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Carbon neutral Finland 2035 – national climate and energy strategy

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Abstract

The National Climate and Energy Strategy outlines measures by which Finland will meet the EU's climate commitments for 2030 and achieve the targets set in the Climate Change Act for reducing greenhouse gas emissions by 60 per cent by 2030 and being carbon neutral by 2035. It is estimated that the share of renewable energy will rise above Finland's indicative minimum target presented in the EU's Fit for 55 Package by 2030. On the other hand, Finland will exceed the indicative final maximum energy consumption laid out in the Fit for 55 Package if the development proceeds according to the scenario calculations.

The strategy focuses on the green transition and the phasing-out of Russian fossil energy, which has become increasingly topical during spring 2022. With regard to heat production, the strategy focuses on promoting non-combustion-based heating. The electrification of the energy system and the use of system integration are vital topics, especially when it comes to sectors where reducing emissions is difficult. The strategy includes a national hydrogen strategy to promote the hydrogen economy and electrofuels and to set quantitative targets for hydrogen electrolysis capacity.

The emissions trading system and a predictable long-term climate and energy policy are key steering instruments of the strategy. The measures outlined in the strategy will improve the opportunities for companies to make long-term investments in advanced clean technologies.

During the preparation of the strategy, the impacts that the policies as a whole could have on the environment, gender, national economy and central government finances were assessed, as were social and regional impacts.

The publication has been updated on September 21, 2022 and this version replaces the earlier version published on September 9, 2022. All updates were corrections of translation terms.

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Hiilineutraali Suomi 2035 – kansallinen ilmasto- ja energiastrategia

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Tiivistelmä

Kansallisessa ilmasto- ja energiastrategiassa linjataan toimia, jolla Suomi täyttää EU:n vuoden 2030 ilmastovelvoitteet ja saavuttaa ilmastolain mukaiset tavoitteet kasvihuonekaasujen vähentämisestä 60 prosentilla vuoteen 2030 ja vuotta 2035 koskevan hiilineutraaliustavoitteen. Uusiutuvan energian osuuden arvioidaan nousevan vuonna 2030 yli EU:n 55-valmiuspaketissa esitetyn Suomen ohjeellisen vähimmäisosuuden. Sen sijaan 55-valmiuspaketin ohjeellinen energian loppukulutuksen enimmäismäärä Suomelle vuonna 2030 ylittyy skenaariolaskelmien mukaisessa kehityksessä.

Strategian keskiössä on vihreä siirtymä ja keväällä 2022 ajankohtaistunut irtautuminen venäläisestä fossiilisesta energiasta. Lämmöntuotannossa edistetään erityisesti polttoon perustumatonta lämmöntuotantoa. Energiajärjestelmän sähköistyminen ja järjestelmäintegraation hyödyntäminen ovat keskeisiä erityisesti sektoreilla, joilla päästöjen vähentäminen on vaikeaa. Strategiaan sisältyy kansallinen vetystrategia, jolla edistetään vetytaloutta ja sähköpolttoaineita sekä asetetaan määrälliset tavoitteet vedyn elektrolyysikapasiteetille.

Päästökauppajärjestelmä ja pitkäjänteinen ennustettava ilmasto- ja energiapolitiikka ovat strategian keskeisiä ohjauskeinoja. Strategiassa linjattavin toimin parannetaan yritysten mahdollisuuksia tehdä pitkäjänteisesti investointeja edistyneeseen puhtaaseen teknologiaan.

Strategiaa valmisteltaessa on politiikkatoimen kokonaisuudesta tehty vaikutusarviot niin ympäristö-, sukupuoli-, kansantalous-, valtiontalous- sekä sosiaaliset ja alueelliset vaikutusten osalta.

Julkaisu on päivitetty 21.9.2022 ja tämä versio korvaa aikaisemmin, 9.9.2022 julkaistun version. Kaikki päivitykset olivat käännöstermien korjauksia.

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Klimatneutralt Finland 2035 – den nationella klimat- och energistrategin

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Referat

I den nationella klimat- och energistrategin dras det upp riktlinjer för åtgärder genom vilka Finland uppfyller EU:s klimatåtaganden för 2030 och uppnår de mål för minskning av växthusgasutsläppen med 60 procent fram till 2030 som anges i klimatlagen och målet om klimatneutralitet för 2035. Andelen förnybar energi beräknas år 2030 öka över Finlands riktgivande minimiandel i EU:s 55%-paket. Den riktgivande maksimala slutliga energiförbrukningen för Finland år 2030 inom ramen för 55%-paketet kommer däremot att överskridas enligt scenariokalkylerna.

I centrum för strategin står den gröna omställningen och avvecklingen av användningen av fossil energi från Ryssland, som blev aktuell under våren 2022. Vid värmeproduktion främjas särskilt sådan värmeproduktion som inte baserar sig på förbränning. Elektrifieringen av energisystemet och utnyttjandet av systemintegrationen är centrala särskilt inom sektorer där det är svårt att minska utsläppen. I strategin ingår en nationell vätgasstrategi som främjar vätgasekonomin och elektrobränslen samt fastställer kvantitativa mål för vätgasens elektrolyskapacitet.

Systemet för handel med utsläppsrätter och en långsiktig, förutsägbar klimat- och energipolitik är centrala styrmedel i strategin. De åtgärder som stakas ut i strategin förbättrar företagens möjligheter att långsiktigt investera i avancerad ren teknik.

När strategin färdigställdes gjordes konsekvensbedömningar av helheten av politiska åtgärder i fråga om miljökonsekvenser, konsekvenser för jämställdheten mellan könen, konsekvenserna för samhällsekonomin, konsekvenserna för statens ekonomi samt de sociala och regionala konsekvenserna.

Publikationen har uppdaterats den 21 september 2022 och denna version ersätter den tidigare versionen som publicerades den 9 september 2022. Alla uppdateringar är översättningsfixar.

Nyckelord	energi, klimat, koldioxidsnålhet, strategiskt arbete, väte		
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Contents

1 Key premises and objectives

1.1 Introduction

Slowing down and halting climate change requires long-term and consistent policies and concrete actions around the world. Finland's national climate and energy strategy covers all greenhouse gas emissions and removals achieved through carbon sinks in society. The strategy forms a comprehensive action plan to move towards a carbon-neutral and, later, carbon-negative society. The objectives will be pursued in a manner that is as cost-effective, efficient and sustainable as possible.

Carbon neutral Finland in 2035 has been specified as a target in the Programme of Prime Minister Sanna Marin's Government. This has been a clear starting point for the climate and energy strategy prepared within the framework of the Government under the leadership of the Ministry of Economic Affairs and Employment. The strategy has been prepared in coordination with both the Medium-term Climate Change Policy Plan (KAISU) and the Climate Change Plan for the Land Use Sector (MISU). This strategy defines the policy measures for the industry and energy production included in the emissions trading system. The Ministry of the Environment coordinates the preparation of the Medium-term Climate Change Policy Plan. The plan defines new policy measures in the so-called effort sharing sectors that fall outside the current EU emissions trading scheme used to meet the obligations imposed by the EU. The Ministry of Agriculture and Forestry coordinates the preparation of the Climate Change Plan for the Land Use Sector. The plan examines agriculture, forestry and other land use comprehensively and promotes overall sustainability.

Therefore, the climate and energy strategy covers all greenhouse gas emissions in the emissions trading sector, the effort sharing sector and the land use sector, as well as carbon sinks in the land use sector and other sectors. Approximately 80 per cent of greenhouse gases causing global warming result from the production and consumption of energy, including transport. Thus, energy and climate policies are closely connected. This is most clearly reflected in the promotion of energy efficiency and clean energy sources. Other key premises in energy policy include security of supply in energy production as well as a competitive energy price essential for energy users and economic growth. The efficient functioning of the energy market is a strong starting point for achieving these objectives. Indeed, the strategy covers the five dimensions of the EU's Energy Union: the decarbonisation of the economy, including renewable energy, energy efficiency, the internal energy market, energy security and research, innovation and competitiveness.

Decarbonisation and the reduction of greenhouse gas emissions are global challenges. In both the EU and Finland, the public debate on climate and energy policy has focused on reducing greenhouse gas emissions. Due to the urgency and relevance of the greenhouse gas reduction targets, the other dimensions of the Energy Union have received less attention. They are often perceived as contributory factors to promoting decarbonisation. The strong increase in electricity and fossil fuel prices that occurred in the second half of 2021 and the Russian military invasion of Ukraine in February 2022 have also brought energy delivery reliability and security of supply and energy imports from Russia to the heart of the debate.

In normal conditions, energy delivery reliability and security of supply are not visible in society. Appropriate energy delivery reliability and security of supply must be ensured, as they will quickly have dramatic effects on citizens and businesses during a crisis. The level of energy delivery reliability and security of supply in the energy sector can also not be changed rapidly; instead, it requires time and investment. The EU's objective is to end its reliance on Russian fossil energy. The green transition, which is a prerequisite for reducing greenhouse gas emissions, is also a key step towards achieving this goal. Section 4.5.5 discusses the efforts to eliminate dependence on Russian fossil energy in more detail.

The changes needed in society, especially in industry and the energy system, can only be achieved through major investments. The policy measures set out in this strategy will improve companies' ability to make long-term investments in advanced clean technology. A predictable and stable operating environment will enable not only investments but also the development of Finnish technology and exporting it to the global market. This will increase the carbon handprint of both Finland and Finnish companies.

Increasing international climate benefits, also referred to as the carbon handprint, should therefore be set as a goal of Finland's climate policy in addition to reducing national emissions. Priority should be given to actions that help to produce new solutions for the world and whose global potential is particularly high. The importance of the carbon handprint of Finnish companies has also been emphasised in the Government's Sustainability Roadmap.

The abandoning of fossil energy sources must involve making investments in emission-free heat production and ensuring the functioning of the electricity system as variable renewable production increases. Ensuring energy delivery reliability and security of supply also requires significant investments in network infrastructure.

Overall, it is essential to get ready and prepare for a wide-ranging introduction of new technologies, naturally strongly depending on their overall development and, in particular, their commercial viability. For this purpose, the strategy includes sections on

the specific themes of system integration and electrification, hydrogen and electrofuels, future heating system, offshore wind power and emerging nuclear energy. The section on hydrogen also serves as a separate national hydrogen strategy. The hydrogen strategy is based on the extensive Hydrogen economy – Opportunities and limitations report[1].

The strategy also includes issues related to adaptation to climate change, energy and greenhouse gas balances and, as an essential part, comprehensive impact assessments of the selected policy measures, including their environmental impacts, gender equality, economic impacts, impacts on central government finances, and social and regional impacts.

The main focus of both policy measures outlined in the strategy and the scenarios based on them is on meeting the climate and energy targets and obligations set by the EU for 2030 and the carbon neutrality 2035 target set in the government programme. The purpose of the new policy instruments and other steering instruments is to ensure a fair and sustainable transition to a carbon-neutral society by 2035. In addition to greenhouse gas emissions, the policy measures also take other environmental impacts into account. The EU's 'do no significant harm' (DNSH) principle has been incorporated into some of the financing instruments.

Policy measures are assessed from the perspective of their impacts and cost-effectiveness, paying attention to regional differences and employment impacts. The scenarios play an essential role in the evaluation of policy measures. Scenario calculations that extend to 2040 assess the energy balances of different sectors and the development of greenhouse gas emissions. The preparation of the strategy has also taken into account the legislative proposals issued by the European Commission in summer 2021 on tightening the 2030 targets (the Fit for 55 package) and the sector-specific reporting carried out by different ministries.

To support the preparation of the Climate and Energy Strategy and the Medium-term Climate Change Policy Plan, an extensive background study funded by the Government's analysis, assessment and research activities, Carbon neutral Finland 2035 – measures and impacts of the climate and energy policies[2], was commissioned. The report abbreviated as the HIISI project was coordinated by the VTT Technical Research Centre of Finland Ltd- and its research partners were the Finnish Environment Institute (Syke), Natural Resources Institute Finland (Luke), the Finnish Institute for Health and Welfare (THL) and Pellervo Economic Research (PTT). The HIISI project produced both computational and qualitative

1 Hydrogen economy – Opportunities and limitations https://tietokayttoon.fi/-/vetytalouden-mahdollisuudet-ja-rajoitteet

2 The HIISI report http://urn.fi/URN:ISBN:978-952-383-257-2 ja www.hiisi2035.fi

analyses of the impacts of new climate and energy policy measures on different emission sectors, industries, people, the environment and nature. The HIISI project was succeeded by the HIISI follow-up study, completed in February 2022. The aim of the further study was to assess the impacts of the Government's latest climate and energy policies on Finland's greenhouse gas emissions and the energy and national economy.

The impact assessments also took into account Finland's greenhouse gas emission targets for 2030, 2040 and 2050 in accordance with the preparation of the proposed Climate Change Act and the emission reduction target for the effort sharing sector for 2030 in accordance with the European Commission's Fit for 55 package.

The climate and energy strategy has been prepared as a joint Government project involving the Ministry of Economic Affairs and Employment, the Ministry of the Environment, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry and the Ministry of Finance. The expertise of the agencies operating under the ministries has also been widely utilised. The strategy work has been coordinated by the ministerial working group on climate and energy policy.

1.2 Climate and energy targets in Sanna Marin's Government Programme

The Programme of Prime Minister Sanna Marin's Government states that the Government will work to ensure that Finland is carbon neutral by 2035 and carbon negative soon after that. This means that greenhouse gas emissions and removals caused by carbon sinks must be equal in 2035, and the impact of sinks must be subsequently greater than that of emissions. The government programme also notes that emission reduction measures will be implemented in a socially and regionally fair manner and will involve all sectors of society. In accordance with the government programme, electricity and heat production must be nearly emission-free by the end of the 2030s, taking into account delivery reliability and security of supply aspects.

The Government Programme states that the Medium-term Climate Change Policy Plan and the national climate and energy strategy will be updated to achieve the emission reduction level required by achieving carbon neutrality in 2030. The government programme also aims to reduce emissions from the land use sector and strengthen carbon sinks in the short and long term. Based on an entry in the government programme, the Government will prepare a comprehensive climate plan for the land use sector.

The carbon neutrality target set by the government programme for 2035 is significantly more ambitious than the corresponding targets currently valid at the EU level and requires higher emission reductions by 2030 than can be achieved by current measures. There is a need to strengthen the measures on cutting emissions set in the Energy and Climate Strategy completed in 2016 and the Medium-term Climate Change Policy Plan that concerns the emissions in the effort sharing sector completed in 2017. Decisions must also be made on new measures, which must be planned both in the emissions trading sector and in sectors outside the emissions trading sector. There is also a need to introduce measures extending beyond 2030.

New measures needed to achieve the carbon neutrality objective have been examined in connection with the preparation of the Climate and Energy Strategy, the Medium-term Climate Change Policy Plan and the Climate Change Plan for the Land Use Sector.

1.3 Preparing a revision of the Climate Change Act

The Climate Change Act (609/2015) contains provisions on the planning and monitoring of climate policy and the long-term emission reduction target. The Government proposal (HE 27/2022 vp) for a new Climate Change Act was confirmed on 10 June 2022. The Act will enter into force on 1 July 2022. The key objective of the new Act is to ensure that Finland will achieve carbon neutrality by 2035 and will be subsequently carbon negative. The objectives of carbon neutrality and carbon negativity also include the objective of strengthening sinks. The new emission reduction targets for 2030 and 2040 have also been added to the Act. In addition, the emission reduction target for 2050 has been updated in the valid Act. As a result of the reform, a new climate change plan for the land use sector will be included in the planning system. In addition, new obligations on taking the rights of the Sámi people into account will be imposed. A new Sámi Climate Change Council will be established to identify key issues in climate policy relevant to the promotion of the rights of the Sámi people.

When the draft government proposal was circulated for comments from July to September 2021, the proposals on municipalities' promotion obligation and regulation on appeals raised criticism. Based on the obtained comments, it was decided that the preparation of these issues would be postponed.

In the government budget session of September 2021, a decision was made to include an obligation for preparing a climate plan at the municipal, regional or regional level. The obligation was to be included in the Climate Change Act. As the obligation imposed on municipalities requires thorough preparatory work, it will be prepared in its entirety in a second proposal that will complement the new Climate Change Act adopted on 1 July

2022. In connection with the preparation, the need for a promotion obligation that may be imposed on municipalities will also be assessed. The new regulation on appeals is set to be also included in the proposal. A proposal on the municipalities' obligations and the appeal process is to be submitted to Parliament in autumn 2022.

1.4 European Union energy and climate policy targets 2030 and 2050

The EU Energy Union's climate and energy policy is based on three main principles: the sustainability of climate and energy policy, safeguarding the security of supply and a competitive energy price. In addition, the preparation of EU policies emphasises the social fairness and an energy efficiency first principle of policy measures.

The Energy Efficiency First principle was adopted by the European Union as part of the legislative proposals for the Clean energy for all Europeans package in 2016. Prioritising energy efficiency is perceived as the easiest way to reduce consumers' costs and cut greenhouse gas emissions. The principle requires the Member States to consider cost-effective measures for energy demand before investing in energy infrastructure. These measures may include savings in final energy consumption, demand response solutions or more efficient energy conversion, transfer and distribution. The Energy Efficiency First principle is applied at different levels of decision-making related to energy, while paying attention to the achievement of the targets of the decision.

1.4.1 Current EU targets for 2030

The EU's climate and energy targets have been tightened on several occasions, and their level of ambition is currently increasing (see section 1.4.3). The EU's current emission reduction target for 2030 decided by the European Council in 2014 is at least 40% of 1990 levels. In the EU's 2030 climate and energy framework for the period 2021–2030, this target has been divided between the emissions trading sector (ETS) and the effort sharing sector (non-ETS). This means a reduction of 43% in the emissions trading sector and 30% in the non-ETS sector compared to the 2005 levels. The EU's emissions trading system ensures that the ETS sector meets the EU's greenhouse gas emission reduction targets set for it. The reduction of non-ETS emissions is the responsibility of the Member States. The EU has set a binding country-specific target for 2030 for each Member State and an emission path for the 2021–2030 period whose cumulative emissions must not be exceeded. Finland's target for 2030 is a 39 per cent reduction in emissions compared to 2005 levels.

The Renewable Energy Directive (REDII) adopted in 2018 raised the EU's common, binding renewable energy target to 32 per cent of final energy consumption; the revision of the Energy efficiency directive (EED) adopted in the same year raised it to 32.5% of the EU's common energy efficiency target. In their national energy and climate plans submitted to the EU in 2019, Member States have announced their own indicative targets for renewable energy and energy efficiency. Finland stated that its target was to increase the share of renewable energy to at least 51 per cent of the total final energy consumption and to achieve the energy efficiency target of a maximum of 290 TWh of final energy consumption.

In order to ensure the security of energy supply, market integration and large-scale introduction of renewable energy sources, a Member State should have in place an electricity interconnection capacity of at least 15 per cent at its borders. The level of interconnection of electricity networks is calculated by dividing the commercial transmission capacity between neighbouring EU countries and Norway and Switzerland by the capacity of the national power plants. Finland's electricity interconnection target is to maintain it at the level of 15 per cent.

1.4.2 EU carbon neutrality target for 2050

In December 2019, the European Commission adopted the Communication on The European Green Deal, which aims to make the EU a modern and competitive economy that will no longer cause net greenhouse gas emissions in 2050. At the same time, the policy programme is a comprehensive growth strategy, which includes the Commission's plans for future actions and initiatives in several sectors related to areas such as energy, transport, forests and agricultural policy.

In addition to the climate neutrality in 2050 target, the objectives of the programme include promoting the competitiveness of companies and helping them become global leaders in clean products and technologies, as well as ensuring a fair and inclusive transition. In addition to legislation, a central part of the programme is the allocation of funding to ensure sufficient investments in new technologies that reduce emissions and innovations in different economic sectors and, through this, the achievement of the targets set in the programme.

By autumn 2021, the Commission has already provided most of the large sets of initiatives included in the Green Deal in the form of communications in which it outlines its more detailed plans for future legislative packages. Climate neutrality in 2050 has been enshrined as a legally binding objective in the European Climate Law.

1.4.3 Tightening the EU's 2030 climate and energy targets

On 17 September 2020, the European Commission published a communication proposing that, in line with the EU Green Deal, the 2030 emission reduction target should be tightened by reducing net greenhouse gas emissions by at least 55 per cent of 1990 levels by 2030. The communication draws attention to the fact that the previous 2030 target is insufficient for achieving climate neutrality at the EU level by 2050. Simultaneously with the communication on the emission reduction target, the Commission published an EU-level assessment of the national energy and climate plans. In the assessment, the Commission presented its estimate of the levels to which the 2030 renewable energy and energy efficiency targets should be raised to make them consistent with the increased emissions reduction target.

To promote the achievement of the emission reduction target, in July 2021, the Commission published a comprehensive package of legislative proposals (the Fit for 55 package), which aims to change the EU's climate, energy, land use, transport and taxation policies to enable meeting the 2030 emission reduction target of at least 55 per cent. Among other things, the package will reform the emissions trading system by gradually extending its scope to shipping while at the same time establishing an emissions trading system for road transport and building-specific heating not covered by the current system. In the Commission's proposal, the current emissions trading system (including shipping) has a -61 per cent target by 2030 compared to 2005 levels. The aim is to achieve the target by tightening the linear emission reduction factor and a one-off reduction in the number of emission allowances. Meanwhile, effort sharing would be renewed as a result of the tightening of the new 2030 emission reduction target: the effort sharing system must cut emissions by 40 per cent as a whole. The binding targets set for each Member State would cover a range of 40 percentage points (10 to 50 per cent). Finland's emission reduction obligation would be among the tightest together with the Netherlands, Sweden, Luxembourg, Denmark and Germany.

Stricter energy legislation is also proposed. As part of the reform of the Renewable Energy Directive (REDII), the overall target for the share of renewable energy would increase from 32 per cent to 40 per cent, and changes are also proposed to sector-specific targets. In addition to the target levels, the Commission's proposal focuses on the heating and transport sectors and sustainability criteria. Meanwhile, the Energy Efficiency Directive (EED) would be tightened so that the EU's target for final energy consumption and primary energy consumption in 2030 would be binding and the efforts to improve energy efficiency would be tightened from 32.5 per cent to between 36 and 39 per cent. The target would be allocated to the Member States using the Commission's formula, which would mean that in Finland, the final consumption of energy would be limited to 250 TWh and total energy consumption, to 360 TWh in 2030. The proposal also contains a number of new obligations as well as increased data collection, reporting and monitoring.

On 18 May 2022, the Commission issued a communication on the REPowerEU plan, which proposes to expand the Renewable Energy Directive to raise the renewable energy target from the 40 per cent proposed in the Fit for 55 package to 45 per cent in the EU by 2030. In the area of energy efficiency, the Commission proposes that the Energy Efficiency Directive's target for 2030 in reducing energy consumption at the EU level be tightened from -9% in the Fit for 55 package to -13%. Tightening the energy consumption target would mean that the final energy consumption in Finland in 2030 would be at most 239 TWh.

The aims of the other proposals of the Fit for 55 package include accelerating the introduction of low-emission modes of transport, adapting tax policy to correspond to the objectives of the European Green Deal and preventing carbon leakage through the carbon border adjustment mechanism (CBAM). The package also includes measures to preserve and grow natural carbon sinks.

The Commission has noted that the proposals in the package are interconnected and complement one another. Furthermore, the Commission has stressed the importance of the fairness of the transition, noting that the package would divide responsibility equally between the different sectors and the Member States. Council working groups started discussing the initiatives mainly in September 2021. The discussion on the initiatives included in the package has progressed at various paces in the different sectors of the Council.

However, the intention has been that the individual proposals of the package could be assessed at the conclusion of the negotiations as part of the overall solution provided by the package. During the French Presidency of the Council of the European Union, the initiatives have been processed rapidly. The Council's general approach to the Carbon Border Adjustment Mechanism (CBAM) was reached at the ECOFIN Council on 15 March 2022. On 2 June 2022, the EU's Transport Council reached a general approach on the three legislative proposals included in the package, i.e. the regulation on alternative fuels for shipping (so-called FuelEU Maritime), the regulation on the deployment of alternative fuels infrastructure (so-called AFIR) and the regulation on alternative aviation fuels (so-called ReFuel Aviation).

France aims to find a general approach on two legislative proposals in the EU Energy Council on 27 June 2022, namely the reform of the Energy Efficiency Directive (EED) and the Renewable Energy Directive (REDIII).

The Environment Council of 28 June 2022 also seeks a general approach to the initiatives of the Fit for 55 package, i.e. France also aims to come to an agreement on the EU ETS Directive, the Social Fund and the Effort Sharing Regulation. For its part, the European

Parliament will deal with initiatives, and several proposals will probably be subject to tripartite consultation in autumn 2022.

The aim is for the new legislation to enter into force gradually from 2023. For example, the aim is to introduce a separate emissions trading system for road transport and building-specific heating in 2026, but the proposal for a directive would enter into force one year earlier, and require the reporting of data for 2024 and 2025. Likewise, the Carbon Border Adjustment Mechanism proposed by the Commission would be introduced in 2026 succeeding a transition period 2024–2025 that would include a reporting obligation for importers.

1.5 International climate negotiations

At the international level, the most important climate policies have been set out in the UN Framework Convention on Climate Change (UNFCCC) which entered into force in 1994, the Kyoto Protocol and the Paris Agreement. The parties to the Framework Convention on Climate Change include all UN Member States, including Finland, three other countries and the European Union. The Agreement obliges the parties to draw up, implement and update climate change mitigation and adaptation plans and to report on greenhouse gas emissions and carbon sinks. The parties must also promote the preservation and improvement of carbon stocks and sinks.

The Paris Agreement was concluded in December 2015 at the 21st session of the Conference of the Parties and entered into force in November 2016. The agreement applies to the period after 2020 and is valid until further notice. Negotiations on detailed rules for the implementation and application of the Convention, i.e. the content of the Katowice climate package, are still partly ongoing. In November 2021, the conference of the parties to the Framework Convention on Climate Change held in Glasgow agreed, on issues such as the detailed rules of Article 6 on market mechanisms, as well as on harmonised and transparent reporting on climate action and emission reporting.

The objective of the Paris Agreement is to keep the global average temperature increase well below 2°C, with the aim of limiting the average temperature increase to 1.5°C compared to pre-industrial times. The aim is also to strengthen the adaptive capacity and climate resilience of the parties to the agreement and to direct financial flows to low-emission development. In order to achieve the temperature target, global greenhouse gas emissions must be reversed as soon as possible and reduced rapidly thereafter to ensure that anthropogenic greenhouse gas emissions and sinks will be balanced in the second half of this century.

One of the key elements of the Paris Agreement is the obligation of the Parties to draw up so-called Nationally Determined Contribution (NDC), by which the Parties declare their emission reduction and possibly also adaptation targets and report on their planned climate actions. The contributions must be tightened at least once every five years and they must correspond to each party's maximum target level. Global stocktakes will be carried out every five years to evaluate the countries' collective progress towards the objectives of the Paris Agreement. The first stocktake will take place in 2023.

According to the NDC Synthesis Report published by the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) in September, 113 countries had announced new commitments which, if accomplished, would result in around a 12 per cent reduction in emissions between 2010 and 2030. In January 2022, the number of countries had increased to 129. In addition, 70 countries have announced that they are aiming for carbon neutrality by the middle of the century, which would lead to higher emission reductions of around 26 per cent. Some large economies have set their carbon neutrality targets later, including China and Russia in 2060 and India in 2070. Before further assessment of the new commitments made during the Glasgow conference, the current NDC commitments of the 193 parties will lead to an increase in the global average temperature by around 2.4°C by the end of the century. The commitments of the parties, and their capability to meet the targets of limiting global temperature rise will already be re-examined in 2022.

2 Policy guidelines of the climate and energy strategy

This chapter presents both new climate and energy policies and measures already decided and partly implemented during Prime Minister Sanna Marin's government's term in office. The policy measures are followed by a section explaining the background, necessity and impacts of the policies.

Chapter 2 does not include quantitative targets related to the use of different energy sources when the development is market-based. The results of the scenario reviews presented in chapter 4 provide an estimate of future development. Some of the development will also occur on market terms without the policy guidelines determining the end result.

The order in which issues are presented in chapter 2 primarily follows that of the National Energy and Climate Plan, which has been prepared in accordance with the EU's energy and climate policy governance mechanism.

2.1 Reducing greenhouse gas emissions and carbon sinks

2.1.1 Emissions trading sector

New policies:

- EU emissions trading is the key steering instrument for reducing emissions in the emissions trading sector. Finland will continue to play an active role in ensuring that the EU's emission reduction targets will be particularly directed to the emissions trading sector.
- In order to improve the cost-effectiveness of emission reductions and, in particular, to meet the obligations of the effort sharing sector, the country will utilise one-off flexibility (emissions are reduced in the emissions trading sector) and LULUCF flexibility (emissions are reduced in the land use sector).
- Finland will continue the implementation of a legislative roadmap for low-carbon construction based on life cycle assessment. The compatibility of the assessment of climate action in different areas of construction (renovation, new buildings and transport infrastructure) will be ensured. The coherence of

climate action at the planning and building level will be ensured. Measures to promote wood construction will be continued. Some of the impacts of the policy will also extend to non-ETS sectors.
- Approaches for supporting technical solutions for the development of sinks will be investigated.

Policies already decided in the government term:
- The reduction of industrial emissions is mainly based on the low-carbon roadmaps by the sectors. The implementation of roadmaps requires a predictable operating environment that promotes low-carbon investments as well as the coordination of public authority.
- An electrification subsidy for energy-intensive companies will be introduced to promote low-carbon investments in industry.
- The low-carbon roadmaps created for the sectors will be updated where applicable in 2023.

The EU's emissions trading system is the key steering instrument for emissions from industry and energy production. The price of emission allowances has increased sharply since the EU agreed on tightening the emission reduction target for 2030. Emissions from both electricity and heat production are decreasing very rapidly. Indeed, the particular challenge is to increase emissions-free heat production sufficiently quickly. Phasing out fossil fuels requires strong linking of different energy systems, i.e. system integration. Electrification and the role of hydrogen play a key role in reducing emissions from the process industry. The Government strongly supports this development. Previously introduced tax solutions, the currently prepared electrification subsidy, and energy and demonstration subsidies encourage companies to make the necessary investments. In the climate and energy strategy, incentives are focused on the development and commercialisation of technology. This also creates sustainable exports for Finnish companies and reduces emissions globally with the help of the carbon handprint of Finnish companies.

From section 2.2 onwards, this strategy presents measures related to energy policy related to areas such as renewable energy, the hydrogen economy, energy efficiency and the use of nuclear energy. These measures will also have a significant impact on the reduction of greenhouse gases in the emissions trading sector. For their part, ensuring the functioning of the energy market and energy delivery reliability and security of supply are a prerequisite for the success of the energy transition required to reduce emissions.

Low-carbon roadmaps

In accordance with the Government Programme, a total of 13 Finnish sectors prepared their own low-carbon roadmap by summer 2020. When preparing the roadmaps, the aim was to create new information and a new perspective on the climate challenge and to engage the sectors and their member companies more strongly in climate work. The roadmaps provided valuable information on the scale, costs and prerequisites of the measures needed to achieve the carbon neutrality target. The main conclusion of the work was that the Government's 2035 target for industry and other sectors is achievable through existing or emerging technologies, provided that the investment environment is favourable and that several boundary conditions are met. Particularly in the industrial sector, individual investments have a major impact on the development of emissions, which is why emission reductions do not take place linearly but in stages. The realisation of individual large investments also involve uncertainties. Although the magnitude of emissions varies between sectors, each sector's contribution is essential and valuable.

