated in the Council Regulation, the long-term incentives to invest should not be affected. It is crucial that the authorities emphasize the temporary, one-time nature of the extraordinary measures.



Öresundsverket. Coal power plant in Malmö, Sweden.
Photo: Unsplash

4. Effects of demand reduction measures

The CR required countries to introduce measures to reduce electricity consumption; however, it did not state any specific measures. The specific implementation was left to the individual countries.

In line with economic theory, measures to reduce demand can be classified as follows:

- Taxes and subsidies
- Command-and-control measures
- Information measures

The measures implemented in the Nordic countries to comply with the CR can be classified as command-and-control or information measures. For instance, the requirements for implementing energy-saving measures in public buildings in Denmark and Sweden are command-and-control measures. The awareness campaigns, such as "Every kWh counts" in Sweden and "Down a Degree" in Finland, as well as the recommendations to reduce temperatures in public buildings in

Denmark, are all examples of informational measures.

The problem with **command-and-control measures** is that they are inefficient. Price is the most efficient tool to allocate resources; increased prices induce consumers with the lowest willingness to pay for electricity to reduce their consumption first. The authorities do not have information about consumers' willingness to pay.

The problem with **information and awareness campaigns** has traditionally been that they are short-lived: consumers respond to campaigns by changing their consumption, but the effect is temporary. However, regarding the case at hand, it may be that the temporary effect was sufficient: by reducing electricity consumption in winter 2022–2023, consumers contributed to lower prices and alleviated the scarcity situation exactly when it was needed. Even if the response diminishes or disappears over time, it has been useful.

Taxes and subsidies influence end-user prices. A general tax on all electricity consumers would ensure that demand is reduced efficiently by allocating demand reductions according to the value of electricity for different consumers. The allocation would be less efficient than if it were left to the market mechanism and market price, as the tax creates a wedge between the consumer and producer prices. Therefore, the market price does not fully reflect the scarcity and does not give the correct signal to the supply side to increase production. If the tax applies only to some consumer groups, it is less efficient in allocating demand reductions.

All Nordic countries have an electricity tax for most end users. However, these taxes were reduced in 2022–2023 to alleviate the situation for end users. Hence, the authorities actually removed (or weakened) one potential measure to reduce consumption.

An alternative to the electricity tax is a subsidy on electricity alternatives. Subsidies for increased energy efficiency measures that reduce electricity consumption are another possibility. It is difficult to find alternatives to electricity for some uses (such as light and electrical appliances), but for others (such as heating), electricity can be replaced by alternate energy sources. Some of the alternatives have undesirable impacts, e.g., emissions. In fact, all Nordic countries have policies to phase out other energy sources, such as oil and firewood. For instance, there are four subsidy schemes in Denmark with the aim of phasing out fossil fuels in the heating of private buildings (as described in Section 2.1.3).

While many of the investments that could reduce electricity use have long lead times (e.g., insulation of buildings, district heating), the most readily available alternative is the installation of heat pumps. This is a relatively small investment that can be carried out quickly.

The payment for reduced consumption as implemented in Sweden (see Section 2.1.2) is a form of subsidy to refrain from consumption.

4.1. Electricity consumption in winter 2022–2023

It is outside the scope of this study to analyse the impact of the different measures to reduce demand in the Nordic countries. Relevant demand data were made available just before the conclusion of the project. Nevertheless, we report on the actual demand reduction. Table 4.1 provides information about the differences in the data and calculations.

Table 4.1. Differences in peak hour and gross consumption reduction calculations

	Sweden	Finland	Denmark
Peak demand:			
<i>Reference period</i>	Average of previous five years	Average of 2015–2021	Denmark's Climate Status and Outlook 2022 report*
<i>Adjustments</i>	Temperature	Temperature	Temperature
Total consumption:			
<i>Reference period</i>	Previous year	Average of previous five years	Denmark's Climate Status and Outlook 2022 report*
<i>Adjustments</i>	Temperature and calendar	Temperature for winter months	

Source: Vista Analyse

* A projection that considers the expected increase in electrification of the energy system, fuel and energy prices and the economic outlook, among other drivers of electricity demand.

4.1.1. Peak demand

Figure 4.1 shows the consumption reduction in peak hours (average for each month) in Denmark, Finland and Sweden from December 2022–March 2023. Note that slightly different reference periods were used in the different countries (see Table 4.1 for details).

Peak-hour consumption was reduced well beyond the target of 5% in all countries: 8.3% in Finland, 9.1% in Sweden and 10.2% in Denmark.

