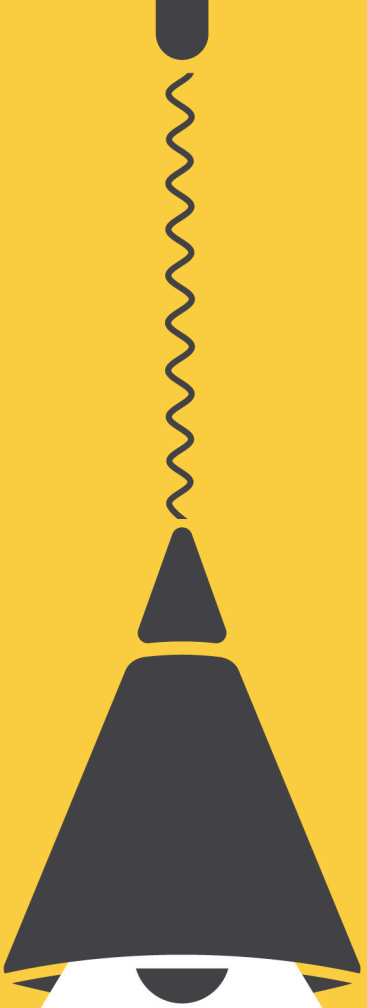
Nordic Energy Research



ENERGY EFFICIENCY IN THE NORDICS

Contents

This publication is also available online in a web-accessible version at:
https://pub.norden.org/nordicenergyresearch2025-01

Foreword

The Nordic countries share a vision of becoming the world's most sustainable and integrated region. Achieving this goal depends on energy efficiency and the resilient use of resources, contributing to significant reductions in greenhouse gas emissions.

Nordic cooperation on energy will continue to prioritise energy efficiency, energy savings, and a secure, economically viable, and environmentally responsible energy transition.

By leveraging advanced technology and promoting behavioral changes, energy consumption across households, businesses, and various sectors can be minimised, further supporting sustainable practices.

This study is funded by the Nordic Council of Ministers and conducted on behalf of the Nordic Committee of Senior Officials for Energy Policy (EK-E).

The report provides a comprehensive mapping of existing energy efficiency (EE) initiatives in the Nordic region. It serves as a platform for policymakers, practitioners, and industry professionals to share insights from successful energy efficiency initiatives implemented across the Nordic countries.

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Key findings and recommendations

Key findings

1. Nordic commitment to energy efficiency
Nordic countries are strongly committed to energy efficiency and have set ambitious national targets across various sectors, including buildings and industry. While specific targets vary by country, common objectives include reducing energy consumption, increasing renewable energy use, phasing out fossil fuels, and achieving carbon neutrality. Additionally, the Nordic countries that are also European Union (EU) members—Denmark, Finland, and Sweden— have aligned their goals and strategies with EU initiatives and directives, such as the Energy Efficiency Directive (EED) and the Energy Performance of Buildings Directive (EPBD).

2. Targeted strategies and policies
Although the Nordic countries share common energy efficiency goals, they tailor their policies and strategies to suit their specific national contexts in the building and industry sectors. The synergistic use of informational tools, regulatory measures, financial instruments, and voluntary initiatives fosters a supportive environment that promotes widespread adoption of energy efficiency measures and ensures progress toward shared objectives. Key strategies include national building codes, mandatory energy audits in industry, financial incentives such as subsidies for heat pumps and energy renovation, tax credits, and support for technological advancements such as smart energy systems and industrial electrification.

3. Exemplary initiatives within energy efficiency
Examples of successful initiatives within energy efficiency in the Nordics include Denmark's minimum requirement targets for energy-saving in new and existing buildings and the energy-saving scheme for energy companies, Sweden's Halve More campaign and energy efficiency networks for small and medium-sized enterprises (SMEs), Finland's Energy Efficiency Agreements for Industries and promotion of heat pumps, Norway's programmes for climate and energy initiatives for industry and energy management introduction, and Iceland's subsidy for heat pumps.

4. Barriers to energy efficiency implementation
A questionnaire conducted among key market actors, revealed persistent barriers to energy efficiency implementation. Despite a high level of policy awareness of both national and EU regulations, several challenges to energy efficiency implementation remain. Key barriers include financial constraints, short-term priorities, lack of expertise, inadequate incentives, bureaucratic complexity, low regional energy costs, and misalignment across government tiers.

5. Households' energy behaviour in response to the energy crisis of 2021–2023
The global energy crisis of 2021–2023 exposed households to high energy prices, sparked heated public debate, and resulted in government intervention to protect households from the worst of the price shock. A survey conducted among Nordic households showed growing awareness of people's own energy consumption in response to the crisis, with many respondents intending to continue their energy-saving efforts even if they perceive the impact as small or moderate. However, household energy behaviour varies between the Nordic countries, with socioeconomic factors and inherent preferences likely having a large impact.

Recommendations

1. Prioritising strategic measures towards common goals
Policy development should promote collaboration on strategic measures aligned with national and EU goals. Here, key initiatives might include energy-efficient renovation of existing buildings under the revised EPBD, replacing fossil-fuel-based heating systems with energy-efficient solutions such as heat pumps, conducting energy audits for SMEs in addition to large industrial energy consumers as mandated by the revised EED, establishing voluntary energy efficiency agreements in industry, and advancing industrial electrification.

Clear regulations, adequate financial support, and strong sector collaboration are essential for scaling these efforts across countries.

2. Leveraging exemplary initiatives and supporting transferability
Several exemplary initiatives from Nordic countries have demonstrated success and offer transferable models for other regions. To enhance the scalability and impact of these initiatives, it is essential to address infrastructure limitations, encourage the adoption of advanced technologies, and streamline administrative processes. Additionally, fostering cross-country collaboration and knowledge exchange can support the adaptation of initiatives while ensuring they remain aligned with local policy contexts and industry needs.

3. Addressing barriers to energy efficiency implementation

To overcome barriers to energy efficiency, increasing financial incentives, simplifying subsidies, and aligning policies across government levels is key. Reducing bureaucratic complexity, along with using effective communication strategies and sharing case studies, could also help drive change. Additionally, performance-based incentives and early stakeholder engagement is crucial for successful adoption of energy efficiency solutions.

4. Supporting changes in households' energy behaviour

To support the growing awareness of and efforts to save energy among Nordic households in response to the recent energy crisis, policies should focus on fostering long-term behavioural changes and measures. These could include further incentives for energy-efficient solutions along with accessible expert consultations. Since energy behaviour varies across socioeconomic groups and countries, tailored solutions may be necessary to address the specific needs of different households.

Government programs should focus on educating households, particularly vulnerable groups, and providing practical resources to make energy-saving actions easier and more cost-effective.

Executive summary

The global final energy consumption totalled around 445 exajoules (EJ) in 2023, with the industrial sector ranking highest at 39%, buildings at 28%, and transport at 27%. In all Nordic countries, there has been an **improvement in the primary energy intensity** – the annual reduction in the energy intensity of the economy – ranging from 2% in Finland to 3.8% in Denmark, from 2010 to 2019.

This report summarises the findings of a project that mapped and analysed energy efficiency activities across the Nordics, particularly in the building and industry sectors.

Chapter 2 outlines the **key energy efficiency goals, targets, and strategies** across Norway, Sweden, Finland, Denmark, Iceland, and the Faroe Islands. All the Nordic countries aim to improve energy efficiency, achieve carbon neutrality, and transition to renewable energy, but each country has specific targets and strategies for various sectors. **Across sectors**, these countries are integrating energy efficiency measures, adopting sustainable technologies, and fostering collaboration to meet their climate and energy goals. In particular, Finland, Sweden, and Denmark are focused on meeting energy savings targets as mandated in the Energy Efficiency Directive (EED). Finland is aiming for a 50% share of renewable energy in final consumption and carbon neutrality by 2035. Sweden is targeting a 50% improvement in energy efficiency by 2030 and net-zero greenhouse gas (GHG) emissions by 2045. Denmark has committed to reducing GHG emissions by 70% by 2030 and becoming fossil fuel free by 2050. Meanwhile, Iceland and the Faroe Islands have prioritized renewable energy adoption; the former is aiming for climate neutrality by 2040 and the latter for 100% green electricity by 2030 and a 45% emissions reduction from 2010 levels. Norway is targeting a 30% improvement in energy intensity by 2030 and aiming for a 'Low Emission Society' by 2050, with ongoing efforts to track energy use and improve energy efficiency across sectors. In the **building sector**, Norway aims to cut electricity use by 10 terawatt-hour (TWh)/year by 2030 compared to 2015, while Sweden targets reducing energy consumption and 50% GHG emissions by 2030, along with net-zero emissions by 2045. Denmark is prioritizing renovations and the transition to renewable heating solutions, with a goal to phase out oil and gas in space heating by 2035 and achieve 100% green gas by 2030. Finland aims to reduce its heating energy use from 71 TWh/year in 2020 to 36 TWh/year by 2050, with a long-term strategy to decarbonize its building stock. The Faroe Islands plan to transition 50% of the private homes to renewable heating by 2030, while Iceland aims for a 7.5% reduction in emissions from energy use in buildings and a 43% total reduction by 2030. In the **industry sector**, Denmark aims for an industrial green transition by 2050 while Finland is targeting the

creation of the world's most competitive carbon-neutral industrial environment. Norway is focusing on phasing out fossil fuels while Sweden is enhancing resource efficiency and energy system flexibility. Iceland aims to completely eliminate its dependence on fossil fuels and transition to a diversified use of renewable energy sources. The Faroe Islands are cutting oil consumption in key sectors such as fishing and shipping, while investing in renewable energy.

Chapter 3 discusses the **implementation of EU regulations** in the Nordic countries, focusing on the status of key directives and initiatives, including the EED, EPBD, *Renewable Energy Directive* (RED), *Ecodesign Directive*, *Energy Labelling Framework Regulation*, *Fit for 55*, and *EU Emissions Trading System* (EU ETS). While the Faroe Islands are not part of the EU, Norway and Iceland follow EU regulations through the European Economic Area (EEA). As EU members, Denmark, Finland, and Sweden directly implement these directives. The implementation of the original EPBD and EED has led to several success stories across the Nordic countries. In Denmark, the EPBD resulted in the creation of a comprehensive database for energy certification data, projecting a 28% reduction in heat demand by 2050. Finland successfully integrated the EPBD through stakeholder collaboration, promoting energy-efficient construction and renovation. Norway has prepared for stricter energy performance requirements with passive house standards and industry collaboration. Sweden has introduced an application programming interface (API) to give businesses easy access to energy performance certificate (EPC) data, supporting green mortgages. In terms of the EED, Denmark has implemented an energy efficiency obligation scheme, Finland has used voluntary agreements to promote energy efficiency, and Sweden has launched a programme to enhance energy efficiency among small and medium-sized enterprises (SMEs).

Chapter 4 presents the **current policy instruments** for energy efficiency across the Nordic countries. The most effective policy strategy integrates informational, regulatory, and financial instruments with voluntary measures, where the latter drive innovation and the former help scale energy efficiency efforts. In the **building sector**, the Nordic countries promote energy efficiency through informational tools such as advisory services (e.g. Denmark's SparEnergi.dk, Finland's Motiva Oy, and Norway's Enova) and specialised centres (e.g. in Denmark, Finland, Iceland, and Sweden). All Nordic countries have regulations setting minimum energy efficiency requirements for new and renovated buildings. Energy labelling systems are common in Denmark, Finland, Norway, and Sweden. Iceland has regulation supporting heating costs, while the Faroe Islands require heat pump systems and installer approvals. Moreover, financial incentives such as grants and subsidies are provided, for instance, for energy-efficient renovations, heat pump installations, and renewable energy transitions. Tax incentives and green financing options are available in most countries. Voluntary initiatives include energy standards (e.g.

Norway's passive house criteria) and environmental certifications such as BREEAM and LEED. In the **industry sector**, informational tools including guides and consulting services are provided by entities such as Denmark's SparEnergi.dk, Finland's Motiva Oy, Iceland's Energy Centre, and Sweden's Energy Agency. Energy audits for large companies are mandatory in most Nordic countries to identify energy-saving opportunities. Financial support includes grants, loans, and green financing options (e.g. Sweden's Climate Leap programme for emissions-reduction and Iceland's National Energy Fund for renewable energy projects). Voluntary initiatives such as ISO 50001 are widely used to promote better energy management practices. Additionally, Sweden, Finland, and Norway also have industrial transition strategies and programmes including Roadmaps for Fossil-Free Competitiveness in Sweden and Green Industrial Initiative in Norway. The Faroe Islands focus on green transition within business networks aligned with the United Nations (UN) Sustainable Development Goals (SDGs).

Chapter 5 outlines selected **energy efficiency measures** across the Nordic region, showcasing their **energy saving potential or effect**. In the **building sector**, Denmark could reduce heating demand by 10.1 TWh/year through building renovations focused on better insulation and heating systems. In Finland, improving energy efficiency in the existing building stock is expected to reduce heating energy consumption by 8 terawatt-hour (TWh)/year by 2050, while building regulations could save 13 TWh/year by 2030. In Iceland, annual energy savings of 0.4 TWh are achievable in commercial services and households. In Norway, energy efficiency measures in buildings could save 24 TWh/year, with heat pumps saving up to 8 TWh/year. In Sweden, smarter heating and insulation could result in savings of 19 TWh/year by 2030, with major contributions from single-family homes (8 TWh) and multi-dwelling units (8 TWh). In the **industry sector**, Denmark could reduce thermal energy use by 7% and electricity use by 17% through more efficient processes such as drying and distillation. In Finland, waste heat recovery could save 35 TWh/year, including 15 TWh/year from industrial plants, supported by combined heat and power (CHP) systems generating 70% of the district heating. In Iceland, industrial waste heat recovery could save 0.357 TWh/year, with 0.112 TWh from the aluminium industry. In Norway, waste heat recovery could save 20 TWh/year, with 6 TWh from easily accessible heat sources (100–250°C). In Sweden, industry efficiency improvements could save 15 TWh/year by 2030 while waste heat recovery and CHP systems could provide a combined savings potential of up to 34 TWh/year. Finally, energy savings from Ecodesign and Energy Labelling in the Nordics are projected to be significant by 2030, with Sweden leading at 51.01 TWh/year in primary energy savings, followed by Finland at 41.58 TWh/year, Norway at 35.50 TWh/year, Denmark at 27.52 TWh, and Iceland at 1.93 TWh/year.

Chapter 6 discusses the **best practices in energy efficiency** across the building and industrial sectors in Nordic countries. In this study, the assessment criteria for energy efficiency measures in Nordic countries focus on energy saving impact and

the level of spread. The best practices, identified through analysis of state-of-the-art reviews and expert consultations, achieve both high energy-saving effects and widespread adoption, while the good practices vary in these attributes. In the **building sector**, common *best practices* across most Nordic countries include highly insulated and airtight building envelopes, energy-efficient windows, mechanical ventilation with heat recovery, energy-efficient appliances and lighting, and heat pumps for heating. These practices are underpinned by stringent building codes in most countries alongside successful initiatives such as energy efficiency agreements in Finland and incentives for energy measures in households in Norway. *Good practices* across Nordic countries include district heating systems (in Finland, Sweden and Denmark) and building energy labelling, along with various subsidy schemes that support energy-efficiency in buildings as in Denmark and Iceland, and technology procurement groups in Sweden, which advance energy-efficient solutions. In the **industry sector**, the common *best practices* include combined heat and power systems, waste heat recovery, energy management systems, and mandatory energy audits for large enterprises. These measures are reinforced by financial incentives and regulations, such as energy taxes in Denmark and environmental permit requirements in Finland. Norway and Sweden provide financial support for energy-efficient technologies, while Iceland supports geothermal projects. *Good practices* include industrial process electrification; energy audits models and advice programmes as in Finland; and industry-specific networks and centres to promote energy savings, such as Denmark's Centre for Energy Savings in Enterprises and Sweden's energy efficiency networks for SMEs. Additionally, public funding initiatives such as Iceland's Energy Fund and Norway's energy and environmental tax system also represent notable good practices.

Chapter 6 also presents a selection of **exemplary programmes and policies**, focusing on energy efficiency and climate change mitigation in the building and industry sectors of the Nordic countries. The initiatives were chosen through a thorough review of historical policies and successful measures from the Mure database and consultations with experts in each country. Each initiative was assessed based on several key criteria, including energy savings, broader impacts, cost-effectiveness, level of spread, implementation barriers, and success factors. The initiatives presented here cover a wide range of energy efficiency strategies across various sectors. In the **building sector**, Denmark's *window energy labelling* informs consumers on window energy performance and its *minimum requirement targets* ensure energy savings for both new and existing buildings. Finland's *Property and Building Sector Energy Efficiency Agreement* is a voluntary initiative promoting energy efficiency, while the *promotion of heat pumps* encourages the use of energy-efficient heating solutions. Norway's *programme for passive houses and low-energy houses* incentivizes energy-efficient building construction, and the *programme for best available technology (BAT) in existing buildings* promotes advanced energy-saving technologies. Sweden's *LÅGAN* focuses on buildings with very low energy

use, while the *Halve More campaign* raises awareness on energy-saving behaviours. Finally, Iceland's *subsidy for heat pumps and geothermal district heating systems* provides financial support for renewable heating systems in buildings. In the **industry sector**, successful voluntary initiatives include Finland's *Energy Efficiency Agreement for Industries* and Sweden's *programme for energy efficiency in energy intensive industry*, both of which encourage energy-saving commitments. Furthermore, Finland's *Energy Audit Programme* and Sweden's *energy efficiency networks for SMEs* help industries identify and implement energy-saving measures. Financial incentives, such as *Energy Fund for industrial energy conversion projects* in Iceland and *subsidy scheme for renewable energy use in production processes* in Denmark, help industries adopt renewable and energy-efficient technologies. Denmark's *energy saving scheme for energy companies* had binding energy efficiency targets for the companies and was implemented by voluntary agreements, while Norway's *programme for climate and energy initiatives for industry* and *support for the introduction of energy management* further promote energy savings and improved energy management. These assessed initiatives share common **success factors**, including strong stakeholder collaboration, alignment with regulations, financial incentives, and effective technical support. Monitoring and reporting mechanisms have also enhanced the accountability and results. **Key obstacles** encountered during the implementation of the assessed initiatives include high upfront costs, technological complexity, limited expertise, and resistance to change. Additionally, administrative burdens and difficulties in quantifying energy savings or cost-effectiveness have further challenged broader adoption.

Chapter 7 presents the **exemplary projects** from the Nordic countries and provides valuable insights into the diverse approaches being taken to enhance energy efficiency across buildings and industries. For instance, the *Powerhouse Kjørbo* project in Norway, *Blå Jungfrun* in Sweden, and the *Drangar project* in Iceland demonstrate how existing buildings can be transformed through energy-positive design, passive house standards, and sustainable renovation techniques. For the industry sector, the *Kalundborg Eco-Industrial Park* in Denmark and *Händelö Eco-Industrial Park* in Sweden showcase the potential of industrial symbiosis to improve resource efficiency and reduce emissions. Meanwhile, projects such as *Nordkalk* in Finland illustrate how companies can integrate heat recovery and renewable energy to enhance production efficiency and minimize environmental footprints.

Chapter 8 assesses the **transferability of energy efficiency initiatives across the Nordic countries**. The results are based on a workshop where a group of Nordic experts discussed how a set of energy efficiency initiatives can be effectively implemented in diverse settings. In the **building sector**, initiatives such as *minimum requirement targets for energy saving for new and existing buildings* in Denmark and *Halve More campaign* in Sweden were rated as highly adaptable initiatives. Denmark's regulatory framework, which involves setting minimum requirements for

energy savings 5 to 10 years ahead, has proven effective. Meanwhile, Sweden's public engagement campaign has successfully reduced household energy consumption through behavioural changes. Additionally, its *LÅGAN programme* for low-energy buildings is a proven model for achieving energy savings and is considered to be easily replicable in different climates. Finally, Finland's *promotion of heat pumps*, rated as having medium-high scalability, integrates well with existing energy policies, although system design and installation are key to its success.

In the **industry sector**, several initiatives demonstrate strong potential for replication across the region. Denmark's *energy-saving scheme for energy companies*, rated with the highest transferability potential, is highly scalable and has been successfully adopted in several EU countries. This scheme has proven particularly successful in SMEs, though it may be considered expensive and labour-intensive in some countries such as Finland. Norway's *support for the introduction of energy management* is also considered as highly transferable, particularly due to its alignment with the *EED*, which mandates energy management for large industrial consumers. This initiative has shown substantial cost-effectiveness and could also benefit SMEs. Sweden's *energy efficiency networks for SMEs* were also graded with high scalability, as it fosters collaboration and knowledge-sharing among SMEs to improve energy efficiency. The initiative's replicability across industries makes it a promising model for broader adoption.

The ***primary factors which can hinder transferability*** of successful energy efficiency initiatives across Nordic countries, ***as discussed during the workshop,*** include concerns about effectiveness, technological constraints, misalignment with national policy priorities, industry-specific needs, and challenges related to implementation and monitoring. Countries may also find certain initiatives redundant or difficult to apply due to existing advancements, regulatory frameworks, or infrastructure limitations.

Chapter 9 examines the **barriers to energy efficiency implementation in Nordic countries** based on a questionnaire targeting consumers, businesses, and industry professionals. Despite technological advances and policy incentives, there is a significant gap between the potential and the actual energy savings, partly due to psychological and behavioural barriers. The findings show moderate to high awareness of regulations among the participants, with some regional differences. Barriers such as financial limitations and short-term priorities have hindered the adoption of energy-efficient practices have hindered the adoption of energy-efficient practices. The respondents suggested stricter regulations and financial incentives along with communication strategies to overcome these challenges. While the incentive schemes are generally appreciated, improvements, particularly aligning support across government levels, are needed. Suggestions for enhancing these schemes include increasing funding, simplifying processes, and introducing performance-based incentives.

Chapter 9 also presents the main findings from a **web-panel survey** that was conducted in the six countries to analyse the **energy behaviour of households before, during, and after the energy crisis of 2021–2023**. The survey covers implemented short-, medium-, and long-term energy efficiency measures during this period, encompassing socio-demographic profiles, attitudes, motivations, and intentions concerning energy consumption and efficiency measures. During the energy crisis, households implemented acute measures. Norwegian respondents reported changes in their showering habits, shifting appliance usage to different hours, and adjusting home temperatures. In Denmark, Finland, and Sweden, there was a significant shift in appliance use to off-peak hours with lower electricity prices as well as widespread temperature adjustments. The Faroe Islands and Iceland were less affected from the energy crisis and exhibited minimal behavioural changes. For medium- and long-term measures, the respondents reported primarily investing in energy-efficient appliances. This accounts for all three periods, before, during, and after the crisis. In terms of future measures, the respondents showed growing interest in implementing energy monitoring systems and consulting energy experts. Most of them also expressed a willingness to continue their efforts despite perceiving the impact as small or moderate. Furthermore, the survey applied a stated preferences method to capture the nuances in the choice of future energy saving measures. The results showed that the investment support level influenced the respondents' choices only in Norway and Sweden, implying that subsidy schemes, which exist or have existed in several of the Nordic countries, did not seem to have a large impact on the investment decisions. The results further suggest that the investment cost is an important attribute in decision-making for the respondents in Iceland, Denmark, Finland, and Sweden. Moreover, a bias was found among the respondents in Sweden and Finland towards choosing 'installing energy-efficient windows' and 'using an energy monitoring system', respectively, which implies a cultural or contextual bias in the choice of measures. While the overall sample exhibited limited interest in subsidy schemes, subgroups with higher education and middle-aged respondents appeared more inclined to value financial support.

Abbreviation list

EU – European Union

EU ETS – Emission Trading System

EEA – European Economic Area

ERDF – European Regional Development Fund

UN – United Nations

SDGs – Sustainable Development Goals

EPBD – Energy Performanceof Buildings Directive

EED – Energy Efficiency Directive

RED – Renewable Energy Directive

ESPR – Ecodesign for Sustainable Product Regulation

NEEAP – National Energy Efficiency Action Plan

SMEs – small and medium-sized enterprises

TES – total energy supply

EJ – exajoules

GWh – gigawatt-hour

MWh – megawatt-hour

TWh – terawatt-hour

kWh – kilowatt-hour

MW – megawatt

kW – kilowatt

kt – kilotons

L – liter

toe – tonne of oil equivalent

GJ – gigajoule

m^2 – square meter

GHG – greenhouse gas emissions

CO_2 – carbon dioxide

EPC – energy performance certificate

API – application programming interface

BAT – best available technology

IEA – International Energy Agency

PPP – purchasing power parity

GDP – Gross Domestic Product

R&D – research and development

RD&D – research, development, and demonstration

nZEB – nearly zero energy building

ZEB – zero emission building

ISO – International Organization for Standardization

VAT – value added tax

HVAC – Heating, Ventilation, and Air Conditioning

LCOE – levelised cost of energy

CHP – combined heat and power

ROI – return on investment

EMS – energy monitoring system

SP – Stated Preference

KPI – key performance indicator

USD – United States dollars

€ – euro

NOK –Norwegian krone

ISK – Icelandic króna

SEK – Swedish krona

DKK – Danish krone

NCS – nanocoated salt

M – million (used before a currency abbreviation)

PFE – Programme for energy efficiency in energy intensive industry

EAP – Energy Audit Programme

LÅGAN – Programme for buildings with very low energy use

NVE – Norwegian Water Resources and Energy Directorate

1. Introduction

1.1 Background

In 2023, the worldwide total final energy consumption reached approximately 445 exajoules (EJ). The industrial sector claimed the largest share, accounting for 39% of the usage, followed by buildings at 28% and transport at 27%. Over the years, the industrial energy consumption has consistently increased, with an annual growth rate of about 1.5% from 2010 to 2023. Industrial energy demand grew by 2% in 2023 while emissions saw an increase of under 1%. In 2023, the energy demand in buildings was over 120 EJ, with an average annual increase of 0.9% from 2010 to 2023[1].

Energy efficiency means the ratio of output of performance, service, goods, or energy to energy input[2]. Efficient energy use involves not only optimizing the use of each energy resource but also selecting the appropriate energy carrier and solution at the right time. Improving energy efficiency has various benefits: for example, reduced energy consumption and subsequent energy savings, environmental gains such as lower greenhouse gas (GHG) emissions, enhanced energy security through decreased reliance on imported energy sources, lower energy costs for both consumers and utilities, increased economic competitiveness, and the creation of new job opportunities[3].

Energy efficiency is ***a key priority in the European Union (EU)*** as it plays a crucial role in lowering the overall energy consumption and realizing the climate goals. It contributes to the EU's aim of reducing GHG emissions by at least 55%, compared to the 1990 levels, by 2030, and thus ensuring a more sustainable and secure energy future.

The principle of ***'Energy Efficiency First'*** mirrors EU objectives and harmonizes with the union's aims for sustainability, climate neutrality, and fostering green growth. It prioritizes producing only necessary energy, avoiding investments in stranded assets, and managing energy demand cost-effectively while considering supply security and market integration[4]. The recent EU strategy for energy system

1. International Energy Agency (IEA), "Energy efficiency 2024," OECD Publishing, Paris, France, 2024. [Online]. Available: https://www.iea.org/reports/energy-efficiency-2024#overview
2. The European Parliament and The Council of The European Union, *Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023/955 (recast)*. Accessed: Nov. 21, 2024. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023L1791
3. L. Pérez-Lombard, J. Ortiz, and D. Velázquez, "Revisiting energy efficiency fundamentals," *Energy Efficiency*, vol. 6, no. 2, pp. 239–254, May 2013, doi: 10.1007/s12053-012-9180-8.
4. European Commission, "Energy Efficiency First principle." Accessed: Nov. 21, 2024. [Online]. Available: https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-first-principle_en

integration not only follows up on this principle but also aims for an efficient interplay between energy carriers through holistic energy system planning[5]

The Nordic region has a relatively high gross final energy consumption per capita, averaging 3.7 tonne of oil equivalent (toe) in 2019 compared to the EU's 2.3 toe. This reflects the region's cold climate, low population density, and the prevalence of energy-intensive industries and highlights the significance of implementing energy efficiency measures to address and manage energy[6].

The International Energy Agency (IEA) database[7] on the energy systems of Europe provides insights into the energy landscape of Nordic countries and examines various aspects such as energy consumption, renewable energy share, energy mix, energy use in different sectors, and the largest sources of electricity generation. The key findings for the Nordic countries are summarized below (a more detailed overview in Table A1 in Appendix 1):

- **Final energy consumption**: Industry dominates energy consumption in most Nordic countries, with Iceland (43%) and Finland (41%) ranking highest. Denmark (29%) and Sweden (23%) have the highest residential consumption. Meanwhile, commercial services make up 12–16% of the consumption in most countries, and transport is most significant in Denmark (31%) and Norway (24%).
- **Renewable energy**: Iceland has the highest share of renewables in final energy consumption (82%), followed by Norway (61%), Sweden (58%), Finland (50%), and Denmark (40%).
- **Energy mix**: Denmark's energy mix is dominated by oil (37%) and biofuels (35%). Finland relies heavily on biofuels (31%) and nuclear energy (28%). In Iceland, wind and solar contribute to 70% of its energy. Norway predominantly depends on hydropower (43%) while Sweden relies on a combination of biofuels (29%) and nuclear energy (27%).
- **Residential energy use**: Denmark relies mainly on heat (43%) and electricity (22%), whereas Finland combines electricity (39%), heat (32%), and biofuels (24%). Iceland uses mostly heat (81%) while Norway and Sweden have higher electricity shares (81% and 49%, respectively).
- **Services and industrial energy use**: Electricity is the main energy source in services across Nordic countries, ranging from 44% to 77%, and heat plays a larger role only in Iceland (61%). In industry, electricity is predominant in the Nordic region, reaching 98% in Iceland, while biofuels are significant in Sweden (43%) and Finland (38%).

5. European Commission, "EU strategy on energy system integration." Accessed: Nov. 21, 2024. [Online]. Available: https://energy.ec.europa.eu/topics/energy-systems-integration/eu-strategy-energy-system-integration_en
6. *Renewable Energy in the Nordics 2021.* Nordic Energy Research, 2021. doi: 10.6027/NER2021-03.
7. International Energy Agency (IEA), "Energy system of Europe." Accessed: Mar. 19, 2024. [Online]. Available: https://www.iea.org/regions/europe

- **Electricity generation**: Denmark generates 58% of its electricity from wind, Iceland relies on hydropower (70%) and geothermal energy (30%), Norway's electricity is primarily from hydropower (89%), and Sweden uses a mix of hydropower (40%) and nuclear (29%).

However, the Nordic countries are striving to reduce their primary energy intensity through targeted energy efficiency measures, as tracked by the IEA Energy Efficiency Progress Tracker[8] **Primary energy intensity** measures the total energy supply (TES) required to produce a unit of gross domestic product (GDP), expressed in constant purchasing power parity (PPP) terms, and is typically measured in gigajoule (GJ) per 1000 United States dollars (USD) *Lower values* of primary energy intensity indicate a *more energy-efficient economy*, where less energy is used relative to economic activity. **Primary energy intensity improvement** indicates the annual reduction in the energy intensity of the economy, with *higher values* reflecting *advancements in energy efficiency*. The key findings from the IEA are illustrated in Figure 1.

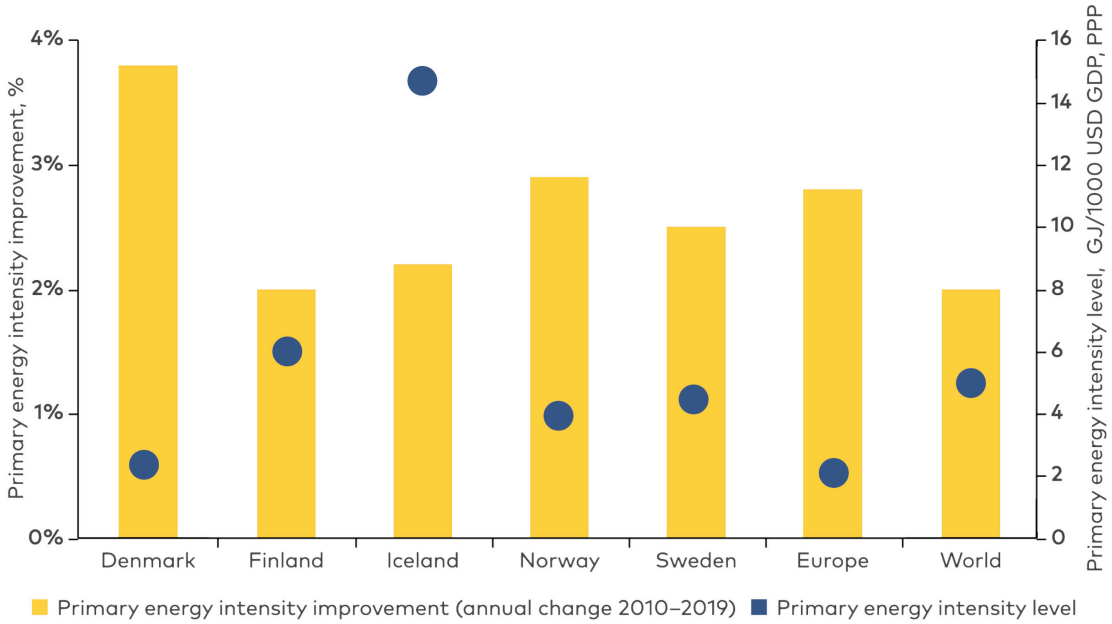

Figure 1: Primary energy intensity and annual improvements in energy intensity from 2010 to 2019, across the Nordic countries, Europe and the world.

8. International Energy Agency (IEA), "Energy Efficiency Progress Tracker." [Online]. Available: https://www.iea.org/data-and-statistics/data-tools/energy-efficiency-progress-tracker#overview

1.2 Aim of the project

This report summarizes the findings of a project initiated by the Nordic Committee of Senior Officials for Energy Policy (EK-E) to foster knowledge sharing and collaboration among the Nordic countries to meet their energy efficiency goals. In response to the EU's comprehensive directives and detailed energy efficiency requirements, the project maps and analyses the experiences of Norway, Sweden, Finland, Denmark, Iceland, and the Faroe Islands.

The key tasks of the project include mapping the past and current activities related to energy efficiency in the Nordics, evaluating the best practices and exemplary policies or programmes, assessing the transferability of successful initiatives, identifying the barriers such as behavioural and psychological challenges, and analysing household energy behaviour during the 2021–2023 energy crisis. Insights were gathered through a comprehensive approach, which included reviewing national and international reports and databases, gathering input from Nordic experts on energy efficiency, and conducting surveys.

2. Nordic objectives, targets, and strategies for energy efficiency

This chapter provides a country-by-country overview of their current objectives, targets, and strategies related to energy efficiency. Notably, it presents a comprehensive snapshot and is not necessarily exhaustive, as strategies and targets are often evolving.

The Nordic countries share a main ***energy efficiency objective***: to reduce the energy consumption across all sectors through enhanced energy saving measures. Moreover, there is currently a concerted effort to align with the EU directives and international climate goals, including carbon neutrality and transitioning to renewable energy.

The common **cross-sectoral** objectives include setting ambitious energy efficiency targets, reducing GHG emissions, and expanding the use of renewable energy. Finland has targeted a 50% renewable energy share and carbon neutrality by 2035. Sweden is aiming for a 50% energy efficiency improvement by 2030 and net-zero emissions by 2045. Denmark has planned a 70% GHG reduction by 2030 and fossil fuel free status by 2050. Iceland and the Faroe Islands have focused on renewable energy, with the former aiming for climate neutrality by 2040 and the latter seeking to achieve 100% green electricity by 2030 and a 45% emissions reduction compared to 2010 levels. Norway is aiming for a 30% energy intensity improvement by 2030 and a 'Low Emission Society' by 2050.

In the **building sector**, most of these countries focus on reducing energy consumption, transitioning to renewable heating, and upgrading existing building stock through long-term renovation strategies. Norway aims to reduce electricity use in buildings by 10 terawatt-hour (TWh)/year by 2030, as compared to the 2015 levels. Sweden plans to reduce energy consumption in buildings and achieve a 50% reduction in GHG emissions by 2030, with net-zero emissions by 2045. Denmark has emphasized renovations in private homes, businesses, and public buildings and the transition to renewable heating solutions, with a goal to phase out oil and gas in space heating by 2035. Finland aims to save 15 TWh through renovations by 2030. The Faroe Islands plan to transition 50% of their private homes to renewable heating by 2030. Finally, Iceland is aiming for a 7.5% reduction in emissions from energy use in buildings and a 43% total reduction by 2030.

In the **industry sector**, decarbonization, electrification, and renewable energy integration are central in most Nordic countries. For instance, Denmark and Finland aim to have carbon-neutral industries by 2050 and 2030, respectively. Iceland is transitioning from fossil fuels to renewable energy, in all industrial areas, while Norway targets phasing out fossil fuels. Sweden is emphasizing resource-efficient and flexible systems, and the Faroe Islands aim to cut oil consumption in key sectors such as fishing and shipping, while investing in renewable energy. Strategic plans, including Finland's Low-Carbon Roadmaps and Norway's Energi21 Strategy, support these transitions, complemented by energy audits and investments in innovative technologies such as carbon capture and smart energy systems.

The following sections provide individual overviews of the objectives, targets, and strategies for Denmark (2.1), the Faroe Islands (2.2), Finland (2.3), Iceland (2.4), Norway (2.5), and Sweden (2.6). Each country overview is organized into three categories: "cross-sectoral, building sector, and industry sector.

2.1 Denmark

2.1.1 Cross-sectoral

Table 1. Selected cross-sectoral energy efficiency and climate change mitigation objectives and targets in Denmark.

Objectives and targets

- Fulfil the Energy Efficiency Directive (EED) requirements that include the energy saving obligations, energy efficiency targets, and national contribution. Denmark is required to achieve cumulative energy savings of 107.2 TWh over the period 2021–2030, while its indicative national contribution to the EU target amounts to 159.7 TWh of the final energy consumption.
- Reduce GHG emissions by 70% in 2030 compared to the 1990 level and be fossil fuel free by 2050.
- Expand the use of renewable energy sources extensivel.

References[9]

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9. Danish Energy Agency, "Final update of Danmark's National Energy and Climate Plan for the period 2021-2030," Jun. 2024. [Online]. Available: https://commission.europa.eu/document/download/13353c72-43bc-486e-bc82-9e8ea7588734_en?filename=DK_FINAL%20UPDATED%20NECP%202021-2030%20%28English%29.pdf

2.1.2 Building sector

Table 2. Selected energy efficiency and climate objectives, targets and strategies for Denmark's building sector.

Objectives and targets

- Focus on improving the energy efficiency of private homes, businesses, and public buildings.
- Phase out oil and gas use in space heating by 2035.
- Achieve 100% green gas by 2030.
- Prohibit new district heat projects that use fossil fuels[10].
- Have life-cycle-based targets for carbon dioxide (CO_2) emissions from new buildings.

Strategies

- Implement the 'National strategy for sustainable buildings', the government's sectoral action plan, to support a comprehensive sustainable transformation of the construction sector, including initiatives for climate-friendly construction, high-quality sustainable buildings, holistic renovation assessments to minimize demolition, and digitally supported construction.
- Execute the 'Danish Climate Agreement for Energy and Industry 2020', which also focuses on the green transition of house heating and energy efficiency improvements in buildings.
- Execute a 'Long-Term Renovation Strategy', as mandated by the Energy Performance of Buildings Directive (EPBD), to support the renovation of the national building stock.

References[11],[12],[13],[14]

10. International Energy Agency (IEA), Denmark 2023: Energy Policy Review. OECD, 2023. doi: 10.1787/755105d6-en.
11. Danish Energy Agency, "Final update of Danmark's National Energy and Climate Plan for the period 2021-2030," Jun. 2024. [Online]. Available: https://commission.europa.eu/document/download/13353c72-43bc-486e-bc82-9e8ea7588734_en?filename=DK_FINAL%20UPDATED%20NECP%202021-2030%20%28English%29.pdf
12. International Energy Agency (IEA), *Denmark 2023: Energy Policy Review*. OECD, 2023. doi: 10.1787/755105d6-en.
13. Danish Ministry of the Interior and Health, "Ny aftale sikrer bæredygtigt byggeri [New agreement ensures sustainable construction]." Accessed: Mar. 20, 2024. [Online]. Available: https://www.ism.dk/nyheder/2021/marts/ny-aftale-sikrer-baeredygtigt-byggeri
14. Danish Ministry of Climate, Energy and Utilities, "Danish Climate Agreement for Energy and Industry 2020 – Overview," 2020. [Online]. Available: https://www.kefm.dk/Media/C/B/faktaark-klimaaftale%20(English%20august%2014).pdf

2.1.3 Industry sector

Table 3. Selected energy efficiency and climate objectives, targets and strategies for Denmark's industry sector.

Objectives and targets

- Achieve a green transition of industry, targeting complete decarbonization by 2050.

Strategies

- Implement the Green research, development, and demonstration (RD&D) Strategy for investments in energy efficiency by pinpointing the key research priorities aligned with energy and climate agreements, including industrial electrification, renewable integration, and more green gas such as biogas and synthetic carbon-neutral fuels.
- Execute the 'Danish Climate Agreement for Energy and Industry 2020', which also focuses on the green transition and energy efficiency improvement in the industry sector.

References[15], [16]

15. Danish Ministry of Climate, Energy and Utilities, "Danish Climate Agreement for Energy and Industry 2020 – Overview," 2020. [Online]. Available: https://www.kefm.dk/Media/C/B/faktaark-klimaaftale%20(English%20august%2014).pdf
16. International Energy Agency (IEA), "Denmark 2023. Energy Policy Review." OECD Publishing, Paris, France, 2023. [Online]. Available: https://www.iea.org/reports/denmark-2023

2.2 The Faroe Islands

2.2.1 Cross-sectoral

Table 4. Selected cross-sectoral energy efficiency and climate change mitigation objectives and targets in the Faroe Islands.

Objectives and targets	References[17], [18]
• Achieve 100% green electricity by 2030. • Reduce emissions by at least 45% by 2030 compared to 2010 levels.	

17. H. M. Tróndheim, T. Nielsen, B. A. Niclasen, C. L. Bak, F. F. D. Silva, and D. Department, "The Least-Cost Path to a 100% Renewable Electricity Sector in the Faroe Islands," presented at the 4th International Hybrid Power System Workshop, Crete, Greece, May 2019
18. Faroese Ministry of Foreign Affairs, Industry and Trade, "Arctic Policy of the Faroe Islands," 2024. [Online]. Available: https://landsstyri.cdn.fo/savn/rqspqfmm/arctic-policy-of-the-faroe-islands-2024.pdf?s=QLOcrrCYmLEDuXePLfm16NTWxSA

2.2.2 Building sector

Table 5. Selected energy efficiency and climate objectives, targets and strategies for the Faroe Islands' building sector.

Objectives and targets

- Reduce energy use and transition 50% of the private houses from heating by oil to renewable energy heating by 2030.

Strategies

- Incentivise the purchase of heat pumps and use of geothermal heating.
- Support the implementation of the 'Proposal for an Energy and Climate Policy 2021-2030', which suggests measures for the transition to renewable energy heating and the reduction of GHG emissions, including a ban on the oil heating in new houses and the introduction of building energy labelling.

References[19], [20]

19. Faroese Ministry of Health and Internal Affairs, "Veðurlagspolitikkur Føroya 2020-2030 [Climate policy of the Faroe Islands 2020-2030]," 2019. [Online]. Available: https://landsstyri.cdn.fo/savn/13155/ve%C3%B0urlagspolitikkur-f%C3%B8roya-2020-2030.pdf?s=dL1rKc5lbIJay6z3KLiqRCoRd2o
20. Faroese Ministry of Environment, Industry and Trade and Faroese Environmental Agency, "Uppskot til Orku- og veðurlagspolitikk 2021-2030 [Proposal for Energy and Climate Policy 2021-2030]." 2021. Accessed: Jan. 08, 2025. [Online]. Available: https://www.us.fo/wp-content/uploads/2023/07/Uppskot-til-Orku-og-vedurlagspolitikk-2021-2030.pdf)

2.2.3 Industry sector

Table 6. Selected energy efficiency and climate objectives, targets and strategies for the Faroe Islands' industry sector

Objectives and targets

- Reduce the oil consumption in industrial operations, especially in sectors such as construction, fishing and shipping.

Strategies

- Support the implementation of the 'Climate policy of the Faroe Islands 2020–2030', to promote the transition to renewable energy sources, including wind and solar, as well as developing energy storage infrastructure.
- Support the implementation of the 'Proposal for an Energy and Climate Policy 2021-2030', which suggests several measures, including electrification of industrial production and machinery.

References[21],[22]

21. Faroese Ministry of Health and Internal Affairs, "Veðurlagspolitikkur Føroya 2020-2030 [Climate policy of the Faroe Islands 2020-2030]," 2019. [Online]. Available: https://landsstyri.cdn.fo/savn/13155/ve%C3%B0urlagspolitikkur-f%C3%B8roya-2020-2030.pdf?s=dL1rKc5lbIJay6z3KLiqRCoRd2o
22. Faroese Ministry of Environment, Industry and Trade and Faroese Environmental Agency, "Uppskot til Orku- og veðurlagspolitikk 2021-2030 [Proposal for Energy and Climate Policy 2021-2030]." 2021. Accessed: Jan. 08, 2025. [Online]. Available: https://www.us.fo/wp-content/uploads/2023/07/Uppskot-til-Orku-og-vedurlagspolitikk-2021-2030.pdf

2.3 Finland

2.3.1 Cross-sectoral

Table 7. Selected cross-sectoral energy efficiency and climate change mitigation objectives and targets in Finland.

Objectives and targets
• Fulfil the EED requirements that include energy saving obligations, energy efficiency targets, and national contribution. Finland is required to achieve cumulative energy savings of 187.5 TWh over the period 2021–2030, and its indicative national contribution to the EU target amounts to 239.6 TWh of the final energy consumption. • Achieve energy efficiency as part of sustainable energy use measures. • Achieve at least a 51% renewable energy share of the final energy consumption. • Achieve carbon neutrality by 2035, with reduced GHG emissions in the effort sharing sectors by 50% in 2030, compared to the 2005 levels.
References[23],[24],[25],[26]

23. Ministry of Economic Affairs and Employment of Finland, "Finland's integrated national energy and climate plan," 2024:30, Jun. 2024. [Online]. Available: https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en
24. Finnish Parliament, *Climate Act (423/2022)*, 2022. [Online]. Available: https://finlex.fi/en/laki/kaannokset/2022/en20220423
25. Finnish Ministry of Economic Affairs and Employment, "Carbon neutral Finland 2035 – national climate and energy strategy," 2022. [Online]. Available: https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/164323/TEM_2022_55.pdf?sequence=4&isAllowed=y
26. Finnish Parliament, *Climate Act (423/2022)*, 2022. [Online]. Available: https://finlex.fi/en/laki/kaannokset/2022/en20220423

2.3.2 Building sector

Table 8. Selected energy efficiency and climate objectives, targets and strategies for Finland' building sector.

Objectives and targets

- Reduce the heating energy use of the building stock from 71 TWh/year in 2020 to 56 TWh/year in 2030, 45 TWh/year in 2040, and 36 TWh/year by 2050.

Strategies

- Implement 'Carbon Neutral Finland 2035 strategy – national climate and energy strategy', where improving energy efficiency is acknowledged as a key measure for the decarbonisation of the building stock.
- Enact 'Long-term renovation strategy', as mandated by EPBD, to support the renovation of the national building stock.
- Execute the 'Ministry of Environment's Strategy 2035', which recognizes energy efficiency and reasonable energy use as well as smart technology as integral parts of planning, implementation, and use.
- Implement the 'Low-carbon roadmap', which emphasizes a significant potential for reducing the energy consumption and emissions from the existing building stock.

References[27], [28], [29], [30], [31]

27. Ministry of Economic Affairs and Employment of Finland, "Finland's integrated national energy and climate plan," 2024:30, Jun. 2024. [Online]. Available: https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en
28. Finnish Ministry of Economic Affairs and Employment, "Carbon neutral Finland 2035 – national climate and energy strategy," 2022. [Online]. Available: https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/164323/TEM_2022_55.pdf?sequence=4&isAllowed=y
29. Finnish Energy Authority, "Long-term renovation strategy 2020-2050: Finland. Report according to Article 2a of Directive (2010/31/EU) on the energy performance of buildings, as amended by Directive 2018/844/EU," 2020. [Online]. Available: https://energy.ec.europa.eu/system/files/2020-04/fi_2020_ltrs_en_0.pdf
30. Finnish Ministry of the Environment, A Better Environment for Future Generations. Ministry of the Environment's Strategy 2035. Accessed: Mar. 20, 2024. [Online]. Available: https://ym.fi/en/strategy-and-goals
31. Finnish Ministry of Economic Affairs and Employment, *Summary of sector-specific low-carbon roadmaps*. [Online]. Available: http://urn.fi/URN:ISBN:978-952-327-796-0

2.3.3 Industry sector

Table 9. Selected energy efficiency and climate objectives, targets and strategies for Finland' industry sector.

Objectives and targets

- Renew the industry sector to make Finland the world's most competitive carbon-neutral industrial environment by 2030.

Strategies

- Implement the 'Low-carbon roadmaps', identifying technological solutions to promote decarbonisation as well as the necessary investments, skills, and training, in more than 10 industry sectors, including the energy, chemical, technological, and textile industries.
- Enforce the 'Renewable Industry Strategy', aiming to make Finland the world's most competitive operating environment for industry by 2030, while achieving carbon neutrality. Recognize increasing industrial investments as crucial, with energy efficiency as a key pathway to carbon neutrality.
- Increase electrification and use of waste heat in the industry sector.

References[32], [33], [34], [35]

32. Finnish Ministry of Economic Affairs and Employment, "Carbon neutral Finland 2035 – national climate and energy strategy," 2022. [Online]. Available: https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/164323/TEM_2022_55.pdf?sequence=4&isAllowed=y
33. Finnish Ministry of Economic Affairs and Employment, Summary of sector-specific low-carbon roadmaps. [Online]. Available: http://urn.fi/URN:ISBN:978-952-327-796-0
34. Finnish Ministry of Economic Affairs and Employment, "Uudistuvan teollisuuden strategia [Renewable Industry Strategy]," 2021. [Online]. Available: https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/163275/TEM_2021_44.pdf?sequence=1&isAllowed=y
35. International Energy Agency (IEA), Finland 2023. Energy Policy Review. in IEA Energy Policy Reviews. Paris, France: OECD Publishing, 2023. doi: 10.1787/d435fa51-en.

2.4 Iceland

2.4.1 Cross-sectoral

Table 10. Selected cross-sectoral energy efficiency and climate change mitigation objectives and targets in Iceland.

Objectives and targets
• Analyse the potential for increased energy efficiency in Iceland and provide support to selected measures. • Replace fossil fuels with renewables. • Achieve climate neutrality by 2040; about 35% emission decrease by 2030, compared to the 2005 levels; and take further actions to reach a 40–46% emission reduction by 2030.
References[36], [37]

36. Government of Iceland. Ministry of Industries and Innovation, "A Sustainable Energy Future. An Energy Policy to the Year 2050," 2020. [Online]. Available: https://www.stjornarradid.is/lisalib/getfile.aspx?itemid=e36477fd-3bc1-11eb-8129-005056bc8c60
37. Government of Iceland - Ministry for the Environment and Natural Resources, "Iceland's 2020 Climate Action Plan," 2020. [Online]. Available: https://www.stjornarradid.is/library/01--Frettatengt---myndir-og-skrar/UAR/Tengd-skjol/Climate%20Action%20Plan%20Iceland%202020_Summary.pdf

2.4.2 Building sector

Table 11. Selected energy efficiency and climate objectives, targets and strategies for Iceland' building sector.

Objectives and targets

- Achieve a 7.5% reduction in emissions from energy use in buildings and a 43% total reduction in emissions from buildings by 2030.

Strategies

- Implement the 'Sustainable energy future – An energy policy to the year 2050', which acknowledges that significant energy savings can be achieved with more efficient buildings, better insulation, and advanced energy systems as well as smart technology, which offers great potential for enhanced energy efficiency. An updated version was undergoing public consultation as of December 2024.
- Execute the 'Roadmap towards a more sustainable construction by 2030', a comprehensive guide for sustainable construction practices in Iceland. It outlines the goals and action plans to achieve environment-friendly constructions.

References[38],[39]

38. Byggjum grænni framtíð, "Vegvísir að vistvænni mannvirkjagerð 2030 [Building a green future: Roadmap to sustainable construction 2030]," 2022. [Online]. Available: https://byggjumgraennframtid.is/
39. Government of Iceland. Ministry of Industries and Innovation, "A Sustainable Energy Future. An Energy Policy to the Year 2050," 2020. [Online]. Available: https://www.stjornarradid.is/lisalib/getfile.aspx?itemid=e36477fd-3bc1-11eb-8129-005056bc8c60

2.4.3 Industry sector

Table 12. Selected energy efficiency and climate objectives, targets and strategies for Iceland' industry sector.

Objectives and targets

- Eliminate the dependence on fossil fuels and transition to renewable energy sources in all industrial areas.
- Diversify energy systems with wind and other renewables alongside hydropower and geothermal energy.

Strategies

- Implement the 'Icelandic Climate Action Plan', which includes a series of mitigation measures for the industry sector to reduce emissions such as the electrification of fishmeal production plants, energy transitioning in manufacturing industries, and carbon capture from geothermal energy plants and heavy industries.
- Implement 'Iceland's Long-Term Low Emission Development Strategy', which illustrates Iceland's climate policies and measures towards climate neutrality and possible scenarios based on different technological solutions and systems.
- Enact the 'Sustainable energy future – An energy policy to the year 2050', which mentions that all energy resulting from other manufacturing activities must be utilised where technically and economically feasible, whether in energy production or industrial manufacturing (waste heat).

References[40], [41], [42]

40. Government of Iceland. Ministry of Industries and Innovation, "A Sustainable Energy Future. An Energy Policy to the Year 2050," 2020. [Online]. Available: https://www.stjornarradid.is/lisalib/getfile.aspx?itemid=e36477fd-3bc1-11eb-8129-005056bc8c60
41. Government of Iceland - Ministry for the Environment and Natural Resources, "Iceland's 2020 Climate Action Plan," 2020. [Online]. Available: https://www.stjornarradid.is/library/01--Frettatengt---myndir-og-skrar/UAR/Tengd-skjol/Climate%20Action%20Plan%20Iceland%202020_Summary.pdf
42. Icelandic Ministry for the Environment and Natural Resources, "On the Path to Climate Neutrality. Iceland's Long-Term Low Emission Development Strategy," 2021. [Online]. Available: https://unfccc.int/sites/default/files/resource/Iceland_LTS1_2021.pdf

2.5 Norway

2.5.1 Cross-sectoral

Table 13. Selected cross-sectoral energy efficiency and climate change mitigation objectives and targets in Norway.

Objectives and targets	Rererences[43]
• Achieve a 30% improvement in energy intensity by 2030, compared to 2015. • Develop indicators for monitoring and improving energy efficiency and emissions. • Develop tools to track energy use in various sectors and identify the potential energy efficiency measure. • Achieve a 'Low Emission Society' by 2050.	

43. Norwegian Ministry of Petroleum and Energy, "Handlingsplan for energieffektivisering i alle deler av norsk økonomi [Action Plan for Energy Efficiency in All Sectors of the Norwegian Economy]," 2023. [Online]. Available: https://www.regjeringen.no/contentassets/76641946084c49e9910bf60cd7df5dd3/no/pdfs/handlingsplan-for-energieffektivisering.pdf

2.5.2 Building sector

Table 14. Selected energy efficiency and climate objectives, targets and strategies for Norway' building sector.

Objectives and targets

- Reduce electricity use in the building sector by 10 TWh/year by 2030, relative to the 2015 levels.
- Cut the GHG emissions by half by 2030, compared to the 1990 levels.

Strategies

- Execute the 'Action plan for energy efficiency in all sectors of the Norwegian economy', with a focus on reducing energy use in buildings and strengthening existing measures through initiatives such as increased funding, regulatory reviews, and improvements to energy labelling.

References[44],[45],[46]

44. International Energy Agency (IEA), *Norway 2022. Energy Policy Review*. in IEA Energy Policy Reviews. Paris, France: OECD Publishing, 2022. doi: 10.1787/7411c642-en.
45. Norwegian Ministry of Petroleum and Energy, *Meld. St. 25 (2015–2016) Kraft til endring — Energipolitikken mot 2030 [Report No. 25 (2015–2016). Power for Change — Energy Policy Towards 2030]*, Apr. 15, 2016. [Online]. Available: https://www.regjeringen.no/no/dokumenter/meld.-st.-25-20152016/id2482952/?ch=1
46. Norwegian Ministry of Petroleum and Energy, "Handlingsplan for energieffektivisering i alle deler av norsk økonomi [Action Plan for Energy Efficiency in All Sectors of the Norwegian Economy]," 2023. [Online]. Available: https://www.regjeringen.no/contentassets/76641946084c49e9910bf60cd7df5dd3/no/pdfs/handlingsplan-for-energieffektivisering.pdf

2.5.3 Industry sector

Table 15. Selected energy efficiency and climate objectives, targets and strategies for Norway' industry sector.

Objectives and targets

- Establish new industries to support transitioning to a low-emission society.
- Phase out fossil fuels in industry.
- Implement extensive energy use analysis for large companies.

Strategies

- Execute the 'Energi21 – National strategy for research and development (R&D) of new energy tech', Norway's national strategy for research, development, and commercialisation of new climate-friendly energy technologies which has been advising on research and investment in the energy sector since 2008.
- Execute the 'Action plan for energy efficiency in all sectors of the Norwegian economy', proposing regulatory measures for energy efficiency in industry, such as mandatory energy audits and cost-use analysis for surplus heat in energy-intensive companies.

References[47],[48],[49],[50]

47. Norwegian Ministry of Petroleum and Energy, "Handlingsplan for energieffektivisering i alle deler av norsk økonomi [Action Plan for Energy Efficiency in All Sectors of the Norwegian Economy]," 2023. [Online]. Available: https://www.regjeringen.no/contentassets/76641946084c49e9910bf60cd7df5dd3/no/pdfs/handlingsplan-for-energieffektivisering.pdf
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49. The Research Council of Norway, "Energy21." Accessed: Mar. 20, 2024. [Online]. Available: https://www.energi21.no/
50. Norwegian Ministry of Petroleum and Energy, "Handlingsplan for energieffektivisering i alle deler av norsk økonomi [Action Plan for Energy Efficiency in All Sectors of the Norwegian Economy]," 2023. [Online]. Available: https://www.regjeringen.no/contentassets/76641946084c49e9910bf60cd7df5dd3/no/pdfs/handlingsplan-for-energieffektivisering.pdf

2.6 Sweden

2.6.1 Cross-sectoral

Table 16. Selected cross-sectoral energy efficiency and climate change mitigation objectives and targets in Sweden.

Objectives and targets
• Fulfil the EED requirements that include energy saving obligations, energy efficiency targets, and national contribution. Sweden is required to achieve cumulative energy savings of 237 TWh over the period 2021–2030, and its indicative national contribution to the EU target amounts to 350 TWh of the final energy consumption. • Achieve 50% more efficient energy use by 2030, compared to the year 2005. • Achieve net-zero GHG emissions latest by 2045 and 100% fossil-free electricity production by 2040. • Review the energy efficiency target to promote more clearly the socio-economically efficient use of energy and the efficient use of the energy system contributing to the green transition.
References[51],[52]

51. Swedish Ministry of Climate and Enterprise, "Sweden's updated national energy and climate plan," KN2024/00362, Jun. 2024. [Online]. Available: https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en
52. Swedish Government Offices, "Regeringens proposition 2023/24:105. Energipolitikens långsiktiga inriktning [Government Proposition 2023/24:105 The Long-Term Direction of Energy Policy]." Accessed: Dec. 09, 2024. [Online]. Available: https://www.regeringen.se/contentassets/2fd0739890d8484b8129d3c0e678f24d/energipolitikens-langsiktiga-inriktning-prop.-202324105.pdf

2.6.2 Building sector

Table 17. Selected energy efficiency and climate objectives, targets and strategies for Sweden' building sector.

Objectives and targets

- Lower energy consumption of the building stock (kilowatt-hour (kWh)/square meter (m^2)) than at the previous milestone by 2030, 2040 and 2050, as an indicative milestone for Swedish long-term renovation strategy.
- Increase the use of renewable energy sources in heating and cooling.
- Reach a climate-neutral value chain in the building sector: 50% reduced GHG emissions by 2030 (compared to 2015); 75% reduced GHG emissions by 2040 (compared to 2015); and net zero GHG emissions by 2045.

Strategies

- Enact 'long-term renovation strategy', as mandated by EPBD, to support the renovation of the national building stock.
- Promote the 'Sector Strategy for Resource-Efficient Construction', which guides and sets ambitions for transitioning into more resource-efficient buildings, with a focus on measures for existing buildings where the potential for resource-efficient energy use is the greatest. This strategy was developed as part of an assignment for the Swedish Energy Agency.
- Encourage the 'Strategy for Efficient Use of Energy and Power', which aims to improve energy efficiency in buildings by optimizing electricity use and upgrading systems. It shows that using electricity more efficiently in buildings and industry is the fastest way to free up electricity, lower prices, and accelerate the transition to a fossil-free society.
- Follow the 'Roadmaps for Fossil-Free Competitiveness – Construction and Civil Engineering Sector', which has 26 challenges to politicians, authorities, and actors in the construction value chain. It suggests that sector strategies for energy efficiency will be developed with various industries and in consultation with relevant authorities.

References[53], [54], [55], [56], [57]

53. Swedish Ministry of Climate and Enterprise, "Sweden's updated national energy and climate plan," KN2024/00362, Jun. 2024. [Online]. Available: https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en
54. G. Brindeby, "Policies for buildings energy efficiency. A case study of the Swedish policy mix regarding buildings' energy efficiency," KTH - Royal Institute of Technology, Stockolm, Sweden, 2023.
55. Fossil Free Sweden, "Färdplaner för fossilfri konkurrenskraft – uppföljning 2022 [Roadmaps for Fossil-Free Competitiveness - Follow-up 2022]," 2022. [Online]. Available: https://fossilfrittsverige.se/wp-content/uploads/2022/10/Uppfo%CC%88ljningsrapport_2022.pdf
56. Swedish Energy Agency, "Sektorsstrategier för energieffektivisering [Sector Strategies for energy efficiency]," 2018. [Online]. Available: https://www.energimyndigheten.se/49ba7e/globalassets/energieffektivisering_/jag-vill-energieffektivisera-mitt-foretag/dokument/sektorsstrategier-for-energieffektivisering.pdf
57. Fossil Free Sweden, "Färdplan för fossilfri konkurrenskraft – Bygg- och anläggningssektorn [Roadmaps for Fossil-Free Competitiveness - Construction and Civil Engineering Sector]," 2021. [Online]. Available: https://fossilfrittsverige.se/wp-content/uploads/2021/10/Fardplan_for_fossilfri_bygg-_och_anlaggningssektor_20181228-1.pdf

2.6.3 Industry sector

Table 18. Selected energy efficiency and climate objectives, targets and strategies for Sweden, in the industry sector.

Objectives and targets

- Unlock the energy efficiency potential in the industry sector, through energy- and resource-efficient production processes and products.
- Enhance the flexibility and robustness of the energy system through methods such as power management, demand response, and electrification,

Note that the above objectives and targets have not been formally adopted by the government.

Strategies

- Encourage the 'Strategy for Efficient Use of Energy and Power', which aims to optimize energy use and efficiency in the industry sector. The strategy highlights energy efficiency as the fastest and most cost-effective way to reduce costs, enhance competitiveness, and support the transition to a fossil-free economy.

Support the sector strategies for energy efficiency concerning industry:

- The sector strategy of 'flexible and robust energy system', focuses on the energy sector and necessitates collaboration among all stakeholders, including producers and energy companies. It aims to foster open and innovative markets, ensure resource-efficient infrastructure use, promote flexibility throughout the energy system, and leverage the energy system to drive societal goals[58].
- The sector strategy of 'world-class production' for a resource-efficient production and products within a circular context integrates energy efficiency in organizational and technological changes and encourages collaboration and digitalization for energy-intensive industries. The strategic areas here are resource-efficient industrial production and products.

Note that the above strategies have not been formally adopted by the government.

References[59],[60],[61],[62]

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58. Swedish Energy Agency, "Sektorsstrategi för Flexibelt och robust energisystem [Sector Strategy for a Flexible and Robust Energy System]," 2021. [Online]. Available: https://www.energimyndigheten.se/energisystem-och-analys/samhallsbyggnad-och-energiplanering/vagledning-for-kommunal-energiplanering/energisystemet/flexibelt-och-robust-energisystem/
59. Swedish Energy Agency, "Sektorsstrategier för energieffektivisering [Sector Strategies for energy efficiency]," 2018. [Online]. Available: https://www.energimyndigheten.se/globalassets/energieffektivisering_/jag-vill-energieffektivisera-mitt-foretag/dokument/sektorsstrategier-for-energieffektivisering.pdf
60. Fossil Free Sweden, "Färdplaner för fossilfri konkurrenskraft – uppföljning 2022 [Roadmaps for Fossil-Free Competitiveness - Follow-up 2022]," 2022. [Online]. Available: https://fossilfrittsverige.se/wp-content/uploads/2022/10/Uppfo%CC%88ljningsrapport_2022.pdf
61. Swedish Energy Agency, "Sektorsstrategi för Flexibelt och robust energisystem [Sector Strategy for a Flexible and Robust Energy System]," 2021. [Online]. Available: https://www.energimyndigheten.se/energisystem-och-analys/samhallsbyggnad-och-energiplanering/vagledning-for-kommunal-energiplanering/energisystemet/flexibelt-och-robust-energisystem/
62. Swedish Energy Agency, "Sektorsstrategi för Produktion i världsklass [Sector strategy for production at world-class level]," 2021. [Online]. Available: https://www.energimyndigheten.se/globalassets/energieffektivisering_/jag-vill-energieffektivisera-mitt-foretag/dokument/sektorsstrategier-for-energieffektivisering.pdfM2Q5NGRhZjlj&ntb=1

3. Implementation status of EU Directives and Initiatives in the Nordics

This chapter provides a detailed overview of the implementation status of key EU directives and initiatives within the Nordic countries.

Denmark, Finland, and Sweden, as EU member states, fully adopt EU directives and ensure compliance through national legislation. In contrast, Norway and Iceland, as part of the European Economic Area (EEA), align closely with EU regulations but have some flexibility in their adoption timelines and implementation methods due to their non-EU status. The Faroe Islands, which are part of neither the EU nor the EEA, remain outside the scope of these directives and operate under independent national policies.