According to the road maps, electrification could mean an increase of 100 per cent in industrial electricity consumption and an increase of more than 50 per cent in Finnish electricity consumption by 2050. Increasing low-emission electricity generation capacity and strengthening the main grid requires significant investments. Enabling and predictable operating environment, RDI investments, the availability of experts, smooth regulation and licensing procedures play a key role in achieving this. The implementation also requires a strong commitment of the sectors to further efforts. The energy transition required by the carbon neutrality target necessitates an increase in affordable and secure electricity. In addition, system integration, the development of energy networks and the dismantling of administrative obstacles play a key role in accelerating the change. The system integration and the associated electrification will enable a significant reduction in emissions.

Construction

The legislative roadmap for low-carbon construction under the government programme has been promoted as part of the overall reform of the Land Use and Building Act. A draft decree on the climate survey of buildings prepared on the basis of the legislative roadmap supports the implementation of sector-specific (construction and properties) roadmaps.

Based on consumption data, buildings and construction account for about one third of Finland's greenhouse gas emissions. Some of these emissions are generated in the emissions trading sector (e.g. energy and part of construction products) and some in the effort sharing sector (e.g. the majority of construction products and emissions from transport, machinery and the treatment and recycling of construction and demolition waste).

For the decarbonisation of the existing building stock life cycle, a key measure involves improving energy efficiency. This involves reducing the energy needs of both heating and cooling without compromising the health of construction. In new energy-efficient buildings, a significant proportion of life cycle emissions are generated by the manufacture of construction materials. The share of heating in the lifecycle emissions of energy-efficient buildings has already fallen to less than half. Road construction involves transporting large masses of land, and emissions are caused by both transport and changes in the degradation of organic matter in the soil.

In order to better steer emissions generated by various sources and distributed over the long life cycle of the built environment, regulatory steering of low-carbon construction based on life cycle assessment has been prepared in accordance with the government programme. Based on the regulatory steering, new buildings would be subject to emission limits based on use categories, which would be reviewed periodically in connection with the monitoring of Finland's carbon neutrality target.

Wood construction systems and related expertise have developed significantly in recent years, and cost-competitive wood solutions and system suppliers are available in the market for all building types. Wood construction and the use of wood in construction support the achievement of climate objectives in many ways. The use of wood reduces the carbon footprint of construction. Industrial wood construction promotes the development of material use and labour productivity. Long-term timber products increase the carbon stock held in the building stock. The promotion of industrial wood construction must be continued through various development measures targeting the industrial sector as well as those more generally concerned with competence in the value network of construction. The competence in the procurement of wood and other biomaterials in the public sector must be promoted as part of green public and low-carbon procurement.

The assessment and notification rules related to the environmental data (including carbon footprint) of construction products will be included in the legislative steering at the EU level derived from the EU Construction Products Regulation (CPR) or alternatively from the Sustainable Products Initiative. The carbon footprint data of construction products will be used as the baseline data for assessing the carbon footprint of buildings. From Finland's point of view, a more efficient and faster route would involve including the environmental data of construction products under the legal framework of the EU CPR rather than waiting for the legislative steering brought by the Sustainable Products Initiative.

Several European countries are developing legislative steering for low-carbon construction. France and the Netherlands have already introduced it. The statutes will enter into force in 2022 in Sweden and in 2023 in Denmark; Norway will decide on the timetable of the drafted statutes after the elections. The steering prepared in Finland

has been carried out in cooperation with the other Nordic countries and the European Commission to ensure that the methods used for evaluation are consistent with the EU Level(s) framework. However, coordination of climate impact assessment is still needed between evaluation carried out at the product level, building level and plan level.

2.1.2 Effort sharing sector

The medium-term climate policy plan in accordance with the Climate Change Act was approved by the Government on 2 June 2022 and submitted as a report to Parliament. The plan concerns emission reduction measures in the effort sharing sector. The effort sharing sector is responsible for emissions from transport, agriculture, building-specific heating, machinery, waste management and F-gases as well as emissions from industries and other energy consumption not included in the emissions trading system.

According to the Effort Sharing Regulation (ESR) published by the European Commission in summer 2021, Finland is obligated to reduce its greenhouse gas emissions in the effort sharing sector by 50% in 2030 compared with 2005 levels. The fulfilment of this obligation is a starting point for the new medium-term climate change plan. The target set in the Government Programme for carbon neutrality in 2035 has also been taken into account and the share of the effort sharing sector in achieving the target has been assessed.

The plan assesses the measures required to make the development of emissions aligned with these goals. The medium-term climate change plan has been prepared alongside the climate and energy strategy, partly drawing on the same knowledge base. In addition to the above-mentioned sectors, the plan also examines cross-cutting themes, such as the significance of regional climate efforts and consumption.

According to the baseline scenario, emissions from the effort sharing sector will fall to 22.8 million tonnes in 2030 and to 20.5 million tonnes in 2035. in accordance with the -50 per cent obligations proposed by the Commission for Finland, the emissions should be a maximum of 17.2 Mt CO_2 eq. in 2030, which means that there will be an emission gap of 5.6 million tonnes between the current measures and the obligation set for 2030. Additional measures will be introduced to respond to this deficit in emission reductions. An operational programme for pursuing the climate objectives of the effort sharing sector will be formed based on the measures.

There is a difference of 2.7 Mt CO_2 eq. between the 2030 target and the expected target level of 2035, some of which can be covered by current measures and some by new policy measures. However, the need for introducing new measures in the period 2030–2035 will depend on the emission level that will eventually be reached in 2030, and also on the

emission trends in the emissions trading and land use sectors. To pursue the 2030 target, the operational programme for the climate change plan will make use of one-off flexibility and LULUCF flexibility, and additional greenhouse gas emission reductions corresponding to these must be achieved in the emissions trading and land use sectors.

The climate change plan has been made to include emission reduction measures for all sectors covered by the plan. Measures are needed in all sectors to reduce emissions as required by the targets. Based on the current estimate, the flexibility achieved by the measures of the operational programme by 2030 includes emission reductions of 5.7 million tonnes compared to the baseline scenario, which would mean that Finland would achieve its emission reduction obligation.

Due to its size, the transport sector plays a key role in achieving the targets. The most important measures for reducing transport emissions are the implementation of the first two phases of the roadmap to fossil-free transport and the implementation of the Commission's new climate package for transport. The necessity of taking the measures in the third phase of the roadmap is also still under consideration.

In the area of agriculture, this is mostly concerned with emission reduction measures implemented under the EU's Common Agricultural Policy (CAP). However, it is not possible or appropriate to implement all measures to mitigate or adapt to climate change in agriculture through CAP. Instead, national measures should also be introduced. The agricultural emission reduction measures presented here are particularly related to mitigating emissions from peatlands, such as the cultivation of peatlands on elevated water levels, increasing carbon sequestration in mineral soils, precision cultivation and reducing methane emissions from dairy cattle. In addition to the agricultural sector, the emissions reduction impacts of the measures largely affect the land use sector.

Emissions from building-specific heating will be reduced above all by eliminating oil heating and switching to low-emission solutions. The transition will be supported by investment grants and a tax credit for household expenses. In addition, the aim is to increase the obligation to distribute heating fuels, which will effectively influence the emissions from the remaining oil heating. Increasing the distribution obligation will also reduce emissions from machinery and other oil use.

The climate change plan defines a set of measures to reduce consumption-based emissions. In environmental accounting, these reduction measures may in practice be reflected in effort sharing sector emissions in areas such as transport, building-specific heating and agricultural emissions. Consumers are encouraged to further halve their carbon footprint. Active climate work in municipalities also promotes emission reductions in different sectors directly and indirectly. Municipalities are responsible for town

planning, land use, transport planning, ownership steering of energy companies, heating choices in many buildings and public procurement in their region.

This time, the climate change plan also takes into account the potential for reducing emissions brought by the circular economy. The circular economy offers solutions that can reduce greenhouse gas emissions and otherwise mitigate the environmental impacts of consumption and production. The most significant emission reductions achieved through the circular economy occur in production due to a reduction in the use of virgin natural resources and, at the same time, the energy needs of manufacturing processes.

The administrative branches are committed to implement the measures specified in the plan to the extent possible within the framework of their resources. Measures requiring funding are discussed and decided separately in the processes concerning the budget and the General Government Fiscal Plan. Measures requiring municipal funding are processed in the municipalities' own decision-making processes.

During the preparation of the climate change plan, various stakeholders and citizens have been consulted extensively and diversely. A highly popular citizen survey was organised as a part of the preparation process, requesting respondents to share their views on predefined emission reduction measures. In addition, a citizens' panel was organised with the University of Turku. The panel enabled systematic discussion on the new measures and issued a statement on them. These procedures clearly demonstrated that citizens have both the capacity and willingness to participate in climate policy planning. During the preparation of the climate change plan, young people were also extensively consulted, and the Ministry of the Environment organised workshops for stakeholders. The Ministry of the Environment also negotiated climate measures relevant to the Sámi people with the Sámi Parliament. Through extensive inclusion, the plan has provided valuable information on the impacts of various climate measures.

The implementation of the climate change plan is monitored by means of the Annual Climate Report submitted by the Government to Parliament each calendar year. The report contains information on the development of emissions and the achievement of emission reduction targets and the additional measures required to achieve them. Factors related to achieving carbon neutrality are also examined as part of the monitoring.

2.1.3 Land use sector

Policies already decided in the government term:

- A Climate Change Plan for the Land Use Sector (MISU) will be prepared.
- The target annual net increase in the carbon sink of the land use sector brought by additional measures implemented in accordance with Government decisions will be at least 3 million tonnes of CO_2 equivalent by 2035. The Climate Change Plan for the Land Use Sector to be completed in the summer of 2022 is used to decide on additional measures to achieve this target. These additional measures will be taken in a frontloaded manner to ensure the flexibility of the land use sector in the effort sharing sector (0.45 Mt CO_2 eq./year).

The land use sector, LULUCF, has several means of reducing greenhouse gas emissions, increasing carbon sinks and maintaining carbon stocks. During Prime Minister Sanna Marin's term, the land use sector will be increasingly integrated into the planning and implementation of national climate and energy policy in accordance with the government programme.

In accordance with Government decisions, measures in the land use sector are expected to achieve an annual impact of at least 3 Mt CO_2 eq by 2035. In accordance with the policies already decided on in the Government term, the new afforestation aid for idle land (2021–2023) has been adopted, the support conditions for ash fertilisation have been amended in the support system for sustainable forestry (Kemera) and Metsähallitus' ownership policies have been drawn up for 2020–2024. The latter also set a growth target for carbon sinks and stocks for the first time, which applies to areas managed by both business and nature services. Other measures in the land use sector will be examined as a part of the preparation of the Climate Change Plan for the Land Use Sector. The plan will be completed in early 2022.

The Climate Change Plan for the Land Use Sector examines several means related to agriculture, forestry and changes in land use that could reduce greenhouse gas emissions and increase carbon sequestration. In agriculture, greenhouse gas emissions can be reduced, in particular by developing cultivation practices for peat fields and mineral soils and by maintaining or increasing their carbon stocks. The European Union's Common Agricultural Policy (CAP) provides measures to reduce emissions from the land use sector. The reform of the CAP for the next funding period is currently underway and its measures will be intensified in this context as far as possible. Carbon sequestration in forests can be strengthened by increasing forest growth and ensuring forest health. The afforestation of idle land provides one way of increasing total forest area and, through this, promotes carbon sequestration. Emissions from the sector can also be mitigated by preventing using forest areas for other land use purposes and by promoting the

construction of multi-objective wetlands and the sustainable further use of areas freed from peat production.

In the future, it is vital to be increasingly prepared for the growing risks resulting from climate change, such as plant diseases and forest damage, in order to preserve the carbon sinks and stocks in forests.

2.2 Promoting renewable energy

New policies:

- A new Government Decree on General Terms of Granting Energy Aid will be prepared in 2022. EUR 150 million will be annually allocated to demonstration projects concerning new technology. Beyond this, sufficient energy aid will be budgeted for smaller renewable energy projects and energy efficiency projects.
- As renewable energy production technologies become commercialised and their profitability improves, direct subsidies will primarily be directed towards new technologies, and efforts will be made to promote the expansion of various financing solutions, such as commercial instruments minimising risk, as well as new financial instruments.
- Renewable transport fuels will continue to be promoted primarily through the distribution obligation. In an aim to promote the commercialisation of new environmentally sustainable raw materials and production technologies, steering instruments and particularly aid schemes will be employed. Adequate R & D resources will be ensured.
- Special methods for reducing the use of oil in working machinery, such as electrification and the use of biogas, will be investigated.
- Regulation by information will be increased especially for energy communities (e.g. with the energy community handbook).
- The opportunities brought by new energy community models and various behavioural changes will be investigated to encourage decentralised energy production, small-scale production and energy efficiency, taking into account the boundary conditions set by the Internal Market in Electricity Directive for the appropriate and balanced participation of energy communities in the sharing of the overall costs of the system and the balance responsibility.
- The opportunities to improve the participation of small and medium-sized enterprises in the Power Purchase Agreements (PPAs) will be examined.
- Cost-effective methods that take into account the security of supply will be prepared to promote the utilisation of renewable energy and waste heat in the district heating network.

- The implementation of at least one offshore wind demonstration project will be primarily supported by EU funding, e.g. through the Sustainable Growth Programme for Finland or the EU renewable energy financing mechanism or some other funding instrument if necessary.
- The regulation, administrative processes and fees related to the utilisation of an area, which are prerequisites for the development and construction of an offshore wind energy project will be developed so that they are clear, transparent and fair and will ensure sufficient investment certainty for project developers.
- Any questions emerging related to increasing offshore wind power and other offshore energy and the development of offshore electricity grids and fair cost sharing will be examined in a frontloading manner from the perspective of the functioning of the energy market.
- In offshore wind projects, the boundary conditions set by the electricity system will be taken into account.
- Wind power construction will be promoted by allocating additional funding for national surveys on wind power as well as for planning, licensing and related studies guiding wind power construction in municipalities and regional councils. A total of EUR 1.5 million in additional funding will be reserved for 2022.
- Licencing procedures for green transition investments will be accelerated by allocating more resources to permit authorities (AVI, ELY Centre, TUKES). The objective is that the licencing process for priority investments by the permit authority will have a maximum duration of 12 months.
- Grants will be allocated to municipalities and regional councils to speed up permit and planning procedures for green transition investments and wind power construction.
- The construction of wind power will be promoted in a comprehensive manner, taking into account the needs of national defence, for example with regard to the reliability of radar surveillance. Cooperation with the Finnish Defence Forces will continue in the coordination of radars and wind power.
- The obligation to distribute light fuel oil will be increased to 30% by 2030.
- The emission reduction and electrification of small industries and small-scale energy production will be supported, also using EU funding instruments, such as regional development funds.
- The introduction of heat production forms that do not involve incineration, such as waste and environmental heat recovery and geothermal heat, will be accelerated in the energy support system and by other means. In the context of the promotion of geothermal heat, risk financing and the development of administrative methods will be examined, taking safety aspects into account. This will be taken into account in annual energy aid policies.

- The production of bioenergy and the availability of sustainable raw material flows will be promoted, for example by strengthening supply chains and logistics (more on the topic in section 2.5.5).
- The use of timber and heavy decayed wood in incineration will be avoided. The use of timber in energy production will be monitored, steering methods will be investigated and, if necessary, plans will be made to intervene in the situation using these methods.
- A study will be carried out in 2022 on the availability of biomass for incineration that is sustainable from the perspectives of climate, nature and the economy. It will be ensured that bio-based fuels are directed to the optimal applications where they would be most difficult to substitute and where they produce the most additional value.

Policies already decided in the government term:

- National investment aid to support new processing techniques for manure and reject material from biogas plants was launched in December 2020. In addition, a biogas production aid based on the nutrient cycle is currently under preparation.
- As part of the Government's COVID-19 recovery package, support rates of agricultural investment aid and rural business funding for biogas investments have been temporarily increased to 50 per cent for the period 2021–2022. The increases are also recorded in the national level CAP strategic plan for the CAP term starting in 2023.
- In March 2022, the ministerial working group outlined measures to be taken between 2022 and 2026 to accelerate the transition of farms and rural enterprises from fossil fuels to renewable energy forms on a rapid schedule: As part of Finland's security of supply package, EUR 28 million in additional funding is allocated to agricultural investment aid for alternative energy sources and other investments related to the security of supply. As part of the Green Transition Package, an additional EUR 20 million is allocated to agricultural investment aid for energy investments by rural enterprises, including investments in biogas installations.
- Biogas and electrofuels have been included in the transport distribution obligation as of the beginning of 2022. The obligation to distribute biofuels will be increased to 34 per cent by 2030.

Energy aid

The current Government Decree on General Terms of Granting Energy Aid will remain in force until the end of 2022 and there is a need to prepare a new decree. In this context, there is reason to assess the aid granted to renewable energy as a whole as well as to

consider the need for a separate energy aid act, for instance. This preparation will also pay attention to the change in the energy sector to ensure that the aid scheme will continue to accommodate new technologies in the future. The 'do no significant harm' (DNSH) principle will also be taken into consideration in the preparation of the Government Decree on General Terms of Granting Energy Aid. The starting point for the currently valid decree is on supporting renewable energy production capacity and energy efficiency projects. In the future, aid regulation should better cover, for example, different storage projects, projects that promote system integration and other similar new types of projects. Annual aid policies take into account aspects such as climate and energy strategy policies, but also the content of the government programme. Heat production projects should particularly prioritise non-incineration technologies, which also contributes to reducing the pressure to increase energy recovery from biomass. It is also important to facilitate abandoning gas in the industry in the new situation where there is a need to reduce dependence on Russian gas. This makes the need for energy aid funding greater than before. However, a key condition is that the European Commission's regulation of government support allows aid to be granted to such projects.

Ministry of Agriculture and Forestry's aid for energy sites

The Rural Development Programme for Mainland Finland 2014–2020 and its transition period 2021–2022 contain various measures for promoting renewable energy and energy efficiency. Investment aid for agriculture and rural business funding can be used to support investments in energy-producing plants, among other things. Structural support for agriculture concerns investments in sites that produce the energy needed in agriculture or improve the state of the environment through means such as enhancing the energy efficiency of production. Corporate financing is intended to support investments in plants that generate commercial energy. The scheme can also be used to fund energy advisory services for farms and various training, communication or cooperation projects that support increased production and use of renewable energy, energy and resource efficiency or decentralised energy solutions.

The Commission is currently processing the national plan for the new CAP period starting in 2023. The future CAP aims to further enhance efforts to promote renewable energy, energy savings and energy efficiency.

Biogas

A biogas working group appointed by the Ministry of Economic Affairs and Employment published its final report in January 2020. In connection with the working group's efforts, stakeholders in the biogas sector were extensively consulted and measures were mapped to promote the production and use of biogas. The working group proposed 24 measures

and prepared an implementation plan for them. In February 2020, the Government's annual meeting held in Vuosaari decided to launch the realisation of the implementation plan. Most of the key measures have progressed as planned. Biogas has been included in the Act on the Promotion of the Use of Biofuels for Transport and the obligation can be fulfilled with biogas from 1 January 2022. The targets for biogas cars have been revised in the Roadmap to fossil-free transport and the amount of aid reserved for refuelling stations has been increased. The aid scheme was updated in 2020 as planned. After 2021, the intention is to continue the distribution infrastructure aid with EU RRF funding. The preparation of the new aid scheme has begun. Investment support for biogas plants and manure processing has also been introduced and will be extended to nutrient recycling and carbon sequestration in 2022. In addition, gas-fuelled heavy-duty vehicles have been supported by a new aid scheme, a decision in principle has been made on the continuation of the conversion aid, funding opportunities and the sustainability of biogas have been examined, safety guidelines have been updated, the availability of advice has been increased, efforts have been made to influence government support regulation, an experimental programme on new technologies for nutrient recycling in ongoing, the preparation of the EU's Common Agricultural Policy (CAP) has made progress, and granting investment aid for biogas plants has continued within the frame of valid support schemes. Investment aid for agriculture and rural enterprises related to biogas plants has been increased for the fixed period 2021–2022, and this increase has also been recorded in the national CAP plan proposal for the new CAP period starting in 2023.

Geothermal energy

Geothermal energy is a heat production method that does not involve incineration. However, the actual geothermal energy in Finland requires deep drilling, which calls for special drilling technology. In addition, Finland still has little valid knowledge on the production volumes that can be achieved with geothermal energy, and so far, there is little information on the production volumes that could be achieved with medium-deep and deep wells. Different permit and other administrative procedures for these projects are still evolving. The development of the permit and administrative procedures must also pay attention to related instructions. Geothermal energy projects also involve risks different from those related to other renewable energy sources, such as an earthquake risk, which should be taken into account.

Renewable transport fuels

Reducing transport-related emissions, especially from heavy-duty vehicles, shipping and air transport requires a significant amount of emission-free liquid and gaseous fuels in addition to electrification. These particularly include biomethane, advanced biofuels and various fuels of non-biological origin, especially so-called electrofuels. In

addition to existing raw materials and production technologies, there is a need for more environmentally sustainable alternatives and, in particular, scalable solutions. There is also global demand for such solutions.

Heating sector

Carbon-neutral heating plays a key role in reducing greenhouse gas emissions. District heating and cooling will also play a central role in future energy systems. Geothermal heat and other renewable energy combined with energy production solutions based on heat pump technology complement emission-free heat sources and are well suited for the district heating network. The utilisation of geothermal energy is already progressing rapidly on market terms. The availability of sustainably produced heating biomass is limited, and as a result, emphasis is placed on a shift towards non-incineration solutions in the heating sector.

Small-scale renewable energy production and energy communities

Promoting small-scale production increases citizens' opportunities to produce part of the energy they consumed and also to make a contribution to the energy market. Promoting energy communities and independent energy generation allows increasing distributed renewable electricity generation, Small-scale electricity production is tax exempt. The tax credit for household expenses can also be utilised in the installation of electricity production systems in detached houses. In December 2020, the Government adopted a decree that enables the sharing of electricity production in energy communities (a so-called compensation calculation service) and the introduction of an hourly netting system in metering. In addition, an amendment to the Electricity Market Act adopted in August 2021 enabled energy communities in crossing property boundaries. The change is expected to particularly improve the profitability of housing companies' small-scale power plant projects and therefore enhance their attractiveness as a type of investment.

PPA agreements

Power purchase agreements (PPAs) have become more common in the renewable energy sector, especially in the context of solar and wind power. According to the agreement, the electricity user buys a certain amount of electricity at the agreed price, for example, for 10–20 years, which provides the electricity producer with a more even income flow for the long term and reduces the financing costs of the project. The buyer of PPA contracts is often a large company. It would be important to make this opportunity also more widely available to small and medium-sized enterprises.

2.3 Hydrogen and electrofuels

New policies:

- Comprehensive preparations will be made to enable the introduction of hydrogen solutions in the entire value chain once these reach commercial profitability. This process will take into account the perspective of long-term planning as necessary.
- The aim will be to direct the use of renewable and low-carbon fuels, i.e. clean hydrogen and electrofuels, above all to the needs of Finnish industry, transport and the energy system. In addition to increasing added value, this will also most effectively contribute to national climate policy objectives. The export of hydrogen or electrofuels is a secondary method of utilising clean energy.
- The emergence of clean hydrogen production capacity will be promoted. A target set for the electrolysis equipment used in hydrogen production will be at least 200 MW in 2025 (9 MW in 2021) and at least 1,000 MW in 2030, taking into account the commercialisation of hydrogen technology. With more rapid technological development, even greater electrolysis capacity will be possible.
- The usability of aid granted through the Carbon Contracts for Difference (CCfD) in promoting a low-carbon industry will be examined.
- The investments needed for the transfer and distribution of hydrogen will be promoted, while also making use of EU funding and the opportunities created by the EU..
- The development of hydrogen networks and related infrastructure will be prepared for in a nationally coordinated manner and in anticipation of the regulatory framework of EU gas market legislation currently under preparation.
- Companies operating in Finland will be encouraged to cooperate in the development of competence and joint projects and to build networks internationally.
- Finland will actively participate in developing the regulation of the hydrogen market in the EU, highlighting the incentive role of a functioning market. Where appropriate, national regulation of the sector will be developed in the areas of the market, infrastructure use and chemical safety.
- Finland will participate in the international partnerships for hydrogen of developed economies, including those built within the framework of the International Energy Agency (IEA) and the Clean Energy Ministry and Mission Innovation.
- New solutions and demonstration projects that promote system integration will be supported.

- Finland will pilot the use of hydrogen in transport, especially in heavy-duty road and waterborne transport.
- The target is that electrofuels will amount to 3 per cent of all transport fuels by 2030.
- The development and use of carbon capture and utilization (CCS/CCU) technologies and solutions will be accelerated.
- The legislative framework for CCS/CCU regulation at the EU level will be promoted.
- Finland will strongly invest in n RDI activities in various areas of hydrogen technology and make effective use of EU/international cooperation and funding opportunities.
- The importance of all emission-free forms of hydrogen production in the EU and globally will be emphasised in a technology-neutral manner.
- CCS/CCU techniques to reduce CO_2 emissions caused by waste incineration will be piloted.
- The safe implementation of hydrogen projects will be ensured by developing technical safety regulations, cooperation between authorities and competence development.

Policies already decided in the government term:

- Finland signed a hydrogen manifesto with 22 other EU Member States in December 2020 and committed to participating in the hydrogen IPCEI process.
- The Sustainable Growth Programme for Finland allocates EUR 150 million to hydrogen projects and carbon capture and utilisation projects.
- Electrofuels will be included in the transport fuel distribution obligation from the beginning of 2023.

Public measures have the potential to create low-carbon hydrogen production capacity and accelerate the use of low-carbon hydrogen in industry and transport, and in balancing the energy market, especially the electricity market. Hydrogen distribution stations have already been included in the new Decree on infrastructure aid for the period 2022–2025. Hydrogen solutions involve an investment risk if hydrogen-based solutions and the hydrogen ecosystem are not turned into commercial applications. Launching investments requires public funding, as the production of hydrogen with electrolysis is still expensive compared to producing hydrogen from natural gas. Furthermore, if natural gas is used as the raw material for hydrogen production, carbon capture will be more expensive than acquiring emission allowances. When developing production technology and storage solutions, consideration must be given to their potential flexibility, the added value brought by by-products (heat, oxygen) and the boundary conditions related to utilisation from the perspectives of hydrogen producers and consumers, technology suppliers and the entire energy system.

Finland has the prerequisites to develop and commercialise hydrogen solutions for the global market. Sufficient production capacity for clean electricity and investments in the transmission system and international connections also make it possible for Finland to develop into an exporter of not only technological solutions but also hydrogen and electrofuels in the long term.

Ensuring safety is an important and integral part of the development of new hydrogen technologies and the safety of their use. Technical safety regulations must be renewed to correspond to new hydrogen technologies and anticipate and manage the safety risks associated with their use. Anticipation and up-to-date regulation of safety risks will support the development and successful introduction of new hydrogen technologies, save costs and avoid serious hydrogen accidents.

2.4 Promoting energy efficiency

New policies:

- The continuation of energy efficiency agreements will be ensured even after the current agreement period 2017–2025. Sufficient incentives will be created for contract companies and municipalities to save energy and promote energy efficiency.
- Energy audit activities and their continuous development will be ensured so that the use of audits can continue as an effective tool for achieving energy savings and improving energy efficiency.
- Taking flexibility capacity and intelligence as well as carbon neutrality and new technologies into consideration in energy audits will be promoted.
- Sufficient resources will be secured for implementing regulation by information and providing energy advice. Energy advisory services aimed at consumers will provide independent and up-to-date information on energy savings, energy efficiency, renewable energy solutions and consumer flexibility opportunities. Funding for regional energy advisory services will be established as part of an energy work programme from 2023 onwards.
- Sufficient resources will be secured for actively highlighting Finland's views in the preparation of EU's ecodesign and energy labelling regulations. To ensure effectiveness, awareness and knowledge of ecodesign and energy labelling will be raised among professionals and consumers. Finland will work actively to ensure that the Ecodesign Directive will be extended to all environmentally relevant product groups.
- It will be ensured that Finland's views are actively heard in the process of reforming the Energy Efficiency Directive so that energy saving and energy

efficiency measures can cost-effectively support the achievement of the EU's greenhouse gas reduction target of 55 per cent by 2030.

- The necessary resources for effectively implementing the new obligations and requirements of the Fit for 55 package will be ensured.
- Adequate energy aid will be allocated at national level to the promotion of energy efficiency and energy savings.
- Finland will promote updating vehicle stock to become more energy-efficient.
- The improvement of the energy efficiency of the entire transport system will be promoted by developing transport services, conditions for walking and cycling as well as the energy efficiency of road transport.
- The requirements concerning the energy efficiency of new buildings and renovation construction subject to a permit will be reviewed at the latest during 2023 and the necessary changes to the requirements level will be made based on the review.
- A decision on launching the testing phase of the Smart Readiness Indicator for buildings will be made after the completion of a feasibility study.
- Grants are available for the measures that aim to improve the energy efficiency of residential buildings and smart and flexible energy consumption, including the replacement of a district heat exchanger for low-temperature district heating. These should be continued. Any financial incentives must be long-term and predictable, as short-term cyclical grants disrupt the market, increase prices and may lead to hastily made repair solutions.
- Energy saving and energy efficiency measures in agriculture will be included in the national CAP plan under preparation and their implementation and development will continue in the new CAP period starting in 2023. The extension of energy efficiency agreements for agriculture will be negotiated with industry organisations.
- The establishment of regular monitoring of progress in energy efficiency at the sectoral and national levels and resources required for this purpose will be ensured. The assessment of energy efficiency requires extensive cooperation between stakeholders and administrative branches. Simplified indicators produce unreliable signals and incorrect conclusions and steering methods.

Energy efficiency will be promoted in Finland in a long-term and broad-based manner, in accordance with an energy efficiency first principle. Concrete national measures include the current period's (2017–2025) energy efficiency agreements, energy audits, energy advice and energy aid for audits and investments made within the scope of energy efficiency agreements.

Energy efficiency agreement period 2026–2035

In Finland, energy efficiency agreement activities are the primary, effective, comprehensive and systematic means of improving energy efficiency, achieving energy savings and fulfilling the EU's strict obligations to use energy more efficiently, save energy and reduce energy consumption. Through monitoring and reporting related to contract activities, Finland reports annually to the EU Commission on the achievement of the energy savings target. The current energy use of those who have joined the energy efficiency agreement activities covers almost 60 per cent of Finland's total energy consumption. Energy efficiency agreements will continue to serve as a key national means of promoting energy saving and energy efficiency as well as a tool for achieving Finland's and the EU's climate targets.

Energy audits

Energy audits are an essential part of systematic energy saving and energy efficiency work. Under the Energy Efficiency Act, the mandatory energy audits of companies concern large companies. Voluntary basic energy audits are carried out in small and medium-sized enterprises and in the municipal sector. New, voluntary thematic review models have been developed mainly for the needs of large companies. Voluntary reviews are promoted through the energy aid scheme. In the next few years, changes in EU legislation will affect stricter energy efficiency and savings targets and the requirements and content of energy audits. This will require ensuring the maintenance and particularly continuous development of the audit activities.

Energy aid

Energy efficiency and energy savings projects are supported by energy aid, see section 2.2.