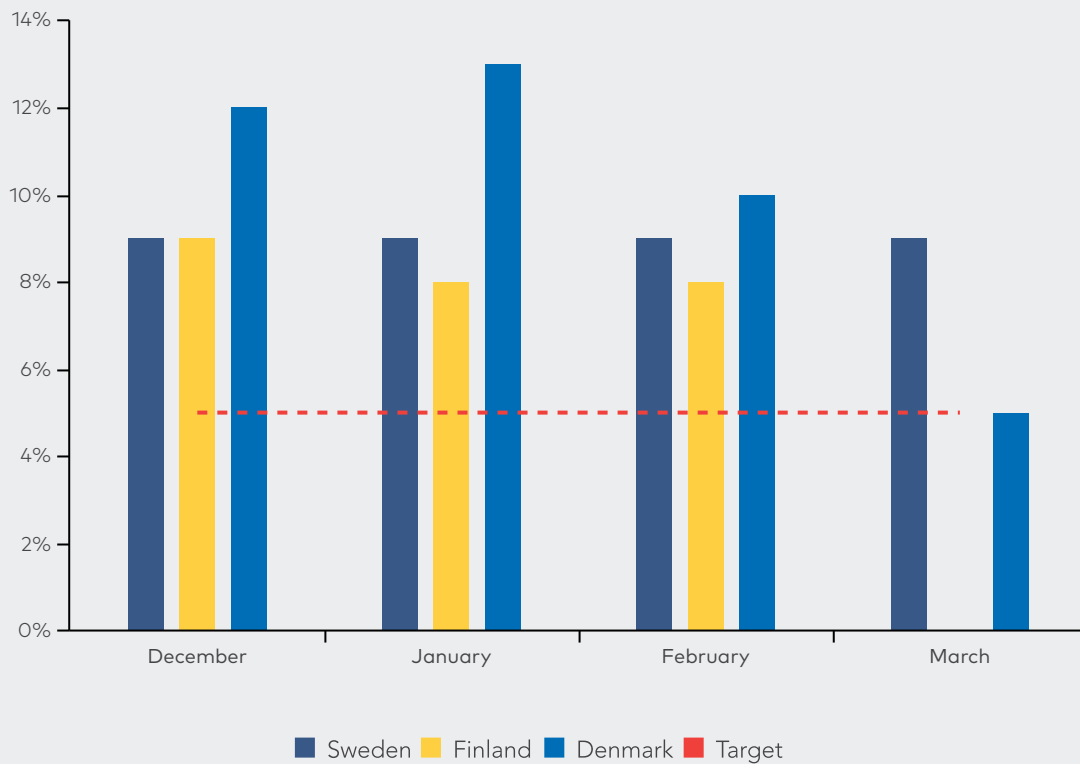


Figure 4.1. Consumption reduction during peak hours (relative to the reference period), 2022–2023

Source: Vista Analyse

Note: The countries use different reference periods, see Table 4.1.

4.1.2. Total consumption

Figure 4.2 shows the total consumption reduction in Denmark, Finland and Sweden from November 2022–March 2023. In total, consumption was reduced by almost 9% in Denmark and Finland and by almost 7% in Sweden.

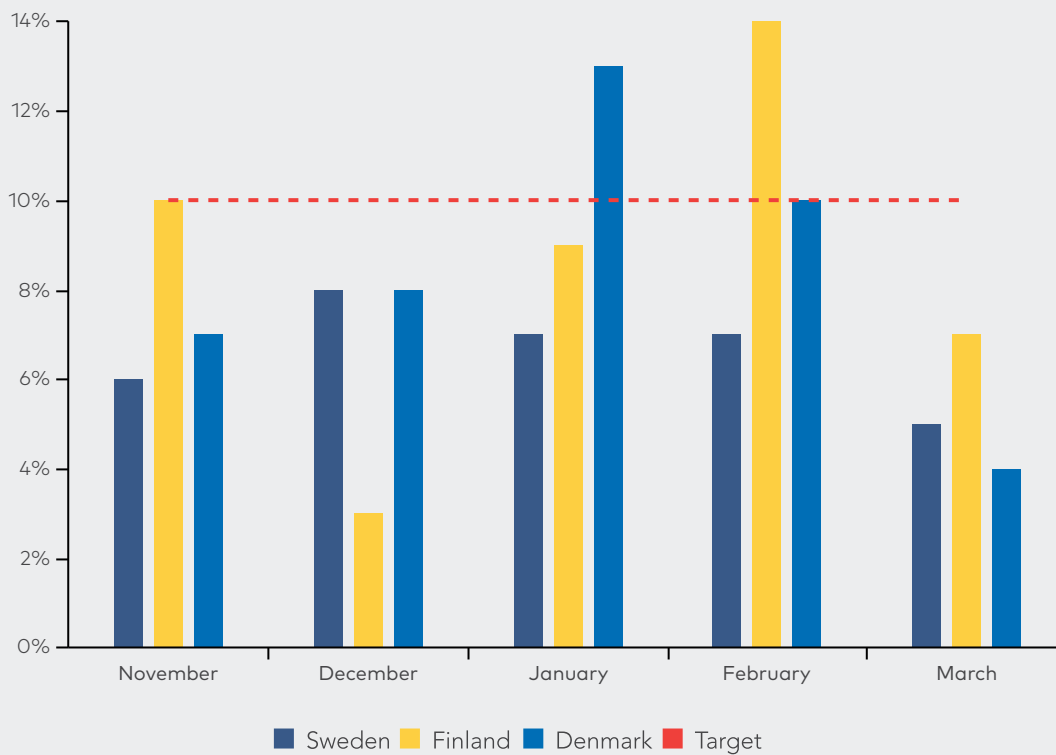


Figure 4.2. Total consumption reduction (relative to the reference period), 2022–2023

Source: Vista Analyse

Note: The countries use different reference periods. See Table 4.1 for details.