The implementation of key EU instruments into national regulations demonstrates the commitment and progress of Nordic countries in aligning their national goals with EU targets

Below is a description of the key EU directives and initiatives:

1. Energy Performance of Buildings Directive (EPBD)[63]: The EPBD (2010/31/EU) set minimum energy standards for new and renovated buildings, promoted nearly zero energy buildings (nZEBs), and required energy performance certificates (EPCs). It also mandated energy system inspections and long-term renovation strategies to decarbonize building stocks by 2050, with a focus on smart technologies and renewable energy integration. The revised EPBD (EU/2024/1275), effective from May 2024, mandates that all new buildings meet zero emissions building (ZEB) standards by 2030, and existing buildings be renovated to these standards by 2050. Member states must develop national renovation plans and introduce minimum energy performance standards for non-residential buildings. Additionally, a binding target requires a 16% improvement in residential energy performance by 2030, with further increases to 20–22% by 2035.

63. European Commission, "Energy Performance of Buildings Directive." Accessed: Nov. 21, 2024. [Online]. Available: https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en

2. Ecodesign Directive[64]: This Directive (2009/125/EC) set the minimum energy efficiency and environmental standards for energy-related products sold in the EU, promoting durability, repairability, and recyclability. It aimed to guide consumer choices through energy labels and support the circular economy. The **Ecodesign for Sustainable Products Regulation (ESPR)**, effective from July 2024, replaces the original Ecodesign Directive. It expands its scope to nearly all physical products and aims to improve sustainability by enhancing circularity, energy performance, and recyclability. The regulation has introduced stricter requirements for product durability, repairability, and reducing environmental impact, driving the EU's transition to a circular economy and supporting innovation in recycling and remanufacturing.

3. Energy Labelling Framework Regulation[65]: This regulation (2017/1369) replaced the Directive 2010/30/EU and requires clear and consistent energy labels for household appliances and energy-related products. The scale (A to G) informs consumers about energy efficiency, encouraging them to choose more efficient products while driving innovation and market transformation.

4. Energy Efficiency Directive (EED)[66]: The original EED (2012/27/EU) established binding energy-saving targets for EU member states and mandated annual public building renovations, energy audits for large industrial consumers, and improvements to metering and billing systems. The revised EED (EU/2023/1791) strengthens these requirements by setting energy-saving targets for each member state, mandating energy audits for large industrial energy consumers, and ensuring annual renovations of public buildings. It also requires energy suppliers to achieve yearly savings, improves metering and billing systems to empower consumers, and promotes efficient heating and cooling systems, including district energy solutions. The directive sets a binding target for the EU final energy consumption and defines rules for each member state's share. It also mandates cumulative end-use energy savings from 2021 to 2030, with progressively increasing annual savings targets starting at 0.8% in 2021–2023 and reaching 1.9% in 2028–2030.

64. European Commission, "Ecodesign and Energy Label." Accessed: Nov. 21, 2024. [Online]. Available: https://energy-efficient-products.ec.europa.eu/ecodesign-and-energy-label_en
65. European Commission, "Ecodesign and Energy Label." Accessed: Nov. 21, 2024. [Online]. Available: https://energy-efficient-products.ec.europa.eu/ecodesign-and-energy-label_en
66. European Commision, "Energy Efficiency Directive." [Online]. Available: https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficiency-targets-directive-and-rules/energy-efficiency-directive_en

5. Renewable Energy Directive (RED)[67]: The original RED (2009/28/EC) set a 20% renewable energy target by 2020, focusing on cooperation between EU countries and increasing renewable energy use in electricity, heating, and cooling. The revised directive EU/2018/2001 set a binding 32% renewable energy target by 2030. This directive was further updated to EU/2023/2413, adopted in 2023, which raises the target to at least 42.5% by 2030 and a goal of 45%. It introduces sector-specific targets for transport, industry, and cooling and includes measures to speed up permitting, support electric vehicle infrastructure, and improve bioenergy sustainability.

6. EU Emissions Trading System (EU ETS)[68]: Launched in 2005, the EU ETS is the world's largest carbon market that caps and trades emissions from power plants, industry, and aviation within Europe. It incentivizes emission reductions by setting a market price for carbon while allowing flexibility for companies to trade allowances. The system has evolved with stricter caps and expanded coverage to meet the EU's climate goals.

7. Fit for 55[69]: The 'Fit for 55' package is a comprehensive EU strategy to reduce GHG emissions by 55% by 2030 from the 1990 levels. It includes updates to directives and regulations, such as EPBD, EED, RED, and EU ETS, to align with the European Green Deal and climate neutrality goals.

8. The EU strategy on sector integration[70], presented in July 2020, aims to optimise the energy system by linking various energy carriers (electricity, heat, gas, etc.), infrastructure, and consumption sectors. This integration is supported by the 'Fit for 55'. This strategy focuses on electrification, flexibility, storage, hydrogen usage, and heating and cooling to deliver decarbonised, efficient energy services while reducing costs.

67. European Parliament and The Council of The European Union, "Renewable Energy Directive." Accessed: Nov. 21, 2024. [Online]. Available: https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-directive_en
68. European Commission, "EU Emissions Trading System (EU ETS)." Accessed: Nov. 21, 2024. [Online]. Available: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en
69. European Council, Council of the European Union, "Fit for 55." Accessed: Nov. 21, 2024. [Online]. Available: https://www.consilium.europa.eu/en/policies/fit-for-55/
70. European Commission, "EU strategy on energy system integration." Accessed: Nov. 21, 2024. [Online]. Available: https://energy.ec.europa.eu/topics/energy-systems-integration/eu-strategy-energy-system-integration_en

Table 19: Implementation status of EU directives and initiatives in Nordic countries.

Directive/ Regulation/Initiat	Denmark	Finland	Iceland	Norway	Sweden
The Energy Performance of Buildings Directive (Old version: 2010/31/EU; Revised version: EU/2024/1275)	The old version fully implemented since 2012 Ongoing implementation of the revised version	The old version fully implemented since 2013 Ongoing implementation of the revised version	The old version fully derogated due to geothermal conditions	The old version incorporated into the EEA Agreement and in force since 2023	The old version fully implemented, since 2012 Ongoing implementation of the revised version
Ecodesign Directive (2009/125/EC)	Fully implemented since 2010	Fully implemented since 2010	Incorporated into the EEA Agreement and in force since 2018	Fully implemented since 2011	Fully implemented since 2010
Energy Labelling Framework Regulation 2017/1369, (earlier directive 2010/30/EU)	Fully implemented since 2018	Fully implemented since 2018	Incorporated into the EEA Agreement and in force since 2021	Fully implemented since 2020	Fully implemented since 2017
Energy Efficiency Directive (Old version: 2012/27/EU Revised version: EU/2023/1791)	The old version fully implemented since 2014 Ongoing implementation of the revised version	The old version fully implemented since 2014 Ongoing implementation of the revised version	The old version derogated and the revised directive under evaluation as of 2024	The old version derogated and the revised directive under evaluation as of 2024	The old version fully implemented since 2014 Ongoing implementation of the revised version
Renewable Energy Directive (Old versions: 2009/28/EC and EU/2018/2001, Revised version: EU/2023/2413)	The old versions implemented by 2010 and 2021 Ongoing implementation of the last version	The old versions implemented by 2010 and 2021 Ongoing implementation of the last version	The 2009/28/ EC implemented in 2012 The EU/2018/2001 under evaluation as of 2024	The 2009/28/ EC implemented in 2011 The EU/2018/2001 under evaluation as of 2024	The old versions implemented by 2010 and 2021 Ongoing implementation of the last version

Fit for 55	Implementation ongoing but current measures fall short of the EU's revised climate targets	Implementation ongoing, part of the Carbon Neutral Finland 2035 strategy	Committed to 55% emission cut by 2030 but with free emissions allowances extended until 2026	Partially implemented, with stricter carbon offset laws to reduce emissions by 55% by 2030	Implementation ongoing, with key agreements reached, but some proposals still under negotiation
EU Emissions Trading System (EU ETS)	Implemented since 2005	Implemented since 2005	Implemented since 2008	Implemented since 2008	Implemented since 2005

References for all five countries can be seen in the online version of the report

3.1 Success stories from the implementation of the selected EU directives

Success stories form the **EPBD implementation** have been identified by the project 'Concerted Action EPBD' [71].

Denmark: **Common database with information on the existing building stock**
Denmark has had a mandatory energy certification scheme since 1997, where energy experts assess existing buildings and issue EPCs. Data from these audits are collected in a common database, which provides insights into the physical state and energy standards of the building stock. Analyses based on these data indicate a potential of 28% reduction in heat demand by 2050 if existing buildings are renovated to the building standard of the 2010 Danish Building Regulations. The information in the database supports government strategies for energy upgrades and is accessible for research. Overall, these data are essential for forming future national energy strategies[72].

Finland: **Collaboration and networking with stakeholders and professionals**
Finland incorporated the EPBD into its legislation and building regulations through a collaboration with stakeholders in the construction/building maintenance industry. This cooperation was key during the finalization of the Finnish National Building Code, which had input from professionals through studies and consultation forums organized by the Ministry of the Environment. The implementation of EPCs involved building ownership and maintenance organizations, with ongoing communication to ensure compliance and quality. Meanwhile, the Ministry of the Environment and Motiva Oy hosted networking events for EPC assessors to discuss developments and key issues. Stakeholder engagement has been vital for the development of the Long-Term Renovation Strategy in Finland, including workshops and public feedback. Additionally, the Ministry has promoted energy-efficient construction and renovations through funding and voluntary energy efficiency agreements, achieving significant energy savings in the property sector[73].

Norway: **Preparing the market for stricter energy performance requirements**.
While the EPBD of 2010 was not implemented in Norway until 2024, stricter energy performance requirements, which aimed to bring Norwegian building codes closer to passive house levels, were enforced in Norway in January 2017. The new building

71. Concerted Action EPBD, "Dynamic Database of Publications." [Online]. Available: https://confluence.external-share.com/content/18675/ca_epbd_v_database_2020_(public)/1861814907/2181726756
72. K. Engelund Thomsen *et al.*, "Implementation of the EPBD. Denmark. Status in 2020," 2020. [Online]. Available: https://epbd-ca.eu/wp-content/uploads/2021/07/Implementation-of-the-EPBD-in-Denmark-%E2%80%93-2020.pdf
73. M. Haakana, P. Laitila, and K.-M. Forssell, "EPBD Implementation in Finland. Status in 2020," 2020. [Online]. Available: https://www.ca-epbd.eu/Media/638373600619852427/Implementation-of-the-EPBD-in-Finland--2020.pdf

regulations set stricter requirements for the energy performance of buildings, leading to more compact, airtight, and well-insulated buildings. Before the implementation of the new building regulations, preparatory work began in 2010 to test various energy-efficient concepts, with the German 'Passivhaus' model being adapted (see chapter 6). Additionally, a strategy was established to share knowledge among planners and contractors and integrate these concepts into the new building market. Evaluations showed that the initiative promoted innovation and knowledge in energy-efficient construction, largely through collaboration among stakeholders. While the most ambitious market segments adapted well, concerns remained about wider adoption, due to increased material costs and reduced internal floor area, in relation to increased insulation thickness[74].

Sweden: **Application Programming Interface for EPC data access**
EPCs for buildings are stored in a central database in Sweden. In 2021, the Swedish National Board of Housing, Building and Planning (Boverket) developed an application programming interface (API) to facilitate access to essential data from the EPC register for businesses. The API allows companies to freely access basic information such as buildings' energy class, EPC identification number, issue date, primary energy number, specific energy use, and whether radon measurement and ventilation control have been conducted. An example of the API's practical application is banks using it to offer green mortgages to customers purchasing or living in buildings with energy classes A or B, enabling them to verify the building's energy class directly from Boverket[75].

Success stories from the **EED implementation** in the Nordic countries are listed below.

Denmark: Energy efficiency obligation scheme
In Denmark, until the end of 2020, Article 7 of the EED was implemented through an energy efficiency obligation scheme. This scheme was based on a voluntary agreement between the former Ministry of Climate, Energy and Housing and the energy sector, with the 2012 Energy Agreement establishing the framework for the energy savings effort. The scheme concluded on December 31, 2020[76]. The Energy Efficiency Obligation scheme is discussed in further detail in Chapter 6.

74. T. Brekke, O. Karstad Isachsen, and I. Marton, "EPBD Implementation in Norway. Status in 2020," 2020. [Online]. Available: https://www.ca-epbd.eu/Media/638373597467765351/Implementation-of-the-EPBD-in-Norway--2020.pdf
75. H.-O. Karlsson Hjorth, R. Antonsson, L. Liljefors, M. Näslund, L. Lagnerö, and E. Svensson, "Implementation of the EPBD. Sweden. Status in 2021," 2021. [Online]. Available: https://epbd-ca.eu/wp-content/uploads/2022/10/Implementation-of-the-EPBD-in-Sweden.pdf
76. Concerted Action Energy Efficiency Directive (EED), "National EED Implementation Report (NIR) 2021. EED implementation in Denmark," 2022. [Online]. Available: https://www.ca-eed.eu/wp-content/uploads/2022/02/CA_EED_report_DENMARK.pdf

Finland: Energy efficiency agreements

In Finland, not all articles of the EED have been implemented through legislation and mandatory measures. The primary instrument for fulfilling the obligations of Article 7/8 is the broad Voluntary Energy Efficiency Agreement Scheme, which, since its inception in 1997, has served as the cornerstone of the country's energy efficiency policy. These Energy Efficiency Agreements not only facilitate compliance with Article 7 but also support the implementation of various other EED articles. This includes promoting energy management systems, conducting energy audits, enhancing communication and information dissemination, and encouraging energy-efficient procurement practices within both companies and municipalities. Through these voluntary frameworks, Finland aims to foster a culture of energy efficiency and encourage broader participation across companies and municipalities[77]. The Energy Efficiency Agreements are discussed in further detail in Chapter 6.

Sweden: Programme promoting energy efficiency among small and medium-sized enterprises (SMEs)

In 2015, a new programme was launched to implement Article 8 of the EED and promote energy efficiency among SMEs. Funded by the European Regional Development Fund (ERDF), this programme focuses on three key areas:

1. Energy Audits: Financial support for energy audits helps SMEs assess their energy performance and identify potential savings.
2. Network Activities: The programme encourages networking among SMEs, facilitating collaboration and knowledge sharing to drive energy efficiency improvements.
3. Capacity Building: Training and resources enhance the skills of SME personnel, empowering them to implement effective energy management practices.

Set to continue until the end of 2021, this initiative plays a crucial role in engaging SMEs in energy efficiency efforts and contributes to the EU's broader climate objectives[78]. The energy efficiency networks for SMEs are described in detail in Chapter 6.

77. Concerted Action Energy Efficiency Directive (EED), "National EED Implementation Report (NIR) 2021. EED implementation in Finland," 2022. Accessed: Nov. 03, 2024. [Online]. Available: https://www.ca-eed.eu/ia-document/national-implementation-report-finland/
78. Concerted Action Energy Efficiency Directive (EED), "National EED Implementation Report (NIR) 2021. EED implementation in Sweden," 2022. [Online]. Available: https://www.ca-eed.eu/ia-document/national-implementation-report-sweden/

4. Mapping of policy instruments for energy efficiency in the Nordics

This chapter presents a comprehensive overview of the current policy instruments for energy efficiency in the Nordic countries. The findings are based on both national and international sources, including the Mure database on EU energy efficiency measures[79], the Odyssee-Mure project[80], and the IEA's Policies and Measures Database[81].

Policy instruments typically fall into four categories: ***'informational instruments', 'regulatory tools', 'financial instruments',*** and ***'voluntary initiatives'.*** The synergistic application of these instruments creates a supportive environment for the widespread adoption of energy efficiency measures. In sectors such as building and industry, where the potential for energy savings is significant, the strategic deployment of these policy instruments is essential for unlocking energy efficiency gains and moving towards a more sustainable and resilient energy system[82],[83].

Public policies establish enforceable frameworks that ensure compliance through regulations, incentives, and minimum standards. However, they can be slow to adapt, potentially limiting innovation. In contrast, *voluntary initiatives* offer greater flexibility, fostering innovation and encouraging practices that exceed compliance standards. However, they may face challenges with inconsistent participation. The most effective strategy integrates both approaches—using voluntary initiatives to drive innovation and public policies to scale these innovations, ensuring broad impact and alignment with regulatory frameworks.

79. Odyssee-Mure project, "Mure database." [Online]. Available: https://www.measures.odyssee-mure.eu/energy-efficiency-policies-database.html#/
80. Ademe, "EU Odyssee-Mure project." LIFE-CET programme of the European Commission, 2025 2022. [Online]. Available: https://www.odyssee-mure.eu/
81. International Energy Agency (IEA), "Policies database." [Online]. Available: https://www.iea.org/policies
82. P. Bertoldi, "Policies for energy conservation and sufficiency: Review of existing policies and recommendations for new and effective policies in OECD countries," Energy and Buildings, vol. 264, p. 112075, Jun. 2022, doi: 10.1016/j.enbuild.2022.112075.
83. M. Economidou, V. Todeschi, P. Bertoldi, D. D'Agostino, P. Zangheri, and L. Castellazzi, "Review of 50 years of EU energy efficiency policies for buildings," Energy and Buildings, vol. 225, p. 110322, Oct. 2020, doi: 10.1016/j.enbuild.2020.110322.

The Nordic countries adopt diverse but aligned policy instruments to enhance energy efficiency and mitigate climate change, with notable similarities and differences across the building and industry sectors.

In the **building sector**, Nordic countries use various *informational instruments* to promote energy efficiency. For instance, Denmark's SparEnergi.dk, Finland's Motiva Oy, and Norway's Enova offer advisory services, Additionally, Denmark, Finland, Sweden, and Iceland also provide guidance through specialised centres. Regarding *regulatory tools*, all Nordic countries have adopted regulations setting minimum energy efficiency requirements for new and renovated buildings through national building codes. Energy labelling systems for buildings are common in Denmark, Finland, Norway, and Sweden. Iceland has regulations to support heating costs, while the Faroe Islands set requirements for heat pump systems and installer approvals. *Financial instruments,* such as subsidies and grants, support activities, such as heat pump installations, energy renovations, and transitions to renewable energy. Denmark offers funds, such as the heat pump fund and energy renovation fund, while Iceland and Finland provide subsidies for energy-efficient equipment and heating system conversions. In Norway, Enova offers financial aid for energy efficiency measures, including energy mapping and performance improvement in commercial building. Tax incentives in Denmark, Finland, and Sweden encourage energy saving renovations, including heat pump installations and window replacements. Green financing options, including low-interest loans and green bonds, are available in most Nordic countries*. Voluntary initiatives* include energy efficiency standards, such as passive house criteria in Norway and the low-energy Building Class 2020 in Denmark. Environmental certifications, including BREEAM, LEED, and the Nordic Swan Ecolabel, are widely used across Denmark, Finland, Iceland, Norway, and Sweden to certify buildings exceeding energy efficiency requirements. Innovation programmes like Sweden's technology procurement clusters and Norway's FutureBuilt aim to promote sustainable-building practices. Collaborative platforms in Denmark and Finland help reduce energy consumption in buildings.

In the **industry sector**, as *informational instruments*, Denmark's SparEnergi.dk, Norway's Enova, and Finland's Motiva Oy offer guides and consulting services on energy efficiency. Iceland's Energy Centre supports businesses with renewable energy adoption, while Sweden's Energy Agency provides sector-specific energy saving advice. Regarding *regulatory tools*, all Nordic countries prioritise energy audits to identify efficiency opportunities, with mandatory requirements in Denmark, Finland, Norway, and Sweden. In Iceland, the National Energy Fund Law outlines the National Energy Authority's role in advising the government, conducting energy research, and planning long-term energy supply. *Financial instruments* are widely adopted across the Nordic countries, with Denmark offering grants, such as the business pool scheme, while Enova support programmes in

Norway fund energy-efficient technology. Finland's energy investment aid and Business Finland provide loans and grants, and Iceland's National Energy Fund supports renewable energy projects. Sweden's Climate Leap programme funds emissions reduction efforts. *Voluntary initiatives*, such as ISO 50001 implementation, are widely encouraged in most Nordic countries to improve energy management practices across industries. Sweden has roadmaps for fossil-free competitiveness, which focus on policy follow-up, national strategies, public procurement climate requirements, regional action plans, and support for green industrial projects. Finland supports voluntary energy audits for SMEs and energy efficiency agreements, while Norway's Green Industrial Initiative promotes the emission reduction in industries. In the Faroe Islands, a network of businesses focuses on green transition and competitive sustainability, aligning with the United Nations (UN) Sustainable Development Goals (SDGs). In countries such as Norway, Sweden, and Denmark, companies set voluntary energy efficiency and/or climate targets.

While this chapter presents a comprehensive overview, it represents a snapshot and only includes a selection of relevant information. We observed a discrepancy in the level of detail available, with the building sector having more extensive data compared to the industry sector, which is likely due to the industry's dynamic nature and complex interconnections.

The following sections provide country overviews of the policy instruments for Denmark (2.1), the Faroe Islands (2.2), Finland (2.3), Iceland (2.4), Norway (2.5), and Sweden (2.6). Each country overview is organised into two categories: building sector and industry sector.

4.1. Denmark

4.1.1 Building sector

INFORMATIONAL INSTRUMENTS

Advisory services

- **Sparenergi.dk**: Danish Energy Agency's website serving as a communication backbone with end users concerning energy efficient solutions. It offers telephone support and email advice.

Energy guidance and information

- **Knowledge Centre for Energy Savings in Buildings**: Centre that disseminates knowledge about energy efficient solutions.

- **Sparenergi.dk** Website that provides various digital tools that assist users in enhancing their energy efficiency.

Energy statistics

- **Danish Energy Agency** collects and shares detailed energy statistics covering production, consumption, prices, and GHG emissions. **Statistics Denmark** compiles a variety of statistical data, including energy related information.

Energy efficiency campaigns

- In 2022, a national campaign was launched to reduce energy use in Danish households by reducing consumption of gas and electricity with a special focus on electricity use reduction during peak hours.

REFERENCES [84], [85], [86]

84. Danish Energy Agency, "Sparenergi.dk [Energy saving.dk]." Accessed: Mar. 20, 2024. [Online]. Available: https://sparenergi.dk/
85. Danish Energy Agency, "Videncenter for Energibesparelser i Bygninger [Knowledge Center for Energy Savings in Buildings]." Accessed: Mar. 20, 2024. [Online]. Available: https://byggeriogenergi.dk/
86. Nordic Energy Research, "Impact assessment of emergency market intervention measures to tackle high energy prices," 2023. [Online]. Available: https://pub.norden.org/nordicenergyresearch2023-04/2-implementation-of-emergency-measures-in-the-nordic-countries.html

REGULATORY INSTRUMENTS

- **National Building Regulation (BR18)**: Regulation setting overall energy consumption requirements for new and renovated buildings, since 2006, including a voluntary low energy Building Class 2020 for new buildings.
- **Energy Performance Certificate Act (Energimærkningsloven)**: Legislative framework requiring buildings that are sold, rented, or constructed to undergo an energy assessment and receive an energy label based on their efficiency. The energy label, accompanied by an energy plan, helps property owners identify opportunities for reducing energy consumption and improving building performance.
- **Energy labelling of windows**: Collaboration between the Danish Energy Agency and the Window Industry, promoting energy-efficient windows with a requirement for B-rated (or A-rated for building class 2020) replacements.
- **Order on individual metering**: Initiative that requires individual measurement of consumption for electricity, gas, water, heating, and cooling, aiming to motivate lower resource consumption.
- **Act on the Promotion of Energy Savings in Buildings**: Act that supports energy efficiency and flexible consumption in buildings.

REFERENCES [87], [88], [89], [90], [91]

87. Danish Ministry of Transport, Building and Housing, "Executive Order No. 1615 on building regulations 2018 (BR18)," 2017. [Online]. Available: https://www.byggerietsregler.dk/wp-content/uploads/2018/09/BR18_Executive_order_on_building_regulations_2018.pdf
88. Danish Parliament, "Energimærkningsloven [Energy Performance Certificate Act]." Accessed: Nov. 22, 2024. [Online]. Available: https://danskelove.dk/energim%C3%A6rkningsloven
89. Danish Energy Agency and Windows Industry, "Energy Label for Windows." Accessed: Mar. 21, 2024. [Online]. Available: https://energivinduer.dk/
90. Danish Ministry of Social Affairs, Housing and the Elderly, "Bekendtgørelse nr 563 af 02/06/2014 om individuel måling af el, gas, vand, varme og køling," [Executive Order No. 563 of 02/06/2014 on individual metering of electricity, gas, water, heating and cooling] 2014. Accessed: Mar. 20, 2024. [Online]. Available: https://www.retsinformation.dk/eli/lta/2014/563
91. Danish Ministry of Climate, Energy and Utilities, "Bekendtgørelsenr 636 af 19/06/2012 af lov om fremme af energibesparelser i bygninger," [Executive Order No. 636 of 19/06/2012 on the Act to Promote Energy Savings in Buildings] 2012. Accessed: Mar. 20, 2024. [Online]. Available: https://www.retsinformation.dk/eli/lta/2012/636

FINANCIAL INSTRUMENTS

- **Subsidy schemes for private buildings**: The building pool, established under the 2018 Energy Agreement, which was split into two new funds in the summer of 2023, i.e., the heat pump fund, supporting conversions away from oil and gas furnaces, and the energy renovation fund, promoting energy savings through renovation measures, such as windows, retrofitting insulation, etc., in residential buildings; the scrapping scheme for grants covering up to 45% of eligible costs for heat pump conversion; and the renovation of social housing scheme, to encourage renovation efforts in the social housing sector for the benefit of tenants; and the district heating pool for conversion projects where energy-efficient district heating networks are rolled out in new district heating areas and where individual oil and gas boilers are converted to district heating.
- **Subsidies for energy efficiency in public buildings**: Subsidy pool targeted at public buildings implementing energy saving measures.
- **Green financing for individuals and municipalities**: Loans and bonds with low interest rates available through credit institutions, such as KommuneKredit, for both municipalities and private entities, supporting energy efficiency initiatives that contribute to a reduction in CO_2 and/or energy consumption.
- **Building job scheme**: Scheme that provides tax deductions for salary expenses related to energy-efficient building improvements, with deductions for cleaning services and building improvements.
- **Tax-deduction scheme**: Initiative enabling individuals to deduct salary expenses for green initiatives in private buildings, covering labour costs, including VAT, for home renovations such as window replacement and heating system upgrades.
- **Subsidy scheme to phase out oil and gas boilers with district heating or heat pumps**: Scheme supporting the transition from oil and gas boilers in private homes, among other measures, and promoting energy efficiency.

REFERENCES,[92],[93],[94],[95]

92. Danish Energy Agency, "Final update of Danmark's National Energy and Climate Plan for the period 2021-2030," Jun. 2024. [Online]. Available: https://commission.europa.eu/document/download/13353c72-43bc-486e-bc82-9e8ea7588734_en?filename=DK_FINAL%20UPDATED%20NECP%202021-2030%20%28English%29.pdf
93. Effect4Buildings, "Green loans in Poland, Sweden, Denmark, Norway and Finland," 2020. [Online]. Available: https://www.effect4buildings.se/wp-content/uploads/7-Green-Loans-in-Poland-Sweden-Denmark-Norway-and-Finland.pdf
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95. K. Engelund Thomsen *et al.*, "Implementation of the EPBD. Denmark. Status in 2020," 2020. [Online]. Available: https://epbd-ca.eu/wp-content/uploads/2021/07/Implementation-of-the-EPBD-in-Denmark-%E2%80%93-2020.pdf

VOLUNTARY INITIATIVES

- **Low-energy Building Class 2020**: Sets voluntary, stricter energy efficiency standards to encourage nearly zero-energy buildings through enhanced insulation, airtightness, and renewable energy use.
- **Environmental certifications**: Various certifications, such as DGNB Denmark, BREEAM, LEED and Swan Ecolabel for construction.
- **Synergy**: Organisation promoting smarter and more efficient use of energy in Denmark.

REFERENCES [96], [97], [98], [99], [100]

96. K. Engelund Thomsen *et al.*, "Implementation of the EPBD. Denmark. Status in 2020," 2020. [Online]. Available: https://epbd-ca.eu/wp-content/uploads/2021/07/Implementation-of-the-EPBD-in-Denmark-%E2%80%93-2020.pdf
97. Rådet for Bæredygtigt Byggeri, "DGNB - Syestemet." Accessed: Apr. 17, 2024. [Online]. Available: https://rfbb.dk/dgnb
98. Ljungdahl AS, "BREEAM & LEED certificering." Accessed: Apr. 17, 2024. [Online]. Available: https://ljungdahl.dk/raadgivning/breeam-leed/
99. Miljømærkning Danmark, "Svanemærket - Byggeri [Svanemærket - Construction]." Accessed: Apr. 18, 2024. [Online]. Available: https://www.svanemaerket.dk/erhverv/virksomheder/byggeri
100. Renovate Europe, "SYNERGI - A better use of Energy in Denmark." Accessed: Apr. 17, 2024. [Online]. Available: https://www.renovate-europe.eu/national-initiatives/denmark/

4.1.2 Industry sector

INFORMATIONAL INSTRUMENTS

- **Sparenergi.dk**: Online platform offering tips on reducing energy consumption, targeting corporations with guides, checklists, and requirement specifications for energy-efficient installations.
- **National energy saving campaign**: Campaign launched in 2022, targeting businesses for reducing energy consumption, with advice and guidance across sectors.

REFERENCES[101], [102]

REGULATORY INSTRUMENTS

- **Mandatory energy audits**: Audits mandated by the EU's EED since 2012 and enforced in Denmark by Executive Order 624 of 2023. The audits target companies with over 250 employees and specific financial thresholds. While audits are mandatory, there is no obligation to implement suggested savings measures. Additionally, Denmark has introduced an emission reduction requirement as part of the audits.

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103. Danish Energy Agency, "Energisyn i store virksomheder [Energy audits in large companies]." Accessed: Mar. 20, 2024. [Online]. Available: https://ens.dk/forsyning-og-forbrug/virksomheder/energisyn-i-store-virksomheder

FINANCIAL INSTRUMENTS

- **Business pool scheme**: Grants aimed at energy efficiency improvements in process energy across industrial, service, and commercial sectors. Private companies can receive subsidies covering up to 50% of project costs.
- **Energy tax rates for businesses**: Taxation on energy consumption for process purposes within businesses, aimed at reducing CO_2 emissions. A planned tax increase, as part of the Green Tax Reform, is designed to encourage businesses to transition to greener energy solutions.
- **Conversion aid**: Part of the Green Tax Reform for Industry, implemented in 2022, to support businesses most affected by the CO_2 tax, helping them transition to more CO_2-efficient energy sources.
- **Subsidies for renewable energy**: The Danish Energy Agency administers a wide range of support schemes for renewable energy when electricity is produced.
- **Green financing for companies**: Some companies can access green loans from credit institutions like KommuneKredit if supported by a municipal guarantee. These loans are approved only for investments that lead to CO_2 reductions and/or lower energy consumption, provided the initial energy use relies on non-fossil resources.

REFERENCES[104],[105],[106],[107],[108]

104. Danish Energy Agency, "Erhvervstilskud til energieffektiviseringer [Business subsidies for energy efficiency improvements]." Accessed: Apr. 17, 2024. [Online]. Available: https://ens.dk/ansvarsomraader/energibesparelser/virksomheder/erhvervstilskud-til-energieffektiviseringer
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107. Danish Energy Agency, "Support for renewable energy." Accessed: Nov. 16, 2024. [Online]. Available: https://ens.dk/ansvarsomraader/stoette-til-vedvarende-energi
108. Effect4Buildings, "Green loans in Poland, Sweden, Denmark, Norway and Finland," 2020. [Online]. Available: https://www.effect4buildings.se/wp-content/uploads/7-Green-Loans-in-Poland-Sweden-Denmark-Norway-and-Finland.pdf

VOLUNTARY INITIATIVES

- **Implementation of ISO 50001** on energy management system.
- **Climate targets**: Targets set on a voluntary basis by several Danish companies, to align with and support the national and international climate goals.

REFERENCES[109], [110]

109. International Organization for Standardization (ISO), *ISO 50001:2018. Energy management systems — Requirements with guidance for use*, Geneva, Switzerland., 2011.
110. UN Global Compact - Network Denmark, "Commitment to the Science Based Targets Initiative (SBTi) in Denmark: A Progress Report in the Lead-up to COP27," 2022. [Online]. Available: https://info.globalcompact.dk/SBTi-in-denmark

4.2 The Faroe Islands

4.2.1 Building sector

INFORMATIONAL INSTRUMENTS

Advisory services

- **SEV**: Faroese energy company that, among other services, provides advice on energy-saving measures for households.

Energy guidance and information

- **Orka.fo**: Website managed by the Energy Department of the Faroese Environment Agency, offering guidance on heat pumps, real-world energy data, and expert answers to promote sustainable energy in the Faroe Islands.

  SEV's app: Application developed by SEV, which monitors the energy distribution on the mainland.

Energy statistics

- Data from various heat pump systems around the country recorded by the Energy Department of the **Faroese Environment Agency**, since 2008.

Energy efficiency campaigns

- NA

REFERENCES[111],[112],[113]

111. Faroese Environment Agency, "Innihitan fært tú úr føroysku luftini og jørðini – og her fært tú føroyska vitan um hitapumpur [Here, you get energy from the Faroese air and ground – and Faroese expertise on heat pumps]." Accessed: Nov. 23, 2024. [Online]. Available: https://www.orka.fo/
112. Visit Faroe Islands, "Green energy" Accessed: Mar. 20, 2024. [Online]. Available: https://visitfaroeislands.com/en/meetings/why-the-faroe-islands/our-distinctions/green-energy
113. SEV, "Húsarhald – Góð ráð [Households - Good advice]." Accessed: Nov. 23, 2024. [Online]. Available: https://www.sev.fo

REGULATORY INSTRUMENTS

- **Law on heat pumps**: Regulation governing the planning, installation, operation, and supervision of heat pump systems. It sets requirements for heat pumps since 2012, including approval requirements for installers and well drillers.
- **Faroese building regulation (BK17)**: Regulation, implemented in 2017 and based mostly on Danish regulations, providing requirements for several areas such as energy consumption, building envelope thermal performance, and ventilation and indoor environment.

REFERENCES[114],[115],[116]

FINANCIAL INSTRUMENTS

- **Value added tax (VAT) exemption on heat pumps:** Initiative that encourages the installation of heat pumps in homes by exempting the purchase of this technology from VAT, promoting the adoption of renewable energy solutions.

REFERENCES[117]

VOLUNTARY INITIATIVES: NA

114. K. K. Saxov and V. Nielsen, "Eftirmeting av verksetanini av føroysku bygningskunngerðini BK17 [Evaluation of the implementation of the Faroese building regulations BK17]," 2021.
115. Faroese Ministry of the Environment, "Kunngerð nr. 72 frá 27. juni 2016 um bygningskunngerð 2017 [Announcement No. 72 from June 27, 2016, regarding the Building Regulations 2017]." 2016. [Online]. Available: https://logir.fo/Kunngerd/72-fra-27-06-2016-um-um-bygningskunngerd-2017
116. Faroese Ministry of the Environment, "Løgtingslóg nr. 22 frá 16. mars 2012 um el riknar hitapumpuskipanir, sum seinast broytt við løgtingslóg nr. 31 frá 9. mars 2023 [Parliament Act No. 22 from March 16, 2012, on district heating heat pump systems, last amended by Parliament Act No. 31 from March 9, 2023]." 2012. [Online]. Available: https://logir.fo/Logtingslog/22-fra-16-03-2012-fra-jardhitaskipanir
117. Nordregio, "Ground source heat pumps on the Faroe Islands." Accessed: Apr. 02, 2024. [Online]. Available: https://nordregioprojects.org/blog/2019/12/04/ground-source-heat-pumps-on-the-faroe-islands/

4.2.2 Industry sector

INFORMATIONAL INSTRUMENTS: NA

REGULATORY INSTRUMENTS: NA

FINANCIAL INSTRUMENTS: NA

VOLUNTARY INITIATIVES:

- **Faroese Sustainable Business Initiative**: Network of businesses targeting green transition and competitive sustainability, collaborative and individual strategic planning, alignment with UN SDGs, focusing on climate and nature.

REFERENCES[118]

118. Burðardygt Vinnulív, "Faroese Sustainable Business Initiative." Accessed: Apr. 22, 2024. [Online]. Available: https://www.burdardygd.fo/burdardygt-vinnuliv

4.3 Finland

4.3.1 Building sector

INFORMATIONAL INSTRUMENTS

Advisory services

- **Motiva Oy**: State-owned sustainable development company that, together with local energy advisers, offers information, solutions, and advisory services for resource-efficient, effective, and sustainable choices.

Energy guidance and information

- **Building services communication forum**: Platform among professionals, offering building owners and operators information on how to improve the energy efficiency of buildings through the proper maintenance of technical building systems.
- **Housing Finance and Development Centre of Finland (ARA)**: Centre that produces information promoting advocating for ecologically sustainable, high-quality, and affordable housing.

Energy statistics

- **Statistics Finland** is the main agency for official statistics, including energy data. The **Finnish Environment Institute** (SYKE) also provides energy-related statistics, emphasizing environmental aspects and sustainability.

Energy efficiency campaigns

- In 2022, the **'Down a degree'** campaign to encourage people, companies and other organisations to save energy and to lower the demand for electricity during peak times.

REFERENCES[119],[120],[121],[122]

119. Motiva Oy, "Motiva – a Sustainable Development Company." Accessed: Mar. 20, 2024. [Online]. Available: https://www.motiva.fi/en/motiva
120. Finnish Ministry of Economic Affairs and Employment, "Down a degree campaign." Accessed: Mar. 20, 2024. [Online]. Available: https://valtioneuvosto.fi/en/-//1410877/down-a-degree-energy-saving-measures-are-starting-to-bite-but-more-effort-is-needed
121. Finnish State Council, "Talotekniikan viestintäfoorumi [Building Services Communication Forum]." Accessed: Mar. 20, 2024. [Online]. Available: https://valtioneuvosto.fi/-/1410903/talotekniikan-viestintafoorumi-edistaa-energiatehokkuutta-viestinnan-ja-neuvonnan-keinoin-kahdessa-vuodessa-yli-1-5-miljoonaa-kontaktia
122. Finnish Ministry of the Environment, "The Housing Finance and Development Centre of Finland (ARA)." Accessed: Mar. 20, 2024. [Online]. Available: https://www.ara.fi/fi-FI

REGULATORY INSTRUMENTS

- **National building code for new buildings**: Regulation requiring compliance with minimum energy efficiency standards, requiring calculations based on energy use, loss, and energy form. All new buildings must be nearly zero-energy buildings (nZEBs), defined by primary energy consumption.
- **National decree for buildings undergoing renovation or alteration**: Decree stating that energy efficiency should be enhanced during repairs, alterations, or changes in building use, if feasible technically, functionally, and economically.
- **Energy Performance Certificate (EPC) Regulation**: Mandatory regulation for all new and existing buildings when rented or sold, with guidance provided by Motiva and a database managed by ARA.
- **Decree on smart meters**: Initiative required by energy companies since a 2009 decree, with a revision in 2021 allowing energy community electricity distribution.
- **Decree on numerical values of primary energy factors**: Decree that is used in building regulations to guide the selection of energy sources, strongly affecting required energy efficiency levels.

REFERENCES[123],[124],[125],[126],[127]

123. Finnish Ministry of the Environment, "1010/2017 Decree of the Ministry of the Environment on the Energy Performance of New Buildings," 2017. [Online]. Available: https://ym.fi/documents/1410903/35099218/1010+2017+YMA_uuden_rakennuksen_energiatehokkuus+EN.pdf/87c893a5-08cf-cc7b-b2a1-90032ebb9368/1010+2017+YMA_uuden_rakennuksen_energiatehokkuus+EN.pdf?t=1680607785707
124. Finnish Ministry of the Environment, "4/2013 Ministry of the Environment Degree on Improving the Energy Performance of Buildings Undergoing Renovation or Alteration," 2013. [Online]. Available: https://ym.fi/documents/1410903/35099218/Decree+4_13.pdf/15a62d9e-6e99-170f-5a81-bdba7650d26f/Decree+4_13.pdf?t=1680608289017
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126. Finnish Ministry of the Environment, "Valtioneuvoston asetus sähköntoimitusten selvityksestä ja mittauksesta [Government Decree on the Survey and Metering of Electricity Supply]," 2021. [Online]. Available: https://finlex.fi/fi/laki/alkup/2021/20210767
127. Finnish Ministry of the Environment, "Valtioneuvoston asetus rakennuksissa käytettävien energiamuotojen kertoimien lukuarvoista [Government decree on the numerical values of the coefficients for energy used in buildings]," 2017. [Online]. Available: https://www.finlex.fi/fi/laki/alkup/2017/20170788

FINANCIAL INSTRUMENTS

- **ARA funding**: Granted subsidies for energy efficiency improvements in buildings, including phasing out oil and interest-subsidy loans for renovations in privately owned dwellings and municipally owned properties. Ara funding was discontinued after 2023.
- **Government financial aid**: Initiative that supports the conversion from oil or natural gas heating to non-fossil-fuel-based heating systems. Financial support is provided by the ELY Centre for individuals for work expenses related to replacing heating systems with renewable energy sources and district heating. ELY support will be discontinued after 2024.
- **Tax credit for household expenses**: Tax credit for household expenses in maintenance and renovation investments that promote energy efficiency in houses, with an increased tax credit for investments to replace oil heating from 2022 to 2028.
- **Low-carbon built environment programme**: A programme that supports projects to boost the development and dissemination of products, technologies, services and practices for the built environment. First requirements for calculating and reporting carbon balance of buildings are planned to come into force in 2025.
- **Green financing for individuals and municipalities**: Loans and bonds provided by banks for projects, such as energy-efficient renovations, the installation of renewable energy systems, and other sustainability measures. An example is MuniFin's Green Bond for municipalities.

REFERENCES[128],[129],[130],[131],[132]

128. ARA, "The housing Finance and Development Centre of Finland." Accessed: Apr. 02, 2024. [Online]. Available: https://www.ara.fi/en
129. Centre for Economic Development, Transport and the Environment, "Avustus pientalon öljylämmityksestä luopumiseksi [Grant for phasing out oil heating in small homes]." Accessed: Apr. 02, 2024. [Online]. Available: https://www.ely-keskus.fi/oljylammityksen-vaihtajalle
130. Vero Skatt, "Tax credit for household expenses." Accessed: Apr. 02, 2024. [Online]. Available: https://www.vero.fi/en/individuals/tax-cards-and-tax-returns/deductions/Tax-credit-for-household-expenses/
131. Finnish Ministry of the Environment, "Low-carbon Built Environment Programme." Accessed: Apr. 02, 2024. [Online]. Available: https://ym.fi/en/low-carbon-built-environment
132. MuniFin, "Green bonds." Accessed: Nov. 23, 2024. [Online]. Available: https://www.kuntarahoitus.fi/en/for-investors/green-and-social-bonds/green-bonds

4.3.2 Industry sector

VOLUNTARY INITIATIVES

- **Energy efficiency agreements** (municipal, property and building, and oil-heated real estate sectors): Sector-specific initiatives aimed at promoting energy efficiency improvements through tailored action plans. These agreements involve commitments to energy saving measures, such as upgrading systems and integrating renewable energy, supported by government subsidies and monitored for progress to achieve substantial energy savings and sustainability goals.
- **Environmental certifications**: Various environmental certifications, including BREEAM, LEED, and Rakennustiedon ympäristöluokitus.
- **Energy classification of windows**: Voluntary initiative for manufacturers. It aims to facilitate comparisons between different window solutions made by builders and renovators[133].

REFERENCES[134],[135],[136]

133. Motiva Oy, "The energy classification of windows." Accessed: Apr. 19, 2024. [Online]. Available: https://www.motiva.fi/en/home_and_household/renovate_and_maintain/the_energy_classification_of_windows
134. Energiatehokkuus-Sopimukset, "Energy Efficiency Agreements." Accessed: Apr. 19, 2024. [Online]. Available: https://energiatehokkuussopimukset2017-2025.fi/en/agreements/
135. Rakennustieto, "Environmental classification of building information." Accessed: Apr. 19, 2024. [Online]. Available: https://ymparisto.rakennustieto.fi/rakennustiedon-ymparistoluokitus
136. Motiva Oy, "The energy classification of windows." Accessed: Apr. 19, 2024. [Online]. Available: https://www.motiva.fi/en/home_and_household/renovate_and_maintain/the_energy_classification_of_windows

INFORMATIONAL INSTRUMENTS

- **Energy Authority (Energiavirasto)**: Authority that regulates the electricity and gas markets, emission reductions, energy efficiency, and renewable energy use since 1995. It also provides oversight and promotion for industry compliance.
- **Advisory service by local energy advisers**: Information, solutions, and consulting services for resource-efficient, effective, and sustainable choices.
- **Energy efficiency advice for companies**: Initiative started in 2009 and implemented by Motiva Oy. It offers comprehensive advice to businesses, including sector-specific seminars, business visits, and the production of advisory materials, with no distinction by company size. Originally co-funded by the Ministry of Employment and the Economy and trade associations.

REFERENCES[137],[138],[139]

REGULATORY INSTRUMENTS

- **Mandatory energy audits**: Audits required for large companies that have a key role in identifying and implementing energy saving measures to enhance overall efficiency.
- **Energy efficiency requirements in environmental permits**: National legislation incorporating the provisions of Council Directive (96/61/EC) on integrated pollution prevention and control, which mandates the consideration of energy efficiency in operations when granting environmental permits.

REFERENCES[140],[141]

137. Finnish Energy Authority, "Energy Authority." Accessed: Apr. 08, 2024. [Online]. Available: https://energiavirasto.fi/en/frontpage
138. Motiva Oy, "Motiva – a Sustainable Development Company." Accessed: Mar. 20, 2024. [Online]. Available: https://www.motiva.fi/en/motiva
139. Mure Database, "Energy advice to industries - Finland." Accessed: Mar. 08, 2024. [Online]. Available: https://www.measures.odyssee-mure.eu/energy-efficiency-policies-database.html#/measures/1115
140. Motiva Oy, "Energy Audits." Accessed: Mar. 20, 2024. [Online]. Available: https://www.motiva.fi/en/solutions/policy_instruments/energy_audits
141. Mure Database, "Energy efficiency requirements in environmental permits - Finland." Accessed: Mar. 20, 2024. [Online]. Available: https://www.measures.odyssee-mure.eu/energy-efficiency-policies-database.html#/measures/1111

FINANCIAL INSTRUMENTS

- **Energy investment aid**: Financial assistance for organisations to promote energy efficiency through new technology and renewable energy adoption. Businesses in energy efficiency agreements can also access aid for conventional energy efficiency technologies.
- **Business Finland**: Government agency that provides funding and loans for the development and commercialisation of new technological solutions.
- **Subsidized energy audits programme**: A programme offering subsidies for energy audits to encourage energy efficiency for SMEs and municipalities exempt from mandatory audits.
- **In-depth energy analysis subsidy**: Financial support for heavy industries as part of energy efficiency agreements, focusing on identifying measures or energy efficiency, use of renewables and other measures to pursue low-carbon operation.
- **Green financing for companies**: Loans provided by Finnish banks, such as OP and Nordea, to enterprises and housing communities for promoting energy efficiency, the use of renewable energy, and sustainable materials.

REFERENCES[142], [143], [144], [145], [146], [147], [148], [149]

142. Motiva Oy, "Energy Aid." Accessed: Apr. 17, 2024. [Online]. Available: https://www.motiva.fi/en/solutions/policy_instruments/energy_aid
143. Business Finland, "Business Finland - Services." Accessed: Apr. 17, 2024. [Online]. Available: https://www.businessfinland.fi/en/for-finnish-customers/home
144. Mure Database, "Energy Audit Programme_industry - Finland." Accessed: Mar. 08, 2024. [Online]. Available: https://www.measures.odyssee-mure.eu/energy-efficiency-policies-database.html#/measures/1118
145. Mure Database, "In-depth energy audits - Finland." Accessed: Mar. 08, 2024. [Online]. Available: https://www.measures.odyssee-mure.eu/energy-efficiency-policies-database.html#/measures/4476
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147. Finnvera, "Loans for green transition and digitalisation." Accessed: Jan. 02, 2025. [Online]. Available: https://www.finnvera.fi/eng/financing/loans-for-green-transition-and-digitalisation
148. Energiatehokkuus-Sopimukset, "Energy Efficiency Agreements." Accessed: Apr. 19, 2024. [Online]. Available:https://energiatehokkuussopimukset2017-2025.fi/en/agreements/
149. Motiva Oy, "Energy Audits." Accessed: Mar. 20, 2024. [Online]. Available: https://www.motiva.fi/en/solutions/policy_instruments/energy_audits

VOLUNTARY INITIATIVES

- **Energy efficiency agreements** (industries): Sector-specific initiatives designed to reduce energy consumption and achieve energy savings targets, with tailored action plans for various industries. Companies commit to implementing energy efficiency measures, including adopting systems such as ISO 50001, with regular monitoring and reporting.
- **Implementation of ISO 50001** on energy management systems.
- **Voluntary energy audits**: Audits for SMEs and municipalities with government financial aid.

REFERENCES[150], [151]

150. Energiatehokkuus-Sopimukset, "Energy Efficiency Agreements." Accessed: Apr. 19, 2024. [Online]. Available: https://energiatehokkuussopimukset2017-2025.fi/en/agreements/
151. Motiva Oy, "Energy Audits." Accessed: Mar. 20, 2024. [Online]. Available: https://www.motiva.fi/en/solutions/policy_instruments/energy_audits

4.4 Iceland

4.4.1 Building sector

INFORMATIONAL INSTRUMENTS

Advisory services

- **Energy Centre of the Energy Authority**: Centre offering offers individual consultations and advice about energy savings in households.

Energy guidance and information

- **National Energy Centre**: Centre contributing to increased awareness of efficient energy use.
- **Housing and Construction Authority (HMS)**: Agency providing information on energy standards for building.

Energy statistics

- **Icelandic National Energy Authority** is the primary agency responsible for energy statistics. **Statistics Iceland** contributes to energy-related statistics, providing information on various aspects of energy use and production.

Energy efficiency campaigns

- **Building a greener future** led by HMS, is a collaborative project between government and stakeholders in the construction industry, focused on environmentally friendly constructions.

REFERENCES[152],[153],[154],[155]

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153. HMS, "Húsnæðis- og mannvirkjastofnun [Housing and Construction Authority]." Accessed: Mar. 20, 2024. [Online]. Available: https://hms.is/
154. Icelandic Energy Authority, "Orkustofnun [National Energy Authority]." Accessed: Mar. 20, 2024. [Online]. Available: https://orkustofnun.is/en/about_us/national_energy_authority
155. Icelandic Housing and Construction Authority, "Byggjum grænni framtíð [Building a greener future]." Accessed: Dec. 16, 2024. [Online]. Available: https://hms.is/husnaedis-og-mannvirkjastofnun/verkefni-a-vegum-hms/byggjum-graenni-framtid

REGULATORY INSTRUMENTS

- **Building Regulation n. 112/2012**: Regulation managed by the Housing and Construction Authority focuses on increasing knowledge about energy use in buildings and implementing energy efficiency measures.
- **Regulation for support to heating costs**: Regulation supporting households with electrical heating without access to geothermal, including funding for geothermal district heating extension and heat pump installations.
- **Laws on subsidies for heating costs**: Laws that aim to subsidise heating costs for residential buildings not fully utilising geothermal heating, promoting environmentally friendly energy acquisition and efficiency improvements.

REFERENCES[156],[157],[158]

156. Icelandic Housing and Construction Authority, *Byggingarreglugerð [Building Regulation] nr. 112/2012*, 2012. [Online]. Available: https://hms-web.cdn.prismic.io/hms-web/e7b857b3-e3fe-402b-ac4a-31d3e720c9b6_uppfaerd-byggingarreglugerd-eftir-11-breytingu.pdf
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158. Icelandic Parliament, *Lög um niðurgreiðslur húshitunarkostnaðar nr. 78 [Regulation on the implementation of the law on heating cost subsidies No. 78]*, 2002. [Online]. Available: https://www.althingi.is/lagas/nuna/2002078.html

FINANCIAL INSTRUMENTS

- **Energy Fund's initiatives**: Initiatives including subsidies for energy exchange projects, covering one-third of the costs for transitioning to renewable energy sources. The Energy Fund has also offered grants for geothermal exploration, to support projects that aim to begin utilising geothermal energy for general space heating in areas where electricity and/or oil are currently used for space heating.
- **Subsidy for home heating**: Government subsidies for distribution and transmission costs of electricity for heating up to 40,000 kWh/year, aimed at people without access to geothermal energy.
- **Subsidy for energy reducing equipment** (including heat pumps): Initiative that offers a one-time subsidy for the initial costs of environmentally friendly energy production that reduces electricity heating or oil consumption.
- **Green financing for individuals and municipalities**: Financing options for projects that contribute to energy efficiency and have positive climate and environmental impact, provided by Icelandic banks such as Íslandsbanki and Arionbanki.
- **Capital funding of new geothermal district heating systems:** Initiative stemming from the heating subsidy laws, which provide funding equivalent to government subsidy savings over 12 years for the installation or expansion of geothermal district heating systems. These funds are payable to both district heating companies and homeowners.

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VOLUNTARY INITIATIVES

- **Green Building Council Iceland**: Non-governmental organisation aimed at increasing focus on sustainable buildings.
- **Various government and public initiatives**: Initiatives targeting energy consumption reduction through measures such as energy-saving house reports and strategies for efficient lighting.
- **Environmental certifications**: Various certifications, such as the Nordic Swan Ecolabel for buildings and BREEAM, to certify sustainable buildings in Iceland that are surpassing national building code standards for energy efficiency.

REFERENCES[165],[166],[167],[168]

4.4.2 Industry sector

INFORMATIONAL INSTRUMENTS

- **Energy Centre of the Energy Authority**: Centre that, since 2005, has been enhancing public and business awareness about efficient energy use and energy savings. Focuses on new energy sources and educational material preparation.
- **Energy Agency services**: Services including consultations, advice, and financial incentives for adopting energy saving technologies. The Energy Agency also runs campaigns and provides information on energy options to individuals and businesses.

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REGULATORY INSTRUMENTS

- **Act on the Energy Fund** (2020 No. 76): Regulatory instrument that established a fund to support efficient energy use in Iceland, focusing on reducing fossil fuel use and promoting renewable energy. Managed by a board, with daily operations overseen by the National Energy Authority, the fund provides grants and loans for energy security and climate-related projects. It is funded through state contributions and interest on the fund's capital.

REFERENCES[171]

FINANCIAL INSTRUMENTS

- **Incentives for industrial energy conversion projects**: Subsidies from the Energy Fund for transitioning to renewable energy sources.
- **Green tax incentives**: Tax deductions for environmentally and climate-friendly activities.
- **Public support to agriculture, land use, and forestry**: Financial support for activities contributing to the energy transition.
- **Grants and loans for geothermal resources**: Financial incentives to promote the utilisation of geothermal energy in cold areas. The Energy Fund allocated specific support for the exploration of geothermal resources in 2023–24.
- **Green financing for companies**: Financing options offered by banks to companies for projects supporting, for instance, green buildings, renewable energy, energy efficiency, and carbon savings.

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VOLUNTARY INITIATIVES

- **Energy efficiency initiatives**: Examples include projects focusing on the electrification of fishmeal factories, energy efficiency improvements in aluminium production, and heat recovery in industrial processes.
- **Implementation of ISO 50001** on energy management system.

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4.5 Norway

4.5.1 Building sector

INFORMATIONAL INSTRUMENTS

Advisory services

- **Enova**: State-owned enterprise that provides advice and support for energy efficiency and services in buildings. Available via chat, phone, and email.

Energy guidance and information

- **Enova's guidance**: Support on energy saving measures tailored to various types of homes.
- **Guidance on smart renovation of building**: Service provided by the Norwegian Building Quality Directorate (DiBK), offering tips for smarter renovation.
- **Norwegian Water Resources and Energy Directorate (NVE)**: Agency that actively promotes energy efficiency in buildings through surveillance and analyses of long-term trends. The focus for NVE in 2024 is to enhance resource efficiency, digitalisation, and regulatory capacity while addressing climate change adaptation, energy efficiency, renewable energy development, and resilience against flood and landslide risks.

Energy statistics

- **Enova**'s building statistics provided annual data on reported energy consumption, until 2017. **Statistics Norway** provides extensive information on energy production and consumption.

Energy efficiency campaigns

- National campaign on energy saving (**sparenergi.no**) to encourage saving electricity and energy through advice, tips, and links.

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REGULATORY INSTRUMENTS

- **Building Technical Regulation (TEK17)**: Regulation that establishes mandatory energy needs for buildings and is divided into 13 categories, with specific requirements for thermal transmittance, air leakage rate, and heat recovery of ventilation air. Fossil fuels heating systems installation banned in new buildings since 2017, and oil heating banned in all buildings from 2020. Applies to both new buildings and major renovations.
- **Energy Labelling Regulation for buildings**: Regulation requiring, since 1 July 2010, that all constructed, sold, or rented buildings must have an EPC rating from A (high efficiency) to G (low efficiency), valid for 10 years or until major renovations.
- **Smart meters roll-out by 2019**: Initiative implemented in 98% of metering points, facilitating hourly electricity consumption measurement and promoting time-of-use information[185].
- **Regulation for heating and hot water systems**: Regulation stemming from the European standards for heating boilers, which were adopted as Norwegian standards since 1998. Among these standards, there is a section outlining boiler performance requirements, including a minimum efficiency prerequisite based on the nominal heat output. This latter requirement varies depending on the type and size of the boiler.

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FINANCIAL INSTRUMENTS

- **Enova's incentives**: Financial aid for energy efficiency measures to individuals, covering items like energy consultancy, storage systems, and solar thermal systems. Funding for energy mapping and performance improvement in commercial buildings is also available, covering up to 50% of costs with various maximum amounts.
- **The Norwegian State Housing Bank (Husbanken)'s incentives**: Loans and grants provided for building private houses that meet high environmental standards, as well as comprehensive upgrades of existing private houses. There is also a grant for energy measures in municipalities, focusing on reducing energy need in in municipal rental housing, care homes and nursing homes.
- **Green loans/green upgrade loans and favourable insurance**: Financing solutions offered by banks and insurance companies for energy-efficient buildings, typically with better terms than traditional loans and insurance. Green upgrade loans focus on improving existing buildings' energy efficiency through upgrades, such as insulation and solar panels. Most banks require an energy label of A or B for green loans, and some offer upgrade loans with a minimum energy improvement requirement of 30%.
- **Energy and environmental taxes**: Initiatives including the implementation of an energy tax on fuel oil, to deter a shift to oil products, as Norway's electricity taxes have been notably low compared to the European average.

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VOLUNTARY INITIATIVES

- **Criteria for passive houses and low energy buildings**: Standards for energy efficiency in commercial (NS 3701:2012) and residential buildings (NS 3700:2013), including passive house and low-energy standards.
- **Environmental certifications**: Various certifications including LEED and BREEAM-NOR certification.
- **FutureBuilt**: Innovation programme aiming for zero-emission city development with 100 pilot projects.
- **Powerhouse Alliance**: Collaboration for sustainable buildings, setting standards based on the Paris Agreement.

REFERENCES[196], [197], [198], [199], [200]

4.5.2 Industry sector

INFORMATIONAL INSTRUMENTS

- **Informational support by NVE**: NVE supports energy efficiency in industry by forecasting energy consumption trends, monitoring energy use, and analysing the impact of new sectors, such as battery factories and data centres. NVE also aids the transition to renewable energy in industry and advises on energy efficiency measures.
- **Enova's information dissemination and advice**: Enova offers insights and advice on energy management, mapping, and diverse strategies tailored to various industries, aiding companies in streamlining energy consumption and enhancing efficiency.

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202. Enova, "Enova's advisory service - Business." Accessed: Mar. 20, 2024. [Online]. Available: https://www.enova.no/bedrift/

REGULATORY INSTRUMENTS

- **Amendments to the Energy Act**: Amendments introduced in 2023, requiring industries to conduct cost-benefit analysis for the utilisation of excess heat in new or extensively upgraded facilities. Targets include power plants, industrial and energy production facilities over 20 MW, and data centres over 2 megawatt (MW). These amendments also mandate large enterprises to carry out regular systematic energy surveys to improve energy use understanding and to identify efficient measures.
- **Mandatory energy audits**: Audits required since 2023 to companies using more than 5 gigawatt-hour (GWh) per year, as part of EED 2012 implementation into Norwegian law, aiming to increase energy efficiency and conservation in significant energy consumers.

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FINANCIAL INSTRUMENTS

- **Enova support programmes**: Funding initiatives promoting efficient and flexible energy use, such as the climate and energy initiatives programme, which encourages heat recovery and the phase-out of fossil fuels; the heating plant programme, which supports renewable energy sources, such as bioenergy and heat pumps; and the Industry 2050 programme, which drives innovations for efficient energy use and reduced emissions, facilitating the industry's transition to a low-emission society.
- **Support to research and innovation programmes**: Funding provided by the Research Council of Norway and Innovation Norway to support the green transition, with a focus on low-emission energy solutions and sustainable technologies. For instance, the Green Platform offers support for business innovation in these areas, while Pilot-E funds the development of environmentally friendly energy technologies. Another example is the Norwegian Catapult Centre, aiming to accelerate the development of sustainable energy systems through its collaborative platforms.
- **CO_2 tax exemption and compensation scheme**: Instruments supporting energy-intensive industries by offsetting the additional costs and increased electricity prices imposed by EU carbon pricing. The purpose of these schemes is to reduce 'carbon leakage' – where production is moved abroad – due to increased energy costs by ensuring competitiveness in Norway. Recent updates include a long-term agreement through 2030, requiring industries to invest 40% of compensation into climate and energy efficiency measures.
- **Green financing for companies**: Favourable loan and insurance products and counselling provided by Norwegian banks and insurance companies to companies investing in energy efficiency, renewable energy, or other environmentally sustainable projects.

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VOLUNTARY INITIATIVES

- **The Green Industrial Initiative:** Initiative aimed at boosting Norwegian exports and contribute to Norway cutting its climate emissions in half by 2030.
- **Implementation of ISO 50001** on energy management system.
- **Energy efficiency and climate targets**: Targets set on a voluntary basis by several Norwegian companies, such as those involved in oil and gas and aluminium production.

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4.6 Sweden

4.6.1 Building sector

INFORMATIONAL INSTRUMENTS

Advisory services

- **Energy Boost**: Multi-step training aimed at promoting the construction and renovation of low-energy buildings.
- **Energy and climate advisory service**: Support for individuals, private apartment building owners, and tenant-owner associations towards more energy-smart choices and a reduction of energy use. Energy and climate advisors help with questions about heating, energy efficiency, transport, energy costs and much more.

Energy guidance and information

- **National Renovation Centre (NRC)**: Centre that collaborates with industry and academia to improve building renovation efficiency. It focuses on supporting stakeholders with knowledge and insights for sustainable renovations.
- **Information Centre for Sustainable Construction (ICHB)**: Centre that promotes energy-efficient, sustainable building practices by providing a platform of research and resources for building owners and entrepreneurs. Both aim to help make informed decisions on energy efficiency and life-cycle sustainability in construction and renovation projects.
- **Technology procurement groups** (such as BeSmå for single-family houses, BeBo for multifamily houses, and BeLok for commercial properties): Networks, named as innovation clusters since 2016, which focus on demonstration projects, developing energy-efficient methods, procuring new technology, and setting exemplary standards. They foster collaboration between industry, state agencies, and consultants to drive technology adoption and influence policies tailored to the Swedish market.
- **Energy guide for sustainable renovation**: Guide that provides information and support for sustainable choices when renovating houses, aiming to reduce energy consumption. The information is aimed at those who own a small or apartment building.

Energy statistics

- **Swedish Energy Agency** promotes energy services and spreads information about energy services to increase competence among purchasers. **Statistics Sweden** compiles a variety of statistical data, including energy-related information.

Energy efficiency campaigns

- In 2022, the Swedish Energy Agency launched the **'Every kilowatt-hour counts'** campaign to promote electricity savings and lower prices, alongside an energy efficiency campaign for single-family homeowners.

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REGULATORY INSTRUMENTS

- **Swedish National Board of Housing, Building, and Planning's Building Regulations (BBR, PBL, and PBF)**: Mandatory provisions for energy efficiency in new buildings and renovations, including maximum yearly energy-use limits according to climate zones. These regulations focus on improving insulation, reducing energy losses, and optimising heating efficiency, contributing to lower energy consumption in buildings.
- **Energy Performance Certificate Act (2006:985)**: Regulation mandating that buildings in Sweden must have an energy declaration if they are sold, rented out, or if significant alterations are made. This declaration provides information on the building's energy performance, helping property owners and tenants make informed decisions about energy consumption and potential improvements.
- **District Heating Act (2008:263)**: Law that regulates district heating in Sweden, ensuring efficient and environmentally responsible operation. It covers the production, distribution, and pricing of heating services, requiring transparency on pricing and renewable energy use. The law protects consumers by ensuring fair contract terms and mandates information on energy performance. It also promotes the use of renewable energy and efficient heating systems.
- **District Cooling Act (2022:332)**: Law regulating district cooling in Sweden, focusing on metering, billing, and transparency of energy use. It mandates accurate measurement of dissipated heat, provides guidelines for invoicing, and ensures accessible information on energy performance and renewable energy shares. The Act also permits municipal district cooling operations in adjacent areas and establishes a framework for oversight and enforcement by a designated authority.

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FINANCIAL INSTRUMENTS

- **Grants for energy efficiency in single-family houses**: Programme supporting the conversion of heating systems and energy-efficient renovation of single-family houses currently using direct-acting electricity or gas. Eligible measures include heating system upgrades and building envelope improvements, such as façade renovations and replacement of windows or doors.
- **Energy and CO_2 tax**: Tax targeting energy savings in the household sector, with taxes on energy use and CO_2 emissions promoting energy efficiency and renewable energy use.
- **Tax deduction for renovations, conversions and extensions (ROT deductions)**: Tax credit covering 30%, introduced in 2008, to cover labour costs for house repairs, maintenance, conversions, and extensions, aiming to boost labour supply and combat undeclared work while also promoting energy efficiency.
- **Climate leap**: Financial support is provided for local and regional investments based on estimated GHG reductions per crown invested, including measures to reduce energy consumption in buildings. However, most energy efficiency applications, such as upgrading lighting, insulation, or ventilation in buildings, are rejected due to low emission reductions per investment, as electricity and district heating have relatively low emission factors.
- **Tax credit for green technology**: Since 2021, a tax credit supports the installation of green technologies, covering a percentage of costs for systems such as solar panels, energy storage, and electric vehicle chargers.
- **Green financing for individuals**: Energy loans to individuals for energy-saving projects, with no collateral required. These loans are earmarked for specific upgrades like energy-efficient home improvements or renewable energy systems. Banks, such as SEB, SBAB, Handelsbanken, and Swedbank, provide favourable terms, including lower interest rates for eco-labelled homes and solar energy investments.
- **Resource-efficient built environment programme**: Programme funded by the Swedish Energy Agency for research and innovation activities that contributes new knowledge and solutions for energy- and resource-efficient buildings without negative impact on the climate.