Energy advisory services

Regulation by information and energy advisory services guarantee that consumers are provided with up-to-date information on the areas of energy and climate policy for the purposes of saving energy and carrying out energy saving and energy efficiency measures. These are also used to raise awareness among consumers on renewable energy solutions and demand response opportunities. National energy saving campaigns can be used to target energy advisory services to specific audiences and to schedule them efficiently for target groups. Changes in EU legislation include increasingly comprehensive obligations for the provision of broad-based energy advice as well as requirements for monitoring and reporting on national measures. It is important to ensure the continuation of regional energy advisory services under the Energy Authority's working plan as well as sufficient human resources. The annual need for resources is estimated to amount to

approximately EUR 1 million and one person-year. In autumn 2022, a campaign to increase citizens' understanding of energy will be launched to respond to the situation changed by sanctions on Russia and ban on Russian imports.

Ecodesign and Sustainable Products Initiative

Ecodesign and energy labelling are among the most important EU measures to promote energy efficiency. They will contribute to saving a significant amount of energy, such as around 9 per cent of the EU's total energy consumption in 2020. While the main objective has previously been to improve the energy efficiency of energy-related equipment, in the future, ecodesign will also promote the circular economy of products. As the European Commission intends to extend the Ecodesign Directive to include new product groups, it will be necessary to ensure that sufficient resources are available to actively bring attention to Finland's views in the preparation of the EU's Ecodesign and Energy Labelling directives.

Energy efficiency measures in transport

The energy efficiency of means of transport

The transition to more energy-efficient technologies will mainly be accomplished through the purchase of new cars. Finland's vehicle stock is very slow to renew. Ensuring a newer vehicle stock would require the number of first registrations of vehicles to climb to on average around 150,000. The accomplishment of the energy efficiency targets set for transport is mainly influenced by the rapid spread of electric vehicles, the main driver of which is the EU's CO_2 limit legislation obliging car manufacturers.

Sustainable modes of transport and shipping

Finland is a sparsely populated country and a car is an essential means of mobility for many people now and in the future. However, there are also alternatives, such as public transport, shared transport, walking and cycling, especially in urban areas and between cities. Through their actions, central government and municipalities can guide people to increasingly switch to these sustainable modes of transport. The aim is that passenger car transport sector will no longer grow in the future, but that people's growing needs for mobility are more often met with sustainable modes of transport. Delivery of goods can also be made more efficient or be transferred from roads to railways or waterways. A target set for the flow of goods is that the performance of vans and lorries will slow down in the 2020s compared to the development so far. This means a more efficient transport of goods by road or a shift to more sustainable modes of transport. Key means of achieving this goal include the digitalisation of logistics and HCT transports.

Energy efficiency measures in buildings

The energy efficiency of new buildings and renovation construction subject to a permit is regulated by decrees issued by the Ministry of the Environment under the Land Use and Building Act. The current energy efficiency requirements entered into force at the beginning of 2018. According to the EU's Energy Performance of Buildings Directive, the energy efficiency requirements set for buildings must be sufficiently close to the cost-optimal level. Furthermore, the Directive requires that information on the fulfilment of this level of requirements be submitted to the Commission at intervals not exceeding five years. Cost-optimal level refers to the energy performance level which leads to the lowest cost during the estimated economic lifecycle.

The lowest costs are influenced by factors such as energy-related investment costs as well as maintenance and operating costs. Many factors related to construction are undergoing changes. Buildings and energy production will be interlinked in many new ways, especially as the share of variable renewable energy production increases. The full utilisation of the green transition and renewable energy sources will require smart steering of the energy use of buildings. The energy efficiency and cost efficiency of construction products have continuously improved. These create preconditions for improving the energy efficiency of buildings.

The readiness of buildings for smart solutions could be assessed using a uniform method that incorporates the perspectives of energy efficiency, building users and energy demand response. Provisions on the smart readiness indicator have been laid down in the Energy Performance of Buildings Directive and the Commission Implementing Regulation (2020/2156).

Commissioned by the Ministry of the Environment, Motiva has examined the opportunities for testing and introducing the indicator and the views of stakeholders in the sector on the method and its benefits. The project provides grounds for decision-making on launching a possible testing phase in Finland.

Buildings are typically repaired one building element or technical system at a time (staged deep renovation). Meanwhile, it is rare to carry out many renovation measures as a single entity (deep renovation) due to the different service lives of structures and systems.

Three key methods have been identified for ensuring that the building stock completed by 2020 will be highly energy-efficient and low-carbon: 1) Removal and improvement of space efficiency; 2) Energy efficiency improvements on the building envelope and technical systems during repairs and maintenance, and 3) Abandonment of fossil fuels in energy production. Climate change will also affect heating energy consumption in the

period 2020–2050. The energy efficiency of buildings can be improved without repair measures with different heat pump solutions and solar panels and solar thermal collectors.

Energy efficiency in agriculture

The energy efficiency of agriculture has been systematically promoted since 2010, first within the framework of the Farm Energy Programme and later with energy efficiency agreements between the Ministry of Agriculture and Forestry and national agricultural and horticultural producer organisations. Aid has been allocated for practical energy efficiency measures on farms mainly through the Rural Development Programme and national farmland consolidation support. Through the Rural Development Programme, farms have been able to receive investment aid for energy efficiency and renewable energy investments as well as support for the costs of energy advisory services.

2.5 Energy delivery reliability and security of supply

2.5.1 General information on energy delivery reliability and security of supply

New policies:

- The measures to ensure energy security of energy will be investigated and necessary government proposals will be prepared.
- It will be ensured that well-functioning security of supply cooperation between the authorities and companies in the energy sector will be further developed in ways required by the low-carbon target.
- In order to ensure the security of supply, the scope of preparedness in the changing energy system will be expanded from the storage of fuels and the functioning of the electricity system to areas such as heat supply, system integration and new fuels.
- The timely implementation of the results of the National Emergency Supply Agency's Energy 2030[3] will be ensured.
- It will be ensured that Finland has versatile energy supply channels and sufficient reserves of security and compulsory stockpiles and that the country is not dependent on individual sources or suppliers of energy. Diverse links between energy systems and between markets will be ensured.
- The intelligence and flexibility of new and decentralised systems will be promoted, for example in electric transportation.

3 https://www.huoltovarmuuskeskus.fi/huoltovarmuusorganisaatio/huoltovarmuuskeskus/4962-2/energia-2030

- Hydropower with control capacity and high predictability will play an important role in Finland's electricity system. The operating conditions for hydropower will be ensured to safeguard energy delivery reliability and security of supply. The utilisation of the adjustability of hydropower, the functioning of the electricity system and variable renewable electricity production will be secured, while integrating targets related to the climate, biodiversity and water management.
- As a result of the electrification of transport and the whole society, greater attention will be paid to securing the electricity system and critical value chains in the security of energy supply.
- Cyber security will be enhanced in the energy sector.

Policies already decided in the government term:

- The Finnish security of supply organisation managed by the National Emergency Supply Agency, especially the energy supply sector, has been changed to meet the development needs of the energy transition.

The security of energy supply is based on well-functioning energy markets, a clear long-term energy policy that encourages investments, and energy efficiency. Finland's particular strengths have included versatile energy sources and infrastructure, which enables diverse supply channels.

Security of supply refers to the security of supply of electricity, natural gas and heat transmission networks and the adequacy of energy and power. Meanwhile, security of supply refers to the capability of sustaining such basic economic functions of society which are vital to the livelihood of the population, the country's economy, the viability and security of society and securing the material preconditions of national defence during serious disruptions and emergency conditions.

The National Emergency Supply Agency's operational strategy includes a programmatic approach with a focus on four programmes that set their sights on 2030. One of these is the Energy 2030 programme. The programme involves building energy security efficiently and transparently as Finland is transforming into a carbon-neutral society by 2035. Together with the Finnish organisation for the security of supply, the National Emergency Supply Agency is updating the means of energy security to correspond to the emerging technology and threats.

The programme aims to systematically develop the preparedness of energy companies and related planning as the operating environment changes. In order to safeguard the security of energy supply, it is vital to identify all agents involved in the value chains critical to society and the risks and preparedness approaches related to their

energy supply, prepare for any national and regional risks efficiently, carry out effective cooperation between business life and the authorities, clarify the responsibilities related to preparedness, and ensure efficient recovery from disruptions and effective exercise activities to prepare for these.

The energy supply sector of the Finnish organisation for the security of supply has been adjusted to meet the needs of changing energy supply. The new structure includes a fuel pool, a gas pool, an electricity pool and a heating pool. The reform emphasises cooperation between pools and sectors. The pool structure responds better to the challenges posed by electrification and growing system integration. As the use of fossil fuels and peat for energy decreases, special attention will be paid to the security of supply related to heating. Abandoning imported fossil fuels and replacing them with domestic energy sources will increase self-sufficiency and can thus improve the security of supply.

In addition to new fuels, electricity and P2X technologies can improve the security of supply in food production directly and through fertiliser production.

2.5.2 Electricity delivery reliability and security of supply

New policies:

- Finland will ensure that the reliability of the national grid remains at an internationally high level.
- Replacement investments in distribution networks and the achievement of the security of supply target will be ensured along with the good security of supply of the distribution networks, the availability of network services in cities, urban areas and sparsely populated areas by the end of 2036.
- Legislation will be supplemented by defining critical client groups in case of power shortages and major disruptions.
- Preparedness for regional electricity islands will be ensured to have capacity to correspond to serious disruptions and emergency conditions. The islands will ensure the functioning of the electricity system in such circumstances.
- Instructions for ensuring the safety of energy supply sites will be updated.
- The peak-load reserve system maintained in order to prepare to electricity shortages will be renewed to meet the requirements of the EU- regulation on the internal market for electricity and, if necessary, the government resolution on the target level of security of supply (Reliability Standard) will be updated.
- The impacts of the structure of electricity production and the low-carbon energy system on the sufficiency of electricity will be examined extensively. If

necessary, the preparedness model will also be updated within the frame set by EU legislation and Nordic cooperation in the electricity market.

Policies already decided in the government term:

- The government resolution on the target level of security of supply (Reliability Standard) was issued in July 2021 and updated on 17 March 2022.

Well-functioning electricity grids lay the foundation for securing the supply of electricity in both normal and disruptive conditions. The role of electricity grids will gain more prominence as society electrifies, and it will become more critical from the perspective of security of supply.

While the market is the most effective and cost-effective way to guarantee competitive electricity prices and security of supply, special solutions are also needed for exceptional disruptions. Finland has a non-market-based peak-load reserve system that safeguards the sufficiency of electricity during the winter season. Efforts have been made to further limit and regulate such arrangements at the EU level due to their potential adverse market effects. As the electricity production structure changes, the preparedness arrangements must also change.

2.5.3 Gas delivery reliability and security of supply

New policies:

- It will be ensured that gas is procured through diverse sources and gas storage opportunities will be promoted by developing the functioning of the joint gas market between Finland and the Baltic countries, gas infrastructure and the LNG market, and by integrating renewable gases more extensively into the gas system.
- The LNG infrastructure will be developed to diversify natural gas import options.
- Finland will investigate the possibility of establishing a procedure for the storage of gas under bilateral treaties similarly to those already used for the compulsory stockpiling of oil.
- A solidarity agreement will be concluded between Finland and Estonia as required by the Regulation concerning measures to safeguard the security of gas supply. The necessary government proposals will be prepared.
- The National Emergency Supply Agency is designated as the competent authority under the Regulation concerning measures to safeguard the security of gas supply. The competent authority is responsible for drawing up plans and taking other measures under the Regulation.

- Efforts will be made to influence the EU to ensure that obligations concerning the delivery reliability and security of supply take into account the special circumstances arising from Finland's geographical position and that the arrangements will be implemented in a sensible manner in terms of the functioning of the market.

Policies already decided in the government term:

- The Act on the Compulsory Stockholding of Imported Fuels (1070/1994) has been revised (amendment 1151/2021).
- The Government's Ministerial Committee on Economic Policy supported measures for leasing a large-scale LNG terminal ship in cooperation with Estonia. The rental of a terminal ship makes it possible for Finland to detach itself from the dependence on Russian pipeline gas exports.

In Finland, gas is mainly used as a raw material in industry and the production of heat and electricity. Therefore, the security of gas supply also safeguards the availability of heat and electricity.

The Finnish gas system is connected to both Russian and Estonian gas networks. New gas supply routes will contribute to safeguarding gas-related security of supply. Gas can be obtained to the Finnish gas system via the Balticconnector gas pipeline from the Klaipeda LNG terminal in Lithuania and, after completion of the GIPL gas pipeline, also from Poland and elsewhere in Europe. The connection is expected to be completed in 2022. Gas can also be stored in liquefied form (LNG), which creates new opportunities from the perspective of security of supply. LNG can be imported to Finland via the LNG terminals in Pori and Tornio and via the Hamina terminal under construction. In the future, gas from the Hamina terminal can also be supplied to the Finnish gas system. The Ministry of Economic Affairs and Employment has noted that the only way to ensure a rapid end to the dependence on Russian pipeline gas exports is to rent a sufficiently large-scale LNG terminal vessel (FSRU) that would be located on the Finnish coast in the immediate vicinity of the natural gas transmission network. On 20 May 2022, Gasgrid Finland Oy and Excelerate Energy, Inc., from the United States, signed a ten-year lease agreement for the floating LNG terminal vessel Exemplar. The intention is to get the vessel running in the winter of 2022/2023.

To ensure the usability of the new gas supply routes, Finland aims to integrate closely into the gas market in the Baltic countries and later in Central Europe and to make efficient use of the capacity of Finnish LNG terminals. Since the introduction of Balticconnector, Finland, Estonia and Latvia have formed a gas market coupling with no separate entry and exit charges at internal borders (FINESTLAT). The countries are also preparing a common balancing zone and, together with Lithuania, the country's entry into the gas market area

formed by the four countries. The FINESTLAT market enables Finnish market parties to make flexible use of the Incukalns gas storage located in Latvia.

The energy transition has a major impact on the security of supply. The security of energy supply is currently largely based on the stockpiling of imported fossil fuels. As the aim is to achieve zero-emission energy production, energy production based on combustion and particularly the combustion of fossil fuels will inevitably decline. New options must be explored to ensure the security of energy supply.

A project has been launched by the Ministry of Economic Affairs and Employment and the National Emergency Supply Agency to outline measures to safeguard energy security. As part of the project, urgent legislative needs were identified related to issues such as the opening of the natural gas market in 2020. The amendment to the Act on the Compulsory Stockholding of Imported Fuels entered into force on 1 January 2022. It is also possible that more extensive reforms to the security of supply system require new legislative drafting.

Climate policy and attitudes affect decisions on the use of district heating energy sources. This also involves significant security of supply aspects. In many cases, wood fuel will be the only competitive energy source in district heating production, especially in the short and medium term. The changing security of supply needs of the heating sector have been taken into account in the organisation of the energy supply sector of the Finnish organisation for the security of supply.

The National Emergency Supply Agency performs the tasks of the competent authority in Finland as defined in the EU's Regulation concerning measures to safeguard the security of gas supply (2017/1938). The gas pool in the energy supply sector is responsible for the security of supply work related to gases. The Energy Authority monitors the security of supply obligations laid down in the Natural Gas Market Act (587/2017) and also follows the security of natural gas supply in Finland.

For very serious gas supply disruptions, preparedness measures and action plans are also needed to prevent any disruption of supply. The integrated gas market also requires common ground rules and agreements on ensuring gas supply between neighbouring countries and gas transmission operators, in particular in the event of disruptions. An example of such an agreement is the solidarity agreement under the EU's regulation concerning measures to safeguard the security of gas supply (2017/1938). Under the Regulation, Member States are required to draw up a solidarity agreement to secure the supply of gas to protected customers in the Member States to which there is a gas pipeline connection and in third countries that meet certain criteria. According to the Regulation, Finland must draw up the agreement with Estonia because of the Balticconnector gas

pipeline between the countries. Negotiations have taken place both with Estonia and with the Baltic countries.

2.5.4 Oil delivery reliability and security of supply

New policies:

- Finland will investigate the measures necessary to ensure the security of supply for the import, production and distribution of fuels in the energy transition. The measures may involve issuing government proposals.
- As the consumption of fossil fuels decreases in transport, Finland will investigate the utilisation of current emergency stockpiling of fossil fuels, for example in ensuring the operation of critical maritime transport and the electricity system.

The Oil Stocks Directive (2009/119/EC) regulates stocks of crude oil and/or petroleum products. Likewise, the membership obligations of the International Energy Agency (IEA) include maintaining oil reserves equivalent to 90 days of net imports. In the event of oil supply disruptions, IEA member states may decide on joint measures to balance the oil market. According to the security of supply targets set by the Government (VnP 1048/2018), Finland's target level in oil stocks corresponds to normal consumption for a five-month period. Provisions on obligatory storage of crude oil and petroleum products are laid down in the Act on the Compulsory Stockholding of Imported Fuels.

An increasing proportion of oil concerns products or components from renewable sources. Finland's level of security of supply could decrease from its current level if compulsory stockholding would only include imported fossil fuels and components mixed with them before importing. The role of oil as a reserve fuel will grow during possible disruptions and peak consumption in electricity and heat production as coal and peat are abandoned.

2.5.5 Heating delivery reliability and security of supply

New policies:

- The National Emergency Supply Agency will establish an emergency stockpile for peat used in energy production.
- From the perspective of the delivery reliability and security of supply of heat production, the quantities of energy peat production and stockpiles will be monitored, and the technical minimum of the peat boiler stock will be assessed.

- In connection with preparing a new system of incentives for sustainable forestry, Finland will examine the possibility of including support for the management of young stands and a related incentive for the collection of small diameter wood in the system. The level of aid under the current scheme will also be increased and the conditions for the aid will be changed.
- The development of a nationwide forest biomass terminal network will be promoted more strongly than at present, for example by harmonising regionally varying requirements for granting environmental permits for terminals and markings used in land use planning. The forest road network must also be kept in good condition.
- Approaches that enable forming a better understanding of the availability of Finnish forest chips will be developed.
- Finland will encourage the use of the opportunities brought by system integration and the development of solutions that enable combining both district heating and the energy production of properties in a manner that allows optimising their use.

As the use of peat for energy and related production has declined more quickly than anticipated, the role of peat as a long-term security of supply fuel has eroded. Peat has been largely replaced by wood fuels. The share of wood fuel, i.e. forest industry side streams and forest chips, as a source of energy for district heating has been growing annually to 37% in 2021, reflecting the significant role of wood fuel in heat production. Abandoning the use of coal and energy peat in primary production will reduce fuel alternatives for heat supply and significantly increase the need to increase the use of energy wood as early as in the next few years. According to several scenarios, wood will continue to play a significant role in energy production for at least 20–30 years, if not longer, as the commercial application of non-combustion technologies has only just begun in many cases. The promotion of non-combustion technologies is also important from the perspective of security of supply, as these contribute to replacing the use of imported fossil fuels in heat production. There is no statutory requirement for the obligatory or security stockpiling of energy wood similar to that for coal and peat; instead, preparedness is based on measures taken by energy companies and fuel suppliers. As the use of wood fuels increases, imports of forest chips have also grown since 2017, accounting for 24 per cent of the total amount of chips used in energy production in 2020. The high share of imports can be considered a risk to the security of energy supply. The supply chain of domestic wood fuel also contains risks related to issues such as forestry production (economic cycles, industrial conflicts) and logistics and weather (harvesting conditions, storms). For wood fuels, both availability and a sustainable supply chain are important. For example, stockpiling can be used to promote the uninterrupted supply of wood fuels. The emergency stockpiling arrangements to be made for energy peat will also play a role in preparing for problems with the availability of forest chips in the next few years.

To ensure the availability of domestic energy wood fractions, there are efforts to examine the possibility of continuing to include an incentive for the collection of small-diameter wood in the incentive scheme for sustainable forestry in the future, strengthen the network of biomass terminals and loading points and improve the condition of the related routes important for the security of supply operating throughout the year. Biomass terminals must already be taken into account in regional land use plans or national land use targets and by harmonising plan notations. The environmental permit process will be developed to ensure that biomass terminal projects important for the security of energy supply will not fail due to the excessive duration of the permit process.

In the longer term, new solutions, such as system integration, may partly replace the narrowing selection of fuels available for heat production. In connection with new solutions, potential risks must also be identified and taken into account (e.g. stockpiling, reserve capacity).

2.5.6 Cyber security of energy systems

New policies:

- The cyber security level in the energy sector, and especially in the electricity sector, will be further developed through joint exercises, development projects and, if necessary, new legislative projects.
- A good level of cyber security will be ensured for energy systems and sufficient resources and competence will be safeguarded for the authorities to supervise the cyber security of energy systems, for example by implementing the recommendations of the Ministry of Transport and Communications working group on information security and data protection[4].

2.6 Use of nuclear energy

New policies:

- The important role of nuclear energy as an emission-free energy source will be taken into account at the national level and in the development of the EU's laws and policies. Applications for permits for nuclear facilities are processed in accordance with the Nuclear Energy Act. The permit process requires that all environmental impacts have been assessed in the project's EIA process.

4 Improving information security and data protection in the critical sectors of society: Working group final report http://urn.fi/URN:ISBN:978-952-243-614-6

- The Nuclear Energy Act will be subject to a reform during the next parliamentary term. The Nuclear Energy Act is based on legislation proposed in 1987 and thus no longer corresponds to the current needs and requirements for legal instruments. The operating environment and other legislation have also developed significantly, which emphasises the need for reform.
- Enabling new technologies, especially so-called small and modular reactors (SMRs), will be taken into account in the legislative reform. The regulatory requirements should be subject to an appropriate proportionality assessment. The need for separate legislative drafting concerning small-scale nuclear power facilities will be assessed, taking into account safety and security as well as societal aspects.
- In connection with the implementation of the overall reform of the Nuclear Energy Act, other relevant national regulations must also be examined.
- Extending the licences for existing nuclear power plants is welcomed, provided that all the licence conditions.
- Finland is the first country in the world to be constructing final disposal of nuclear waste activities and the first operating licence will be prepared for decision by the Government in the next few years.

Use and control of nuclear energy

Nuclear energy is a key part of Finland's energy system. The fifth nuclear power plant unit in Finland, TVO's Olkiluoto 3, will be commissioned in spring 2022. This will play an important role in increasing Finland's electricity self-sufficiency in the production of emission-free energy.

Finland uses nuclear energy responsibly. This responsibility includes a strong safety culture and regulation as well as preparedness for the costs and implementation of nuclear waste management. The world's first final disposal facility for used nuclear fuel has been constructed in Olkiluoto, and Posiva has submitted an application for an operating licence for the facility.

The use of nuclear energy in energy production requires compliance with the requirements of the Nuclear Energy Act and continuous safety monitoring. The use of the nuclear facility is based on licenses granted by the Government in accordance with the Nuclear Energy Act at different stages of plant projects and plant use; a decision-in-principle adopted by the Parliament, a construction licence, an operating licence and, at the end of the facility's life cycle, a decommissioning licence.

The licensing system laid down in the Nuclear Energy Act was created back in the 1980s, when the emphasis in use of nuclear plants, their operating life and the need for electricity production was on so-called baseload production. In this operating environment, plant suppliers focused on providing large-scale and growing plant sizes until the early 2000s.

In the last decade, significant changes have taken place as decentralised renewable electricity production has become competitive and fossil fuels are being phased out. At the same time, the service life of nuclear power plants has increased significantly from what was originally planned. The previously estimated 40-year service life of all four nuclear power plants operating in Finland has already passed, and the estimated service life of the newest plant is at least 60 years. At the same time, nuclear waste management has taken major leaps when it comes to both the used nuclear fuel as well as the operational waste from power plants.

Finland has developed workable final disposal solutions for various types of nuclear waste generated in nuclear power plants during their operation. Finland has been the first country in the world to begin constructing a final disposal solution for spent nuclear fuel and the plant will enter the commissioning phase in the 2020s, as Posiva submitted its first application for an operating licence to the Government in December 2021. Nuclear waste management licences should be examined in legislation to ensure that they correspond with current and future needs. Particular attention should be paid to the time span of the operation of the disposal facility, approximately 100 years, which is a considerably long time compared to other nuclear facilities. However, the currently valid Act has enabled the development of nuclear waste management, and the obligation to manage nuclear waste related to nuclear facilities has been well met in Finland. The nuclear waste management solutions have also enabled the development of broad-based national expertise which is highly regarded internationally. The significance of competence should also be reflected in future regulations.

In addition to changes in the operating environment and the development of the use of nuclear energy, the 2010s have seen an emphasis of EU directives and taking their requirements into account in legislation and regulations. Acts applied alongside the Nuclear Energy Act, primarily the Radiation Act and the Environmental Protection Act as well as many other regulations related to safety and security, have already been reformed in the 2000s.

The comprehensive reform of the Nuclear Energy Act is an extensive and topical task and it will be implemented without delay. The effective monitoring of the use of nuclear energy and the development of new technologies require up-to-date and modern legislation. However, due to its scope and significance, the overall reform requires sufficient time for preparation and processing. As a result, the reform could be completed by 2027.

Development of new technologies

Changes in energy production have also led to the active development of new nuclear energy technologies. The primary objective of research and development has been to improve the safety of plants and the management of ageing systems during the plants' operating life. However, changes in the energy system have increased the need to develop aspects such as adaptability and ways of using the plants. At least in financial terms, the most important development target has been solving the question of nuclear waste. Solutions have been sought through means such as the development of fusion technology and so-called fast reactors. Nevertheless, these future technologies will not yet be ready for commercial application in the next few decades, so faster solutions to climate change mitigation should be sought.

The aim to replace fossil fuels and other changes in the operating environment has led to the development of so-called small modular reactors (SMRs) alongside with, or as a replacement of, large plants. The aim of SMR plants is to offer an alternative to both electricity and heat production and an opportunity for more flexible production. The introduction of SMR technology also requires new business models. Plant projects must, nevertheless, give priority to the safety of solutions, and licencing processes must continue to include an EIA process to assess and take into account environmental impacts when deciding on plant licences. Regardless of the size of the plant, the licence holder must fulfil obligations concerning waste management and preparedness in accordance with the Nuclear Energy Act.

The current regulatory environment does not directly recognise this sort of technology or a more decentralised approach to nuclear power plants. These issues will be examined in the ongoing VN-TEAS PIEMOS project carried out in 2021 and 2022 concerning small modular nuclear reactors. The results of the VN-TEAS project will be available in the summer of 2022, and can also therefore be utilised in amending and reforming the Nuclear Energy Act.

The benefits of new technologies also require commercial manufacturing and demand, which are not yet ready. When the aim is to find low-emission solutions, the benefits of SMR reactors should be assessed alongside other alternatives for energy generation, particularly in heat production. Finland's high expertise in the use of nuclear energy and the development of nuclear waste management make this possible. From the perspective of the competitiveness of SMR reactors, it is also important that the regulatory authorities for nuclear safety cooperate effectively in assessing and licensing plant models at the international level.

2.7 Development of the energy market

2.7.1 Development of the energy infrastructure

Electricity networks

New policies:

- It will be ensured that the possessors of electrical networks will be capable of taking the necessary measures required by a strong increase in electricity consumption and security of supply, including investments in electricity networks. There is also a need for investments in information systems and automation as well as the integration of energy systems. Finland will maintain its pioneering position in the development of smart networks.
- It will be ensured that clean electricity production, e.g. with wind power, is utilised broadly and that Finland will remain a single electricity price area through adequate national and international electricity transmission connections and smooth and high-quality licensing processes.
- The implementation of the third alternating current connection between Finland and Sweden (Aurora Line) as scheduled will be promoted using EU funding instruments such as the Connecting Europe Facility.
- The principles of connecting wind power to the network will be examined while allowing the cost-effective use of the network and dividing the costs incurred fairly between network users. In addition, regulatory and other options for centralising transmission line routes will be assessed to mitigate the impact of wind power construction on landowners and the carbon sink.

Policies already decided in the government term:

- An amendment that entered into force on 1 August 2021 has been added to the Electricity Market Act and included:
  - a provision on the obligation of system operators to design, build and maintain their electricity network in such a way that the possessor of the network is able to provide transmission and distribution services to its network users in a cost-effective manner;
  - provisions on changes to the distribution system development plans, according to which future development plans must include a plan for the possible use of flexibility in electricity consumption, electricity storage, energy efficiency measures by the possessor of the distribution network and other resources as an alternative to expanding the transmission capacity of the distribution system and appropriate comparisons of the development activities concerning the cost-effectiveness of the distribution system; and
  - provisions on the consultation of network users and other possessors of networks in the preparation of the development plan.

Facilitating the significant increase in electricity consumption and production required for the transition to a low-carbon society requires sufficiently strong electricity networks. This applies to both transmission and distribution systems. The increase in wind power has already brought challenges in the construction of network connections for wind power plants, as they require the strengthening of the existing electricity networks and due to the different schedules set for the projects. This has led to uncoordinated and partly even suboptimal construction of electricity networks. The same questions also apply to connecting offshore wind power to the grid.

Gas pipeline networks

New policies:

- It will be ensured that the opportunities brought by the gas system are exploited in system integration.
- The development of hydrogen infrastructure will be monitored and, if necessary, the need for regulation will be examined and EU legislation influenced.

Policies already decided in the government term:

- Finland's national biogas programme will be implemented.

System integration aims to increase the interoperability of different energy systems so that the flexibility offered by different systems can be utilised to increase renewable and low-carbon energy production. For example, the transmission capacity of the gas pipeline system is considerably higher than that of the electricity system, and this transmission capacity could be utilised to transfer low-carbon gases produced using electricity, such as hydrogen. At the same time, it would provide valuable flexibility for the electrical system.

2.7.2 Electricity market development

New policies:

- At the moment, investments in electricity production are exclusively targeted at technologies whose production does not tend to be flexible to variation in consumption. To also ensure the targeting of investments at the flexible capacity needed by the system as a whole, the price signals in short-term markets must also reflect the demand and supply of electricity.
- Digitalisation will be promoted by increasing the flexibility of consumption and production and active participation in the electricity market through smart solutions. The electricity market will be developed based on proposals

by the Smart Grid Working Group[5] and the working group on sector integration[6] based on a customer-oriented approach as well as an increase in consumption flexibility and decentralised electricity production, and a fair and equitable distribution of costs between electricity system users.
- Legislative amendments enabling a so-called single invoice model will be prepared.
- Before the end of the parliamentary term, the need to amend the regulation of separate power lines to enable energy communities to operate as an appropriate part of the energy system will be examined based on extensive preparation and a comprehensive impact assessment.
- The implementation of legislation on transmission prices will be monitored and reasonable electricity transmission prices will be ensured while taking steps to enable electricity system operators to make the investments required by the strong growth in electricity consumption and the security of supply in electricity networks, information systems used in the energy system and automation as well as the integration of energy systems. If necessary, additional regulations will be prepared within the framework of EU legislation on the electricity market and the case-law of the European Court of Justice.
- A report on energy poverty will be prepared, especially from the perspective of the impacts of the energy transition and system integration.
- Efforts will be made to exert influence actively in the EU to keep the electricity market model functional and encourage clean energy production.

Policies already decided in the government term:

- Provisions on curbing electricity transmission prices have been added to the Electricity Market Act. The provisions provide the Energy Authority with the tools to reform the existing methods for calculating transmission prices in order to curb them. The maximum annual increase in transmission prices has been reduced from 15 to 8 per cent. The provisions entered into force on 1 August 2021. In connection with the amendments to the Electricity Market Act, Parliament approved two non-binding resolutions concerning transmission prices, which have been taken into account in the policy guidelines of the climate and energy strategy. Based on the legislative amendments, the Energy Authority changed the pricing control method for electricity distribution network operations. The amendments entered into force from the beginning of 2022 and concern the years 2022 and 2023.