Electricity consumption was reduced considerably in winter 2022–2023. A thorough analysis of the different measures' impacts on consumption is outside the scope of this project; thus, we cannot deduce how much of this reduction was due to emergency measures and how much was due to increased prices or relatively mild weather. Electricity prices were much higher this winter than historically (as shown in Figure 1.1). Electricity prices were slightly below 250 EUR/MWh on average in Denmark, Finland and Southern Sweden in December 2022, and around 100 EUR/MWh in January 2023. Moreover, the winter of 2022–2023 was relatively mild, contributing to lower demand in Finland and Sweden.

Nevertheless, we cannot rule out the impact of the information campaigns: consumers have become more aware of both prices and opportunities to adjust their consumption. There are two interesting points to note:

- A large reduction in demand occurred in January, when prices were significantly lower than in December. This may imply a time lag in demand reduction due to either more information becoming available and increased awareness of the prices or to more possibilities to reduce demand over time. In addition, total electricity consumption was reduced the most in Denmark, where electricity demand is independent of temperature.
- The reduction of demand in peak hours in Sweden was considerably larger than the 75 MW (corresponding to less than 0.4% of peak demand) procured in the flexibility procurement scheme. Hence, the reduction in electricity consumption in the rest of the economy was significant.

4.2. Electricity consumption in Sweden

4.2.1. Peak consumption reduction in Sweden

Svenska kraftnät published monthly reports on consumption reduction during peak hours in winter 2022–2023.^[64]

Electricity consumption during peak hours was reduced by 9.1% on average during the period of December 2022–March 2023 in Sweden. Figure 4.3 shows that the reduction was roughly the same in all months. The consumption reduction was calculated relative to the corresponding period during the previous five years and adjusted for temperature and known changes in industrial load (see the reports from Svenska kraftnät for details).

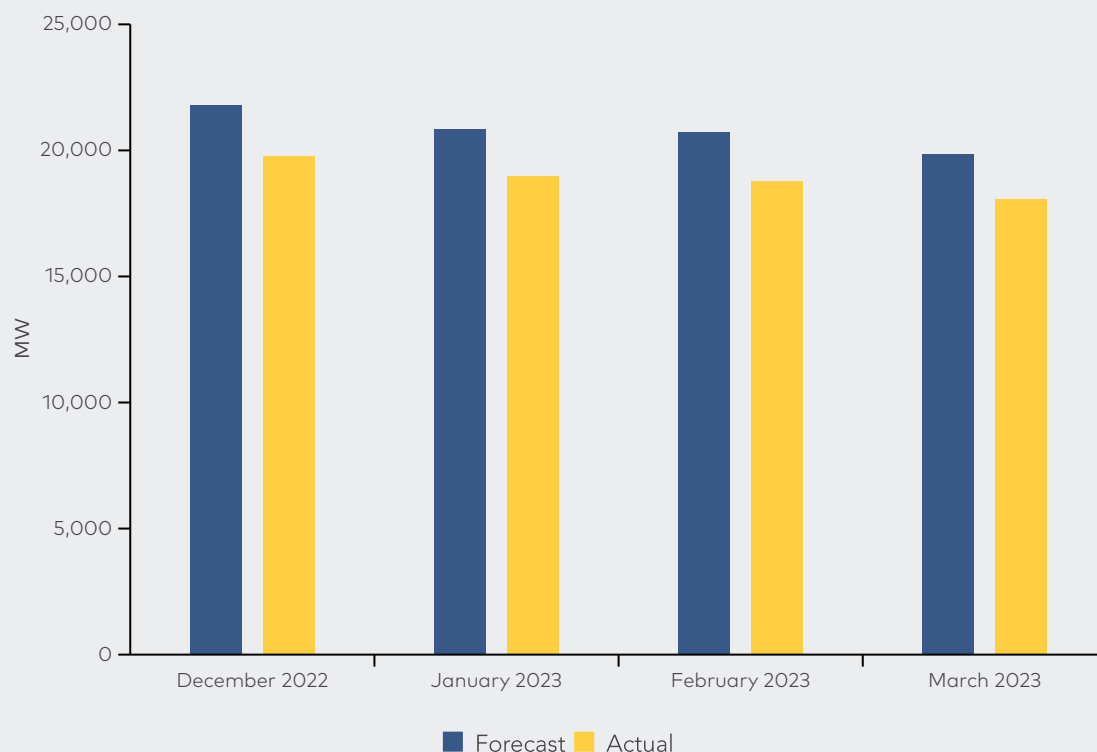


Figure 4.3. Peak hour consumption (temperature-adjusted) in Sweden

Source: Vista Analyse, based on Svenska kraftnät's reports on electricity consumption during peak hours for December 2022, January 2023, February 2023 and March 2023.

64. See reports for December 2022, January 2023, February 2023 and March 2023.

4.2.2. Total consumption reduction in Sweden

Total electricity consumption also decreased in Sweden during the autumn and early winter. Figure 4.4 shows total consumption for November–March in 2021–2022 and 2022–2023. The figures were adjusted for temperature and calendar differences.