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224. Skatteverket, "ROT and RUT work." Accessed: Jan. 14, 2025. [Online]. Available: https://skatteverket.se/servicelankar/otherlanguages/inenglishengelska/businessesandemployers/startingandrunningaswedishbusiness/declaringtaxesbusinesses/rotandrutwork.4.8dcbbe4142d38302d793f.html

VOLUNTARY INITIATIVES

- **Environmental certifications**: Various certification including BREEAM SE, LEED, and Miljöbyggnad.
- **Sveby**: Programme to standardize and verify energy performance in buildings.
- **Green rental agreements** (Gröna hyresavtal): Contractual arrangements between landlords and tenants aimed at reducing environmental impacts, with a focus on energy efficiency, waste management, and sustainable practices.

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225. Sweden Green Building Council, "BREEAM-SE." Accessed: Apr. 19, 2024. [Online]. Available: https://www.sgbc.se/certifiering/breeam-se/
226. Sweden Green Building Council, "Miljöbyggnad." Accessed: Apr. 19, 2024. [Online]. Available: https://www.sgbc.se/certifiering/miljobyggnad/
227. Sveby, "Standardisera och verifiera energiprestanda i byggnader [Standardize and verify energy performance in buildings]." Accessed: Apr. 17, 2024. [Online]. Available: https://www.sveby.org/
228. Property Owners Association, "Grönt hyresavtal [Green rental agreements]." [Online]. Available: Gröna hyresavtal.https://www.fastighetsagarna.se/globalassets/broschyrer-och-faktablad/avtalshandledningar/handledning_gront_hyresavtal.pdf?bustCache=1736477489803

4.6.2 Industry sector

INFORMATIONAL INSTRUMENTS

- **Swedish Energy Agency support**: Initiative that acts as a point of contact for end users, offering information on energy services and assisting in market development for energy services. Also focuses on increasing competence among purchasers and providers.
- **Energy and climate advisory service**: Informational service provided by municipalities and supporting, among others, SMEs towards more energy-smart choices and a reduction of energy use. Energy and climate advisers help with questions about heating, energy efficiency, transport, energy costs and more.
- **Business guidance**: Resources supporting companies and organisations in enhancing energy efficiency through a systematic approach, including performing energy audits, setting policies and goals, creating action plans, implementing measures, and tracking results.
- **Stakeholder cooperation in local nodes for energy efficiency**: Local businesses are encouraged to collaborate on reusing residual heat, especially from large industrial facilities, by redirecting it to district heating or other users. This initiative is similar to technology procurement groups and operates at the municipal level, involving seven strategic nodes with over 100 actors from various sectors.

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229. Swedish Energy Agency, "Swedish Energy Agency." Accessed: Mar. 20, 2024. [Online]. Available: https://www.energimyndigheten.se/en/
230. Swedish Ministry of Climate and Enterprise, "Sweden's updated national energy and climate plan," KN2024/00362, Jun. 2024. [Online]. Available: https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en
231. Swedish Energy Agency, "Energieffektivisering i företag [Energy Efficiency in Companies]." Accessed: Jan. 14, 2025. [Online]. Available: https://www.energimyndigheten.se/effektiv-energianvandning/foretag/vagledning-och-hjalp/Broschyrer-och-rapporter/vagledningar-for-energieffektivisering-i-foretag/

REGULATORY INSTRUMENTS

- **Mandatory energy audits**: Audits that were enforced by the Act on Energy Audits in Large Enterprises (EKL) from 2014, which obliges large companies to conduct quality-assured energy audits every four years. The audits must document annual energy usage, recommend cost-efficient energy reduction measures, and are divided into steps within a four-year period starting 2016. Results must be reported to the Swedish Energy Agency, which also provides guidelines for the process. Both private and public sectors are included, emphasising the comprehensive approach to energy efficiency. Energy audits must be performed by certified energy auditors.
- **Environmental inspections and guidance**: The Environmental Code, effective since 1998, emphasizes energy conservation and the use of renewable energy. Operators are required to gain knowledge on energy use, identify potential measures, and continuously implement reasonable actions.

REFERENCES[232], [233]

232. Swedish Energy Agency, *Lagen om energikartläggning i stora företag (EKL) [The law on energy mapping in large companies (EKL)]*. Accessed: Mar. 20, 2024. [Online]. Available: https://www.energimyndigheten.se/effektiv-energianvandning/foretag/energikartlaggning/energikartlaggning-i-stora-foretag/#:~:text=Den%201%20juni%202014%20tr%C3%A4dde%20lagen%20om%20energikartl%C3%A4ggning,Energimyndigheten%20ansvarar%20f%C3%B6r%20f%C3%B6reskrifter%20och%20tillsyn%20av%20lagen.
233. Swedish Ministry of Climate and Enterprise, "Sweden's updated national energy and climate plan," KN2024/00362, Jun. 2024. [Online]. Available: https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en

FINANCIAL INSTRUMENTS

- **Energy and climate advice for SMEs**: Financial support to local climate and energy advisers, offering tailored guidance on energy efficiency and climate measures for SMEs.
- **Aid to technology procurements**: Partial financing of the Swedish Energy Agency to technology procurements, which are methods to trigger producers to develop more energy-efficient and thereby more environmentally friendly products and systems.
- **Energy and CO_2 tax**: Tax targeting energy savings in the industry sector, with taxes on energy use and CO_2 emissions promoting energy efficiency and renewable energy use.
- **Industrial leap**: Financial support introduced by the Swedish government in 2017 to fund projects aimed at reducing industrial GHG emissions, focusing on areas such as biofuels, hydrogen, recycling, and fossil-free steel.
- **Climate leap**: Financial support provided to local and regional investments based on estimated GHG reduction per crown invested. Example of eligible investments include biogas plants, substitution of oil with biofuel or district heating, extension of smaller district heating networks.
- **Energy and climate transition of industry programme**: Initiative funded by the Swedish Energy Agency, including research and development activities contributing to the national climate and energy goals, while also strengthening the international competitiveness of Swedish industries and universities.
- **Green financing for companies**: Major banks in Sweden offer energy loans with favourable terms for businesses financing energy-saving projects, such as renewable energy installations. These loans typically require no collateral and come with competitive interest rates, especially for eco-certified buildings and solar energy investments.

REFERENCES[234],[235],[236],[237],[238]

234. Swedish Ministry of Climate and Enterprise, "Sweden's updated national energy and climate plan," KN2024/00362, Jun. 2024. [Online]. Available: https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en
235. R. Holmberg and B. Lapillone, "How are the Swedish taxes on energy and carbon dioxide related to energy efficiency?" Odyssee-Mure. Policy brief, 2021.
236. Effect4Buildings, "Green loans in Poland, Sweden, Denmark, Norway and Finland," 2020. [Online]. Available: https://www.effect4buildings.se/wp-content/uploads/7-Green-Loans-in-Poland-Sweden-Denmark-Norway-and-Finland.pdf
237. Refrence: Mure Database, "Technology Procurements (Energimyndighetens teknikupphandlingar) - Sweden." Accessed: Mar. 08, 2024. [Online]. Available: https://www.measures.odyssee-mure.eu/energy-efficiency-policies-database.html#/measures/1360
238. Swedish Environmental Protection Agency, "Lägesbeskrivning för Klimatklivet [Status report for Climate Leap]," 2024. [Online]. Available: https://www.naturvardsverket.se/497a0b/globalassets/amnen/klimat/klimatklivet/redovisning-av-stod-tilllokala-klimatinvesteringar-2024.pdf

VOLUNTARY INITIATIVES

- **Roadmaps for fossil-free competitiveness**: Industry-specific roadmaps for becoming fossil free, focusing on policy follow-up, national strategies, public procurement climate requirements, regional action plans, and support for green industrial projects.
- **Energy efficiency and climate targets**: Targets established voluntarily by various Swedish companies, including those in the automative sector.
- **Implementation of ISO 50001** on energy management system.

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239. Fossil Free Sweden, "Roadmap for fossil free competiteveness. Summary Report," 2020. [Online]. Available: https://fossilfrittsverige.se/wp-content/uploads/2020/12/Sammanfattning_Webb_ENG_2020.pdf

5. Energy savings from selected efficiency measures in the Nordics

This chapter highlights the energy savings resulting from the implementation of selected measures across the Nordic countries aimed at improving energy efficiency. The goal is to provide insights rather than a comprehensive analysis of all measures. Data comparison can be challenging due to differing calculation methodologies, policies, and technological maturity. A full understanding of each country's approach requires a consideration of their unique frameworks and priorities.

Energy savings can be expressed through ***energy saving potential*** and ***energy saving effect***, where the former outlines the maximum achievable savings in an ideal setting, while the latter reflects the tangible outcomes of implementing an energy efficiency measure in real-world scenarios. Assessing energy saving potential involves comparing the measure's impact on reducing energy consumption to a baseline scenario where no energy-saving measure is applied. This assessment sets a benchmark for evaluating the performance of individual or combined energy efficiency measures[240],[241]. In contrast, the energy saving effect is used to assess the actual impact of measures, such as policies, programmes, or initiatives, once they are implemented and applied in practical settings[242],[243].

Assessing the energy savings of measures is complex, as various factors, such as climate and the initial condition of the energy consumption, can influence the effectiveness of the measures. Additionally, ***the interaction between energy efficiency measures must be considered***, as one measure can affect the performance of another.

240. K. Tanaka, "Assessment of energy efficiency performance measures in industry and their application for policy," *Energy Policy*, vol. 36, no. 8, pp. 2887–2902, Aug. 2008, doi: 10.1016/j.enpol.2008.03.032.
241. N. H. Sandberg, J. S. Næss, H. Brattebø, I. Andresen, and A. Gustavsen, "Large potentials for energy saving and greenhouse gas emission reductions from large-scale deployment of zero emission building technologies in a national building stock," *Energy Policy*, vol. 152, p. 112114, May 2021, doi: 10.1016/j.enpol.2020.112114.
242. B. Boza-Kiss, S. Moles-Grueso, and D. Urge-Vorsatz, "Evaluating policy instruments to foster energy efficiency for the sustainable transformation of buildings," *Current Opinion in Environmental Sustainability*, vol. 5, no. 2, pp. 163–176, Jun. 2013, doi: 10.1016/j.cosust.2013.04.002.
243. X. Labandeira, J. M. Labeaga, P. Linares, and X. López-Otero, "The impacts of energy efficiency policies: Meta-analysis," *Energy Policy*, vol. 147, p. 111790, Dec. 2020, doi: 10.1016/j.enpol.2020.111790.

For instance, in buildings, installing thermal insulation can reduce heating demand, thus reducing the total energy savings potential from installing a heat pump. Conversely, some measures can have reinforcing effects. For example, switching to energy-efficient lighting may slightly increase the need for heating, thereby enhancing the impact of installing a heat pump.

Additionally, it is crucial to consider the possibility of a ***rebound effect***, where an energy-saving measure may not produce the expected results as indicated by theoretical calculations. For example, households that install heat pumps might increase the indoor temperature to a more comfortable level while maintaining the same energy cost as before the installation, thereby not reducing the actual energy consumption as much as anticipated.

Energy efficiency measures often bring ***multiple benefits***, such as improved comfort, indoor climate and health outcomes, in addition to reducing energy consumption. This underscores the importance of a holistic and nuanced approach to assessing the overall impact of energy efficiency measures, considering various interconnected factors[244].

The next sections provide a country-by-country overview of energy-saving potential and the effects of selected energy efficiency measures in the building sector (5.1) and the industry sector (5.2). This includes detailed analyses for Denmark (5.1.1 and 5.2.1), Finland (5.1.2 and 5.2.2), Iceland (5.1.3 and 5.2.3), Norway (5.1.4 and 5.2.4), and Sweden (5.1.5 and 5.2.5).

244. S. Sorrell, "The Rebound Effect: Definition and Estimation," in *International Handbook on the Economics of Energy*, J. Evans and L. C. Hunt, Eds., Edward Elgar Publishing, 2009. doi: 10.4337/9781849801997.00014.

5.1 Building sector

5.1.1 Denmark

For Denmark, ***tightening building regulations for energy efficiency*** was a pivotal energy-efficiency measure implemented in 2010. It introduced stricter energy frameworks and requirements for new buildings, alongside component requirements for installations and building envelopes in minor renovations of existing buildings. The measure resulted in 0.28 TWh of energy savings in 2010, with projections estimating annual savings of 3 TWh in 2016 and 5 TWh in 2020[245].

In a national study from 2021,[246], it is noted that ***renovating buildings*** *and* ***upgrading the building envelope*** can reduce total heating demand by 10.1 TWh/year, equivalent to 20.5% of the current heating demand, assuming that indoor temperature after renovation and additional insulation are raised to the levels typical in similarly insulated buildings. If indoor temperatures are maintained at pre-renovation levels, the savings from renovation would instead amount to 15.1 TWh/year, representing 30.7% of the current heating demand.

The promotion of ***energy-efficient appliances and equipment*** constitutes a crucial aspect of Denmark's endeavours to enhance energy efficiency. In 2024, a study on energy savings from Ecodesign and Energy Labelling Directivesin the Nordics[247] highlighted significant savings in the region. The top-down method scaled EU savings from the 2023 Ecodesign Impact Accounting report[248], while the bottom-up method used updated sales data and rescaled energy labels from 2021. The revised top-down calculations for Denmark project annual primary energy savings for 2030 (with final energy savings in parentheses) as 27.52 TWh/year (16.34 TWh/year).

245. Danish Energy Agency, "The Second Danish National Energy Efficiency Action Plan under Directive 2006/32/EC (NEEAP 2)," 2011. [Online]. Available: https://circabc.europa.eu/ui/group/8f5f9424-a7ef-4dbf-b914-1af1d12ff5d2/library/59af32b5-6ae0-45b2-8110-6fe4a9c009c6/details
246. J. Kragh and S. Aggerholm, "Varmebesparelse i eksisterende bygninger. Segmentering [Heat savings in existing buildings. Segmentation]," BUILD Rapport 08, 2021. [Online]. Available: https://vbn.aau.dk/ws/portalfiles/portal/410909490/BUILD_Rapport_2021_08.pdf
247. Nordic Energy Research, "Energy Savings from Ecodesign and Energy Labelling in the Nordics," 2024. [Online]. Available: http://dx.doi.org/10.6027/NER2024-03
248. European Commission. Directorate General for Energy., *Ecodesign impact accounting annual report 2023 - Overview and status report.* Publications Office of the European Union, 2024.

5.1.2 Finland

For Finland, the ***improvement of energy efficiency in the existing building stock,*** reducing the energy used for heating, cooling, ventilation, and water heating systems in buildings, is anticipated to result in an 8 TWh/year reduction in total heating energy consumption by 2050, representing an 11% decrease from the 2020 level. This measure is part of the long-term renovation strategy spanning from 2020 to 2050[249]. While not directly an energy efficiency measure, the expected increase in average outdoor temperatures due to climate change is predicted to lower the need for space heating, contributing to a further 9 TWh/year reduction, or a 12% decrease in total heating energy consumption in buildings by 2050, compared to the 2020 level. The ***adoption of heat pumps in single-family and terraced houses***, as outlined in the National Climate and Energy Strategy of 2022 [250], offers a promising avenue for energy savings, with a potential of 12 TWh/year by 2030. Similarly, ***building regulations*** focusing on energy efficiency in both new construction and renovation are set to contribute substantially to energy savings, with projections of 9 TWh/year and 4 TWh/year by 2030, respectively.

Significant energy savings also result from the implementation of ***Ecodesign and Energy Labelling Directives*** in Finland. Updated projections for 2030 estimate a primary energy savings at 41.58 TWh/year and final energy savings at 24.07 TWh/year[251].

The role of digitalisation in enhancing energy efficiency is increasingly significant. One milestone was the roll-out of remote-readable smart meters for electricity, which was completed in 2013 and now feeds data into the Finngrid Dathub, which provides valuable data for optimising energy use[252]. The utilization of IoT sensors for monitoring indoor conditions and adjusting HVAC systems accordingly is becoming more common, especially among large real estate owners.

249. Finnish Energy Authority, "Long-term renovation strategy 2020-2050: Finland. Report according to Article 2a of Directive (2010/31/EU) on the energy performance of buildings, as amended by Directive 2018/844/EU," 2020. [Online]. Available: https://energy.ec.europa.eu/system/files/2020-04/fi_2020_ltrs_en_0.pdf
250. Finnish Ministry of Economic Affairs and Employment, "Carbon neutral Finland 2035 – national climate and energy strategy," 2022. [Online]. Available: https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/164323/TEM_2022_55.pdf?sequence=4&isAllowed=y
251. Nordic Energy Research, "Energy Savings from Ecodesign and Energy Labelling in the Nordics," 2024. [Online]. Available: http://dx.doi.org/10.6027/NER2024-03
252. Fingrid, "Datahub." Accessed: Dec. 02, 2024. [Online]. Available: https://www.fingrid.fi/en/electricity-market/datahub/

5.1.3 Iceland

A study from November 2023 presents a comprehensive analysis of Iceland's potential for improved energy efficiency in electricity consumption across various sectors[253]. The study identifies significant opportunities for electricity savings, even as it underscores the country's reliance on expanding electricity generation alongside efficiency improvements. Iceland's energy supply, especially electricity, faces increasing pressure due to growing demand (15% over the last decade, with sectors other than aluminium seeing a 40% increase). The study identifies a ***potential for approximately* 1.5 TWh*/year in electricity savings, equating to around 8% of total electricity consumption in 2022***. These savings span various sectors, including services, households, and energy-intensive industries. Notably, 24% of this potential is realisable over the next five years, with an additional 53% achievable over the next decade. It is important to note that potentials are ranked by feasibility, as some savings are challenging to achieve.

Regarding ***commercial and public services***, about 0.32 TWh*/year* of savings potential is identified mainly through LED lighting, efficient appliances, and improved building management systems. For ***households***, the study sees a potential for around 0.058 TWh*/year* in savings from well-known technologies without detrimental costs, primarily in the service sector.

In Iceland, the implementation of ***Ecodesign and Energy Labelling Directives*** is projected to yield a primary energy savings of 1.93 TWh/year by 2030, with final energy savings estimated at 0.97 TWh/year. This represents significantly lower savings compared to other Nordic countries, where primary energy savings are projected to be between 14 to 26 times higher, ranging from 28 TWh/year to 51 TWh/year[254].

253. IMPLEMENT Consulting Group, "No wasted energy. Uncovering the electricity efficiency potential in Iceland," 2023. [Online]. Available: https://library.arcticportal.org/2833/1/2023%20No%20wasted%20energy.pdf
254. Nordic Energy Research, "Energy Savings from Ecodesign and Energy Labelling in the Nordics," 2024. [Online]. Available: http://dx.doi.org/10.6027/NER2024-03

5.1.4 Norway

A study by NVE published in 2022[255] estimates the economic potential for energy efficiency improvements in buildings at 23.6 TWh/year, calculated using a 4% discount rate and a levelised cost of energy (LCOE) below 1 Norwegian krone (NOK)/kWh for measures involving building envelope upgrades, technical system enhancements, and energy management. This potential represents the total achievable energy savings through cost-effective measures (those with an LCOE under 1 NOK/kWh). ***Non-residential buildings*** exhibit the largest potential at 11.8 TWh/year, followed closely by ***single-family houses*** at 10.1 TWh/year, while ***apartment buildings*** present a potential of 1.7 TWh/year.

The economic potential for energy efficiency encompasses several key areas, such as:

- ***Building envelope measures***: These have a potential of approximately 12 TWh/year. This category includes measures, such as adding insulation to roofs and walls, particularly considering the additional cost of insulation when siding or roofs are being replaced anyway.
- ***Upgrading technical systems***: This area has a potential of just under 9 TWh/year, including measures on ventilation systems.
- ***Energy management***: Measures in this category have a potential of 3 TWh/year.
- ***Heat pumps***: The potential for heat production using heat pumps is close to 8 TWh/year. However, this potential cannot be directly added to the other categories. Implementing measures that reduce a building's energy demand will decrease the potential for heating with heat pumps.

In the NVE study, the figures primarily reflect economically viable potential from a socio-economic perspective, rather than private economic profitability. Regarding regulatory policy measures, a study from 2014[256] estimated that the ***implementation of the new building regulation (TEK17)*** in 2015 have resulted in significant energy savings by 2020, with cumulative net savings of 0.9 TWh and 0.83 TWh of delivered energy, compared to keeping the TEK10 ***building regulation.***

In Norway, the application of ***Ecodesign and Energy Labelling Directives*** is expected to achieve primary energy savings of 35.50 TWh/year by 2030, with final energy savings projected at 17.42 TWh/year[257].

255. The Norwegian Water Resources and Energy Directorate (NVE) and The Norwegian Building Authority (DiBK), "Underlag for langsiktig strategi for energieffektivisering ved renovering av bygninger [Foundation for the long term strategy for energy efficiency by renovation of building]," Mar. 2022.
256. Multiconsult, "Konsekvensvurdering Energiregler 2015 [Impact Assessment of the 2015 Energy Regulations]," 2014. [Online]. Available: https://www.dibk.no/globalassets/02.-om-oss/rapporter-og-publikasjoner/konsekvensvurdering_energiregler.pdf
257. Nordic Energy Research, "Energy Savings from Ecodesign and Energy Labelling in the Nordics," 2024. [Online]. Available: http://dx.doi.org/10.6027/NER2024-03

5.1.5 Sweden

A strategy, provided by Fossilfritt Sverige, outlines an ambitious plan to enhance energy efficiency across various sectors in Sweden by 2030, contributing to the country's fossil-free competitiveness. It emphasizes that while Sweden's energy consumption has remained stable since the 1970s, despite population growth and economic development, there remains a significant untapped potential for energy efficiency improvements[258].

Regarding the building sector, the total energy efficiency potential is estimated at 19 TWh/year.

For ***multi-dwelling units*** by 2030 the energy efficiency potential is estimated to at least 8 TWh/year, of which 7.5 TWh/year comes from district heating and 0.5 TWh/year from electricity. A profitable saving potential of over 6 TWh/year by 2030 has been identified for multi-dwelling units, not including household electricity . For Sweden's over two million ***single-family houses***, there is a cautious estimate of releasing 8 TWh/year of electricity by 2030. The measures with the greatest potential for energy efficiency in single-family homes include ***smarter heating system controls, more efficient water fixtures, and additional insulation of attics***. The strategy estimates that energy efficiency improvements corresponding to 3 TWh/year by 2030 can be implemented within ***commercial and public buildings***, of which 2 TWh/year comes from district heating and 1 TWh from electricity. Energy efficiency improvements in commercial buildings are generally more challenging due to the diversity of building types and operations.

In Sweden, the implementation of ***Ecodesign and Energy Labelling Directives*** is projected to result in the highest energy savings among the Nordic countries. By 2030, primary energy savings are estimated at 51.01 TWh/year, with final energy savings reaching 25.85 TWh/year[259].

258. Fossil Free Sweden, "Strategi för fossilfri konkurrenskraft. Effektiv användning av energi och effekt [Strategy for fossil-free competitiveness. Efficient use of energy and power]," 2023. [Online]. Available: https://fossilfrittsverige.se/wp-content/uploads/2023/02/FFS_Strategi_Energi_Tryck_V2-1-1.pdf
259. Nordic Energy Research, "Energy Savings from Ecodesign and Energy Labelling in the Nordics," 2024. [Online]. Available: http://dx.doi.org/10.6027/NER2024-03

5.2 Industry sector

5.2.1 Denmark

Focusing on the industry sector, a national report dated 2022[260] has provided detailed quantitative information on energy-saving potentials across various applications and processes. The work covers the manufacturing industry, agriculture, and construction and civil engineering sectors, encompassing a total of 42 industries, 21 end-uses, and 16 types of energy. Overall, it is observed that:

- The energy-saving potential ***for thermal end-uses*** is 7% with payback periods of up to 4 years and double that for payback periods of up to 10 years.
- The energy-saving potential for ***electrical end-uses*** is somewhat higher at 17% with payback periods of up to 4 years and up to 25% for payback periods of up to 10 years.

The following information with regards to ***thermal energy saving potential*** in the building and industry fields are outlined considering a payback period of 10 years:

- Conversion and network losses: A potential savings of up to 18% can be realised, translating to 0.33 TWh/year at the highest investment level.
- Heating and boiling: Potential savings of up to 13% are identified, equating to approximately 0.47 TWh/year for investments with longer payback periods.
- Drying: This process has a significant potential for savings, with up to 26% or around 1.13 TWh/year achievable with comprehensive investments.
- Evaporation: Savings potential is assessed at up to 17%, corresponding to about 450 TJ/year for the most comprehensive measures.
- Distillation: Here, up to 18% savings are possible, translating to approximately 0.125 TWh/year for the highest investment levels.
- Burning and sintering: A relatively lower potential of up to 3% is noted, equivalent to roughly 0.05 TWh/year, reflecting the high energy intensity and specialised nature of these processes.
- Melting: Up to 7% savings can be achieved, which amounts to about 310 TJ/year, showcasing opportunities for efficiency improvements in high-temperature processes.

260. Danish Energy Agency, "Kortlægning af energiforbrug og opgørelse af energisparepotentialer i produktionserhvervene [Mapping of energy consumption and assessment of energy-saving potentials in the manufacturing industries]," 2022. [Online]. Available: https://ens.dk/analyser-og-statistik/analyser/analyser-af-dansk-erhvervslivs-energiforhold

- Other process heat: Represents a broad category with up to 15% savings potential, or approximately 0.09 TWh/year, indicating diverse opportunities across different industries.
- Internal transport: Shows a potential of up to 9%, or roughly 0.48 TWh/year, highlighting the importance of efficient logistics and machinery operation.
- Room heating: Potential savings of up to 13% are identified, translating to 0.42 TWh/year, emphasizing the importance of efficient building and process heating.

The following information with regards to ***electric energy saving potential*** in the building and industry fields are outlined, considering a payback period of 10 years:

- Room cooling: Potential savings of up to 28%, equivalent to 0.02 TWh/year for the most comprehensive measures.
- Lighting: Significant savings potential of up to 22%, translating to 0.21 TWh/year, reflecting the impact of transitioning to more efficient lighting solutions.
- Pumping: Potential savings of up to 25%, which amounts to 0.24 TWh/year, showcasing the importance of efficient pump systems.
- Cooling and freezing: Savings potential of up to 26%, equivalent to approximately 0.21 TWh/year, highlighting opportunities in refrigeration efficiency.
- Room ventilation: Potential savings of up to 28%, translating to 0.25 TWh/year, indicating the impact of optimizing ventilation systems.
- Fans: A potential savings of up to 32%, or roughly 0.27 TWh/year, emphasizing the benefits of improving fan efficiency.
- Compressed air systems: Significant potential savings of up to 30%, translating to 0.23 TWh/year, reflecting the high energy use and savings opportunities in compressed air systems.
- Hydraulics: Potential savings of up to 33%, equivalent to 0.07 TWh/year, indicating efficiency opportunities in hydraulic systems.
- Other electric motors: Savings potential of up to 22%, which amounts to 0.49 TWh/year, highlighting the importance of motor system efficiency across various applications.
- IT and other electronics: Potential savings of up to 15%, translating to 0.05 TWh/year, showcasing opportunities for reducing energy consumption in IT and electronic equipment.
- Other electric uses: Savings potential of up to 27%, equivalent to approximately 0.17 TWh/year, covering a broad range of miscellaneous electric services.

In the consulted study, calculations of ***electrification potentials*** indicate a very significant reduction in primary energy consumption for most end uses, for example, a 45% reduction for drying, a 75% reduction for distillation – but only a 4% reduction for firing/sintering (high temperature). Thus, the total final energy consumption of industry could be halved (49% saving) through full electrification. This reduction is expected to increase towards 2050 as new high-temperature heat pumps are anticipated to be developed.

5.2.2 Finland

In Finland, the potential for energy savings through various proposed measures highlights significant opportunities for further reducing energy consumption and increasing efficiency within the industry sector. ***Combined heat and power (CHP)*** play a crucial role in the country's energy production landscape, accounting for more than one-third of all electricity production, significantly higher than the EU average of 12%. In the realm of district heating, CHP's contribution is even more pronounced, providing 70% of the total heat. This efficient use of primary energy through CHP results in considerable energy savings, with approximately one-tenth of the country's primary energy use being saved, underscoring the efficiency and effectiveness of CHP systems in energy production and heating[261]. The following energy efficiency measures and savings are outlined in the National Climate and Energy Strategy of 2022[262]. ***Waste heat recovery and utilisation*** represents a burgeoning field with substantial potential for energy savings. Currently, only 5 TWh/year of low-temperature waste heat from sources such as wastewater and ventilation are utilised, with a total potential of 35 TWh/year. Particularly, 15 TWh/year of this potential comes from industrial plants, indicating a significant opportunity for increased utilisation of waste heat in district heating systems, pending further actions to make this low-temperature heat usable. It should be noted, however, that not all industries producing waste heat are in close vicinity to district heating grids. ***Renewable energy investments in agriculture***, focusing especially on solar power plants and replacing oil boilers by renewable energy sourced boilers, are expected to contribute 4 TWh/year by 2030. This measure illustrates the growing emphasis on integrating renewable energy sources into agricultural operations, highlighting the sector's potential contribution to the broader energy savings and sustainability goals. ***Surplus heat utilisation***, involving the use of high-temperature heat from industrial processes or heat from heat pumps, offers an additional 1.6 TWh/year by 2030. This heat could be directly utilised in district heating networks, providing a practical example of how industrial by-products can be repurposed to contribute to the heating needs of communities.

261. Minister of the Environment, Energy and Housing Finland, "Finland's Seventh National Communication under the United Nations Framework Convention on Climate Change," 2017. [Online]. Available: https://stat.fi/media/uploads/tup/khkinv/fi_nc7_final.pdf
262. Finnish Ministry of Economic Affairs and Employment, "Carbon neutral Finland 2035 – national climate and energy strategy," 2022. [Online]. Available: https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/164323/TEM_2022_55.pdf?sequence=4&isAllowed=y

5.2.3 Iceland

In Iceland, the energy savings potential related to the ***utilization of industrial waste heat***[263] is estimated to 0.357 TWh*/year*. This includes direct use for electricity generation or efficient heating applications.

The ***aluminium industry,*** accounting for 64% (12.5 TWh) of Iceland's total net electricity consumption in 2022, has an energy savings potential of approximately 0.112 TWh/year, which is deemed likely achievable in the next decade, and an additional 'difficult to achieve' potential for 0.351 TWh/year. In general, energy efficiency measures in the aluminium industry can be applied to the smelting process (electrolysis), anode production, and the electrification of the cast house. Since cast houses in Iceland are already largely electrified, the greatest potential for improving energy efficiency in the Icelandic aluminium industry lies in optimising the smelting process.

Agriculture industry in Iceland has an estimated 0.043 TWh/year in potential electricity savings, driven by improvements in farming activities such as irrigation, ventilation, and milk cooling, as well as more efficient use of electricity in greenhouses for lighting and pumping.
Fishmeal factories have also significant energy-saving potential, up to 0.024 TWh/year, if all Icelandic production operates at best-in-class efficiency, driven by improvements such as lowering cooking temperatures and optimizing energy-intensive processes like drying, evaporation, and cooking.

Given the relatively low cost of energy in Iceland, not all identified efficiency measures may be economically attractive without policy intervention. A set of policies needs to be enacted, along with technology adaptation, before these savings can be realised.

263. IMPLEMENT Consulting Group, "No wasted energy. Uncovering the electricity efficiency potential in Iceland," 2023. [Online]. Available: https://library.arcticportal.org/2833/1/2023%20No%20wasted%20energy.pdf

5.2.4 Norway

In a national report dated 2010[264],it was stated that the Norwegian ***land-based industry*** has a substantial technical potential to reduce its net energy use by 29% or 27 TWh/year compared to the baseline for 2020. The report distinguished between the potential for all measures for improved energy efficiency (27 TWh/year) and measures that are economically reasonable (22 TWh/year). Out of these 22 TWh, 12 TWh is profitable and stems from the reduced use of primary energy (electricity, oil, gas, and coal) in the industry. An additional 10 TWh can be derived from the external utilisation of waste heat from the industry, which could help reduce the use of primary energy in society at large. However, realizing this potential requires sufficient off-take (demand and infrastructure) for the waste heat.

The report elaborates on 120 individual measures that make up the total technical energy savings potential. The 120 measures can be divided into five main categories: 1) ***internal and external utilisation of low-temperature waste heat*** (13.3 TWh), 2) ***electricity production and cogeneration plants*** (1.8 TWh), 3) ***optimisation of support systems*** (4.3 TWh), 4) ***improved operation and control*** (2.5 TWh), as well as 5) ***optimisation of industry-specific core processes*** (4.9 TWh). In 2023, the potential for energy savings by using ***waste heat*** in Norway was estimated at 20 TWh/year, with 6 TWh/year originating from relatively easily applicable heat sources in the temperature range of 100–250°C.

The Prosess21 Expert Group report forecasts the power consumption of the process industry until 2050, suggesting an annual energy efficiency potential of 0.1–0.4% from 2020 to 2050. This translates to an overall efficiency potential of 1–5 TWh/year, assuming an increase of 3 TWh/year from 42 TWh in 2020. While many industrial processes have a minimum consumption threshold and have already optimised their energy use, there is still potential for new technologies to provide further savings[265].

264. Enova, *Potensial for energieffektivisering i norsk landbasert industri [Potential for energy efficiency in Norwegian land-based industry]*. in Enovarapport, no. 5. 2009.
265. LO Norge and NHO, "Strategi for energieffektivisering og lokal solkraft [Strategy for Energy Efficiency and Local Solar Power]," 2023. [Online]. Available: https://www.lo.no/contentassets/d760d8ebcd27421481e666c4fae8af01/strategi-for-energieffektivisering-og-lokal-solkraftproduksjon.pdf

5.2.5 Sweden

In Sweden, a cautious estimate suggests that 15 TWh/year could be saved in the industrial sector by 2030, focusing on ***process heat*** and ***machine operation efficiency*** improvements[266]. This sector's potential is significant, given its historical dependence on fossil fuels and the substantial benefits of transitioning to more efficient processes and technologies. The efficiency potential within the industrial sector includes 8 TWh/year from process heat and 5 TWh/year from machine operation.

CHP and ***waste heat recovery*** play pivotal roles in optimizing energy use, particularly in electricity and district heating production. CHP accounts for a substantial portion of electricity production (more than one-third) and district heating (70% of total heat produced), emphasizing its efficiency and potential for energy savings. The strategy highlights an overall potential for energy efficiency improvements equivalent to 34 TWh/year, or about 9% of the total energy usage in 2020. This includes approximately 14.5 TWh/year from electricity, 9.5 TWh/year from district heating, and around 10 TWh/year from various fuels. Flexibility measures are emphasised, with a potential to free up to 3.5 GW of power by 2030, demonstrating the importance of flexible energy use in mitigating peak demand and enhancing the efficiency of the energy system.

266. Fossil Free Sweden, "Strategi för fossilfri konkurrenskraft. Effektiv användning av energi och effekt [Strategy for fossil-free competitiveness. Efficient use of energy and power]," 2023. [Online]. Available: https://fossilfrittsverige.se/wp-content/uploads/2023/02/FFS_Strategi_Energi_Tryck_V2-1-1.pdf

6. Selection of best practices and exemplary initiatives within energy efficiency in the Nordics

This chapter covers two principal tasks:

1. Identifying energy efficiency best practices across Nordic countries in building and industry sectors. This task outlines criteria for evaluating best practices in the Nordic countries, focusing on energy saving impact and the extent of their implementation. It also provides examples of best practices from the region.
2. Presenting notable programmes and policies aimed at promoting energy efficiency and mitigating climate change in the building and industry sectors. This task involves showcasing successful initiatives from each Nordic country.

6.1 Best practices

6.1.1 Background

A good practice is an approach or method confirmed through practical experience and research, consistently proving its effectiveness in achieving desired results while optimising resource utilisation. Key criteria for defining good practices include efficiency, technical feasibility, and economic viability[267]. Consequently, a ***best practice in energy efficiency*** could be defined as a highly effective and efficient measure, supported by empirical evidence and demonstrated outcomes, leading to significant improvements in energy efficiency. However, the definition of energy efficiency best practice lacks standardisation, and energy efficiency improvement is not the sole critical factor. Therefore, key performance indicators (KPIs), such as cost-effectiveness and environmental impact, often assessed through energy savings, are commonly

267. R. Anna, M. Simone, Z. Claudio, and F. Giorgio, "Key performance indicators of 'good practices' of energy efficiency in industry: Application to real cases in Italy and in the European union," *Int. J. EQ*, vol. 2, no. 3, pp. 239–250, Oct. 2017, doi: 10.2495/EQ-V2-N3-239-250.

used[268]. Successful energy efficiency measures typically exhibit cost-efficient CO_2 reduction, ease of development, and additional societal benefits, including positive economic impact and job creation[269].

The EU Odyssee-Mure project [270] has focused on assessing energy efficiency measures by sector for most European countries. One of the project's key outcomes was the creation of the Mure database, which offers valuable insights into energy efficiency policies and implemented measures across these countries. As part of the project, 'good practices' in energy efficiency were identified based on a set of criteria such as energy savings, cost efficiency, market transformation potential, ability to overcome barriers to energy efficiency, ease of re-financing, long-term savings persistence, transferability across countries, connections to other measures, proven experience, avoidance of negative side effects, promotion of positive side effects, and acceptance by relevant stakeholders

6.1.2 Assessment criteria

To identify best practice energy efficiency measures, we have focused specific ***assessment criteria*** based on key aspects such as energy savings and the level of spread.

- ***Energy saving impact***: This criterion evaluates the actual or potential energy savings from implementing energy efficiency measures, which is crucial for decision-makers and stakeholders.
- ***Level of spread***: This criterion assesses the extent to which energy efficiency measures have been adopted, implemented, or disseminated within or across designated areas. A higher level of spread typically indicates greater success in achieving widespread adoption, suggesting a broader realisation of energy efficiency benefits[271].

268. B. Boza-Kiss, S. Moles-Grueso, and D. Urge-Vorsatz, "Evaluating policy instruments to foster energy efficiency for the sustainable transformation of buildings," *Current Opinion in Environmental Sustainability*, vol. 5, no. 2, pp. 163–176, Jun. 2013, doi: 10.1016/j.cosust.2013.04.002.
269. K. Tanaka, "Review of policies and measures for energy efficiency in industry sector," *Energy Policy*, vol. 39, no. 10, pp. 6532–6550, Oct. 2011, doi: 10.1016/j.enpol.2011.07.058.
270. Ademe, "EU Odyssee-Mure project." LIFE-CET programme of the European Commission, 2025 2022. [Online]. Available: https://www.odyssee-mure.eu/
271. C. Morton, C. Wilson, and J. Anable, "The diffusion of domestic energy efficiency policies: A spatial perspective," *Energy Policy*, vol. 114, pp. 77–88, Mar. 2018, doi: 10.1016/j.enpol.2017.11.057.

This chapter defines the energy saving impact of the measures based on scientific and national studies, such as[272] [273] [274] [275] [276] [277] [278] [279] [280] [281] [282] [283] [284], expert consultations, and internal evaluations, supplemented by the semi-quantitative evaluation available from the Mure database. Similarly, the evaluation of the spread level uses consultations with national experts and the database's semi-quantitative evaluation. It is crucial to acknowledge that this evaluation represents subjective expert judgment of the impact rather than an absolute measure.

6.1.3 Examples of best practices in the Nordics

Energy efficiency measures in each of the Nordic countries were initially identified through the state-of-the-art review conducted in Chapter 2, Chapter 3 and Chapter 4. This comprehensive analysis facilitated the recognition and prioritisation of best practices in the Nordic region.

In this analysis, ***best practices*** are defined as measures that exhibit both high energy-saving impact and widespread adoption. In contrast, ***good practices*** may vary in energy-saving impact and level of spread; however, since they do not achieve high ratings in both attributes, they are not classified as best practices.

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272. Finnish Energy Authority, "Long-term renovation strategy 2020-2050: Finland. Report according to Article 2a of Directive (2010/31/EU) on the energy performance of buildings, as amended by Directive 2018/844/EU," 2020. [Online]. Available: https://energy.ec.europa.eu/system/files/2020-04/fi_2020_ltrs_en_0.pdf
273. IMPLEMENT Consulting Group, "No wasted energy. Uncovering the electricity efficiency potential in Iceland," 2023. [Online]. Available: https://library.arcticportal.org/2833/1/2023%20No%20wasted%20energy.pdf
274. Oslo Economics and SINTEF Energy, "Industrien: Etterspørsel etter kraft, beslutningsfaktorer og energieffektivisering [Industry: Demand for power, decision factors and energy efficiency]," OE-rapport 64, 2022.
275. The Norwegian Water Resources and Energy Directorate (NVE) and The Norwegian Building Authority (DiBK), "Underlag for langsiktig strategi for energieffektivisering ved renovering av bygninger [Foundation for the long term strategy for energy efficiency by renovation of building]," Mar. 2022.
276. Fossil Free Sweden, "Strategi för fossilfri konkurrenskraft. Effektiv användning av energi och effekt [Strategy for fossil-free competitiveness. Efficient use of energy and power]," 2023. [Online]. Available: https://fossilfrittsverige.se/wp-content/uploads/2023/02/FFS_Strategi_Energi_Tryck_V2-1-1.pdf
277. Danish Energy Agency, "Kortlægning af energiforbrug og opgørelse af energisparepotentialer i produktionserhvervene [Mapping of energy consumption and assessment of energy-saving potentials in the manufacturing industries]," 2022. [Online]. Available: https://ens.dk/sites/ens.dk/files/Analyser/kortlaegning_af_energisparepotentialer_i_produktionserhvervene_2022.pdf
278. Enova, *Potensial for energieffektivisering i norsk landbasert industri [Potential for energy efficiency in Norwegian land-based industry]*. in Enovarapport, no. 5. 2009.
279. V. M. Nik, E. Mata, A. Sasic Kalagasidis, and J.-L. Scartezzini, "Effective and robust energy retrofitting measures for future climatic conditions—Reduced heating demand of Swedish households," *Energy and Buildings*, vol. 121, pp. 176–187, Jun. 2016, doi: 10.1016/j.enbuild.2016.03.044.
280. É. Mata, A. Sasic Kalagasidis, and F. Johnsson, "Energy usage and technical potential for energy saving measures in the Swedish residential building stock," *Energy Policy*, vol. 55, pp. 404–414, Apr. 2013, doi: 10.1016/j.enpol.2012.12.023.
281. M. Pomianowski, Y. I. Antonov, and P. Heiselberg, "Development of energy renovation packages for the Danish residential sector," *Energy Procedia*, vol. 158, pp. 2847–2852, Feb. 2019, doi: 10.1016/j.egypro.2019.02.048.
282. R. Fazeli and B. Davidsdottir, "Energy performance of dwelling stock in Iceland: System dynamics approach," *Journal of Cleaner Production*, vol. 167, pp. 1345–1353, Nov. 2017, doi: 10.1016/j.jclepro.2017.05.009.
283. T. Niemelä, R. Kosonen, and J. Jokisalo, "Cost-effectiveness of energy performance renovation measures in Finnish brick apartment buildings," *Energy and Buildings*, vol. 137, pp. 60–75, Feb. 2017, doi: 10.1016/j.enbuild.2016.12.031.
284. J. Hirvonen, J. Jokisalo, J. Heljo, and R. Kosonen, "Towards the EU emissions targets of 2050: optimal energy renovation measures of Finnish apartment buildings," *International Journal of Sustainable Energy*, vol. 38, no. 7, pp. 649–672, Aug. 2019, doi: 10.1080/14786451.2018.1559164.

In the **building sector**, common *best practices* across most Nordic countries include highly insulated and airtight building envelopes, energy-efficient windows, mechanical ventilation with heat recovery, energy-efficient appliances and lighting, and heat pumps for heating. These practices are supported by stringent building codes in most countries, alongside successful initiatives such as Finland's energy efficiency agreements and Norway's incentives for energy measures in households. *Good practices* across the Nordic countries include district heating systems (in Finland, Sweden, and Denmark), building energy labelling, and various subsidy schemes that promote energy efficiency in buildings, such as those in Denmark and Iceland. Additionally, Sweden's technology procurement groups advance energy-efficient solutions.

In the **industry sector**, common *best practices* encompass combined heat and power systems, waste heat recovery, energy management systems, and mandatory energy audits for large enterprises. These measures are reinforced by financial incentives and regulations, such as Denmark's energy taxes and Finland's environmental permit requirements. Norway and Sweden provide financial support for energy-efficient technologies, while Iceland supports geothermal projects. *Good practices* include industrial process electrification, energy audit models, and advisory programmes, as seen in Finland, as well as industry-specific networks and centres to promote energy savings, such as Denmark's Centre for Energy Savings in Enterprises and Sweden's energy efficiency networks for SMEs. Additionally, public funding initiatives such as Iceland's Energy Fund and Norway's energy and environmental tax system, represent notable good practices.

An overview of selected best and good practices in building and industry sectors for each Nordic country appears in the Appendix 2. The Faroe Islands are excluded from this detailed analysis due to limited available literature on best practice energy efficiency measures.

Furthermore, Section 6.2 describes selected measures from each country in more detail, focusing on additional criteria such as cost-effectiveness, potential obstacles, and success factors.

6.2 Exemplary initiatives

Exemplary programmes and policies for energy efficiency and climate change mitigation were selected through a comprehensive review of the historical policies from each Nordic country and by consulting successful measures documented in the Mure database[285]. The selection process was further refined through consultations with experts from each country, ensuring an informed and comprehensive decision-making process.

The exemplary programmes and policies presented in this chapter are analysed based on a set of key criteria.

- ***Energy saving impact***: This criterion focuses on the actual or potential energy savings achieved through the implementation of the initiatives.
- ***Level of spread***: This criterion examines the extent to which energy efficiency measures have been adopted, implemented, or disseminated across the country.
- ***Other effects*** beyond energy savings: This criterion focuses on additional impacts resulting from the initiatives, such as environmental improvements, economic growth, and technological advancements.
- ***Cost-effectiveness***: This criterion assesses the comparison between the investment required to implement the initiative and the resulting energy savings. The costs assessed, where available, primarily refer to the administrative and funding expenses associated with the initiatives' implementation.
- ***Obstacles to implementation***: This criterion identifies and evaluate challenges encountered during implementation.
- ***Success factors***: This criterion uncovers the key drivers behind the success of the initiatives, exploring the elements that contributed to achieving goals and delivering tangible results in terms of energy savings, cost-effectiveness, and environmental benefits.

Note that for some initiatives, data on energy savings and costs were not always readily available, potentially limiting a comprehensive evaluation of certain aspects of the initiatives.

The table below provides an overview of the initiatives selected in each Nordic country, which are described in detail in the following sections.

285. Odyssee-Mure, "Successful Measures." Accessed: Mar. 20, 2024. [Online]. Available: https://www.measures.odyssee-mure.eu/successful-efficiency-measures-tool.html#/

	Denmark	Finland	Iceland	Norway	Sweden
Building sector	Window energy labelling	Property and Building Sector Energy Efficiency Agreement and HÖYLÄ IV	Subsidy for heat pumps and geothermal district heating systems	Programme for passive houses and low-energy houses	Programme for buildings with very low energy use (LÅGAN)
	Minimum requirement targets for energy saving for new and existing buildings	Promotion of heat pumps		Programme for best available technology (BAT) in existing buildings	Halve More campaign (Halvera Mera)
Industry sector	The energy saving scheme for energy companies	Energy Efficiency Agreement for Industries	Incentives for industrial energy conversion projects through the Energy Fund	Programme for climate and energy initiatives for industry	Programme for energy efficiency in energy-intensive industry (PFE)
	Subsidy scheme for renewable energy use in production processes	Energy Audit Programme (EAP)		Support for the introduction of energy management	Energy efficiency networks for SMEs

The next sections provide a country-by-country overview of selected energy efficiency policies and programmes in the building sector (6.2.1) and the industry sector (6.2.2). This review includes detailed analyses for Denmark (6.2.1.1 and 6.2.2.1), Finland (6.2.1.2 and 6.2.2.2), Iceland (6.2.1.3 and 6.2.2.3), Norway (6.2.1.4 and 6.2.2.4), and Sweden (6.2.1.5 and 6.2.2.5).

6.2.1 Building sector

6.2.1.1 Denmark

WINDOW ENERGY LABELLING

Duration: 2011–ongoing

Description: The Danish Energy Agency and the Danish Window Industry Association implemented an energy labelling system for windows in 2011 aimed at facilitating the identification of the most energy-efficient options available. The idea of the labelling originates from the EU's 'Energy Labelling Directive'. This system states that products with a high potential for energy savings must be energy labelled and uses an A to F scale to indicate the level of energy efficiency estimated for the window on the market. This scale is similar to the energy labels of other products, such as refrigerators, dishwashers, cars, light bulbs, and more.

This A to F scale determines the energy class of windows by their 'energy balance' (expressed in W/kWm^2), accounting for heat loss and solar heat gain through the window. A negative value signifies that the window negatively contributes to the building's heating, while a positive value indicates a positive contribution to heating. Energy Class A windows are deemed energy-neutral according to specified calculation rules, allowing as much heat in as they release.

The energy labelling scheme targets consumers seeking new windows for existing buildings, aiming to simplify the comparison of energy performance across various window types. The window manufacturer is obligated to furnish energy data for current windows in different designs and sizes when presenting an offer or confirming an order.

Since 2010, Danish Building Regulations (BR10) have required new windows to meet at least Energy Class C standards. Subsequently, with BR15 in 2015 and BR18 in 2018, the requirement was upgraded to Energy Class B. The energy labelling programme initiated a partnership with regulatory bodies to ensure impartial verification of energy labelling data to ensure accessibility to all manufacturers of window solutions without discrimination, including non-member manufacturers of the Window Industry Association. The programme is responsible for verifying that all window solutions included in the energy labelling meet the specified requirements outlined in this agreement.

Energy saving impact: Not directly quantifiable, but about 70% of Danish windows (approx. 31 million m^2) can be replaced with more energy-efficient windows with a savings potential corresponding to approximately 4,327 GWh, the majority of which (2,960 GWh) comes from replacing windows with U-values of around 2.1-2.9 W/m^2K.

Other effects

- Development of new windows with broader glass and reduced frames.
- Local employment opportunities for craftsmen.

Cost-effectiveness: Not directly quantifiable. The Window Industry Association stated that no significant external investment was involved in the agreement. However, the window industry itself had to invest in producing new products, including materials and tests.

Level of spread: High. Window energy labelling is integrated into building code minimum requirements.

Obstacles

- High upfront costs for producers to make new window designs.
- Challenges arose in applying the windows' energy balance principle, necessitating higher solar gains and reduced frame sizes.

Success factors

- Alignment with building regulation minimum requirements.
- Political agreement between the window industry and Climate and Energy Ministers.
- An informative website established by the Window Industry Association aimed at informing users about energy labelling of new windows and the associated energy savings. The website also provides comprehensive details on energy-labelled product systems, allowing users to calculate energy gains for various window configurations.
- Possible inclusion in the EU labelling scheme (currently on hold).

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286. Danish Secretariat for the Energy Labeling Scheme for Facade Windows, "Energivinduer: en del af løsningen [Energy-efficient windows: part of the solution]." Accessed: Mar. 20, 2024. [Online]. Available: https://energivinduer.dk/

MINIMUM REQUIREMENT TARGETS FOR ENERGY SAVING FOR NEW AND EXISTING BUILDINGS

Duration: 2006–ongoing

Description: Established in 2006, minimum energy saving targets for both new and existing buildings aim to improve Danish energy efficiency standards over time.

For **new buildings**, the strategy involved minimum requirements five and 10 years ahead, known as 'low energy class level 2015' or 'Building Class 2020' in building regulations. Denmark has seen a consistent decrease in energy use in new buildings since the 1961 introduction of energy requirements in building regulations.

In 2008, the Danish government committed to reducing building energy needs for new buildings by 25 % in 2010, 50 % in 2015, and 75 % in 2020 compared to the 2006 requirements. This initiative gained broad support from various Danish Parliament political parties.

In 2010, the first step involved introducing the Building Regulation 2010 (BR10), which tightened energy requirements by approximately 25%, and a voluntary energy class was revised and renamed 'Low-energy Class 2015 (Lavenergiklasse 2015)'. Buildings constructed to meet the low-energy class standards of 2015 exhibited an energy framework reduced by 50% compared to the 2006 level.

Responding to requests from the Danish building industry for ample time for product development, the voluntary low energy class known as 'Building Class 2020' was introduced in 2011.

In July 2016, the formerly voluntary 'Low-energy Class 2015' transitioned into a mandatory standard and was rebranded as the 'Danish Building Regulation 2015 (BR15)'. BR15 sets the minimum energy performance criteria for all new building types. Alongside these minimum standards, BR15 outlines requirements for the voluntary 'Building Class 2020' (equivalent to the nZEB level at that time). Building Class 2020 reduced the energy consumption of buildings by 75% compared to the 2006 level.

In 2018, slight adjustments were made to the energy performance requirements, primarily due to updates in primary energy factors and calculation procedures, and these modifications were incorporated into the Building Regulation 2018 (BR18). The voluntary 'Class 2020' was found to exceed the cost-optimal level and continues as a voluntary low-energy class with minimal adjustments to requirements, reflecting updated primary energy factors.

The BR10 legislation also extended to **existing buildings** by including component requirements for installations and minor renovations. These requirements prioritised cost-effective energy efficiency initiatives for building owners, ensuring the adoption of energy-efficient solutions when replacing items such as windows, pumps, and boilers.

Additionally, as an alternative to component requirements, two voluntary renovation classes were introduced:

- A residential building qualifies as 'Renovation Class 2' if the total energy demand for heating, ventilation, cooling, and domestic hot water per square meter of heated floor area is no more than 70.0 kWh/m² per year, plus an additional 2,200 kWh per year divided by the heated floor area. For non-residential buildings, the energy performance framework sets the threshold at 95 kWh/m^2 + 2,200 kWh per year divided by the heated floor area.
- Similarly, a residential building falls into 'Renovation Class 1' if the total energy demand for heating, ventilation, cooling, and domestic hot water per square meter of heated floor area does not exceed 52.5 kWh/m² per year, plus 1,650 kWh per year divided by the heated floor area. For non-residential buildings, the energy performance framework sets the threshold at 71.3 kWh/m^2 +2,200 kWh per year divided by the heated floor area.

Meeting the renovation class standards requires improving the supplied energy requirement by a minimum of 30 kWh/m² per year. Additionally, compliance with the indoor climate requirements for new buildings is necessary to achieve 'Renovation Class 1'.

Energy saving impact: Not directly quantifiable, but heat consumption in single-family houses decreased by 25% from 2006 to 2011, which corresponds to the political ambition of the specific requirements.

Other effects: Slight increase in summer overheating because of the increase of windows, among other things.

Cost-effectiveness: Not directly quantifiable. Presumably low additional initial investment with high energy savings.

Level of spread: High. This measure was eventually incorporated into building codes.

Obstacles: Initial resistance from the building industry as the suggested percentages of energy saving seemed too difficult to achieve.

Success factors: The advance notification of the upcoming energy requirements has provided the industry with sufficient time to develop the necessary solutions, thereby reducing costs.

REFERENCES[287], [288]

287. K. Engelund Thomsen *et al.*, "Implementation of the EPBD. Denmark. Status in 2020," 2020. [Online]. Available: https://epbd-ca.eu/wp-content/uploads/2021/07/Implementation-of-the-EPBD-in-Denmark-%E2%80%93-2020.pdf
288. Aarhus University, "Danskere bruger mindre energi på varme [Danes are using less energy for heating]." [Online]. Available: https://ingenioer.au.dk/aktuelt/nyheder/nyhed/artikel/danskere-bruger-mindre-energi-paa-varme/

6.2.1.2 Finland

ENERGY EFFICIENCY AGREEMENT FOR THE PROPERTY AND BUILDING SECTOR AND HÖYLÄ IV

Duration: 2017–2025

Description: The Energy Efficiency Agreement Scheme is a cornerstone of Finland's energy efficiency policy.

The Agreement for the Property and Building Sector, signed in October 2016 for the 2017–2025 period, succeeds its predecessor spanning 2008–2016. This agreement is integral to the nation's broader energy efficiency initiative and encompasses various governmental bodies such as the Ministry of Employment and the Economy, the Ministry of the Environment, the Energy Authority, and RAKLI – the Finnish Association of Building Owners and Construction Clients.

One of this agreement's main focuses is to improve energy efficiency within the rental housing and commercial property sectors, a vital component of the nation's built environment. Signatories commit to specific Action Plans outlined within the agreement, aimed at enhancing energy efficiency measures within their respective properties. These plans are meticulously designed to align with national and EU energy savings objectives, ensuring a concerted effort towards sustainability.

Companies joining the agreement pledge to adhere to these Action Plans, committing themselves to implement measures aimed at improving energy efficiency. This includes initiatives such as upgrading insulation, optimising heating and cooling systems, and integrating renewable energy sources where feasible.

The government grants energy subsidies to support the implementation of new energy-efficient technology and, case-dependently, conventional energy efficiency investments and energy audits of the participant SMEs and municipalities. However, energy audits of large companies are not subsidised.

Monitoring and reporting mechanisms, overseen by Motiva Oy, ensure transparency and accountability by requiring companies to report annually on their energy usage, efficiency measures implemented, and the realisation of other activities outlined in the Action Plans. This robust monitoring system allows for progress evaluation and the identification of areas for improvement.

The agreement emphasises the importance of raising awareness among stakeholders, including tenants and residents, about energy efficiency benefits. By promoting awareness and education, the agreement aims to foster a culture of energy conservation.

HÖYLÄ IV is another energy efficiency agreement that promotes the upkeep of oil heating systems, including regulators and burners, along with the replacement of boilers and other energy efficiency measures in buildings. It aims to increase the use of renewable energy alongside oil heating and the proportion of biofuel in heating oil sales.

Efforts to improve the efficiency of oil heating are concentrated in several key areas:

- Inspection and advisory services: Providing advisory services alongside routine maintenance by installation companies, with specific performance targets set for activities such as customer visits and repair suggestions.
- Upgrading old oil-heating systems: Facilitating comprehensive services for boiler replacements and system renovations, often by a single-service provider, while integrating renewable energy sources with oil heating systems.
- Promotion of advanced oil-heating systems: Encouraging the adoption of energy-efficient technologies, such as condensing boilers and heating units utilising multiple energy sources, while ensuring functionality across different conditions and building stocks.
- Promotion of renewable energy use: Promoting renewable energy in oil-heated properties through initiatives such as sustainably produced bioliquids and heating systems utilising renewable energy alongside or instead of oil.
- Overall building energy efficiency: Addressing factors influencing building energy consumption, such as heating, hot water demand, ventilation, insulation, and resident behaviour, through cooperation with industry partners to provide property owners with skills and information.

Currently, the focus of the agreement's implementation is more on disseminating information regarding energy efficiency related to oil-heating maintenance and user behaviour rather than replacing outdated oil boilers.

Participants in these agreements can receive subsidies for both conventional and new energy efficiency technologies, whereas non-participants are only eligible for subsidies for new technologies.

Energy saving impact

- **The Property and Building Sector Energy Efficiency Agreement** achieved annual energy savings of 600 GWh in 2022 from measures taken between 2017 and 2022. The savings arise from almost 8,500 implemented measures.
- **HÖYLÄ IV** had energy savings of 2,500 GWh/year in 2020.

Other effects

- Reduction in CO_2 emissions.
- Facilitation of the national targets on increasing the use of renewable energy.
- Improvement in Finland's security of supply and self-sufficiency in energy via efficient energy use.
- Green growth and new markets for clean technology solutions.
- Support in the fulfilment of international climate-related obligations.
- Reduction in oil consumption (10–30%) through the heating system upgrade.

Cost-effectiveness: Not directly quantifiable. The costs related to implementing the energy efficiency agreements are low but not quantified. Investments in energy efficiency measures for the **Property and Building Sector Energy Efficiency Agreement** in the 2017–2022 period are estimated to be around 120 million euro (M€). Cost-effectiveness is not calculated due to insufficient data on total costs.

Level of spread: High, though not directly quantified.

Obstacles: Potential technical challenges during new system installations.

Success factors

- The agreement serves as an alternative, flexible, and cost-effective approach to regulations, aligning with the EED and national climate and energy strategies.
- Subsidies for implementing energy efficiency measures.
- Collaboration among different operators, namely the industry associations, the state, and Motiva.
- Promotion measures consisting of things such as information dissemination in webinars and other events, as well as energy advice given to companies and information disseminated through client magazines.

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PROMOTION OF HEAT PUMPS

Duration: 2000-ongoing

Description: Sales of heat pumps in Finland experienced a significant surge around the year 2,000, coinciding with the promotional efforts by the Finnish Heat Pump Association and Motiva Oy. From only a few hundred units sold annually in the 1990s, sales escalated to about 200,000 by 2022, with a cumulative total of 1,500,000 units. The popularity of geothermal heat pumps has also grown, with approximately half of new single-family houses now being heated by a geothermal heat pump.

The installation of heat pumps received support through investment subsidies from 2006 to 2011. Additionally, since 2011, a partial tax credit for installation costs (labour cost) has been available in annual taxation for heat pumps installed in existing buildings, with some changes in the tax credit rules over time. For instance, in 2017, the deduction was set at 50% of the labour cost.

Alongside financial support, information dissemination has played a crucial role. Motiva Oy, in collaboration with other stakeholders, continually promotes heat pumps to enhance the energy performance of small residential buildings and encourage the use of renewable energy sources.

Annual monitoring of new heat pump sales figures is conducted, and the results are incorporated into the official energy statistics. The promotion of heat pumps in detached and terraced houses was outlined already in Finland's National Energy Efficiency Action Plans (NEEAPs). It is also recognised as one of the household sector measures under Finland's compliance with EED Art 7/8. Heat pumps serve as an illustration of system integration and electrification. Heat pump technology for heating has experienced substantial growth, evident in housing energy statistics, showcasing increased heat pump energy and electricity consumption. Heat pumps also have applications in generating district heating and cooling, allowing the utilisation of surplus and geothermal heat. They contribute to reducing the reliance on fossil fuels while enhancing energy efficiency compared to direct electric heating or electric boilers. Looking ahead, heat pumps are expected to become more prevalent in both individual building heating and district heating production. Potential heat sources encompass surplus heat, soil (geothermal), and air (via air/air or air/water-source heat pumps).

According to an amendment to the Act on Excise Tax on Electricity and Certain Fuels, which entered into force at the beginning of 2022, electricity used in heat pumps and electric boilers that produce heat for district heating or cooling networks has been transferred to electricity tax category II. Lowering the electricity tax on heat pumps supports heat pump competitiveness and may partly compensate for other risks and uncertainties related to projects, such as the security of supply and investment costs.

Energy saving impact: Data not available. Cumulative energy savings by 2030 are estimated at 20,400 GWh according to EED Article 7. The estimate covers all air pump types (geothermal, air-air, air-water and exhaust air recovery). Annual energy savings are estimated to range from 400 GWh/year in 2021 to 160 GWh/year by 2030.

Other effects

- Potential increase in the utilisation of waste heat and support to carbon-neutral energy systems.
- Potential reduction of fossil-fuel use while facilitating electrification in heating buildings. Heat pumps enable heat production that is more energy efficient than direct electric heating or electric boilers.

Cost-effectiveness: Not directly quantifiable as costs are not quantified, and, consequently, cost-effectiveness is not assessed.

Level of spread High, as evidenced by sales figures.

Obstacles

- Potential high upfront costs (investment and installation) for heat pumps.
- Possible technological barriers related to the installation and operation of heat pumps.

Success factors

- Information dissemination from the Finnish Heat Pump Association and Motiva Oy.
- Subsidy first (2006–2011) and tax credit later (2011–ongoing) for the installation cost in annual taxation for heat pumps installed in existing buildings.
- Lowering the electricity tax on heat pumps that produce heat for district heating or cooling network (2022–ongoing).

REFERENCES[292], [293]

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6.2.1.3 Iceland

SUBSIDY FOR HEAT PUMPS AND GEOTHERMAL DISTRICT HEATING SYSTEMS

Duration: 2004–ongoing

Description: Energy consumers in Iceland without access to geothermal heating rely on electricity to heat their homes, which is notably more costly than geothermal alternatives. To promote equitable living standards, the government extends subsidies to households to offset the distribution and transmission expenses associated with electric heating. Although these subsidies are significant and fully cover these costs for households utilising electric heating, they are limited to a specified maximum kilowatt-hour threshold per user. Essentially, subsidy recipients collaborate with the government to heat their homes, highlighting a mutual interest between the government and users in minimising the expenses associated with electric heating.

Apartment owners with subsidised electric heating who wish to adopt environmentally friendly energy generation and/or implement measures that lead to improved energy efficiency in heating can apply for a subsidy for heat pump installations.

Eligible costs for the installation of heat pump systems include the following:

- Heat pump.
- Mounting and all additional equipment with the heat pump.
- Material costs from electricians.
- Piping material costs.
- Transportation costs of the heat pump.
- Part of the trenching and core drilling costs for the connection of the geothermal heat pump.

The prices of heat pumps and their installation costs can vary significantly, and operational expenses may also arise. Subsidies are calculated based on equipment purchase and installation material costs, covering half of the total material cost up to a maximum of 1,337,000 Icelandic króna (ISK) (ca. 9,000 €)[294].

Until 2021, individuals had the option of receiving a lump sum payment for heat pump purchases and electricity expenses over a 10-year period. However, now, due to recent changes in the system, individual applicants receive payment for heat pump purchases along with a monthly subsidy. Additionally, electricity used for heating has a reduced VAT of 11% compared to the standard 24% rate for other electricity uses.

294. 1 ISK = 0.0069 € at the time of writing

This subsidy also funds the installation and expansion of geothermal district heating systems in areas using subsidised electricity, particularly in rural regions with potential geothermal resources.

Energy saving impact: Heat pumps: Since the introduction of the subsidy, energy saving has been around 11 GWh/year from 2004–2023. Geothermal district heating systems: energy savings are not quantified.

Other effects: Reduces the government's electricity subsidy burden.

Cost-effectiveness

- Heat pumps: investments totalled 393,000,000 ISK (2.7 M€), leading to a cost-effectiveness of approximately 35,000,000 ISK/GWh per year (240,000 €/GWh per year) from 2004–2023.
- Geothermal district heating systems: investments totalled 2,250,000,000 ISK (15 M€), but without quantified energy savings, cost-effectiveness is not assessed.