5 A Final report by the Smart Grid Working Group; Final report by the Smart Grid Working Group, http://urn.fi/URN:ISBN:978-952-327-346-7

6 Final report of the working group on sector integration, http://urn.fi/URN:ISBN:978-952-327-697-0

- The Ministry of Economic Affairs and Employment has appointed an academic working group to issue a statement to the Energy Authority on the capital structure used in the calculation of the weighted average cost of capital (WACC%) used in the calculation of electricity transmission and distribution tariffs during a period of monitoring the possessors of electrical networks starting in 2024. The working group may also draw up an opinion for the Energy Authority on other elements of the electricity transmission and distribution tariff calculation methods for the monitoring period of electricity network operators starting in 2024.
- Provisions on local energy communities and groups of active customers have been added to the relevant government decree. This makes it easier to share small-scale electricity production produced together with others.
- It has been made possible to connect small-scale electricity production to where electricity is consumed with a separate wire crossing the property boundary.
- The commissioning date for centralised information exchange services in the electricity retail market known as datahub has been set on 21 February 2022. In addition, the Government submitted a government proposal to ensure the introduction of the datahub on 2 September 2021. The legislative proposals contained in the government proposal entered into force on 27 October 2021.

The operation of the electricity market will be developed from the premises of the regional and European markets in the Nordic and Baltic countries. The aim is to meet climate objectives and ensure a competitive price and good security of supply. Effective regional and European electricity markets and sufficiently strong cross-border connections are the most efficient and cost-effective way of guaranteeing competitive electricity prices and security of supply.

Low-emission electricity production technology mainly includes solar or wind power, which depends on windiness, or nuclear power, which lends itself poorly to adjustments. However, the production and consumption of electricity must be balanced at any given moment. For this reason, greater emphasis should be placed on the flexibility of the electricity system in the future. This requires both consumption and production resources, electricity storages and the utilisation of the flexibility of different energy systems. The theme has been discussed extensively in the Ministry of Economic Affairs and Employment's Smart grid working group and the working group on sector integration.

The electricity retail market should also be developed in a more user-friendly direction. In its final report, the Smart grid working group recommended a transition to a customer-oriented retail market model in which all customers could choose a combined

transmission and energy bill. This would also help service providers to offer services that take all costs of purchasing electricity better into consideration.

The potential of smart grids and demand response must be fully utilised. Regulation has been developed, for example, by means of datahub regulations so that all parties, including housing companies, detached houses and farms, can benefit from small-scale energy production. According to the government programme, the Government's decision-making also takes into account the functioning of vital infrastructure and the livelihood and functional capacity of the population. According to the Government Programme, the prerequisites for living and entrepreneurship will also be ensured diversely across Finland, taking into account the needs of regions and cities and safeguarding the rights of people in sparsely populated areas and archipelago to basic services by supporting regional cooperation, new operating methods and sufficient resources (availability of services, security of society, prerequisites for mobility).

An increasing number of electricity users are interested in small-scale self-generation of electricity, and issues such as the price development of solar panels has been making independent power production more profitable in recent years. Small-scale electricity production is based on renewable energy sources, which contributes to the set climate targets. Changes to electricity market legislation have made it easier for a local energy community or group of active customers on the same property to share the electricity they produce together. In addition, provisions have been added to the Electricity Market Act on a separate line for connecting small-scale electricity production to an electricity consumption site across a property boundary. Before the end of the parliamentary term, the need to amend the regulation of separate power lines to enable energy communities to operate as an appropriate part of the energy system will be examined. The report will be based on broad-based preparation and comprehensive impact assessment.

The Ministry of the Environment commissioned reports on energy poverty in 2013 and 2015. The rise in energy prices in the period 2021–2022 has led to extensive discussions on prices and their impact on consumers. Energy prices are also expected to fluctuate more in the future than before. The Government considers it necessary to investigate the risk and extent of energy poverty. It is particularly necessary to investigate energy poverty from the perspective of the impacts of the energy transition and system integration.

2.7.3 Gas market development

New policies:

- The functioning of the joint gas market between Finland and the Baltic countries and the LNG market will be developed with the aim of closer cooperation in the FINESTLAT market area, for example in the form of a common balancing area, and by promoting the inclusion of Lithuania in the common market area of Finland, Estonia and Latvia.
- Finland's gas system and market as well as support systems for renewable gases will be developed to better integrate renewable gases into the gas system.
- A reform of EU gas legislation will promote more effective measures for forming larger common market areas within the EU, more efficient access for market operators to gas reserves, the integration of renewable gases into the gas system and the utilisation of the gas system to the extent possible in the integration of energy systems. Security of gas supply must be ensured without compromising the efficient functioning of the market.

Policies already decided in the government term:

- Provisions on centralised information exchange services for natural gas, i.e. datahub, have been added to the Natural Gas Market Act. The provisions entered into force on 1 June 2020.
- Finland's national biogas programme will be implemented.

The Balticconnector gas pipeline, constructed between Finland and Estonia and introduced in December 2019, provided Finland with a new route to acquire gas and connected the Finnish gas system to the European gas system. With this connection, Finland is no longer solely dependent on a single gas supplier. The construction of the pipeline also meant that the Finnish gas market had to be opened up as required by EU legislation. This has required, among other things, the separation of gas transmission and sales activities and the dismantling of the sales monopoly.

As a result of the opening of the gas market, Finland has actively participated in the development of marketplaces together with the Baltic countries, and a cross-border marketplace, progressive even at the European level, has also been created in the region. To ensure the usability of the new gas supply routes, Finland aims to integrate closely into the gas market in the Baltic countries and later in Central Europe and to make use of the LNG market. Since the introduction of Balticconnector, Finland, Estonia and Latvia have formed a gas market coupling with no separate entry and exit charges at internal borders (FINESTLAT). The countries are also preparing a common balancing zone and, together with Lithuania, the country's entry into the gas market area formed by the four countries. The FINESTLAT market enables Finnish market parties to make flexible use of the Incukalns gas storage located in Latvia.

2.7.4 Development of the heat market

New policies:

- Cost-effective methods will be prepared to promote the utilisation of renewable energy and waste heat in the district heating network.
- Aids will be used to promote the introduction of new energy technology solutions, particularly those based on non-combustion techniques, in district heating systems.
- The temperature rating of the district heating network will be lowered as far as possible, which also supports production based on non-combustion technology. The sector has published a recommendation on new dimensioning temperature for heat distribution centres, which entered into force at the beginning of 2022.
- Finland will encourage the use of solutions that enable combining both district heating and the energy production of properties in a manner that allows optimising their use.
- The utilisation of demand-side management services will be promoted in heat production.
- Land use planning will be used to streamline the provision of waste heat, other non-combustion production and renewable energy for district heating networks.
- Finland will prepare a government loan guarantee model for private households as well as a model for a central government deficiency guarantee to support climate-friendly investments by housing companies. The model could focus on areas such as investments that significantly improve the energy efficiency of buildings or modify heating systems to accommodate renewable energy sources, such as geothermal heat, wind and solar energy.

Policies already decided in the government term:
As part of a fair transition:

- Peat entrepreneurs will be provided with grants and advice for developing new business and finding new employment.
- A scrapping aid scheme will be created to compensate peat entrepreneurs for the depreciation of peat production machinery. The aid scheme was implemented in February 2022.
- Entrepreneurs giving up their peat business are offered a possibility of direct financial compensation, taking government support rules into consideration.

In addition to the abovementioned policies, the Medium-term Climate Change Policy Plan proposes measures to abandon oil heating in separate building-specific heating.

In accordance with an entry in the government programme, electricity and heat production must be nearly emission-free in Finland by the end of the 2030s, taking into account delivery reliability and security of supply aspects. The introduction and piloting of new non-combustion district heating production and storage methods will be promoted and the Nordic electricity market and the integration of energy systems will be developed. For a long time, district heating has been the most common heating method in Finland. However, competition in the heating market has intensified in recent years due to the technological development of different forms of heat production, the narrowing selection of fuels available for heat production and a strong increase in emission allowance prices, as well as increasing interest among customers in their own carbon-neutral production and more predictable costs.

As district heating systems in Finland are closed and use fixed prices, the utilisation of the flexibility potential of district heating systems and the integration of energy systems may not be optimal at present. In recent years, energy companies have sought competitive heat production and supply methods and developed different business models, such as two-way and open distribution of district heating through bilateral agreements.

There are well-functioning international market mechanisms for electricity and natural gas. When the mechanisms work well, energy forms can be changed on a market basis and benefits can be produced for different energy systems. When energy systems are integrated, low-emission electricity generation enables both other types of low-carbon energy as well as increase the production of renewable electricity through the flexibility of other sectors. Joining industrial, transport and heating energy networks enables effectively balancing the consumption and production of different sectors.

According to the Fit for 55 package published by the European Commission in July 2021, Member States should implement the obligation to open district heating and cooling networks to third parties with certain exceptions. There is also a need to strengthen the cooperation between district heating and cooling companies and potential producers of waste heat as well as the main grid company and distribution system operators.

In view of these factors, alternatives and operating methods will be examined to allow for more flexible consideration of non-combustion renewable heat production and waste heat, utilisation of demand response and integration of different energy systems in the district heating market. As part of the premises of this examination, it is also necessary to examine whether Finland will continue to meet the requirements of EU legislation for providing customers with carbon-neutral district heating by 2030.

In early autumn 2021, the Ministry of Economic Affairs and Employment examined cost-effective alternatives and operating methods for improving the operating conditions of

district heating and for increasing renewable and other emission-free energy and waste heat in the district heating network[7].

Potential of waste heat in district heating systems

In Finland, generated waste heat is estimated to amount to around 130 TWh, of which 3 TWh is currently utilised in district heating. The potential of waste heat that can still be reasonably technically recovered is estimated to amount to 35 TWh. By utilising waste heat, Finland could completely eliminate the use of coal in energy production.

However, there are still challenges related to the potential of waste heat that can still be utilised related to aspects such as profitability and business risks. There is potential for the additional utilisation of waste heat in the industry and condensing power plants. The waste heat potential available for industrial plants amounts to approximately 15 TWh, its utilisation requires significant investments. In the utilisation of waste heat, a significant cost item consists of the construction of the transmission network and heat pumps.

Heat pumps will play an important role in the utilisation of waste heat and a carbon-neutral energy system. In the future, the importance of heat pumps will increase as previously unprofitable heat sources become profitable due to changes in technology and the operating environment. The changes will increase system integration between the heating and electricity markets, which will promote the development of new energy solutions.

2.8 Research, innovation and competitiveness

New policies:

- Clean innovations and solutions will be developed and introduced in a broad and technology-neutral manner to enable a carbon-neutral economy.
- Investments will be made in the development of new technologies and the commercialisation of innovations, particularly concerning energy infrastructure, new energy technologies, hydrogen and power-to-X solutions, electrification and the circular economy.
- Cooperation between business and research actors will be strengthened by directing public RDI funding to strategic partnerships, internationally significant R&D projects and shared research and development environments. New solutions will be sought to the growing need for

7 https://tem.fi/selvitykset-lampomarkkinat

experts in the energy sector. Increasing business and exports in the sector requires experts with substance knowledge of the energy sector as well as digitalisation and business.

- Finland will actively participate in selected international cooperation forums, such as Clean Energy Ministerial (CEM) and Mission Innovation. Focus areas in advocacy and cooperation include issues related to the integration of the energy system, hydrogen and the circular economy.
- The internationalisation of climate and energy solutions will be promoted in cooperation between Team Finland actors.
- Opportunities will be created to make better use of different statistics, spatial data and open data in the steering of energy and climate policy.
- The possibility of enabling testing environments for innovative solutions by legislative means in the energy market will be investigated.
- Measures will be taken to promote the consideration of flexibility and intelligence in research and development projects and when introducing new processes or new technologies. Flexibility and intelligence will be taken into account in public funding instruments and investment aid.
- The goal is to strengthen the carbon handprint of Finnish companies. Carbon handprint refers to the positive climate impacts of a company's business activity, such as its products and services.
- The strategy for the renewal of industry outlined in the mid-term policy review session will be implemented. This will include streamlining the investment permit procedure as determined in the strategy.
- The need to create a regulatory framework for negative technical emissions, i.e. carbon dioxide removal solutions, will be assessed. This would promote the innovation and export of Finnish technology. Creating a regulatory framework for carbon dioxide removal solutions requires EU-level solutions.

Policies already decided in the government term:

- The Sustainable Growth Programme for Finland is Finland's plan for the use of EU Recovery and Resilience Instrument (RRF) funding. In the programme, Finland has allocated half of the total funding of EUR 2 billion to green transition. This is a significant part of the funding for the implementation of the Climate and Energy Strategy. The programme allocates EUR 192 million to RDI activities supporting the green transition, and EUR 75 million to research and innovation infrastructure investments supporting sustainable growth and digitalisation. EUR 645 million has been allocated to energy system projects and industrial low-carbon and circular economy projects in the programme. In particular, funding will be used for the demonstration of new solutions.

The transition to a low-carbon, clean and sustainable future requires significant investments in the development of clean energy technologies, research and innovation. The development of new solutions will enable the reduction of emissions and improve competitiveness.

The global transition of the energy system entails enormous new business opportunities for Finnish companies. New low-carbon solutions create new growth and export opportunities. As the change in energy systems is accelerating at the global level, companies and society more broadly need to take action to seize the emerging opportunities. Finnish companies' low-carbon solutions have a major effect on the country's handprint, as the solutions have the potential to achieve large-scale reductions in global greenhouse gas emissions.

Increasing international climate benefits, also referred to as the carbon handprint, should therefore be set as a goal of Finland's climate policy in addition to reducing national emissions. Priority should be given to actions that help to produce new solutions for the world and whose global potential is particularly high. The importance of the carbon handprint of Finnish companies has also been emphasised in the Government's Sustainability Roadmap.

Finland's strengths include energy-efficient solutions for the manufacturing industry, electrification of transport and the development of bioenergy products. Finland has expertise in the electrification of transport, for example in mobile machinery. The most promising growth opportunities in the energy sector are related to electrification, smart energy solutions, low-carbon energy production technologies and industrial energy solutions, such as hydrogen.

A strong battery industry hub is emerging in Finland. In the coming years, it will be important for Finland to invest in the development of products with higher added value in the value chain in the battery industry. If the planned investments are realised, the value chain of the battery industry in Finland will have a significant handprint effect in the EU, as internal combustion engines will be replaced by battery-based solutions in the transport sector.

An increasing shortage of experts is already restricting the growth of international business and export of clean solutions. In addition to experts in the energy sector, there is a need for digitalisation experts and international business professionals. Growth must also be supported by international partners and additional investments in industrial-scale testing and demonstration environments.

Finland must actively communicate about its activities and expertise in various forums. Key forums include Clean Energy Ministerial Conference (CEM) and Mission Innovation (MI), whose members are the G20, several EU countries and the Nordic countries.

New innovative solutions may not be fully feasible within the framework of existing legislation, even if they promote the objectives of energy policy and legislation. However, such innovative solutions may prove to work well, and testing them in practice in the energy market can be useful. New legislative solutions may also be developed at the same time. The transforming energy sector is in need of new innovations and solutions. As a result, legislation that enables testing environments should be examined, especially in the energy market, where regulation is increasingly detailed.

Equality in the energy sector

New policies:

- Equality in the energy sector will be promoted in education, career advancement and pay, and the reputation of the energy sector as an equal employer for everyone.

In 2018, Finland joined the international Equal by 30 campaign. The campaign aims to ensure equal pay in the energy sector, gender equality in the appointment of management and uniform opportunities for all to study and choose careers by 2030. The campaign is part of the International Energy Agency's (IEA) Technology Collaboration Programme, which promotes the opportunities that the clean energy sector provides as an equal working environment. New jobs in the energy sector are mainly created in renewable energy.

Standardisation

New policies:

- Finland will promote and encourage strong participation in European and international standardisation work in the field of energy, which is key to industrial competitiveness.

The ongoing energy transition is an opportunity to develop products and services for both national demands and international markets. International standardisation plays an important role in the spread of new technologies and enables a global market for the product. Promoting international and European standardisation can contribute to the functioning of the EU's internal market and develop the competitiveness of industry and businesses in the transition towards a climate-neutral economy.

Active participation in the international standardisation of renewable energy technology and electricity networks will strengthen the competence of national experts, promote international networking and advance export opportunities for Finnish technology and expertise. Renewable energy technology standards support pursuing the UN's Sustainable Development Goals and help achieve national climate targets.

2.9 Taxation

Policies already decided in the government term:

- In accordance with the projected increase in consumer prices, the taxation of fossil fuels will be increased by EUR 250 million during the parliamentary term.
- The tax subsidy for paraffinic diesel oil will be phased out in the period 2021–2023
- In the tax model for biogas, the tax only concerns the use of biogas in transport, not for heating.
- To promote electrification, fully electric cars will be exempt from the car tax; correspondingly, the basic portion of the vehicle tax on fully electric cars will be increased. The increase in vehicle tax does not apply to fully electric cars that have been deployed earlier. The car tax exemption applies to cars taxable after 1 October 2021.
- It will be ensured that conversions of the vehicle's propulsion power that enable lower emissions will be taken into account in car tax, vehicle tax and tax on driving power.
- The taxable value of zero-emission company cars will be temporarily reduced for the period 2021–2025, the charging benefit for electric cars will be temporarily waived for the period 2021–2023, the tax exemption of an employer-subsidised commuter ticket will be increased to EUR 3,400, the employee bicycle benefit will be made tax-exempt up to EUR 750.
- The taxable value of low-emission company cars will be reduced by EUR 85 per month for the period 2022–2025. The change concerns low-emission hybrids and gas-powered company cars.
- An act will be enacted to enable the introduction of congestion charges aimed at managing transport in urban areas.
- The industry's electricity tax rate will be reduced to the minimum level allowed by the EU in a cost-neutral manner. The industry's energy tax refund system will be eliminated. The change will be implemented in such a way that it does not lead to unreasonable situations for individual operators.
- Tax subsidies will be reduced in combined electricity and heat production and the tax rate for heating fuels will be increased so that tax revenue

will increase by a total of EUR 100 million during the parliamentary term. Incentives for demand response will be promoted, for example through dynamic electricity taxation. Double taxation of electricity storage will also be abolished for pumped-storage plants and batteries smaller than those currently manufactured.

- Data centres, heat pumps and electric boilers producing heat for the district heating network will be transferred to lower electricity tax category II. Data centres outside the district heating network that meet the energy efficiency and energy utilisation criteria, as well as heat pumps of industrial capacity, are also entitled to a reduced electricity tax. The electricity tax reduction also applies to circulating pumps in geothermal heating plants. The changes will enter into force once the necessary approval for the measures has been obtained from the EU.
- The recycling industry will be transferred to the industrial tax rate for the electricity tax category from the beginning of 2022. Fish farming will be included in the agricultural energy tax refund system, which will reduce the electricity tax to the industrial electricity tax category, provided that the necessary approval for the action is obtained from the EU.
- A floor price mechanism for peat will be introduced at the beginning of 2022. The floor price is based on the combined level of the emission allowance price and the tax on peat (e//tCO_2) recorded in an act. Based on expert assessments, this is estimated to be sufficient for halving the energy use of peat by at least half by 2030.
- The limit for tax-free use of peat for energy will be increased for a fixed period from the current 5,000 MWh to 10,000 MWh for the period 2022–2026 and to 8,000 MWh for the period 2027–2029, so that in 2022–2029, taxes will only be paid for the part exceeding the limit.
- A mining tax will be introduced in 2023 instead of an increase in the electricity tax for the mining industry.
- For the replacement of oil heating, changes in heating methods will be supported by increasing the maximum amount of the domestic help credit from EUR 2,250 to EUR 3,500 and the compensation percentage from 40 to 60. This is a temporary change that will be effective from 2022 to 2027. A domestic help credit is not granted for those who have received other aid for similar work. The Government's objective is that after the support received through the Sustainable Growth Programme for Finland, the alteration work could continue with the support of the household allowance.
- The tax base of the waste tax will be expanded from the beginning of 2023. More specific details will be decided in the spending limits discussion in spring 2022, taking into account the report under preparation.

- Work aimed at securing the fiscal basis of transport taxation over a longer period than the current government term will be launched. This work will pay attention to ensuring social fairness and regional equality as emission reductions become stricter.
- The Government will prepare a roadmap for energy taxation, which will support the achievement of the carbon neutrality target of 2035 together with the emissions trading system. Extensive preparation will be used to assess how to secure the tax base in connection with emission reductions and technological changes in a socially and regionally fair manner while taking into account the operating conditions of business life.
- A report will be launched to determine how the domestic help credit could be extended to other energy renovations as well as renovations commissioned by housing companies. Other examined topics include how to develop the domestic help credit so that the reduction encourages renovation services and repairs, prolongs the operating life of buildings and materials, improves energy efficiency or otherwise supports the circular economy and emission reduction. The report will be completed by the end of February 2022.
- A project by the Government's analysis, assessment and research activities (TEAS) will be launched in an aim to develop the assessment of lifecycle emissions from food and other consumer goods to direct consumption taxation to take into account climate and environmental impacts.
- The tax exemption for small-scale electricity production will continue.

Most of the tax changes outlined by the Government have already been implemented in the period 2020–2022. Since August 2020, taxes on transport fuels were increased by around EUR 254 million, the tax subsidy for paraffinic diesel oil will be abolished under the currently valid legislation in the period 2021–2023, and a tax on the use of biogas in transport was imposed at the beginning of 2022. From the beginning of 2021, electricity tax category II was lowered to the EU minimum tax level, taxes on heating fuels were increased by EUR 2.7/MWh, and the 0.9 coefficient reducing the amount of taxable fuels in combined production was abolished. Under the currently valid act, the tax refund for energy-intensive enterprises will be phased out gradually by 2025. The taxation of electricity storage was reformed at the beginning of 2019 in order to eliminate double taxation, and regulation concerning the definition of equipment used in independent electricity production was specified on 14 September 2020 so that the electricity used by pumped-storage plants is considered to be consumed energy for tax-free self-use equipment.

A working group on the energy taxation reform prepared the implementation of the intentions of the government programme and assessed the development needs of the

energy taxation system. The working group completed its work in September 2020[8]. In connection with the intentions of the government programme, the working group also agreed with the views of the smart grid working group of the Ministry of Economic Affairs and Employment concerning dynamic electricity taxation and did not support the introduction of the dynamic electricity tax.

A working group on the reform of transport taxation submitted its final report in May 2021[9]. The final report examines transport taxation as a whole from the perspective of reducing emissions and securing the tax base. Based on an entry in the government programme, the final report also examines the tax treatment of conversions. According to the working group, promoting conversions by means of car and vehicle taxation is not justified, but if it is considered necessary to promote making conversions more prevalent, this may be implemented by continuing the current direct conversion support.

A background report on the development of Finnish energy taxation[10] commissioned by the Ministry of Finance was published in April 2022. The study carried out by VTT Technical Research Centre of Finland is part of preparatory work that aims to prepare a roadmap for energy taxation. The report examined the energy taxation of heating, industrial and machinery fuel use and the taxation of electricity use. The report included assessing the impacts on Finland of the directive on the taxation of energy products and electricity included in the Commission's Fit for 55 package.

2.10 Strengthening climate change adaptation

New policies:

- Risk management of the impacts and consequences of climate change will be strengthened in the energy and industrial sectors, and this will be taken into account in the preparation of the next national climate change adaptation plan in 2022.
- Investments in developing a weatherproof infrastructure will be ensured in line with the strategy's section on electricity networks (2.7.1).

8 Report of the working group on energy taxation reform: A proposal for implementing the intentions and goals of the Government Programme and for further developing energy taxation, http://urn.fi/URN:ISBN:978-952-367-299-4

9 Final report of working group on the reform of transport taxation, http://urn.fi/URN:ISBN:978-952-367-521-6

10 https://vm.fi/-/taustaselvitys-suomen-energiaverotuksen-kehitystyolle-julkistettiin

The aim of the National Climate Change Adaptation Plan is that society will have the ability to manage the risks associated with climate change and to adapt to climate change. The targets are to:

1) Carry out climate change adaptation cost-effectively by making adaptation part of the normal planning and decision-making processes in different sectors.
2) ensure that those involved will have access to the necessary climate risk assessment and management methods; and
3) increase adaptive capacity in society, innovative solutions and awareness of climate change adaptation through research and development, communication and education.

In accordance with the Climate Change Act, the plan is updated at least once every ten years. In addition, the Act requires adaptation action plans specific to each administrative branch as necessary. The next National Climate Change Adaptation Plan for 2030 will be prepared under the leadership of the Ministry of Agriculture and Forestry during 2022.

The new EU Climate Change Adaptation Strategy adopted in February 2021 will focus on issues such as investments in the climate resilience of infrastructure, particularly critical infrastructure such as electricity networks. The National Climate Change Adaptation Plan contributes to implementing the EU Adaptation Strategy in the national context.

2.11 Influence within the EU

Policies:

- At the EU level, Finland needs to be committed to ambitious measures for the widespread abandonment of fossil fuels in the energy system. Reducing emissions must be a priority when reforming the legislative framework for the EU's climate and energy policies.
- Efforts will be made to develop EU climate and energy legislation so that the climate and energy targets will be achieved through cost-effective and efficient measures. The efficiency of the emission and energy markets will be ensured, taking into account delivery reliability and security of supply.
- Finland will ensure extensive and proactive advocacy at the EU level, active data collection through cooperation networks and sufficient resources to participate in EU projects that are key to the ambition, national influence and implementation of climate policy.
- Exerting influence in the EU will promote investments, sustainable production of renewable energy, regulation that supports the achievement

of climate targets and a predictable operating environment. Advance and follow-up evaluation of the legislative impacts of the implementation of directives will be strengthened as highlighted by the Finnish Council of Regulatory Impact Analysis.

EU regulation on climate and energy policy is constantly changing. The number of obligations to be implemented nationally will increase and become more detailed. The challenges of implementation are also increased by the new overarching horizontal themes on values, which must be taken into account in all areas, and the obligations laid down in several different EU regulations concerning the same individual substance area, such as transport. Working in networks to gather and share information and exert influence at the right time has played a significant role in national advocacy work.

The EU's climate targets must be in line with those set in the Paris Agreement, and they must be made increasingly strict over time. The EU's joint ambitious climate policy and the predictable operating environment it creates are also in Finland's national interest.

3 Impact assessments

3.1 Achievement of climate targets

The development of emissions presented in this chapter is based on the energy system and emissions modelling prepared in the Carbon neutral Finland 2035 – measures and impacts of the climate and energy policies (HIISI) project[11] and its follow-up report[12]. The HIISI project produced a large number of background calculations and data used in the preparation of the national climate and energy strategy. Meanwhile, the aim of the follow-up study was to assess the impacts of the Government's latest climate and energy decisions on Finland's greenhouse gas emissions and the energy and national economy. The following two main scenarios are key for the impact assessments:

- the WEM scenario of the HIISI follow-up study, representing the base scenario, and
- the policy scenario, which is illustrated by the WAM-H scenario of the HIISI follow-up study.

The base scenario describes the development in the current operating environment, taking into account the development of technologies, sectors, markets and infrastructure, reflecting trends and taking into account climate and energy policy steering and policy measures implemented on 31 December 2019 and earlier. The base scenario serves as a comparison scenario for the policy scenario, which includes the policy measures decided after 1 January 2020, including those outlined in this strategy and the Medium-term Climate Change Policy Plan. Both scenarios include modelling of the emission development the scenario will lead to, and the modelling does not set emission targets which the scenarios are forced to fulfil.

3.1.1 Carbon neutrality 2035

The total amount of greenhouse gas emissions between 1990 and 2020 is presented in Figure 1 alongside emission trends in the baseline and policy scenarios until 2040. Finland's carbon neutrality target means that greenhouse gas emissions and carbon

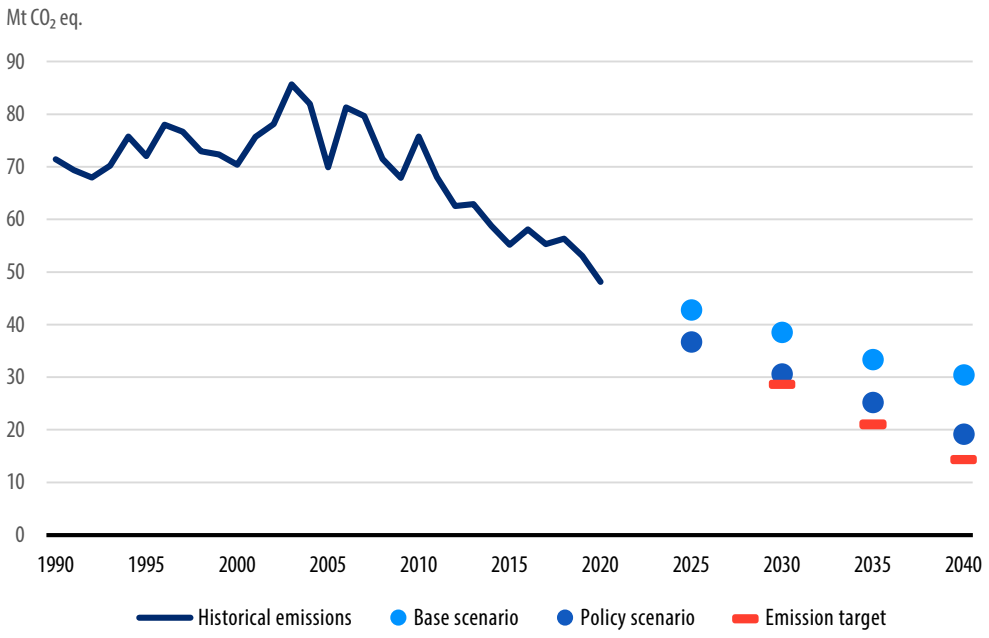
11 The HIISI report http://urn.fi/URN:ISBN:978-952-383-257-2 and www.hiisi2035.fi

12 VTT Technology 402: Impact assessments of the climate and energy policy measures ofo Prime Minister Sanna Marin's Government

sinks must be equal in 2035, and the sinks must subsequently exceed the emissions. The emission target for 2035 in Figure 1 is in line with the carbon neutrality target, in which greenhouse gas emissions are determined based on the HIISI project's modelling results on the land use sector and the Government's decision to enhance carbon sinks. When net sinks of 18 Mt CO_2 eq. in the baseline scenario are strengthened by the 3 Mt CO_2 eq. outlined by the Government for the land use sector, the net sink of the land use sector as well as the emission target for 2035 will be 21 Mt CO_2 eq. The modelling of the land use sector of the HIISI project assumed that imports of raw timber from Russia and the growth of Finnish forests will continue at the previous levels. However, in spring 2022, imports of raw timber, veneer sheets and chips from Russia ended due to Russian counter-sanctions. In 2021, a total of about nine million cubic metres of raw and waste wood were imported into Finland from Russia. In particular, fibre wood and chips have been imported into Finland from Russia. The end of wood imports from Russia may therefore have an impact on the extent of domestic logging operations and, through these, also on the net sink of the land use sector.

The total amount of greenhouse gas emissions will decrease in the base scenario after 2020 at approximately the same rate as on average in the early decades of the 2000s, but even more rapidly in the policy scenario. In 2035, the emissions in the policy scenario are about 25 Mt CO_2 eq., which means that the emissions gap to the carbon neutrality target would be over 4 Mt CO_2 eq.