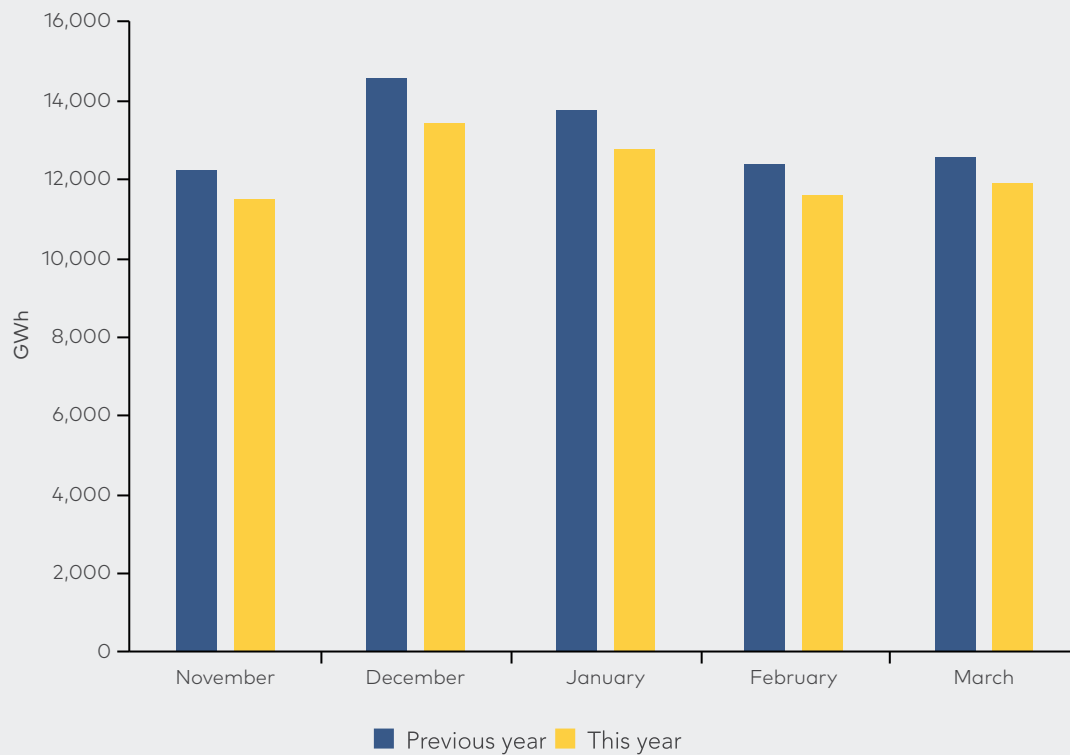


Figure 4.4. Total consumption in Sweden

Source: Vista Analyse, based on data reports from Svenska kraftnät.

4.3. Electricity consumption in Finland

4.3.1. Peak consumption reduction in Finland

Figure 4.5 shows a reduction in peak hour consumption in the period from December 2022–February 2023 in Finland. Consumption reduction was the highest in December (8.8%). On average, peak consumption was reduced by 8.3% during the winter months. This was more than the 5% required by the CR.

The forecast was based on temperature-adjusted consumption data from the past few years (2015–2021). The forecast excludes the effects of reduction measures.