Level of spread: High for heat pumps with about 550 applications since 2009, with 180 in the last two years under the new monthly subsidy. Data for geothermal district heating systems are not available.

Obstacles

- Potential high upfront costs in addition to the subsidy.
- Possible technological barriers related to the installation and operation of heat pumps.

Success factors

- Indirect contribution to the availability of 'high-value' electricity in the market by subsidising the adoption of heat pumps.
- Offering a win-win measure, as heat pump usage reduces electricity consumption, thereby decreasing government expenses on electric heating subsidies.
- Enhancing transparency and accessibility by making real-time savings accessible online.

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6.2.1.4 Norway

PROGRAMME FOR PASSIVE HOUSES AND LOW-ENERGY HOUSES

Duration: 2010–2013

Description: In 2010, Norway defined passive houses as buildings consuming less than half the energy of Norwegian houses, with specific criteria outlined to meet this classification. The Norwegian standards for passive houses and low-energy buildings were introduced by this programme in 2010 (NS 3700 for residential buildings) and 2011 (NS 3701 for service buildings) and established minimum requirements for heating energy demand, calculation criteria, and building components and installations.

To meet the passive house standard, buildings must have improved insulation, better components such as windows and doors, efficient heat recovery in ventilation, and minimal air leakage compared to the minimum building code requirements. These measures, defined as passive, reduce energy needs for heating and ventilation, leading to lower energy costs. Active strategies include installing energy systems such as solar collectors or heat pumps.

Enova's Passive House Programme, operational from 2010 to 2013, aimed to support both new and existing buildings that adhered to passive house or low-energy building standards. This programme provided advisory services during the design phase and financial assistance per square meter for projects meeting passive house standards, encompassing both residential and service buildings.

The roots of Enova's Passive House programme trace back to the innovative exemplary buildings programme in 2007, which served as prototypes that demonstrated the feasibility of passive houses in Norway. Legislative changes between 2007 and 2010, alongside the development of the exemplary buildings and the Passive House programme, underscored a broader shift towards energy efficiency.

While initial demand for advice through this programme was modest in 2010 and 2011, interest surged in 2012 and 2013, leading to a notable increase in passive house projects. By mid-2013, it seemed that the ambitious goal of having 10% of new buildings constructed to NS 3700 and NS 3701 standards had been met.

Energy saving impact: The energy savings from the funded projects are estimated 302 GWh/year from 2010-2013. The experiences and changes in regulations following the programme may have led to larger savings in the building sector.

Other effects

- Enhanced knowledge and expertise in the construction sector.
- Utilisation of passive houses for reputation building and marketing by project partners and building owners.
- Integration of passive house standards into Norwegian building regulations (TEK15 and TEK17), incorporating U-values and technical requirements closer to low-energy/passive house standards.
- Increased collaboration among contractors during the planning phase of passive house projects, leading to the exploration of new cooperation methods and technologies.
- Greater involvement of academia experts in passive house projects compared to traditional construction projects.
- Surge in sales of energy-efficient building products and materials, such as doors and windows.

Cost-effectiveness: 979 MNOK (ca. 85 M€)[297] was awarded to projects through applications, resulting in a cost-effectiveness of 3.2 MNOK/GWh per year or 275,000 €/GWh per year from 2010–2013.

Level of spread: High, with the aim for 10% of new constructions and renovations to participate in the passive house programme, resulting in around 5–6 million square meters of such buildings or nearly 10% market share. From June 2010 to November 2013, 751 support applications were approved, including 182 for feasibility studies and 569 for square metre support for construction.

Obstacles

- Lack of expertise and experience in the construction of passive houses in the market at the programme's launch.
- Challenges posed by initial process understanding. Enova simplified measurements with indicators but faced issues, such as difficulty in measuring reduced costs and saved energy, leading to estimation practices and a limited basis for linking indicators to programme goals.
- Varied quality of the documentation on energy-saving effects among projects.
- Disagreement among contractors on whether to recommend building according to the passive house standard after the programme concluded.

297. 1 NOK = 0.086 € at the time of writing

Success factors

- Connection to clear criteria/standard. The establishment of the passive house standard (NS 3700 and NS3701) gave clear criteria for performance requirements of passive houses and low-energy buildings.
- Effective cooperation among all stakeholders and active involvement from the funding/advisory partner (e.g., Enova-hired experts) and architects.
- Gradual increase in the expertise on passive house/low-energy buildings.

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PROGRAMME FOR BEST AVAILABLE TECHNOLOGY (BAT) IN EXISTING BUILDINGS

Duration: 2018–2021

Description: Enova's programme aimed to facilitate sustainable market transformation by promoting investments in energy and climate measures within existing buildings, prioritising the adoption of the BAT.

This initiative targets investments in BAT for existing commercial or larger residential buildings, with a focus on achieving at least one of the following objectives:

1. Reduction of energy consumption.
2. Promotion of local renewable thermal energy production.
3. Transition from direct electric heating to waterborne heating connected to renewable energy-based heat sources or district heating.

Enova provided a list of predefined BAT measures for existing buildings, each with specific requirements to qualify for incentives. Examples include external wall insulation meeting a U-value ≤ 0.18 $W/m^2/K$, upgrading to energy-efficient lighting with light control, and transitioning from direct electric room heating to hydronic heating connected to renewable energy-based heat sources or district heating, covering at least 70% of the net annual energy demand for room heating. Additionally, establishing a system for detailed energy monitoring was encouraged.

For commercial buildings, the establishment of simplified energy management and monitoring systems (EMS) was a prerequisite for final report approval. Regarding heat pumps, measuring electricity and heat quantity was mandatory. In instances where the heat pump served multiple purposes, all energy flows had to be accurately measured.

Support excluded measures involving air-to-air heat pumps, heating plants not owned by the building owner, and heating systems for buildings already connected to or obliged to connect to district heating networks.

The maximum support rate varied based on the measure and company size, ranging from 30–50% of approved costs. Additionally, support could be subject to further limitations based on the measures' profitability.

Energy saving impact: Energy savings of 65 GWh/year from the funded projects from 2018–2021.

Other effects

- Potential win out of the best solutions in the market and outcompeting currently off-the-shelf options. This implies a lasting market transformation and a change in market standards for rehabilitation and upgrading.
- Potential better quality of energy upgrades by adopting the best technical solutions.
- Minimisation of emissions and environmental effects.

Cost-effectiveness: Approximately 370 MNOK (31 M€) was financed from 2018–2021, leading to a cost-effectiveness of 5.6 MNOK/GWh per year (480,000 €/GWh) from 2018–2021.

Level of spread: Medium to high, with 409 projects financed from 2018–2021.

Obstacles

- High upfront costs, with significant initial investment required for energy-efficient measures.
- Technical complexity of BAT adoption.
- Resistance to change due to reluctance to deviate from traditional practices.

Success factors: Enova motivated market players within rehabilitation, retrofits and extensions to raise energy ambitions regarding both building structures and future operations.

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6.2.1.5 Sweden

PROGRAMME FOR BUILDINGS WITH VERY LOW ENERGY USE (LÅGAN)

Duration: 2010–2016 (first programme period)

Description: To expedite market progress and achieve national objectives, Sweden's Construction Industry and the Swedish Energy Agency launched a five-year funding programme called LÅGAN, targeted at buildings with very low energy consumption. The programme aimed to stimulate energy-efficient construction, promote a national market for low-energy buildings, and foster a wide range of suppliers for such projects. The programme focused on four main areas: communication, networking, demonstration, and development. LÅGAN aimed to establish a market with a wide range of new actors offering products and services for the construction of low-energy buildings.

1. **Communication**: Communication activities aimed to showcase programme initiatives to diverse stakeholders in the construction sector, including clients, contractors, designers, and small-scale builders. Utilising structured documentation and a database for low-energy buildings, these efforts facilitate comprehensive results dissemination, fostering market awareness and enabling the effective monitoring of industry trends. The programme predominantly executed communication initiatives through project-based approaches, typically initiated by the board or member group.
2. **Network**: The programme achieved national collaboration through the coordination of regional networks. Network projects aimed to capture ideas, exchange experiences and knowledge, and develop projects for broad dissemination in the regions. LÅGAN's network financing provided opportunities for actors who lacked prior exposure or resources to develop business opportunities in low-energy buildings. LÅGAN-supported networks were established in Umeå, Norrbotten, Southeast (Växjö), Dalarna and Värmland, Örebro, and Uppsala. Companies with both natural and financial resources participated in network projects.
3. **Demonstration**: Programme demonstration projects aimed to support building initiatives for evaluation and knowledge dissemination, fostering market development and overcoming resistance to untested methods. Companies with both natural and financial resources participated in demonstration projects. To qualify for support, all building types must meet specific criteria, demonstrating energy consumption significantly below regulatory standards for both new construction and renovation.
4. **Development**: Development projects encompassed collaboration among companies with sufficient natural and financial resources to develop tools for implementing low-energy buildings. Firstly, member group representatives were expected to initiate these projects; however, external interest prompted

opportunities for external actors to seek support. LÅGAN's orientation aimed to stimulate the construction sector and promote the broad implementation of low-energy buildings with innovative solutions.

From 2016 to 2019, LÅGAN operated as a national and regional cluster collaboration. Since 2019, the programme has transitioned into a national network. Projects and regional collaborations are now initiated through competitive funding applications, focusing on resource-efficient buildings with low climate impact throughout their life cycle.

Energy saving impact: Total energy savings from the programme are unquantified.

Other effects: The programme established a national knowledge platform, actively disseminating the results from funded projects.

Cost-effectiveness: Not directly quantifiable. The programme's original budget amounted to 54 Swedish krona (SEK)[302] (4.7 M€), with the Swedish Energy Agency financing 40%. However, industry co-financing significantly increased the total to 77 MSEK, with the agency's contribution reduced to 28%.

Level of spread: High, with approximately 4,000,000 m^2 of low-energy buildings registered in the LÅGAN market overview from 2010–2015[303].

Obstacles: Resource and time-intensive administration, with the programme coordinator dedicating considerable effort to supporting project managers with both project applications and final reports. This was driven by the programme's goal to engage individuals and organisations unfamiliar with writing such documents.

Success factors

- Extensive communication efforts through the programme's website and market overview, including a web-based database showcasing construction projects with low-energy consumption nationwide.
- Programme structure that integrated the four areas of communication, networking, demonstration, and development.
- Very high organisational and administrative standards.
- An effective combination of concrete examples and general knowledge related to low-energy building.

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HALVE MORE CAMPAIGN (HALVERA MERA)

Duration: 2013–2017

Description: The Swedish Energy Agency aimed to accelerate energy efficiency in the housing sector through demonstration projects, which emerged as an effective approach. To expedite progress, the agency's procurement group for energy-efficient housing, BeBo, developed the concept of 'Rekorderlig Renovering' (Record-breaking Renovation). This initiative sought to conduct demonstration projects to renovate multi-family dwellings, aiming for energy performance improvements of at least 50%. To increase the number of demonstration projects in line with Rekorderlig Renovering, the 'Halvera Mera' (Halve More) campaigns were launched in three consecutive phases:

First, **Halvera Mera 1.0** (2013) was successful, prompting the Swedish Energy Agency to announce a new phase in 2014, **Halvera Mera 2**. A third round, **Halvera Mera 3**, ran from 2016–2017, aiming to reach more property owners and further increase the method's dissemination.

The campaigns' main goal for property owners was to identify measures resulting in a halving of energy consumption in multi-family dwellings during renovation. The first Halvera Mera campaign aimed to initiate several feasibility studies (Stage 1) according to the Rekorderlig Renovation method through a grant. The purpose of the campaign was to obtain an overall picture based on many property owners, which shows that it is possible to halve energy use when renovating apartment buildings. While property owners were not explicitly required to implement some of the feasibility study's measures (Stage 2), the intention was that the property owners would see that it was possible to implement measures in a profitable way, encouraging several of them to proceed with implementation and follow up on the results (Stage 3).

The pre-study report adhered to a specified template, containing information on the building's condition before renovation, a description of the examined energy measures, a presentation of calculated energy savings, and life cycle cost (LCC) analyses for selected measures. This template was gradually developed across the three Halvera Mera campaign phases to clarify how the pre-study had to be conducted and to align with BeBo's other tools as they were developed.

The feasibility studies investigated several measures, with the most common being window replacement, additional insulation of roofs and facades, replacement of thermostatic valves, and installation of heat recovery ventilation or heat recovery ventilation with heat exchange.

Energy saving impact: Exact energy savings were not quantified; however, the calculated average savings amounted to 80 kWh/m² per year, representing a 61% improvement in energy performance.

Other effects

- Identification of the technical measures with the highest energy saving potential based on real projects.
- Recognition of varying prioritisation of measures among stakeholders and across geographical regions.

Cost-effectiveness: Although not directly quantifiable, the campaign allocated 150,000 SEK (13,000 €) to each accepted property owner, totalling around 9,000,000 SEK for 60 owners. Additionally, the average investment cost for implemented measures was approximately 1,380 SEK per square metre or 190,000 SEK per apartment. Energy efficiency costs varied widely, ranging from 40 SEK to 8,300 SEK per square metre, depending on the included measures.

Level of spread: Medium. After the three phases of Halvera Mera, around 60 property owners participated in the campaign, including both private and municipal sectors, as well as housing cooperatives.

Obstacles

- Lack of experience among property owners to conduct feasibility studies, including energy calculations and needed assumptions.
- Initial uncertainty and knowledge gaps among property owners regarding profitability assessments.
- Insufficiently clear templates and instructions for property owners to ensure more comparable results. In many cases, interpreting the figures has been challenging, and some reports lack complete information.

Success factors

- Continuous programme improvements after each phase.
- Support for implementing the feasibility studies and quality checks, particularly in Halvera Mera 3.
- Introduction of a tool to assess the profitability of different energy-saving measures in Halvera Mera 3.
- Establishment of the Resource Pool, a support system specialised in the Rekorderlig Renovering methodology, offering assistance, guidance, and expertise, including technical advice and quality checks, to property owners and consultants involved in the campaign.
- Insights gained from the investigations by the property owners, even when measures were not implemented on the studied properties.

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6.2.2 Industry sector

6.2.2.1 Denmark

THE ENERGY SAVING SCHEME FOR ENERGY COMPANIES
(also known as the Energy Efficiency Obligation Scheme)

Duration: 2006–2020

Description: In 2005, Denmark launched an ambitious initiative to enhance energy conservation by establishing energy efficiency obligations through voluntary agreements with energy companies. This initiative prompted significant legislative changes in 2006, which facilitated the implementation of four agreements with industry organizations across different energy sectors, including electricity suppliers, natural gas suppliers, electricity grid companies, natural gas distribution companies, and district heating companies. These changes were grounded in legal principles, mandating an annual energy efficiency obligation for these companies. However, in practice, the implementation occurred through agreements with the relevant sectors/companies. These agreements underwent renegotiations in 2009, 2012, and 2016 to adapt to evolving energy conservation goals and strategies.

The scheme's core objective was to encourage grid and distribution companies, collectively referred to as energy companies, to commit to specific targets for energy savings. Typically, these companies enlisted the expertise of external stakeholders such as craftsmen or energy advisors, to execute projects aimed at controlling energy consumption among end-users, particularly households and businesses.

The scheme obligates energy companies to achieve an energy-saving target at the sector level. However, in practice, the scheme operated as a voluntary arrangement between energy companies and the Danish Energy Agency, allowing participating companies to have significant flexibility in defining energy-saving initiatives. Typically, energy companies provide financial assistance to help cover the costs for businesses or households implementing these measures. These subsidies could be provided directly or channelled through the entity overseeing the energy-saving activity.

The scheme facilitated energy efficiency measures spanning households, service buildings, and industries. For instance, when a single-family household replaces an outdated gas boiler, the gas provider might offer a subsidy based on estimated annual savings per kilowatt-hour, commonly at a rate of 0.4 Danish krone (DKK)/kWh[307]. The expenses for such measures were then distributed among all energy consumers.

307. 1 DKK = 0.13 € at the time of writing

Upon completing energy-saving projects, energy companies provided subsidies to either the participants or the end-users involved. Additionally, they reported the achieved energy savings to the Danish Energy Agency. The costs incurred by these energy-saving measures were ultimately passed on to the customers of the energy companies through their energy bills.

Energy saving impact: Approximately 31,000 GWh of total energy savings were achieved between 2006 and 2020 across electricity, district heating, gas, and oil sectors.

Other effects

- CO_2 emission reductions.
- Cost reduction for businesses undertaking energy-saving measures.

Cost-effectiveness: While not directly quantifiable, the scheme's annual expenditure was limited to the following: 1,300 MDKK (174 M€) from 2013–2014 and 1,500 MDKK (200 M€) from 2015–2020. The cost target was adhered to, except in 2015, and the total costs from 2013 to 2020 were approximately 9,500 MDKK (1,200 M€). However, several household measures were deemed economically unviable, as many would have likely been pursued without the support scheme.

Level of spread: High, with ministry estimates indicating at least 100,000 energy-saving cases annually from 2013–2015, increasing to 120,000 from 2018–2020.

Obstacles

- Inability to measure the energy savings within the scheme accurately.
- Energy company audit inadequacy in ensuring agreement compliance and detecting potential misuse, as highlighted by the National Audit Office (Rigsrevisjonen).
- Increased energy costs for users, which favoured those able to afford energy-saving measures.
- Potential initial conflicting interests among stakeholders due to inadequate pre-scheme collaboration planning.

Success factors

- Annual audits and adjustments to agreements in cases of reported misuse to prevent further occurrences.
- Annual renegotiation and adaptation of agreements to align with evolving energy conservation goals and strategies.
- Engagement of external stakeholders such as craftsmen and energy advisors to execute energy-saving projects, ensuring specialised expertise and efficient implementation.

- Flexibility provided to participating energy companies to develop energy-saving initiatives, enabling tailored approaches to address diverse challenges and opportunities.
- Transparent reporting mechanisms, ensuring accurate documentation and assessment of achieved energy savings, enhancing accountability and facilitating continuous improvement efforts.

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SUBSIDY SCHEME FOR RENEWABLE ENERGY USE IN PRODUCTION PROCESSES

Duration: 2013–2021

Description: In a 2012 political agreement, the Danish Parliament set a target for renewable energy to constitute 35% of final energy consumption by 2020. However, despite this goal, favourable tax policies for fossil fuels provide little incentive for industries to transition to renewable energy. To address this issue, a subsidy programme was introduced to promote the energy-efficient utilisation of renewable energy in industrial operations.

This scheme aimed to narrow the cost disparity between renewable energy sources and fossil fuels. State subsidies were directed towards assisting industries in shifting to renewable energy sources or district heating through several aims:

- Substituting fossil fuels with renewable energy sources (e.g., wind, solar, biogas, and biomass) for manufacturing processes. Subsidies encompassed various forms of renewable energy, with biomass conversions being predominant. For instance, companies transitioning from coal to wood chips could benefit from the scheme. However, for electricity generation from renewables, such as wind turbines, companies had to decide between receiving investment support through the renewable energy process scheme or opting for a premium price for environmentally friendly electricity.
- Transitioning from fossil fuels to district heating for industrial processes. For example, a greenhouse might replace its individual coal-fired plant and connect to district heating. Simultaneously, there were opportunities to optimise energy consumption processes when upgrading to a new energy supply system.
- Investing in energy-efficient measures directly associated with the transition to renewable energy or district heating. Offering investment assistance for energy-efficient equipment ensured that supported projects achieved maximum energy efficiency. Additionally, this assistance facilitated reasonable payback periods for companies.
- Supporting the Conversion from conventional cogeneration to biomass-based energy production. This entailed providing investment assistance to coal-fired CHP plants transitioning to biomass. These CHP plants passed on the benefits to industrial companies in the form of reduced heat prices.

The aid was distributed to industrial companies through reduced heat prices, facilitating their transition to renewable energy sources. Companies already using district heating for industrial processes were not eligible for projects replacing fossil fuels with renewable energy sources.

Energy saving impact: Exact energy savings were not quantified; however, an ex-ante analysis indicated a reduction of fossil-fuel use of approximately 4,400 GWh/year until 2020.

Other effects

- Reduction in CO_2 emissions through renewable energy adoption.
- Reduction in fossil-fuel dependency, with a diversification of energy mix and enhancement of energy security.
- Innovation in energy efficiency and renewable energy technologies, fostering technological advancements and competitiveness in the clean energy sector.

Cost-effectiveness: Direct cost-effectiveness was not directly quantifiable; however, the total grant allocation was 3,750 MDKK (500 M€), divided as follows: 250 MDKK in 2013 and 500 MDKK annually from 2014 until 2020.

Level of spread: Medium. Data were unavailable.

Obstacles

- Market price fluctuations of renewable energy sources or competing non-renewable energy sources.
- Comprehensive documentation required to prove the energy efficiency of the project, including the mapping of energy consumption, analysis of current and future energy (fuel) utilisation, assessment of profitable energy savings in the company's processes, and energy-conscious design of the renewable energy system.

Success factors

- Coverage of a wide variety of project types.
- Provision of comprehensive guidance on the application process.

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6.2.2.2 Finland

ENERGY EFFICIENCY AGREEMENT FOR INDUSTRIES

Duration: 2017–2025

Description: The Energy Efficiency Agreement for Industries is a component of the Finnish energy efficiency agreement scheme, which is applied across various sectors of the economy. The most recent agreement, signed in October 2016, spans from January 1, 2017 to December 31, 2025. It supersedes the previous energy efficiency agreement covering the period from 2008 to 2016 and the energy conservation agreement spanning 1997 to 2007. The agreements ranging from 2008 to 2016 were crafted to align with the requirements of the Energy Services Directive, while those for the period spanning 2017 to 2025 consider the implementation needs of the EED.

The objective of this agreement is twofold: Firstly, it seeks to ensure compliance with national energy savings targets and those outlined in the EED during its implementation period from 2014 to 2020. Secondly, it aims to significantly contribute to meeting the EU's shared energy savings target set for 2030. Furthermore, the agreement sets ambitious targets for the energy usage of industry companies. By the end of 2018, it aimed to encompass at least 80% of the energy use of industry companies within its scope. In energy-intensive industries with an annual consumption of 100 GWh/year, full coverage of energy use is the objective.

The industry sector's agreement is integrated into the broader Energy Efficiency Agreement for Industries, which also encompasses the energy industry and the private services sector.

This agreement is comprised of three main components:

- A framework agreement.
- Action plans tailored for different sub-sectors or branches.
- Accession documents.

Companies participate in the agreement by signing a distinct Accession Document specific to the Action Plan of their respective sub-sector or branch. By doing so, they pledge to enhance their energy efficiency in accordance with the outlined actions and targets within their Action Plan. Action Plans have been developed for various branches, including energy-intensive industries, the food and drink industry, the chemical industry, the technology industry, the wood product industry, energy production, energy services, motor trades and repairs, the commerce sector, and the hotel and restaurant sector.

Energy-intensive industries aim for a target of 7.5% energy savings by 2025, with an interim goal of 4% by 2020. Companies joining agreement set their targets for 2017–2025 and commit to implementing an energy efficiency or ISO 50001 system.

In mid-sized industries, the target is to cover at least half of the sector's energy use with Action Plans, aiming for a 7.5% saving by 2025 and 4% by 2020. Participants align their targets accordingly.

Mid-sized companies from previous periods set targets of 10.5% for 2014–2025 and 7% for 2020, utilising their reported savings.

Additionally, companies commit to continuous improvement of energy efficiency, the organisation and planning of energy efficiency activities, the implementation of energy efficiency measures, and the integration of energy efficiency considerations into planning and procurement processes. Regular monitoring, reporting, internal communication, and training are also integral aspects of their commitment.

Monitoring and reporting on energy usage, efficiency measures, and related activities are conducted annually by agreement participants, with compiled reports aiding in the execution and monitoring of targets outlined in the Action Plans.

Energy saving impact: Cumulative annual energy savings until 2020: 8325 GWh; 11.5 TWh/year in 2022 (all savings valid in 2022 from the period 2017–2022).

Other effects

- Reduction in CO_2 emissions.
- Mitigation of the national targets for increasing the use of renewable energy.
- Improvement in Finland's supply security, and self-sufficiency through efficient use of energy is also improved.
- Green growth and new market possibilities for clean technology solutions.

Cost-effectiveness: The budget for the assignment, covering most of the operational costs of the agreement scheme's administration, was approximately 1 M€ in 2017. The level was generally similar in previous years. Cost-effectiveness has not been calculated due to the lack of data on the total costs associated with the agreements.

Level of spread: High. By 2023, 776 companies had joined the Energy Efficiency Agreement for Industries. The coverage accounts for over 90% of the total energy consumption of industry.

Obstacles: Extensive administrative work to ensure timely submission of good quality data.

Success factors

- Specific commitment of participants to set energy efficiency targets and implement actions accordingly.
- Guidelines provided for energy saving calculations.
- Robust monitoring and evaluation process, with annual reports detailing energy efficiency measures submitted to an online monitoring system.
- Communication efforts of successful results to foster motivation and continuous improvement.

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ENERGY AUDIT PROGRAMME (EAP)

Duration: 1994–ongoing

Description: Energy auditing has been a key energy conservation tool in Finland since 1992 and has been included in every national climate strategy since that time.

The EAP began as a subsidy policy in 1992, became a full programme in 1993, and was implemented in 1994. It consisted of the following elements: programme administration, detailed guidelines, auditor training and authorisation, along with a monitoring system and promotion activities.

Originally aimed at all companies, this programme is now intended only for those not subject to the mandatory energy audits required by the EED since June 2014. This has led to a consistent reduction in the number of audits.

While the EAP is voluntary, industrial participants receive a 40% subsidy from the Ministry of Economic Affairs and Employment.

Implemented by the Energy Authority and operated by Motiva Oy, energy audits consist of three basic elements:

1. Analysis of the gross energy consumption of the audited company
2. Investigation of the potential for energy saving measures, and
3. Reporting which includes relevant profitability calculations. Energy audits serve as a tool for company energy management and can also be integrated into a company's environmental management system.

Motiva monitors the audit volumes, results, and quality of the reported energy audits. Specific energy audit models are designed for different sectors, such as industrial energy audits, industrial energy analysis, process industry energy analysis, energy inspection, building energy audits, post-acceptance energy audits, follow-up energy audits, and limited energy audits (for smaller industries). Analysis models also exist for compressed air, refrigeration, steam-condensate systems, and for power plant energy analysis.

Effective auditing support tools such as an auditor handbook have streamlined the auditing process, enhancing efficiency and accuracy. These tools have provided auditors with the necessary resources and guidelines to conduct comprehensive and effective audits.

Finally, Motiva energy audits are conducted by two experts: one who specialises in HVAC and one who specialises in electrical systems. By the end of 2013, around 2,000 experts had been authorised to work as Motiva energy auditors.

Energy saving impact: Energy saving potential identified by energy audits within the EAP from 1992 to 2004 (not including the saving potential of the process industry, which is monitored via the voluntary agreement scheme):

- Heat: 2,807 GWh/year
- Electricity: 557 GWh/year

Other effects

- Reduction in environmental impacts.
- Enhanced competitiveness among industries that undergo energy audits to improve operational efficiency.

Cost-effectiveness: Total costs (subsidies + audits) in the period 1992–2004: 60 M€.

In 2014, 82% of subsidies went to industries with Energy Efficiency Agreements. However, after mandatory audits were enforced by the EED, voluntary audits plummeted. From 2018 to 2021, only 10 sites were audited, with approximately 60,000 € in subsidies.

Potential cost-effectiveness identified by energy audits within EAP from 1992 to 2004: 60,000 €/GWh (ca. 200 M€ required investments and ca. 3,300 GWh energy savings in heat and electricity).

Level of spread: High. The number of sites audited totalled approximately 9,800 at the end of 2014. In 2014, 82% of energy audit subsidies were given to industries participating in the Energy Efficiency Agreements, thus, confirming the strong link between the two measures.

Obstacles

- Insufficient awareness among market actors regarding profitable short-term energy-saving measures.
- Permanent authorisation granted to energy auditors, resulting in the presence of less credible auditors with no opportunity for re-evaluation.
- Expensive and labour-intensive monitoring system.

Success factors

- Motiva's proactive promotion campaign capitalised on favourable market conditions during the 1990s recession, attracting consulting companies and fostering collaboration with stakeholders.
- Motiva's supportive role throughout the process, coupled with sustained political backing, has ensured continuous development and effective implementation of this comprehensive programme.

- The inclusion of effective auditing support tools and an auditor handbook, complemented by rigorous auditor training and strict quality control measures.
- Market-driven incentives for high-quality audits incentivised auditors to uphold standards, contributing to the programme's credibility and success, which has been meticulously monitored to track progress and ensure accountability.

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6.2.2.3 Iceland

INCENTIVES FOR INDUSTRIAL ENERGY CONVERSION PROJECTS THROUGH THE ENERGY FUND

Duration: 1980–ongoing

Description: The Icelandic Energy Fund promotes subsidies for energy conversion projects aimed at phasing out the use of fossil fuels and transitioning to renewable and environmentally friendly energy sources. The Energy Fund's role is to bolster the efficient utilisation of the country's energy resources through subsidies or loans, primarily targeting actions aimed at reducing fossil fuel usage and boosting the utilisation of domestic renewable energy sources. The state assumes responsibility for the fund's obligations, with ministers vested with administrative oversight.

The day-to-day administration of the Energy Fund is overseen by the National Energy Authority while under the supervision of the fund's board.

The recipients of subsidies from the Energy Fund include individuals, municipalities, and larger companies. Furthermore, the Energy Fund extends assistance to projects contributing to energy security and competitiveness in the energy sector, aligned with the energy policy, innovation policy, regional development policy, and governmental climate policies. The Energy Fund can provide subsidies up to one-third (33%) of the total project cost, excluding VAT.

Operating as a competitive fund, the main evaluation criteria for funded projects revolve around the amount of fossil fuels that can be displaced per specific subsidy amount—a metric known as the 'price per litre' benchmark. Additional criteria vary depending on the nature and focus of each project undertaken by the fund, encompassing the consideration of factors such as production and service relevance, project credibility, implementation speed, and the potential for catalysing further energy transitions through similar equipment or technology.

The fund adopts a risk-averse approach, ensuring that subsidies are only disbursed upon project completion and fulfilment of the agreement terms with the fund. The Energy Fund is committed to expediting energy transitions using proven technology, although it may support cutting-edge technology if it involves a promising market product.

Energy saving impact: Annual oil use replaced by funded projects:

- 2021: 42.7 GWh
- 2022: 37.5 GWh
- 2023: 21.1 GWh

Other effects

- Reduction in Iceland's future energy costs as renewable energy sources often have lower operational and maintenance expenses compared to fossil fuels, leading to potential long-term savings for the country.
- Reduction in CO_2 emissions, helping to lower the carbon footprint of Iceland's energy sector.

Cost-effectiveness
Funding amounts:

- 2021: 914,000,000 ISK (6,300,000 €)
- 2022: 871,000,000 ISK (6,000,000 €)
- 2023: 469,000,000 ISK (3,200,000 €)

Cost effectiveness of ca. 22,000,000 ISK/GWh (150,000 €/GWh) in the period 2021–2023.

Level of spread: High, but not directly quantifiable.

Obstacle: Connection to energy price trend. Low prices do not favour this measure.

Success factors

- Enhancing the availability of environmentally friendly electricity, deemed 'high-value' for its lower environmental impact and long-term sustainability. This availability accelerates the transition towards a cleaner energy market.
- Transparent framework for assessing the economic viability and impact of funded projects, through evaluation criteria, such as the 'price per litre' benchmark for oil displacement.

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6.2.2.4 Norway

PROGRAMME FOR CLIMATE AND ENERGY INITIATIVES FOR INDUSTRY

Duration: 2012–ongoing

Description: 'Climate and energy initiatives for industry' is an Enova-supported programme that aims to accelerate and broaden the transition to climate-friendly and energy-efficient solutions within the industry sector. It focuses on implementing measures to enhance energy efficiency, promote electrification, optimise waste heat utilisation, and facilitate the shift from fossil fuels to renewable energy sources.

Projects within this programme are selected based on their cost-effectiveness, considering factors such as support per CO_2 equivalent or kWh saved, or per kW, as well as their alignment with Enova's strategic priorities and potential ripple effects beyond the individual project. Priority may be given to projects offering valuable insights for future technological development, cost reduction opportunities, or those that can significantly enhance market awareness of effective solutions.

The applicable technologies eligible for support may vary from one application period to another, and specific ranking criteria are provided within each thematic area. For projects seeking investment support, the costs should primarily be associated with physical investments, with only a small portion allocated for hours.

In cases in which support is sought for investigations, a small proportion of costs for necessary equipment (such as meters or loggers) can be included, up to a maximum of 20% of the total costs. Generally, support is primarily granted for hours that are owned or purchased by the company.

Companies engaged in industrial or process-related activities, with initiatives related to existing industrial production or facilities, are eligible to apply for this programme. Support can be provided to cover a portion of the additional costs associated with adopting climate- or energy-friendly solutions, or for investigating potential climate- or energy-related measures.

The maximum percentage of support is determined based on the size of the company and the content of the project in compliance with state aid regulations. However, projects are prioritised within the available budget for each application deadline by considering overall scores that evaluate the impact per costs sought, alignment with Enova's priorities, and potential for innovation and broader effects.

Energy saving impact: Energy saving in the period 2019–2022: 700 GWh/year. Data on energy saving missing for 20% of executed projects.

Other effects

- Reduction in energy-related CO_2 emissions in projects aiming at increasing energy efficiency.
- Additional reduction in CO_2 emissions in projects involving electrification and transition from fossil fuels. The estimated overall effect is a reduction of 141.75 kilotons (kt) of CO_2.
- Increase in energy flexibility and reduction in the load on net capacity.

Cost-effectiveness: Total subsidies of approximately 670 MNOK (5.7 M€), which leads to a cost-effectiveness of ca. 950,0000 NOK/GWh per year (81,000 €/GWh per year) in the period 2019–2022. However, this is not an accurate estimation, as the exact energy saving is unknown due to no data for 20% of the financed projects.

Level of spread: High. 552 projects totally supported.

Obstacles

- Limited coverage of upfront costs. The fund covers only 20% of costs for necessary equipment (meters, loggers) for energy-efficiency measures.
- Limited net capacity for projects related to electrification.
- Limited opportunities for external use of waste heat due to few industry actors that could make use of their waste heat being located in the proximity of waste heat producers.
- Elevated energy prices associated with renewable fuels (e.g., bioenergy) in projects centred around transitioning from fossil fuels to renewable energy.

Success factors

- The programme's flexibility in supporting various types of projects and technologies.
- Prioritisation mechanism of projects based on their cost-effectiveness.
- Emphasis on project innovation that can lead to a broader adoption of energy- efficient solutions beyond individual projects.

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SUPPORT FOR THE INTRODUCTION OF ENERGY MANAGEMENT

Duration: 2012–2019

Description: This programme, led by Enova SF, aimed to support the adoption of energy management practices within Norwegian industries, with a particular focus on systematic mapping and monitoring of energy use during regular operations and light maintenance. Recognising the significant energy consumption and GHG emissions within the industry, the programme aimed to increase energy efficiency and reduce GHG emissions. Key findings of this initiative revealed a general decrease in energy intensity within Norwegian mainland industries but noted an increase in the mining and oil extraction sectors.

The programme provided guidance and helped develop tailored energy action plans for each company. These plans encompassed efficiency and transition goals, project activities, and implementation strategies. Companies were offered various options for establishing energy management practices, ranging from adhering to international standards such as NS EN ISO 50001 to simpler approaches suitable for smaller enterprises. The energy action plan typically covered the following:

- Energy efficiency and transition goals.
- Activities and projects contributing to goal achievement.
- Implementation strategies for activities and projects.

While an energy action plan was able to function independently, an energy management system relied on having an energy action plan in place. Once a company had commenced its energy action plan, it could progress toward implementing simple energy management practices. Eventually, consideration could be given to investing in certified energy management systems.

Enova also developed specific guidelines to assist companies in assessing their energy management practices, along with providing templates for documenting energy management systems. The aim was to define a straightforward solution that was particularly suited for SMEs and energy users.

Energy saving impact: Energy saving 2012–2019: 3,100 GWh/year. Experience showed that energy use could be reduced by approximately 10% through the implementation of energy management, with higher potential for reduction in the oil and gas industry.

Other effects

- Contribution to reducing CO_2 emissions related to energy use, with an estimated reduction effect of 18.25 $ktCO_2$ in 2012–2019.
- Increase in the awareness of own energy use among companies.
- Reduction in the energy costs of the companies.

Cost-effectiveness: Total subsidies of approximately 220 MNOK (20 M€), leading to a cost-effectiveness of ca. 71,000 NOK/GWh per year (6,000 €/GWh per year). Introduction of energy management shown to be a cost-effective measure that allows companies to reduce energy use through inexpensive measures connected to awareness of their own energy use.

Level of spread: High. 589 projects supported in the period 2012–2019. Since 2012, Enova has contributed to establishing energy management in over 500 Norwegian companies and assisted in building up entities capable of delivering necessary systems and services. There has also been a cautious increase in the number of Norwegian companies with ISO certification in energy management.

Obstacles

- Effective results require the right competence and good knowledge and systematic follow-up of a company's own processes.
- Need for clear endorsement and support from company management, where leadership priorities determine resource allocation, including personnel and finances.

Success factors

- Development of a specific guideline aimed at small and medium-sized companies, including a checklist to evaluate their status regarding various requirements in a simplified energy management system.
- Increase in awareness within industries of the significance of energy management and rise in its adoption, regardless of ENOVA's assistance.

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6.2.2.5 Sweden

PROGRAMME FOR ENERGY EFFICIENCY IN ENERGY INTENSIVE INDUSTRY

Duration: 2004–2012. The last industries joined in 2012 but continued their contracts until 2017.

Description: The Swedish PFE programme was a voluntary initiative targeting energy-intensive manufacturing industries to enhance electricity efficiency in the production process. An industry is considered energy-intensive if either energy costs constitute at least 3% of the production value, or if the combined energy, CO_2, and sulphur taxes amount to at least 0.5% of the company's added value. The programme's inception was linked to the introduction of an energy tax on electricity consumption (0.5 €/megawatt-hour (MWh)), which took effect on July 1st, 2004. Participation in the programme was voluntary, with manufacturers committing to five-year contracts. In 2004, there was a tax increase on process-related electricity use from 0 to 0.005 SEK per kWh. By enrolling in the programme, manufacturing companies would receive a tax reduction equivalent to the new tax expenses.

The programme's duration (five years) was divided into two periods. During the first two years, the companies had to implement and certify a standardised energy management system (EMS), conduct energy mapping and analyses of energy consumption, establish energy efficiency protocols for projections, and plan changes and renovations of their plants and for the procurement of electricity-consuming equipment. At the end of the first period, the company would commit to submitting an evaluation of the initial two years to the Swedish Energy Agency, including proposals for energy efficiency improvements. If approved by the Swedish Energy Agency, the companies would implement these measures over the next three years. By the conclusion of the second period, the companies would submit a final report, and the Swedish Energy Agency would evaluate the outcomes. Subsequently, it became possible to initiate a second five-year period.

The incentive for participating in the programme was twofold: Firstly, the company was exempted from paying energy tax. Secondly, through measures to enhance energy efficiency, the overall cost of energy consumption was reduced.

In 2012, the EC advised that the tax reduction available for participating companies, a crucial aspect of the programme, contravened EU rules for state aid. Consequently, the programme was gradually phased out, with no new entrants accepted after 2012. However, participants already registered for the programme were permitted to continue as scheduled until 2017.

Energy saving impact: Energy saving of ca. 1450 GWh/year in the period 2004–2012 through electricity saving measures. The largest electricity savings occurred in the pulp and paper industry.

Other effects

- Increased knowledge of energy efficiency among the employees of the companies.
- Decreased environmental impacts.
- Experiences and results of the energy efficiency efforts can continue to be shared with other companies, that is, both with participants in the programme and with other companies.
- Companies that ceased participating in the programme retained practices and ISO 50001 certification to a very high extent, enabling them to continue systematically working on improving their energy use.

Cost-effectiveness: Total costs were ca. 1,000 MSEK (88 M€) in the period 2004–2009, leading to a cost-effectiveness of ca. 690,000 SEK/GWh per year (60,000 €/GWh per year). The main costs were companies' investments into electricity saving measures and administrative costs to comply with PFE regulations.

Level of spread: High. At the start of the programme, it was estimated that 1,150–1,300 companies were eligible to participate in PFE. Of these, 105 companies across more than 250 manufacturing sites completed a five-year programme cycle, which was more than expected.

Obstacles

- Lack of an overarching quantifiable performance target for the programme. Such a target would have laid the foundation for a quantitative evaluation of the socio-economic benefits of PFE. This has contributed to PFE being subject to various assessors' expectations and criticism regarding the programme's goals, means, and results.
- Less attractive for companies with electricity consumption <100 GWh/year.

Success factors

- Use of a standardised energy management system defined by the programme.
- The programme's overall objective of improving industrial electricity efficiency while safeguarding industrial competitiveness.

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ENERGY EFFICIENCY NETWORKS FOR SMALL AND MEDIUM-SIZED ENTERPRISES (SMEs)

Duration: 2015–2021

Description: The initiative targeted SMEs and was administered by regional energy agencies and county administrative boards, receiving support from the Swedish Energy Agency. Participating companies voluntarily paid a fee to enrol in a local network, collaborating with other enterprises to commit to energy-saving measures and share insights.

The overarching objectives aimed to nationally support SMEs across diverse industries, seeking to enhance their overall energy efficiency by 15% and reduce electricity consumption by 10%. Additionally, the project aspired to equip these companies with sufficient knowledge to sustain their focus on energy issues beyond the project's conclusion. Companies willingly shared their experiences on mutually relevant issues.

The networks aimed to serve as a platform for the exchange of knowledge and information regarding energy efficiency. It is important to note that the financing from the Energy Agency covered only this informational aspect and did not extend to the implementation of actual measures in various industries.

Each network included four stages:

1. Introduction: Formalisation of the network's direction and signing of agreements.
2. Energy assessment: Energy experts visit each company; conduct energy assessments or updates; and establish energy policies, goals, and action plans.
3. Networking: Definition of common needs, exchange of experiences, and work on energy efficiency measures. This phase may run alongside the assessment phase and include network meetings, training, result tracking, and assistance in seeking grants.
4. Evaluation: Utilisation of tools provided by the Swedish Energy Agency to monitor energy usage and assess the impact of implemented measures. Measures implemented might include replacing fluorescent tubes with LED lights, streamlining ventilation in the heavy production line, or digitising the company.

Examples of established networks:

- ENIG network, established in 2009, aimed for a 5% annual reduction in energy consumption for participating SMEs by 2015, focusing on manufacturing techniques. It later transitioned to commercialise the findings after the planned funding conclusion.
- EESI, founded in 2010, targeted a 20% reduction in specific energy use in sawmills by 2020 through mapping and modelling.
- Project GeniAl aimed to demonstrate a 25% reduction in energy use in the aluminium sector by 2020 compared to 2005, focusing on implementing energy-efficient measures.
- JoSEn research projects, funded by the Swedish Energy Agency from 2013 to 2017, aimed to promote energy efficiency in steel-producing companies in collaboration with Jernkontoret.

Energy saving impact: Energy saving not quantified. By the beginning of 2021, participating companies reported an average energy efficiency improvement of 14% and a 14.2% increase in electricity use efficiency. In Halland County, the participating companies managed to reduce energy use by one-fifth on average.

Other effects: Continuous cooperation, which persisted after the end of the programme, had an impact on overall energy efficiency developments in Swedish industry.

Cost-effectiveness: Not directly quantifiable. Costs of the programme are not quantified and, consequently, cost-effectiveness is not assessable. The plastic and rubber manufacturer, National Sweden, in Halmstad generated the largest savings in the county and has reduced its energy costs by almost one MSEK per year.

Level of spread: High. 288 companies in 34 networks have implemented 2,274 energy efficiency measures.

Obstacles

- Lack of time and staff resources to work continuously within the networks.
- Varying levels of engagement among participants, with some promptly initiating work while others hesitated due to uncertainties about the effectiveness of measures and challenges in prioritising energy efficiency efforts.

Success factors

- Advantages derived from conducting the energy audits. Companies started monitoring oil and electricity consumption, allowing them to pinpoint potential areas for savings based on the audits.
- Increased awareness of the excessive energy use among the companies through network participation. They acquired knowledge on operating production equipment more efficiently, thereby reducing energy loss during machine shutdowns, for example.
- Reduction of companies' costs and increased competitiveness.
- Improved network of contacts and increased understanding between companies, energy agencies, county administrative boards, and the Swedish Energy Agency.

REFERENCES[326], [327]

326. Odyssee-Mure, "Successful Measures." Accessed: Mar. 20, 2024. [Online]. Available: https://www.measures.odyssee-mure.eu/successful-efficiency-measures-tool.html#/
327. S. Paramonova and P. Thollander, "Energy-efficiency networks for SMEs: Learning from the Swedish experience," *Renewable and Sustainable Energy Reviews*, vol. 65, pp. 295–307, Nov. 2016, doi: 10.1016/j.rser.2016.06.088.

7. Innovative energy efficiency projects in the Nordics

This chapter presents a selection of outstanding projects emerging from the Nordic countries. These projects exemplify innovation, sustainability, and forward-thinking approaches across diverse fields, including energy efficiency, renewable energy, environmental conservation, and urban development. Through these case studies, we aim to highlight success stories that have emerged from the Nordic region to serve as inspirations for future projects and demonstrate the Nordic region's commitment to energy efficiency.

7.1 Exemplary building and urban projects

Figure 2. Powerhouse Kjørbo, Norway. Photo by Chris Aadland. Copyright: Powerhus.no

The Powerhouse Kjørbo project (Norway)

The Powerhouse Kjørbo project[328] was an initiative in which two 1979 office blocks located in Sandvika, Norway underwent a complete refurbishment.

The refurbishment work commenced on March 18th, 2013 and was successfully concluded on February 5th, 2014. The total renovated heated floor area amounted to 5,180 m^2. One of the primary objectives of the project was to create an energy-positive building by compensating for energy demands associated with material production, construction, operational energy consumption, and end-of-life treatment through on-site renewable energy production. Additionally, achieving BREEAM Outstanding certification, with an emphasis on ensuring a high-quality indoor environment, was a significant goal. Moreover, ensuring profitability served as a key objective for all stakeholders involved in the project.

Following the renovation, the buildings' energy demands were reduced by over 86%. The energy systems at Powerhouse Kjørbo utilise energy wells and a heat pump to ensure a steady energy supply and minimise the energy use for heating and cooling. Other measures applied to reduce the energy consumption include optimising ventilation, increasing building envelope insulation, and improving the lighting systems. Additionally, the buildings were equipped with one of Norway's largest photovoltaic panel installations at the time. The electric energy produced on-site is distributed within the buildings, to the neighbouring structures in the Kjørbo park, and to a nearby Uno-X hydrogen station. During the operational phase, there is an annual energy surplus of approximately 21 kWh/m^2 of heated usable area, excluding energy consumed by user equipment.

328. Powerhouse, "Powerhouse Kjørbo." Accessed: Mar. 20, 2024. [Online]. Available: https://www.powerhouse.no/en/prosjekter/powerhouse-kjorbo/

Figure 3. Blå Jungfrun residential development in Stockholm[329].

Blå Jungfrun (Sweden)

In Sweden, Blå Jungfrun[330] represents a pioneering residential project adhering to passive house standards, with a total of 97 rental apartments. The apartment complex is situated in the southeastern region of Stockholm, between Farsta and Hökarängen, approximately 10 kilometres south of the Stockholm city centre. The planning phase of the development started in October 2008 and construction was completed in 2010. The apartment buildings were built using prefabricated frame structures and concrete wall sections. The sections were cast and then enveloped with a plastic insulation-based facade on-site.

In the Blå Jungfrun project, buildings are strategically oriented southward, with most windows facing in this direction to optimise passive solar heating gains. The design incorporates visually appealing architectural features while maintaining functionality. Large south-facing balconies provide shade during summer, enhancing resident comfort and contributing to cooling energy use savings. Despite the initial construction costs, the balconies are expected to yield long-term savings. Careful consideration was given to window placement to maximise solar energy gains, thereby reducing reliance on external heating sources and improving overall energy efficiency.

The residents' awareness of energy efficiency is fostered through the installation of Smart Boxes in each apartment unit providing feedback on energy consumption to tenants. The tenants benefit from reduced rents; however, they are responsible for covering the costs of warm water and any additional heating they consume, which are billed separately from the rent. Following the initial year of occupancy by tenants in the Blå Jungfrun apartments, Svenska Bostäder assessed the energy

329. M. Khatibi, "Passive house-concept apartments: sustainability evaluation in a case study of Stockholm, Sweden," *IOP Conf. Ser.: Earth Environ. Sci.*, vol. 323, no. 1, p. 012032, Aug. 2019, doi: 10.1088/1755-1315/323/1/012032.
330. M. Khatibi, "Passive house-concept apartments: sustainability evaluation in a case study of Stockholm, Sweden," *IOP Conf. Ser.: Earth Environ. Sci.*, vol. 323, no. 1, p. 012032, Aug. 2019, doi: 10.1088/1755-1315/323/1/012032.

consumption of the apartment project. The findings revealed a remarkable reduction in heating energy usage, estimated to be approximately 85% lower than the standards outlined in the Swedish building legislation of 2009.

Figure 4. Drangar renovation project in Iceland. Copyright: Gallery of Drangar Renovation / Studio Granda – 2 (archdaily.com)

Drangar project (Iceland)

The Drangar project in Iceland[331] is conspicuous as a model of energy efficiency and sustainability. Located on the northern coast of the Snæfellsnes peninsula, Drangar was previously a functioning farm with buildings dating back to the early 1980s. Afterwards, the older buildings were converted into tourist accommodation, and some of the original charm of the old farm buildings diminished, prompting the initiation of the Drangar project to restore the charm of the buildings while at the same time promoting the re-use of buildings and increasing energy efficiency. Currently, two buildings at the Drangar farm have undergone renovation and been converted from farm buildings into energy-efficient tourist accommodation: the tractor shed and the cowshed/barn.

The tractor shed was an uninsulated building with an earth floor and tin roof which has been transformed into four guest rooms. The original rough-cast concrete walls were retained in the renovation, and a new terrazzo floor was installed. In the renovation project, the shed was externally insulated and clad with corrugated copper.

The cowshed and barn, with weathered concrete, presented preservation challenges and underwent significant renovation to convert the building to a communal kitchen, eight guest rooms, and the owner's apartment.

Energy efficiency was a key focus of the project and was increased through insulation, fenestration, and the instalment of a heat pump system to supply area heating and domestic hot water heating. The heat pump system extracts heat from the surrounding fields using a closed-loop system.

331. ArchDaily, "Drangar Renovation / Studio Granda." Accessed: Mar. 20, 2024. [Online]. Available: https://www.archdaily.com/925031/drangar-renovation-studio-granda

During the renovation process, emphasis was placed on preserving and reusing original materials whenever possible to reduce the environmental impact of the project. For example, original concrete slats from the cowshed floor were repurposed as paving for terraces, while corrugated tin was reused as shuttering for new concrete walls.

The Defined Energy Company (Faroe Islands)

Defined Energy is a Faroese company that introduced an innovative method to recycle the heat from warm wastewater for the heating of domestic water[332] in 2014. They developed a heat exchanger in which hot wastewater is used to heat cold supply water, without the use of pumps, by utilising gravitation and centrifugal forces. By using their heat exchanger, up to 90% of the heat from the wastewater is recycled. The system is flexible, can be adapted to service buildings and residential buildings, and can be combined with all types of water-borne heating systems. The first heat exchanger system was installed at the swimming pool in Tórshavn on the Faroe Islands. By installing four heat exchangers at Torhavn swimming pool, the energy consumption for the heating of shower water was reduced by 58%, from 327 MWh to 139 MWh annually. Their heat exchangers were also installed in Tórshavn's Boðanesheimið, a 64-apartment retirement home. Here, water-to-air heat exchangers, powered by four 60 kW heat pumps, extract heat from the Gulf Stream, which is subsequently used for heating both rooms and water in the retirement home.

Defined Energy's wastewater heat recovery was recognised as a best practice example in the EU project SECURE (Smarter Energy Communities in Northern & Arctic Regions) and supported by the 'Northern Periphery' and 'Arctic Programme 2014–2020'[333].

332. K. Saramäki, "Best practices in SECURE partner regions," Karelia University of Applied Sciences Publications, 53, 2018. [Online]. Available: https://bestepi.files.wordpress.com/2018/06/secure_best_practices_2018_final.pdf
333. K. Saramäki, "Best practices in SECURE partner regions," Karelia University of Applied Sciences Publications, 53, 2018. [Online]. Available: https://bestepi.files.wordpress.com/2018/06/secure_best_practices_2018_final.pdf

7.2 Exemplary industry projects

Figure 5. The TINE dairy facility in Bergen Norway. Copyright: Tine.no.

Tine Dairy Factory in Bergen (Norway)

TINE SA is Norway's largest dairy product cooperative. Their dairy factory in Bergen (Norway) has emerged as one of the most energy efficient within the TINE network [334], while also prioritising environmental sustainability.

The dairy factory has committed strongly to improving the energy efficiency of production, lowering energy use from 0.24 kWh/liter (L) to 0.15 kWh/L since 2015.The energy savings are derived from the installation of a range of different technologies and upgrades. Hot water is heated through a sophisticated interplay of electric boilers, district heating, and high-temperature heat pumps. A heat recovery system has also been installed and is integrated with the heat pumps to facilitate efficient recovery of heat from refrigeration equipment and compressors to further improve the energy efficiency.

TINE actively engages in multiple research projects on industrial energy efficiency, funded by institutions such as the Research Council of Norway. The knowledge acquired from this project is disseminated throughout TINE's network of 31 dairy facilities, fostering a culture of continuous learning and improvement and reduced investment costs.

334. Enova, "New Tine dairy facility in Bergen." Accessed: Mar. 20, 2024. [Online]. Available: https://www.enova.no/om-enova/om-organisasjonen/teknologiportefoljen/nytt-tine-meieri-bergen/

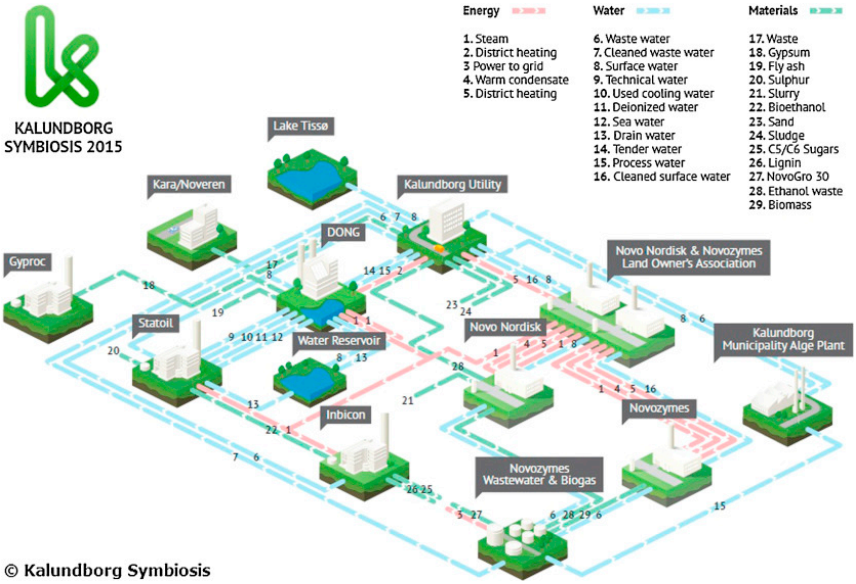

Figure 6. Kalundborg Eco-Industrial Park in Denmark.[335]

Kalundborg Eco-Industrial Park (Denmark)

The Kalundborg Eco-Industrial Park[336] in Denmark serves as a pioneering example of industrial symbiosis in which companies collaborate to use each other's by-products and share resources, resulting in significant energy efficiency gains and environmental benefits. The park, developed over a period of 20 years through private initiatives, showcases a model for private planning of eco-industrial parks.

At the core of the Kalundborg network is the Asnæs Power Station, a coal-fired plant that provides surplus heat to local homes and businesses. Other companies involved are Statoil (refinery), Novo Nordisk (insulin producer), Gyproc A/S (a construction company specialising in plasterboards), Novozymes (a major producer of industrial enzymes), Kalundborg municipality, and other regional players including farmers and small waste management companies. The resource exchanges occur as follows: 1) Excess steam from the Asnaes Power Plant is sold to Kalundborg's heat station, benefiting Statoil and Novo Nordisk; 2) Statoil exports treated wastewater back to Asnaes for cooling or as condensed steam; 3) Gyproc receives industrial plaster and excess gas from Asnaes and uses them for plasterboard production; and 4)Yeast by-products from Novo Nordisk's insulin production are sold as fertiliser to local farmers or converted into yeast slurry for animal feed mixes. Waste products from the power plant, such as sulphur dioxide scrubber residues, are repurposed, thus, reducing the need for open-pit mining and

335. S. Gulipac, "Industrial Symbiosis: Building on Kalundborg's waste management experience," *Renewable Energy Focus*, vol. 17, no. 1, pp. 25–27, Jan. 2016, doi: 10.1016/j.ref.2015.11.015.
336. Nordregio, "Industrial symbiosis in Kalundborg." Accessed: Mar. 20, 2024. [Online]. Available: https://nordregio.org/nordregio-magazine/issues/industrial-symbiosis/industrial-symbiosis-in-kalundborg/

landfilling. The Kalundborg cooperation results in substantial environmental benefits, including a reduction of up to 175,000 tons/year in CO_2 emissions, a reduction of 60,000 tons/year in water consumption, and a decrease of 45,000 tons/year in oil consumption. The park highlights the importance of trust and economic viability in industrial co-operation. Over the last 25 years, Kalundborg has demonstrated significant water savings, fuel reduction, and waste avoidance. Its success has spurred interest in industrial symbiosis globally, leading to the development of similar eco-industrial parks aimed at replicating its model. However, research suggests that the spontaneous development of symbiotic relationships, as seen in Kalundborg, tends to be more successful than forced or planned initiatives, emphasising the importance of spontaneous growth in such attempts.

Figure 7. Händelö Eco-Industrial Park in Sweden. Copyright: heip.se

Händelö Eco-Industrial Park (Sweden)

Another successful example of industrial symbiosis can be found in Sweden between Händelö Eco-Industrial Park and Norrköping Municipality. Händelö Eco-Industrial Park consists of several companies that share resources and waste streams to enhance resource efficiency and environmental sustainability. The park relies on renewable and recycled materials for 95% of its operations, with a combined heat and power plant using residual forest products and municipal waste to generate district heating and electricity. The waste energy generates electricity and district heating for Norrköping while supplying residual steam to the ethanol production plant. Furthermore, the industrial park permits the production of a bioethanol, with a saving of more than 95% in CO_2 emissions compared to production facilities that are based on fossil fuel energy. Linköping University is leading a project focused on bio-based and circular economy practices within the industrial plant[337].

This collaborative effort involves various stakeholders, including businesses, researchers, and public entities, working together to drive climate-friendly innovations. The partnership has led to significant advancements, such as Lantmännen's biorefinery, which converts raw materials into ethanol, feed, and other valuable products, thus, reducing reliance on imports and fossil fuels. Additionally, ongoing investments in research and development underscore the commitment to continuous improvement and innovation within the industrial park.

The success of Händelö Eco-Industrial Park serves as a model for similar initiatives worldwide, demonstrating the potential for industrial symbiosis to address environmental challenges and foster sustainable economic growth.

337. HEIP, "Händelö Eco-Industrial Park." Accessed: Mar. 20, 2024. [Online]. Available: https://heip.se/projekt/utveckling-av-handelo-eco-industrial-park-for-ett-mer-resurs-och-energieffektivt-ostergotland/

Nordkalk (Finland)

Nordkalk is a Finnish producer of limestone-based products for industry, agriculture, and environmental care, with several plants located in Finland (and in other countries). Over recent years, Nordkalk has committed to improving energy efficiency through the implementation of heat recovery systems, supplying heat to district heating networks and increasing the use of renewable energy and innovative energy storage solutions. All the rotary kilns in their limestone factories are equipped with heat recovery setups. This means that waste heat generated during the production process is captured and used, rather than being released into the environment.

Nordkalk delivers a significant amount of surplus heat to district heating networks. In 2019 alone, they supplied 72,000 MWh of heat to district heating, which is equivalent to 7.2 million L of heating oil.

At the Vampula grinding plant, Nordkalk has successfully replaced a substantial portion of heating oil with locally produced biogas. Specifically, in 2019, 72% of heating oil was replaced with biogas. This transition to a renewable and locally sourced energy source further enhances the energy efficiency and sustainability of Nordkalk's operations.

Nordkalk is currently exploring innovative energy storage solutions using lime and nanocoated salt (NCS). This thermo-chemical energy storage system has the potential to revolutionise energy storage capabilities in the industry. The planned capacity of the full-scale energy storage facility will be 10,000 tonnes of NCS, equivalent to 4,000 MWh of thermal energy storage. By efficiently storing excess energy and releasing it when needed, Nordkalk can optimise its energy usage and minimise waste, ultimately enhancing overall energy efficiency[338].

338. Business Finland, "Smart Energy. Energy and Resource Efficiency in Finland." Accessed: Mar. 20, 2024. [Online]. Available: https://www.businessfinland.fi/49682b/globalassets/finnish-customers/02-build-your-network/bioeconomy--cleantech/alykas-energia/industrial-energy-efficiency-final_2021.pdf

8. Transferability of successful energy efficiency initiatives across the Nordics

In this chapter, we explore the ***successful initiatives within the building and industry sectors*** in each Nordic country, as detailed in Chapter 6, focusing on their potential for transferability and adaptability to other Nordic countries. The objective was to assess how easily these initiatives could be duplicated or implemented in different contexts or locations. High replicability potential indicates that the measures can be successfully adapted to various settings, with consideration of factors such as technology scalability, ease of implementation, and infrastructure compatibility.

Transferability refers to the potential for initiatives to be adopted and effectively implemented in diverse geographical, political, and economic contexts. Sharing successful models among Nordic countries and beyond can accelerate responses to energy and climate challenges. However, each country's unique characteristics influence the success of these initiatives, which must be adapted to local conditions with respect to infrastructure, regulations, cultural attitudes, and economic structures. This underscores the importance of tailoring best practices to local contexts rather than simply replicating them.

A ***workshop*** was held on May 27, 2024, gathering several experts from Nordic countries who shared their ideas and observations on the transferability and adaptability of energy efficiency and climate change mitigation initiatives among the Nordic countries. During the workshop, participants engaged in discussions, exchanged valuable insights, and identified strategies for effectively implementing and customising selected initiatives across borders.

Table 20 illustrates a summary of all the initiatives discussed during the workshop.

Table 20. Overview of all assessed initiatives.

No.	Initiative's title	Sector	Initiative's original country
1	Window energy labelling	Buildings	Denmark
2	Minimum requirement targets for energy saving for new and existing buildings	Buildings	Denmark
3	Property and Building Sector Energy Efficiency Agreement and HÖYLÄ IV	Buildings	Finland
4	Promotion of heat pumps	Buildings	Finland
5	Subsidy for heat pumps and geothermal district heating systems	Buildings	Iceland
6	Programme for passive houses and low-energy houses	Buildings	Norway
7	Programme for best available technology (BAT) in existing buildings	Buildings	Norway
8	Programme for buildings with very low energy use (LÅGAN)	Buildings	Sweden
9	Halve More campaign (Halvera Mera)	Buildings	Sweden
10	The energy saving scheme for energy companies	Industry	Denmark
11	Subsidy scheme for renewable energy use in production processes	Industry	Denmark
12	Energy Efficiency Agreement for Industries	Industry	Finland
13	Energy Audit Programme (EAP)	Industry	Finland
14	Incentives for industrial energy conversion projects through the Energy Fund	Industry	Iceland
15	Programme for climate and energy initiatives for industry	Industry	Norway
16	Support for the introduction of energy management	Industry	Norway
17	Programme for energy efficiency in energy-intensive industry (PFE)	Industry	Sweden
18	Energy efficiency networks for small and medium-sized enterprises (SMEs)	Industry	Sweden

8.1 Assessing transferability of successful initiatives

The workshop consisted of ***two group sessions***. In the first group session, workshop participants were divided into two main groups to discuss two sets of initiatives. One group focused on initiatives related to the building sector, while the other concentrated on those pertaining to the industry sector.

Participants were tasked with sorting the initiatives based on their potential cost-effectiveness and scalability (their possible transferability to other countries). While the focus was on scalability, cost-effectiveness was also included as an attribute to encourage participants to discuss the initiatives in a broader context and to increase their familiarity with the details of each initiative.

8.1.1 Building sector

The ***building-related initiatives identified as successful in different Nordic countries***, as outlined in Chapter 6, are further discussed below in terms of potential cost-effectiveness and transferability.

1. Denmark: Window energy labelling
This initiative was rated as possessing medium-high scalability and medium-high cost-effectiveness. It is a market-driven initiative that has elevated all new window products to the A-level rating, which represents the highest energy standard. However, it has also resulted in overheating problems in new buildings. The initiative might therefore be expanded to include shading systems.

2. Denmark: Minimum requirement targets for energy saving for new and existing buildings
This initiative was rated as possessing high scalability and medium-high cost-effectiveness. However, it was noted that cost-effectiveness is not necessarily the same for building owners as it is for society. Furthermore, while achieving a high insulation level is beneficial for energy conservation, it can inadvertently lead to overheating and increased cooling loads and material use. Notably, minimum requirements differ between new and existing buildings, which is advantageous but not common in all Nordic countries.

3. Finland: Property and Building Sector Energy Efficiency Agreement and HÖYLÄ IV
This initiative was rated as possessing medium-low scalability but medium-high cost-effectiveness. HÖYLÄ IV has been historically effective, especially in phasing out oil heating, but its future impact may be limited as oil heating declines. Energy efficiency agreements for the property and building sector focus on the rental market segment, which remains highly relevant for sustainability efforts, although

their widespread adoption faces challenges. They could complement other policies such as the EPBD in national implementations, which requires a robust public-private partnership and high trust levels for replication, which can be challenging, particularly when establishing similar initiatives from scratch.

4. Finland: Promotion of heat pumps
This initiative was rated as possessing medium-high scalability and medium-high cost-effectiveness. It was observed that the cost-efficiency of heat pumps depends on proper system design, installation, and maintenance. Furthermore, while individual homeowners may see variable cost-efficiency, a broader energy system perspective, including effects on flexibility and peak demand, generally shows reduced costs.