Figure 1. Total actual emissions 1990–2020, emission trends in the base and policy scenarios 2025–2040 and emission targets for 2030, 2035 and 2040.



Until 2035, HIISI results show a strong emphasis on emission reductions in the energy production sector, mainly in electricity and heat production, in which the emissions trading system and the price of emission allowances determined under the system are effective economic steering factors. According to the policy scenario calculations, the emission reduction in the emissions trading sector amounts to approximately 3.6 Mt CO_2 eq. by 2035 compared to the baseline scenario. This would make the share of the emissions trading sector around 44 per cent of the total reduction in emissions between the scenarios.

Long-term energy and climate policy creates preconditions for achieving emission reductions in the emissions trading sector. However, substantial relative reductions can also be achieved in the building-specific heating of buildings, for which energy taxation is a guiding factor in addition to subsidies for phasing out oil heating, and in F-gas emissions, in which context reductions are guided by EU-level restrictions on the use of harmful substances and related standards. In the policy scenario, emissions from both these sectors and transport and machinery will decrease significantly more than in the base scenario. In the policy scenario, phasing out fossil fuels in machinery and heating is accelerated by higher excise tax rates and increases in biofuel distribution obligations.

The results of the scenarios show that it is considerably more difficult to reduce greenhouse gas emissions in industrial sectors compared to energy production, despite the fact that a large proportion of industrial emissions are covered by the emissions trading system. In Finland, the most substantial greenhouse gas emissions from industrial processes are generated in the manufacture of carbon steel and the refining of fossil oil. While new technologies are being developed to reduce emissions, there is considerable uncertainty about their commercial viability and large-scale introduction.

The policy scenario assumes that the blast furnaces of the SSAB steel plant in Raahe will only be phased out after 2035. If SSAB will also transition to fossil-free steel production in Raahe in 2030, as indicated by the company's press release published in January 2022, emissions will decrease by 3–4 Mt CO_2 eq. more in the scenario, which would significantly reduce the emissions gap to the carbon neutrality target.

The impact of carbon capture and storage (CCS) technology investments on greenhouse gas emissions will only be significant in the policy scenario from 2040 onwards, and in 2050, the total reduction brought by CCS amount to approximately 9 Mt CO_2 eq. If CCS investments become profitable faster than expected, for example in a steam reforming plant for natural gas or so-called BECCS (bioenergy CCS) technology, industrial emissions may be significantly lower already in 2035.

In late 2021, a target was set for reducing greenhouse gas emissions from agriculture. The target is to reduce greenhouse gas emissions from agriculture (greenhouse gas emissions from agriculture in the effort sharing sector and the land use sector) by 29% from the 2019 level by 2035. Emissions from agriculture are over 6 Mt CO_2 eq. in the effort sharing sector and over 8 Mt CO_2 eq. in the land use sector. Therefore, the emission reduction would amount to a total emission reduction of approximately 4 Mt CO_2 eq. The Natural Resources Institute Finland is currently working on a carbon-euro programme for agriculture (HERO). The aim is to draw up a programme on how to achieve a 29 per cent reduction in greenhouse gas emissions from agriculture by 2035, without undermining the financial situation of farms but, instead, improving it. The climate and environmental measures in agriculture will be collected into a single set of measures that will specify the emission reduction pathway to 2035 in more detail. The measures to be implemented in Finland in the period 2023–2027 under the EU's new Common Agricultural Policy (CAP) period starting at the beginning of 2023 will contribute to the achievement of the target of a 29 per cent reduction in emissions. However, achieving the target also requires a whole range of measures outside the CAP and on market terms.

On the other hand, according to the HIISI study, the target of strengthening the carbon sink of the land use sector by 3 million tonnes is also largely concerned with land and field use, which could mean that there is at least some overlap with the above emissions reduction target of 29 per cent in agriculture. An emission target or emissions gap analysis also includes other uncertainties, some of them positive and some negative. For example, there is uncertainty about whether the measures recently proposed by the European Commission (such as the emissions trading system for transport or building-specific heating) will be realised. It is also difficult to make predictions of industrial activity and its emission solutions (such as decommissioning the blast furnaces at the Raahe steel plant mentioned above) and technological development (e.g. the production costs of clean hydrogen) over a period of more than 10 years – and this also applies to consumer behaviour (e.g. red meat consumption) and choices concerning issues such as travel and movement. Due to the factors mentioned above, even the base scenario may change a lot compared to the current estimate.

All in all, based on current knowledge, the measures agreed in the policy scenario can be evaluated to achieve carbon neutrality in 2035, provided that the aforementioned blast furnaces of the Raahe steel plant are decommissioned and the latest emission reduction target for agriculture is met.

3.1.2 Total emissions in 2030 and 2040

The Climate Change Act contains provisions on new climate targets. In addition to the 2035 carbon neutrality target, the Act lays down reduction targets for total emissions for 2030 and 2040. The emission reduction target for 2030 is at least 60 per cent and for 2040 at least 80 per cent compared to 1990. These targets are indicated in Figure 1 together with the development of the base and policy scenario.

If emissions were reduced by at least 60 per cent by 2030, there would be a maximum of 28 Mt CO_2 eq. left. In the policy scenario, greenhouse gas emissions are just under 31 Mt CO_2 eq., which means that the emissions gap would be just over 2 Mt CO_2 eq. without the above-mentioned measures that are not included in the scenario but could be implemented. According to the policy scenario calculations, the emission reduction in the emissions trading sector amounts to approximately 4.2 Mt CO_2 eq. by 2030 compared to the baseline scenario. This would make the share of the emissions trading sector around 53 per cent of the total reduction in emissions between the scenarios. In 2040, the emissions in the policy scenario are about 19 Mt CO_2 eq., while they should not exceed 14 Mt CO_2 eq. under the new Climate Change Act. This would make the emission gap in 2040 around 5 Mt CO_2 eq. If SSAB also moves to fossil-free steel production in Raahe in 2030, emissions would be reduced in accordance with the 2030 emission reduction target set in the Climate Change Act. Further efforts would be needed to achieve the 2040 emissions target.

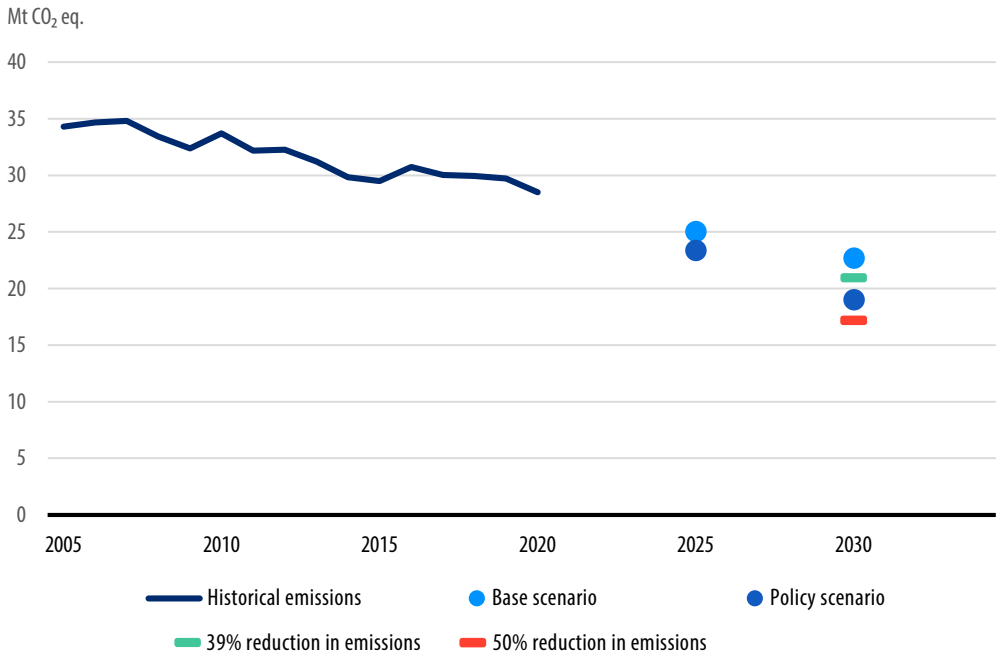
In the policy scenario, the emissions gap will grow until 2040, after which the new technologies assumed in the modelling will enable an emission reduction of up to 90 per cent in 2050.

3.1.3 Emissions from the effort sharing sector 2030

In the policy scenario, emissions from the effort sharing sector will be 19 Mt CO_2 eq. in 2030, which is approximately 2 Mt CO_2 eq. below the 39 per cent emission reduction target under current EU legislation. As the details of the EU's increasingly strict climate targets have not yet been agreed upon, we do not yet know exactly what Finland's new emission reduction target for the effort sharing sector will be. Both the HIISI project and this impact assessment assume that the EU's 2030 emission target will be 50 per cent compared to 2005 emissions in line with the EU's Effort Sharing proposal. The 2005 emission benchmark calculated by the Commission for Finland is 34.4 Mt CO_2 eq., which means that the emissions target corresponding to a 50-per cent reduction would be 17.2 Mt CO_2 eq. Compared to this amount, the emissions gap in the effort sharing sector in the policy scenario is just under 2 Mt CO_2 eq. without applying flexibility mechanisms. Figure 2 illustrates the actual emissions in the effort sharing sector in the period 2005–2020, the

examined alternative paths towards the 2030 emissions target, and the development of emissions in the base and policy scenarios.

Figure 2. Actual emissions in the effort sharing sector 2005–2020, the 2030 emissions targets and the development of emissions in the base and policy scenarios.



Various flexible mechanisms may be employed to meet the emission reduction target in the effort sharing sector. The final extent of the flexibility that can be utilised is not yet known at this stage. According to estimates made in the HIISI project, one-off flexibility in the emissions trading sector and flexibility in the land use sector is presumed to amount to a total of 1.1 Mt CO_2 eq. in 2030. If these flexibility mechanisms are fully used and measures in line with the Medium-term Climate Change Policy Plan are implemented, the 50-per-cent emission reduction target set for the effort sharing sector will be achieved.

The main uncertainty in the effort sharing sector is related to the development of transport, whose greenhouse gas emissions should be at least halved from 2005 to achieve the target set for the effort sharing sector. As the agricultural sector is the second largest source of emissions in the effort sharing sector after transport, an increase in emission reductions in agriculture would ease the burden on other effort sharing sectors and promote the achievement of the emissions targets. While the initiatives included in the Fit for 55 package could help with the target set for Finland's effort sharing sector,

not all of them have been taken into account in the modelling and assessment of the emissions gap in the policy scenario.

If it turns out that the decided measures fail to reach the emission reduction targets of the effort sharing sector, there will be a need to introduce new policy measures or strengthen existing measures. The KAISU plan presents a number of actions that are not included in the policy scenario as no political decisions have been made on them. The introduction of these or other new measures should be considered if necessary.

3.2 Impacts on central government finances

Issues concerning needs for funding are processed in the normal manner in procedures concerning the budget and the General Government Fiscal Plan within the spending limits of central government finances, reconciling them with other expenditure needs. Table 1 presents a summary of the additional funding required by the climate and energy strategy. Additional funding needs[13] for the effort sharing sector have been included in the medium-term climate change policy plan[14]. The additional funding needs required by the climate change programme for the land use sector will be approved in connection with the adoption of the climate plan for the land use sector.

13 https://api.hankeikkuna.fi/asiakirjat/11131553-2171-402c-b1ac-482e99430154/0cc706a1-bd38-408f-b787-635f91d48fd9/MUISTIO_20220609094106.docx

14 http://urn.fi/URN:ISBN:978-952-361-262-4

Table 1. Additional funding required by the national climate and energy strategy.

Sector	Measure	Additional information	Implementation	Funding	Annual needs for additional funding compared to the General Government Fiscal Plan 2023–2026
Energy	Energy aid (large demonstration projects)	EUR 150 million will be annually allocated to demonstration projects concerning new technology.	2024-->	National Current funding for large demonstrations ends in 2023	EUR 150 million from 2024 onwards
Energy	Energy aid (basic budget authority)	Beyond this, sufficient energy aid will be budgeted for smaller renewable energy projects and energy efficiency projects.	2024-->	National Currently, the basic level in the General Government Fiscal Plan is EUR 30 million	EUR 10 million/year from 2024 onwards
Energy	Energy advisory services for consumers	Changes in EU legislation include increasingly comprehensive obligations for the provision of broad-based energy advice as well as requirements for monitoring and reporting on national measures.	2023-->	National Currently EUR 1 million in the General Government Fiscal Plan	
Energy	Promoting the hydrogen economy	Promoting the emergence of clean hydrogen production capacity.	2022-->	May be included in the funding of large demonstration projects.	
Energy	Promoting low-carbon industry	The usability of aid granted through the Carbon Contracts for Difference (CCfD) in promoting a low-carbon industry will be examined.			
Energy	Promoting the hydrogen economy	The investments needed for the transfer and distribution of hydrogen will be promoted, while also making use of EU funding and the opportunities created by the EU.	2022-->	Included in RRF funding.	

Sector	Measure	Additional information	Implementation	Funding	Annual needs for additional funding compared to the General Government Fiscal Plan 2023–2026
Delivery reliability and security of supply	Promoting the supply of forest chips	In connection with preparing a new system of incentives for sustainable forestry, Finland will examine the possibility of including support for the management of young stands and a related incentive for the collection of small diameter wood in the system. The level of aid under the current scheme will also be increased and the conditions for the aid will be changed.	2022-->	No additional funding is required.	
Delivery reliability and security of supply	Promoting the supply of forest chips	EUR 40 million will be allocated in the 2022 supplementary budget to promote the national comprehensive wood terminal network and improve the resilience of energy wood supply chains.	2022-->	2022 supplementary budget EUR 40 million Decided in the Ministerial Working Group on Preparedness in April 2022.	
Delivery reliability and security of supply	Promoting the supply of forest chips	Security of supply and the availability of domestic wood for the needs of both the forest industry and energy production will be promoted by improving the condition of roads and bridges. A condition assessment will be performed on private roads and bridges and activation measures aimed at reducing the existing maintenance backlog will be implemented.	2022–2023	EUR 2.5 million per year for condition assessments and activation measures and EUR 10 million per year for repairs to private roads. Decided in the Ministerial Working Group on Preparedness in April 2022.	
Delivery reliability and security of supply	Promoting the supply of forest chips	The Finnish Forest Centre will carry out an advisory campaign to activate forest owners and other relevant operators in the collection of small-diameter wood at young stands management sites.	2022	Additional resources needed for item 30.40.46 (government aid to the Finnish Forest Centre); EUR 350,000 will be reserved in the 2022 supplementary budget. Decided in the Ministerial Working Group on Preparedness in April 2022.	

In recent years, the typical budget authority level of the energy subsidy item (32.20.41) has been approximately EUR 35-40 million. This budget authority has been particularly used to support small renewable energy and energy efficiency projects by companies and municipalities. In addition, there have been separate fixed-term aid schemes or additional budget authorities for different large demonstration projects. These have included the Government's key projects related to energy (in total EUR 100 million 2016–2018), energy projects replacing coal (total EUR 90 million 2020–2021) and current RRF energy projects (around EUR 500 million 2022–2023) and large demonstration projects. Initially, a total of EUR 200 million was earmarked for large demonstration projects in the period 2019–2022. The Ministerial Working Group on Preparedness decided to increase the budget authority for the energy aid item for 2022–2023 by a total of EUR 150 million. At the same time, an additional budget authority was decided for hydrogen projects (EUR 150 million) and battery ecosystem projects (EUR 50 million). The development is partly based on the policies of the previous climate and energy strategy on shifting the focus of renewable energy subsidies from production subsidy type aid schemes to supporting new technologies. In addition, the number of projects has increased significantly and national targets have become stricter.

Sections 3.2.1 to 3.2.7 cover different financial instruments and sector-specific impacts on central government finances compared to the WEM scenario.

3.2.1 Funding of the Sustainable Growth Programme for Finland

The funding of the Sustainable Growth Programme comes from the European Union's Next Generation EU, a one-off economic recovery instrument. EU funding is paid through the budget. The recovery instrument is divided into seven programmes, of which the Recovery and Resilience Facility (RRF) is by far the largest. The Sustainable Growth Programme for Finland is divided into four pillars, the first of which concerns the green transition, which supports structural adjustment of the economy and a carbon-neutral society.

Funding for the green transition would be divided as follows:

- Energy transition in total EUR 318.7 million, of which energy infrastructure would amount to EUR 155 million, investments in new energy technologies EUR 161 million and investments in renewable energy in Aland EUR 2.7 million.
- Industrial reforms and investments supporting the green and digital transition in total EUR 326 million, of which low carbon hydrogen and carbon capture and recovery would amount to EUR 156 million, direct electrification and decarbonisation of industrial processes EUR 60 million, reuse and

recycling of key materials and industrial side streams EUR 110 million, of which EUR 30 million would be allocated to the bioeconomy and EUR 30 million for circular economy solutions in the battery sector.
- Reducing the climate and environmental impacts of the building stock in total EUR 110 million, of which EUR 70 million would be used to support the replacement of heating systems in buildings from fossil oil to low-carbon energy-efficient heating solutions and EUR 40 million for an investment programme for tackling challenges related to climate change in the real estate and construction sector.
- Low-carbon solutions for communities and transport in total EUR 40 million, of which EUR 20 million would go to public transport electricity and gas distribution and refuelling infrastructure and EUR 20 to private recharging infrastructure.
- Environmental sustainability and nature-based solutions totalling EUR 30 million, of which EUR 20 million would go to the gypsum treatment of cultivated fields and nutrient recycling and EUR 10 million to climate-resilient measures in the land use sector.

3.2.2 Funding decisions by the Ministerial Working Group on Preparedness

In April 2022, the Ministerial Working Group on Preparedness agreed on a funding package as part of measures to ensure energy production and availability as well as measures to strengthen self-sufficiency, abandon fossil energy and strengthen investments.

Measures in an acute situation

Related to improving the availability of forest chips

- Improving the incentive of the Kemera financing system for sustainable forestry for the management of young stand and the collection of small-diameter wood by restoring the 2015 funding conditions and support level. The increase is EUR 20/ha to the current aid level (EUR 430/ha). The changes do not require increasing resources.
- EUR 40 million will be allocated in the 2022 supplementary budget to promote the national comprehensive wood terminal network and improve the resilience of energy wood supply chains.
- Security of supply and the availability of domestic wood for the needs of both the forest industry and energy production will be promoted by improving the

condition of roads and bridges. A condition assessment will be performed on private roads and bridges and activation measures aimed at reducing the existing maintenance backlog will be implemented. In the period 2022–2023, additional funding of EUR 2.5 million per year will be allocated to condition assessments and activation measures and EUR 10 million per year for private road repairs.

- The Finnish Forest Centre will launch an advisory campaign to activate forest owners and other relevant operators in the collection of small-diameter wood at young stands management sites. Additional resources are needed for item 30.40.46 (government aid to the Finnish Forest Centre); EUR 350,000 will be reserved in the 2022 supplementary budget.

Longer-term efforts to strengthen self-sufficiency, abandon fossil energy and boost investments

In the period 2022–2023, based on decisions made, a total of EUR 700 million in national additional funding will be allocated to the green transition in an aim to accelerate the transition.

Accelerating energy investments

- The adequacy of energy aid to support small/medium-sized projects will be ensured, e.g. in the electrification of district heating and heat production in small industry, and demonstration aid will be ensured to support large projects to develop and commercialise new technologies to replace fossil energy. A total of EUR 150 million in additional funding will be reserved for the period 2022–2023.
- Funding will be ensured for the investments needed for the transition to the hydrogen economy. While funding for hydrogen solutions included in Finland's Sustainable Growth Programme enables launching significant projects, based on applications, there will be a need for additional public investment in a pure hydrogen economy independent of natural gas and links to Russia in companies' project flows in the next few years. A total of EUR 150 million in additional funding will be reserved for the period 2022–2023.
- Finland's status as a target country for investments in a sustainable and responsible battery value chain will be strengthened. Battery investments ensure the security of supply across the EU as they allow for an accelerated transition from fossil fuels. In 2022–2023, an additional EUR 50 million will be allocated to investments in the battery value chain, pilot and demo facilities and investment projects related to environmental protection.

- Wind power construction will be promoted by allocating additional funding for national surveys on wind power as well as for planning, licensing and related studies guiding wind power construction in municipalities and regional councils. A total of EUR 1.5 million in additional funding will be reserved for 2022.

Phasing out fossil fuels in transport

- In 2022–2023, a total of EUR 13 million in additional funding will be allocated to support buying fully electric cars and a total of EUR 30 million for electric-vehicle charging infrastructure aid for housing companies.
- EUR 20 million will be allocated to support low-emission equipment purchases and the distribution infrastructure of logistics companies in the period 2022–2023.
- To accelerate biogas investments
- A total of EUR 20 million is allocated to energy investments by rural enterprises between 2022–2023.

Heating solutions for single-family houses and public properties

- The grant appropriation for discontinuing the use of oil heating in residential buildings will be increased and the scope extended. The item is changed to apply to both phasing out fossil oil and gas heating. A total of EUR 72 million in additional appropriations will be allocated in the period 2022–2023. To speed up the processing of applications, EUR 5.3 million will be added to the operating resources of the ELY Centres for 2022 and 2023.
- A total of EUR 100 million will be allocated to an energy grant for residential buildings from the Housing Fund of Finland in the period 2022–2023.
- The grant appropriations for eliminating oil or gas heating in the properties of municipalities, parishes and associations will be increased by EUR 10 million in 2022. The increase aims to respond to the increase in demand following a change in the subsidy intensity.

3.2.3 Investment aid for renewable energy and energy efficiency

Sufficient funding will be reserved for smaller-scale projects related to renewable energy, energy saving and energy efficiency, amounting to EUR 40 million per year. Additionally, EUR 150 million will be annually allocated to demonstration projects concerning new technology.

3.2.4 Energy advisory services for consumers

EUR 1.92 million has been proposed for the general government fiscal planning period 2023–2026, for example for energy advisory services at the regional level and energy advisory services in Motiva's energy work programme. The funding allocated to regional energy advisory services is distributed by the Energy Authority through the item Promotion of energy efficiency and use of renewable energy. The purpose of the additional appropriations is to continue to ensure the systematic implementation of regional energy advisory services, whose launch has been successful and which have been expanded to cover the entire country. The aim is to also promote the achievement of targets binding on Finland by ensuring the sufficient performance of the annual work programme for the promotion of energy efficiency and renewable energy.

3.2.5 Electrification subsidy for industry

The costs of the electrification subsidy for industry for central government finances consist of the subsidy paid to operators and the state aid authority's needs for resources. With a subsidy intensity of 25 per cent, the amount of the subsidy would be EUR 87 million per year in 2022 and EUR 150 million per year in the period 2023–2026. The total cost of official tasks related to the electrification subsidy is estimated to be EUR 1.75 million by 2029. Based on a preliminary estimate, the total cost of setting up and maintaining the related information system during the subsidy scheme is approximately EUR 0.22 million. Other administrative costs during the scheme amount to approximately EUR 0.1 million.

3.2.6 Cost of effort sharing activities

Transport

In the first phase of the roadmap to fossil-free transport, subsidies and incentives will be utilised to reduce transport emissions. These include various subsidies related to the procurement of electric and gas cars and distribution infrastructure as well as subsidies for walking, cycling and public transport. The costs in the first phase mainly concern the years between 2022 and 2026. The total costs are estimated to amount to around EUR 360 million.

The 2022 budget includes an appropriation of EUR 13.2 million for the development of public charging and refuelling infrastructure and an appropriation of EUR 10 million for the development of a private plug-in infrastructure. The appropriation corresponds to the estimated need for appropriations in the roadmap to fossil-free transport. Finland's recovery and resilience plan allocated EUR 40 million in additional funding for the development of distribution infrastructure for alternative fuels in the period 2021–2023.

The 2022 budget also includes an appropriation of EUR 6 million to support the purchase of fully electric cars, gas and electric vans and lorries. This appropriation may also be used to support the conversion of passenger cars into gas or ethanol vehicles. In addition, a total of EUR 5 million has been allocated to the development of an electronic heavy-duty transport ecosystem, of which EUR 1.5 million is for 2022.

In the 2022 budget, EUR 113 million has been reserved for promoting public transport, walking and cycling.

The roadmap for fossil-free transport estimated that EUR 17.5 million per year should be reserved for procurement subsidies between 2022 and 2025. In addition, the transformation of new motive forces in transport should be accelerated through research. The roadmap proposes an appropriation of EUR 2 million for this purpose. The roadmap to fossil-free transport estimates that an additional appropriation of EUR 53.28 million should be allocated to support walking, cycling and public transport in the period 2022–2024. After 2024, subsidies for walking, cycling and public transport should also be continued at the same funding level, which has been included in the National Transport System Plan (Transport 12).

Building-specific heating

One of the key objectives of the effort sharing sector is to replace oil heating with low-emission heating solutions by 2030. To achieve the target set for housing and the service and public sector properties, an action plan to abandon fossil oil heating has been prepared.

Phasing out oil in residential dwellings will be promoted through introduced grants. The 2022 budget proposal includes a grant appropriation for households amounting to EUR 28.9 million. Finland's recovery and resilience plan has reserved an additional EUR 70 million in funding for phasing out oil heating.

Energy grants for projects to improve energy efficiency will also be used to reduce emissions from residential buildings. A preliminary amount of EUR 100 million has been reserved for grants for the period 2020–2022. While some of the emission reduction impacts concern the emissions trading sector, there will probably still be a need for the aid in order to achieve the targets set for building-specific heating.

Phasing out oil heating in buildings owned by municipalities and transitioning to other forms of heating have been accelerated with grants since October 2020. An appropriation of approximately EUR 15 million has been allocated to the grants. In addition, the 2022 budget reserves a total of EUR 4.9 million for this purpose for municipalities, parishes and

associations. During its budget session in September 2021, the Government decided to increase the subsidy intensity for phasing out of oil heating in municipalities to 30 per cent of approved and actual costs for a fixed period in 2022–2024.

Agriculture

In the policy scenario of the HIISI report, the costs of policy steering related to agriculture by the public authorities are estimated to amount to EUR 1,870 million for the entire 2023–2040 period. According to the calculation, the average annual emission reduction measures would cost approximately EUR 105 million per year in public funds.

The total cost of agricultural emission reduction measures in the policy scenario is estimated at around EUR 58 million in 2023, EUR 115 million in 2030 and around EUR 137 million in 2040. The reason for the rising costs is that the total number of wet peatlands and afforestation areas and annual management fees is increasing.[15]

3.2.7 Impacts of tax changes on central government finances

This section presents the short-term impacts of tax changes included in the climate and energy strategy on general government finances based on the impact assessments of government proposals on tax changes. In the longer term, tax-related climate and environmental regulation as well as other forms of steering and technological development will change the behaviour and energy use of households and companies, which will affect tax revenue.

Changes in energy taxes (HE 144/2020 vp, HE 167/2020 vp, HE 144/2021 vp, HE 212/2021 vp)

The phasing out of the tax subsidy for paraffinic diesel in the period 2021–2023 will increase central government tax revenue by approximately EUR 115 million on an annual basis after the subsidy has been completely eliminated.

In total, an increase in the tax on heating and machinery fuels, including a reduction in the tax subsidy for combined production, a reduction in category II electricity tax and the abolition of the tax refund for energy-intensive companies would increase the government's net energy tax revenue by approximately EUR 73 million by 2025 at the

15 Carbon neutral Finland 2035 scenarios for LULUCF and agriculture sectors. http://urn.fi/URN:ISBN:978-952-383-263-3

2025 level based on a static estimate. As the changes increase incentives to replace the use of taxable heating fuels by other means, the impact of the changes on the medium-term tax revenue from fuels may be significantly lower than this static estimate.

The net annual impact of tax increases on heating and machinery fuels, including the reduction of tax subsidies for combined production, on central government finances will be approximately EUR 105 million (2021 level) before taking into account the reduction in category II electricity tax rate and the gradual reduction in tax refunds for energy-intensive companies. The gross tax revenue from heating and machinery fuels will increase by approximately 135 million per year at the 2021 level. The tax increase on heating fuels will increase the tax subsidy granted through the tax refund for energy-intensive companies by approximately EUR 23 million per year and the tax subsidy granted through the energy tax refund for agriculture by approximately EUR 7 million.

Cutting the tax rate for electricity tax category II to the minimum tax rate allowed by the EU will reduce gross tax revenue by approximately EUR 241 million at the 2021 level. As a result of lowering the electricity tax category II, tax refunds for energy-intensive companies will decrease by approximately EUR 167 million, and energy tax refunds in agriculture will increase by about EUR 6 million.

Once the electricity tax will no longer be subject to tax refunds, the phasing out of the tax refund for fossil fuels for energy-intensive companies during the transition period will reduce central government expenditure by an estimated EUR 77 million by 2025, if the consumption of industrial heating fuels remained at the 2018 level. As a result of a 2021 reduction in tax refunds, the paid tax refunds will be reduced by around EUR 19 million.

Raising the limit for tax-free use of peat to 10,000 MWh and extending it to all power plants and heat stations that burn peat for energy would reduce the government's gross energy tax revenue by approximately EUR 7 million per year. The change would reduce the tax subsidy granted to energy-intensive companies through tax refunds by approximately EUR 1 million per year. The net annual impact on central government finances would therefore be approximately EUR 6 million.

Tax changes concerning heat pumps and electric boilers as well as circulating pumps, data centres and the manufacturing and processing of industrial recycled materials in geothermal heating plants will reduce central government tax revenue by approximately EUR 23 million per year. Of this, the tax change concerning data centres accounts for about EUR 7 million and the production and processing of recycled materials for about EUR 2 million. There is some uncertainty related to this estimate, as there is currently no detailed data available on all equipment transferred to the lower electricity tax category.

Changes in biogas taxation will increase tax revenue by an estimated EUR 3 million at the 2022 level. Including aquaculture in the scope of the energy tax refund for agriculture will increase the energy tax refund for agriculture by approximately EUR 0.5 million a year, of which electricity accounts for EUR 0.4 million and fuel oils for EUR 0.1 million.

Changes in car and vehicle taxation (HE 176/2021 vp)

A reduction in car tax on zero-emission cars would reduce car tax revenue by approximately EUR 17 million at the 2022 level. The loss of tax revenue would increase annually as the sales of electric cars grow; at the 2023 level, the tax revenue loss would be about EUR 21 million. An increase in the basic tax of the vehicle tax would increase central government tax revenue by approximately EUR 2 million at the 2023 level, after which the tax revenue increase would continue to increase annually. The aim is to ensure that the combined effect of the tax change will be neutral for central government finances in the long term, but the change would postpone the accumulation of tax revenue compared to the current situation. Car tax revenue from electric cars would decrease immediately, but it would be compensated for by an increase in the basic tax revenue from vehicle tax over the years.

Changes in income taxes concerning employee benefits and the domestic help credit (HE 142/2020 vp and HE 142/2021 vp)

Temporarily reducing the taxable value of fully electric cars by EUR 170 per month in the period 2021–2025 is estimated to reduce tax revenue by a total of approximately EUR 16 million during the period, of which the state's share would be EUR 8.5 million and municipalities' share EUR 7.5 million. The impact assessments contain major uncertainty, as the development of the number and price of electric cars in the next few years is very uncertain. Temporarily reducing the taxable value of low-emission company cars by EUR 85 per month in the period 2022–2025 is estimated to reduce tax revenue by a total of approximately EUR 43 million during the period, of which the state's share would be EUR 34 million and municipalities' share EUR 9 million.