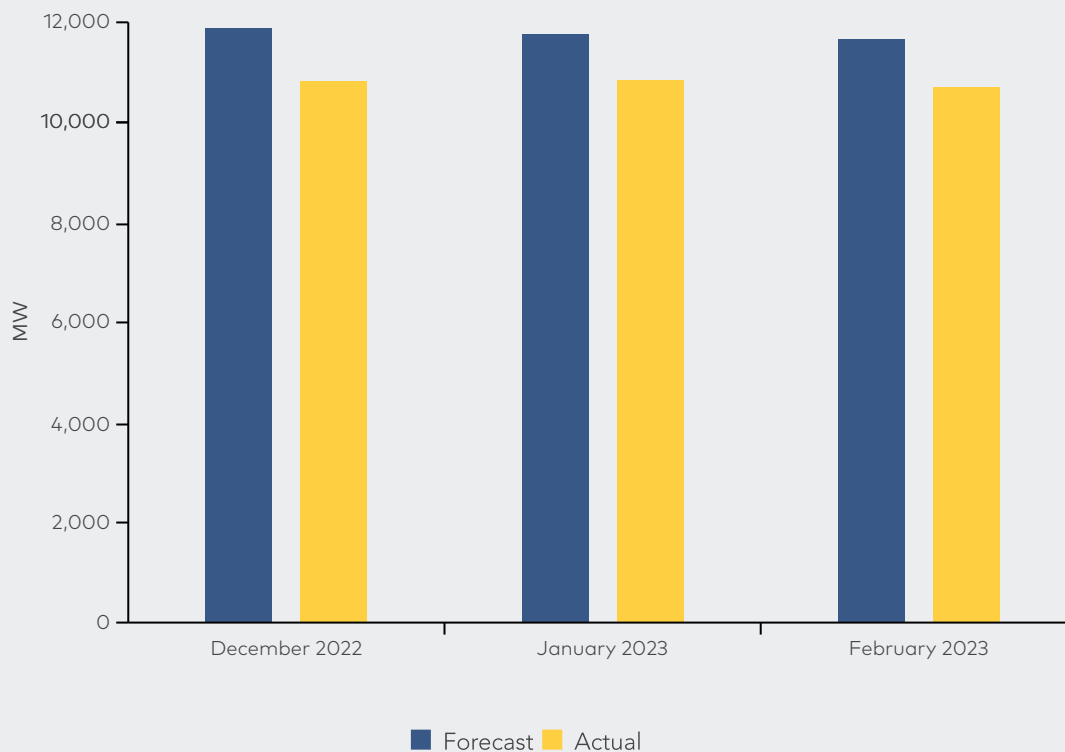


Figure 4.5. Peak hour consumption reduction in Finland

Source: Vista Analyse, based on data from Fingrid

4.3.2. Total consumption reduction in Finland

In Finland, consumption reduction was measured relative to consumption in the same month in the previous five-year period. For the winter months (December–February), the figures were temperature adjusted.

Total consumption was reduced in all months (see Figure 4.6). The reduction ranged from 3.1% in December to 13.6% in February. In total, the reduction was 8.6%.

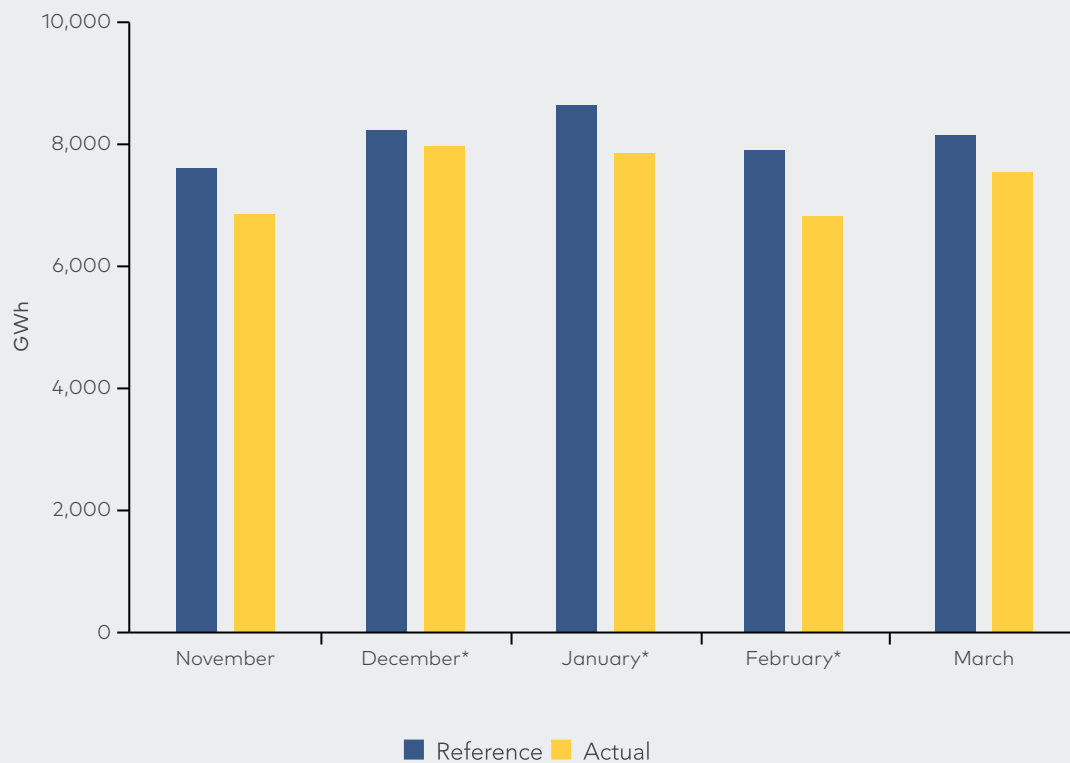


Figure 4.6. Total consumption in Finland

Source: Vista Analyse based on Fingrid's reports

* Temperature adjusted

4.4. Electricity consumption in Denmark

4.4.1. Peak consumption reduction in Denmark

Figure 4.7 shows peak demand for December 2022–March 2023 in Denmark. Peak demand was reduced by more than 10% in the winter months and by more than 5% in March 2023, relative to the forecast.