5. Iceland: Subsidy for heat pumps and geothermal district heating systems
This initiative was rated as possessing medium-low scalability and medium cost-effectiveness. It was noted that Iceland presents a special case where heat pumps are more expensive than district heating systems. Individual households might see varying levels of cost-efficiency, but from a broader energy system perspective given the unique geothermal resources available, the integration of these systems typically results in optimised overall costs and energy utilisation.

6. Norway: Programme for passive houses and low-energy houses
This initiative was rated as possessing medium scalability and medium-low cost-effectiveness. It was emphasised that there should be a focus on both the building envelope and HVAC systems in this kind of initiative. While the type of programme is beneficial, the topic is considered outdated for most countries, highlighting the need for more advanced and innovative approaches in the current global context.

7. Norway: Programme for BAT in existing buildings
This initiative was rated as possessing low scalability and low cost-effectiveness. It was noted that being the first mover in such initiatives can be expensive, but it is necessary for societal advancement. The importance of adopting cutting-edge technologies in existing buildings to drive long-term benefits was emphasised, despite the initial high costs.

8. Sweden: Programme for buildings with very low energy use (LÅGAN)
This initiative was rated as possessing high scalability and medium cost-effectiveness. The effects of the programme are well-documented, demonstrating its impact on reducing energy consumption in buildings. By promoting the construction of buildings with very low energy use, the programme provides a proven model for achieving significant energy savings across a wide range of applications.

9. Sweden: Halve More campaign (Halvera Mera)
This initiative was rated as possessing high scalability and medium cost-effectiveness. The effects of the programme are well-documented. It focused exclusively on apartments, with a goal of reducing energy use by 50%. Therefore, the scope was rather limited, but it could be extended to include more building categories.

Table 21 summarises the main findings from the discussion on building-related initiatives during the first group session of the workshop. It focuses on the potential transferability of each initiative to other Nordic countries and the factors to consider.

Table 21. Transferability assessment of building-related initiatives.

No.	Initiative	Transferability potential	What to consider?
1	Denmark: Window energy labelling	Medium-high	• Applicable in other Nordic countries with established market-driven frameworks. • Overheating issues may require additional measures such as shading systems in similar climates. • Potential challenges in harmonising labelling standards.
2	Denmark: Minimum requirement targets for energy saving for new and existing buildings	High	• Different requirements for new and existing buildings are beneficial for all countries. • High insulation requirements may need adaptations to prevent overheating. • Varied cost-effectiveness can influence policy adoption.
3	Finland: Property and Building Sector Energy Efficiency Agreement and HÖYLÄ IV	Medium-low	• Requires high levels of public-private partnership and trust, which might be difficult to establish from the beginning. • Relevant to rental markets, which vary significantly across countries. • May complement existing policies such as the EPBD implemented at national level.
4	Finland: Promotion of heat pumps	Medium-high	• Effective system design, installation, and maintenance are critical for success. • Cost-efficiency varies, but a broader energy perspective makes it generally beneficial. • Can be integrated with existing energy policies and incentives in all countries.
5	Iceland: Subsidy for heat pumps and geothermal district heating systems	Medium-low	• Iceland's unique geothermal resources make direct transfer challenging. • Other countries with geothermal potential could adapt similar models. • Cost-efficiency for households varies, but overall energy system benefits are significant.

6	Norway: Programme for passive houses and low-energy houses	Medium	• Focus on building envelope and HVAC systems is universally relevant. • Considered outdated in many countries; more advanced goals and approaches are needed. • Provides a foundation for evolving toward more innovative energy-efficient building standards.
7	Norway: Programme for BAT in existing buildings	Low	• High initial costs for adopting cutting-edge technologies may deter adoption. • Essential for long-term societal benefits and technological advancement. • Potentially beneficial for countries seeking to lead in energy efficiency innovation.
8	Sweden: Programme for buildings with very low energy use (LÅGAN)	High	• Proven model for achieving significant energy savings, adaptable to various climates. • Detailed documentation aids in replication. • Can serve as a benchmark for setting national energy efficiency standards.
9	Sweden: Halve More campaign (Halvera Mera)	High	• Focus on reducing energy use by 50% in apartments can be expanded to other building types. • Well-documented results facilitate adaptation. • Potential for significant impact if integrated into broader national energy policies.

8.1.2 Industry sector

The industry-related initiatives identified as successful in different Nordic countries, as outlined in Chapter 6, are further discussed in terms of potential cost-effectiveness and transferability in this sub-chapter.

10. Denmark: The energy saving scheme for energy companies
This initiative was rated as possessing high scalability and high cost-effectiveness. The scheme has been adopted by 18 EU countries outside the Nordics. It has proven to be particularly cost-effective in SMEs rather than large industries. In Finland, the scheme was considered expensive and labour-intensive, leading the country to choose an alternative approach. Norway also evaluated the scheme but decided against its adoption.

11. Denmark: Subsidy scheme for renewable energy use in production processes
This initiative, rated as possessing high scalability and medium-low cost-effectiveness, provides subsidies to promote the use of renewable energy in production processes alongside energy efficiency measures. Despite its medium-low cost-effectiveness, its high scalability suggests significant potential for widespread adoption across various industries. By incentivising the transition to renewable energy, the scheme supports Denmark's goals of environmental sustainability and energy efficiency.

12. Finland: Energy Efficiency Agreement for Industries
This initiative was rated as possessing high cost-effectiveness and medium-low scalability. It involves agreements aimed at enhancing energy efficiency in industries, boasting low transaction costs. Participants benefit from improved subsidy levels. While challenging to implement from scratch, it is comparatively easier in the Nordics.

13. Finland: Energy Audit Programme
This initiative was rated as possessing high scalability but medium-low cost-effectiveness. It currently primarily targets SMEs and municipalities, after the implementation of compulsory audits for large industries. The programme has always involved subsidies. However, there may be considerations regarding the distribution of costs between the public and private sectors.

14. Iceland: Incentives for industrial energy conversion projects through the Energy Fund
This initiative was rated as possessing medium-high scalability and medium-high cost-effectiveness. This programme aims to encourage industries to adopt more sustainable energy practices, thereby reducing reliance on fossil fuels. It aligns with the overarching goals of the Nordics to enhance energy efficiency and promote environmental sustainability within the industrial sector.

15. Norway: Programme for climate and energy initiatives for industry
This initiative was rated as possessing medium-high scalability and medium cost-effectiveness. The programme is characterised by a certain degree of flexibility, accommodating various deadlines and objectives tailored to industry needs. While comprehensive, it addresses both broad and specific challenges, often tailored to the Norwegian context, ensuring relevance and effectiveness in promoting sustainable practices within the industrial sector.

16. Norway: Support for the introduction of energy management
This initiative was rated as possessing high cost-effectiveness and medium-high scalability. This initiative plays a crucial role in promoting energy management practices, which prove highly cost-effective for larger companies, offering numerous benefits at relatively low costs. While energy management is currently a mandatory requirement for large industrial energy consumers under the EED, it can also be beneficial for SMEs.

17. Sweden: Programme for energy efficiency in energy intensive industry (PFE)
This initiative was rated as possessing medium cost-effectiveness and medium-high scalability. While the initiative facilitates high energy savings that may occur naturally, companies may incur significant costs. However, the programme's structure is highly transferable to other Nordic countries. Notably, the networking aspect of the programme was highly appreciated, suggesting its potential for easy transfer to similar initiatives in other regions.

18. Sweden: Energy efficiency networks for SMEs
This initiative was rated as possessing medium cost-effectiveness and high scalability. This programme aims to foster collaboration and knowledge-sharing among SMEs to enhance energy efficiency practices, offering a scalable solution that can be easily replicated across various industries and regions.

Table 22 summarises the main findings from the discussion on industry-related initiatives during the first group session of the workshop. It focuses on the potential transferability of each initiative to other Nordic countries and the factors to consider.

Table 22. Transferability assessment of industry-related initiatives.

No.	Initiative	Transferability potential	What to consider?
1	**Denmark:** The energy saving scheme for energy companies	High	• Highly replicable, given its adoption by 18 EU countries outside the Nordics. • Proven cost-effectiveness in SMEs. • Consideration of alternative approaches due to perceived expense and labour-intensity in some countries, such as Finland.
2	**Denmark:** Subsidy scheme for renewable energy use in production processes	High	• High scalability across various industries. • Aligns with Nordic goals of environmental sustainability and energy efficiency.
3	**Finland:** Energy Efficiency Agreement for Industries	Medium	• Low implementation costs by the government. • Improved subsidy levels for participants. • Possible challenges when implementing from scratch.
4	**Finland:** Energy Audit Programme (EAP)	Medium-High	• Subsidies involved, but with cost distribution between public and private sectors. • Alignment with local energy efficiency goals and economic conditions.
5	**Iceland:** Incentives for industrial energy conversion projects through the Energy Fund	Medium-High	• Alignment with the overarching goals of the Nordics. • Specific energy transition needs and challenges, which differ across the Nordic countries.
6	**Norway:** Programme for climate and energy initiatives for industry	Medium-High	• Flexibility to accommodate various industry needs. • Tailored approach addressing both broad and specific challenges.
7	**Norway:** Support for the introduction of energy management	High	• Mandatory requirement for large industrial energy consumers under the EED. • Potential benefits for SMEs.
8	**Sweden:** Programme for energy efficiency in energy-intensive industry (PFE)	Medium-High	• High scalability and transferability to other Nordic countries. • Networking aspect facilitates easy replication in similar initiatives in other regions.
9	**Sweden:** Energy efficiency networks for SMEs	High	• Fosters collaboration and knowledge-sharing among SMEs. • High scalability and potential for easy replication across various industries and regions.

8.2 Examples of initiatives' adaptability across the Nordic region

In the second group session of the workshop, participants were divided into groups representing their home countries. This session consisted of two tasks.

In the first task, each country group was asked to sort the initiatives from the other Nordic countries for both the building and industry sectors based on relevance (importance or need) to their own country on a scale (low to high).

In the second task, the country groups were asked to select two or more initiatives (at least one each for the building and industry sectors) among the most relevant initiatives selected in task 1 and investigate the potential for transferability by reflecting on crucial adaption challenges and specific technical measures needed for adaption in the local context.

8.2.1 Task 1: Sorting initiatives by relevance

Each country group sorted the initiatives from the other countries for both the building and industry sectors based on their relevance (importance or need) to their own country.

In **Denmark,** certain technologies such as heat pumps (Initiative 4 – Promotion of heat pumps) are already well-promoted. However, initiatives based on subsidies (Initiative 5 – Subsidy for heat pumps and geothermal district heating systems; Initiative 7 – Programme for BAT in existing buildings; Initiative 11 – Subsidy scheme for renewable energy use in production processes; and Initiative 14 – Incentives for industrial energy conversion projects through the Energy Fund) are considered ineffective and faces general reluctance.

Meanwhile, the **Faroe Islands** emphasised the importance of integrating specific initiatives into their national building codes (Initiative 6 – Programme for passive houses and low-energy houses and Initiative 7 – Programme for BAT in Existing Buildings). Additionally, certain initiatives, such as Initiative 4, have already been implemented in the Faroe Islands, and others, such as Initiative 5, necessitate prior heat supply planning. This region faces a unique challenge due to the presence of only one electricity utility and district heating company, rendering Initiative 10 (The energy saving scheme for energy companies) ineffective.

Finland recognised most of the initiatives as either already implemented or similarly developed. The country boasts a high level of energy efficiency but acknowledges the potential of specific initiatives, such as Initiative 9 (Halve More campaign), to further enhance its energy policies in the building renovation sector. Furthermore, Initiative 17 (Programme for energy efficiency in energy intensive industry) and

Initiative 18 (Energy efficiency networks for SMEs) were noted for their potential to strengthen networking, particularly among SMEs.

Iceland did not identify initiatives that rely on voluntary agreements, such as Initiative 12 (Energy Efficiency Agreement for Industries), as particularly effective, preferring mandatory regulations. Currently, Initiative 1 (Window energy labelling) and Initiative 11 (Subsidy scheme for renewable energy use in production processes) are actively implemented, whereas Initiative 3 (Property and Building Sector Energy Efficiency Agreement and HÖYLÄ IV) is less favoured in Iceland due to low energy prices and specific natural conditions.

Norway recognised the importance of initiatives such as Initiative 1 (Window energy labelling) and Initiative 2 (Minimum requirement targets for energy saving in new and existing buildings) for their alternative requirements for existing buildings and windows. However, Initiative 3 (Property and Building Sector Energy Efficiency Agreement and HÖYLÄ IV) and Initiative 5 (Subsidy for heat pumps and geothermal district heating systems) were not regarded as relevant due to Norwegian bans on oil-heated properties and the lack of geothermal heating in the country. Initiative 9 (Halve More campaign) was considered outdated and uninteresting. Initiative 10 (The energy saving scheme for energy companies) and Initiative 12 (Energy Efficiency Agreement for Industries) were regarded as relevant since Norway lacks industry-level energy efficiency targets. Due to Norway's focus on electrification and biofuels, Initiative 11 (Subsidy scheme for renewable energy use in production processes) and Initiative 14 (Energy fund for industrial energy conversion) were noted as less relevant. Norway regarded Initiative 13 (Energy Audit Programme) as interesting, as it could extend the need for energy audits to smaller companies that are not covered by the EED commitment.

Sweden, meanwhile, balances established programmes with the need for innovation. While Initiative 6 (Programme for passive houses and low-energy houses) may overlap with existing Swedish programmes, it remains vital for piloting new technologies. Non-technological approaches to building energy efficiency (Initiative 9 – Halve More campaign) are prioritised to maintain neutrality in technological choices. The relevance of Initiative 11 (Subsidy scheme for renewable energy use in production processes) was questioned due to extensive renewable energy use in Swedish industries. Initiative 13 (Energy Audit Programme) presents opportunities for enhanced monitoring and evaluation practices, whereas Initiative 15 (Programme for climate and energy initiatives for industry) has similarly already been implemented in Sweden.

In summation, the primary motivations shared by all the countries for scoring initiatives with the lowest relevance to their own countries are as follows:

- **Effectiveness**: Some initiatives are perceived as ineffective or irrelevant due to existing advancements, in which similar outcomes have already been achieved through current technologies, policies, or practices. For instance, Denmark questions the impact of initiatives relying on subsidies, reflecting its doubts about their effectiveness. Similarly, Norway's emphasis on electrification and biofuels diminishes the relevance of initiatives targeting fossil fuel switching. Additionally, several initiatives are already well-established across various countries.
- **Regulatory and market fit**: The alignment of initiatives with national building codes and regulatory frameworks is crucial. For instance, the Faroe Islands prioritise integrating initiatives into their building codes, highlighting the importance of regulatory compliance for effective implementation, while Norway cites regulatory bans on oil-heated properties as a factor that impacts the relevance of some initiatives.
- **Technological and infrastructure constraints**: Countries may lack the necessary technological infrastructure or face unique challenges for the implementation of certain initiatives. For instance, Norway notes that the national scarcity of geothermal district heating affects the feasibility of some initiatives.
- **National policy alignment**: Initiatives may not align with national policy priorities or may address outdated topics. For example, Iceland favours mandatory regulations over voluntary agreements, while Norway believes that Initiative 9 addresses an outdated topic.
- **Industry-specific issues**: Specific industries within countries may not find certain initiatives applicable or beneficial. For instance, Sweden questions the relevance of Initiative 11, as its industries already make extensive use of renewable energy.
- **Implementation and monitoring challenges**: Concerns about implementation feasibility and monitoring effectiveness also play a role. For instance, Norway considers Initiative 13 intriguing as it contributes to extending energy audits; at the same time, it notes challenges in its implementation for smaller companies.

8.2.2 Task 2: Relevant initiatives for each Nordic country

8.2.2.1 Relevant initiatives for Denmark

Two key initiatives were chosen for the building sector

Initiative 8 – Sweden's LÅGAN programme
Needed adaptations: The Danish adaptation of the LÅGAN programme requires a sharper definition of the activities it promotes. Specifically, it is crucial to focus on well-defined, impactful activities and remove smaller projects to ensure that the programme delivers additional benefits rather than duplicating existing efforts.

Challenges: One of the main challenges is the current national shifting focus towards industrial projects rather than residential buildings. This trend favours larger, more significant projects, which can be more complex to implement. Such a shift is not unique to Denmark; it is also observed in other countries such as France, Ireland, and Italy.

Additional comments: The LÅGAN programme in Sweden bears similarities to Initiative 10 – Denmark's energy-saving scheme for energy companies, which has been successfully replicated in more than 13 European countries. This suggests that a well-defined, impactful programme can have significant positive effects and can serve as a model for other countries.

Initiative 4 – Finland's Promotion of heat pumps
Challenges: The primary challenge in promoting heat pumps, particularly air-to-water heat pumps, is their high cost. This cost barrier can limit widespread adoption, making it essential to find ways to make these technologies more affordable or provide sufficient financial incentives.

Additional comments: In Denmark, heat pumps are already recognised and promoted through legislative measures. However, this Finnish initiative offers valuable insights, especially in terms of effective promotional strategies and incentives that can be adopted to enhance the existing Danish efforts. Learnings from Finland's approach can help address some of the financial and practical challenges faced in Denmark.

Two key initiatives were chosen for the industry sector

Initiative 18 – Sweden's energy efficiency networks for SMEs
Needed adaptations: To effectively implement this initiative in Denmark, a secretariat will need to be established to manage the network, or alternatively, regional funding will be required to support its operations.

Challenges: Encouraging participation among SMEs can be challenging due to limited resources within the target group. Additionally, ensuring a favourable cost-benefit ratio is crucial to justify the investments required for the related efficiency measures.

Initiative 13 – Finland's Energy Audit Programme
Needed adaptations: The Danish version of this programme should have a primary focus on SMEs. This involves customising the programme's structure and content further to better suit the scale, resources, and operational realities of SMEs in Denmark.

Technical measures: Implementing an automated system to collect data from the audits would enhance efficiency and accuracy, making the process more manageable and informative.

Additional comments: While energy audits are primarily aimed at larger companies under the EED, adapting them for SMEs can provide substantial benefits by addressing the specific needs and constraints of smaller enterprises.

8.2.2.2 Relevant initiatives for the Faroe Islands

Two key initiatives were chosen for the industry sector

Initiative 18 – Sweden's energy efficiency networks for SMEs
Needed adaptations: To effectively implement this initiative in Denmark, a secretariat will need to be established to manage the network, or alternatively, regional funding will be required to support its operations.

Challenges: Encouraging participation among SMEs can be challenging due to limited resources within the target group. Additionally, ensuring a favourable cost-benefit ratio is crucial to justify the investments required for the related efficiency measures.

Initiative 13 – Finland's Energy Audit Programme
Needed adaptations: The Danish version of this programme should have a primary focus on SMEs. This involves customising the programme's structure and content further to better suit the scale, resources, and operational realities of SMEs in Denmark.

Technical measures: Implementing an automated system to collect data from the audits would enhance efficiency and accuracy, making the process more manageable and informative.

Additional comments: While energy audits are primarily aimed at larger companies under the EED, adapting them for SMEs can provide substantial benefits by addressing the specific needs and constraints of smaller enterprises.

8.2.2.3 Relevant Initiatives for Finland

Two key initiatives were chosen for the building sector

Initiative 7 – Norway's Programme for BAT in existing buildings
Needed adaptations: Both technical measures and improvements to design and installation guidelines need to be adapted to better implement modern heating, ventilation, and air conditioning systems, such as smart controls and heat pumps.

Challenges: Currently, it is politically impossible to introduce any new subsidies, limiting the financial support available for implementing these measures.

Technical measures: Measures that can be considered in this initiative include heat pumps, renewable energy sources, smart control and system integration, operation, and maintenance.

Additional comments: This initiative is strongly connected to behavioural matters, such as demand response, where energy consumption is adjusted based on supply conditions. Effective implementation requires educating occupants and operators about these systems and their benefits. Furthermore, Finland already boasts a good level of energy efficiency; thus, a programme focusing on the best available technology would be instrumental in advancing energy efficiency even further.

Initiative 8 – Sweden's LÅGAN programme
Needed adaptations: The current energy efficiency goals sets a strict standard for energy efficiency measures. Sweden's programme content needs to be adapted to the current situation, including the integration of net-zero energy buildings.

Challenges: Busy schedules and individual requirements of each operator can make it challenging to find time for collaborative system-level development.

Additional comments: Education, development, communication, and collaboration remain paramount and highly valued in Finland. Developing skills and know-how is crucial, especially when aiming to achieve higher energy efficiency levels.

Two key initiatives were chosen for the industry sector

Initiative 18 – Sweden's energy efficiency networks for SMEs
Needed adaptations: Strengthening networking within voluntary agreements, especially among SMEs, is essential. It requires fostering trust among participants and in the facilitator to provide opportunities for collaboration and information-sharing.

Challenges: Ensuring openness among competitors can be challenging within these networks. Additionally, utilising waste heat effectively often requires finding external demand for it, which can be logistically challenging.

Technical measures: Various cooling technologies, compressed air or steam systems, and heat recovery solutions, basically any industrial processes, could be considered in this initiative.

Additional comments: Trust is vital for fostering successful collaboration within these networks. Finland has already implemented multiple voluntary energy efficiency agreements, some of which involve smaller companies. Strengthening networking within these agreements, particularly among SMEs, could yield significant benefits.

Initiative 17 – Sweden's programme for energy efficiency in energy intensive industry (PFE)
Needed adaptations: Finland's voluntary energy efficiency agreements can be investigated further to determine if insights from the PFE can be integrated into the next generation of agreements.

Challenges: Each new generation of energy efficiency agreements must address the latest EU regulation updates and requirements. Ensuring compliance with EU directives while minimising the administrative burden of documentation and reporting is crucial. However, combining previously implemented schemes with new initiatives can be challenging.

Additional comments: Finland has provided training and technical support to participants in energy efficiency agreements, aiding in monitoring and reporting energy use and conducting savings calculations. Moreover, subsidies have been incorporated, instead of tax rebates, in voluntary agreements, further incentivising participation and cooperation.

8.2.2.4 Relevant initiatives for Iceland

One key initiative was chosen for the building sector

Initiative 6 – Norway's programme for passive houses and low-energy houses
Needed adaptations: The ambitions of this initiative need to be adjusted to fit Iceland's unique energy landscape, particularly the low energy prices and extensive use of geothermal energy in the country. Adaptation should ensure that energy efficiency measures are both economically viable and environmentally beneficial.

Challenges: The primary challenge lies in the current knowledge gap in the industry regarding energy efficiency. However, this gap is closing rapidly as awareness and expertise grow.

Technical measures: Measures that can be included in this initiative are insulated and airtight building envelopes, heat pumps, geothermal heating systems, energy monitoring systems, mechanical ventilation with heat recovery, and smart control for heating and cooling.

Two key initiatives were chosen for the industry sector

Initiative 17 – Sweden's programme for energy efficiency in energy intensive industry (PFE)
Needed adaptations: The energy contracts managed by the National Power Company of Iceland, Landsvirkjun, may need revision to ensure the effectiveness of this initiative in Iceland. These revisions can include introducing incentives for increased energy efficiency, even in a landscape dominated by renewable energy sources.

Challenges: Significant challenges include low energy prices and rigid energy contracts, which diminish the industry's incentive to save energy. This diminished motivation can primarily be attributed to the fact that the energy in question is renewable, which leads to the perception of a lower need for efficiency improvements.

Technical measures: Measures that can be considered in this initiative are waste heat recovery for industrial processes, process optimisation, equipment upgrades and retrofits, and combined heat and power for electricity.

Initiative 18 – Sweden's energy efficiency networks for SMEs
Needed adaptations: It may be necessary to establish regional coordinators to facilitate the creation and management of energy efficiency networks in order to implement this initiative in Iceland. This can involve providing training and resources to ensure the effective participation of SMEs.

Challenges: One of the key challenges is the geographic dispersion and varying sizes of SMEs across Iceland, which might necessitate tailored approaches to effectively

bring these enterprises into energy efficiency networks. Additionally, there may be a need for initial funding or subsidies to encourage participation.

Additional comments: This initiative is particularly relevant for Iceland, where collaboration and knowledge sharing are vital due to its small market size and limited resources. By creating networks for SMEs, Iceland can enhance its overall energy efficiency through shared expertise and coordinated efforts.

8.2.2.5 Relevant initiatives for Norway

Two key initiatives were chosen for the building sector

Initiative 2 – Denmark's window energy labelling
Needed adaptations: This initiative assesses solar gains and U-value, and the standards of assessment must be adjusted for Norwegian conditions, such as outdoor temperatures and solar conditions. The revision should also include setting minimum requirements for sales.

Challenges: Managing solar gains in new, well-insulated buildings to prevent increased cooling needs is crucial. Ensuring compliance through audits and control, updating requirements, and refining the calculation method to reflect expected energy losses are some key challenges.

Additional comments: Similar to energy labels for appliances, the window energy label could incorporate additional parameters like shading and control for customer information. Deciding whether labels should be calculated by the manufacturer, or a third party is also essential.

Initiative 3 – Finland's Property and Building Sector Energy Efficiency Agreement (excluding Höylä IV)
Needed adaptations: National targets for energy savings in the commercial sector and rental housing market must be established. Focusing on renewables is less relevant for Norway; instead, emphasis should be placed on energy efficiency, management of peak loads, and energy prices.

Challenges: Ensuring compliance through audits and controls, as well as attracting participation from property owners in a voluntary programme, can be challenging. Cost considerations also pose significant challenges.

Additional comments: Only this initiative was considered for potential transferability to Norway. Höylä IV was excluded due to the national ban on oil-heated properties since 2020. Few initiatives currently target rental properties in Norway. In addition, subsidies through the national electricity price support scheme (Strømstøtteordning) can be explored.

Two key initiatives were chosen for the industry sector

Initiative 12 – Finland's Energy Efficiency Agreement for Industries
Needed adaptations: Implementation of national-level energy efficiency targets specific to the industrial sector is crucial.

Challenges: Establishing clear guidelines to define and calculate energy efficiency metrics within the industry is critical. In this regard, NVE was commissioned in 2023 to define energy efficiency key performance indicators (KPIs) across all industry sectors.

Technical measures: Comprehensive oversight of energy use and process data is necessary. Infrastructure expansion may be required to enable the effective external utilisation of surplus heat, such as through district heating networks.

Additional comments: Standardised guidelines for defining energy efficiency KPIs across various sectors are essential to facilitate comparisons of measures across industries.

Initiative 18 – Sweden's energy efficiency networks for SMEs
Needed adaptations: The concept is robust, with no significant adaptations required for the Norwegian context.

Challenges: A primary barrier is the reluctance of enterprises to share sensitive process data and information outside their respective industries.

Technical measures: Additional infrastructure may be needed to support efficient resource exchange among participating enterprises.

Additional comments: Implementation involves creating relevant networks at different organisational levels, whether at a regional or industry-specific level. Shared infrastructures and joint investments are essential to fostering collaborative energy efficiency initiatives. Key goals of this initiative include the following:

1. Facilitating the exchange of critical information, such as residues and waste heat available from one company that could benefit another
2. Sharing experiences and best practices on successful energy efficiency measures implemented by participating enterprises

8.2.2.6 Relevant initiatives for Sweden

Two key initiatives were chosen for the building sector

Initiative 1 – Denmark's Minimum Requirement Targets for Energy Saving in New and Existing buildings
Needed adaptations: Minimum energy performance standards for existing buildings are currently not established in Sweden, necessitating significant efforts to introduce these requirements.

Challenges: Implementation challenges include the absence of such requirements in Sweden's current regulatory landscape and the need for developing these requirements from scratch.

Technical measures: The initiative is technology-neutral, focusing solely on energy targets or performance metrics.

Additional comments: It is assumed the programme will align with the updated EPBD requirements, rather than the specific levels set in the Danish initiative.

Initiative 3 – Finland's Property and Building Sector Energy Efficiency Agreement and HÖYLÄ IV
Needed adaptations: No specific adaptations were identified.

Challenges: Collaboration is necessary to co-create solutions with a diverse and influential stakeholder group.

Additional comments: This initiative holds significant potential across social, economic, environmental, and organisational dimensions, despite targeting a relatively minor market sector. It is particularly relevant due to current market inefficiencies in the building sector.

One key initiative was chosen for the industry sector

Initiative 16 – Norway's Support for the introduction of energy management
Needed adaptations: As this programme closely aligns with Sweden's Energy Step Programme, no specific adjustments are required.

Challenges: Budget priorities and political changes may pose challenges to maintaining alignment with national and international targets.

Technical measures: In line with Sweden's objective of being technology-neutral, the initiative should primarily focus on energy targets or performance criteria.

Additional comments: This initiative mirrors aspects of Sweden's Energy Step Programme, providing familiarity and potential synergies in energy management practices.

9. Understanding barriers to energy efficiency and households' energy behaviour in the Nordics

This chapter describes two key tasks:

1. A questionnaire was designed to investigate barriers to implementing energy efficiency measures, focusing on three areas: awareness of national and EU regulations, strategies for driving energy efficiency, and the effectiveness of government incentives. It included both open-ended and multiple-choice questions, targeting 22 responses from consumers, businesses, and industry professionals in the building and industry sectors of the Nordic region.
2. A web-panel survey was conducted to analyse household energy behaviour before, during, and after the 2021–2023 energy crisis, targeting 3,349 respondents across six Nordic countries. The survey included mainly multiple-choice questions, covering socio-demographic details, energy use attitudes, behaviour changes during the energy crisis, energy efficiency measures, and future preferences. The final section of this survey used the stated preference method to assess preferences for future energy efficiency investments and factors influencing respondents' decisions.

9.1 Barriers to energy efficiency

9.1.1 Background

Despite the technological advancements and policy incentives aimed at promoting energy efficiency, there remains a significant gap between the potential for energy savings and its actual achievement. This discrepancy is often attributed to not just economic or technical challenges but also a range of psychological and behavioural barriers that impede the adoption of energy efficiency measures by consumers, businesses, and industry professionals. Understanding these barriers is crucial for developing effective strategies to encourage the uptake of energy efficiency

solutions. Consumers, the end-users of energy in buildings, often face hurdles such as a lack of awareness[339], resistance to change or understanding of the benefits of energy efficiency, lack of interest and psychological distance to the impacts of their energy use[340], and the upfront costs associated with making energy-efficient improvements. These challenges are compounded by behavioural biases such as inertia and the status quo bias[341], which lead to a preference for maintaining existing habits over adopting new, more energy-efficient practices.

Similarly, businesses and industry actors encounter their own set of barriers ranging from organisational inertia, which resists changes in established procedures to the split incentive problem, where the benefits of energy efficiency investments are not fully accrued by the investing party. Additionally, market actors such as industry professionals and practitioners often face a lack of information or misaligned incentives[342] that discourage the promotion and implementation of energy-efficient technologies and practices.

The interplay of these psychological and behavioural barriers presents a complex challenge for the widespread adoption of energy efficiency measures in the Nordic building and industry sectors. This chapter aims to delve deeper into these barriers, drawing on insights from a survey designed to understand the underlying reasons for resistance to energy efficiency.

9.1.2 Questionnaire framing

The goal of the questionnaire was to gain insights about ***three categories*** that not only constitute barriers but can also help address those barriers towards a more widespread implementation of energy efficiency measures.

1. ***Awareness and familiarity across practitioners*:** This category focuses on understanding how industry professionals and practitioners are influenced by national and EU regulations promoting energy efficiency in their sectors.
2. ***Addressing change*:** This category examines how the efforts of the building and industry sectors can be directed towards greater energy efficiency through effective strategies.
3. ***Incentive schemes*:** This category examines how government incentive programmes can be improved to be more effective in encouraging energy efficiency adoption among consumers and industries.

339. E. Hirst and M. Brown, "Closing the efficiency gap: barriers to the efficient use of energy," *Resources, Conservation and Recycling*, vol. 3, no. 4, pp. 267–281, Jun. 1990, doi: 10.1016/0921-3449(90)90023-W.
340. A. Trianni, E. Cagno, E. Worrell, and G. Pugliese, "Empirical investigation of energy efficiency barriers in Italian manufacturing SMEs," *Energy*, vol. 49, pp. 444–458, Jan. 2013, doi: 10.1016/j.energy.2012.10.012.
341. N. Hanus, G. Wong-Parodi, M. J. Small, and I. Grossmann, "The role of psychology and social influences in energy efficiency adoption," *Energy Efficiency*, vol. 11, no. 2, pp. 371–391, Feb. 2018, doi: 10.1007/s12053-017-9568-6
342. N. Hanus, G. Wong-Parodi, M. J. Small, and I. Grossmann, "The role of psychology and social influences in energy efficiency adoption," *Energy Efficiency*, vol. 11, no. 2, pp. 371–391, Feb. 2018, doi: 10.1007/s12053-017-9568-6

Within each of the three categories, there is one main question to be answered, as illustrated in Figure 8. Then, several questions are included in each category to provide a more founded background for answering the three main questions. The categories and questions are designed based on findings from the literature, such as Bagaini et el.[343], examining barriers to energy efficiency implementation in buildings in several European countries, or the report by the United Nations Economic Commission for Europe focusing on overcoming barriers to investing in energy efficiency[344]. The category "*Awareness and familiarity across practitioners*" consists of six questions, whereas the categories "*Addressing change*" and "*Incentive schemes*" have seven and 15 questions respectively. Both **open-ended and multiple-choice questions were included** to gather comprehensive insights without conducting direct interviews.

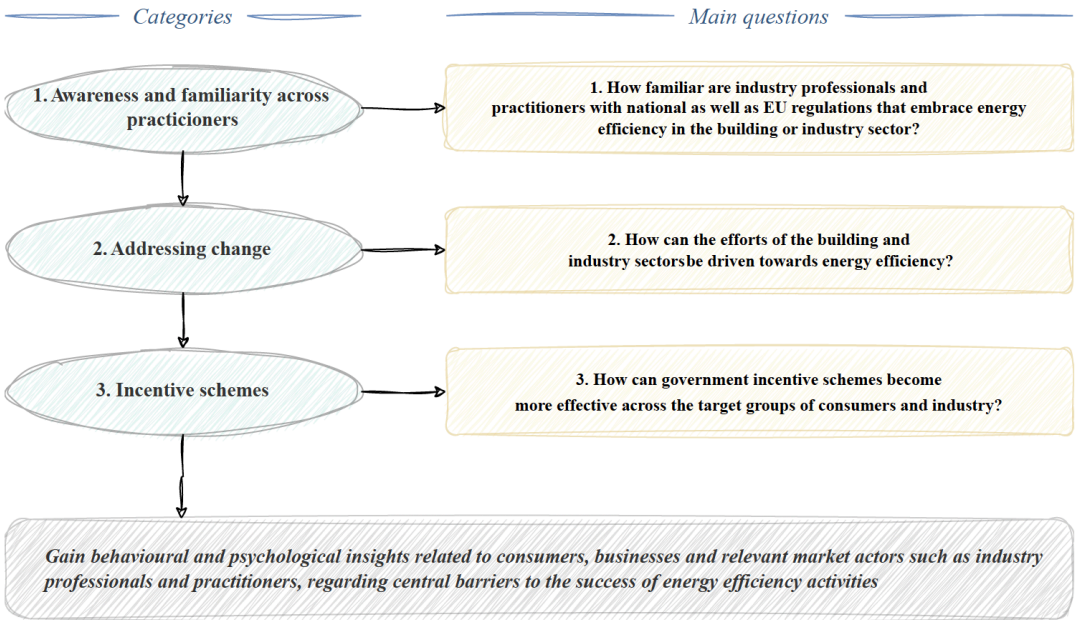

Figure 8. Questionnaire framing to investigate barriers towards the implementation of energy efficiency measures.

343. A. Bagaini, F. Colelli, E. Croci, and T. Molteni, "Assessing the relevance of barriers to energy efficiency implementation in the building and transport sectors in eight European countries," *The Electricity Journal*, vol. 33, no. 8, p. 106820, Oct. 2020, doi: 10.1016/j.tej.2020.106820.
344. United Nations, Ed., *Best policy practices for promoting energy efficiency: a structured framework of best practices in policies to promote energy efficiency for climate change mitigation and sustainable development*. in UNECE Energy Series, no. 53. New York and Geneva: United Nations, 2017. [Online]. Available: https://unece.org/DAM/energy/se/pdfs/geee/pub/Promoting_EE_ECE_ENERGY_100_Rev.1_pdf_web.pdf#:~:text=impact%20policies%20and%20measures,%20which%20will%20help%20policy%20makers%20in

The ***target audience*** of the questionnaire was consumers, businesses, and relevant market actors such as industry professionals and practitioners from the building and industry sectors in the Nordic countries.

The questionnaire was administrated from February 21 to April 30, 2024. It was prepared as a Google Form in English and distributed via email to several relevant experts working in the Nordic countries, with the aim to receive at least two responses per country, ideally one respondent from the building sector and one from the industry sector. The complete questionnaire is provided in the Appendix 3.

9.1.3 Summary and discussion of findings

The total number of valid responses was 22. Approximately 10% of the respondents were female. Responses were received from each of the Nordic countries – three answers from Denmark; four each from Norway, Iceland and Sweden; five from Finland; and two answers from the Faroe Islands. For each country, except for Faroe Islands, at least one of the respondents is from the building or industry sector. Most of the experts (45%) represent national federations and research working within both or one of the two sectors, followed by 33% from the industry sector and 24% from the building sector.

Key findings from the questionnaire are presented below for each category. For a detailed analysis of the responses, including a question-by-question overview, the reader can refer to Appendix 3.

9.1.3.1 Awareness and familiarity across practitioners

Based on the first part of the questionnaire, it can be concluded that respondents show moderate to high familiarity with both national and EU regulations, such as the EED and EPBD. However, regional differences exist, with respondents from Iceland and the Faroe Islands reporting lower familiarity due to their non-EU status. Professionals engage with these regulations through official notifications, industry associations, and direct interaction with regulatory bodies, supplemented by participation in conferences, webinars, and courses.

The responses highlight government incentives that support energy efficiency awareness, although there is a need for more accessible, user-friendly resources and stronger government-industry collaboration. Successful strategies, such as energy efficiency agreements and public awareness campaigns, demonstrate the effectiveness of these regulations. While industry professionals are generally well-informed, continued efforts are needed to improve access to information and foster greater collaboration between the government and industry. This will ensure the effective implementation of energy efficiency measures.

Figure 9, Figure 10, and Figure 11 illustrate some of the key findings from this questionnaire category.

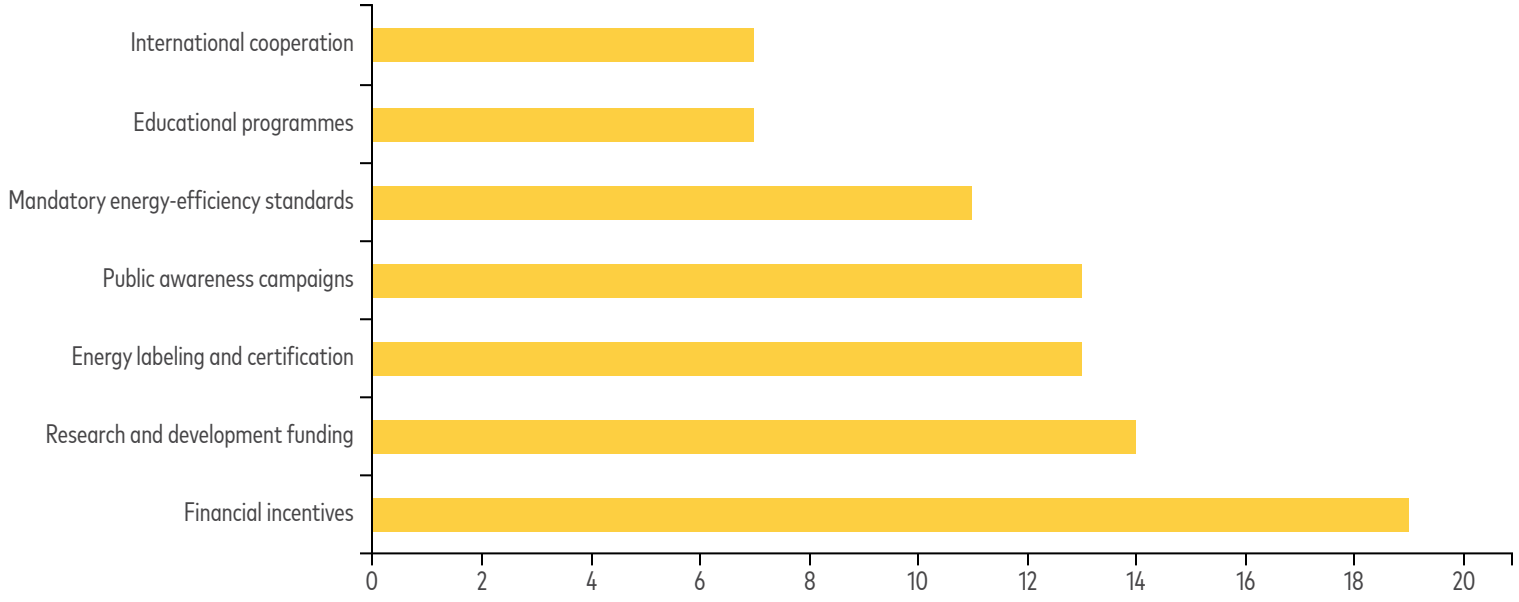

Figure 9. Actions to promote energy efficiency awareness.

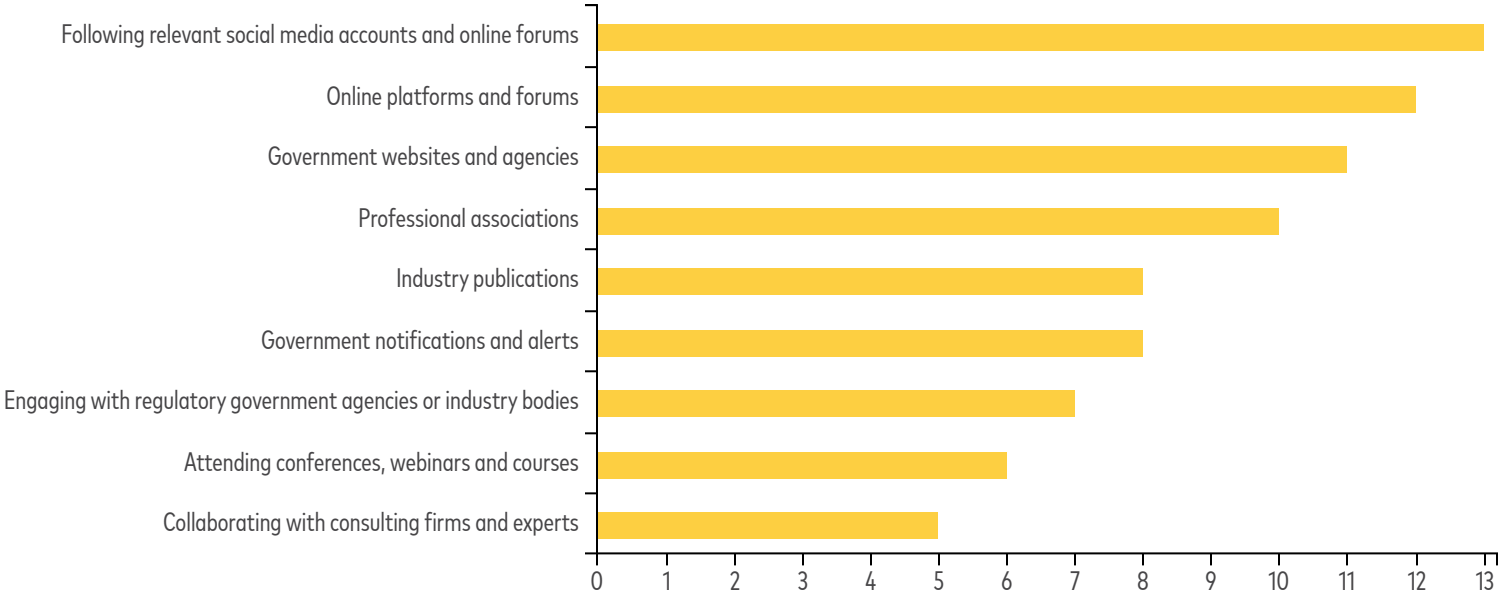

Figure 10. Common methods to stay updated on energy efficiency regulations.

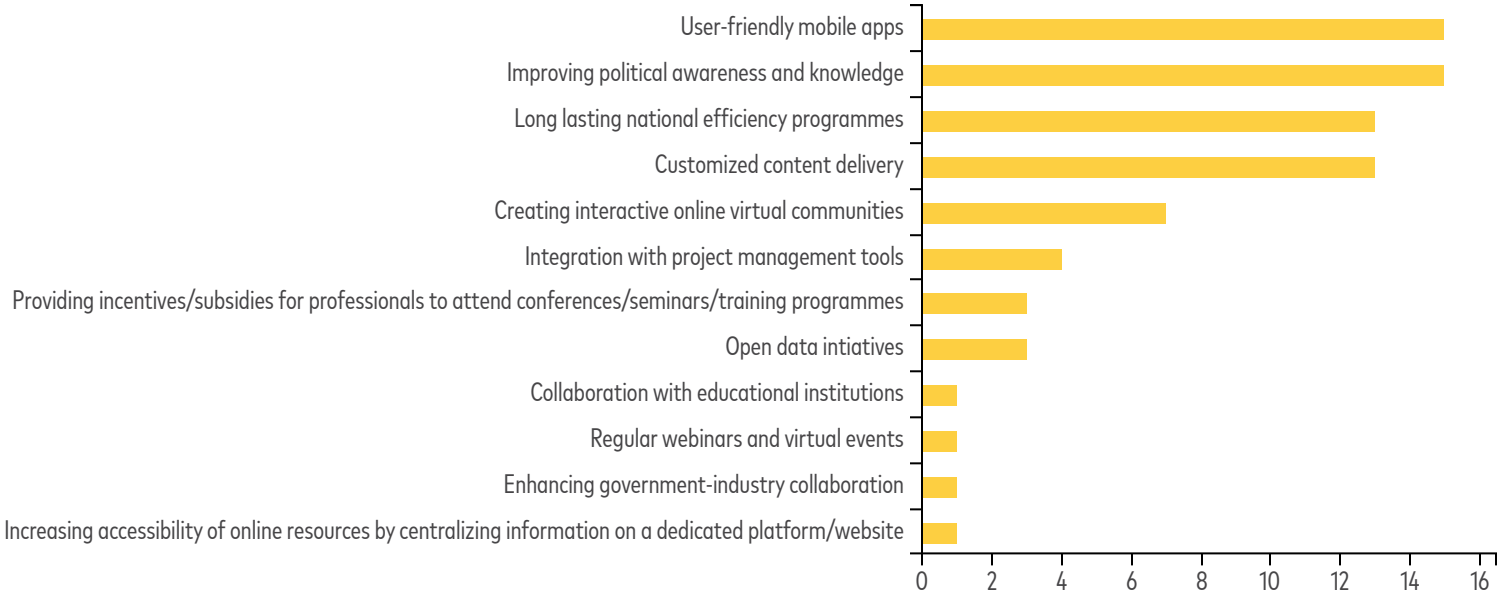

Figure 11. Options to improve mechanisms to keep industry professionals updated on energy efficiency regulations.

9.1.3.2 Addressing change

The second part of the questionnaire explores factors influencing the adoption of energy-efficient practices, focusing on behavioural and psychological barriers. Many respondents report moderate to high energy efficiency implementation, with key motivators including return on investment, environmental responsibilities, corporate social responsibility, and regulatory compliance. However, psychological and behavioural barriers hinder progress. Financial constraints, mainly budget limitations, project prioritisation, and uncertainties around return on investment (ROI) were cited as major obstacles. Additionally, short-term priorities often overshadow long-term sustainability, with a lack of expertise and inadequate incentives also cited as challenges.

To overcome these barriers, respondents recommend combining strict regulations with robust financial incentives, such as national support schemes and stronger regulations at both national and EU levels. Regular energy audits and sharing successful case studies can also drive change. Communication strategies such as storytelling and benchmarking are seen as effective tools for reducing resistance and increasing urgency. Figure 12, Figure 13, Figure 14, and Figure 15 present some key findings from this questionnaire category.

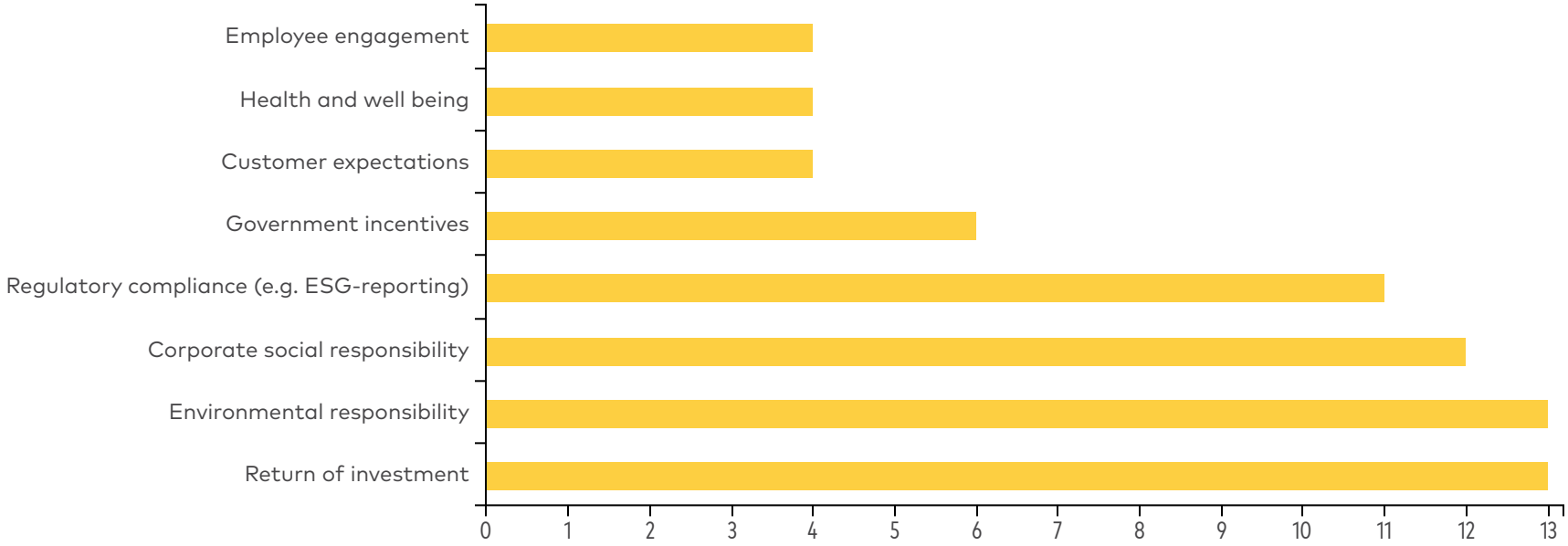

Figure 12. Motivating factors to the implementation of energy efficiency measures.

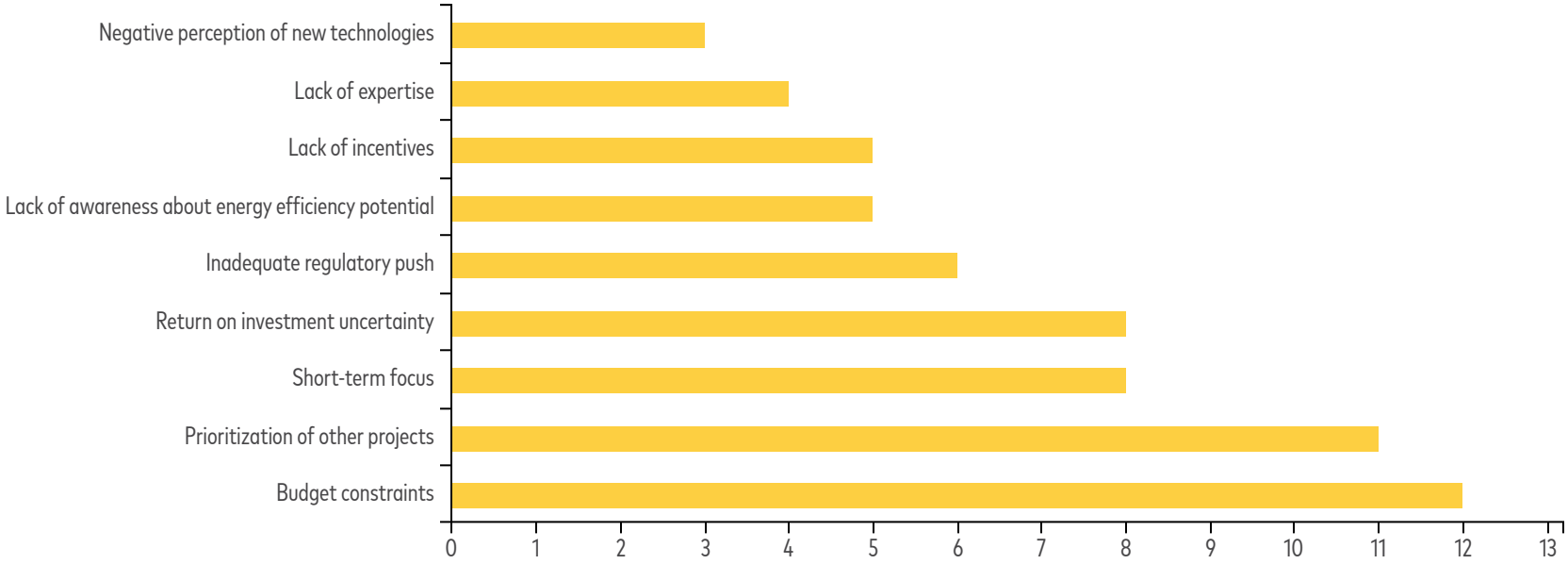

Figure 13. Barriers for the implementation of energy efficiency measures.

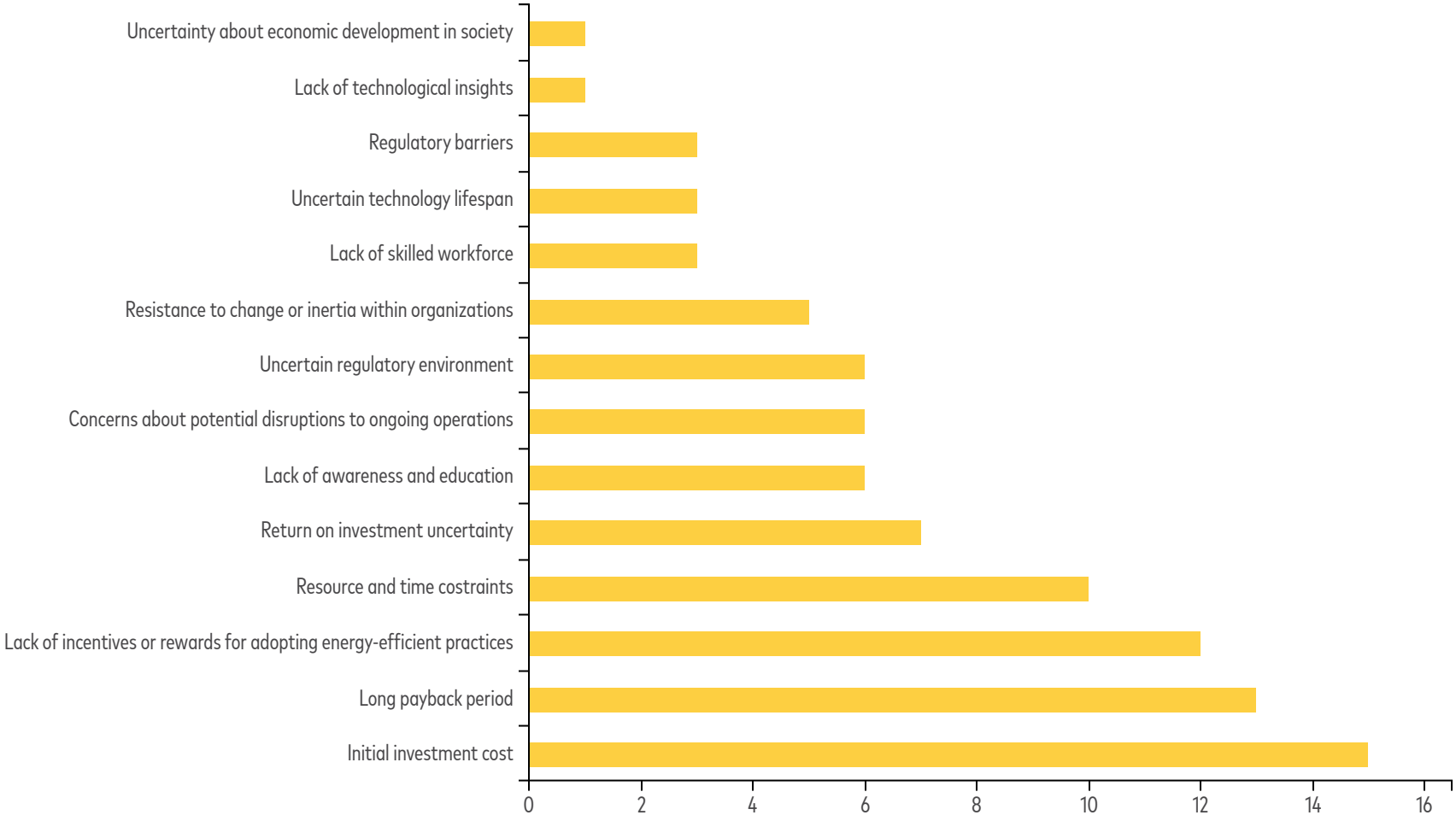

Figure 14. Main challenges for shifting towards more energy-efficient solutions in the building and industry sector.

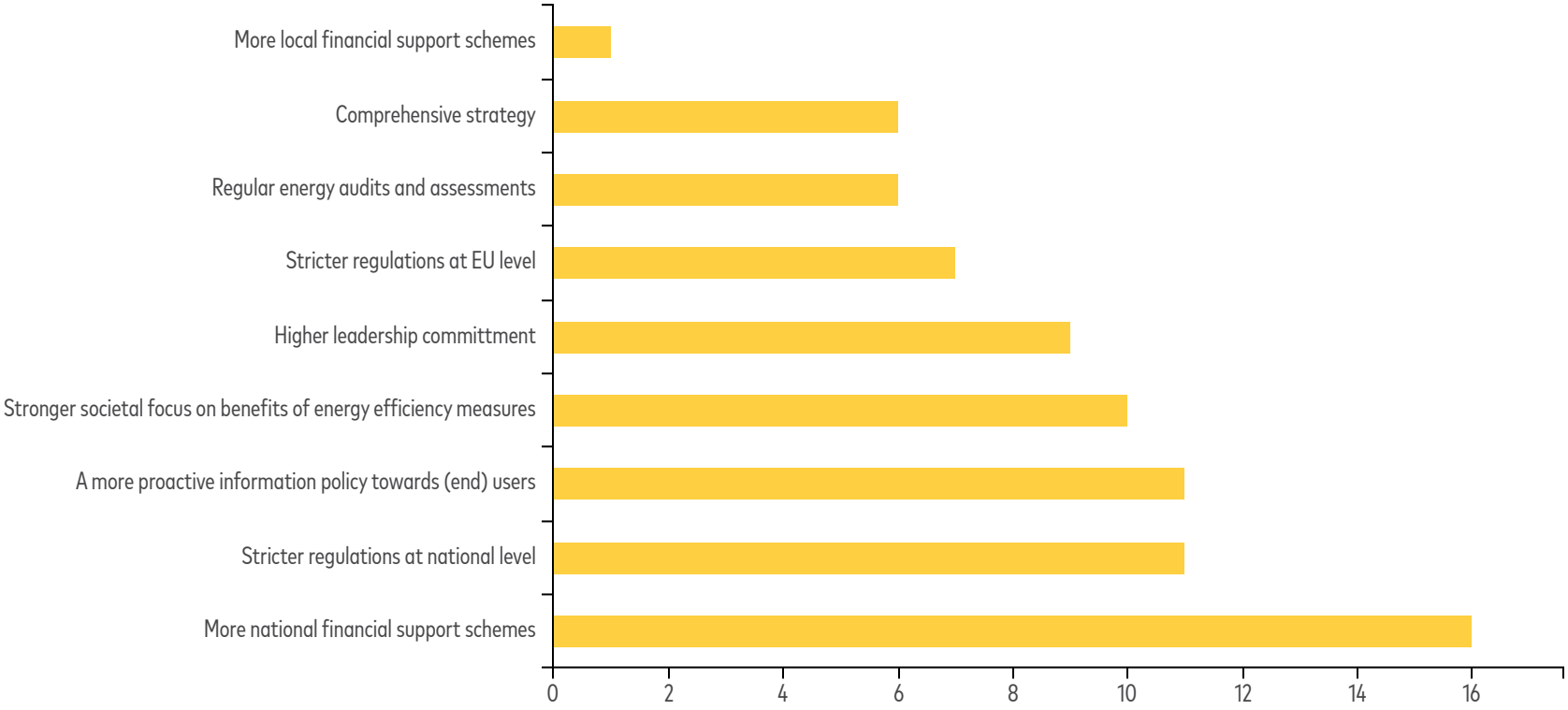

Figure 15. Efforts to make energy efficiency a core element of business models and operations.

9.1.3.3 Incentive schemes

To improve the effectiveness of government incentive schemes, understanding existing measures and their impact is essential. Feedback shows positive views on programmes promoting energy efficiency, although mixed reviews on regulatory frameworks, particularly those in Iceland, suggest a need for adjustments. A major concern is the perceived lack of support at regional and local levels, pointing to misalignment across government tiers. This calls for more coherent policies to support energy efficiency.

Barriers such as bureaucratic complexity, competing priorities, long payback periods, and regional energy costs hinder scheme effectiveness. Suggestions for improvement include increasing funding, offering tax incentives, simplifying application processes, and enhancing public awareness. Performance-based incentives linked to measurable outcomes are also proposed.

For better outcomes, schemes should align across government levels, adapt to market needs, and streamline processes. Engaging stakeholders early and showcasing successes can help design more widely accepted incentive schemes. Figure 16, Figure 17, and Figure 18 present some key findings from this questionnaire category.

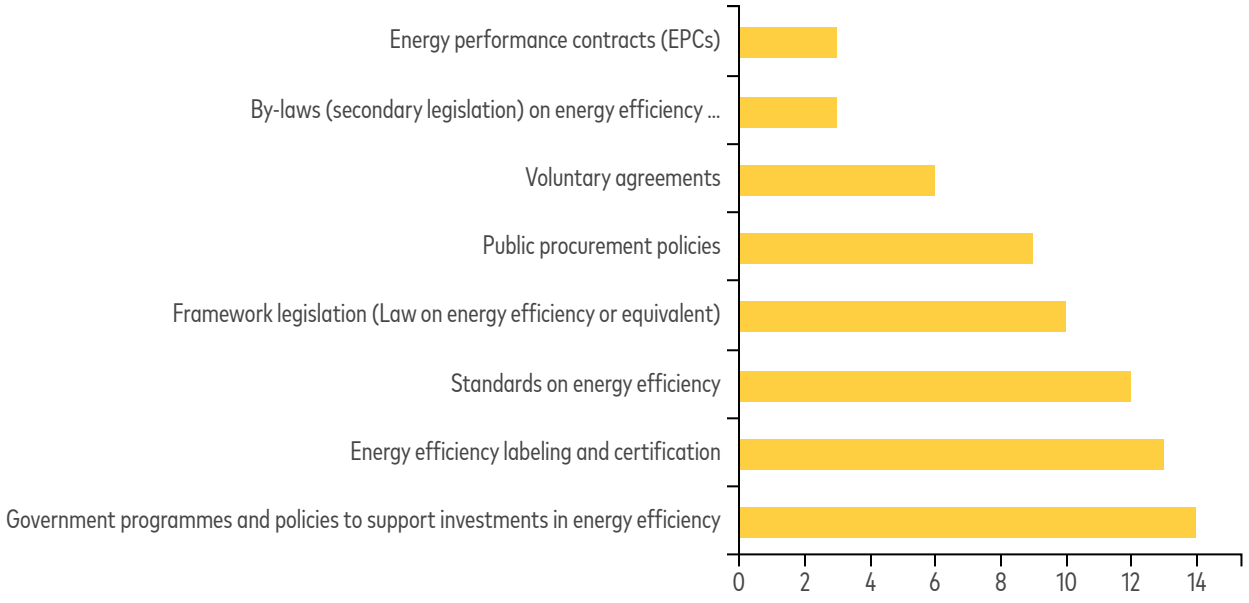

Figure 16. Legislative and policy support for energy efficiency measures.

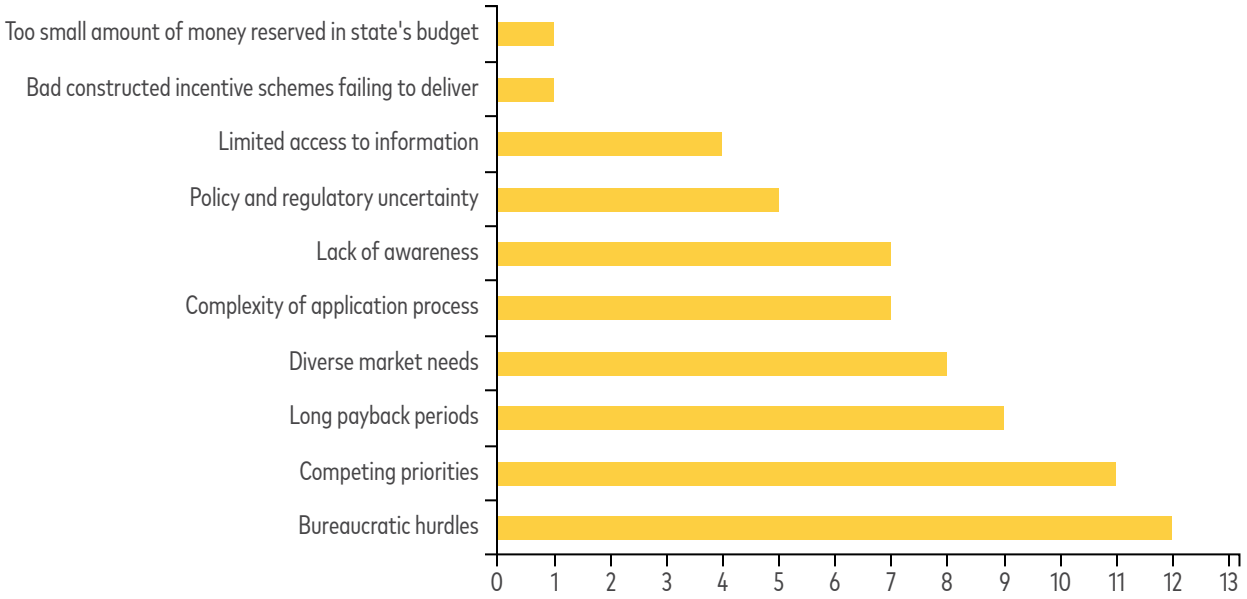

Figure 17. Barriers and limitations of government incentive schemes for energy efficiency.