It is estimated that increasing the maximum value of an employer-subsidised commuter ticket to EUR 3,400 will reduce tax revenue by approximately EUR 5.5 million, of which the state's share would be EUR 2.5 million and the municipalities' share EUR 3 million. There is considerable uncertainty in a cost estimate of a tax subsidy for company bicycles, as there is no information available on the numbers of company bicycles. However, based on estimates, the tax subsidy will be largely targeted at those population groups that are currently covered by the employer-subsidised commuter ticket benefit. As a result, the change will at least partly reduce the use of employer-subsidised commuter tickets. This would mean that if, for example 10,000 people would benefit from a company bicycle

benefit amounting to EUR 1,200 in the longer term, the proposed change is expected to reduce tax revenue by EUR 4 million, of which the state's share is EUR 1 million, and municipalities' share is EUR 3 million.

Temporarily reducing the taxable value of the charging benefit for electric vehicles in the period 2021–2025 is estimated to reduce tax revenue by a total of approximately EUR 37 million during the period, of which the state's share would be EUR 20 million and municipalities' share EUR 17 million.

It is estimated that the maximum amount of the domestic help credit and an increase in the proportion that entitles people to the credit when abandoning oil heating will reduce tax revenue by about EUR 8 million per year. Of this, EUR 1 million would concern tax revenue from capital income, EUR 4 million central government progressive income tax and EUR 3 million local income tax. The estimate is based on an assumption that approximately 7,000 alterations would fall within the scope of the increased domestic help credit.

According to the government programme, changes in local government tax revenue will be compensated in net terms.

Development of tax revenue from transport

The final report of the working group on the reform of transport taxation in spring 2021 estimates the development of transport tax revenue based on the sensitivity calculation published by VTT in spring 2020. Based on the calculation, by 2030, there will be 600,000 electric cars in the passenger car stock. However, unlike in the calculation, it is assumed that transport performance will remain at the 2019 level from 2022 onwards, based on the actual development of transport performances. The projected number of electric cars in 2030 is the same as in the baseline scenario of the Medium-term Climate Change Policy Plan and the climate and energy strategy and includes 150,000 cars less than in the policy scenario. The development of transport performance assumed in the working group's final report is close to the performance in the policy scenario, although the performance of vans, lorries and buses is projected to increase by 4–5 per cent in the policy scenario by 2030. In addition, the improvement of fuel efficiency in the passenger vehicle and van stock is slower in the strategy and plan scenarios, as the projected fuel efficiency in new cars with an internal combustion engine was corrected in autumn 2021.[16]

16 The revised assumed development of energy efficiency was no longer taken into account in the transport performance projection underlying the base projection.

In real terms, tax revenue from transport was projected to decrease by about EUR 0.8 billion from 2019 to 2025. The tax-to-GDP ratio will decrease by an estimated 0.4 percentage points, which corresponds to approximately EUR 1.2 billion at the 2025 level. Thus, the fiscal weight of transport tax revenue will be significantly reduced by 2025.

In a projection extending to 2030, the tax revenue accruing from transport would be approximately EUR 1.1 billion lower in 2030 than in 2019 in nominal terms. If consumer price inflation was two per cent per year from 2026 on, tax revenue from transport would decrease in real terms by around EUR 1.7 billion from 2019 to 2030. If, on average, the gross domestic product at current market prices increased by about 3.3% per year between 2026 and 2030, the tax-to-GDP ratio would decrease by approximately 0.9 percentage points, which at 2030 level would mean approximately EUR 2.8 billion in nominal terms.

3.3 Impacts on the national economy

The Carbon-neutral Finland 2035 – climate and energy policy measures and impacts (HIISI) project and its follow-up project included modelling scenarios concerning the national economy. The modelling was also used to assess the impacts of climate and energy policy measures on the national economy. The modelling has been carried out using a computational general equilibrium model describing the national economy. This section presents a summary of the starting points and results of the national economy assessment carried out by the HIISI follow-up project.

The national economy modelling included examining the impacts of a current policy measures scenario, i.e. the base scenario (WEM) and an additional measures scenario, i.e. the policy scenario (WAM-H) by comparing the impacts of the policy scenario with the base scenario.

Base scenario

The premises for the base scenario for the national economy are in line with the baseline scenario by the long-term labour and training needs anticipation consortium (ENKO)[17], which assessed the development of the industry over a long period. The scenario is based on industry-specific productivity trends, global market growth trends and population projections. The impact of coronavirus has been taken into account so that it will have an

17 https://www.ptt.fi/julkaisut-ja-hankkeet/kaikki-julkaisut/millaista-osaamista-suomi-tarvitsee-vuonna-2040.html

impact on growth in the next few years, but the assumption is that Finland has recovered from the effects of the pandemic in the longer term. It is assumed that the economy would gradually return to the balanced growth path projected by the Ministry of Finance in spring 2020.

In the base scenario, the average growth rate for the national product in the period 2020–2050 will be about 1.5%, but the per capita growth will remain at 1.2 per cent in the period 2020–2050. Private consumption and exports account for most of the national product growth. Private services account for the biggest growth impacts caused by consumption, while other industries (vehicles, engineering products) are the largest through exports. The HIISI project's report on the scenarios concerning the national economy, national product growth has also been examined through added value in specific sectors.

Policy scenario

Compared to the base scenario, the policy scenario consists of new measures in energy production and industry as well as in transport and the heating of buildings. Key basic assumptions are estimates of renewable energy production (fuel consumption, investments in renewable energy and nuclear power) and estimates of adopting new forms of energy use in the construction sector and key industrial sectors (fuels, investments).

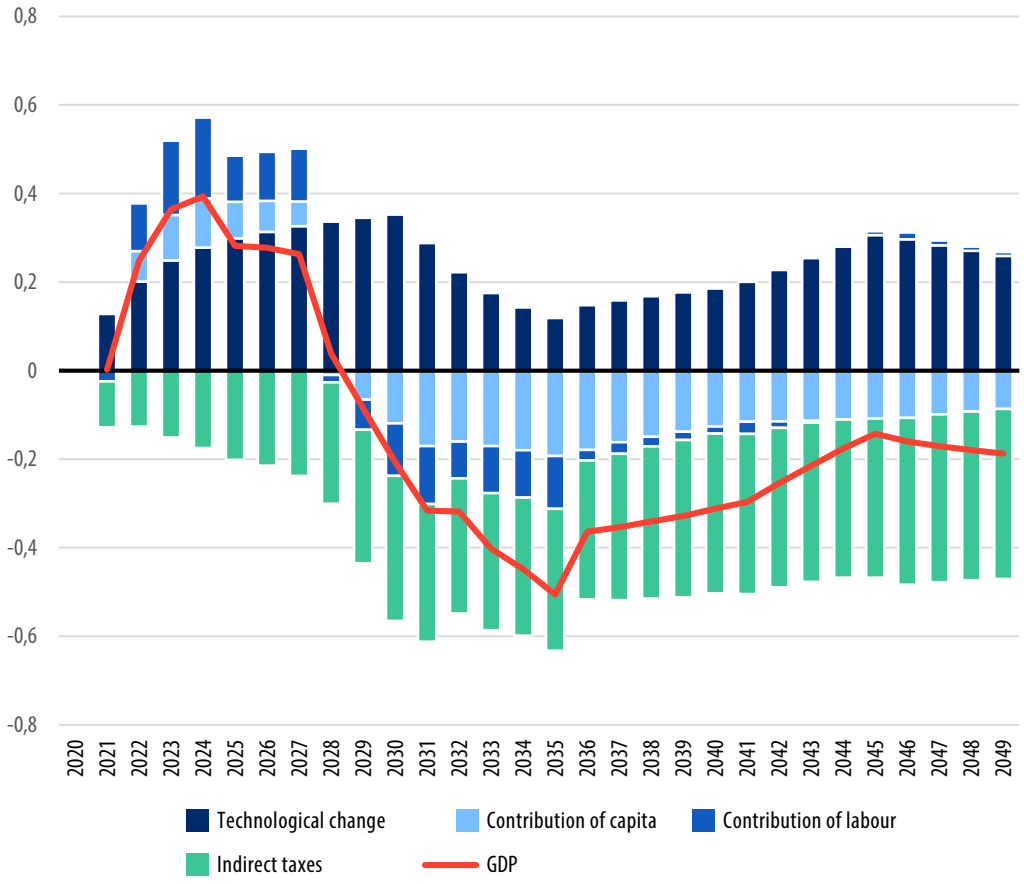
In the policy scenario, the impacts on the national economy are a result of additional costs arising from the measures needed to reduce emissions, which will increase as a result of the emission reduction target. Above all, the impacts arise from additional investments in energy technology, but also from additional investments in increasing energy efficiency and production processes and the electrification of transport. Investments will renew the production structure of the economy, which will create significant efficiency gains and new opportunities as the economy becomes more electrified, and electricity production will become emission-free. New technologies will also replace fossil fuels in production, which will increase the energy and material efficiency of production. This structural change is reflected in the development of the national economy when comparing the policy scenario with the base scenario.

The policy scenario assumes that the national economy will finance investments through both domestic savings and also through indebtedness, which increases the current account deficit. The policy scenario assumes that the additional investments will mainly be carried out on market terms unless funding from the state budget has been allocated as a policy measure supporting the investments. In this case, the investments may not be fully realised, but only within the framework of profitability.

In the HIISI follow-up project, the impacts on the national economy have been described with the help of GDP decompositions. In the 2020s, growth primarily results from growth in total productivity enabled by investments. Overall productivity will also remain positive throughout the period under review, until the end of 2050. Industrial growth is mainly realised through exports. Additional investments will increase GDP, especially as industrial exports grow. Large investments concern heavy industry, transport and the energy sector and allow these sectors to grow compared to the base scenario. If the hydrogen reduction and biorefinery investments in steel production are not realised on the scale assumed in the calculations, the investments and the exports of these sectors will have a smaller growth impact. In this case, cutting emissions will result in a greater GDP reduction. In household consumption, the greatest change is caused by the decline in oil product consumption. However, the additional price of emission reductions will cut the purchasing power of households over time, resulting in lower consumer demand. The decline in the purchasing power of households is also reflected in a decline in demand for other consumer goods. The demand for many services is also smaller in the policy scenario compared to the base scenario.

Investments and growth in net exports will increase the national product in the 2020s and 2040s, but the national product will decrease by about 0.2 per cent compared to the base scenario due to the decline in consumer demand. As a whole, in the policy scenario, the change in the national product is estimated to remain positive until 2028 and then take a negative turn until 2050 (see Figure 3). In the policy scenario, the change in the national product compared to the base scenario will be -0.2 per cent in 2030, -0.3 per cent in 2040 and -0.2 per cent in 2050.

Figure 3. The decomposition of the policy scenario supply items, percentages compared to the base scenario. Source: HIISI follow-up project.



Impacts on employment

The structural change in the economy triggered by climate policy and carbon neutrality measures is also reflected in employment. Overall employment will decrease, but construction investments and employment will increase throughout the period considered. In the 2020s, service exports will grow slightly more in the base scenario in the policy scenario, which will increase employment in private services. In the 2030s and 2040s, the growth in industrial exports will direct labour from services to industry, which means that the number of people employed in services will begin to decline.

The structural change in the economy is also reflected in the emergence of labour demand in different professions. While primary production sectors will see the biggest decline in jobs, this trend will stop in the 2030s and 2040s, as industrial growth will also be reflected in the primary production sectors. In the 2020s, private services will support employment, and the decline in primary production will have the greatest negative impact on

employment. In the 2030s and 2040s, construction will have the greatest positive impact on employment, while primary production will have the greatest negative impact.

Regional impacts

The structural change in the economy resulting from climate policy will cause regional differences, as measures taken to renew technology and maintain growth are most clearly targeted at the processing and primary production sectors. Once the focus of the economy shifts towards the processing and primary production sectors, those counties where these sectors account for a large share of the regional economy will reap benefits. Comparing the policy scenario with the base scenario, the difference in service exports is the highest in 2030, which is visible in growth centres such as Uusimaa, Southwest Finland, Pirkanmaa and Northern Ostrobothnia. After this, more growth will occur in the counties, whose growth will be boosted by investments. By 2050, the structural overhaul of industry and energy supply will largely have been accomplished. With a few exceptions, the change in total regional production is negative for the entire period under review until 2050 in the policy scenario compared to the base scenario. The impacts are clearly higher in relative terms compared to the national level in those counties where there is no industry with growth potential and where the share of primary production sectors (agriculture) is higher than average. In these counties, the total regional value added will be around two per cent lower than in the base scenario by 2050. However, it should be noted that in the base scenario, the regional economy will grow by at least one quarter in all counties and by about one third in most of them from 2021. In other words, this outcome does not mean that growth will be halted in any county.

Impact on households

In households, the impacts of policy scenario measures increasing prices are visible mainly in the consumption of housing and transport services. However, indirect impacts also reflect on the prices of other products and services depending on how energy-intensive and emission-intensive their production is. The impacts are relatively higher for those with average and high incomes. This is because energy consumption and the use of in particular energy-intensive services in particular is higher in high-income households compared to lower-income households, both in absolute and relative terms.

3.4 Environmental impact assessment procedure (SEA)

3.4.1 Requirements under the Act on the Assessment of the Effects of Certain Plans and Programmes on the Environment (SEA)

Under the Act on the Assessment of the Effects of Certain Plans and Programmes on the Environment (SEA Act, 200/2005), an authority must investigate and assess the environmental impacts of the plans and programmes it has prepared to a sufficient extent during the preparation process (section 3), if their implementation may result in significant impacts on human beings, nature and its diversity, the built environment, landscape or natural resources in Finland or outside its region (section 2).

In accordance with the SEA act, these environmental impacts include impacts affecting: the population and human health, living conditions and comfort; soil, waters, air, climate, vegetation, organisms and biodiversity; urban structure, the built environment, landscape, townscape and cultural heritage; natural resources use; and any interactions between the factors listed above.

These impacts may occur in Finland and also outside Finland's geographical borders. In the area of greenhouse gas emissions, the impacts are divided into the emissions trading sector, the effort sharing sector, the land use sector (LULUCF) and outside Finland's borders. Due to the extensive interpretation of the SEA Act, it is often not possible to identify all environmental impacts. Instead, the aim of environmental impact assessment is to identify the key impacts and impact chains of measures.

The Climate and Energy Strategy and the Medium-term Climate Change Policy Plan were assessed in accordance with the SEA Act as part of "Carbon neutral Finland 2035 – Environmental impact assessment of energy and climate policy actions" carried out by the HIISI project. This environmental impact assessment mainly involved assessing the environmental impacts related to the achievement of Finland's carbon neutrality target and subsequent climate targets. The assessment has been carried out by evaluating the policy scenario that meets the target compared to the base scenario, which would continue existing policy measures. Both scenarios were modelled in the HIISI project. The assessment also included examining various uncertainty factors and risks to the realisation of the scenarios and considering ways to reduce the uncertainties and risks.

3.4.2 Results of the SEA assessment

If the climate targets are accomplished, they will have both positive and negative impacts on the environment and society referred to in the Act on the Assessment of the Effects of Certain Plans and Programmes on the Environment. Positive impacts mean consequences

that promote the achievement of the set societal objectives, whereas negative impacts mean consequences that hamper the achievement of objectives other than the climate targets. In addition to the climate, the impacts will affect such areas as air pollution, human health, natural resources use, biodiversity, soil and water systems and human living conditions.

The most significant environmental impacts concern greenhouse gas emissions, climate change, air pollution, biodiversity, forest carbon sinks and water bodies. These environmental impacts are linked to people's health, comfort and wellbeing, and they can also be influenced by the climate and energy strategy's policies or the economic instruments used to implement these, such as taxes and charges. These impacts are also closely linked to the overall acceptability of measures, perceived social fairness and overall sustainability as part of the transition towards a carbon-neutral society. Some of these impacts will be felt outside the Finnish borders.

As a rule, the achievement of climate targets is expected to have positive environmental impacts when climate change mitigation is successful in preventing the extensive, partly irreversible and unpredictable impacts of climate change on the environment and society. The reduction of greenhouse gas emissions will be achieved in the policy scenario, especially through widespread electrification of transport and industry and by replacing the use of fossil fuels with renewable energy and electricity in different sectors. However, any construction of infrastructure and power generation and transmission, and the production and use of electric cars, wind power and biofuels involves consuming natural resources, which contributes to reducing the achieved environmental benefits. The electrification of Finland's car stock will increase greenhouse gas emissions abroad, as components such as electric car batteries cause greenhouse gas emissions that currently exceed those caused by the production of similar petrol cars by 40 to 80 per cent. However, on average, it takes less than five years to compensate for the emissions from manufacturing as a result of reduced in-use emissions.

Air pollutants will decline, although the health risks posed by both domestic sources and long-distance transport of air pollutants remain significant. The largest domestic emission sources are small-scale burning of firewood and street dust, to which current climate measures are not significantly connected. Exhaust emissions from transport have already clearly decreased and will continue to decrease as engine technology develops. Therefore, future changes in the driving power of vehicles will not have a significant impact on particulate matter emissions from exhaust gases. However, nitrogen oxide emissions will decrease as the use of electric cars replaces petrol and diesel cars, especially in passenger car transport. The impact of transport-related air pollution on the air quality of cities and the exposure of humans to air pollution will ultimately depend on the development of vehicle performances, their regional distribution and community structure. Small-scale

burning is a source of small particles that cause negative health impacts, as well as climate-warming black coal and, in a smaller extent, methane. Emissions from small-scale burning of wood can be influenced by technical standards, innovations, education and instructions issued by municipalities. Small-scale burning is expected to decline from 2020 levels in both the base (about 5 per cent) and policy scenario (about 20 per cent by 2040). If achieved, this would reduce emissions from small-scale burning and the related harmful environmental and health impacts. Emissions from the high stacks of power plants particularly affect the generation of secondary particles in the atmosphere. While the role of combustion plants to fine particulate concentrations in the air we breathe has not been comprehensively modelled in Finland, a transition from combustion processes in energy production would presumably have a favourable effect on air quality and related health impacts.

The use of renewable energy will increase significantly in both the base and policy scenarios, by about 50 per cent of the 2020 level by 2050. There is particularly an increase in wind and solar energy, which also explains the higher renewable energy use in the policy scenario compared to the base scenario. In both scenarios, the use of wood fuels will increase by just under 20 per cent by 2050, and only slightly exceeds the base scenario in the policy scenario. In both the base and policy scenario, it is estimated that roundwood removal will increase from approximately 70 Mm^3 in the period 2016–2025 to slightly over 80 Mm^3 in the period 2036–2045. An increase in felling together with an increase in collecting logging residues reduces the carbon sink of forests and increases the risk of biodiversity loss and harmful impacts on water bodies. These impacts will strongly depend on the extent to which the fellings and the harvesting of stumps and felling residues will increase as a result of increased wood use. Stress on water systems is mainly caused by fellings, fertilisation and ditch reconditioning. Key measures for preventing biodiversity loss include saving more dead trees in fellings, promoting the conservation of old-growth forests and sites of high natural value, avoiding harvesting on valuable natural sites, leaving more large live trees standing in regeneration fellings and burning for environmental management purposes. It is challenging to accomplish significant increases in forest conservation areas and nature management areas to combat biodiversity loss while increasing felling and growing carbon sinks at the same time.

In farming, increasing grass cover on organic soils and the agricultural use of wetlands will reduce CO_2 and N_2O emissions from the degradation of peat and also the leaching of nitrogen into water systems. Precision cultivation and the use of catch crops will reduce the need for nitrogenous fertilisers and therefore cut the associated emissions to air and water systems. Methane emissions from dairy cows are reduced through the utilisation of feed additives. Limiting the clearing of fields can reduce deforestation and peatland peat degradation in peatlands and the resulting emissions. While the carbon sink can be somewhat increased by reforestation of abandoned or poor-quality fields, reforestation

also reduces habitat for open area species and changes the landscape. Increasing biogas production from biowaste will enable the avoidance of methane emissions from degradation and nutrient recycling, which reduces emissions by restricting the need to manufacture new fertilisers. In farming, biogas production may indirectly reduce land clearing and the consequent emissions into air and water bodies. The replacement of natural gas and other fossil fuels with biogas will produce emission reductions in transport, energy production and the process industry.

The increased use of renewable energy sources, especially with the help of wind power stations and solar panels, will reduce air pollution but increase the use of rare or critical materials and create pressure to open mines in which these materials may be obtained. However, solar panels are evolving rapidly, and in the future, more common raw materials may be used for manufacturing them. The increase in renewable energy will be likely to improve employment and thus human well-being in areas targeted by investments, construction and raw material acquisition. However, the impacts on the national economy depend, among other things, on how the steering instruments and regulation required to achieve the climate targets are implemented and how the implementation affects other domestic investments, regional employment, exports and the purchasing power of households.

Regulation of construction and land use will have a direct impact on living conditions. There is a great need for renovations that improve energy efficiency, especially in older building stock. While some of the current indoor air problems may be solved as these renovations are implemented, it is necessary to ensure the repairs do not create new indoor air quality risks.

Positive impacts on health and comfort will be achieved through the increase in public transport and pedestrian and bicycle traffic and the resulting reduction in transport performance, as well as the reduction in particulate matter emissions and noise resulting from the growth of the electric car stock. Reduced transport performances, on the other hand, will reduce street dust emissions, and journeys taken by cycling and walking will increase the population's physical activity, bringing diverse health benefits. At the same time, attention should be paid to the fact that the implementation of the necessary steering instruments and regulation may locally increase pressures on green spaces or exposure to noise and air pollution in areas with a highly compact urban structure. The significance of the impacts will to a great extent be determined by the planning and practical implementation of the measures and general technical development.

Increasing the production of electric cars and renewable energy will increase the use of rare or critical materials, causing more pressure to start new mining activities. Mines may have a major impact on the environment and employees' working conditions, especially

in developing countries. However, new innovations may emerge in battery technology related to the use of materials. Significant improvements are also expected to emerge in the coming years in the recycling of battery minerals and the energy storage capacity of batteries. Batteries are associated with many kinds of development, which will also open up new opportunities for Finnish expertise and mining activities, boosting employment.

The gas emission reduction targets set for 2030 and after are relatively demanding compared to previous emission reduction requirements, and the measures needed to achieve these targets therefore have more significant impacts on people's overall living conditions. Some of the measures will encourage innovations, which may offer new business opportunities and jobs. The consumer's position may also change. While technological progress may enable energy savings without the consumers taking on an active role, many of the policies require a new type of agency of the citizens in changing living conditions. The implementation of the necessary measures may increase the significance of income gaps and regional inequalities, for example due to rising energy prices, unless a fair transition can be adequately ensured in the implementation of the measures.

Various measures are required to achieve the climate targets, and these also affect one another. In addition, the implementation of the climate and energy strategy will have dynamic impacts, resulting in the emergence of both new solutions and obstacles to achieving the climate targets. These will have further environmental impacts, both positive and negative ones. Table 2 identifies the strengths, opportunities, weaknesses and threats concerning the environmental impacts of achieving the climate targets.

Table 2. The strengths, opportunities, weaknesses and threats concerning the environmental impacts of achieving the climate targets.

Strengths
The achievement of climate targets has primarily positive impacts on the environment and health, as the harmful effects of climate change on the environment can be curbed at the same time.
Increasingly transitioning to non-combustion energy production will reduce air pollution and the related negative impacts on the environment and health.
Cutting emissions by directing consumption to climate-resilient alternatives and more reasonable consumption and improving energy and material use efficiency will also directly reduce other environmental impacts linked to production.
Opportunities
Stricter climate targets may accelerate the development and commercial application of technologies to reduce emissions faster than expected, which will create new competence and financial opportunities.
The synergy benefits of the reduction of climate and other impacts may promote the implementation of steering mechanisms and legislation required in accomplishing the climate targets.
Weaknesses
Achieving the climate targets requires significant changes in the ways we produce and consume energy and materials, which involves a considerable amount of construction and use of natural resources. The means to reduce greenhouse gas emissions require investments that include new natural resource inputs. These also contribute to increasing harmful impacts on the environment, such as those related to biodiversity, water bodies, the air and the soil, and people's living conditions and comfort.
The currently used assessment methods and approaches are not entirely capable of exploring the questions of consistency between the policy areas from a sustainable development perspective. Interaction between various stakeholders is also relatively limited.
Threats
It may not be possible to achieve the climate targets if the currently developed emission reduction technologies are translated into commercial applications more slowly than estimated, the harmful environmental impacts related to the technologies limit their introduction more than expected, or if the steering methods and regulation required by their introduction cannot be implemented.
Achieving the required emission reductions on a tight schedule may cause path dependence and the underestimation of other environmental impacts, which may hinder the opportunities for implementing future emission reduction measures.
The implementation of climate actions may cause regional inequality due to the different resources and economic structures of the regions.
Unless sufficient support measures are introduced, tax reforms, bans and limitations may raise concerns related to the just allocation and acceptability of the measures. This may lead to more political polarisation and opposition to climate actions.
The actual emission reductions may end up smaller than expected if people find the measures that these require unfair and will, as a result, fail to implement them to the extent desired.

By recognising and accounting for the links between various environmental impacts, synergy benefits may be achieved in reducing harmful impacts. The overall (global) economic development and, among other things, aid policies concerning various forms of energy production are constantly changing. Economic and technological developments may change rapidly, which increases the uncertainty of impact assessments. The intensification of the impacts of climate change may also hamper the implementation of mitigation measures, for example through degradation of ecosystems and disruptions to various energy or raw material supply chains, which may increase costs and instability in the operating environment.

Each individual assumption made in the preparation of the base and policy scenarios may turn out differently in practice. The most significant risks identified for climate target achievement include the assumptions related to carbon sinks, nuclear power, increasing the use of renewable energy, carbon capture and storage, efficiency and reduction of energy use, human behaviour and consumption, and the implementation of the necessary steering instruments and regulations. It is essential to monitor the development of the anticipated (and as yet unanticipated) impacts to gain a better understanding of the observed development and identify areas in which amending or specifying the policies is justified. A precondition for this will be systematic data collection on policy implementation and regular evaluation of the consequences.

3.5 Impacts on fundamental and human rights

3.5.1 Fundamental rights with key relevance to the climate and energy strategy

Fundamental rights refer to the rights of the individual laid down in the Constitution. Human rights mean the basic rights of the individual guaranteed in international human rights documents in general. The contents of the national system of fundamental rights in Finland are closely linked to the human rights protected by the international conventions (including the European Convention on Human Rights, International Covenant on Economic, Social and Cultural Rights (ICESCR), the International Covenant on Civil and Political Rights (ICCPR). The interpretation of fundamental and human rights must pay attention to, e.g. the interpretation practice of the European Court of Human Rights and human rights treaty bodies.

Various UN actors have consistently recognised that climate change poses fundamental risks to the realisation of different human rights. The warming of the atmosphere beyond the target set out in the Paris Agreement will lead to an increase in drought, floods, storms and heatwaves and, at northern latitudes, a particular decline in the amount of

snow and ice. This will result in a decline in food security and biodiversity, an increase in uninhabitable areas, illnesses, forced migration and instability in societies. This puts the realisation of human rights at risk and harms people's livelihoods worldwide. While safeguarding fundamental and human rights in the short and long term requires effective climate and energy policy measures, it must be ensured that any restrictions imposed by fundamental and human rights are taken into account in the measures.

The following section provides information about the provisions on fundamental rights in the Constitution of Finland with key relevance to the policies of the national climate and energy strategy.

Equality (section 6)

> According to the general equality clause, everyone is equal before the law. The general equality clause does not impose strict limits for the regulation required by the social development in question, as long as the distinctions can be justified in a manner acceptable to the fundamental rights system and are not arbitrary or unreasonable (e.g. regional experimental legislation has also been adopted).
>
> Non-discrimination provisions supplement the general equality clause. The prohibition of discrimination applies to both indirect and direct discrimination, but allows, for example, affirmative action, as long as this can be justified in a manner acceptable to the fundamental rights system. Children should be allowed to influence matters that concern them in an age-appropriate manner. Promoting gender equality includes promoting equal opportunities for participation and influence in societal decision-making.

Freedom of movement (section 9.1)

> Finnish citizens and foreigners legally resident in Finland have the right to freely move within the country and to choose their place of residence. The right to move freely from one place to another is an important element of the individual's right to self-determination.

The right to privacy (section 10.1)

> Everyone's private life, honour and the sanctity of the home are guaranteed. More detailed provisions on the protection of personal data are laid down by an Act.

Protection of property (section 15)

Under the general clause on the protection of property, the property of everyone is protected. The general clause is mainly used to assess the different limitations to owners' rights of use and ownership, which are subject to the general conditions for restricting fundamental rights. However, regulation of the use of property does not always imply a restriction on the protection of property.

Provisions on the expropriation of property, for public needs and against full compensation, are laid down by an Act. In some situations, the actual effects of far-reaching restrictions on access may also be comparable to expropriation.

The protection of property under the Constitution also safeguards the permanency of contractual relations.

The status of the Sámi as an indigenous people (section 17.3)

The status of the Sámi people as Finland's only indigenous people and the right to practice traditional livelihoods inherent to the Sámi culture will be safeguarded.

The right to work and the freedom to engage in commercial activity (section 18.1)

Everyone is guaranteed the right, "as provided by an Act", to earn his or her livelihood by the employment, occupation or commercial activity of his or her choice. In other words, the right safeguarded by the provision may be restricted under law and any regulation relevant to it must be implemented in law. It is possible to make business activities subject to a permit by an act that must meet the general requirements of a law restricting a fundamental right (for example, provisions on the conditions and permanency of the permit must provide sufficient predictability for official activities).

Promoting the health of the population (section 19.3)

The public authorities shall promote the health of the population as provided by law. This also refers to the development of the conditions in society in different sectors of public administration in a direction that promotes the overall health of the population.

Responsibility for the environment (Section 20)

> Nature and its biodiversity, the environment and the national heritage are the responsibility of everyone, i.e. not only the public authorities but also natural and legal persons. The provision is mainly akin to a declaration and emphasises the need for wide-ranging cooperation between different parties, both in the prevention of environmental destruction and pollution and in taking active measures favourable to nature. Future generations of people can also be considered its subjects. An obligation has also been imposed on the public authorities under which they shall endeavour to guarantee for everyone the right to a healthy environment and for everyone the possibility to influence decisions that concern their own living environment. Sustainable development is one dimension of the fundamental right to environmental protection.

Protection under the law (section 21)

> Everyone has the right to have his or her case dealt with by a legally competent court of law or other authority. The guarantees of a fair trial and good governance shall be laid down by an Act.

Protection of basic rights and liberties (section 22)

> The public authorities have a general obligation to guarantee the observance of basic rights and liberties and human rights. The effective implementation of fundamental rights frequently requires active measures of the Government, for example in order to protect the fundamental rights against violations by any third parties or in order to create factual preconditions for the exercise of fundamental rights. Safeguards also include the introduction of legislation that ensures and specifies the use of fundamental rights.

In addition to the fundamental rights provisions, the Constitution contains several provisions that need to be taken into account when deciding on the implementation of the climate and energy strategy policies:

- the general principles governing the bodies of State administration (mainly the name and mandate of the unit and its primary tasks and powers) shall be laid down by an Act, if their duties involve the exercise of public powers (section 119.2);
- public administrative tasks not involving the significant exercise of public powers may be delegated to others than public authorities (section 124);

- The state tax is governed by an Act, which contains provisions on the grounds for tax liability and the amount of the tax, as well as on the legal remedies available to the persons or entities liable to taxation (section 81.1);
- Matters that under the Constitution fall within the scope of an Act shall be laid down by an Act (see e.g. sections 81.1 and 119.2) when they concern the principles governing the rights and obligations of private individuals and the other matters key to the realisation and exercise of fundamental rights (section 80.1);
- under certain conditions, arrangements concerning property owned by municipalities may be relevant for the self-government of the municipality's residents (section 121.1).