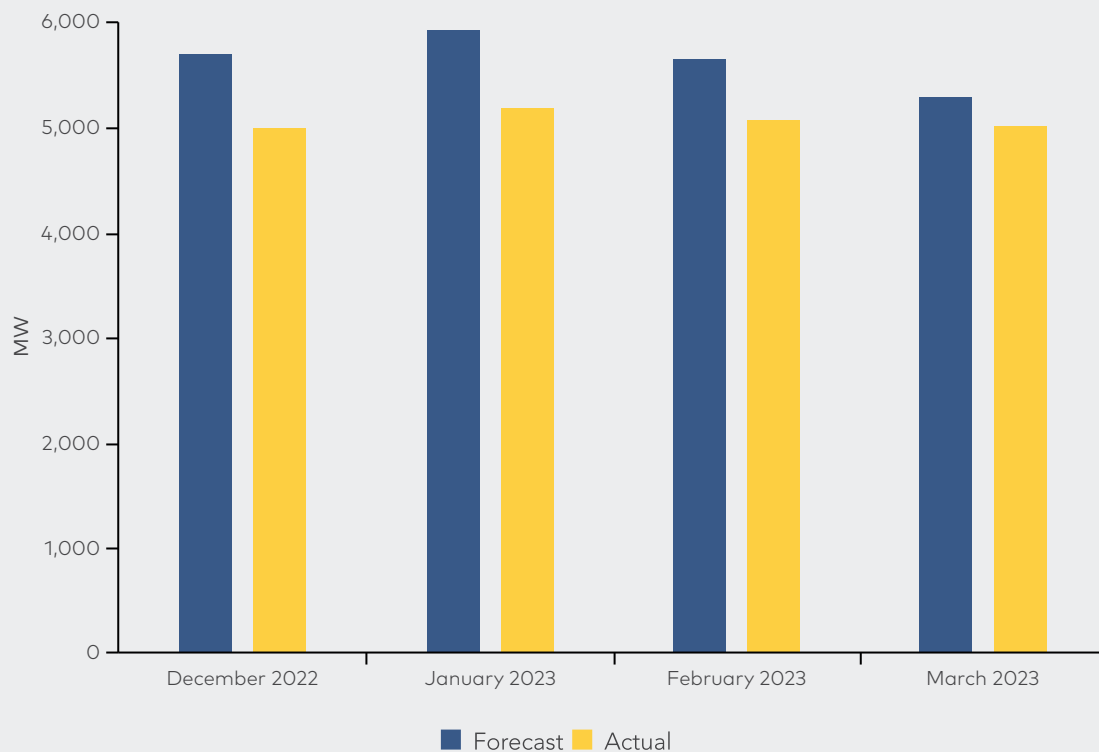


Figure 4.7. Peak demand in Denmark

Source: Vista Analyse, based data from Energistyrelsen

4.4.2. Total consumption reduction in Denmark

Figure 4.8 shows total consumption in Denmark for November 2022–March 2023, together with normal consumption for the same months (based on Climate Status and Outlook 2022). This projection takes into account the expected increase in electrification of the energy system, fuel and energy prices, and the economic outlook, among other drivers for electricity demand.

Consumption in Denmark was reduced in all months, the most in January and the least in March. In total, consumption was reduced by 8.7% over this period.

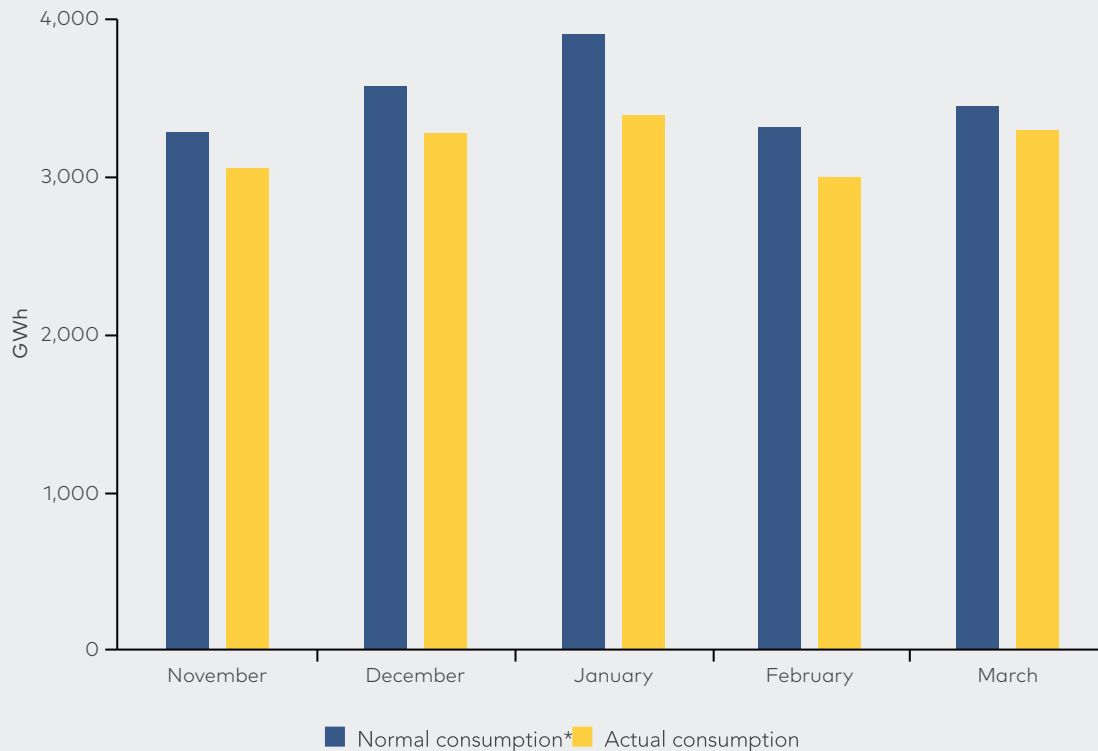


Figure 4.8. Total consumption in Denmark

Source: Vista Analyse, based on data from the Danish Energy Agency.