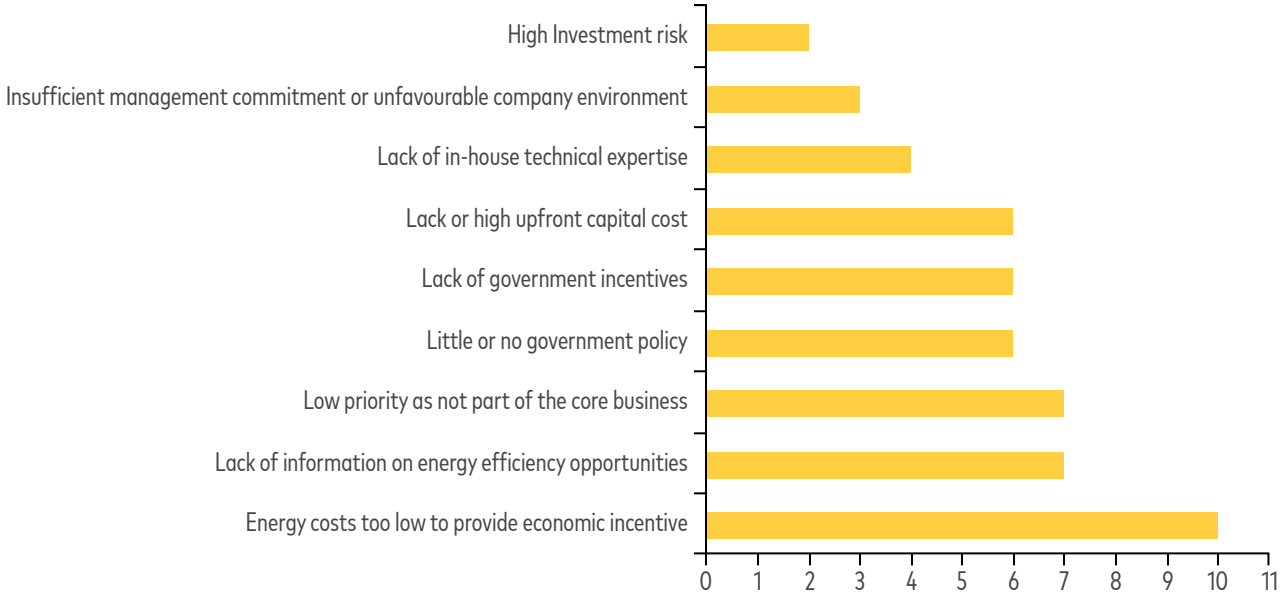

Figure 18. Main barriers for companies to investing in energy efficiency measures.

9.2 Changes in the energy behaviour of households in relation to the 2021–2023 energy crisis

9.2.1 Background

Understanding the complexities of energy use within households is paramount, since it is pivotal in both individual lifestyles and broader environmental sustainability efforts. The decision-making processes underlying energy efficiency enhancements and are often multifaceted, often influenced by a myriad of internal and external factors. Previous studies, such as Faiers et al.[345], have highlighted the significance of individual preferences and actions in shaping energy-related behaviours. Moreover, research suggests that while socio-demographic features have traditionally been used as proxies for categorising consumer groups, attitudes towards sustainability and environmental consciousness play increasingly prominent roles[346], [347], [348]

In addition to individual predispositions, habitual patterns and external stimuli also exert notable influences on energy-related decisions. Salmela and Varho[349] emphasise the role of habits in shaping consumption behaviours, indicating the importance of ingrained routines in guiding energy-related choices. Furthermore, external factors, such as informational reinforcement and cultural contexts, contribute significantly to the energy consumption landscape[350], [351]

Given the dynamic interplay of these factors, the survey is structured to comprehensively explore various dimensions of household energy dynamics. By delving into socio-demographic profiles, attitudes, motivations, and intentions surrounding energy consumption and efficiency measures, the survey aims to provide nuanced insights into the intricate tapestry of energy-related behaviours. Through this approach, it seeks to not only elucidate current consumption patterns but also inform future strategies aimed at promoting sustainable energy practices within households.

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345. A. Faiers, M. Cook, and C. Neame, "Towards a contemporary approach for understanding consumer behaviour in the context of domestic energy use," *Energy Policy*, vol. 35, no. 8, pp. 4381–4390, Aug. 2007, doi: 10.1016/j.enpol.2007.01.003.
346. P. C. Stern, "New Environmental Theories: Toward a Coherent Theory of Environmentally Significant Behavior," *Journal of Social Issues*, vol. 56, no. 3, pp. 407–424, Jan. 2000, doi: 10.1111/0022-4537.00175.
347. C. J. Correia, T. A. Benson, and K. B. Carey, "Decreased substance use following increases in alternative behaviors: A preliminary investigation," *Addictive Behaviors*, vol. 30, no. 1, pp. 19–27, Jan. 2005, doi: 10.1016/j.addbeh.2004.04.006.
348. A. Prakash, "Green marketing, public policy and managerial strategies," *Bus Strat Env*, vol. 11, no. 5, pp. 285–297, Sep. 2002, doi: 10.1002/bse.338.
349. S. Salmela and V. Varho, "Consumers in the green electricity market in Finland," *Energy Policy*, vol. 34, no. 18, pp. 3669–3683, Dec. 2006, doi: 10.1016/j.enpol.2005.08.008.
350. D. F. DiClemente and D. A. Hantula, "Applied behavioral economics and consumer choice," *Journal of Economic Psychology*, vol. 24, no. 5, pp. 589–602, Oct. 2003, doi: 10.1016/S0167-4870(03)00003-5.
351. L. H. Pedersen, "The dynamics of green consumption: a matter of visibility?," *J. Environ. Policy Plann.*, vol. 2, no. 3, pp. 193–210, Jul. 2000, doi: 10.1002/1522-7200(200007/09)2:3<193::AID-JEPP53>3.0.CO;2-5.

9.2.2 Questionnaire framing

Structured into five distinct sections which are comprised primarily of multiple-choice questions, the survey is designed to provide a comprehensive understanding of various facets of household energy dynamics, encompassing socio-demographic profiles, attitudes, motivations, and intentions concerning energy consumption and efficiency measures. At its core, the survey seeks to gather insights into respondents' energy consumption patterns, their perspectives on energy efficiency, and their willingness to adopt energy-saving practices, even amid the global energy crisis of 2021-2023.

While formulating the survey questions, several scientific works were consulted, which have been detailed in each section below. In addition, we designed the survey partially in alignment with a survey developed for the Norwegian context within the research project *Role of energy behaviour in the low-carbon transition (BEHAVIOUR)*, 2020-2025[352]. The Norwegian survey aimed to explore how energy behaviour can be optimised for cost-effectiveness from the perspective of the energy system. We were also influenced by the *Behavioural Energy and Travel Tracker (BETT)*[353] launched by the Sustainable Energy Authority of Ireland. Furthermore, we aligned with a survey conducted by the Danish Energy Agency regarding the energy behaviour of Danes.

The main sections of the survey are described below.

Section 1 – Background
This segment focused on gathering information related to the socio-demographic factors and housing characteristics of the respondents. The questions spanned topics such as age, gender, education level, employment status, household composition, income, housing type, occupancy status, floor area, energy efficiency rating, year of construction and heating systems.[354], [355], [356]

352. IFE, "Role of energy behaviour in the low-carbon transition (BEHAVIOUR)." Accessed: May 10, 2024. [Online]. Available: https://ife.no/en/project/role-of-energy-behaviour-in-the-low-carbon-transition-behaviour/
353. C. Lavin and H. Julienne, "Behavioural Energy and Travel Tracker. Results report 1- heating season 2022/2023," Sustainable Energy Authority of Ireland, 2023.
354. R.-A. Corbos, O.-I. Bunea, and D.-C. Jiroveanu, "The effects of the energy crisis on the energy-saving behavior of young people," *Energy Strategy Reviews*, vol. 49, p. 101184, Sep. 2023, doi: 10.1016/j.esr.2023.101184.
355. P. Dato, "Investment in Energy Efficiency, Adoption of Renewable Energy and Household Behavior: Evidence from OECD Countries," *The Energy Journal*, vol. 39, no. 3, pp. 213–244, May 2018, doi: 10.5547/01956574.39.3.pdat.
356. S. Halleck Vega, E. Van Leeuwen, and N. Van Twillert, "Uptake of residential energy efficiency measures and renewable energy: Do spatial factors matter?," *Energy Policy*, vol. 160, p. 112659, Jan. 2022, doi: 10.1016/j.enpol.2021.112659.

Section 2 – Attitudes / motivations

This section explored respondents' attitudes and motivations concerning energy usage. It delved into the respondents' concerns about environmental impact, considerations of cost, willingness to conserve energy, interest in adopting energy-efficient housing solutions, awareness of energy consumption, and flexibility in adjusting their energy usage patterns[357],[358].

Section 3 – Behaviour

The focus of this section was on understanding the behaviour changes in the households, particularly during the crisis period of 2021-2023, correcting for the measures they already adopted before the crisis. The questions probed into respondent behaviours such as temperature adjustments, changes in showering habits, reduction of appliance usage, and exploration of alternative heating sources. Additionally, the respondents' perceptions of the impact of these actions on energy and cost savings were also evaluated, along with their willingness to sustain these behaviours over time[359],[360],[361]

Section 4 – Energy efficiency measures

This section investigated medium to long-term energy efficiency measures either adopted or planned by respondents during the energy crisis or over the next two to three years, correcting for measures they implemented before the crisis. Topics cover investments in energy-efficient appliances, insulation enhancements, heating and ventilation system upgrades, and installation of monitoring systems. We assesed perceived energy and cost-savings resulting from these measures, as well as intentions to seek financial support for their implementation[362],[363].

Section 5 – Future intentions

In this last section, we delved into respondents' preferences regarding the implementation of medium to long-term energy efficiency measures and factors influencing their decisions. The Stated Preference (SP) method was used to elaborate this section of the questionnaire. This method is a well-established approach that is commonly employed in environmental assessment, transportation

357. F. Hanke, K. Grossmann, and L. Sandmann, "Excluded despite their support - The perspectives of energy-poor households on their participation in the German energy transition narrative," *Energy Research & Social Science*, vol. 104, p. 103259, Oct. 2023, doi: 10.1016/j.erss.2023.103259.
358. G. Trotta, "The determinants of energy efficient retrofit investments in the English residential sector," *Energy Policy*, vol. 120, pp. 175–182, Sep. 2018, doi: 10.1016/j.enpol.2018.05.024.
359. S. Seebauer and A. Wolf, "Disentangling household and individual actors in explaining private electricity consumption," *Energy Efficiency*, vol. 10, no. 1, pp. 1–20, Feb. 2017, doi: 10.1007/s12053-016-9435-x.
360. European Commission, "Playing my part. Key energy saving actions." Accessed: Jan. 05, 2024. [Online]. Available: https://energy.ec.europa.eu/topics/markets-and-consumers/actions-and-measures-energy-prices/playing-my-part_en
361. M. A. Tovar Reaños, D. Meier, J. Curtis, and A. Pillai, "The role of energy, financial attitudes and environmental concerns on perceived retrofitting benefits and barriers: Evidence from Irish home owners," *Energy and Buildings*, vol. 297, p. 113448, Oct. 2023, doi: 10.1016/j.enbuild.2023.113448.
362. G. Trotta, "The determinants of energy efficient retrofit investments in the English residential sector," *Energy Policy*, vol. 120, pp. 175–182, Sep. 2018, doi: 10.1016/j.enpol.2018.05.024.
363. A. Schueftan, C. Aravena, and R. Reyes, "Financing energy efficiency retrofits in Chilean households: The role of financial instruments, savings and uncertainty in energy transition," *Resource and Energy Economics*, vol. 66, p. 101265, Nov. 2021, doi: 10.1016/j.reseneeco.2021.101265.

planning, and market research, as it helps elucidate individuals' preferences, choices, and decision-making processes regarding specific attributes of goods, services, or policies. This method is based on random utility maximisation, which assumes that a person chooses the option that gives them the greatest utility, which is influenced by the attributes of the alternatives[364]. The analysis of these responses allows the researchers to infer the importance individuals place on different attributes and estimate the potential impact of changes in those attributes on overall preferences. By delving into these preferences, valuable insights can be gained to inform the development of policies or products that better align with consumer preferences.

There are different techniques to design SP questions, with the attribute-based stated choice being the most used technique in recent decades due to its advantages such as the possibility of designing the scenarios and choice alternatives, including hypothetical options, and controlling for choice sets to allow statistically efficient quantitative analyses.[365]. This methodology involves creating choice scenarios, with each scenario being characterised by various alternatives and each alternative consisting of some attributes and different attribute levels. The respondents were presented with these scenarios and asked to indicate their preferences by selecting their preferred alternative. Some of the challenges of this methodology are the lack of realism in the choices or high complexity, leading to significant cognitive effort, fatigue, and thus, biased choices of the respondents. [366]. To overcome these challenges, the following was ensured: the choices provided in the survey were as realistic as possible; only five potential alternatives were included; three attributes for each alternative were provided to avoid complex decisions; and the levels were visually presented for ease of understanding of the respondents. In addition, to avoid the fatigue effect, only four choice scenarios were presented to each respondent.

The analysed medium to long-term energy efficiency measures are as follows:

1. Install energy-efficient triple-glazed windows
2. Add extra insulation to external walls
3. Use energy monitoring systems
4. Implement night temperature-lowering systems
5. Install a balanced ventilation system with heat recovery

364. K. Train, "Discrete Choice Methods with Simulation." Cambridge University Press, 2002. [Online]. Available: https://eml.berkeley.edu/books/train1201.pdf
365. V. Adamowicz and P. Boxall, "Future Directions of Stated Choice Methods for Environment Valuation," Jan. 2001.
366. E. Cherchi and D. A. Hensher, "Workshop Synthesis: Stated Preference Surveys and Experimental Design, an Audit of the Journey so far and Future Research Perspectives," *Transportation Research Procedia*, vol. 11, pp. 154–164, 2015, doi: 10.1016/j.trpro.2015.12.013.

The attributes considered for the selected measures are as follows:

1. Investment cost for implementing the energy efficiency measures
2. Energy savings through the adoption of the measures
3. Investment support to offset the initial expenses associated with implementing the energy efficiency measures

For the attributes of energy savings and investment cost, assigning a precise value to each analysed measure that would be suitable for all Nordic countries is challenging. To address this, a nuanced approach was employed using colour-coded bars to denote low, medium, and high levels for energy savings and price related to each measure. These levels were derived from an extensive analysis conducted by NVE and Multiconsult[367]; they were primarily tailored to the Norwegian context, but potential applicability to other Nordic nations and market price ranges was also ensured. The visual representation within the colour-coded bars utilises a spectrum of colours and a scale from zero to ten (Figure 19). In this scale, green indicates favourable values, while red indicates less desirable ones. Consequently, for the investment cost, where lower values are preferable, the colour progression moves from green to red. Conversely, for attributes such as energy savings and investment support, where higher values are more desirable, the colour scheme transitions from red to green.

It is worth noting that the numbers (0-10) associated with colours for each attribute were not considered absolute values. Instead, they were defined as relative to the other measures. This was achieved by normalising all energy savings and investment cost values to the maximum value available for each of these two attributes across all measures.

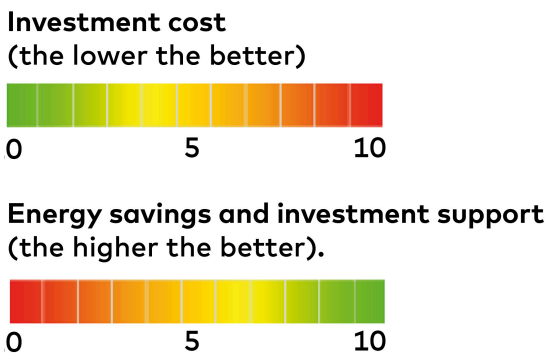

Figure 19. Colour-coded bars used in the web-panel survey to denote attribute values for energy efficiency measures.

367. Multiconsult, "Kostnader for energieffektivisering i bygg [Costs for energy efficiency in buildings]," NVE external report No. 6/2021, 2021.

Finally, for the investment support attribute, three levels were considered, representing the following percentages: 0%, 15%, and 35%.

Each choice set was designed including two potential measures with different levels for the attributes and a, 'do nothing' alternative. This prevented respondents from selecting a random alternative if none of the alternatives was clearly preferred. There are several combinations of the measures, and levels for each attribute using a D-efficient design; the combinations (choice sets) were reduced to eight to ensure a D-error lower than 0.01. The software NGENE[368] was used to compute the efficient design using a Federov algorithm to allow accounting for the selection of two out five measures and a, "do nothing", alternative in each set. These choice sets were organised into blocks, with each containing four sets, and randomly presented to the respondents; in addition, the sets in each block were also randomly presented to avoid bias due to order effects.

The target audience for the survey consisted of individuals over eighteen years old living in the six Nordic countries. The survey was available in all native languages and conducted through web panels comprising 604 participants in Iceland, 345 participants in the Faroe Islands and 600 participants each in Denmark, Finland, Norway, and Sweden, totalling 3,349 respondents. The survey was conducted by Norstat between September and October 2024.

The complete survey is provided in the Appendix 4.

9.2.3 Summary and discussion of findings

9.2.3.1 Behaviour and measures before, during and after the global energy crisis in 2021-2023

Examining behavioural patterns across different countries before, during, and after the energy crisis reveals notable trends. The results imply that the crisis impacted respondents in Nordic countries to varying degrees, influencing their awareness of energy consumption at different levels (Figure 20).

368. ChoiceMetrics Pty Ltd, *Ngene 1.4 User manual & Reference guide*. (2024)

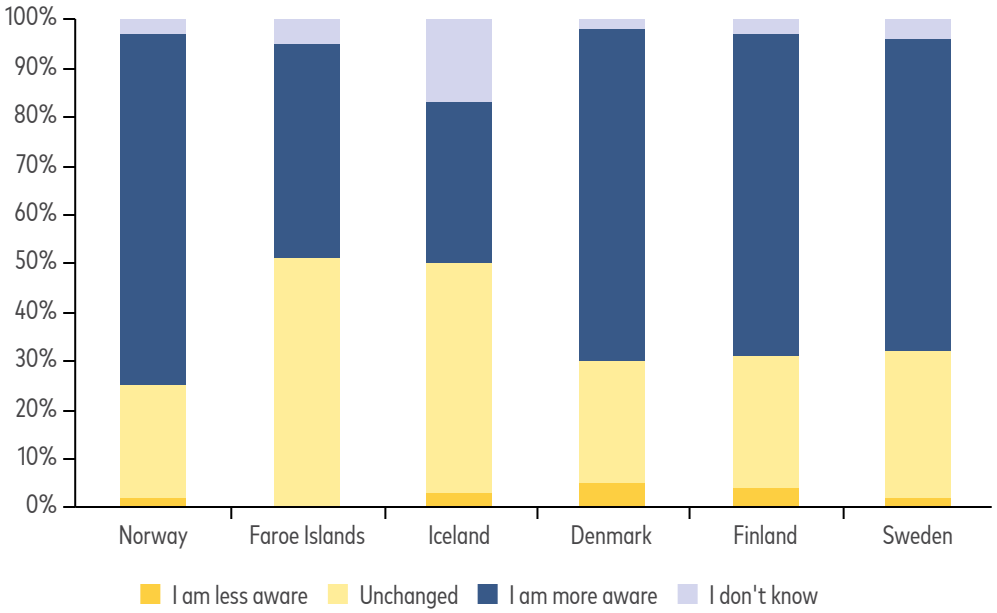

Figure 20. Differences between respondent in Nordic countries on whether the energy crisis in 2021-2023 led to higher awareness of energy use.

Correspondingly, energy-saving behaviours also vary, reflecting differences in awareness and response across the countries. Households in Norway implemented acute measures during the energy crisis and respondents reported changes in their showering habits, shifting appliance usage to different hours, adjusting home temperatures, and slightly reducing appliance use. In Denmark, Finland, and Sweden, there was a significant shift in appliance usage to off-peak hours with lower electricity prices, along with widespread temperature adjustments. These respondents also reported a slight reduction in appliance usage. In contrast, respondents in the Faroe Islands and Iceland exhibited minimal behavioural changes during the examined period. In addition to examining short-term energy-saving behaviours, we explored medium- to long-term energy efficiency measures adopted or planned by respondents. The findings indicate that during all phases—before, during, and after the energy crisis—respondents primarily focused on investing in energy-efficient appliances, which is often considered a straightforward and accessible measure. Looking ahead to the next two to three years, respondents show a growing interest in implementing energy monitoring systems and consulting energy experts to better manage their consumption over the long term.

Regarding energy-saving behaviours, most respondents express a willingness to continue their efforts, despite perceiving the impact as small or moderate. This trend is illustrated in Figure 21.

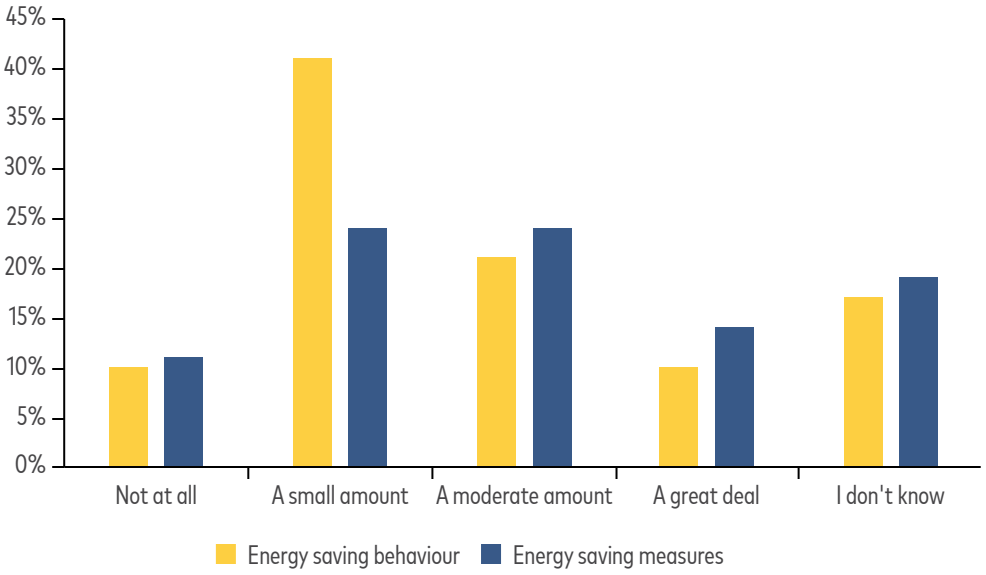

Figure 21. Respondents perception of impacts for short-term energy saving behaviour and long-term energy saving measures.

Although respondents view the impact of long-term energy efficiency measures as significant, they do not plan to apply for investment support (Figure 22). Understanding the reasons behind this choice is crucial, as it may reveal how respondents in each country perceive and engage with support schemes for energy-saving initiatives. This insight can help tailor future programmes to better align with user expectations and needs.

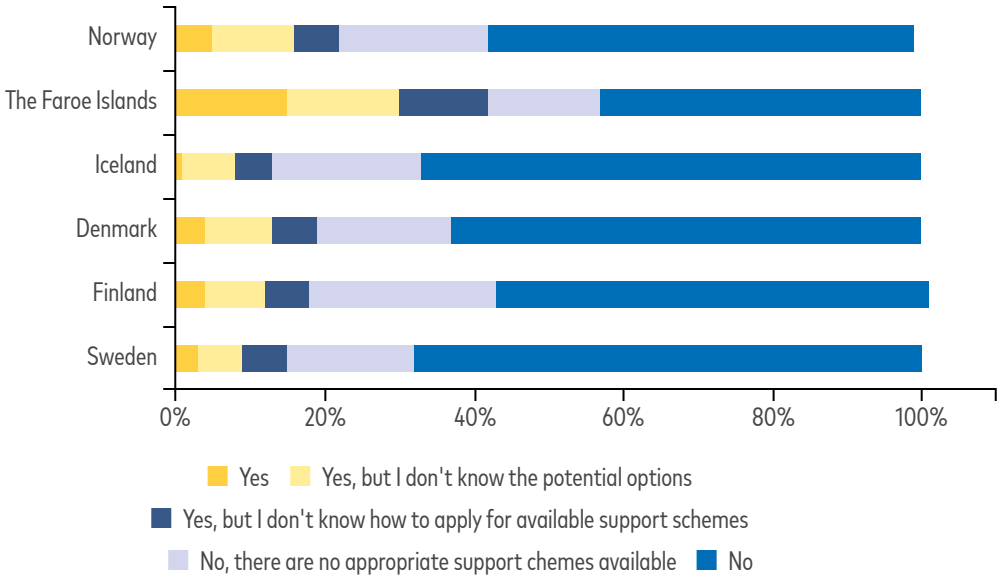

Figure 22. Intention to apply for support to implement medium to long-term measures.

More detailed information on the responses is provided in the Appendix 4.

9.2.3.2 Future intentions with stated preference analysis

In this SP survey, respondents were presented with options characterized by three key attributes: investment costs, energy savings, and investment support level. Based on their choices, the parameters associated with each attribute were estimated. The objective was to determine the relative importance of these attributes to respondents across different countries, age groups, and education levels, offering insights into their future intentions to adopt energy-savings measures. A simple logit model, using the maximum likelihood method, was employed to estimate the parameters, as summarized in the table below. The sign of each parameter indicates its effect on the likelihood of an alternative being chosen: a positive sign suggests a positive impact, while a negative sign indicates a negative impact. Statistical significance is denoted by stars, with two stars indicating a 99% significance level and one star representing a 95% significance level.

		COST	Saving	Support	Alt_2	ALT_3	ALT_4	ALT_5
Countries	**Norway**	-0.0004	0.0537**	0.0123*	0,34	-0,03	0,12	0,49
	The Faroe Islands	-0.0001	0.0649**	0.0087	0.34	-0.03	0.12	0.49
	Iceland	-0.0005**	0.0639**	0.0028	0.34	-0.03	0.12	0.49*
	Denmark	-0.0003**	0.0698**	0.0069	-0.05	-0.48*	-0.57*	-0.27
	Finland	-0.0003**	0.0391**	0.0015	-0.67**	1.65**	1.41**	1.6**
	Sweden	-0.0003**	0.0485**	0.0091*	-0.09	-0.56**	-0.65**	-0.19
Age	**18-29**	-0.0004**	0.0700**	0.0047	0.34**	-0.01	-0.02	0.25*
	30-49	-0.0003**	0.0556**	0.0043*	0.04	-0.14*	-0.29**	0.10*
	50-69	-0.0003**	0.0144**	0.0083**	-0.11	-0.71	-0.70**	-0.30**
	Over 70	-0.0003**	0.0000	0.0043	-0.27	-1.24**	-1.04**	-0.80**
Education	**Low**	-0.0002*	0.0254	-0.0085	0.26	-0.32*	-0.52**	-0.17
	Middel	-0.0003**	0.0354**	0.0062**	-0.01	-0.56**	-0.59**	-0.22**
	High	-0.0003**	0.0444*	0.0046*	0.03	-0.45**	-0.43**	-0.11

Country heterogeneity: The findings reveal that the energy-savings attribute is consistently important across all countries. In contrast, the investment support level significantly influences only the choices of respondents' in Norway and Sweden. Meanwhile, the price attribute plays a statistically significant role in decision-making for respondents in Iceland, Denmark, Finland, and Sweden.

We also examined whether respondents exhibit a pre-existing preference for any alternative, regardless of its investment costs, energy savings, and investment support level. To capture this potential bias, fixed parameters were introduced into the model. These parameters reflect the respondents' tendencies to favour certain options independently of the attributes.

The results indicate that respondents in Finland and Sweden demonstrate such biases. In Finland, 'using an energy monitoring system' is the preferred choice, while respondents in Sweden favour 'installing energy-efficient windows for the entire home', regardless of variations in the defined attributes. This suggests that cultural or contextual factors may influence these inherent preferences.

Age group heterogeneity: Analysing the heterogeneity and variation in choices across age groups reveals that respondents aged 30–49 years and 50–69 years consider all three attributes when choosing an alternative. In contrast, the youngest age group (18–29 years) places greater weight on investment costs and energy savings. Among the oldest age groups, the importance of these factors is not statistically significant, with decisions more influenced by pre-existing preferences and perceptions of the alternatives.

Education level heterogeneity: Individuals with lower education levels appear less influenced by the specific attributes of alternatives, relying more on pre-existing preferences. In contrast, higher-educated groups consider all attributes, showing statistically significant responses influenced by their preferences. Understanding this discrepancy requires further investigation into factors such as housing type and annual energy costs, which may be lower for less-educated respondents. These contextual factors could explain their decision-making patterns.

The stated preference survey requires detailed analysis to identify the optimal policy set tailored to specific target groups. Enhancing the examination of heterogeneity is essential to uncover preferences within the defined main target group. While the current results offer a broad categorisation of respondents, more nuanced sub-groups can be established to design policies that address the needs of specific groups.

10. Conclusions

This report presents findings from a project commissioned by the Nordic Committee of Senior Officials for Energy Policy (EK-E), for which SINTEF analysed energy efficiency experiences in the building and industry sectors across the Nordic countries – Norway, Sweden, Finland, Denmark, Iceland, and the Faroe Islands.

Chapter 1 introduces the concept of energy efficiency in the Nordic region, presenting an overview of energy consumption trends, efficiency goals, and challenges in this region. Chapters 2, Chapter 3 and Chapter 4 cover energy efficiency objectives, strategies, and policies in the building and industry sectors. Chapter 5 highlights selected energy efficiency measures and energy savings from these measures. Chapter 6 and Chapter 7 review best practices and successful initiatives across the Nordic countries. Chapter 8 explores the transferability of these initiatives across countries. Chapter 9 presents insights from two surveys: one on barriers to energy efficiency and another on changes in household energy behaviour during the 2021–2023 energy crisis, with detailed findings in the Appendix 3 and Appendix 4.

The following sections present insights from each chapter of this report.

CHAPTERS 1 TO 5

- **Energy efficiency commitment**: Nordic countries are committed to achieving ambitious energy efficiency and climate goals by setting national targets for reducing energy consumption, increasing the use of renewable energy, and achieving carbon neutrality. All Nordic countries, except the Faroe Islands, align their national objectives, policies, and regulations with European Union (EU) directives and initiatives, such as the Energy Efficiency Directive (EED), Energy Perfromance of Buildings Directive (EPBD), and EU Emission Trading System (EU ETS).
- **Targeted strategies for building and industry sectors**: Each country has implemented tailored energy efficiency measures and policies to address the unique challenges and opportunities in the building and industry sectors, which are influenced by differences in climate, geography, demography, building practices, and industrial landscapes across the Nordic countries.
- **Building-sector initiatives**: Efforts include reducing building energy consumption, transitioning to renewable heating, and upgrading existing building stock through long-term renovation strategies, supported by regulatory frameworks and financial incentives.

- **Industry-sector challenges**: The diversity and complexity of the industrial sector pose challenges in establishing uniform energy efficiency targets across the region. Tailored strategies are essential for different industries, emphasising decarbonisation, electrification, and renewable energy integration across the Nordic countries.
- **Policy instruments**: A combination of informational, regulatory, financial, and voluntary instruments is used to enhance energy efficiency. While there are common approaches across the region, such as advisory services, building codes, tax incentives, subsidies, and environmental certifications, each country tailors these instruments to its specific national context and priorities, reflecting both similarities and differences in their strategies.
- **Energy savings impact**: Assessing energy savings from efficiency measures is complex, with differences between energy-saving potential (ideal savings) and energy-saving effect (real-world outcomes). Factors such as climate conditions, measure interactions, and rebound effects must be considered to understand the actual impact of energy efficiency initiatives.

CHAPTERS 6 AND 7

- **Best practices in energy efficiency**: In the building sector, key measures include highly insulated building envelopes, energy-efficient windows, heat pumps, and energy-efficient appliances and lighting, supported by strict building codes and incentives. In the industry sector, best practices include combined heat and power, waste heat recovery, and energy management, reinforced by mandatory audits and financial incentives.
- **Exemplary initiatives**: These initiatives demonstrate the effectiveness of combining regulatory measures, financial incentives, and collaboration, leading to energy savings and climate change mitigation. In the building sector, key examples include Denmark's minimum requirement targets, Finland's energy efficiency agreements, Norway's passive houses programme, Iceland's heat pump subsidies, and Sweden's LÅGAN programme. In industry, Denmark's energy-savings scheme, Finland's subsidised energy audits, Iceland's incentives for energy conversion projects, Norway's climate and energy initiatives programme, and Sweden's programme for energy efficiency in energy intensive industry promote energy savings and technology adoption.
- **Success factors**: The main success factors for energy efficiency and climate change mitigation initiatives include clear regulatory requirements, financial support mechanisms that offset initial investment costs, and strong collaboration among government, industry, and consumers. Additionally, effective communication and education, along with robust monitoring systems to track progress and outcomes, play a crucial role in ensuring widespread adoption and sustained impact.

- **Barriers to implementation and adoption**: Key barriers include high upfront costs, the need for specialised expertise, resistance to change, and administrative challenges in managing large-scale programmes. Furthermore, insufficient data on the costs and benefits of initiatives, along with fluctuating market conditions, may deter investment in energy efficiency measures.

CHAPTER 8

- **Effectiveness of initiatives**: Many of the examined initiatives are effective, but some are becoming outdated due to rapid advancements in existing technologies, policies, practices, or all of them. This highlights the need to focus on proven initiatives that maximise resource efficiency while also redefining future targets to stay aligned with emerging technologies.
- **Regulatory and market fit**: Successful energy efficiency initiatives must align closely with national building codes and regulatory frameworks. Initiatives that fit well with national policy objectives are more likely to be accepted and effectively integrated across various sectors. Moreover, the design of policy and financial instruments should be harmonised with existing incentives.
- **Technological and infrastructure constraints**: Countries may face technological or infrastructural limitations that hinder the feasibility of certain initiatives. Adapting initiatives to local technological capabilities and infrastructure is key to their success.
- **Industry-specific needs**: Some initiatives may not be applicable or beneficial to specific industries. Customising initiatives to fit industry-specific operational practices and energy consumption patterns enhances their chances of successful implementation and greater energy savings.
- **Collaboration and knowledge exchange**: Sharing experiences, best practices, and innovations among Nordic countries can prevent duplication of efforts and accelerate the adoption of successful measures. This collaborative approach helps identify effective solutions, address common challenges, and tailor initiatives to local needs.

- **Barriers to energy efficiency**: A moderate to high level of awareness of national and EU regulations can be observed among industry professionals, which is essential for fostering compliance and encouraging energy efficiency adoption. However, significant barriers persist, including financial constraints, competing project priorities, and a focus on short-term goals over long-term savings, which hinder the broader implementation of energy-efficient measures. Combining stronger regulations, targeted financial incentives, and simplified administrative processes could reduce these barriers and encourage long-term energy-efficient behaviour.
- **Incentive scheme improvements**: Existing government incentives are considered effective but could be improved by simplifying application processes, increasing funding, and offering performance-based incentives. Aligning policies across government levels and tailoring them to market needs would enhance their impact and encourage broader participation.
- **Communication and engagement**: Public awareness campaigns and effective communication strategies, such as showcasing successful case studies, can help overcome psychological barriers and promote energy-efficient practices. Engaging stakeholders early and fostering collaboration across sectors ensures that policies and incentives address the diverse needs and challenges within the building and industry sectors.
- **Price peaks trigger acute measures**: During the energy crisis, households implemented acute measures such as temperature adjustments. Vulnerable groups, especially in Norway, Denmark, Finland, and Sweden, should, thus, be given extra attention during periods of high electricity prices and low temperatures.
- **Good habits are lasting habits**: Most respondents expressed a willingness to continue their efforts despite perceiving the impact as small or moderate.
- **Lack of one-size-fits-all solutions**: The survey shows differences in responses between age groups and education levels. Respondents show a growing interest in implementing energy monitoring systems and consulting energy experts. These are measures that can more easily be adapted to individual users.
- **Subsidies may support those who would invest regardless**: The stated preference survey shows that subsidy levels did not have a large impact on investment decisions. Investment costs and the potential to save energy are more important attributes. Furthermore, the survey results show that in Sweden and Finland, respondents have inherited preferences and would choose specific measures regardless of the values of investment costs, energy savings, and subsidies.

Acknowledgements

We are grateful to the Nordic Committee of Senior Officials for Energy (EK-E) for commissioning this project and to the Nordic Council of Ministers for providing financial support. We also thank Nordic Energy Research's project coordinators, Maj Dang Trong and Astrid Bratli, for their guidance throughout the project period.

We are grateful for the support from experts in different Nordic countries who assisted us with grey literature, best practices, and the workshop on the transferability of measures. Specifically, we thank Steffen Petersen from Aarhus University in Denmark, Vilhjálmur Nielsen from DTU in Denmark, Anssi Laukkarinen and Juha Vinha from Tampere University in Finland, Þórhildur Fjóla Kristjánsdóttir from Reykjavik University in Iceland, Elisa Magnanelli and Till Holmes from SINTEF Energy in Norway, and Erika Mata and Sevda Jusufovska from IVL in Sweden.

We also thank the experts who participated in the questionnaire on energy efficiency barriers and the Tour de Capital, as well as those who generally supported us with comments, feedback, and contributions to the report. In particular, we appreciate the contributions of the Danish Energy Agency, Faroese Environment Agency, Motiva Oy, Finnish Ministry of Economic Affairs and Employment, Energy Authority of Finland, Icelandic National Energy Authority, Icelandic Ministry of the Environment, Energy and Climate, NVE, Norwegian Ministry of Energy, Enova, IFE, Statnett, Swedish Energy Agency, Swedish Government Office (Energy and Climate), and the Nordic Council of Ministers.

Finally, we thank Peter Bach from the Danish Energy Agency and Jan Bråten from Statnett in Norway for their thorough review of the final draft of the report, and Christian Klöckner from NTNU for his help in aligning our web-panel survey with the Behaviour survey.

Appendix 1: Key energy features in the Nordics

Table A 1. Key features of Nordic countries regarding final energy consumption, proportion of renewable energy, national energy composition, electricity generation sources, electricity percentage distribution in final energy use, and electricity costs, as of December 2024[369].

	Denmark	Finland	Iceland	Norway	Sweden	Faroe Islands
Final energy consumption, largest sectors	29% Residential 31% Transport 18% Industry 15% Commercial and public services	41% Industry 21% Residential 16% Transport 12% Commercial and public services	43% Industry 16% Residential 16% Commercial and public services 11% Transport	30% Industry 24% Transport 18% Residential 14% Commercial and public services	36% Industry 23% Residential 21% Transport 14% Commercial and public services	NA
Renewables, share in final energy consumption	40%	50%	82%	61%	58%	NA
Energy mix, largest sources (total energy supply)	37% Oil 35% Biofuels and waste	31% Biofuels and waste 28% Nuclear	70% Wind, solar, etc. 20% Hydro	43% Hydro 25% Oil	29% Biofuels and waste 27% Nuclear	NA
Residential energy use, largest sources	43% Heat 22% Electricity 18% Biofuels and waste	39% Electricity 32% Heat 24% Biofuels and waste	81% Heat 16% Electricity	81% Electricity 15% Biofuels and waste	49% Electricity 36% Heat	NA

369. International Energy Agency (IEA), "Energy system of Europe." Accessed: Mar. 19, 2024. [Online]. Available: https://www.iea.org/regions/europe

Services energy use, largest sources	44% Electricity 39% Heat	51% Electricity 36% Heat	61% Heat 38% Electricity	77% Electricity 11% Heat	63% Electricity 29% Heat	NA
Industrial energy use, largest sources	33% Electricity 26% Natural gas 25% Oil	38% Biofuels and waste 30% Electricity	98% Electricity	65% Electricity 14% Oil	43% Biofuels and waste 35% Electricity	NA
Electricity generation, largest sources	58% Wind 16% Biofuels	42% Nuclear 19% Hydro	70% Hydro 30% Geothermal	89% Hydro 9% Wind	40% Hydro 29% Nuclear	NA

Appendix 2: Best and good practices in the Nordic countries

The following sections provide country overviews of the good and best practices for Denmark, Finland, Iceland, Norway, and Sweden. Each country overview is organised into two categories: building sector and the industry sector.

2.1 Denmark

BUILDING SECTOR

Best practices

- Highly insulated and airtight building envelope
- Energy-efficient windows
- Mechanical ventilation with heat recovery
- Heat pumps for house heating (prevalence of air and ground-source heat pumps)
- Energy-efficient appliances and lighting
- Building code for new buildings and major renovations.

Good practices

- District heating systems
- Building energy labelling
- Subsidy schemes for private buildings, including heat pump replacement outside district heating grids
- BetterHomes scheme for energy-efficient renovation
- Knowledge centre for energy savings in buildings
- Building job scheme ('Bolig Job ordningen')

References[370], [371], [372], [373], [374], [375]

370. Danish Ministry of Transport, Building and Housing, "Executive Order No. 1615 on building regulations 2018 (BR18)," 2017. [Online]. Available: https://www.byggerietsregler.dk/wp-content/uploads/2018/09/BR18_Executive_order_on_building_regulations_2018.pdf
371. Danish Parliament, "Energimærkningsloven [Energy Performance Certificate Act]." Accessed: Nov. 22, 2024. [Online]. Available: https://danskelove.dk/energim%C3%A6rkningsloven
372. Danish Energy Agency, "Final update of Danmark's National Energy and Climate Plan for the period 2021-2030," Jun. 2024. [Online]. Available: https://commission.europa.eu/document/download/13353c72-43bc-486e-bc82-9e8ea7588734_en?filename=DK_FINAL%20UPDATED%20NECP%202021-2030%20%28English%29.pdf
373. Danish Energy Agency, "BedreBolig [BetterHomes scheme]." Accessed: Mar. 20, 2024. [Online]. Available: https://sparenergi.dk/privat/velkommen-til-bedrebolig
374. Danish Energy Agency, "Videncenter for Energibesparelser i Bygninger [Knowledge Center for Energy Savings in Buildings]." Accessed: Mar. 20, 2024. [Online]. Available: https://byggeriogenergi.dk/
375. Danish Energy Agency, "Bygningspuljen [Building Fund]." Accessed: Apr. 02, 2024. [Online]. Available: https://ens.dk/service/tilskuds-stoetteordninger/bygningspuljen

INDUSTRY SECTOR

Best practices

- CHP for electricity and district heating
- Waste heat for district heating, industrial processes, and CHP plants'Use of energy management systems
- More efficient processes and technologies
- Energy taxes on business energy consumption for process purposes
- Mandatory energy audits in large enterprises
- Scheme for energy saving by energy companies

Good practices

- Electrification of industrial processes
- Subsidy for the use of renewable energy in production processes
- The centre for energy savings in enterprises
- The business poll scheme for private enterprises

References[376], [377], [378], [379], [380], [381]

376. Mure Database, "Increase in energy tax rates on business as part of Green Tax Reform - Denmark." Accessed: Apr. 17, 2024. [Online]. Available: https://www.measures.odyssee-mure.eu/energy-efficiency-policies-database.html#/measures/4372
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379. Mure Database, "Renewable energy for production processes - Denmark." Accessed: Apr. 17, 2024. [Online]. Available: https://www.measures.odyssee-mure.eu/energy-efficiency-policies-database.html#/measures/1083
380. Mure database, "Centre for energy savings in enterprises - Measure Detail." Accessed: Nov. 22, 2024. [Online]. Available: https://www.measures.odyssee-mure.eu/energy-efficiency-policies-database.html#/measures/1085
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2.2 Finland

BUILDING SECTOR

Best practices

- Highly insulated and airtight building envelope
- Energy-efficient windows
- Mechanical ventilation with heat recovery
- Heat pumps for house heating (prevalence of air and ground-source heat pumps)
- Energy-efficient appliances and lighting
- Building code for new buildings and building energy efficiency decree for renovation
- Energy efficiency agreements (for oil-heated buildings and the property and building sector)
- Window energy-rating system
- Subsidies for energy efficiency in buildings

Good practices

- District heating systems
- Building energy labelling

References[382], [383], [384], [385], [386], [387]

382. Finnish Ministry of the Environment, "1010/2017 Decree of the Ministry of the Environment on the Energy Performance of New Buildings," 2017. [Online]. Available: https://ym.fi/documents/1410903/35099218/1010+2017+YMA_uuden_rakennuksen_energiatehokkuus+EN.pdf/87c893a5-08cf-cc7b-b2a1-90032ebb9368/1010+2017+YMA_uuden_rakennuksen_energiatehokkuus+EN.pdf?t=1680607785707
383. Energiatehokkuus-Sopimukset, "Energy Efficiency Agreements." Accessed: Apr. 19, 2024. [Online]. Available: https://energiatehokkuussopimukset2017-2025.fi/en/agreements/
384. Motiva Oy, "The energy classification of windows." Accessed: Apr. 19, 2024. [Online]. Available: https://www.motiva.fi/en/home_and_household/renovate_and_maintain/the_energy_classification_of_windows
385. ARA, "The housing Finance and Development Centre of Finland", Accessed: Apr. 02, 2024. [Online]. Available: https://www.ara.fi/en/
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387. Finnish Ministry of the Environment, *Ympäristöministeriön asetus rakennuksen energiatodistuksesta [Decree of the Ministry of the Environment on the energy certificate of the building]*, 2017. [Online]. Available: https://www.finlex.fi/fi/laki/alkup/2017/20171048

INDUSTRY SECTOR

Best practices	Good practices	References[388], [389], [390], [391]
• CHP for electricity and district heating • Use of energy management systems • Energy-efficiency agreements (industry, energy production and energy services) • Subsidies for energy audits and energy investments • Mandatory energy audits for large industries • Subsidised Energy Audit Programme for non-mandatory audit subjects • Energy efficiency requirements in environmental permits	• Electrification of industrial processes • Waste heat in industrial processes and district heating • Use of waste heat and heat pumps (to allow low-temperature sources) in district heating production • In-depth energy audit model for large industries • Energy-related guidance to industry (within the framework of energy efficiency agreements)	

388. Energiatehokkuus-Sopimukset, "Energy Efficiency Agreements." Accessed: Apr. 19, 2024. [Online]. Available: https://energiatehokkuussopimukset2017-2025.fi/en/agreements/
389. Mure Database, "Energy Audit Programme_industry - Finland." Accessed: Mar. 08, 2024. [Online]. Available: https://www.measures.odyssee-mure.eu/energy-efficiency-policies-database.html#/measures/1118
390. Motiva Oy, "Energy Audits." Accessed: Mar. 20, 2024. [Online]. Available: https://www.motiva.fi/en/solutions/policy_instruments/energy_audits
391. Mure database, "In-depth energy audits - Measure Detail." Accessed: Nov. 22, 2024. [Online]. Available: https://www.measures.odyssee-mure.eu/energy-efficiency-policies-database.html#/measures/4476

2.3 Iceland

BUILDING SECTOR

Best practices	Good practices	References[392], [393], [394], [395]
• Energy-efficient appliances and lighting • Geothermal heating systems • Building regulation for new buildings and major renovations • Capital funding of new geothermal district heating systems	• Energy-efficient windows • Mechanical ventilation with heat recovery; heat pumps for house heating • Subsidy for home heating; subsidy for heat pumps • Green financing for energy efficiency in buildings	

392. Icelandic Housing and Construction Authority, *Byggingarreglugerð [Building Regulation] nr. 112/2012*, 2012. [Online]. Available: https://hms-web.cdn.prismic.io/hms-web/e7b857b3-e3fe-402b-ac4a-31d3e720c9b6_uppfaerd-byggingarreglugerd-eftir-11-breytingu.pdf
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395. Icelandic Energy Authority, "Energy Reducing Equipment." Accessed: Apr. 02, 2024. [Online]. Available: https://orkustofnun.is/en/energy_transition/subsidies/energy_equipment

INDUSTRY SECTOR

Best practices	Good practices	References[396], [397], [398]
• Geothermal energy in district heating networks and industrial processes • Grants and loans to increase the use of geothermal resources	• Waste heat in industrial processes • Energy fund for industrial energy conversion projects • Green tax incentives for businesses • Public support for agricultural, land use, and forestry activities • Energy audits and assessments • Use of energy management systems	

396. Icelandic Ministry of Industries and Innovation, "The Icelandic National Renewable Energy Action Plan for the promotion of the use of energy from renewable sources in accordance with Directive 2009/28/EC and the Commission Decision of 30 June 2009 on a template for the national renewable energy action plans," 2014. [Online]. Available: https://energy.ec.europa.eu/system/files/2014-11/dir_2009_0028_action_plan_iceland__nreap_0.pdf
397. Icelandic Energy Authority, "Energy Fund." Accessed: Apr. 02, 2024. [Online]. Available: https://orkustofnun.is/en/energy_transition/energy_fund
398. *Use of economic instruments in Nordic environmental policy 2018-2021*. Copenhagen: The Nordic Council of Ministers, 2023.

2.4 Norway

BUILDING SECTOR

Best practices

- Highly insulated and airtight building envelope
- Energy-efficient windows
- Mechanical ventilation with heat recovery
- Heat pumps for house heating (prevalence of air-source heat pumps)
- Energy-efficient appliances and lighting
- Building technical regulation for new buildings and major renovations
- Incentives for energy measures in households (Enova)

Good practices

- Building energy labelling
- Energy information helpline (Enova svaretjeneste)
- The Norwegian State Housing Bank's (Husbanken) incentives
- Norwegian standards for passive houses and low-energy buildings

References[399], [400], [401], [402], [403], [404], [405]

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404. Norwegian State Housing Bank, "Tilskot til energitiltak i kommunale bustader [Grants for energy measures in municipal housing]." Accessed: Nov. 01, 2024. [Online]. Available: https://www.husbanken.no/kommune/lan-og-tilskudd/tilskudd-energitiltak/
405. Standards Norway, "NS 3701: Criteria for passive houses and low energy buildings - Non-residential buildings (in Norwegian)," Lysaker, Norway, 2012.

INDUSTRY SECTOR

Best practices	Good practices	References[406], [407], [408], [409], [410], [411]
• Use of energy management systems • Financial support for energy measures in the industry • Financial support for new energy and climate technologies in the industry • Financial support for heating plants	• Waste heat in industrial processes through heat pumps • Mandatory energy audits in large industries • Energy and environmental taxes, with tax exemption for energy-intensive industries • Energy information helpline (Enovas svartjeneste)	

406. Enova, "Project List 2012-2023 [Project List 2012-2023]." [Online]. Available: https://www.enova.no/om-enova/om-organisasjonen/prosjektliste-2012-2023/
407. Enova, "Support for industry." Accessed: Dec. 09, 2024. [Online]. Available: https://www.enova.no/bedrift/industri-og-anlegg/
408. Enova, "Project List 2012-2023 [Project List 2012-2023]." [Online]. Available: https://www.enova.no/om-enova/om-organisasjonen/prosjektliste-2012-2023/
409. International Energy Agency (IEA), *Norway 2022. Energy Policy Review*. in IEA Energy Policy Reviews. Paris, France: OECD Publishing, 2022. doi: 10.1787/7411c642-en.
410. The Norwegian Government, "Agreement on the CO2 compensation scheme until the end of 2030." Accessed: Nov. 22, 2024. [Online]. Available: https://www.regjeringen.no/no/aktuelt/enighet-om-co2-kompensasjonsordningen-ut-2030/id3029857/
411. Enova, "Enova's advisory service." Accessed: Mar. 20, 2024. [Online]. Available: https://www.enova.no/om-enova/kontakt-oss/

2.5 Sweden

BUILDING SECTOR

Best practices

- Highly insulated and airtight building envelope
- Energy-efficient windows
- Mechanical ventilation with heat recovery
- Heat pumps for house heating
- Energy-efficient appliances and lighting
- Building code for new buildings and major renovations
- Energy and carbon dioxide tax in the household sector and tax deduction for renovation
- Programme for buildings with very low energy use (LÅGAN)

Good practices

- Use of biomass heating systems
- District heating systems
- Building energy labelling
- Technology procurement groups (e.g. Belok, Bebo)

References[412], [413], [414], [415], [416], [417], [418]

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416. Swedish Ministry of Climate and Enterprise, *Lag (2006:985) om energideklaration för byggnader [Law (2006:985) on energy performance certificates for buildings]*, 2006.
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INDUSTRY SECTOR

Best practices	Good practices	References[420], [421], [422], [423]
• Combined heat and power for electricity and district heating • Use of energy management systems • Waste heat for district heating and industrial processes • The energy step programme (Energisteget) • Programme for energy efficiency in the energy-intensive industry (PFE) • Mandatory energy audits in large companies	• Electrification of industrial processes • District heating systems as supplementary heat • Energy efficiency networks for SMEs[419]	

419. S. Paramonova and P. Thollander, "Energy-efficiency networks for SMEs: Learning from the Swedish experience," *Renewable and Sustainable Energy Reviews*, vol. 65, pp. 295–307, Nov. 2016, doi: 10.1016/j.rser.2016.06.088.
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421. Swedish Energy Agency, "Programmet för energieffektivisering. Erfarenheter och resultat efter fem år med PFE [The program for energy efficiency. Experiences and results after five years with the PFE]," 2011. [Online]. Available: https://www.energimyndigheten.se/effektiv-energianvandning/foretag/energikartlaggning/energikartlaggning-i-stora-foretag/#:~:text=Den%201%20juni%202014%20tr%C3%A4dde%20lagen%20om%20energikartl%C3%A4ggning,Energimyndigheten%20ansvarar%20f%C3%B6r%20f%C3%B6reskrifter%20och%20tillsyn%20av%20lagen.
422. Swedish Energy Agency, *Lagen om energikartläggning i stora företag (EKL) [The law on energy mapping in large companies (EKL)]*. Accessed: Mar. 20, 2024. [Online]. Available: https://www.energimyndigheten.se/energieffektivisering/jag-vill-energieffektivisera-min-organisation/energikartlaggning/energikartlaggning-i-stora-foretag/
423. S. Paramonova and P. Thollander, "Energy-efficiency networks for SMEs: Learning from the Swedish experience," *Renewable and Sustainable Energy Reviews*, vol. 65, pp. 295–307, Nov. 2016, doi: 10.1016/j.rser.2016.06.088.

Appendix 3: Questionnaire on barriers for Nordic energy efficiency

3.1 Descriptions and proposed questions

1. Awareness and familiarity across practitioners

Main question: How familiar are industry professionals and practitioners with national as well as EU regulations that embrace energy efficiency in the building or industry sector?

1.1 How do you perceive the level of awareness among industry professionals and practitioners regarding energy efficiency regulations and standards?

1.2 Which national or EU regulations that embrace energy efficiency are you aware of?

1.3 Which governmental incentives or programmes promoting energy efficiency in your region/country are you aware of? Mention some of them.

1.4 In your opinion, what specific actions or initiatives could be taken by governments to promote energy efficiency awareness? Please, select up to five (5) options that you consider most important.

- Public awareness campaigns
- Educational programmes
- Financial incentives
- Mandatory energy efficiency standard
- Energy labelling and certification
- International cooperation and development funding

1.5 a) How do you and other industry professionals currently stay updated on energy efficiency regulations and best practices? Please, select up to five (5) options that you consider most important.

- Government notifications and alerts
- Government websites and agencies
- Government-sponsored training programmes or incentives related to energy efficiency
- Actively engaging with government agencies or industry organizations responsible for setting regulations

- Online platforms and forums
- Attending conferences, webinars and courses
- Industry publications
- Professional associations
- Collaborating with consulting firms and experts
- Following relevant social media accounts and online forums
- Other

1.5 b) How could these mechanisms be improved? Please, select up to five (5) options that you consider most important.

- Increasing accessibility of online resources by centralizing information on a dedicated platform or website
- User-friendly mobile apps
- Collaboration with educational institutions
- Creating interactive online virtual communities
- Regular webinars and virtual events
- Providing incentives or subsidies for professionals to attend conferences, seminars, and training programmes related to energy efficiency
- Enhancing government-industry collaboration
- Integration with project management tools
- Open data initiatives
- Customized content delivery
- Other

1.6 Based on your experience, can you provide examples of successful strategies or programmes that have effectively increased awareness and understanding of energy efficiency among practitioners in your sector (building or industry) in your country?

Your answer can include any mechanism (financial or knowledge) from the past years. Please, state roughly the year that the mentioned programmes were active.

2. Addressing change

Main question: How can the efforts of the building and industry sector be driven towards energy efficiency?

2.1 a) Have you or your organization already implemented energy efficiency measures?

2.1 b) If so, what were the motivating factors? Please, select up to five (5) options that you consider most important.

- Return on investment
- Regulatory compliance (e.g. ESG-reporting)
- Corporate social responsibility
- Government incentives
- Health and well-being
- Job creation
- Customer expectations
- Employee engagement
- Environmental responsibility
- Other

2.2 What factors have prevented the implementation of energy-efficient measures in your organization? Please, select up to five (5) options that you consider most important.

- Budget constraints
- Return on investment uncertainty
- Lack of incentives
- Lack of awareness about energy efficiency potential
- Negative perception of new technologies
- Lack of expertise
- Prioritization of other projects
- Short-term focus
- Inadequate regulatory push
- Other

2.3 What do you consider as the main challenges industry professionals encounter when wanting to shift to energy-efficient systems and practices in building and industry projects?

Please, select up to five (5) options that you consider most important.

- Initial investment cost
- Return on investment uncertainty
- Long payback period
- Lack of incentives or rewards for adopting energy-efficient practices
- Uncertain technology lifespan
- Uncertain regulatory environment
- Regulatory barriers
- Resource and time costraints
- Concerns about potential disruptions to ongoing operations
- Resistance to change or inertia within organizations
- Lack of awareness and education
- Lack of skilled workforce
- Other

2.4 From your point of view, how can "your" sector`s efforts be directed on making energy efficiency a core element of their business models and operations?

Please, select up to five (5) options that you consider most important.

- More national financial support schemes
- More local financial support schemes
- Stricter regulations at national level
- Stricter regulations at EU level
- A more proactive information policy towards (end) users
- Stronger societal focus on benefits of energy efficiency measures
- Higher leadership commitment
- Regular energy audits and assessments
- Comprehensive strategy
- Other

2.5 How should we address decision factors (in management) that might hinder the implementation of measures?

2.6 What strategies or initiatives have been successful in encouraging industry professionals to adopt energy-efficiency in their projects?

2.7 In your experience, what are the most effective communication and marketing strategies for overcoming psychological resistance and encouraging energy-efficient practices among consumers, businesses, and industry stakeholders?

3. Incentive schemes

Main question: How can government incentive schemes become more effective across the target groups of consumers and industry?

3.1 In your experience, how well are government incentive programmes working to encourage energy efficiency in buildings and industries?

3.2 Does the regulatory framework in your country support and enable investments in energy efficiency?

3.3 How much support do the authorities at various levels provide for development and implementation of energy efficiency projects in your country?

a) At the national level

b) At the regional (provincial) level

c) At the local (municipal) level

3.4 What kind of legislation, policy or programmes does your country have to support (investments in) energy efficiency?

- Framework legislation (Law on energy efficiency or equivalent)
- By-laws (secondary legislation) on energy efficiency (meaning legislations tailored to address specific regional or local needs, conditions, and priorities
- Standards on energy efficiency
- Government programmes and policies to support investments in energy efficiency
- Energy efficiency labeling and certification
- Energy performance contracts (EPCs)
- Voluntary agreements
- Public procurement policies
- Other

3.5 What barriers or limitations do government incentive schemes face when targeting different segments of consumers and industry professionals in your country?

Please, select up to five (5) options that you consider most important.

- Diverse market needs
- Lack of awareness
- Complexity of application process

- Bureaucratic hurdles
- Long payback periods
- Competing priorities
- Limited access to information
- Policy and regulatory uncertainty
- Other

3.6 Can you provide examples of innovative incentive schemes, whether locally or internationally, that have demonstrated success in driving energy efficiency adoption in "your" sector (buildings or industries)?

3.7 What specific improvements or changes can be made to government incentive schemes to make them more effective in driving energy efficiency?

Please, select up to five (5) options that you consider most important.

- Simplified application processes
- Increased funding and budget certainty
- Tailored incentives for different sectors
- Flexible financing options
- Public awareness campaigns
- Continuous programme evaluation
- Performance-based incentives
- Feedback mechanisms
- Tax incentives and deductions
- Other

3.8 Have you or your organization ever participated in a government incentive programme related to energy efficiency?

- Yes (if yes, please tick the last box and state which programmes you participated in)
- No
- I don`t know
- Other

3.9 What do you believe are the main barriers or challenges preventing you or your organization from taking advantage of such incentive schemes?

Please, select up to five (5) options that you consider most important.

- Complex application processes
- Uncertainty about returns
- Perceived disruption to operations
- Lack of technical expertise
- Inadequate information on benefits
- Skepticism about effectiveness
- Competing priorities
- Regulatory uncertainty
- Other

3.10 How can policymakers and stakeholders collaborate more effectively to design and implement incentive schemes that encourage energy-efficiency practices across the building and industry sector?

Please, select up to three (3) options that you consider most important.

- Engage stakeholders early and often
- Transparent communication
- Provide education and training
- Public-private partnerships
- Regular evaluation and adjustment
- Demonstrate success stories
- Other

3.11 a) Does your country have institutions at the national level responsible for developing and/or implementing policies supporting investments in energy efficiency projects?

- Yes (If Yes, please tick the last box and name these institutions (e.g. energy efficiency agency, unit at the ministry of energy, energy efficiency fund, etc.))
- No
- More...

3.11 b) How effective are these institution(s)?

3.12 What are, in your opinion, the main barriers to increasing investment and financing flows to energy efficiency projects in your country?

Please, select up to five (5) options that you consider most important.

- Lack of specific policies, programmes, legislation, by-laws, norms and standards
- Inadequate implementation and enforcement of existing policies and legislation
- Administrative barriers, bureaucracy
- Political/economic instability in the country
- High interest rates for energy efficiency projects
- Too low energy prices
- Difficulties with obtaining commercial loans and other types of financing
- Lack of understanding of energy efficiency financing by banks or other financial institutions
- Low awareness about the multiple benefits of energy efficiency projects
- Lack of technical expertise and capacity to identify/evaluate/implement projects
- Other

3.13 What are, in your opinion, the main business benefits to your organisation/company from implemented energy efficiency measures?

Please, select up to five (5) options that you consider most important.

- General cost control
- Risk management – hedging against volatile energy costs
- Demonstrate corporate social responsibility
- Comply with legislation
- Comply with requests from shareholders, customers and/or suppliers
- Improve production efficiency and quality
- Ensure security of power supply
- Other – please specify

3.14 What are, in your opinion, the main barriers that your organisation/company faces when considering investment in energy efficiency?

Please, select up to five (5) options that you consider most important.

- Energy costs too low to provide economic incentive
- Lack or high upfront capital cost
- High Investment risk
- Lack of information on energy efficiency opportunities

- Little or no government policy
- Insufficient management commitment or unfavourable company environment
- Lack of in-house technical expertise
- Lack of government incentives
- Low priority as not part of the core business
- Other

10.3 In your experience, what strategies or interventions have been effective in addressing behavioural and psychological barriers among consumers and industry professionals regarding energy efficiency?

3.2 Detailed analysis of findings

Awareness and familiarity across practitioners

The ***main question*** was how familiar industry professionals and practitioners are with national as well as EU regulations that embrace energy efficiency in the building or industry sector.

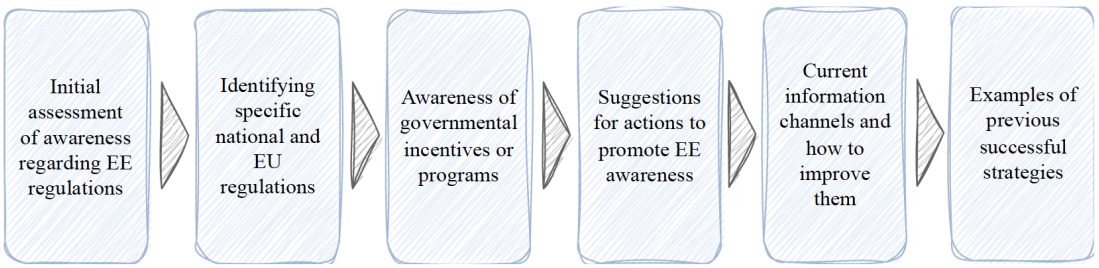


Figure A 1. Sequential approach to investigate the awareness and familiarity with EE regulations across practitioners.

A sequence of questions helped establish a comprehensive understanding of the level of awareness and the effectiveness of existing mechanisms, while also gathering insights on potential improvements. This structured approach, presented in Figure A1, enabled a thorough exploration of the topic, progressing from general awareness to specific knowledge and suggestions for enhancement.

The ***first question*** aimed to understand what the perceived awareness among industry professionals regarding existing energy efficiency regulations is. Approximately 43% of the respondents perceived the level of awareness as average, answering 3 on a scale from 1 (not aware) to 5 (fully aware). The majority of the respondents perceived the level of awareness among professionals rather high, answering 4 on the same scale. Respondents from Iceland and the Faroe Islands rated the level of awareness as very low, which may be attributed to the fact that they are not members of the EU. This initial question confirmed the overall perception that professionals are mostly aware of energy efficiency regulations, but that there are differences between the Nordic countries.

The ***second question*** was an open question and asked which specific regulations that embrace energy efficiency the respondents were aware of. The responses can be broken down into two parts: i) the most commonly mentioned directives and regulations, and ii) a general understanding of the geographical spread and specificity of the answers. The responses frequently mentioned a few key directives:

- The EED was mentioned by 13 out of 21 respondents, reflecting its broad impact and recognition across EU member states as a core component of energy efficiency legislation.
- Almost as commonly recognised as the EED, the EPBD (11 out of 21) focuses specifically on improving the energy performance of buildings within the EU.
- The eco-design directive appeared in several responses (5 out of 21), indicating awareness of regulations aimed at improving the energy efficiency of products through design requirements.

Various national laws and regulations were mentioned, demonstrating a mix of knowledge on both EU-wide directives and country-specific laws, such as the Swedish Building Regulations (BBR), the Finnish National Building Code and Danish Building Regulations. Some responses indicated a robust understanding of both EU and national regulations, while others showed a more limited or specialised awareness. A few responses explicitly stated a lack of familiarity with specific regulations or mentioned only very broad themes, such as building codes or national laws without specific references. The responses included references from various EU countries, including Sweden, Finland, Denmark, and non-specific EU references. This variety shows both common EU directives and varied national approaches to implementing energy efficiency. There was also an indication of awareness outside the EU, as shown by the mention from the Faroe Islands highlighting peripheral knowledge of EU directives despite non-membership.