3.5.2 Fundamental and human rights from the perspective of the climate and energy strategy's policies

As a rule, fundamental rights protect every individual in Finland's jurisdiction (including children). Legal persons are indirectly protected by fundamental rights, as interfering with the status of a legal person may entail infringing on the rights of the individual person behind a legal entity. However, as its wording suggests, the equality provision applies only to people, not to legal entities.

The measures proposed in the climate and energy strategy affect both people and legal entities. Measures aimed at people include the guidance by information provided to consumers and energy communities; similarly, measures targeted at residential buildings and, in some parts, transport also directly affect people. The strategy also contains a number of policies aimed at encouraging or obliging self-employed people to take action. In these cases, the restrictions on fundamental rights will not apply in all situations. This particularly applies to situations where a legal person is distant from individuals and the effects of measures on individuals remain minor and indirect. In accordance with established legislative practice, municipalities and bodies governed by public law are excluded from the protection of fundamental rights.

Fundamental rights are primarily binding on public authorities. On one hand, fundamental rights may be a cause of restrictions on legislation and, on the other, obligations to take legislative or other active measures to safeguard fundamental and human rights. In general, fundamental rights affect private relationships through ordinary legislation. As a rule, the climate and energy strategy and the measures it contains are in line with the obligation to perform certain activities imposed on public authorities, especially taking into account the fundamental right to the environment and the obligation to take into account future generations as well as the general obligation of public

authorities to safeguard and promote fundamental and human rights, but also the obligation to promote equality and health and to safeguard the status of the Sámi as an indigenous people.

As a rule, fundamental rights do not give rise to absolute restrictions on legislation; for example, the regulatory reserve included in several fundamental rights provisions leaves room for manoeuvre for the legislator. Even in the absence of such a regulatory reserve, fundamental rights are not generally absolute; instead, the general conditions for restricting fundamental rights are applied, including the requirements on:

- legislation;
- the accuracy and precision of an act;
- the acceptability of the restriction;
- the proportionality of the restriction;
- the integrity of the core area of the fundamental right;
- the adequacy of legal protection arrangements; and
- compliance with human rights obligations.

In many respects, the policies of the climate and energy strategy are concerned with clarifying matters, allocating sufficient resources or trying to influence matters internationally or as part of the EU. In this context, there is also need to pay attention to the relevant fundamental rights aspects, including the promotion of equality. The policies also contain opinions on aid schemes and other means of promotion, but these are not yet specific. Similarly, relevant fundamental rights aspects should be taken into account when preparing aid schemes and other incentives. As an example, Table 3 provides more detailed examples of the fundamental rights aspects of certain policies that should be taken into account in further preparation.

Table 3. Examples of fundamental rights aspects related to the policies and observations on the further preparation of measures.

Examples of measures carried out under the climate and energy strategy	Comments on the further preparation of the measures
Subsidies, incentives and other promotional measures that target people or have an immediate impact on people	
Finland will promote updating vehicle stock to become more energy-efficient. The improvement of the energy efficiency of the entire transport system will be promoted by developing transport services, conditions for walking and cycling as well as the energy efficiency of road transport. Grants are available for the measures that aim to improve the energy efficiency of residential buildings and smart and flexible energy consumption, including the replacement of a district heat exchanger for low-temperature district heating. Digitalisation will be promoted by increasing the flexibility of consumption and production and active participation in the electricity market through smart solutions. The utilisation of demand-side management services will be promoted in heat production. Equality in the energy sector will be promoted in education, career advancement and pay, and the reputation of the energy sector as an equal employer for everyone.	Subsidies, incentives and other promotion measures are in line with the obligation to guarantee the *fundamental right to a healthy environment.* Subsidies, aid and other promotion measures should primarily effectively promote the desired climate and energy policy outcome (e.g. improving the energy efficiency of buildings). In addition, subsidies provided to pursue climate and energy policy targets can also be used to promote other objectives, such as *positive health impacts or gender equality.* The preparation process must pay particular attention to the aspects of *non-discrimination* and *equality*. It is also key to identify how subsidies and aid are allocated to e.g. different income levels or groups of people. The preparation must also examine how different groups of people can benefit from subsidies, incentives and new solutions. Subsidies, incentives and other promotion measures in the transport sector should also be examined from the perspective of *freedom of movement*. In this case, attention should also be paid to the possibility of different groups of people (e.g. children, persons with disabilities) to exercise their freedom of movement. In addition, for example, the policy to *promote equality* in the energy sector is, as such, in line with the fundamental rights system. The measures may involve the collection of personal data, in which case it is necessary to assess the matter from the perspective of *privacy protection*. In the further preparation of the measures, sufficient *participatory rights* must also be secured for different groups of people to enable them to influence the measure. Ensuring participation requires technical accessibility, clear language, different language versions and accessibility of events. Safeguarding the participatory rights of children and persons with disabilities may also require other forms of participation than written ones.

Examples of measures carried out under the climate and energy strategy	Comments on the further preparation of the measures
Subsidies, incentives and other promotional measures primarily targeted at companies	
As renewable energy production technologies become commercialised and their profitability improves, direct subsidies will primarily be directed towards new technologies, and efforts will be made to promote the expansion of various financing solutions, such as commercial instruments minimising risk, as well as new financial instruments. In an aim to promote the commercialisation of new environmentally sustainable raw materials and production technologies, steering instruments and particularly aid schemes will be employed. The emergence of clean hydrogen production capacity will be promoted. New solutions and demonstration projects that promote system integration will be supported. Finland will pilot the use of hydrogen in transport, especially in heavy-duty road and waterborne transport. The development and use of carbon capture and utilization (CCS/CCU) technologies and solutions will be accelerated. Aids will be used to promote the introduction of new energy technology solutions, particularly those based on non-combustion techniques, in district heating systems. Investments will be made in the development of new technologies and the commercialisation of innovations, particularly concerning energy infrastructure, new energy technologies, hydrogen and power-to-X solutions, electrification and the circular economy.	Subsidies, incentives and other promotion measures are in line with the obligation to guarantee the *fundamental right to a healthy environment.* The fundamental rights aspects of subsidies for companies and other promotion measures are not key areas in further preparation. Instead, such subsidies and incentives are subject to significant restrictions and obligations through EU rules on state aid. Subsidies and aid should primarily effectively promote the desired climate and energy policy outcome (e.g. the introduction of new technologies). If the subsidy or incentive targeted at a given company promotes projects in the *Sámi homeland,* the authorities must determine whether the measure requires negotiations with the Sámi Parliament. In the further preparation of the measures, sufficient *participatory rights* must also be secured for different groups of people to enable them to influence the measure.

Examples of measures carried out under the climate and energy strategy	Comments on the further preparation of the measures
Obligations, prohibitions, restrictions, regulations	
The obligation to distribute light fuel oil will be increased to 30% by 2030. An act will be enacted to enable the introduction of congestion charges aimed at managing transport in urban areas (previously decided). The requirements concerning the energy efficiency of new buildings and renovation construction subject to a permit will be reviewed at the latest during 2023 and the necessary changes to the requirements level will be made based on the review.	In the preparation process, it is necessary to examine the measure, especially from the perspective of the *protection of property* and *freedom to engage in commercial activity*. It may also be necessary to examine, e.g. the *freedom of movement*. Freedom of movement is also linked to the freedom to engage in commercial activity. However, freedom of movement is not unrestricted; instead, e.g. restrictions on driving can be justified from the point of view of safeguarding the freedom of movement of other road users. The measures may involve the collection of personal data, in which case it is necessary to assess the matter from the perspective of *privacy protection*. As a rule, these fundamental rights do not prevent the issuing of obligations, prohibitions, restrictions and orders in accordance with the policies. From the perspective of fundamental rights, the general conditions for limiting fundamental rights are essential. The key objective of climate and energy policy, which is linked to the *fundamental right to a healthy environment,* is to reduce transport emissions and the proportionality of the restriction. In the further preparation of the measures, sufficient *participatory rights* must also be secured for different groups of people to enable them to influence the measure.

Examples of measures carried out under the climate and energy strategy	Comments on the further preparation of the measures
Safeguarding the basic functions of society	
The implementation of legislation on transmission prices will be monitored and reasonable electricity transmission prices will be ensured while taking steps to enable electricity system operators to make the investments required by the strong growth in electricity consumption and the security of supply in electricity networks, information systems used in the energy system and automation as well as the integration of energy systems. Legislation will be supplemented by defining critical client groups in case of power shortages and major disruptions. As a result of the electrification of transport and the whole society, greater attention will be paid to securing the electricity system and critical value chains in the security of energy supply. Replacement investments in distribution networks and the achievement of the security of supply target will be ensured along with the good security of supply of the distribution networks, the availability of network services in cities, urban areas and sparsely populated areas by the end of 2036. Finland will investigate the measures necessary to ensure the security of supply for the import, production and distribution of fuels in the energy transition. A good level of cyber security in energy systems and sufficient resources and expertise for authorities will be ensured in the monitoring of the cyber security of energy systems.	With these measures, the public authority promotes its obligation to safeguard the implementation of fundamental and human rights. A well-functioning energy system also safeguards the implementation of fundamental and human rights. *Equality aspects* should also be taken into account in the preparation of the measures. Users must participate equally in maintaining the costs of the system.
Taxation (measures already decided)	
Tax increases for fossil fuels. The tax exemption for small-scale electricity production will continue. To promote electrification, fully electric cars will be exempt from the car tax and the basic portion of the vehicle tax on fully electric cars will be increased. The taxable value of low-emission and zero-emission company cars will be reduced for a fixed period.	Tax solutions can promote the carbon neutrality of the energy system and therefore advance the realisation of the *fundamental right to a healthy environment,* and take into account the special needs of groups of people and therefore promote *non-discrimination and equality.* The provisions of the Constitution on the enactment of tax laws must be observed in the preparation.

Examples of measures carried out under the climate and energy strategy	Comments on the further preparation of the measures
Guidance by information	
Sufficient resources will be secured for implementing regulation by information and providing energy advice. Energy advisory services aimed at consumers will provide independent and up-to-date information on energy savings, energy efficiency, renewable energy solutions and consumer flexibility opportunities. Guidance by information is also aimed at energy communities (e.g. with the energy community handbook). Awareness and knowledge of ecodesign and energy labelling will be raised among professionals and consumers.	As a rule, regulation by information supports the strengthening of the *right to obtain information.* The implementation of regulation by information methods should take into consideration any aspects that promote *equality and non-discrimination*, including the age and educational level of the target group, plain language and accessibility as well as available language versions (in addition to Finnish and Swedish also e.g. Sámi and minority languages if necessary).
Reports	
A report on energy poverty will be prepared, especially from the perspective of the impacts of the energy transition and system integration. The potential of new energy community models and various methods related to behavioural changes for encouraging decentralised energy production, small-scale production and energy efficiency. A report will be used to investigate how the domestic help credit could be extended to other energy renovations as well as renovations commissioned by housing companies. Other examined topics include how to develop the domestic help credit so that the reduction encourages renovation services and repairs, prolongs the operating life of buildings and materials, improves energy efficiency or otherwise supports the circular economy and emission reduction. (previously decided)	Reports may help identify matters that are essential from the perspective of fundamental and human rights, such as *equality* (e.g. a report on energy poverty may identify impacts on children and impacts on people with low incomes, reports on energy communities and the extension of the domestic help credit may promote the identification of aspects related to equality in different housing solutions) or the promotion of the *fundamental right to a healthy environment*. More significant impacts on fundamental rights mainly depend on whether the reports lead to measures.

3.5.3 The relationship between a just transition and fundamental and human rights

Fundamental and human rights reflect the perception of justice in society. Fundamental and human rights are binding on the state, and they can be seen as guarantees of socially accepted basic preconditions for the realisation of justice. As safeguarding fundamental and human rights is a binding and legal obligation for central government, they provide a clear framework for examining the justice of the climate and energy strategy policies.

We may disagree on the exact content of fundamental and human rights, but their binding nature cannot be eliminated by ordinary legislation. Meanwhile, "justice" is a concept that cannot be unambiguously defined. Justice means different things for different groups and different people. In particular, the definition of justice depends on presumptions of values, human nature, society and the state (e.g. presumption of individual responsibility and autonomy or of the central government's responsibility and obligations). Any requirements for interests, rights and obligations can be rationalised by justice. The weight of the requirements is greater if they are based on a clearly demonstrable obligation of fundamental and human rights binding on the state.

Justice is closely linked to a set of values that it implements and that are seen as prerequisites for a fair distribution. The key principles are equality, non-discrimination and equity and taking all interested parties into account. Justice is often associated with the distribution of benefits or disadvantages. This also includes the value-based choice regarding the extent to which the benefits and disadvantages arising from combating or adapting to climate change can be considered fair and the extent to which they require, for example, compensation or a transition period. The criteria for the just distribution of benefits or disadvantages can include an aim to allocate resources or actual opportunities fairly or the objective of promoting a fair outcome. The criteria for the just allocation of resources vary according to different situations and assumptions. The allocation criteria may be an equal distribution or distribution based on earnings or needs.

A government programme policy notes that emission reduction measures will be implemented in a socially and regionally fair manner and will involve all sectors of society. This objective of justice can be rationalised both by the fundamental and other rights of the individual and by promoting the functioning and stability of society. The pursuit of justice also serves as a frame of reference for political processes and promotes the acceptability of measures in accordance with the climate and energy strategy. As a result, the aim to promote a more balanced representation of different groups in the decision-making and related discussion on climate and energy policy is also important.

In the efforts to combat climate change and the adaptation to climate change, justice is often examined from a supranational and transgenerational perspective. However, the climate and energy strategy policies are concerned with national policy measures. Furthermore, when these policy measures are primarily aimed at reducing emissions and other measures to combat climate change, policy measures cannot be required to remedy all existing inequalities and injustices.

When preparing policy measures based on the policies of the climate and energy strategy, it is necessary to examine proposals from the perspective of fundamental and human rights and in a complementary manner from the perspective of a just transition. For the purpose of structuring justice, the dimensions of justice in climate policy can be considered to include *distributive justice*, *recognition justice* and *procedural justice*, as well as *global justice* and the *equality of human rights*.[18]

- Distributive justice pays attention to the allocation of various economic resources, welfare and health impacts or environmental risks. In the context of climate change adaptation, both the distribution of risks related to climate change and the distribution of benefits and disadvantages arising from the adaptation measures are examined. Here, distributive justice is based on effectively combating climate change and successfully adapting to it. In many respects, the distribution impacts of climate policy are also linked to the issues safeguarded by fundamental and human rights. Compensatory justice has also been highlighted in connection with and separately from distributive justice. Compensatory justice refers to compensating for realised damages or alleviating their impacts by various means that balance out the distribution effects (e.g. income transfers, education, regional development, ecological compensation). Compensatory justice approaches can be used to make otherwise unfair policy instruments fairer and more acceptable.
- A fair opportunity to participate in society is at the core of recognition justice. Regional, global and intergenerational issues can also be included in the recognition of justice.
- Procedural justice examines the fairness of opportunities for participation and the transparency and impartiality of decision-making as well as the accountability of decision-makers to citizens and residents. In connection with procedural justice, decision-making processes are understood extensively, covering all stages from the preparation to the impact

18 How can fairness be taken into account in climate policy? Publication of the Finnish Climate Panel 2/2021, chapter 2 (https://www.ilmastopaneeli.fi/wp-content/uploads/2021/06/ilmastopaneelin-julkaisuja-2-2021-kuinka-oikeudenmukaisuus-voidaan-huomioida-ilmastopolitiikassa.pdf).

assessment of the realised policies. Procedural justice is closely related to recognition justice.
- Global justice shifts the focus from the state level to the global level and emphasises equality, equal rights and responsibility for the wellbeing of others of all people.
- The perspective of the equality of human rights, and in particular fundamental and human rights, lay a clear foundation based on which any assessment of justice should be carried out. Fundamental and human rights have content related to distributive justice, especially concerning the realisation of fundamental freedoms and needs.

3.6 Gender impact assessment

A gender impact assessment has been carried out on the climate and energy strategy in accordance with the Government Action Plan for Gender Equality[19]. This has included the examination of the policy measures proposed in the draft strategy from the perspective of human impacts and gendered aspects.

The gender impact assessment of the climate and energy strategy was carried out as part of the Government Action Plan for Gender Equality by Prime Minister Sanna Marin's Government. The Action Plan brings together key government measures for promoting gender equality and for eliminating gender-based discrimination. The Action Plan for Gender Equality includes key projects by the ministries that promote gender equality and include the gender perspective. For the Ministry of Economic Affairs and Employment, the climate and energy strategy served as a pilot project that included gender impact assessment.

The gender impacts of the climate and energy strategy have been assessed by Oxford Research Oy, which also involved Gaia Consulting Oy and Equality Research Helsinki. Equality Research Helsinki assessed gender impacts in a literature review based on published studies, and Gaia Consulting Oy conducted an impact analysis to assess the gender and human impacts of policy measures.

19 Gender Impact Assessment of the Finnish climate and energy strategy. Juho-Matti Paavola, Amanda Kinnunen, Inkeri Tanhua, Tuukka Rautiainen. Publications of the Ministry of Economic Affairs and Employment, Energy 2021:52. http://urn.fi/URN:ISBN:978-952-327-887-5

3.6.1 Gender and human impacts of the policy measures in the climate and energy strategy

The researchers' assessment shows that taking gender impacts into account in the planning of measures is relevant for both equality and the acceptability and effectiveness of climate action.

Climate policy is often considered gender-neutral. However, policy measures aimed at reducing emissions have wide-ranging impacts on economic activity and employment in different sectors.

The gender impact assessment included assessing the gender impacts of policy measures by first identifying their key human impacts with a particular focus on changes in economic activity and environmental impacts in different sectors. Subsequently, the impacts on different genders were assessed at a more detailed level. The evaluation included 101 proposals for policy measures that were part of the review of the strategy in spring 2021.

The research group examined the human impacts of the measures and their gendered characteristics in six different sectors: energy production, construction and buildings, transport, industry, the service sector and agriculture. The assessment of the main presumed consequences of the policy measures did not take a stand on the magnitude of the impact or its timetable, but only on its direction.

The main conclusions of the researchers:

1) The policy measures mainly target male-dominated sectors, contain technical solutions that interest men and have a greater impact on men's consumption habits. From this point of view, men can be considered to bear a greater burden on the consequences of the proposed measures.
2) However, in male-dominated sectors (energy production, construction, transport, industry and forestry), the overall impact on economic activity and employment is positive, even though some male-dominated jobs are lost, especially those related to fossil fuels.
3) The most significant negative impacts on employment are directed at service sectors dominated by women. These should be taken into account more extensively in climate policy. Two aspects gain emphasis due to the impact of the proposed measures on the service sectors: the budgeting of climate policy must be gender-sensitive, while the elimination of gender-based segregation in sectors benefiting from climate action is more important than before. Women's education in (male-dominated) sectors that benefit from

climate action and also energy-related tasks in the service sector should also be set as a goal in the climate and energy strategy.

4) Women and young people are more prepared to make and support climate-friendly decisions. However, the proposed measures put more emphasis on the inclusion of men in climate policy, as they mainly target male-dominated sectors, affect men's consumption habits and contain technical solutions of interest to men. Alongside technical solutions, there is need to emphasise measures that increase the contribution of women to climate policy. This could lead to higher emission reductions.

Impacts of policy measures on individual sectors

In energy production, a significant trend involves the increase in distributed small-scale production, especially in the form of heat pumps and solar power. There are also efforts to promote consumer participation in the energy market as providers of consumer flexibility. This emphasises the role of individual consumers as both energy producers and consumers. This development will most significantly benefit those who have an opportunity to invest in small-scale energy production and control of consumption. The electrification of industry, transport and machinery will be reflected as a growing need for electricity production and a reduction in the use of fossil fuels. Employment in services related to small-scale energy production will increase. The production of biogas, geothermal energy, offshore wind power and electrofuels is also increasing, which will lead to growth in employment in these industries. The majority of employees in the energy sector are men, which means that the employment impacts also affect men more strongly. The activity of different groups of people to start experimenting with decentralised small-scale energy production varies, so the aim is to make small-scale production inviting and easy to encourage the participation of diverse groups. Changes in tasks and competence needs also provide an opportunity to eliminate gender segregation in the energy sector by training women in new tasks in the field.

In construction, both for new buildings and existing buildings, the most significant impacts of the policy measures emerge as an increase in small-scale, building-specific energy production, tighter energy efficiency requirements, an increase in wood construction, a spread of machinery running on electricity or biofuel, and an increase in the use of recycling, demolition and recycled materials. Abandoning oil heating requires investments in single-family houses and buildings owned by municipalities. The energy efficiency requirements of buildings will become stricter and the need for energy audits and energy-efficient construction will increase. Increased energy efficiency and small-scale energy production will reduce the environmental impacts of buildings. The construction sector is a clearly male-dominated industry, which means that the changes in employment are more clearly concerned with men. However, new tasks and competence needs in

professions related to the circular economy also provide an opportunity to increase the share of women in the sector. Nevertheless, this is so far not enough to compensate for the strong segregation, and the construction sector will continue to be clearly male-dominated.

In transport, the identified impacts include an increase in the use of biofuels, biogas, electrofuels and electricity as a driving force for transport, resulting in an increase in employment in related services. On the other hand, the use of fossil diesel and petrol will be reduced, resulting in a decline in services related to fossil fuels. Reducing local transport emissions and increasing the share of walking and cycling as modes of transport have a positive impact on human health. Transport-related industries are highly male-dominated sectors; for example, 95 per cent of transport workers were men in 2020. Therefore, any changes in employment in the transport sector and also in the construction of distribution infrastructure affect men more. In 2021, 53 per cent of driving licences in Finland were issued to men and 47 per cent to women, but men are more likely to have access to a car. As a result, the measures aimed at reducing emissions from private cars affect men more, and measures aimed at promoting public transport bring more benefits to women of working age in urban areas. From the perspective of gender equality, the most neutral means of reducing transport emissions include increasing the proportion of cycling as a mode of transport and measures promoting remote work, leading to less commuting.

In industry, the identified impacts concern the electrification of processes, which increases demand and employment in electricity-based industrial energy production solutions. Industry is increasingly integrated into the energy market, both as an energy producer and through flexibility in consumption. The production and utilisation of green hydrogen in industrial processes will increase, as will business related to the production of biofuels, electrofuels and biogas, which will also increase employment related to these. Business and employment also increase in the production of sustainable construction materials. The increase in employment related to the electrification of industry occurs in male-dominated sectors. The HIISI project estimates that the proposed policy measures will improve employment in industry compared to a situation in which these are not implemented. The proposed policy measures primarily benefit the forest industry, electricity and heat production and other manufacturing, all of which are male-dominated sectors. Meanwhile, the need for new kinds of skills opens up opportunities to eliminate industrial gender segregation and increase the share of women in the sector, which requires an increase in the number of women in education.

The service sector includes trade, health care, banking and insurance, education services and catering. The impacts identified in the service sector were related to an overall increase in needs for commerce, guidance and communication in climate and energy

matters, which will increase employment in the service sector. Small-scale production of electricity and heat is growing in the service sector, similarly to commerce. The service sector will also become more integrated into the energy market, and business and employment in this sector will grow. The HIISI project estimates that the overall impact of policy measures on jobs in the service sector is negative compared to a situation in which no measures are taken. The negative employment trend caused by a slowdown in private consumption mainly occurs in consumer services, such as the commercial sector and restaurant and accommodation activities, which are female-dominated sectors. Policy measures should therefore aim at increasing the (re)training of service workers to help them find employment in sectors where employment is increasing. For example, training women for professions in energy production, and energy efficiency in the service sector and the integration of the sector into the energy market would reduce the negative impact on women's employment. While the policy measures increase employment in many male-dominated service sectors, such as the development of digital services and systems as well as cyber security, according to a global ILO estimate, the increase in the circular economy and recycling have a negative impact on medium-skill services, which are male-dominated.

In agriculture, the production structure will diversify and be increasingly integrated into the activities of other sectors, forming cross-sectoral clusters in which added value will be created from by-products and further processing. The reduction in the use of peat will have a negative impact on business and employment in peat production areas, but the transition will be supported by controlled implementation. Farms will become more integrated into the energy market as small-scale electricity and heat production and biogas production grow. Biogas production is growing, increasing business and employment in agriculture and in particular in the utilisation of its side streams, such as manure and field biomass. On the other hand, changes in diets and the promotion of eating according to nutrition recommendations also affect agricultural production, reducing the demand for animal production and, in the long term, also farms as well as the biomass (manure) obtained from them. The increase in plant-based diets will reduce emissions and harmful impacts on water systems. The use of electrical and biofuel machinery will increase and the use of fossil fuel machinery will decrease, and the related business and employment will change as a result of changes in the amount of use. As a whole, agriculture is a male-dominated industry; 74 per cent of those working in agriculture, forestry, fisheries and mining are men. On the other hand, women in particular are interested in small-scale farming and more ethical agriculture, and new ethically produced products could also serve as a competitive advantage.

3.7 Strategy monitoring and reporting

The implementation of policy measures outlined in the climate and energy strategy, monitoring of implementation, assessment of the impacts of measures and reporting on impacts are an essential part of the overall approach of Climate and Energy Policy. The objectives of climate and energy policy and the implementation of the decided measures to pursue these targets are monitored through national and international reports, which will be drawn up by both ministries as well as other central government agencies and expert institutions. The reporting related to Climate and Energy Policy is extensive and applies not only to greenhouse gas development but also to other areas discussed in the strategy and the achievement of the targets set for these.

Greenhouse gas emissions reporting concerns the actual trends in greenhouse gas emissions as well as estimates of future development (projections) and the policy measures taken to reduce the emissions. Reporting covers both implemented policy measures and ones on which decisions and plans exist, as well as evaluations of their impacts. Preliminary and follow-up impact assessments will be carried out. The extensive inventory and monitoring work required for reporting consists of several data collections carried out separately and periodically, and evaluation and reporting of results by several research institutes and agencies.

The European Commission recently renewed the reporting on energy and climate policy as part of the monitoring of the achievement of the targets of the Energy Union. The EU Regulation on the Governance of the Energy Union and Climate Action (Governance Regulation, 2018/1999)[20], which entered into force in 2018, lays down provisions on reporting and the requirements for report contents. Chapter 4 of the Governance Regulation contains provisions on two-year progress reports and their monitoring. Article 17 of the Regulation requires each Member State to report to the Commission on the status of implementation of its integrated national energy and climate plan (NECP) every two years starting from 2023. The progress report on the integrated national energy and climate plan should cover all five dimensions of the Energy Union (energy security, internal energy market, energy efficiency, low-carbon economy including renewable energy, and research, innovation and competitiveness). Integrated reporting is detailed in Articles 18 to 25 regarding (18) greenhouse gas policies and measures and projections, (19) national adaptation actions, and financial and technological support provided to developing countries and auctioning revenues, (20) renewable energy, (21) energy efficiency, (22) energy security, (23) internal energy market, (24) energy poverty, (25) research, innovation and competitiveness. Reporting on greenhouse gases under the Governance Regulation will take place every two years as of 2021, but reporting on other

20 https://eur-lex.europa.eu/legal-content/fi/TXT/?uri=CELEX:32018R1999

dimensions of the Energy Union will be carried out for the first time in 2023 and every two years thereafter. Reporting in accordance with the Governance Regulation will be carried out in cooperation between several ministries as well as the agencies and expert institutes working under the ministries.

Each sectoral ministry is responsible for the measures recorded in the strategy and their implementation. The ministries are responsible for introducing the policy measures to practice, which often requires legislative changes. When implementing the policies, the ministries must also assess the measures required for the practical implementation of the policy. A detailed impact assessment will also be carried out in connection with government proposals for legislative amendments related to implementation. The Governance Regulation replaces the previous National Renewable Energy Action Plans (NREAP) and National Energy Efficiency Action Plans (NEEAP) with reporting in accordance with the Governance Regulation, and the Governance Regulation also repealed the previous EU Monitoring Mechanism Regulation (525/2013).

In addition to the EU, the impacts of climate action are also reported to the UN. The UN Climate Pact requires that each country party to the Convention regularly produces National Communication once every four years to report on its activities to implement the Paris Agreement. The National Communications are also used to monitor the progress made by the Parties to the Kyoto Protocol in complying with its obligations.

The purpose of the Biennial Report under the UN Framework Convention on Climate Change is to produce concise data presented on tables on the progress made by the developed states party to the Convention in achieving their goals and complying with their obligations. The reports and the associated data tables are public and can be accessed on the websites of the EU and UN climate agreement. The National Communication and the Biennial Report are government reports.

At the national level, climate and energy issues are also reported in the Government's annual report to Parliament. National reporting requirements in the energy and climate sector are also imposed by the Climate Change Act. Under section 18 of the Climate Change Act, the Government submits an annual climate change report to Parliament each calendar year. The annual climate change report must include information about the development of emissions and removals based on data produced by Statistics Finland. The annual climate change reports also inform the Parliament on the achievement of climate targets and the impact of the measures taken. Reports are also submitted to international organisations in which Finland is a member, including the International Energy Agency IEA, Organisation for Economic Co-operation and Development OECD, and the International Renewable Energy Agency IRENA.

4 Current status and development and the impact of the policies on the energy system

4.1 Basic requirements of the energy system

The energy and climate policy has three basic dimensions that must be constantly kept in balance when transitioning towards a carbon neutral society. The energy system must be:

i) cost-effective and it must ensure growth in the national economy and the competitiveness of Finnish companies in the global market,
ii) sustainable from the perspective of greenhouse gas emissions and the environment, and
iii) ensure sufficient delivery reliability and security of supply.

Cost-effectiveness of the energy system involves a competitive price for energy and for households and companies. The costs of the system must also be distributed equally and fairly between the users of the energy system. In addition, it must be ensured that there is effective competition in the energy market and that companies have the capacity to make long-term investments in advanced clean technology. This makes it possible to export Finnish technology to the global market and increase the so-called carbon handprint of companies. A sustainable energy system is a prerequisite for Finland to achieve its share of global greenhouse gas reduction while also taking care of other environmental targets. For energy production, the focus is on zero-emission energy sources. Energy delivery reliability and security of supply to households and businesses must be maintained at a sufficiently high level. As fossil energy sources are abandoned, there is a need to make new investments in emission-free heat production and to ensure the functioning of the electricity system as variable renewable production increases. Ensuring energy delivery reliability and security of supply also requires significant investments in network infrastructure.