** Based on the report Climate Status and Outlook 2022. This is a projection that takes into account the expected increase in electrification of the energy system, fuel and energy prices, and the economic outlook among other drivers for electricity demand.*



Avedøre Power Station. Cogeneration plant in Copenhagen, Denmark
Photo: Orsted.com

5. Effects of the fossil fuel solidarity contribution

The fossil fuel solidarity contribution is, in essence, an extraordinary tax on the profits of fossil fuel companies.

A company is defined as a fossil fuel company if at least 75% of its turnover is from economic activities related to the extraction, mining, refining of petroleum or manufacture of coke oven products, according to the CR. In other words, this tax does not directly influence electricity producers.

As explained above, a profit tax does not influence short-term incentives to produce, but it may influence long-term incentives to invest if it influences expectations about future net-of-tax revenues. Representatives of the fossil fuel sector have pointed out exactly this.

Drivkraft Sverige argued also that the solidarity contribution may reduce investments in green technologies. This would be the case if only fossil fuel companies could make green investments. However, other companies and authorities can also invest in green technologies. As long as green investments are

profitable relative to other investments in the economy, capital will flow towards such projects, regardless of the profit level of fossil fuel companies. The profit tax redistributes income from the fossil fuel sector to the authorities, and the authorities may choose to invest that income in the green sector. The profitability of green investments is thus unaltered by the tax on fossil fuel companies.

Taxing the fossil fuel sector in cases where fossil fuel profits are extraordinarily high may reduce investments in fossil fuels compared to a no-tax scenario, but it will not reduce investments in green energy. Moreover, as stated previously, if companies are convinced that the tax is a temporary and extraordinary measure, incentives are not affected.



Oil rig in Esbjerg, Denmark
Photo: iStock

6. Conclusions

The Nordic electricity market has responded relatively well to the current crisis. The increased prices, together with information and awareness campaigns and other measures, resulted in significantly lower demand. Based on the current data, it is difficult to distinguish between the effects of the special measures and the effects of prices.

A revenue cap on inframarginal technologies, as implemented in Denmark and Sweden, does not distort the short-term incentives to produce to a significant degree. However, administrative costs may be high. Considering that power prices have been much lower in 2023 than they were in the second half of 2022, the actual tax revenue from the measures is relatively low. A profit tax, as implemented in Finland, is theoretically better than a revenue cap. In addition, the administrative costs of a profit tax are expected to be lower.

The main potential impacts of the emergency measures relate to incentives to invest in new production capacity. Hence, it is crucial that the authorities emphasize that the emergency measures are exceptional, targeted and time-limited.

6.1. Measures to reduce electricity demand

The core property of a well-functioning market is that it allocates resources efficiently. Efficiency implies that (1) electricity is produced at the lowest possible cost, (2) electricity is consumed by those who value it the most, and (3) the right amount of electricity is produced and consumed. Efficiency also implies that in periods of scarcity, the demand with the lowest value is reduced first. Price is the most efficient tool for allocating resources. However, efficiency does not imply that the allocation is fair or perceived as fair.

It lies at the heart of the CR that measures other than the price mechanism and the electricity market itself are to be used to manage scarcity.

A general tax on all electricity consumption would ensure that demand is reduced efficiently by allocating demand reductions according to the value of electricity for different consumers. However, such allocation is less efficient than if it were fully left to the price mechanism, as the tax creates a wedge between the consumer price and the producer price. Therefore, the market price does not fully reflect the scarcity in the market and does not give the correct signal to the supply side to increase production. Instead of the price being at a level that signals the value of increased production to producers, the tax leads to a reduced market price. The value of electricity to consumers is then higher than the cost of production, which implies a deadweight loss. If the tax applied only to some consumer groups, it would allocate demand reductions even less efficiently.

The Nordic countries have an electricity tax for most end users. However, the tax has been reduced in response to high electricity prices. Hence, the authorities have actually removed (or weakened) one potential measure to reduce consumption.

A thorough analysis of the different measures' impacts on consumption is outside the scope of this project. We note that electricity consumption was reduced considerably in the winter months of 2022–2023. However, we cannot deduce how much of this reduction was due to the emergency measures and how much was due to increased prices or relatively mild weather. Nevertheless, we cannot rule out the impact of the information campaigns: consumers have become more aware of both prices and opportunities to adjust their consumption. The large reduction in demand that occurred in January, when prices were significantly lower than in December, may imply a time lag in demand reduction.

We also note that the reduction of demand in peak hours in Sweden was considerably larger than the 75 MW procured in the flexibility procurement scheme. Hence, the reduction in electricity consumption in the rest of the economy was significant.

6.2. Revenue cap and profit tax

We assessed the short- and long-term impacts of the revenue cap on the wholesale electricity markets. The main question was whether the revenue cap on inframarginal technologies would affect the incentives of power market participants. The short-term impacts were found to be related to incentives to produce, while the long-term impacts were found to be related to incentives to invest in new capacity.