The ***third question*** was also an open question and asked about governmental incentives or programmes promoting energy efficiency. Respondents listed a variety of energy efficiency programmes and incentives specific to their regions or

countries. The programmes mentioned included both broad initiatives and very specific projects aimed at enhancing energy efficiency. The responses illustrated that awareness of incentives was closely tied to local or national contexts. There were mentions of initiatives for each Nordic country reflecting the geographical diversity of the respondents. The responses suggested a robust awareness of local programmes, which vary significantly in their nature and scope. These range from grants and financial incentives to strategic agreements and technology-specific initiatives (such as those for PV cells and energy storage). It appears that in each country, the respondents were primarily aware of the programmes directly impacting their sector or local area, highlighting the localised approach to promoting energy efficiency.

Question 1.4 asked about specific actions or initiatives that governments could take to promote energy efficiency awareness. A variety of actions was suggested, and the respondents were allowed to select up to five options. Financial incentives and energy labelling and certification were among the most frequently mentioned initiatives, indicating a strong belief in their effectiveness for enhancing public awareness and compliance with energy efficiency standards. Research and development funding and public awareness campaigns were highly regarded, suggesting that both direct financial support for technological innovation and efforts to educate the public were seen as crucial. Mandatory energy efficiency standards were noted as a tool, which implies a need for regulatory measures alongside educational and financial incentives. Educational programmes and international cooperation were seen as less important, being less frequently mentioned compared to other options.

The ***next question*** targeted methods for staying updated on energy efficiency regulations. Again, a variety of actions was suggested, and the respondents were allowed to select up to five options. The methods were quantified by how often each was mentioned across responses. The use of *consulting firms and experts* was the most common method, followed by *attending conferences, webinars, and courses*. *Following government notifications and alerts* and *engagement with government agencies or organisations* were also commonly used. *Online platforms and forums, industry publications, and social media and online forums* were used to varying extents.

In direct connection to the previous question, the ***follow-up question*** was about improving mechanisms to keep industry professionals updated on energy efficiency regulations and best practices.

The findings indicate that while professionals actively utilise a range of methods to stay informed, there is a strong call for more integrated, accessible, and interactive tools. The emphasis on online resource accessibility and the popularity of webinars and virtual events in the suggestions for improvement reflect a significant interest

in digital solutions that streamline information gathering and learning processes. This shift towards digital platforms can also be linked to broader trends in workplace digitisation and remote learning, accelerated by recent global events, such as the COVID-19 pandemic. The responses also suggest that while current methods are valued, there is a perceived gap in how these methods integrate with each other and how easily accessible they are. Improvements in government-industry and educational collaborations indicate a desire for a more cohesive regulatory framework and educational outreach, which could help in bridging the gap between current practices and the ideal state as envisioned by the respondents. The findings underscore the importance of adaptive and forward-thinking strategies in the dissemination of regulatory and best practice information in the field of energy efficiency, with a clear leaning towards enhancing digital accessibility and collaborative efforts.

The ***final question*** asked for the personal experience of the respondents regarding previous successful strategies or programmes that enhanced the awareness of industry professionals on energy efficiency regulations. Various examples of successful strategies or programmes in the building or industrial sectors within different countries were mentioned. Among the strategies mentioned, *national programmes and incentives* played a significant role. Examples included the national procurement programmes for energy efficiency, such as those overseen by NUTEK in Sweden, which have historically set benchmarks for promoting energy efficiency technologies. Another notable programme was TETS in Finland, a voluntary energy saving agreement involving major real estate owners, which has been active since 1995. This programme has demonstrated the long-term commitment necessary for sustained improvements in energy practices.

Research and development initiatives also emerged as critical components of successful strategies. Initiation projects supported by the Research Council of Norway highlighted the role of innovation in promoting energy efficiency through the development of new building technologies. In Denmark, the Danish Energy Agency was active in developing and promoting state-of-the-art demonstration projects, although such initiatives have decreased over time. *Public awareness campaigns* are another effective strategy. The 'Down a degree' ('Astetta alemmas') campaign in Finland focused on lowering energy use and engaged the public directly to improve energy literacy. Similarly, the Orkusetur initiative in Iceland, originally funded through an EU project, was successful in promoting energy efficiency through various outreach efforts.

Economic incentives, even when indirectly related to energy efficiency, can also foster a broader energy-conscious mindset among practitioners. These incentives encourage a shift towards renewable energy sources, which indirectly supports energy efficiency measures by promoting a more holistic approach to energy usage.

From the examples provided, it is evident that successful strategies for promoting energy efficiency awareness combine policy support, economic incentives, technical innovation, and public engagement. A multifaceted approach appears essential, utilising sustained governmental programmes, innovative research projects, and targeted public campaigns to create an environment conducive to ongoing improvement and widespread understanding of energy efficiency practices. This holistic approach not only educates and engages practitioners and the public but also establishes a framework for continuous advancement in energy efficiency.

Addressing change

The ***main question*** was how the efforts of the building industry sector could be driven towards energy efficiency.

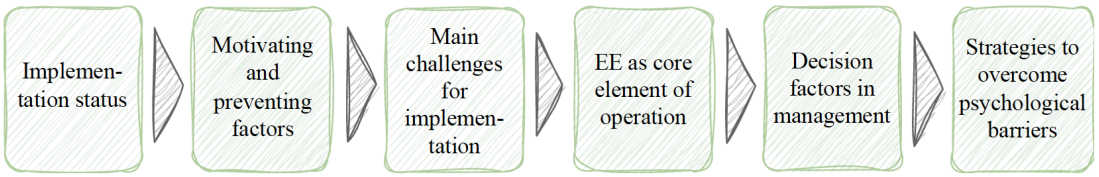


Figure A 2. Sequential approach to investigate how to address a change towards widespread implementation of energy efficiency measures.

A sequence of questions facilitated a comprehensive understanding of the motivating and hindering factors for implementing energy efficiency measures, as well as strategies to address change and overcome psychological barriers in companies.

The ***first question*** asked for the level of implementation of energy efficiency measures by respondents' organisations. The responses were based on a Likert scale (1 to 5) where higher values indicated a greater degree of implementation. Among the 22 respondents, 17 reported a high level of implementation, answering 3 or higher. The survey showed a generally positive trend towards the adoption of energy efficiency measures among the surveyed entities, with a significant proportion reporting moderate to high implementation levels.

The ***second question*** aimed to understand the motivating factors for the implementation of energy efficiency measures. Several answer possibilities were proposed, and respondents could choose up to five answers. *Return on investment* and *environmental responsibility* were the most frequently cited reasons, each mentioned by 13 respondents (60%). *Corporate social responsibility* followed closely with 12 mentions (55%) and *regulatory compliance* (e.g., ESG-reporting) was also a

significant factor for 11 respondents (50%). Less frequently mentioned, but still notable, were *government incentives*, *customer expectations*, *health and well-being*, and *employee engagement*, each cited in several responses.

The ***follow-up question*** targeted the barriers for implementation of energy efficiency measures. The key preventive factors that have hindered the implementation of energy efficiency measures within organisations were *budget constraints*, which represented the most frequently cited barrier (55%). This indicates that financial limitations significantly impact organisations' ability to adopt energy-efficient practices. Additionally, *uncertainty about the return on investment* was a major concern (36%), as many respondents doubted the financial returns on such investments. Other significant factors included the *prioritisation of other projects* (50%), suggesting that energy efficiency often competes with other business initiatives for resources. A *short-term focus* within some organisations also prevented the adoption of practices that could provide long-term sustainability benefits. *Lack of incentives and expertise* were also considerable barriers, highlighting the need for external support and internal capabilities to implement these measures. Lastly, *inadequate regulatory push* and a *lack of awareness about the potential of energy efficiency* revealed opportunities for policy improvement and education to enhance adoption rates. The survey highlights the need for multifaceted strategies to address these barriers, including better financial incentives, regulatory support, and awareness campaigns to increase the adoption of energy efficiency measures.

The main challenges industry professionals encounter when wanting to shift to energy-efficient systems and practices in building and industry projects are part of the ***next question***. The survey reveals that *initial investment costs* (68%) and *long payback periods* (60 %) are prominent concerns, cited by many respondents. Additionally, there is a significant focus on the *return-on-investment uncertainty* (40%), which reflects financial risk perceptions related to energy efficiency investments. *Resistance to change* or *inertia within organisations* also appeared as considerable challenges, illustrating the cultural and structural barriers to adopting new technologies or practices. Other notable challenges included *concerns about potential disruptions to ongoing operations* and a *lack of incentives or rewards for adopting energy-efficient practices* (55%). These factors collectively highlight the complex array of internal and external barriers that must be navigated to enhance the adoption of energy-efficient solutions in the industry.

The ***sixth question*** aimed to understand how efforts can be directed to making energy efficiency a core element of the sectors' business models and operations. The survey revealed that *stricter regulations* at both the *national* (50%) and *EU levels* (32%) were frequently cited as necessary approaches. This indicates a belief that more robust legal frameworks could drive compliance and integration of energy-efficient practices. *Higher leadership commitment* (40%) was also seen as

crucial, reflecting the need for top-down encouragement and prioritisation of energy efficiency. *Regular energy audits and assessments* were mentioned multiple times (27%), suggesting that ongoing monitoring and optimisation are key to embedding energy efficiency within operational practices. *National financial support schemes* were noted as significant enablers (73%), alongside *a more proactive information policy towards end users* (50%), which could help raise awareness and foster an environment supportive of energy efficiency measures. These insights indicate a comprehensive approach involving regulatory, financial, and educational strategies to promote energy efficiency more effectively within the industry.

The responses to the ***next question,*** on how decision factors (in management) that might hinder the implementation of measures should be addressed, illustrated diverse perspectives on overcoming management-related obstacles in implementing energy efficiency measures. The question was formulated in an open way so that respondents had to provide an answer themselves. Each respondent provided unique insights, reflecting the complexity of integrating such strategies into business practices. The responses ranged from advocating for *the use of life-cycle cost (LCC) methods* and emphasising energy efficiency as a regular part of management evaluation, to calling for *stronger leadership commitment and increasing financial incentives*. Several responses suggested *enhancing stakeholder engagement* and *promoting demonstration projects to showcase the benefits* of best available technologies (BAT). Others emphasised the need for *comprehensive management strategies* that include financial, market, social, and health considerations. A recurring theme suggested that *improving information dissemination* about the success of ongoing projects and the potential benefits of energy efficiency could help shift management perspectives. Some responses also highlighted the importance of *aligning energy efficiency with organisational goals* through regulatory frameworks or more focused management practices.

The responses to the ***question*** 'What strategies or initiatives have been successful in encouraging industry professionals to adopt energy efficiency in their projects?' highlighted a range of successful approaches that have promoted the integration of energy efficiency within industry settings. The respondents were asked to formulate their own answer. Several respondents emphasised the importance of *financial incentives such as energy tax cuts, green bonds, and subsidy schemes* that align the economic benefits with energy efficiency goals, making such projects financially attractive. The use of *free audits and expert support teams* were mentioned as critical mechanisms, providing the necessary expertise and guidance to help industries understand and implement energy efficiency measures effectively. *Regulatory tools*, such as national building codes, were praised for setting high standards that require energy efficiency as a compliance norm, pushing industries towards greener practices. *Education and awareness campaigns* had played a substantial role in shifting industry perspectives, making professionals

more aware of the benefits and necessities of energy efficiency. *Cross-sectorial collaboration* and *sharing of best practices*, particularly through demonstration projects, such as those involving industrial heat pumps, were also mentioned as effective.

The ***last question*** of this section asked for the respondents' experience on what the most effective communication and marketing strategies were for overcoming psychological resistance and encouraging energy-efficient practices among consumers, businesses, and industry stakeholders. Respondents highlighted the effectiveness of storytelling and personal narratives as powerful tools to connect emotionally with stakeholders, making the benefits of energy-efficient practices more tangible and relatable. Several responses underscored the importance of showing quantitative results and case studies that detail the financial payoffs and other benefits, suggesting that concrete data and examples can significantly reduce psychological barriers. *Education and open dialogue* about the advantages and potential drawbacks of energy efficiency were also considered critical. This approach helped in setting realistic expectations and addressing any misconceptions directly, which can enhance stakeholder engagement and acceptance. The *use of benchmarking* was mentioned as a method to create competitive and motivational incentives for adopting energy efficiency, by showing how businesses or consumers stack up against peers. Industry-specific approaches, such as *targeted marketing by associations to their members*, and hosting *site visits and conferences* were strategies that had been used to effectively spread the message within particular sectors. *Communication during crisis situations*, such as the recent energy crises, where the relevance of energy efficiency becomes even more pronounced due to high and fluctuating energy prices, was noted as particularly effective. This scenario naturally drives the conversation about energy consumption and can be leveraged to promote energy-efficient solutions. These strategies collectively emphasise the need for a multifaceted approach that combines *emotional engagement, factual education, competitive benchmarking, and timely communication* to effectively address psychological barriers and motivate diverse stakeholders towards energy-efficient practices.

Incentive schemes

The ***main question*** was how government incentive schemes can become more effective across the target groups of consumers and industry.

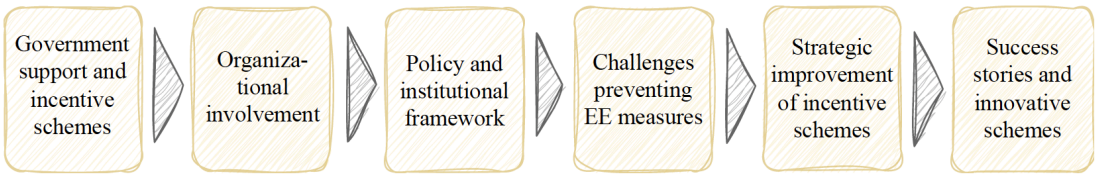


Figure A 3. Sequential approach to investigate how to improve incentive schemes towards widespread implementation of energy efficiency measures.

A sequence of questions helped establish a comprehensive understanding of how to improve incentive schemes to reach a more widespread implementation of energy efficiency measures.

The ***first question***, 'In your experience, how well are government incentive programmes working to encourage energy efficiency in buildings and industries?', received a range of responses on a scale from 1 to 5, where 1 represented 'least effective' and 5 represented 'most effective'. The responses showed a general leaning towards the effectiveness of government incentive programmes, with the majority rating them as 4 (13 out of 22), implying good effectiveness. The average rating (3.4), slightly above neutral, further supported this view, indicating overall positive feedback about the incentive programmes' impact on promoting energy efficiency in buildings and industries. This analysis provides a clear indication that while there is some room for improvement, the incentive programmes were generally viewed as beneficial by the majority of respondents.

The ***next question***, 'Does the regulatory framework in your country support and enable investments in energy efficiency?', received varied responses on a scale from 1 to 5, where 1 signified 'strongly disagree' and 5 signified 'strongly agree'. The responses to this question revealed diverse opinions across Nordic countries. Many respondents agreed or remained neutral, but a notable number expressed disagreement, indicating a critical perspective. While opinions generally leaned towards a neutral or slightly positive view, Iceland clearly showed dissatisfaction, highlighting varied experiences and needs related to regulatory support in these countries. This mixed feedback suggests the need for a possible re-evaluation or adjustment in the regulatory frameworks to better support and encourage investments in energy efficiency, reflecting the diverse experiences and perceptions of the respondents.

The ***third question*** explored the support provided by authorities at various levels (national, regional/provincial, and local/municipal) for the development and implementation of energy efficiency projects. The national level showed slightly higher (mean 2.8) support than regional (mean 2.0) and local levels (mean 2.2 each), suggesting more positivity in perceptions of national support for energy efficiency projects. At the regional level, the support was perceived as the least favourable, with the lowest mean score, indicating strong disagreement about adequate support. The local level scores were similar to the national but still indicated an overall perception of insufficient support, closely mirroring the regional level. The analysis indicates that respondents generally perceived a lack of sufficient support across all levels of government, with the regional level viewed as the least supportive for energy efficiency projects. This suggests potential areas for improvement in policy and support frameworks at regional and local levels to better align with national efforts or perceptions.

The ***fourth question*** focused on legislative, and policy supports for energy efficiency measures.

The analysis of responses regarding the types of legislative and policy support for energy efficiency investments showed a comprehensive approach across different countries. Government programmes and policies were the most frequently cited form of support, appearing in 14 responses, which highlights their central role in national energy strategies. Close behind were energy efficiency labelling and certification, and standards on energy efficiency, mentioned in 13 and 12 responses, respectively. These measures are crucial for promoting and standardising energy efficiency practices. Framework legislation, such as laws on energy efficiency, was also prominent, featured in 10 responses, indicating that foundational legal frameworks are commonly in place. Public procurement policies, which encourage energy-efficient choices in government procurement, appeared in nine responses, underscoring their importance in driving market demand for efficient products and services. Voluntary agreements were noted in six responses, suggesting that some countries rely on collaborations with industry stakeholders to exceed baseline regulatory requirements. The survey revealed a mix of mandatory regulations and voluntary initiatives, pointing to a multifaceted approach to fostering energy efficiency. The varied responses underscore the importance of a layered policy framework that includes both broad legislation and specific programmes tailored to local or regional needs.

The ***fifth question*** targeted barriers and limitations that government incentive schemes face when addressing different segments of consumers and industry professionals. The analysis of responses highlights several barriers and limitations that government incentive schemes for energy efficiency face, each varying in importance and impact. *Bureaucratic hurdles* emerged as the most critical barrier, mentioned by the highest number of respondents, which indicates a prevalent issue

with administrative complexities that significantly impede the effectiveness of these schemes. *Competing priorities*, which include the need to balance energy efficiency with other pressing economic, political, or social goals, also represented a major challenge, as they were nearly as frequently cited as bureaucratic hurdles. *Long payback periods* stood out as another significant economic barrier, suggesting that the slow return on investment discourages participation in energy efficiency projects. This was closely followed by *diverse market needs*, underscoring the inadequacy of one-size-fits-all approaches and highlighting the necessity for schemes that are adaptable to varied consumer requirements. *Complexity of the application process* and *lack of awareness* were also substantial barriers, indicating that both the procedural difficulties in accessing schemes and insufficient knowledge about them hinder effective participation. *Policy and regulatory uncertainty*, although mentioned less frequently, still posed a considerable challenge by creating an unstable investment climate. *Limited access to information*, although not as prevalent as other barriers, still critically affected the ability of consumers and professionals to engage fully with energy efficiency initiatives. Minor issues, such as poorly constructed incentive schemes and inadequate budget allocation, while mentioned infrequently, pointed to specific areas that could be addressed to enhance the effectiveness of incentive programmes.

In the ***sixth question***, the respondents were asked to provide information regarding innovative incentive schemes that were successful in promoting energy efficiency in the building and industry sectors. The respondents provided specific examples reflecting both success stories and challenges. One example of a specific method mentioned was the *total concept method*[424], which was proposed for non-residential building projects. This approach is designed to promote significant energy savings in existing buildings through an integrated package of measures, ensuring the investments are financially viable, based on the savings achieved in energy costs. This method focuses on maximising energy savings with a calculative approach to investment and payback. *EENet*[425] was mentioned as an effective and appreciated tool for SMEs to collaborate on energy efficiency matters. The Swedish *programme for energy efficiency in energy-intensive industry (PFE)*[426] is mentioned by two out of four Swedish respondents. Respondents from Denmark mentioned the *Energy Efficiency Obligation schemes with binding commitments for energy companies*[427] as a successful incentive scheme. Norwegian respondents mentioned *ENOVA's programmes* as the main source for the provision of incentive schemes.

424. Total Concept Method, "Major reduction of energy use in non-residential Buildings." Accessed: Apr. 20, 2024. [Online]. Available: https://totalconcept.se/
425. European Commision, "Enterprise Europe Network (EEN)." Accessed: Apr. 20, 2024. [Online]. Available: https://een.ec.europa.eu/
426. Swedish Energy Agency, "Programmet för energieffektivisering. Erfarenheter och resultat efter fem år med PFE [The program for energy efficiency. Experiences and results after five years with the PFE]," 2011. [Online]. Available: https://energimyndigheten.a-w2m.se/System/TemplateView.aspx?p=Arkitektkopia&id=b1b49f2d3ad6467e83dad1c60fcaced6&q=pfe&lstqty=1
427. Danish Energy Agency, "Afrapportering af energispareordningen [Reporting on the Energy Saving Scheme]," 2022. [Online]. Available: https://ens.dk/forsyning-og-forbrug/energiselskabernes-energispareindsats

The ***next question*** aimed to understand which specific improvements or changes could be made to government incentive schemes to make them more effective in driving energy efficiency. From the 22 respondents, 15 proposed *increased funding and budget certainty*, followed by *tax incentives and deductions* (12 out of 22), and *tailored incentives for different sectors* (11 out of 22). To a lesser extent, *flexible financing options* (8/22), *simplified application processes* (6/22), *public awareness campaigns* (6/22) and *performance-based incentives* (6/22) were chosen.

For the **following question** on perceived main barriers or challenges that prevent the respondents' organisation from taking advantage of relevant incentive schemes, the respondents were allowed to choose up to five options. The main barriers were *competing priorities* (8/22), *complex application processes* (7/22) and *uncertainty about returns* (5/22). *Perceived disruption to operation* (3/22), *lack of technical expertise* (2/22) or *inadequate information on benefits* (2/22) were voted for to a lower extent.

The ***next question*** aimed at understanding how policymakers and stakeholders can collaborate more effectively to design and implement incentive schemes that encourage energy efficiency practices across the building and industry sector. The respondents were allowed to choose up to three options. The two main drivers were *engaging stakeholders early and often* (16/22) and *demonstrating success stories* (15/22). Other measures, such as *transparent communication, providing education and training,* and *public-private partnerships* each received 7 votes.

Another question investigated which institution at national level is responsible for developing and implementing energy efficiency policies and how effective these institutions are. Most respondents (10/22) rated the effectiveness of their national institutions as neutral (rating 3 on the Likert scale). However, even though not representative for the whole country, it should be noted that the Finnish respondents perceived their national institutions as most effective among the respondents, scoring the highest on average.

The ***next question*** asked for the personal opinion of the respondents on what the main barriers to increasing investment and financing flows to energy efficiency projects in their respective countries were. Respondents were allowed to choose up to five options among 10 different options. By far the most evident barriers were *lack of specific policies, programmes, legislation, by-laws, norms and standards* (14/22), *too low energy prices* (13/22), and *low awareness about the multiple benefits of energy efficiency projects* (12/22).

The responses were more varied for the ***question*** on the main business benefits to the respondents' organisation from implemented energy efficiency measures. Excluding the respondents working in consultancy, a total of 19 respondents were included in the analysis of this question. Among the 19 respondents, 15 chose *demonstration of corporate social responsibility* as one of the main business

benefits, followed by *complying with legislations* (11/19). The other options were selected almost equally with 9/19 for *risk management – hedging against volatile energy costs* and *improving production efficiency and quality*, 8/19 for *general cost control* and *ensure security of power supply*, and 7/19 for *comply with requests from shareholders, customers and/or suppliers*.

Focusing on the barriers that companies face when considering investments in energy efficiency, 10 out of 22 marked *too low energy costs and thus low economic incentive* as the main barrier, followed by a *lack of information on energy efficiency opportunities* and *low priority as energy efficiency is not part of the core business* of the company (both 7/22). A *high investment risk* was barely considered a barrier for investing in energy efficiency.

The responses to addressing behavioural and psychological barriers in energy efficiency emphasised the importance of a multipronged approach. Key strategies included continuous public awareness through newsletters, embedding energy efficiency in business strategies, and leveraging regulations and voluntary agreements. Effective communication, demonstrated by successful case studies and campaigns, such as the 'down a degree' initiative in Finland, also played a crucial role. These methods collectively highlight the necessity of integrating educational, regulatory, and strategic efforts to shift perceptions and encourage sustainable practices in energy efficiency.

Appendix 4: Web-panel survey on changes in households' energy behaviour in relation to the 2021–2023 energy crisis

4.1 Descriptions and proposed questions

INTRO TO THE SURVEY

The purpose of the survey is to gain a better understanding of Nordic households' attitudes, behaviours, and motivations concerning their home energy consumption and the implementation of efficiency measures, especially considering the global energy crisis of 2021-2023. This period saw households facing high energy prices, leading to growing awareness of one's own energy consumption and possible ways to increase energy efficiency. It also led to a heated public debate, which resulted in government intervention to protect households from the worst of the price shock.

The survey will take approximately 10 minutes to complete

Your participation in this survey is greatly appreciated. All data collected will be treated with the utmost confidentiality and anonymity, in compliance with the General Data Protection Regulation (GDPR). Your responses will be aggregated to ensure your individual identity will remain completely anonymous throughout the process. Thank you for your valuable input!

SECTION 1 – BACKGROUND (part 1)			
ID	**Question**	**Answers**	**Logic**
HOU_1	What type of house do you live in?	1. Detached house/villa 2. Semi-detached house 3. Terraced house or other small detached house 4. Apartment building/ block of flats 5. Building for shared housing 6. Other building type (please specify)	
HOU_2	What is your occupancy status?	1. Owner (no mortgage) 2. Owner (mortgage 3. Tenant 4. I do not know	
HOU_3	What is the living floor area of your apartment/house (excluding storage rooms, garage, etc.)?	(free text field)	
HOU_4	What is the energy label of your house?	1. A 2. B 3. C 4. D 5. E 6. F 7. G 8. I do not know	Not relevant for The Faroe Islands or Iceland
HOU_5	When was the house built (approx.)?	1. <1949 2. 1950-1959 3. 1960-1969 4. 1970-1979 5. 1980-1989 6. 1990-1999 7. 2000-2009 8. 2010-2019 9. >2020	
HOU_6	When did you move to your house? (specify the approx. year)	(free text field)	
HOU_7	What space heating systems are at your home, and how much are they used during the time of year when the home is heated?	1. District heating /Central heating 2. Electric panel heaters 3. Electric floor heating 4. Liquid to water (rock, ground, water-source) heat pump 5. Air to water heat pump 6. Air to air heat pump 7. Fire stove/fire place/wood burner 8. Gas furnace/burner/boiler 9. Oil furnace/burner/boiler 10. Bio furnace/burner/boiler 11. Other (please specify)	Multiple choice columns: 1. Not found in the home 2. Found but rarely or never used 3. Used occasionally or primarily in specific rooms 4. Used as main heating source for the whole house 5. I don't know

HOU_8	Do you pay a different energy price depending on the time of the day you use it? Example: It is more expensive to use energy in the morning, than late in the evening?	1. Yes 2. No 3. I do not know	
HOU_8a	Do you pay a different energy rate depending on how much energy you use at the same time? Example: Is your rate lower if you use appliances like a washing machine and dishwasher at different times rather than running both at the same time, even if the total energy used is the same?	1. Yes 2. No 3. I do not know	
HOU_9	Do you have an electric vehicle	1. Yes 2. No 3. I do not know	
STA_1	Who in the household pays expenses related to the home (electricity, water, property tax, etc.)?	1. Me 2. My partner/spouse 3. Children 3. Other family members 5. Others who are not family 6. It is included in the rent	Multiple choice (all that apply)
STA_2	How much electricity (measured in kWh and the local currency) did your household use approximately during the period 2021-2023? Enter an estimate of your average annual electricity consumption and/or cost for this period.	1. Yes 2. No 3. I do not know	
STA_3	How much district heating (measured in kWh or m3 of water and the local currency) did your household use approximately during 2021-2023? Enter an estimate of your annual consumption and/or cost for this period.	1. [kWh] 2. [m3 of water] 3. [local currency] 4. I do not know	If answer 1 in HOU_7
STA_4	During the energy crisis in 2021-2023, how often did you lower the temperature of your home to uncomfortable levels specifically to avoid economic difficulties?	• Never • Very rarely • Rarely • Sometimes • Often • Very often • Always	

SECTION 2 – ATTITUDES / MOTIVATIONS			
ID	**Question**	**Answers**	**Logic**
ATT_1	How much do you agree or disagree with each of these statements?	1. I care about whether my energy consumption has an impact on global greenhouse gas emissions 2. I think about the energy costs every day 3. I could do more to save energy 4. I want to move to a more energy-efficient house 5. Energy efficiency and energy saving is a recurring topic in my household 6. I am considering getting an electric vehicle 7. I believe that people should be able to use as much energy as they want if they can afford to pay for it.	Multiple choice columns: 1. Strongly disagree 2. Somewhat disagree 3. Neither agree nor disagree 4. Somewhat agree 5. Strongly agree 6. I don't know 7. Not relevant
ATT_2	Has your awareness of energy use changed since the energy crisis in 2021-2023?	1. I am much less aware 2. I am a little less aware 3. Unchanged 4. I am a little more aware 5. I am much more aware 6. I do not know	
ATT_7	During a significant increase in energy prices, which policy measure would you prefer?	1. Reduced energy tariffs (Lower costs for energy use, often due to incentives such as reduced energy or value-added taxes) 2. Cash payouts to all (Financial assistance to all members of a population, regardless of their socioeconomic status or other factors) 3. Cash payouts to selected groups (Financial assistance exclusively to specific demographics or categories within a population) 4. Economic support based on energy consumption (Financial assistance or benefits provided to individuals or entities, determined by their energy use) 5. Price regulation, like subsidized price and social tariffs. (Prices' control, often through financial assistance or implementing special pricing schemes to ensure affordability for certain groups within the population) 6. Subsidy scheme for energy efficiency measures (Financial assistance or incentives for implementing measures aimed at improving energy efficiency) 7. Other (please specify)	Multiple choice (up to 3)
ATT_6	Before, during, and after the energy crisis in 2021-2023 - What was your motivation to save on your energy consumption at home?	1. I had no motivation to save on energy 2. To save money 3. To contribute to a sustainable future energy system 4. To contribute to avoid that the energy supply becomes under pressure 5. Nothing could motivate me to save even more on energy 6. To do something good for the climate and environment 7. Other (please specify) 8. I do not know	Multi-column (before 2021 / during the energy crisis 2021-2023 / after) Not relevant for The Faroe Islands

ATT_3	Before, during, and after the energy crisis in 2021-2023 - Did you follow the development of electricity prices from day to day?	1. Yes, I actively monitored hourly electricity prices using an app or the internet 2. No, I relied on a smart management system that automatically controlled my electricity usage 3. No, I only checked electricity prices when I received app or SMS notifications about high prices. 4. No, I had a general impression of how electricity prices tended to vary and didn't feel the need to actively follow them. 5. No, I only gauged whether electricity was cheap or expensive based on discussions around me and the media. 6. No, I didn't pay attention to electricity prices at all	Multi-column (before 2021 / during the energy crisis 2021-2023 / after) Not relevant for The Faroe Islands
ATT_4	Before, during, and after the energy crisis in 2021-2023 - How often did you think about your electricity and/or heat consumption?	1. More than one time a day 2. One time a day 3. 1-2 times a week 4. 1-2 times a month 5. 1-2 times a year 6. Never 7. I do not know	Multi-column (before 2021 / during the energy crisis 2021-2023 / after) Not relevant for The Faroe Islands
ATT_5	Before, during or after the energy crisis in 2021-2023 - Did you move parts of your energy consumption to different times with lower electricity prices?	1. Yes 2. I started to explore options for doing so, and plan to implement some 3. I started to explore options, but opted out due to comfort or convenience 4. I would have liked to, but could not due to work schedule or household needs 5. No	Multi-column (before 2021 / during the energy crisis 2021-2023 / after) Not relevant for The Faroe Islands
ATT_8	Did you consider retrofitting your home by investing in energy efficiency measures?	1. Yes, I considered it (but I didn't take any action) 2. Yes, I implemented energy efficiency measures 3. No	If answer 1 and 2 in HOU_2

ATT_8a	What are the potential barriers for retrofitting your home (investing in energy-efficient measures)?	1. I can't decide what to do first when it comes to retrofitting 2. It is not yet the right time to retrofit my house 3. Building protection regulations prevent me from carrying out retrofitting 4. I do not have available financial resources (savings or loans) to invest in retrofitting 5. The construction companies are inexperienced and/or lack the necessary knowledge 6. I have to agree with my neighbours if I want to retrofit my house 7. A retrofitting project creates a lot of disruption and practical disorder in daily life 8.Retrofitting my home requires a lot of time to the follow-up of the craftsmen 9. I have negative experiences from previous retrofitting projects 10. There are long waiting times for building materials 11 I can't get hold of craftsmen 12. Upgrading will ruin the charm of the house 13 Lack of information/support/advice on what to do and expected savings of different measures 14. There are no cost-efficient options of energy-efficient measures available 15. Other (please specify)	If answer 1 or 3 in ATT_8 Multiple choice (all that apply)

SECTION 3 – BEHAVIOUR			
ID	**Question**	**Answers**	**Logic**
BEH_1	Before, during, and after the energy crisis in 2021-2023- Which of these measures did you adopt to reduce energy consumption and/or save money? You can choose multiple alternatives	1. Lower temperature in unused rooms when you are at home 2. Lower rooms' heating/air conditioning when you are not at home 3. Lower rooms' temperature during night 4. Lower all rooms' temperature when you are at home 5. Shower less often/take shorter showers 6. Lower the water temperature when showering 7. Turn off lightning and other electric devices when not in use 8. Pay more attention to cooking habits (i.e. put lids on boiling pans) 9. Load full dishwasher before turning it on 10. Lower the water temperature when hand washing the dishes 11. Load full washing machine before turning it on 12. Use washing machine programmes with lower temperatures 13. Air dry clothes instead of using the tumble dryer 14. Swich to use electric appliances to hours with lower electricity prices 15. Reduce the use of electric devices (such as: computer, TV...) 16. Shift to other fuels for heating (i.e. firewood) when the electricity prices are high 17. Reduce the use of energy-intensive amenities, such as hot tubs, saunas, etc. 18. None of these 19. Other (please specify)	Multi-column (before 2021 / during the energy crisis 2021-2023 / after)
BEH_3	Before, during, and after the energy crisis in 2021-2023 - How much money do think you have saved with these measures?	1. None at all 2. A small amount 3. A moderate amount 4. A great deal 5. I do not know	Only measures that were selected in BEH_1
BEH_4	To what extent are you willing to stick to your current energy habits for the next three months?	1. To a great extent 2. To a considerable extent 3. To some degree 4. To a low degree 5. Not at all 6. I do not know	Only measures that were selected in BEH_1 for "after 2023"

SECTION 4 – MEASURES			
ID	**Question**	**Answers**	**Logic**
MEA_1	Before, during, and after the energy crisis in 2021-2023 - Which of these measures have you implemented or do you plan to implement in the next 2-3 years, to save energy and/or money? You can choose multiple alternatives	1. Enhance building airtightness 2. Install energy-efficient exterior doors 3. Install energy-efficient double-glazed windows 4. Install energy-efficient triple-glazed windows 5. Replace high-energy consuming appliances with energy-efficient appliances 6. Install solar thermal collectors for domestic hot water and/or home heating 7. Install solar panels (PV) for electricity production 8. Install air-to-air heat pump 9. Install air-to-water heat pump 10. Install liquid-to-water (rock, ground, water- source) heat pump 11. Install accumulator tank for storing and distributing hot water 12. Add extra insulation to the roof and/or ceiling facing unheated attic spaces 13. Add extra insulation to the floor facing outdoors or unheated spaces 14. Add extra insulation to external walls 15. Improve heat recovery in existing ventilation system 16. Insulate hot water pipes 17. Improve fan power efficiency in existing ventilation system 18. Install balanced ventilation system with heat recovery 19. Use an energy monitoring system 20. Implement night temperature lowering system 21. Install a waterborne heating system 22. Employ energy consultancy 23. Install programmable timers and motion sensors for lighting control 24. Install a smart control system for heating and/or cooling/ventilation 25. Replace incandescent or halogens bulbs with energy-efficient LED lighting 26. None of these 27. Other (please specify) 28. Not relevant, I am renting or my building does not allow such measures	Multi-column (before 2021 / during the energy crisis 2021-2023 / after / the next 2-3 years)
MEA_2	Before, during, and after the energy crisis in 2021-2023 - How much money do you think you have saved with these measures?	1. None at all 2. Very little 3. A small amount 4. Some amount 5. A moderate amount 6. A significant amount 7. A great deal 8. I do not know	Only measures that were selected in MEA_1
MEA_4	Are you planning to apply for a support scheme to implement some of these measures?	1. Yes 2. Yes, but I do not know the potential options 3. Yes, but I do not know how to apply for available support schemes 4. No, there are no appropriate support schemes available 5. No	

SECTION 5 – FUTURE INTENTIONS

In this section, you will encounter four hypothetical scenarios where you can choose to adopt one out of two energy efficiency measures presented or none of them. Each measure is characterized by factors such as investment cost, potential energy savings, and government investment support. Please respond as if you have not yet implemented any of these measures, regardless of whether you own or rent your property.
Please note that the values for installation price and energy savings are not absolute but rather relative among the considered measures.

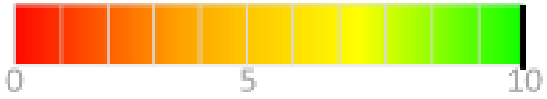
BLOCK 1
Which of these options, if any, would you prefer to implement in your home, regardless of whether you own it or rent it, assuming you have not yet implemented any of these measures?

SET 1_1	Option 1	Option 2	None
Measure	Use energy monitoring system	Implement night temperaure lowering system	
Investment cost			
Energy savings			
Investment support	Financed 0% investment cost	Financed 35% investment cost	

Which of these options, if any, would you prefer to implement in your home, regardless of whether you own it or rent it, assuming you have not yet implemented any of these measures?

SET 1_2	Option 1	Option 2	None
Measure	Install energy-efficient triple-glazed windows for the entire home	Add extra insulation to the external walls	
Investment cost			
Energy savings			
Investment support	Financed 0% investment cost	Financed 15% investment cost	

Which of these options, if any, would you prefer to implement in your home, regardless of whether you own it or rent it, assuming you have not yet implemented any of these measures?

SET 1_3	Option 1	Option 2	None
Measure	Install energy-efficient triple-glazed windows for the entire home	Add extra insultation tothe external walls	
Investment cost			
Energy savings			
Investment support	Financed 15% investment cost	Financed 35% investment cost	

Which of these options, if any, would you prefer to implement in your home, regardless of whether you own it or rent it, assuming you have not yet implemented any of these measures?

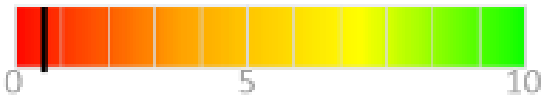
SET 1_4	Option 1	Option 2	None
Measure	Implement night temperature lowering system	Install balanced ventilation system with heat recovery	
Investment cost			
Energy savings			
Investment support	Financed 0% investment cost	Financed 15% investment cost	

BLOCK 2

Which of these options, if any, would you prefer to implement in your home, regardless of whether you own it or rent it, assuming you have not yet implemented any of these measures?

SET 2_1	Option 1	Option 2	None
Measure	Implement night temperature lowering system	Install balanced ventilation system with heat recovery	
Investment cost			
Energy savings			
Investment support	Financed 15% investment cost	Financed 35% investment cost	

Which of these options, if any, would you prefer to implement in your home, regardless of whether you own it or rent it, assuming you have not yet implemented any of these measures?

SET 2_2	Option 1	Option 2	None
Measure	Use energy monitoring system	Install balanced ventilation system with heat recovery	
Investment cost			
Energy savings			
Investment support	Financed 35% investment cost	Financed 35% investment cost	

Which of these options, if any, would you prefer to implement in your home, regardless of whether you own it or rent it, assuming you have not yet implemented any of these measures?

SET 2_3	Option 1	Option 2	None
Measure	Install energy-efficient triple-glazed windows for the entire home	Add extra insulation to the external walls	
Investment cost			
Energy savings			
Investment support	Financed 0% investment cost	Financed 15% investment cost	

Which of these options, if any, would you prefer to implement in your home, regardless of whether you own it or rent it, assuming you have not yet implemented any of these measures?

SET 2_4	Option 1	Option 2	None
Measure	Use energy monitoring system	Implement night temperature lowering system	
Investment cost			
Energy savings			
Investment support	Financed 15% investment cost	Financed 35% investment cost	

SECTION 1 – BACKGROUND (part 2)				
ID	**Question**	**Answers**	**Logic**	**Comment**
DEM_1	How old are you?	(free text field)		Norstat-panel
DEM_2	What is your gender?	1. Woman 2. Man 3. Other		Norstat-panel
LOC_1	Where do you live? Fill in your postcode	(free text field)		Norstat-panel
DEM_3	What is your highest level of education?	1. Primary school 2. Secondary school 3. Vocational school, apprenticeship certificate, or other 1–2-year education after upper secondary school 3. University/college up to 3 years 4. University/college, 4 years or more 5. Other		Norstat-panel
DEM_4	What is your employee status?	1. Employed full-time with income 2. Employed part-time with income 3. Self-employed 4. Age pensioner 5. Currently unemployed/receiving employment benefit 6. Other type of social security recipient 7. Pupil, student 8. Stay-at-home/homemaker 9. Other (please specify)		As Behaviour survey
DEM_6	What type of household structure do you have?	1. Live alone 2. Live with friends/in a collective 3. Live with a partner/spouse without children 4. Live with a partner/spouse with children 5. Live alone with children 6. Live with my parents 7. Other (please specify) 8. I prefer to not answer		Norstat-panel
DEM_7	How many people live in your home, including you?	1. 1 person 2. 2 persons 3. 3 persons 4. 4 persons 5. 5 persons or more		As Behaviour survey
DEM_8	What is the average annual gross income (before taxes) of your household, including all members?	1. Fill in (local currency) 2. I prefer to not answer 3. I don't know		

4.2 Figures and detailed responses

This section provides a comprehensive analysis of the findings from the web-panel survey.

Household size and structure: Norway, Denmark, and Finland had smaller households, mostly with one or two members, while over 30% of Faroese respondents lived in households with more than five members. Average household sizes ranged from 2.5 in Denmark to 3.6 in The Faroe Islands.

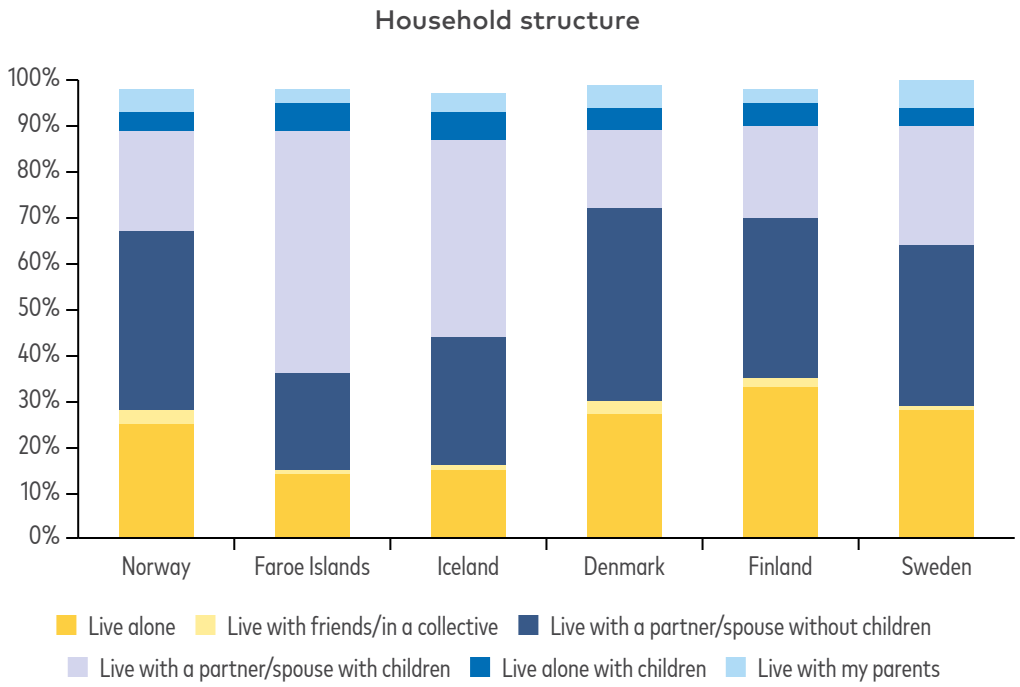


Figure A 4. Distribution of household structure in the survey, by country.

* Note that the answers "Other (please specify)" and "I prefer not to answer" are excluded from the graph due to their negligible contributions.

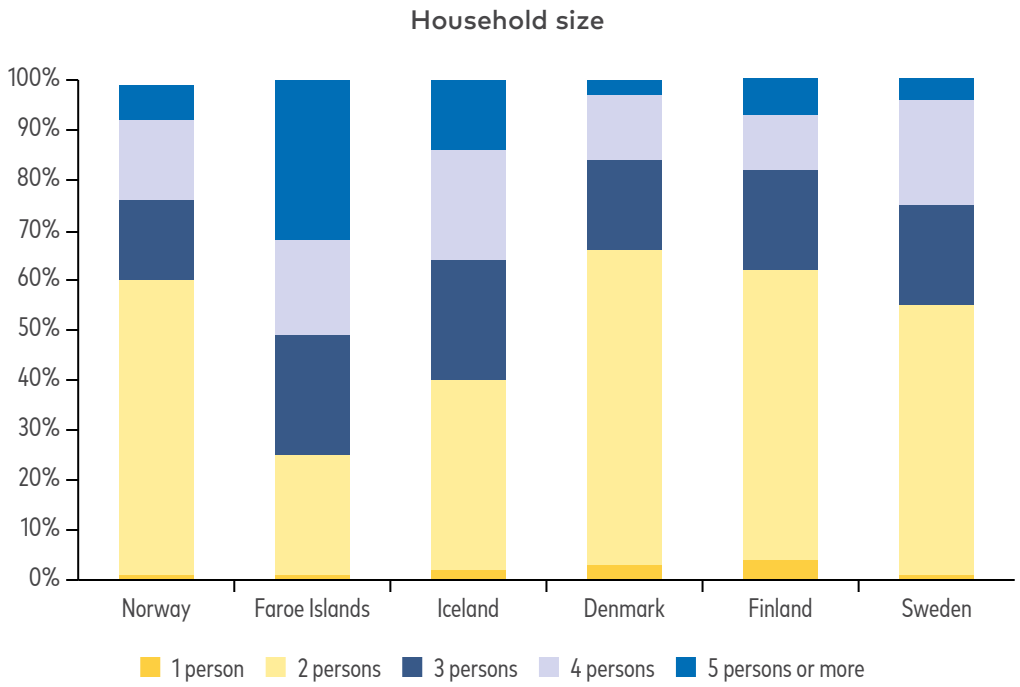


Figure A 5. Distribution of household size in the survey, by country.

Housing information: respondents answered questions related to their house, the occupancy status of their residential place, and ownership of an electric car. Analysing the results and comparing differences between countries revealed several differences among them. First, The Faroe Islands was the only country among all respondent countries where most of the respondents lived in detached houses or villas. While almost half of the respondents in Iceland, Finland and Sweden lived in blocks, this percentage was lower in Denmark and Norway, in favour of detached houses and villas. Homeownership was highest in Norway, The Faroe Islands, and Iceland, often with mortgages. In Denmark, Finland, and Sweden, renting was more common. Awareness of energy labels was highest in Norway, followed by Denmark, Sweden, and Finland.

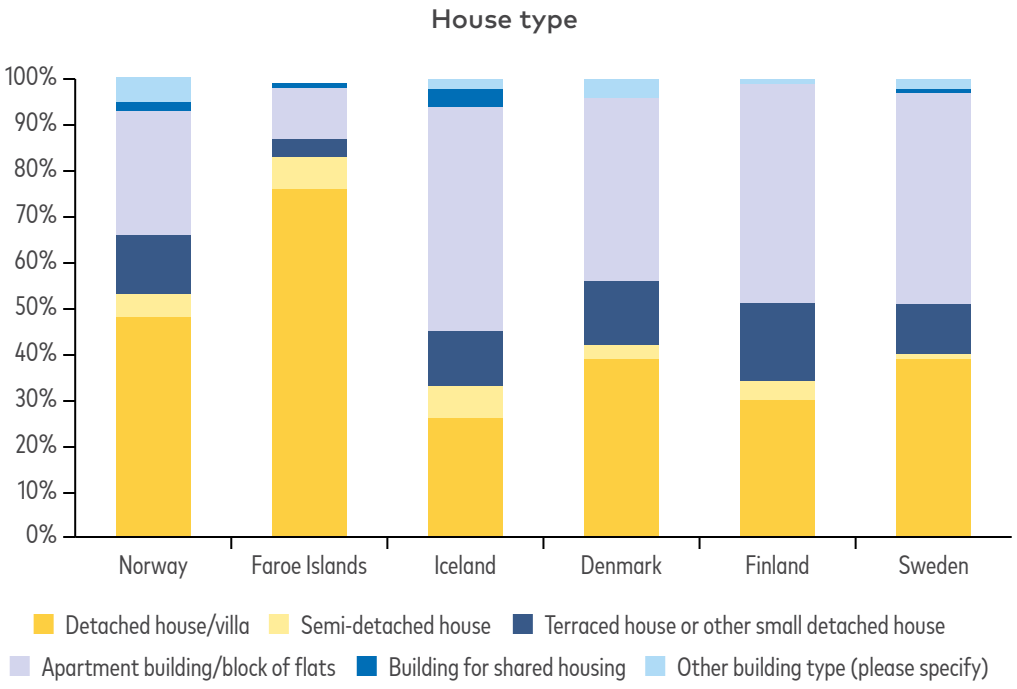


Figure A 6. Distribution of household types in the survey, by country.

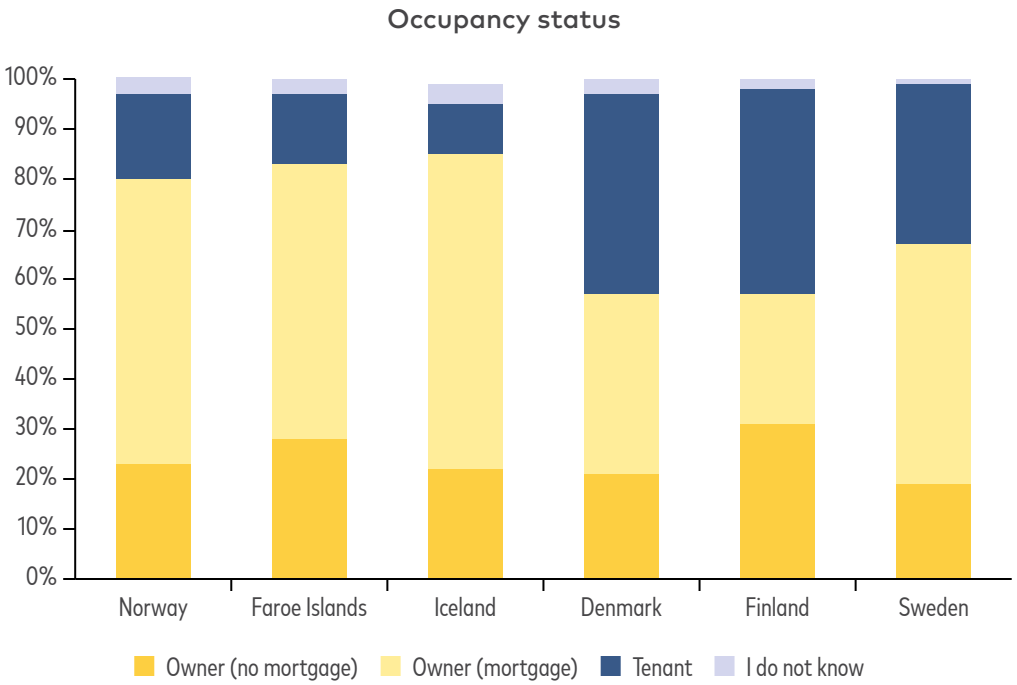


Figure A 7. Distribution of the occupancy status in the survey for households, by country.

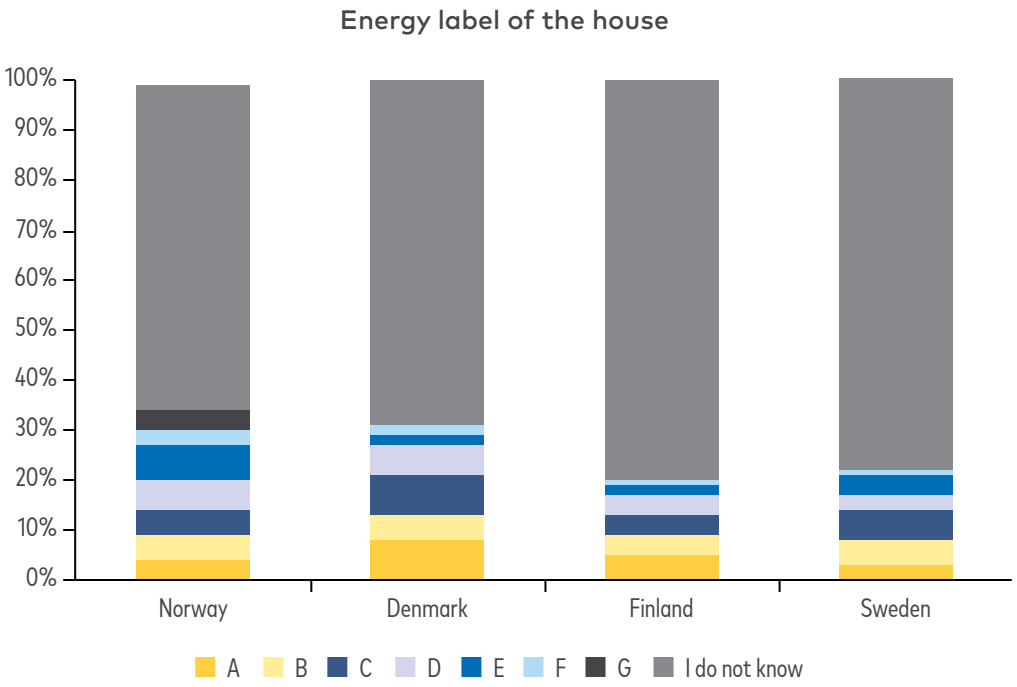


Figure A 8. Distribution of energy labels in the survey for households, by country.

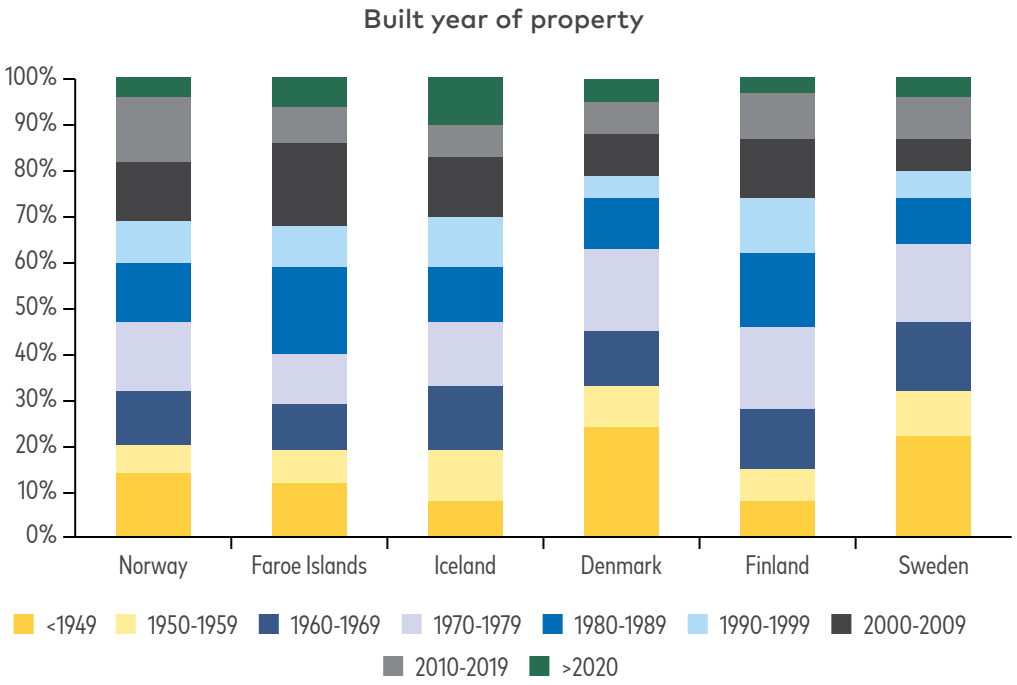


Figure A 9. Distribution of the years when residential properties were built in the survey for households, by country.

The average living floor area of apartments and houses, excluding storage rooms, garages, and similar spaces, varied across the Nordic countries as follows: Norway had an average of 132 m^2, Sweden 101 m^2, Iceland 118 m^2, Finland 87 m2, Denmark 109 m^2, and the Faroe Islands 161 m^2.

In addition, respondents were asked to indicate when they had moved into their current house. On average, respondents in Norway have lived in their current homes for 12 years, while in Sweden and Denmark, the average was 13 years. In Iceland and Finland, the average was 11 years, whereas in the Faroe Islands, respondents reported an average of 16 years.

Electric car ownership: Norway led in electric vehicle ownership at over 30%, followed by Iceland, Denmark, The Faroe Islands, Sweden, and Finland.

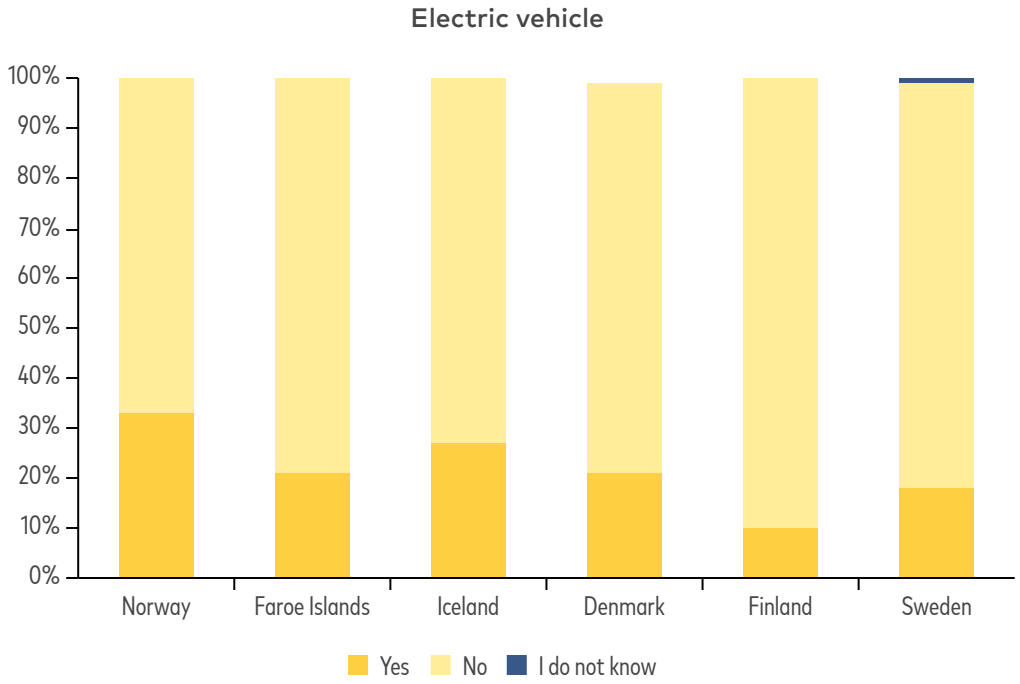


Figure A 10. Ownership of electric vehicles in the survey for households, by country.

Energy consumption pattern: A set of question was proposed to the respondents to describe their heating system and energy consumption pattern. In Norway, electric floor heating, panel heaters, wood burners, and air-to-air heat pumps were prevalent. In the Faroe Islands, respondents mainly used oil burners, air-to-water and liquid to water heat pumps. In Iceland, Denmark, and Finland, district heating and central heating were dominant, with additional use of liquid to water heat pumps in Iceland, and electric floor heating, panel heaters and wood burners in Denmark and Finland. In Sweden, heating sources were diverse, including district heating and central heating, electric floor heating, fire stove/fireplace/wood burner, air to air heat pumps, liquid to air heat pumps, and electric panel heaters. The detail for each country is illustrated in the figures below:

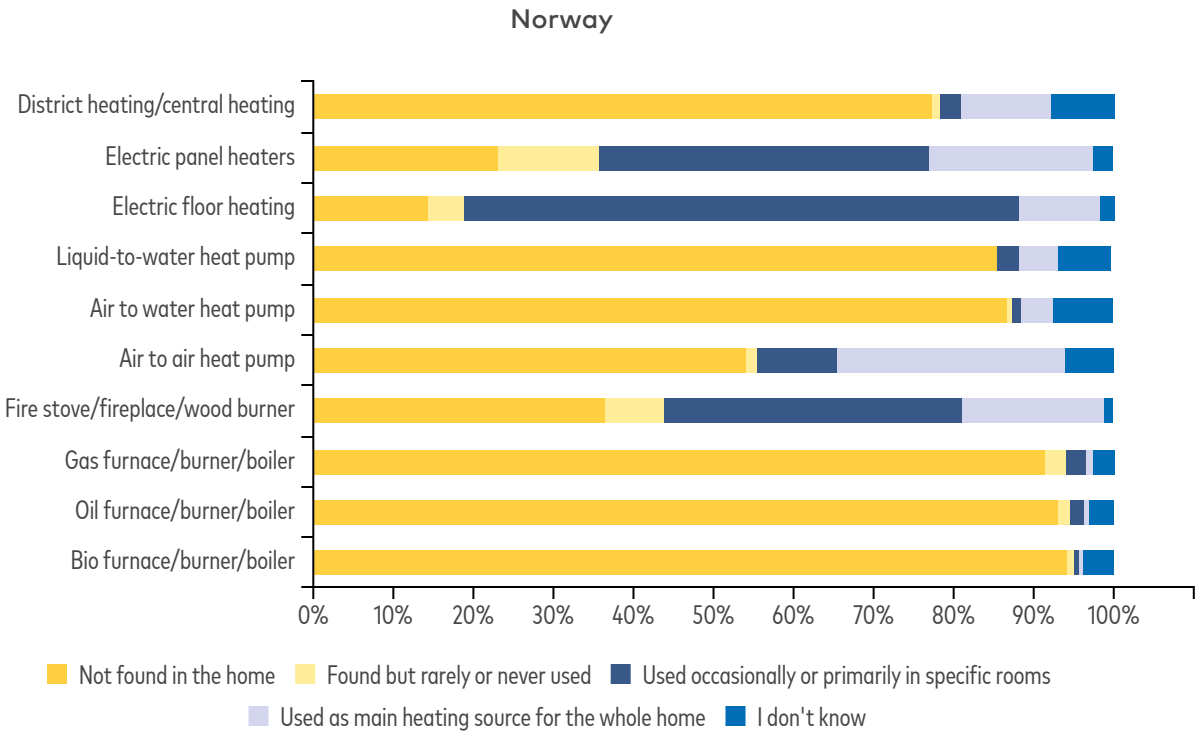


Figure A 11. Distribution of heating sources from the survey for households in Norway

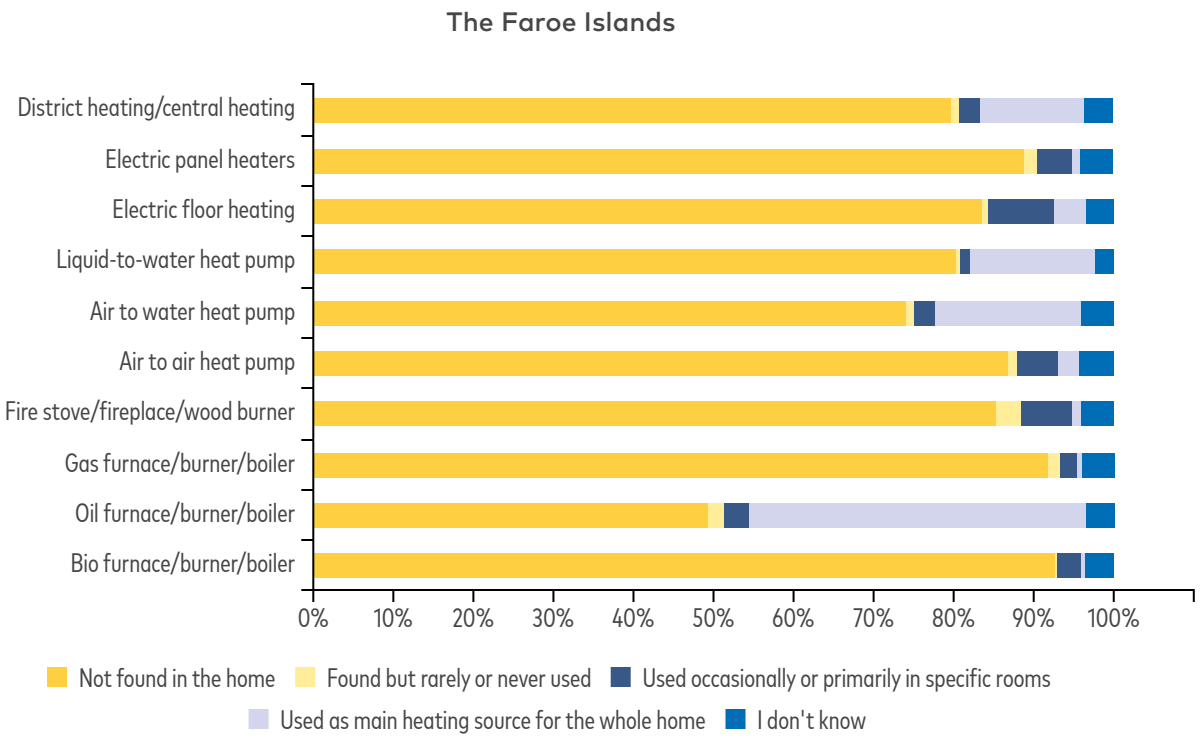


Figure A 12. Distribution of heating sources from the survey for households in the Faroe Islands.

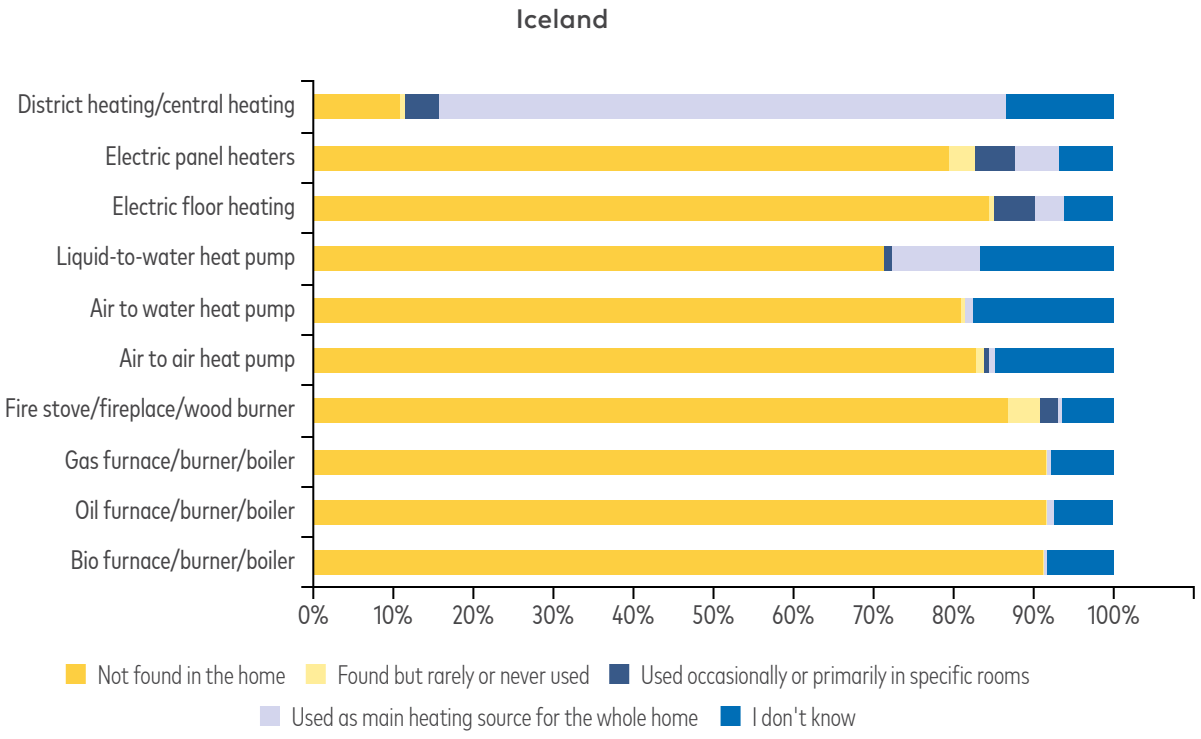


Figure A 13. Distribution of heating sources from the survey for households in Iceland.

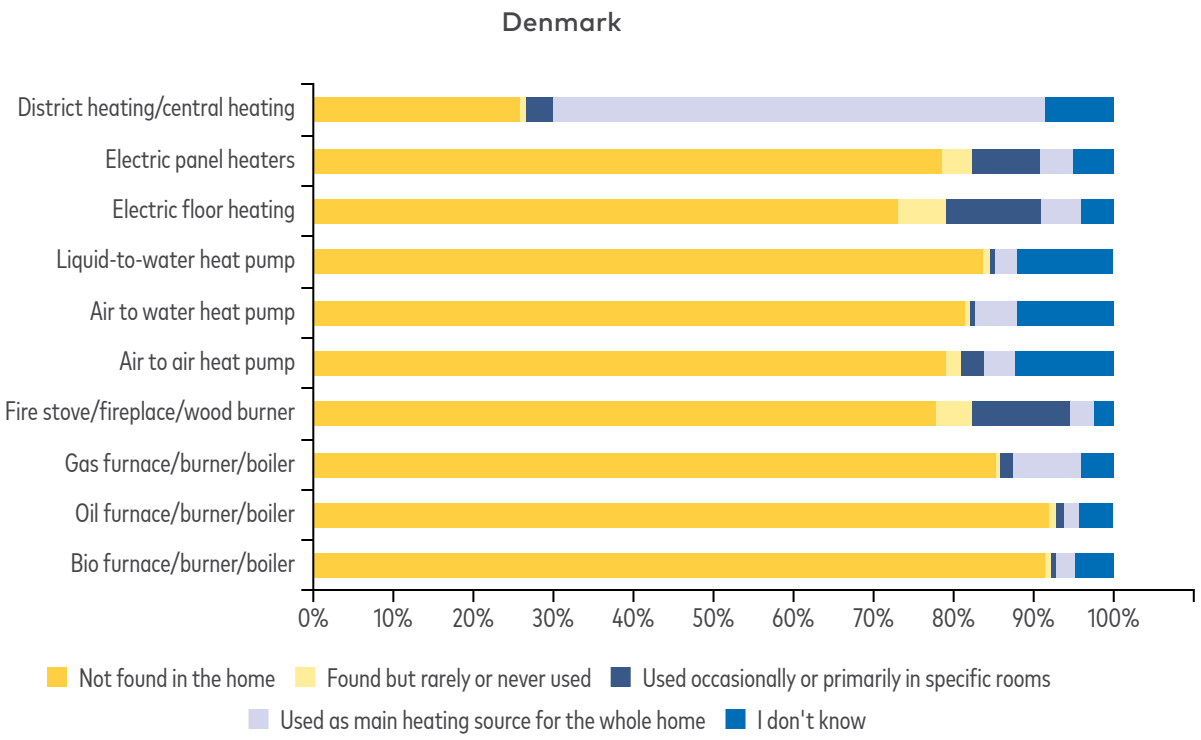


Figure A 14. Distribution of heating sources from the survey for households in Denmark.

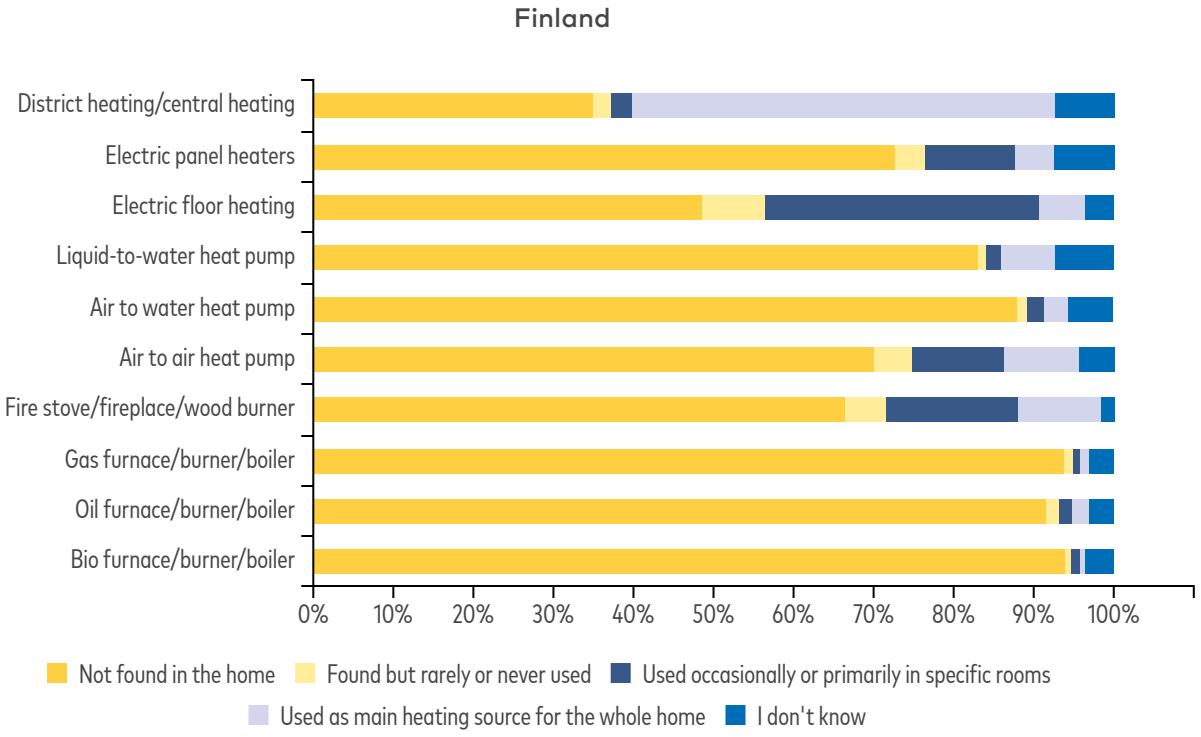


Figure A 15. Distribution of heating sources from the survey for households in Finland.

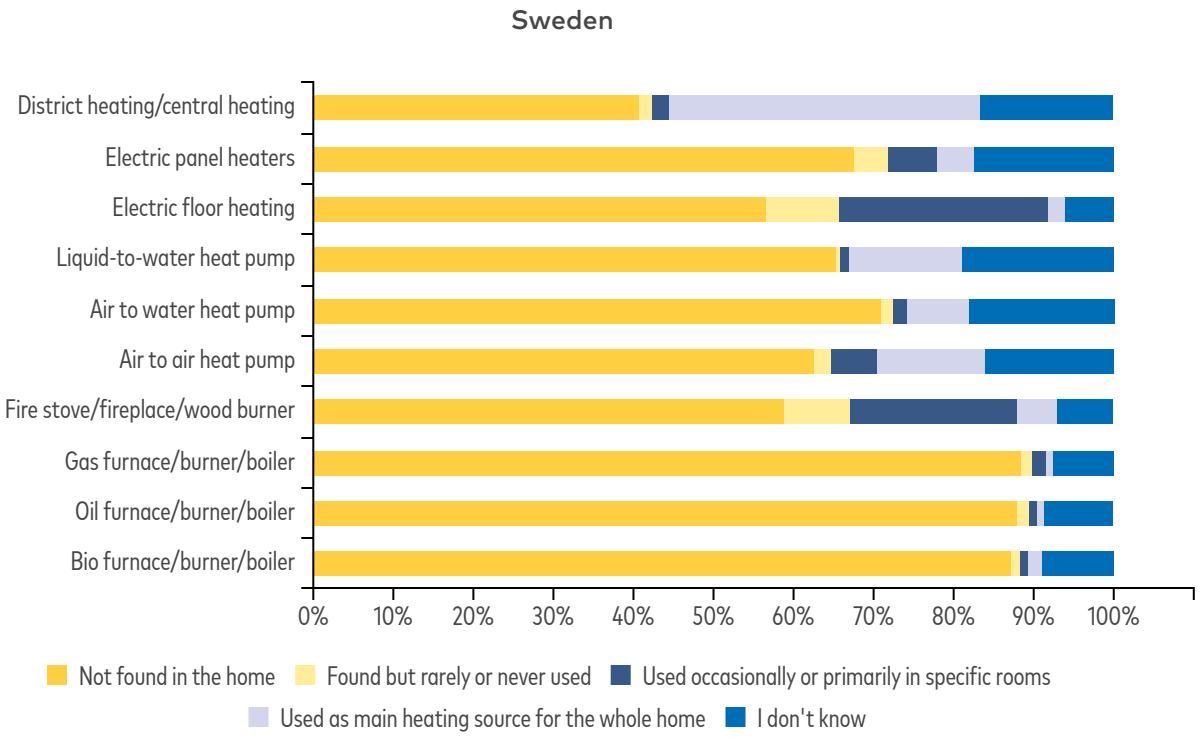


Figure A 16. Distribution of heating sources from the survey for households in Sweden.

The survey asked respondents about their household electricity consumption and costs for the period 2021-2023, measured in kWh and local currency. A significant proportion of respondents in each country did not provide any estimate of their electricity usage or cost (65% in Norway, 67% in Sweden and Denmark, 87% in Iceland, 60% in Finland, and 52% in Faroe Islands). Among the remaining respondents, the responses varied across countries as follows:

Norway: 21,000 kWh annual consumption, costing 26,000 NOK on average
Sweden: 16,000 kWh annual consumption, costing 39,000 SEK on average.
Iceland: 16,000 kWh annual consumption, costing 24,000 ISK on average.
Finland: 10,000 kWh annual consumption, costing 1,412 EUR on average.
Faroe Islands: 4,700 kWh annual consumption, costing 8,600 DKK on average.
Denmark: 5,400 kWh annual consumption, costing 13,600 DKK on average.

Respondents were also asked about their district heating consumption during the period 2021-2023; however, the response rate for this question was negligible across all Nordic countries.

Energy saving behaviours before, during and after the energy crisis of 2021-2023
The figures below show the responses on short-term measures applied before, during, and after the energy crisis, per Nordic country.

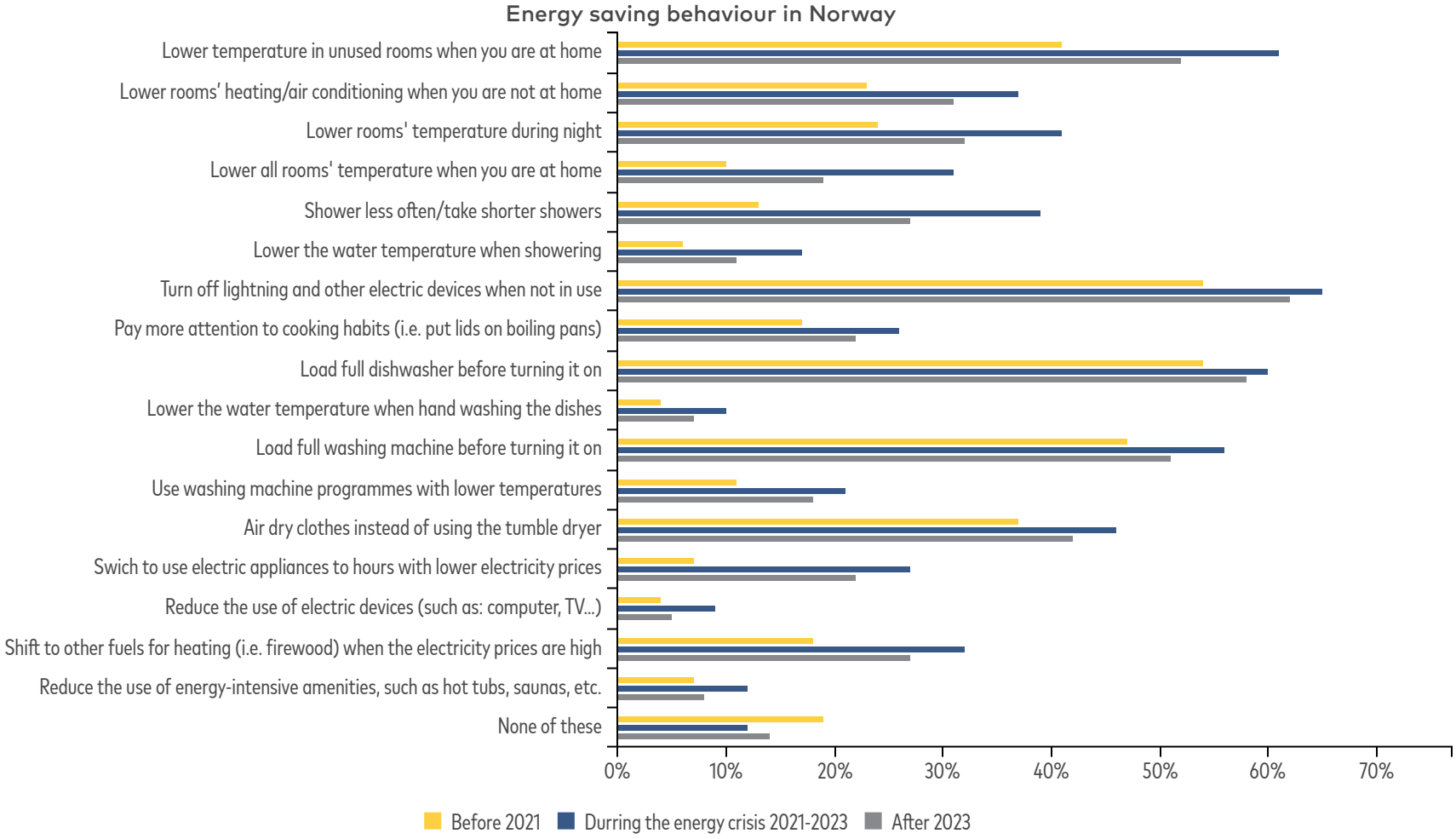


Figure A 17. Distribution of applied short-term energy efficiency measures before, during and after the energy crisis in Norway.

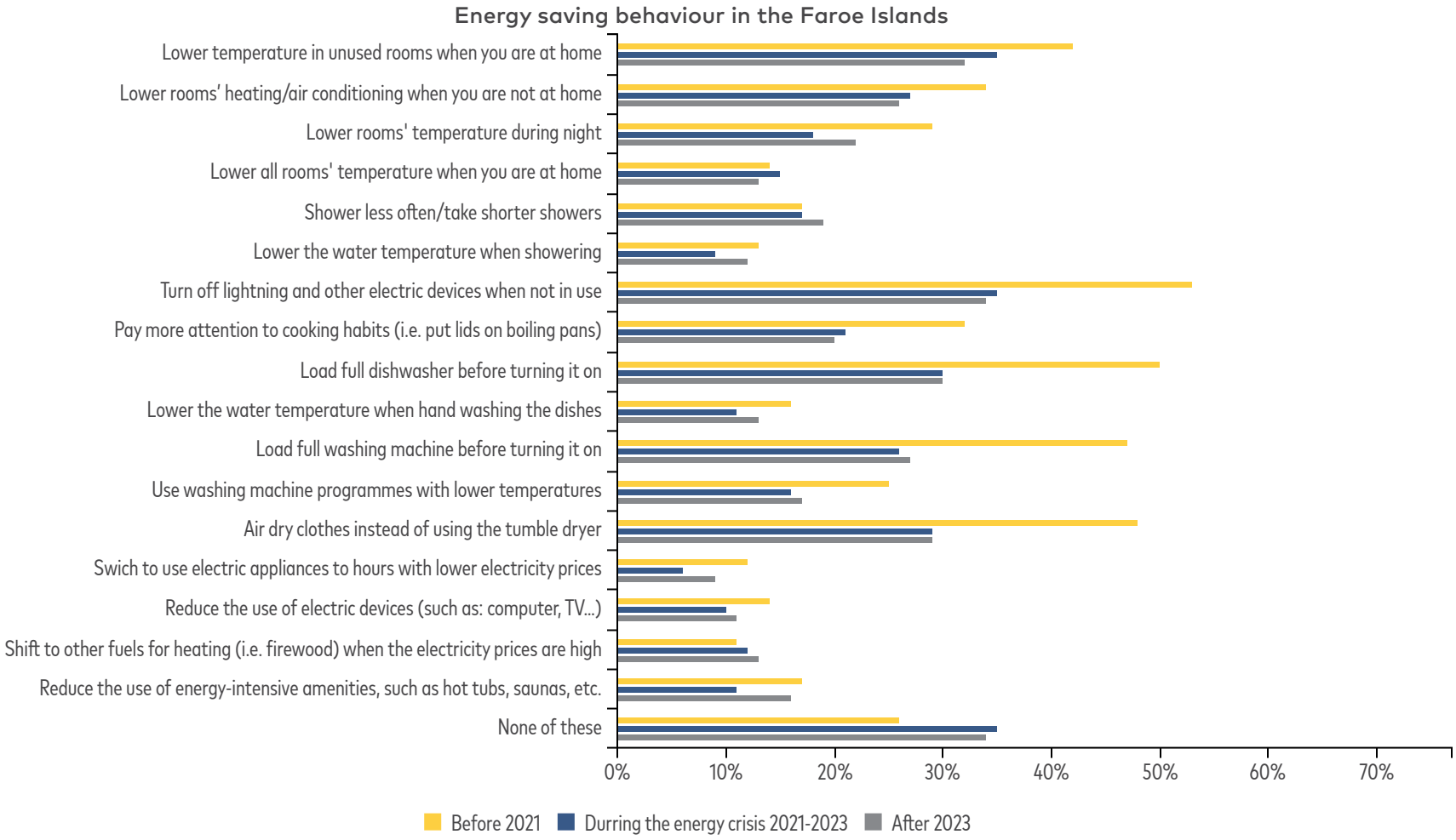


Figure A 18. Distribution of applied short-term energy efficiency measures before, during and after the energy crisis in the Faroe Islands.

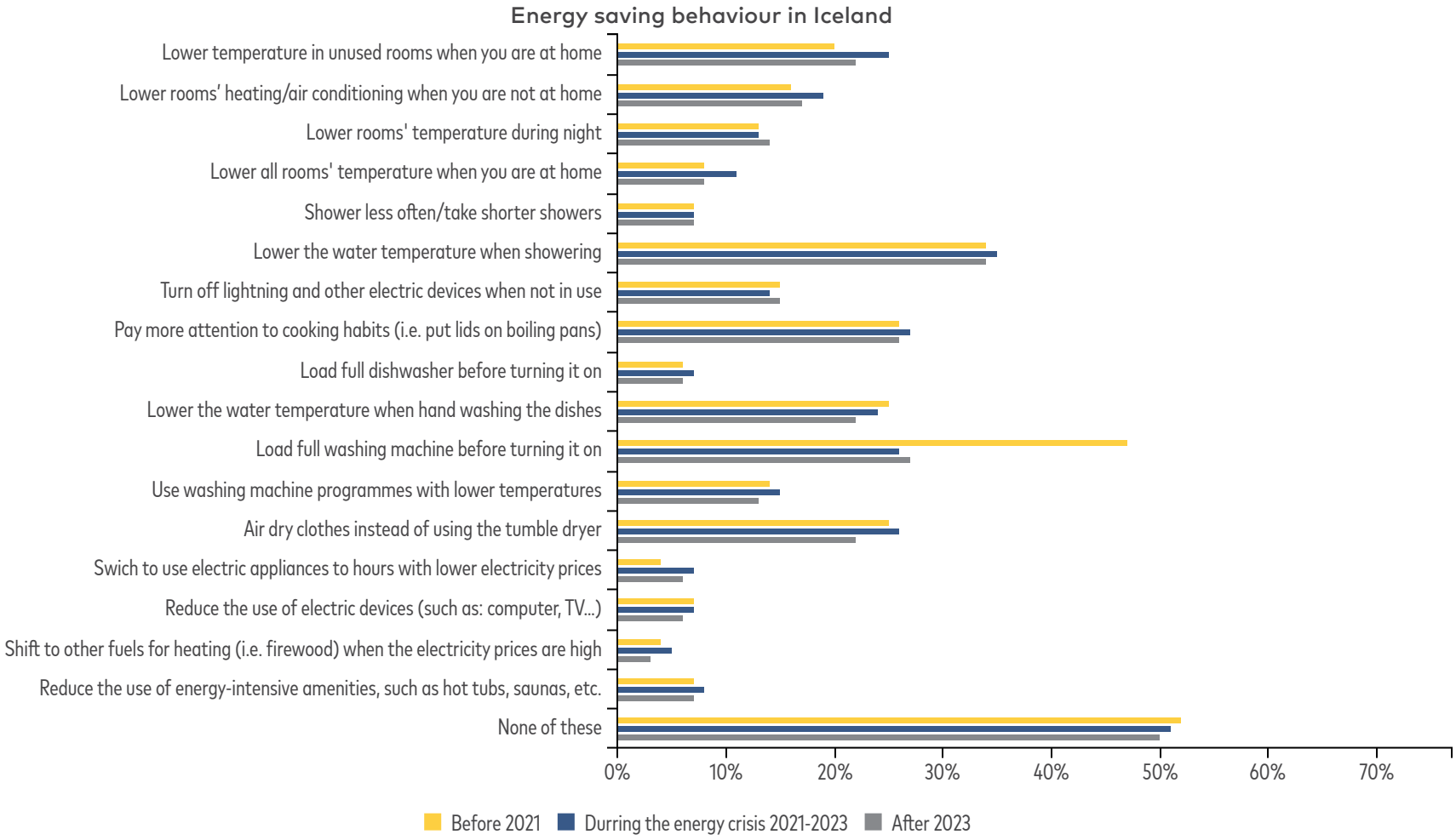


Figure A 19. Distribution of applied short-term energy efficiency measures before, during and after the energy crisis in Iceland.

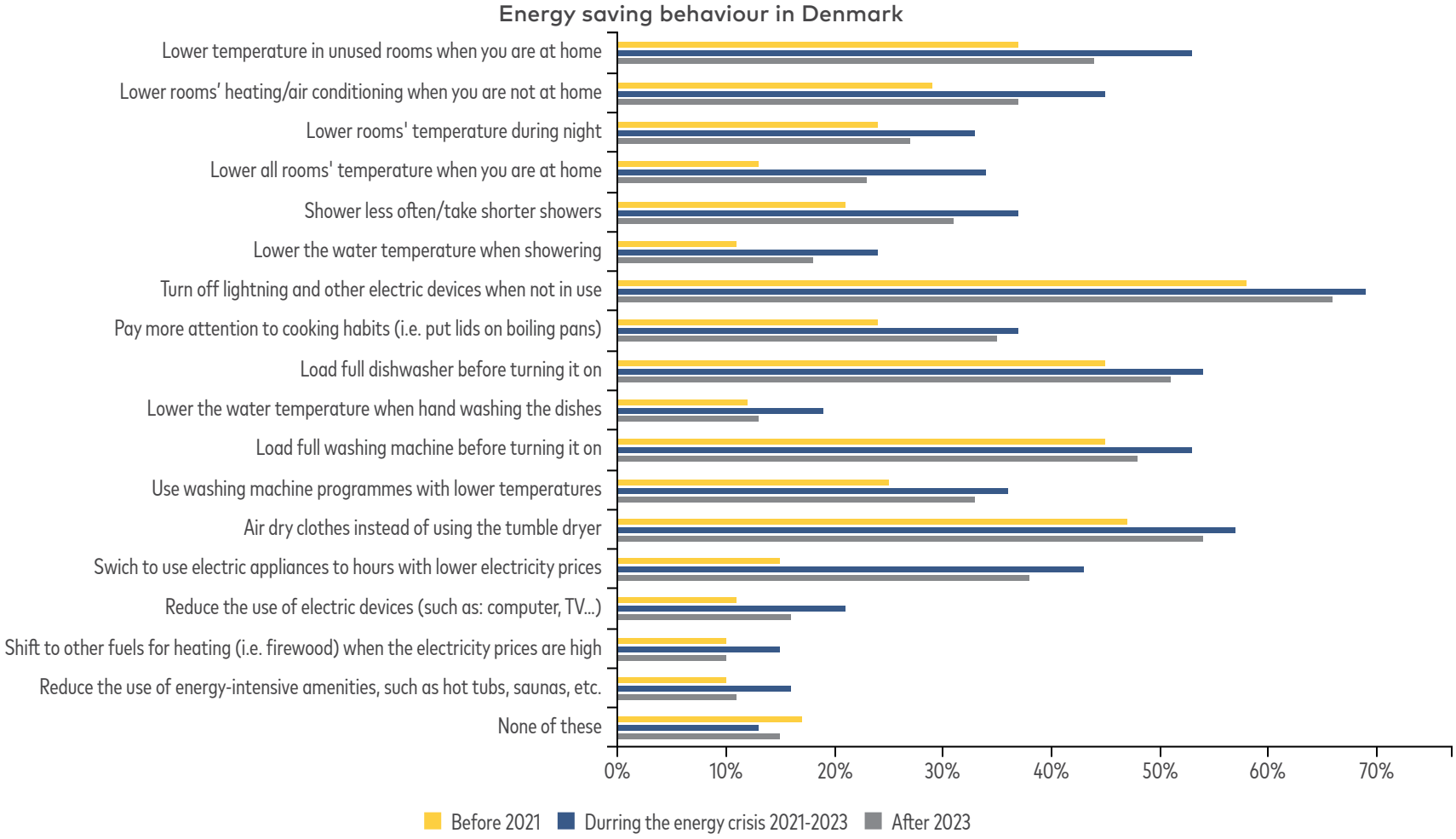


Figure A 20. Distribution of applied short-term energy efficiency measures before, during and after the energy crisis in Denmark

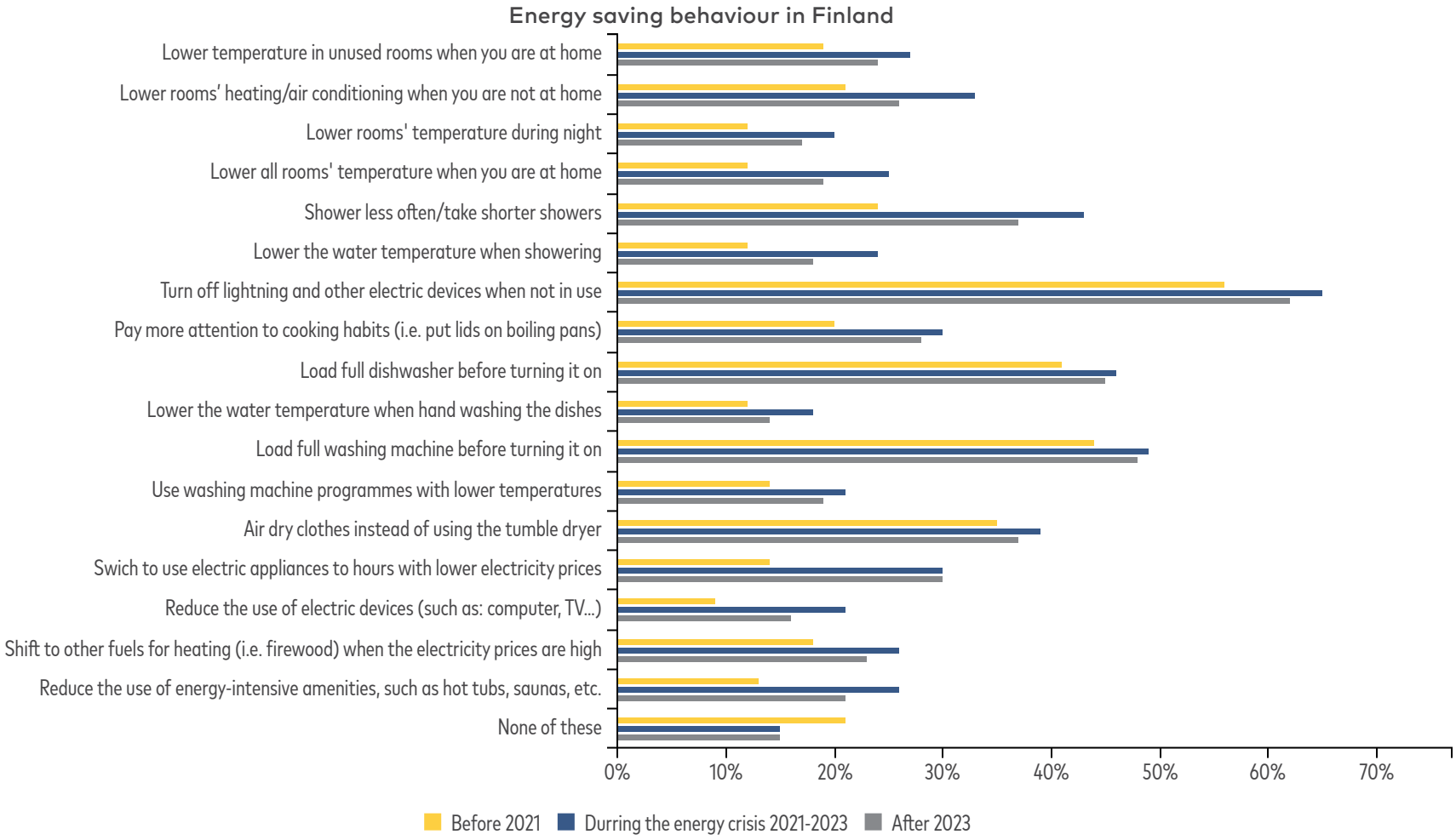


Figure A 21. Distribution of applied short-term energy efficiency measures before, during and after the energy crisis in Finland.

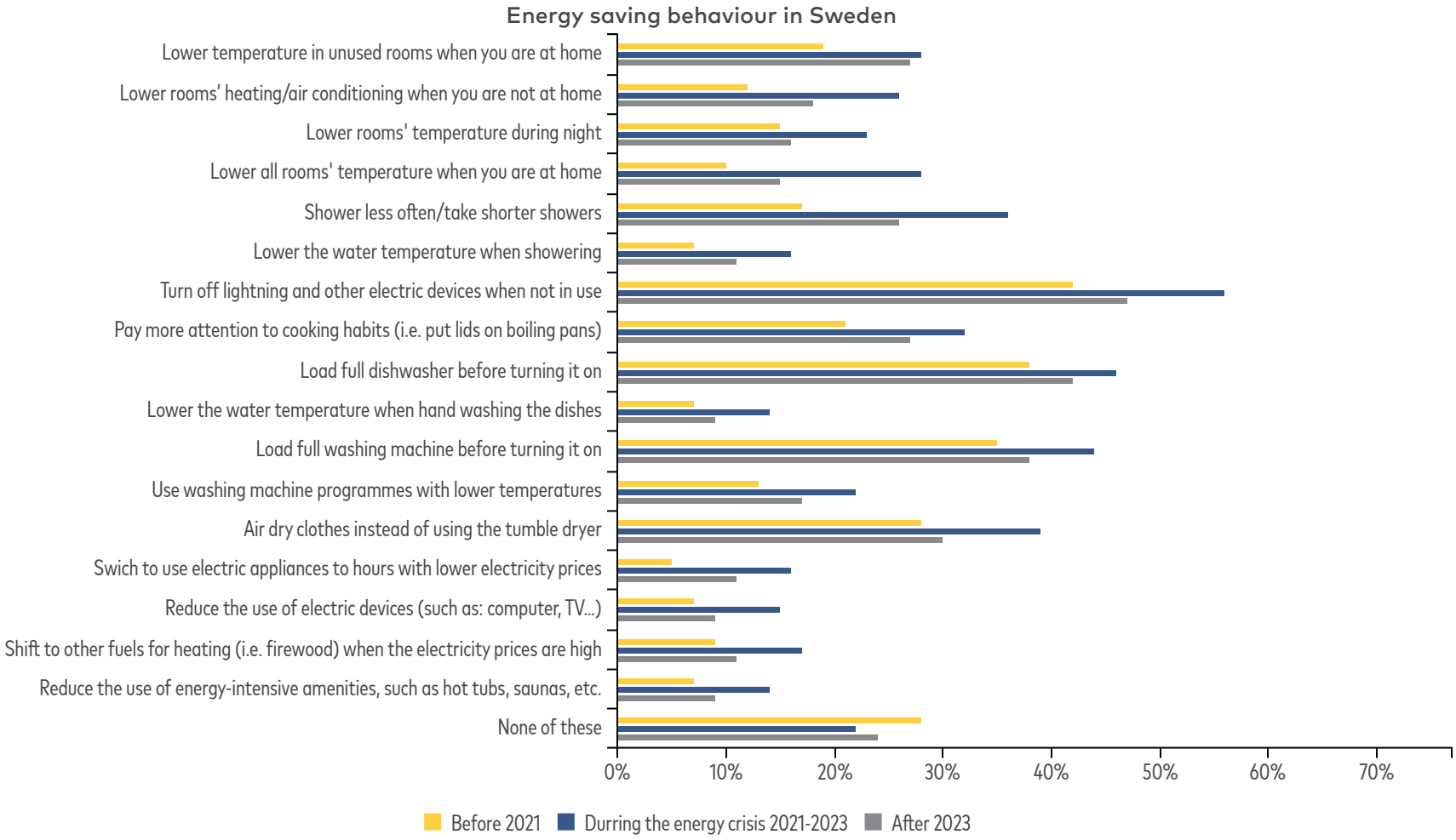


Figure A 22. Distribution of applied short-term energy efficiency measures before, during and after the energy crisis in Sweden.

Respondents were asked how often they lowered their home temperature to uncomfortable levels to avoid economic difficulties during the energy crisis of 2021-2023. Overall, 49% of respondents never lowered the temperature, with Iceland showing the highest percentage (80%), followed by Faroe Islands (57%) and Finland (53%). In contrast, Sweden, Norway, and Denmark reported lower percentages of respondents who never adjusted the temperature (43%, 29%, and 35%, respectively). The remaining respondents reported varying frequencies, with 16% sometimes lowering the temperature, 7% often, and 3% very often. Only 2% stated they always lowered the temperature.

Respondents showed varying levels of awareness and experience regarding time-of-day and consumption-based energy pricing, with notable differences across the countries.

Overall, 46% of respondents said they do not pay a different energy price depending on the time of day, 29% said they do, and 26% were unsure ('I don't know'). Norway had the highest percentage of 'yes' responses (62%), followed by Denmark (46%). The highest percentage of 'no' responses came from the Faroe Islands (75%), followed by Finland (60%) and Sweden (57%). Iceland had a notably high percentage of 'I don't know' responses, at 46%.

Overall, 49% of all respondents said they do not pay a different energy rate based on how much energy they use at the same time, while 18% said they do, and 33% were unsure ('I don't know'). Norway had the highest percentage of 'yes' responses (50%), while other countries showed much lower percentages, with rates of up to 15%. Finland had the highest percentage of 'no' responses (69%), followed by the Faroe Islands (66%) and Sweden (57%). A notable percentage of respondents, especially in Iceland (47%) and Denmark (43%), were unsure about this.

Overall, most respondents (81%) replied that they pay the household expenses themselves, followed by 39% stating that their partner does it. For 7%, it is included in the rent. The trend was similar across all countries, with few divergencies.

The figure below shows the perceptions of the impact of energy saving measures aggregated for all respondents.

Among the most common energy-saving measures, 'Turning off lights and devices when not in use' is widely recognized. 53% of respondents across all countries believed it could save a small amount of money, while 16% thought it could save a moderate amount, and another 16% were unsure. Finland had the highest proportion (62%) believing it could save a small amount of money, with the Faroe Islands and Iceland showing somewhat lower perceptions, at 34% and 45%, respectively.

For the measure 'Load full dishwasher before turning it on', 46% of respondents across all countries believed it saved a small amount of money, while 20% thought

it saved a moderate amount. Finland, Sweden and Denmark reported the highest proportions of respondents feeling they saved a small amount (around 52%, 50% and 50%, respectively).

A similar trend characterised the measure 'Load full washing machine before turning it on', where 45% of respondents across all countries believed it saved a small amount of money, while 22% thought it saved a moderate amount. A significant number of respondents in Finland (52%) and Denmark (49%) felt they saved a small amount. Iceland reported the largest number of respondents uncertain about their savings (30%).

Finally, for the measure 'Air dry clothes instead of using the tumble dryer', 29% of respondents across all countries believed it saved a small amount of money, and 28% thought it saved a moderate amount. Finland (33%) and Denmark (32%) saw the highest number of respondents saving a moderate amount, with Sweden reporting a relatively higher percentage of people who saved a great deal (19%).

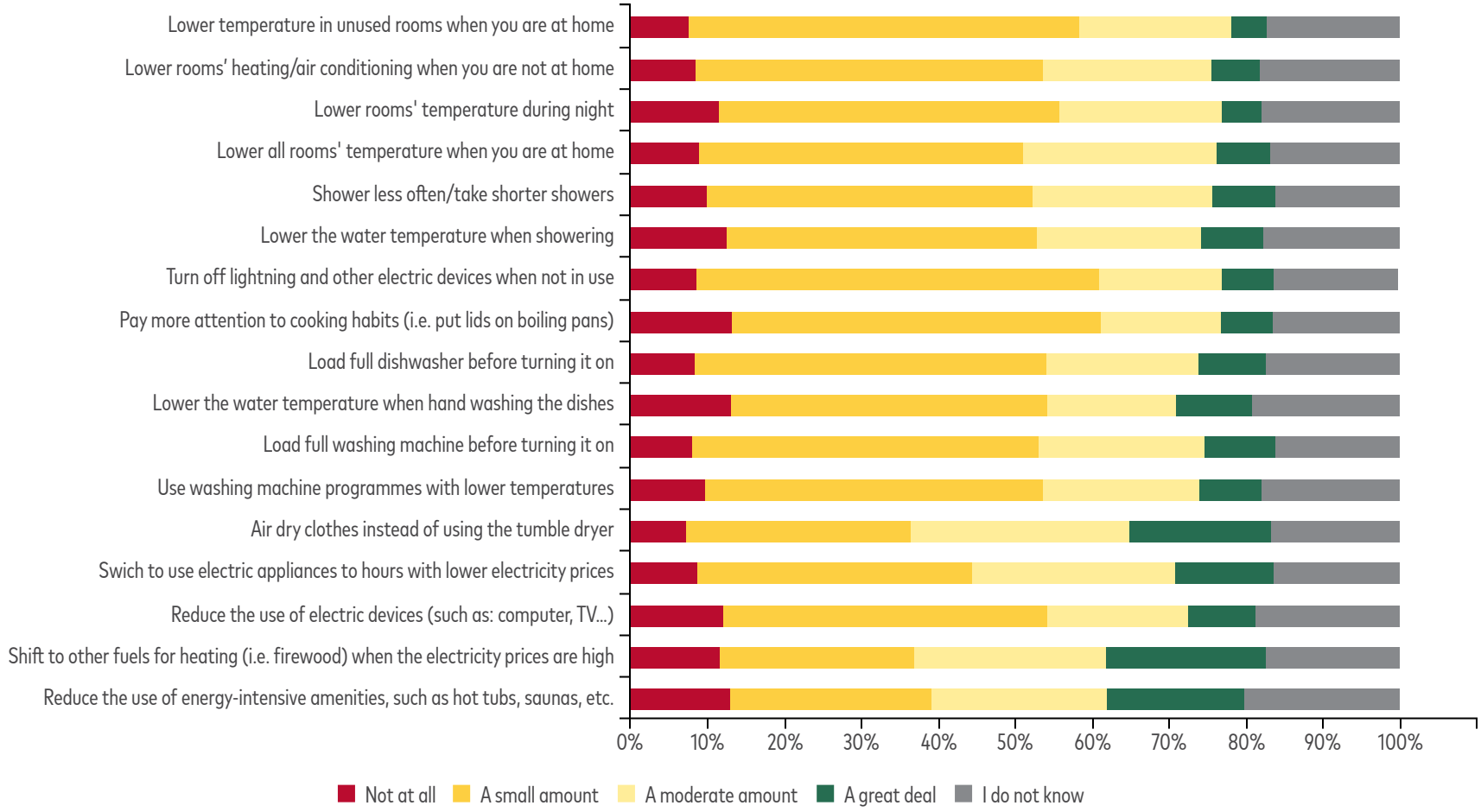


Figure A 23. Distribution of perceptions of the impact of energy saving actions, per energy efficiency measure, and aggregated for Norway, Sweden, Finland, Denmark, Iceland and the Faroe Islands.

The figure below illustrates the willingness to sustain the energy saving behaviour among all respondents in all countries. However, the results show variations when it comes to sticking to energy-saving habits over the next three months.

For 'Turning off lights and devices when not in use', 59% of all respondents were willing to stick to this habit to a great extent. Iceland (69%) had the highest commitment, while the Faroe Islands (37%) showed the least.

For 'Loading full dishwashers before turning them on', 63% of all respondents were willing to maintain this habit. Denmark (71%), Iceland (70%), and Sweden (69%) had the highest willingness, with the Faroe Islands at 39%.

Regarding 'Loading full washing machines before turning them on', 64% of all respondents were committed to sticking with it, led by Iceland (74%) and Sweden (71%).

For 'Air drying clothes instead of using the tumble dryer', 66% of all respondents were willing to continue. Sweden (71%) had the highest commitment, while the Faroe Islands (50%) showed the least.

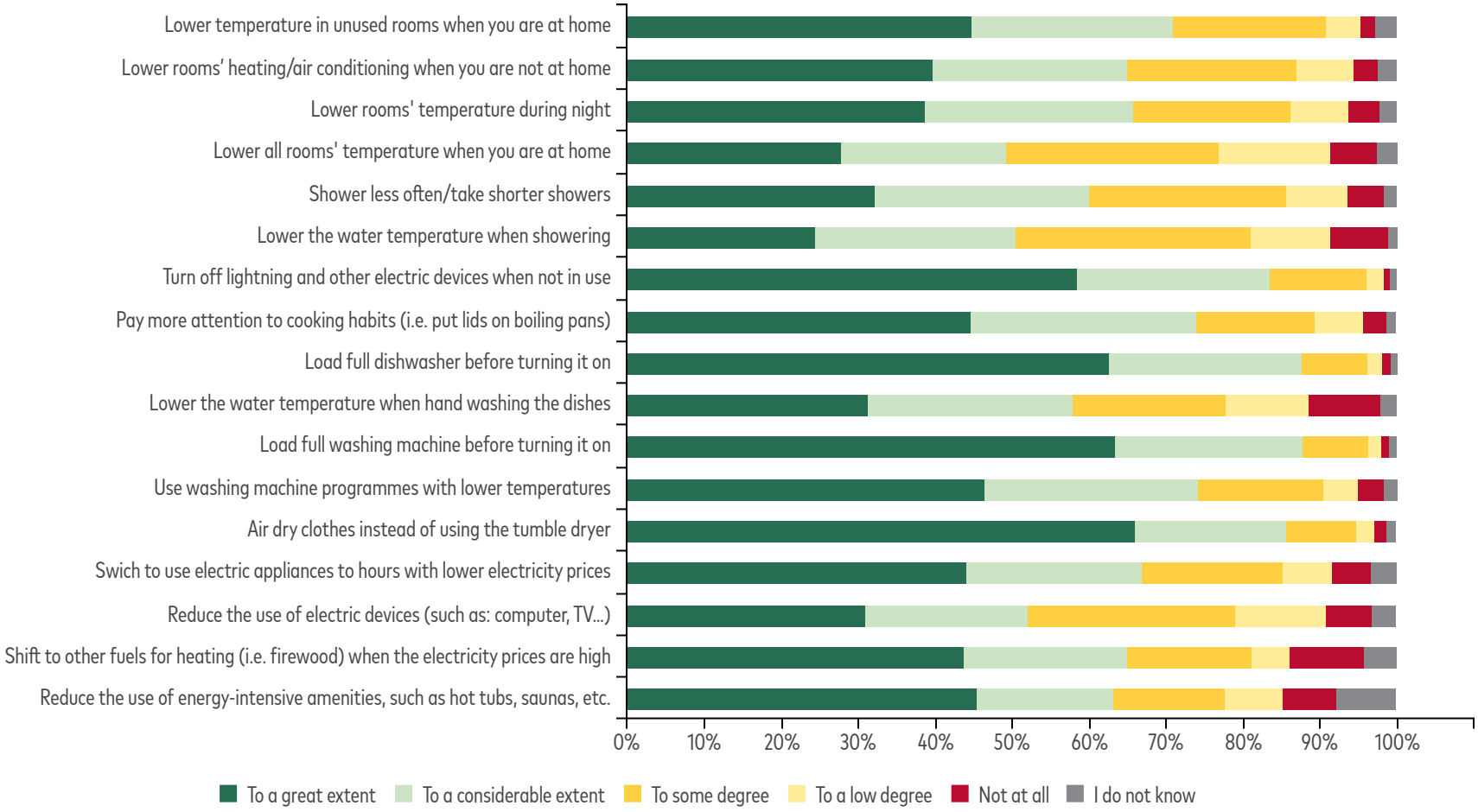


Figure A 24. Distribution of willingness to sustain energy saving behaviours over time, per energy efficiency measures, and aggregated for Norway, Sweden, Finland, Denmark, Iceland and the Faroe Islands.

Medium to long-term energy efficiency measures: Respondents were asked which energy-saving measures they have implemented or plan to implement in the next 2-3 years to save energy and/or money. The following graph summarises the results for all respondents in Nordic countries, as similar patterns were observed across the countries. Only the Faroe Islands showed a slightly different trend in the answers, with specific measures such as adding extra insulation in external walls and ceilings, installing energy-efficient windows, and replacing high-energy consuming appliances with energy-efficient ones standing out with higher percentages compared to the other countries.

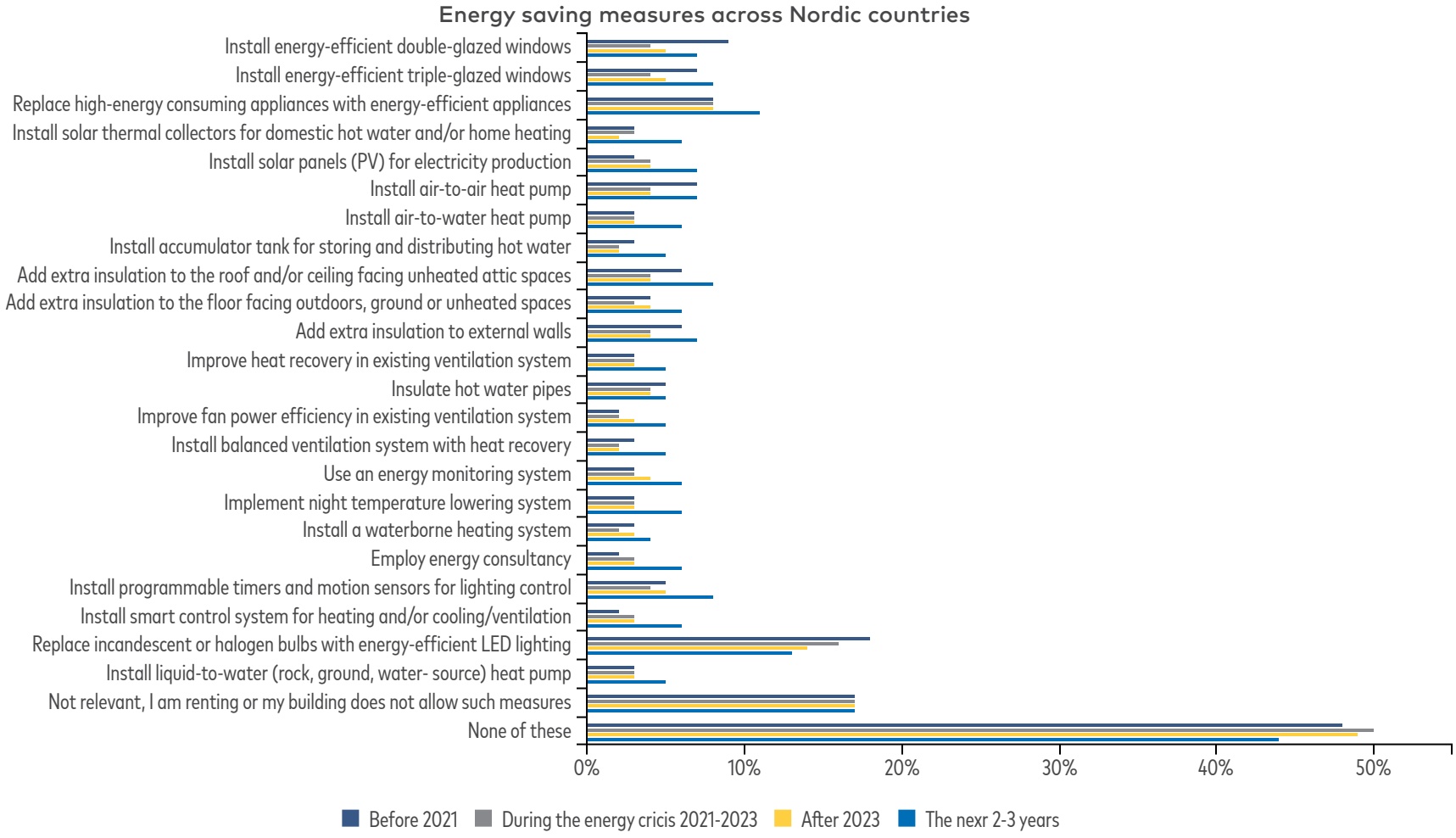


Figure A 25. Distribution of responses about energy saving measures in the Nordic countries.

Note that, for one of the most chosen measures, 'Replace incandescent or halogen bulbs with energy-efficient LED lighting', 51% of respondents reported saving a small amount, 23% a moderate amount, and 8% a great deal, with the highest proportion of respondents in Finland and Sweden (57%) believing they saved a small amount.

Attitudes and motivations towards energy consumption and efficiency: The following sections explore respondents' attitudes, motivations, and behaviours related to energy consumption, efficiency measures, and responses to energy crises. Topics include agreement with energy-related statements, preferred policy measures, awareness and monitoring of energy usage, behavioural changes, and motivations for energy-saving actions. Results highlight variations across countries and shifts before, during, and after the energy crisis (2021-2023).

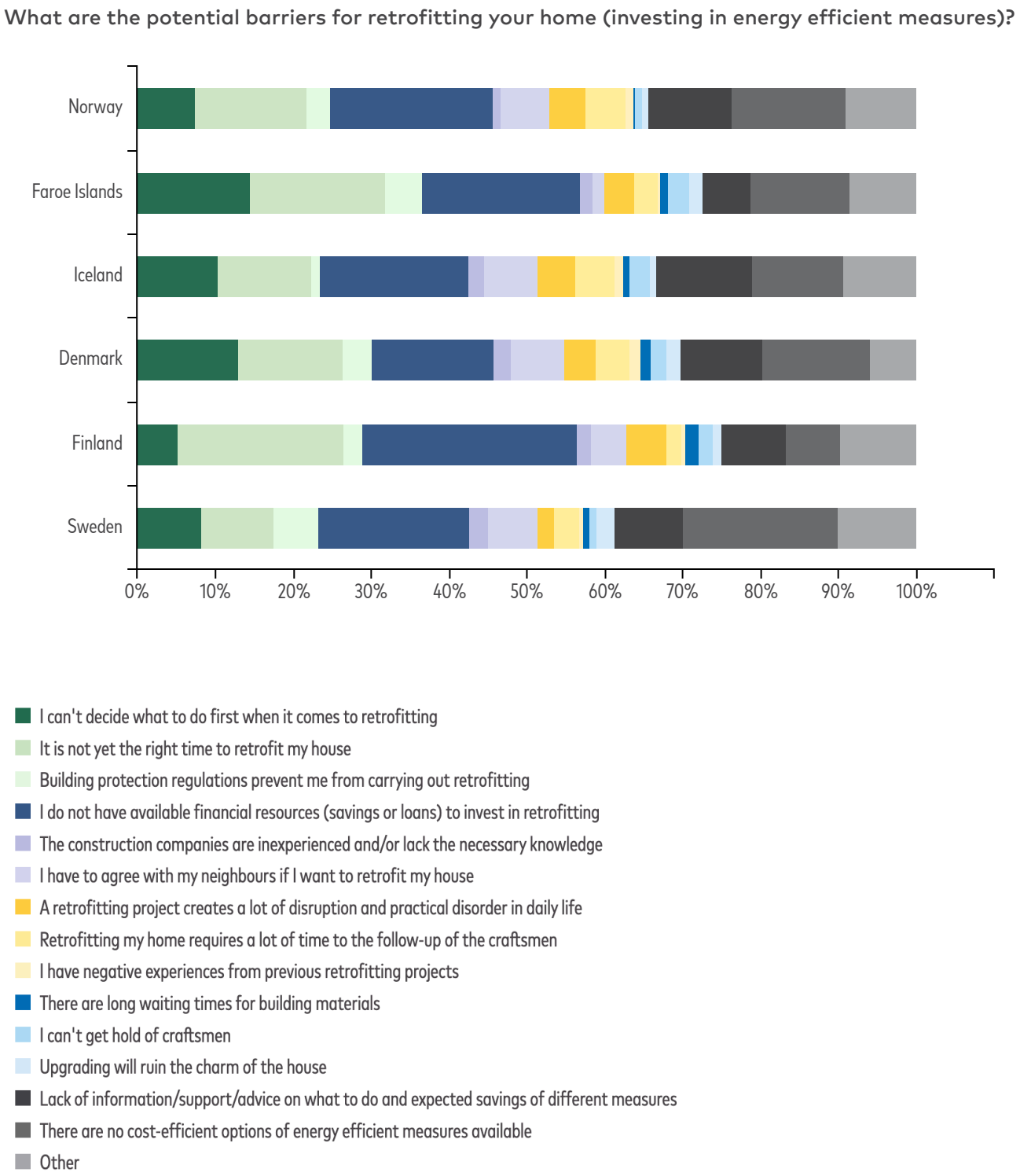


Figure A 26. Respondents' agreement with statements on energy consumption, efficiency, and environmental impact across the Nordic countries

Regarding preferred policy measures during a significant increase in energy prices, 49% of all respondents favoured 'reduced energy tariffs. However, there were notable differences across countries: Norway had the highest preference for this measure (59%), while Finland had the lowest (37%). A 'subsidy scheme for energy efficiency measures' was another popular choice, particularly in Iceland (48%) and Norway (45%). 'Price regulation, such as subsidized prices and social tariffs', was favoured by 30% overall, with Norway leading at 44%, while Iceland had the lowest preference at 20%. 'Cash payouts to all' were selected by 11% overall, but this was highest in Norway (17%) and lowest in Iceland (9%). 'Economic support based on energy consumption' was preferred by 16%, with Finland showing the highest support (19%).

Before, during, and after the energy crisis (2021-2023), the way respondents followed electricity prices varied. Before 2021, 33% didn't pay attention to electricity prices at all, and 25% had a general impression of how prices fluctuated but didn't actively track them. A smaller portion (10%) actively monitored prices through apps or the internet, and 8% relied on smart systems to control usage. During the energy crisis, active monitoring significantly increased, with 36% of all respondents tracking hourly prices, particularly in Norway (51%). However, many still had a general sense of price trends (20%), and a smaller group (10%) checked prices when notified by app or SMS. After 2023, 31% of respondents continued actively monitoring prices, with the highest rates in Norway (40%) and Iceland (39%). While fewer used smart systems (7%) or checked prices through notifications (11%), many still relied on general impressions (23%) or media discussions (15%). Note that this question was not directed to the Faroe Islands and Iceland.

Before, during, and after the energy crisis (2021-2023), respondents showed varying levels of awareness regarding their electricity and heating consumption. Before 2021, 24% of all respondents did not think about their electricity and heating consumption at all, with Finland and Sweden at 26%. About 23% of respondents considered it 1-2 times a month, particularly in Denmark (25%) and Sweden (26%). Only 3% of respondents thought about it more than once a day, with Norway at 4%. During the energy crisis, there was an increase in attention towards energy use, with 14% of respondents thinking about it more than once a day and 19% once a day. Norway led with 20% of respondents thinking about it more than once daily, while Sweden was lower at 10%. After 2023, awareness decreased slightly, with 8% of respondents thinking about it more than once a day. Norway remained higher at 11%, while Sweden had only 4%. Note that this question was not directed to the Faroe Islands and Iceland.

Before, during, and after the energy crisis (2021–2023), there was a shift in respondents' behavior regarding the timing of energy consumption, i.e., adjusting

the energy use to times with lower electricity prices. Before 2021, only 10% adjusted their consumption, with Denmark (14%) leading and Sweden (5%) having the lowest rate. A significant portion (71%) did not make any changes. Additionally, 7% explored options but didn't implement them, and 7% considered but opted out due to comfort or convenience. During the crisis, 32% of respondents adjusted their usage, with Denmark (46%) and Norway (42%) having the highest engagement. However, 43% still did not move their consumption, and 8% explored options but didn't act on them. After 2023, 30% of all respondents continued adjusting energy consumption, with Denmark (43%) still with the highest engagement, while 46% of respondents opted not to change. Notably, 11% of all respondents explored options and planned to implement them. Sweden continued to have the lowest engagement, with 68% of respondents not making any changes. Note that this question was not directed to Faroe Islands and Iceland.

Regarding motivations to save energy before, during, and after the energy crisis (2021-2023), 50% of respondents cited 'saving money' as their primary motivation, followed by 'doing something good for the climate and environment' (45%). In Denmark, Finland, and Sweden, the main motivation was saving money (68%, 69%, and 60%, respectively), while Norway stood out with 73% selecting 'to do something good for the climate and environment' and only 5% choosing 'to save money.' Other motivations included contributing to a sustainable future energy system (25%) and preventing energy supply pressure (15%). 8% of respondents felt nothing could motivate them to save more energy, while 7% had no motivation to save at all. Note that this question was not directed to the Faroe Islands and Iceland.

Respondents were asked whether they considered retrofitting their homes by investing in energy efficiency measures. The results revealed that 22% of all respondents took action, with the highest percentage in the Faroe Islands (39%). Another 20% considered implementing measures but did not follow through, with Iceland showing the lowest percentage in this category (13%). The majority of respondents (58%) did not consider house retrofitting, with the highest 'no' responses coming from Iceland (81%) and Finland (62%).

Respondents were also asked about potential barriers to retrofitting their homes for energy efficiency, such as financial constraints, lack of knowledge or information, and practical challenges like disruption to daily life or coordinating with neighbours. The respondents had the option to choose more than one alternative and therefore the percentage of the answers exceeds 100% in the row data. The figure below summarises the normalised percentage of the chosen alternatives across the countries.

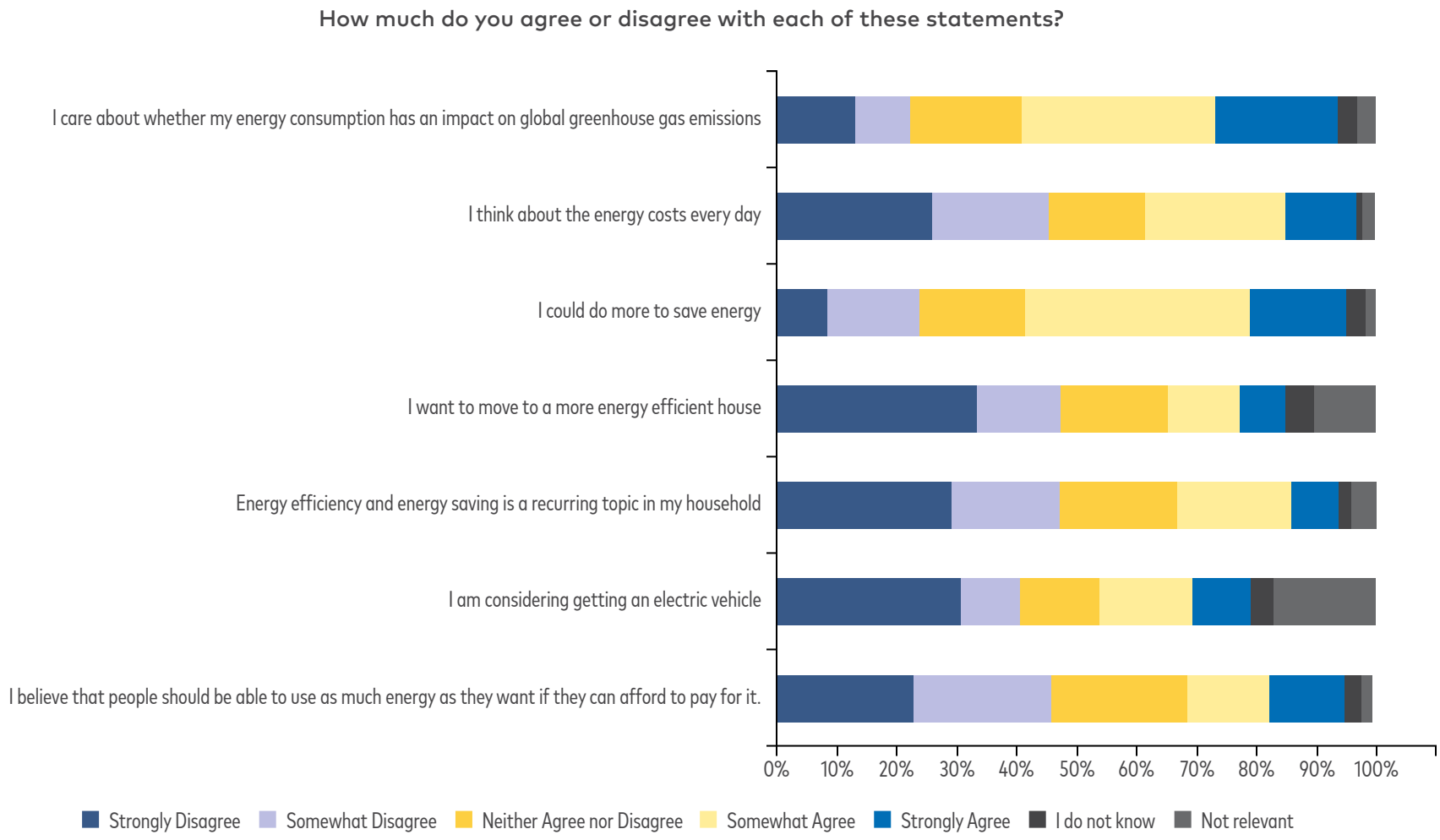


Figure A 27. Potential barriers to retrofitting homes and investing in energy-efficient measures across the Nordic countries.

Demographics: The following demographic information provides an overview of various respondent characteristics across Denmark, Sweden, Norway, Finland, the Faroe Islands, and Iceland, including age distribution, gender, education, employment status, and other related factors.

Regarding the respondents' age, there was an even distribution among the age groups across all countries. In Norway, the oldest group (60+) made up the majority (31%), followed by the 18-29 age group (19%). In the Faroe Islands, the 40-59 age group prevailed (54%). In Iceland, the 30-39 age group represented 30%, with the 60+ group at 28%. In Denmark, the 60+ group accounted for 33%, followed by the 18-29 group at 19%. In Finland, 36% were in the 60+ group, followed by the 18-29 group (17%) and the 30-39 group (16%). In Sweden, the 60+ group also represented 33%, with the 18-29 and 30-39 groups each at 18%

Overall, 50% of respondents were men, and 50% were women across all countries.

Additionally, 29% of respondents had the highest level of education (university/college). 25% of respondents had 1-2 years of education after upper secondary school, and 17% had only completed secondary school. There were some differences across countries, with the highest percentage of university/college education in Iceland (41%), the Faroe Islands (32%), and Norway (30%). In contrast, Finland (37%) and Denmark (31%) had the highest percentages for 1-2 years of education after upper secondary school. Sweden had the highest percentage (34%) for secondary school education. Other education levels, such as primary school or other types of education, were reported by smaller percentages of respondents across the countries.

Overall, 47% of respondents were employed full-time, with the highest percentage in the Faroe Islands (66%) and the lowest in Denmark (36%). Age pensioners accounted for 23%, with Finland having the highest percentage (28%), followed by Denmark (27%), Sweden (26%), and Norway (24%). Part-time employment was reported by 8%, with the Faroe Islands having the highest at 11%. Students represented 7%, with Denmark having the highest percentage (11%). Self-employed individuals made up 5%, while unemployed respondents were 3%, with the highest unemployment rate in Finland (6%).

Respondents were asked to provide the information about the household annual income, and they were given the option not to give this information. A significant share of respondents across the surveyed countries did not provide information about its annual household income: 37 % in the Faroe Islands 41% in Norway, and around 50% in Sweden, Finland, Denmark and Iceland. Among those who responded, the average annual gross income before taxes was 1,400,000 NOK in Norway, 628,000 SEK in Sweden, 13,260,000 ISK in Iceland, 53,700 Euros in Finland, 860,000 DKK in the Faroe Islands, and 644,000 DKK in Denmark.

About this publication

Energy efficiency in the Nordics

The core project team consisted of consultants and researchers from SINTEF, led by project manager Roberta Moschetti. The SINTEF team also included Eli Sandberg, John Clauß, Synne Krekling Lien, Sahar Babri, and María Díez-Gutiérrez.

In addition, the project involved key partners from across the Nordic region, including Aarhus University (Denmark), Tampere University (Finland), Reykjavik University (Iceland), and IVL (Sweden).

http://dx.doi.org/10.6027/NER2025-01

Cover illustration: iStock
Layout: Agger Grafisk Design

Published: 17.02.2025

Nordic Energy Research

Nordic Energy Research is the Nordic institution for joint energy research and research-based policy development, under the Nordic Council of Ministers.
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