6.2.1. Short-term impacts

Our main findings related to the **revenue cap** in Sweden and Denmark include the following:

- In principle, the inframarginal producers' incentives to produce are not affected by a revenue cap; producers will produce as long as their marginal revenues are larger than their marginal costs. Furthermore, taxing only 90% of revenues exceeding 180 EUR/MWh contributes to maintaining the incentives to produce.
- Special provisions for high-cost producers (biomass- and oil-fired power plants) ensure that their incentives are preserved, thus ensuring security of supply.
- The way the tax was implemented in Sweden, with a day-ahead price as a reference price and hourly prices for settlements, did not influence the producers' short-term incentives. The impacts of using the monthly average price, as in Denmark, are not straightforward, but the incentives were preserved in Denmark as well.
- However, the actual prices obtained by the producer form the tax base. Hence, if a producer has hedging agreements or power purchasing agreements (PPAs) and does not earn a market price exceeding 180 EUR/MWh, the tax does not apply. The share of hedging agreements in the Nordic market is relatively high. In particular, wind and solar power producers are hedged to a large degree. Therefore, a large share of production is not influenced by the tax, even when spot prices are high.
- Using the monthly average price as the tax base is likely to reduce the administrative costs of the tax. However, it also reduces tax revenue, as illustrated in Figure S.3. Recall that the tax in Sweden applied only to revenues obtained between 1 March 2023–30 June 2023.

Our main findings about the **profit tax** in Finland are as follows:

- A profit tax does not distort short-term production incentives. Profit-maximizing firms will still have incentives to maximize profits even if a share of profits is taxed. Thus, rational agents in the electricity sector behave as before and offer the same supply in the same markets as before.
- A profit tax is easier to implement and has lower administrative costs than a revenue cap.
- The present profit tax implies a higher tax level in Finland than the revenue tax in Denmark and Sweden, as the profit tax was calculated to be equivalent to a revenue tax for electricity prices of 280 EUR/MWh and applies to a longer period. While this does not influence short-term incentives, it may influence competitiveness and long-term investment decisions.

6.2.2. Long-term impacts

The potential long-term impacts relate to incentives to invest. Investment decisions depend on expectations about future prices and cash flows. Therefore, the main question is how such crisis measures influence expectations about the future – whether investors believe that policymakers will implement a revenue cap or profit tax (or other extraordinary measures) whenever prices are extraordinarily high. If they believe that a similar tax will be introduced in the future, the expected after-tax profitability of new investment projects will be reduced, and investments may be reduced as well. In order to maintain incentives to invest, it is important to emphasize that the measures were introduced as a response to an extraordinary crisis and not as regular taxes.

Electricity prices are much higher now than they were prior to 2021, and investments have been planned and carried out at much lower prices than those of today. However, uncertainty about market conditions in general – prices and taxes – may cause some investors to postpone making decisions.

It is also worth noting that the differences in the implementation of the measures may lead to changes in competitiveness between countries, which could have long-term impacts, such as investments being “moved” from one country to another. The negative effects on investment can be mitigated by communicating that these crisis measures are unlikely to be used again.

Hence, we conclude that if investors believe that the current emergency measures are exceptional and time-limited, long-term incentives to invest should not be affected. Therefore, it is crucial that the authorities emphasize the temporary, one-time nature of these extraordinary measures.

6.3. Solidarity contribution from fossil fuel sector

The third measure is the solidarity contribution from the fossil sector – a mandatory contribution of at least 33% of the taxable profits in fiscal years 2022 and/or 2023 that are higher than 20% of the average profits in the four preceding fiscal years. This applies to companies with activities in the crude oil, natural gas, coal and refinery sectors. This measure has appeared to be less relevant for the three countries of this report: no such companies were identified in Finland, and only a few relevant companies were identified in Sweden and Denmark.

The fossil fuel solidarity contribution is, in essence, an extraordinary tax on the profits of fossil fuel companies. A profit tax does not influence short-term incentives to produce, but it may influence long-term incentives to invest if it influences expectations about future net tax revenues. Representatives of the fossil fuel sector have argued that the solidarity contribution may reduce investments in green technologies. However, the profitability of green investments will not change because of the tax on fossil fuel companies. Other companies will invest in green technologies as long as these investments are profitable relative to other investments in the economy. Moreover, if companies are convinced that the tax is a temporary and extraordinary measure indeed, incentives to invest will not be affected.

About this publication

Impact assessment of emergency market intervention measures to tackle high energy prices – with a focus on the Nordic wholesale market

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<http://doi.org/10.6027/NER2023-04>

Cover illustration: iStock

Layout: Mette Agger Tang

Published: 16.08.2023

Nordic Energy Research commissioned Vista Analyse to conduct an analysis of how the Council of the EU's Regulation on an emergency intervention to address high energy prices in Europe has been implemented in the Nordic countries and its impacts on the Nordic power market. The assignment was carried out from January to May 2023. The emergency measures were still being discussed and implemented at the outset of the assignment.

About Vista Analyse

Vista Analyse is a social science consultancy whose main emphasis is economic research and policy analysis, advice and evaluation. We carry out projects to the highest professional standards, with independence and integrity. Our key thematic areas include climate change, energy, transport, urban planning and welfare issues.

Our employees have high academic credentials and broad experience in consulting. When needed, we utilise an extensive network of companies and resource persons both nationally and internationally. The company is fully employee owned.

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Nordic Energy Research is an institution under the Nordic Council of Ministers which manages and finances international research programs and projects that add value to national work in the Nordic countries. In addition, we perform certain secretariat and analytical functions in the energy policy cooperation under the Nordic Council of Ministers.