4.2 Reducing greenhouse gas emissions and carbon sinks

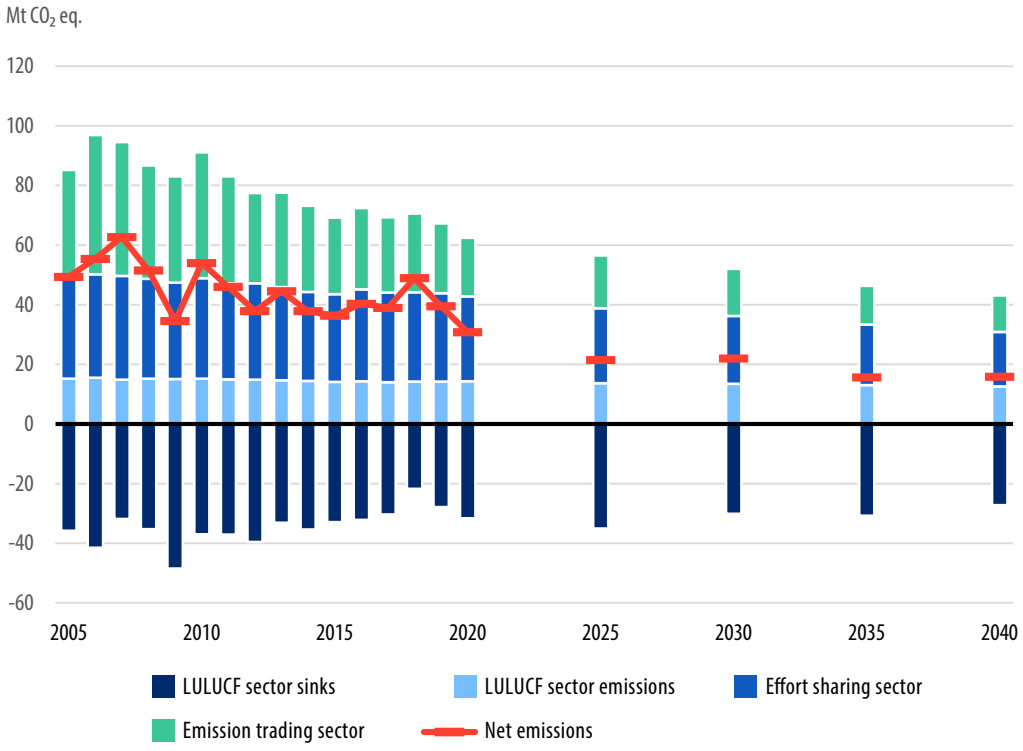
4.2.1 Total emissions and removals

Finland's annual greenhouse gas emissions have decreased by some thirty million tonnes from the record levels of fifteen years ago. The biggest emission reduction has occurred in emissions from the emissions trading sector. Emissions from the effort sharing sector have decreased more evenly but also more slowly. In the land use sector, emissions have remained at a somewhat steady level over time, while removals vary considerably from year to year, and therefore also cause major variation in the net removals of the land use sector.

As a whole, Finland's net emissions are also on a declining path. According to the preliminary data, Finland's net emissions in 2020 were at a record low at only about 25 Mt CO_2 eq. However, it should be noted that 2020 was an exceptional year also when it comes to emissions, both due to the warm weather that significantly reduced the need for heating and due to the coronavirus pandemic that kept transport volumes low.

Figure 4 shows the actual emissions and removals and a projection of their development based on the current measures in 2025–2040. According to this so-called base scenario, net emissions will be 22.6 Mt CO_2 eq. in 2030 and 16.4 Mt CO_2 eq. in 2035. The following sections present current and new policy measures by sector as well as estimates of the development of emissions and removals in the emissions trading sector (ETS), the effort sharing sector (ESS) and the land use sector (LULUCF).

Figure 4. Actual emissions and removals 2005–2020 and emission projection in the base scenario 2025–2040 by sector.



4.2.2 ETS emissions

The aim of the EU's emissions trading is to maintain the greenhouse gas emissions of industrial and energy production plants and aviation within the EEA below the emission cap set for the whole EU emissions trading sector. Currently, the emissions trading system covers more than 40 per cent of greenhouse gas emissions within the EU, and slightly less than half of the greenhouse gas emissions within Finland. The Greenhouse Gas Emission Trading system is based on the principle of reducing greenhouse gas emissions where it is cheapest to do so. For instance, if it is cheaper for companies to obtain emission allowances on the market than to implement emission reduction measures, it is more economical for them to purchase emission allowances than to cut their own emissions.

Installations within the emissions trading scheme must have a permit to emit greenhouse gas emissions into the environment, granted by the competent authority. The permit includes monitoring and reporting obligations, with an obligation to surrender a number of allowances equal to the emissions from that installation during the preceding calendar year each year to the competent authority. One emissions allowance is equivalent to

one tonne of carbon dioxide. Emission allowances will be allocated to operators for free, or by auction. Operators can sell and purchase emission allowances freely throughout the EU-wide market. There are several stock exchanges trading in emissions. Emission allowances are also traded outside the stock exchanges. The price of an emission allowance is formulated similarly to the price of other commodities.

The ETS covers large industrial installations, energy production plants with a total rated thermal input exceeding 20 MW and air transport within the EEA. In Finland, the system also includes some installations that produce district heat at less than 20 MV.

Figure 5 shows the actual emissions from the emissions trading sector until 2020 and the development in accordance with the base scenario until 2040. The figure illustrates a significant reduction in emissions in the energy sector in the last 10 years alone and shows that reducing emissions from industrial processes is challenging despite the emissions trading system. In the energy sector, the emissions trading system already significantly affects fuel choices, and it takes relatively little time to implement changes such as those concerned with boilers affecting biomass and increasing heat production with heat pumps. For example, the spread of wind power has also been strongly subsidised. However, the introduction of suitable replacement technologies in the industry is often much more difficult for reasons such as process technology or costs, even though more plans have recently been presented to reduce emissions from processes. In addition to energy efficiency agreements, industrial low-carbon road maps are an excellent example of this.

Figure 5. Actual emissions in the emissions trading sector 2005–2020 and the development of emissions in the base scenario 2025–2040.

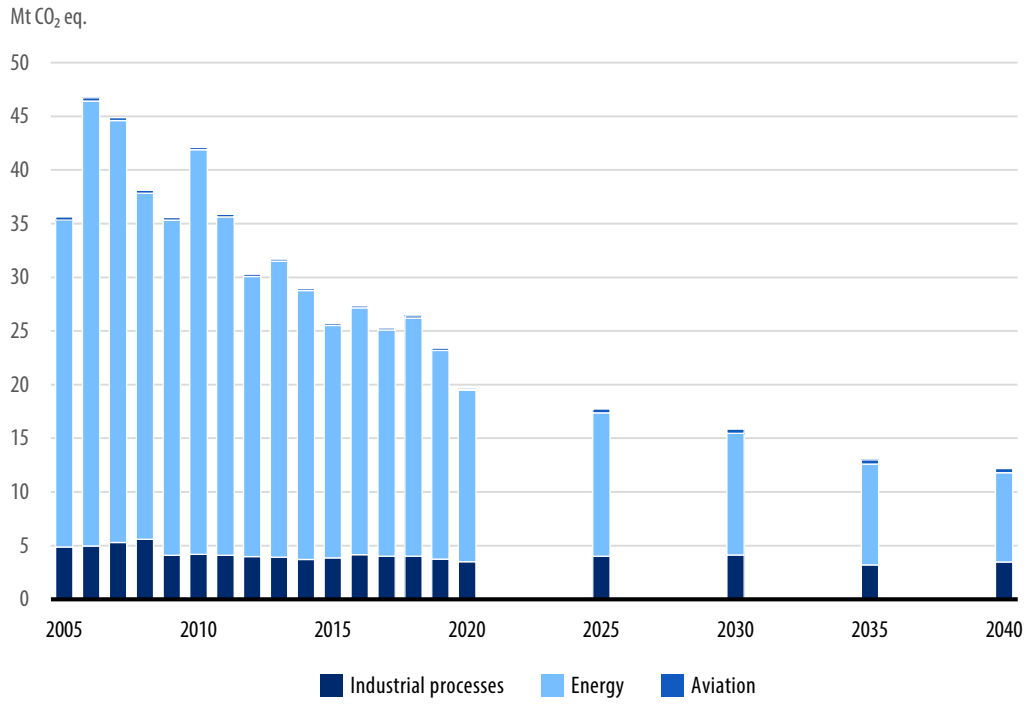
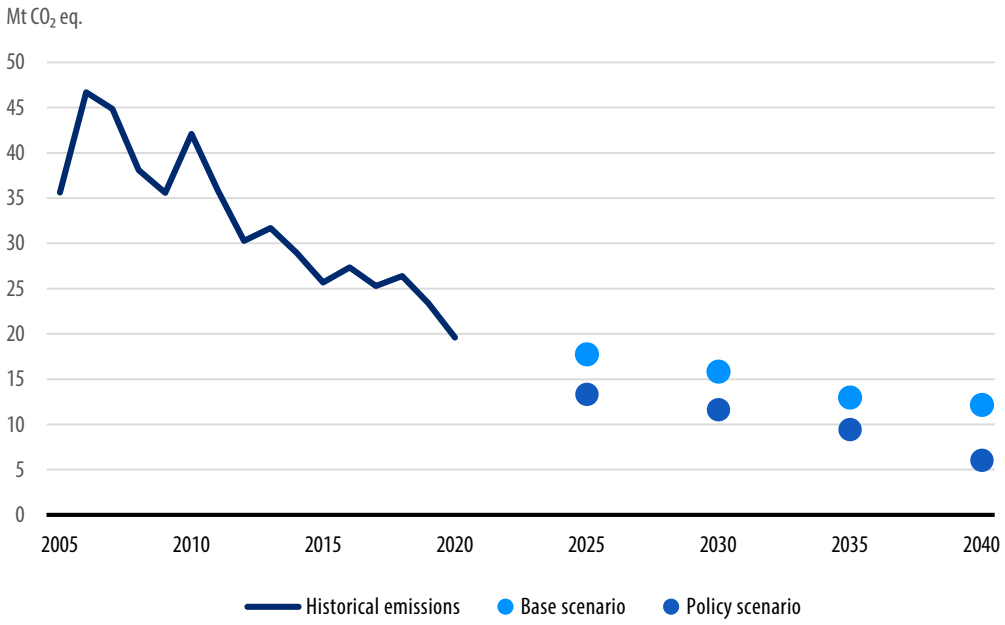


Figure 6 shows the overall development of emissions in the emissions trading sector in both the base and policy scenarios. In the policy scenario, total emissions are about 5 Mt CO_2 eq. lower than in the base scenario. The estimated emissions in the policy scenario have taken into account a significantly faster increase in the price of emission allowances than in previous forecasts. The market stability reserve for emissions trading, which entered into force on 1 January 2019, is expected to contribute to keeping the price of emission allowances at the current, high level. The more rapid increase in the price of emission allowances compared to the base scenario means that the energy sector and industry should invest in measures presented in low-carbon road maps earlier than in the base scenario. In addition to the price of emission allowances, the policy scenario includes the promotion of offshore wind power through an energy subsidy in the energy sector and cutting the tax on electricity used by district heating heat pumps and data centres. In the industrial sector, the policy scenario also takes into account the tax reduction for electricity used to power industrial installations, the reduction of the tax refund for energy-intensive companies and the Government decision on the electrification subsidy for industry.

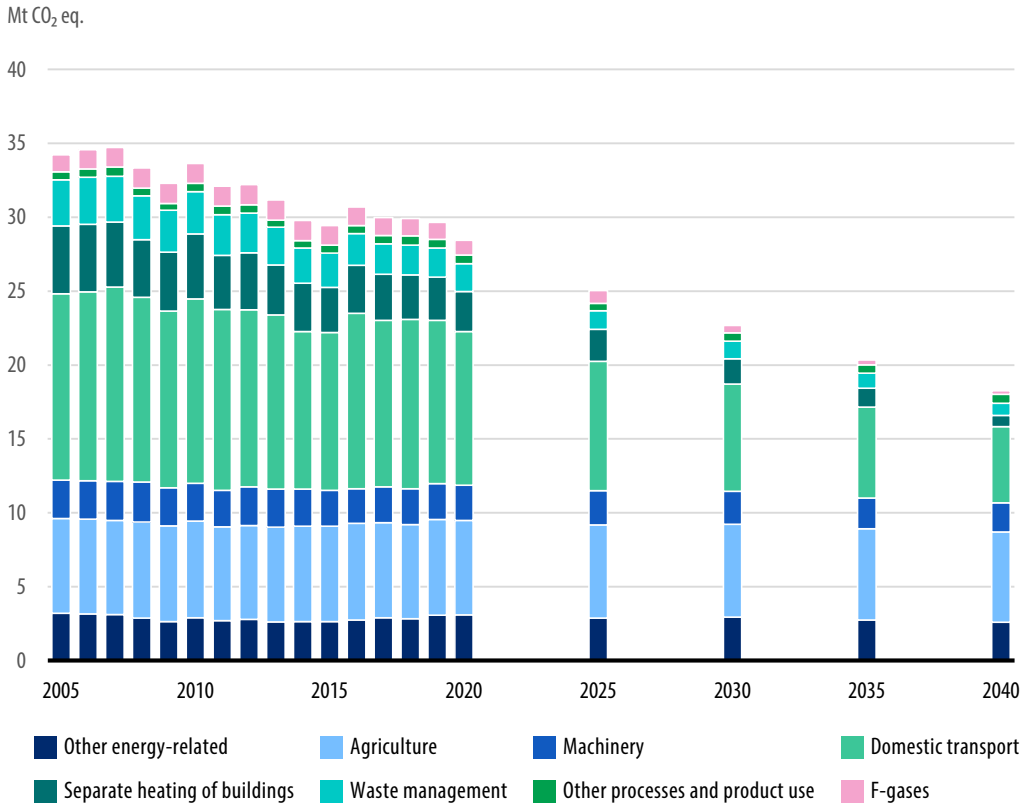
Figure 6. Actual emissions in the emissions trading sector 2005–2020 and the development of emissions in the base and policy scenario 2025–2040.



4.2.3 Effort sharing sector emissions

Figure 7 shows the realised emissions in the effort sharing sector until 2020 and the development of emissions in the base scenario until 2040 with global warming potential (GWP) coefficients in accordance with the Fifth IPCC Assessment Report (AR5). Annual emissions have decreased from the 2005 level to 5 Mt CO_2 eq. The most important factors influencing the change are increasing the binding distribution obligation for biofuel in road transport, changes in heating methods in buildings and improving their energy efficiency as well as better treatment of waste, such as incinerating a larger share of waste in energy production and more accurate recovery of biomethane from landfills.

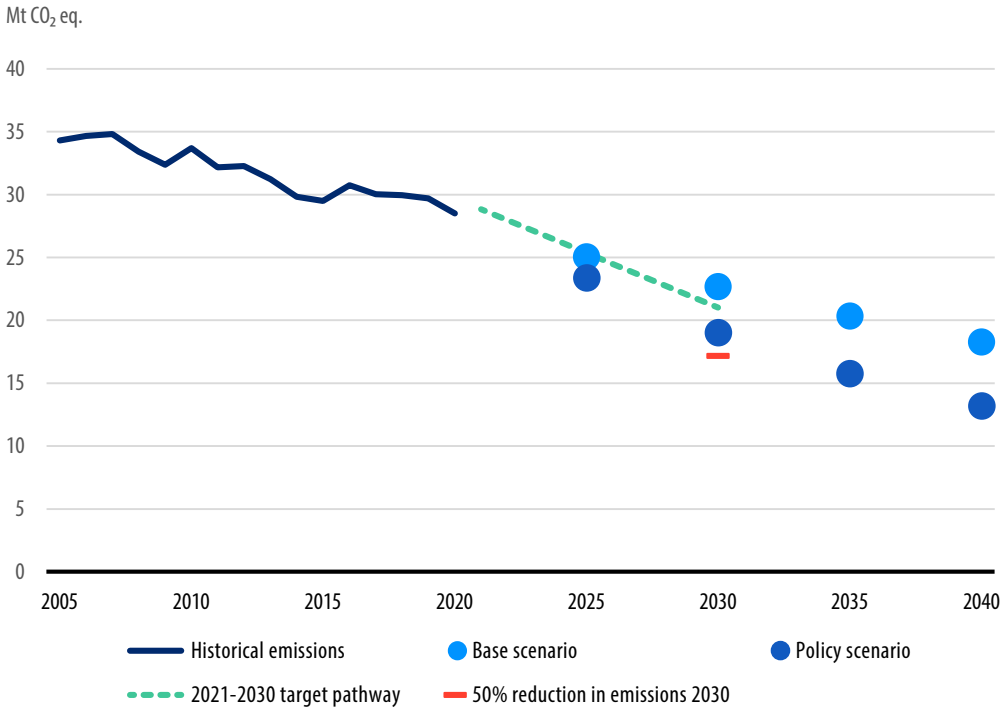
Figure 7. Actual emissions in the effort sharing sector 2005–2020 and the development of emissions in the base scenario 2025–2040.



Emissions from the effort sharing sector will decrease fairly evenly in both the base and policy scenarios (figure 8) by 2040, mostly due to an increase in the distribution obligation percentage in the transport sector and the steering effect of energy taxation. However, not all measures presented in the KAISU plan are included in the policy scenario. In the base scenario, total emissions will decrease to around 23 Mt CO_2 eq. by 2030, which is more than 5 Mt CO_2 eq. higher than required by the new 50-per-cent reduction target tentatively proposed by the EU Commission and less than 1 Mt CO_2 eq. higher than the target under current legislation. Compared to the 2005 status, the clearly biggest emission reduction occurs in domestic transport, with a reduction of approximately 5.4 Mt CO_2 eq. in the base scenario. (43%) and in the policy scenario around 6.4 Mt CO_2 eq. (51%). In the policy scenario, the reduction in additional transport emissions is rather moderate, which is due to the assumed relatively strong electrification achieved already in the base scenario. The policy scenario also includes transport emissions trading proposed by the EU, although its implementation is still uncertain. Its impact is estimated to be between 0.3 and 0.4 Mt CO_2 eq.

After transport, the biggest emission reductions in the base scenario are achieved in the heating of buildings (about 3 Mt CO_2 eq.) and waste treatment (about 2 Mt CO_2 eq.). In the policy scenario, these reductions will increase to slightly under 4 Mt CO_2 eq. and about 2 Mt CO_2 eq. For machinery, the reduction achieved by 2030 in the base scenario amounts to approximately 0.4 Mt CO_2 eq. and in the policy scenario about 1 Mt CO_2 eq. The results fare rather well in indicating the significance of policy measures targeting the use of petroleum products, which is mostly a result of a major increase in the level of the distribution obligation and increases in energy taxes.

Figure 8. Development of emissions in the effort sharing sector in the baseline and policy scenarios, the current trajectory for the period 2021–2030 and the Commission proposal for Finland's new emission reduction target for 2030.



4.2.4 Land use sector

The role of the land use sector in achieving Finland's climate and energy targets

The Land use, land-use change, and forestry (LULUCF) sector, also referred to as the land use sector, can strengthen carbon sinks in several ways, maintain carbon stocks, reduce greenhouse gas emissions and promote the adaptation of agriculture and forestry to climate change. The land use sector is a net sink in Finland, which means that the

greenhouse gases absorbed by the sector exceed its emissions. The extent of the net sink in LULUCF varies from year to year. For example, in 2019, the sector formed a net sink of 14.8 Mt CO_2 eq. as a whole.

Finland's carbon neutrality target means that in 2035, greenhouse gas emissions and the net carbon sink must be at the same level, and from then on, the net carbon sink must exceed emissions. The climate and energy strategy does not define the climate measures in LULUCF in detail; instead, these are included in the Climate Change Plan for the Land Use Sector (MISU), which will be submitted to Parliament as a report in summer 2022. In accordance with the Government Programme, the Climate Change Plan for the Land Use Sector will become part of the planning system laid down in the Climate Change Act.

The target annual net increase in the carbon sink of the land use sector brought by additional measures implemented in accordance with Government decisions will be at least 3 million tonnes of CO_2 equivalent by 2035. To achieve this target, the Climate Change Plan for the Land Use Sector will include measures targeting agricultural land carbon dioxide emissions, forests, land use change and climate wetlands. Agriculture promotes farming methods, techniques, products and services that bind and store more carbon, reduce emissions from farming and maintain existing carbon stocks. Forestry measures are implemented to ensure the management, ability to grow and health of forests and promote diverse forest farming and management methods, which simultaneously strengthens the carbon sequestration of forests, i.e. carbon sinks. Greenhouse gas emissions from the land use sector can be reduced, especially by developing the use of peatlands. In addition, efforts will be made to reduce deforestation and emissions from transforming forests into built areas and fields. As part of the climate action package of the land use sector, the afforestation of idle land, the construction of multi-objective wetlands and the sustainable further use of areas no longer used for peat production will also be promoted.

To preserve carbon sinks and stocks, it is also important to prepare for increasing risks, such as plant diseases and forest damage. As the climate changes, the growing weather and climate risks affect the development of sinks in the land use sector. This is why the perspective of adaptation is an essential part of climate action in the land use sector.

Development of the land use sector according to different scenarios

This section presents estimates of the development of forests and agriculture and their impacts on greenhouse gas emissions, carbon sinks and stocks in the land use sector based on the scenarios drawn up in the Carbon-neutral Finland 2035 – climate and energy policy measures and impacts (HIISI) project.

The estimates are based on projections of the development of forestry production as well as forest growth and roundwood removal rate, which affect the development of forest carbon sinks. The estimated development of forestry production and use of wood in Finland until 2035 are based on the baseline scenarios presented in the low-carbon roadmaps of the Finnish Forest Industries Federation and the Finnish Sawmills Association as well as on revisions based on investment and disinvestment decisions made on the development of the production volumes of different forest industry products.

Based on production estimates of the forest industry, roundwood removal rates were estimated until 2035. The calculations were based on estimates of wood use in the forest industry and energy production. In the base scenario (WEM), the annual roundwood removal rate is estimated to increase to approximately 79 million m^3 by 2035 and remain at this level until 2045. According to the baseline scenario, the roundwood removal rate will rise close to the same level as the 80 million m^3/year level set in the National Forest Strategy 2025. For example, in 2020, 69 million m^3 of roundwood was removed annually. The largest roundwood removal rate that can be maintained in terms of timber production is estimated to be 86 million m^3 per year for the next thirty years (2016–2045).

The modelling of the land use sector of the HIISI project assumed that imports of raw timber from Russia and the growth of Finnish forests will continue at the previous levels. However, in spring 2022, imports of raw timber, veneer sheets and chips from Russia ended. In 2021, a total of about nine million cubic metres of raw and waste wood were imported into Finland from Russia. In particular, fibre wood and chips have been imported into Finland from Russia. The end of wood imports from Russia may therefore have an impact on the extent of roundwood removal and, through these, also on the net sink of the land use sector.

In the logging calculation of the policy scenario (WAM), the roundwood removal rate is the same as in the base scenario described above. The policy scenario differs from the base scenario, especially regarding the measures to increase forest growth and thus carbon sequestration. In the policy scenario, forest growth will be increased by significantly promoting forest fertilisation on both mineral soil and peatland. In the policy scenario, fertilisation for growth will expand to 150,000 hectares per year in the second half of the first calculation period (2016–2025). In the policy scenario, the practices of thinning eutrophic wooded mires will be changed so that 30 per cent of the thinning will be implemented with a crown pruning technique. In the policy scenario, the amounts of ditch drainage in drained peatlands is also lower than in the base scenario, which means that in addition to eutrophic wooded mires, ditch drainage will also not be used in pine bogs during thinning. Both base and policy scenario assume that recently planted trees will be maintained whenever necessary.

It should be noted that HIISI calculations only include certain measures related to forest growth and the development of carbon sinks. No assumptions were made on issues such as increasing the use of processed seedling material or advancing the maintenance of recently planted trees although some recent reviews have also assessed their impact. A more detailed description of the measures assumed in the policy scenario to increase forest growth can be found in the HIISI report.

In the policy scenario, wood growth will increase from 106.3 million cubic metres per year in the baseline scenario to approximately 109.3 million cubic metres per year by 2035. The impact of increased forest growth on the development of forest carbon sinks is described below.

The forest sector also plays a role in Finland's energy production. In the HIISI project, the amount of forest chips harvested as a by-product of felling was estimated to rise to 16–17 million cubic metres per year in the climate and energy strategy scenarios. The targets set for the accumulation of energy wood are higher in the policy scenario than in the baseline scenario. In recent years, an average of 7–8 million cubic metres of forest chips have been used in heating and power plants, which is why the amount of forest chips in the scenarios is estimated to approximately double from the current level by 2035. The energy use of forest chips is described in more detail in sections 4.3 Renewable energy and 4.5 Energy delivery reliability and security of supply. After the completion of the HIISI project, the import of forest chips from Russia ended in the spring, and this may have an impact on the volumes of domestic forest chips to be utilised in the next few years.

The scenarios describing forest growth and logging did not examine measures related to the maintenance and promotion of forest biodiversity or the protection of forests; instead, these examinations will be included in the scenarios prepared to support the update of the National Forest Strategy in 2022.

The sources for the preparation of the agricultural scenarios have included a draft national plan of the EU's Common Agricultural Policy (CAP) that contained the following proposals for measures: transforming cleared areas into permanent grassland, catch crops and land reclamation and soil-building plants, a grassland and fallow land subsidy (including grassland in peat fields), investments in and management of controlled subsurface drainage, and establishment and management of wetlands (including climate wetlands). In addition to CAP, the source material includes an afforestation subsidy for idle land, which will have an impact from 2021, an estimate of the emission reduction potential of the land use sector and a climate roadmap for the Central Union of Agricultural Producers and Forest Owners MTK and the climate roadmap by the Svenska lantbruksproducenternas centralförbund SLC.

The emission reduction measures in the agricultural policy scenario are related to changes in land use, field use (cultivation of peatlands on elevated water level, increasing carbon sequestration in mineral soils), precision farming and reduction of methane production in dairy cows. In addition to the agricultural sector, the emissions reduction impacts of the measures largely affect the land use sector.

The scenarios also made assumptions on the total area covered by changes in land use, such as the development of agricultural land, grassland and built land, afforestation, changes in peat production sectors and the new land area required by wind and solar power plants located on land. The role of deforestation in emissions in the land use sector is illustrated by the fact that an essential part of the annual emission reductions in the entire land use sector in Finland could be achieved by mitigating deforestation. An example of these changes is the total area of forest land, which would decrease by about 66,000 hectares in the base scenario in the period 2021–2040 and increase by about 17,000 hectares in the policy scenario. Meanwhile, the area of agricultural land was estimated to remain at its current level in the base scenario. In the policy scenario, the total area of agricultural land would be reduced by approximately 90,000 hectares in the period 2021–2040 due to a smaller clearing area and larger afforestation areas. The HIISI report provides a more detailed description of the projected land use development in Finland in 2010–2040.

Estimated development of the net carbon sink in the land use sector until 2035

According to the HIISI project scenarios, the net sink of the land use sector would increase from the current situation. The baseline scenario estimates that in 2035, the land use sector would be a net sink of 18.0 Mt CO_2 eq. With the policy scenario measures, the estimated net sink in 2035 would be 23.7 Mt CO_2 eq., i.e. the net sink in 2035 in the policy scenario would be 5 Mt CO_2 eq. higher than the net sink in the base scenario thanks to additional measures.

If the estimates of the development of the sector's net sink in 2035 are compared to the current situation, the net sink will be larger than in the current situation in both the base and policy scenarios. For example, the total land use sector was a net sink of 14.8 Mt CO_2 in 2019, and, according to preliminary data, 17.2 Mt CO_2 in 2020. The rapid advance data set for the land use sector for 2021 was significantly smaller compared to the data used in this strategy. The scenarios of the land use sector will be updated together with the update of the national climate and energy scenarios as part of the Government's analysis and research activities in 2023.

The policy scenario of the HIISI project (Table 5) shows that measures in the land use sector have the potential to increase sinks and reduce emissions. However, continuously

increasing the net sink or maintaining it at the same level is challenging. The impacts of human activity can be rapid and cause fluctuations between years, such as changes in the roundwood removal rate or the introduction of new policies.

Table 4. Emissions and removals of the Land Use, Land Use Change and Forestry (LULUCF) sector by emission category in the base scenario, Mt CO_2 eq. The 2019 data corresponds to the values of the greenhouse gas inventory with the AR5 GWP coefficients, and the 2025–2040 data comprise the results of the base scenario.

	2019	2025	2030	2035	2040
Forest land	-23,01	-29,17	-23,71	-24,85	-21,92
Arable land	7,94	7,47	7,58	7,61	7,67
Grassland areas	0,70	0,69	0,68	0,67	0,65
Wetlands	2,23	1,75	1,28	1,13	0,90
Built-up area	0,68	1,27	1,23	1,00	0,82
Wood products	-3,37	-3,22	-3,92	-3,56	-2,82
Total	**-14,83**	**-21,20**	**-16,85**	**-18,00**	**-14,69**

Table 5. Emissions and removals of the Land Use, Land Use Change and Forestry (LULUCF) sector by emission category in the policy scenario, Mt CO_2 eq. The 2019 data corresponds to the values of the greenhouse gas inventory with the AR5 GWP coefficients, and the 2025–2040 data comprise the results of the policy scenario.[21]

	2019	2025	2030	2035	2040
Forest land	-23,01	-30,14	-26,72	-28,37	-26,92
Arable land	7,94	6,99	6,70	6,45	6,12
Grassland areas	0,70	0,73	0,75	0,79	0,82
Wetlands	2,23	1,25	0,62	0,57	0,56
Built-up area	0,68	1,28	1,23	1,04	0,85
Wood products	-3,37	-3,22	-3,92	-3,56	-2,82
Total	**-14,83**	**-23,11**	**-21,33**	**-23,07**	**-21,38**

21 Carbon neutral Finland 2035 – Land use and agricultural sector scenarios.

An examination of the net sink of forests (forest land) shows that the amount of carbon sink in Finnish forests, i.e. carbon dioxide binding from the atmosphere to the forests, has varied from 17.5 to 47 Mt CO_2 eq. since 1990. In 2019, the net sink of forests was around -23 Mt CO_2 eq. In the base scenario of the HIISI project (WEM), the net sink of forests will be -24.9 Mt CO_2 eq. in 2035; in the policy scenario, which involves measures to increase forest growth, the net sink of forests will be -28.4 Mt CO_2 eq.. As a result, according to the scenarios, measures to increase forest growth would amount to an additional sink of around -3.5 Mt CO_2 eq. in 2035.

In the base scenario, soil emissions from organic agricultural land will increase by 1 Mt CO_2 eq. over the period considered. As a result of the declining peat field area and high water level cultivation in peatlands in the policy scenario, the emission will be 0.3 Mt CO_2 eq. less in 2040 compared to the base scenario. In the base scenario, the emission trend of mineral soils declines from 0.5 Mt CO_2 eq. in the initial situation to 0.1 Mt CO_2 eq. in 2040. In the policy scenario, emissions turned into a small sink after 2030, reaching about -0.2 Mt CO_2 eq. in 2040. The increase in grassland, catch crop area and area used for cultivating land improvement and soil-building plants are the most important factors behind the lower emissions of mineral soils in the policy scenario. In 2035, grassland areas, wetlands and transforming land into built land will form a total emission source of approximately 2.8 Mt CO_2 eq. according to the base scenario and 2.4 Mt CO_2 eq. according to the policy scenario.

The carbon sink of wood products was assessed based on valid reporting rules for wood products in the scenarios. According to the rules, the development of the carbon stock of wood products is calculated based on the production volumes of wood products made of domestic wood and the half-life of the carbon these contain. Based on the scenarios, it is estimated that the net carbon sink of timber products would be approximately 3.6 Mt CO_2 eq./year in 2035.

4.3 Renewable energy

4.3.1 General information

The share of renewable energy in Finland's total consumption has been growing rapidly. For the first time in 2014, Finland exceeded the binding EU target set for 2020 (38%), and the share had grown to nearly 44 per cent in 2020 when statistical transfers were taken into account. Finland sold part of the statistical surplus of renewable energy to Belgium and Flanders in Belgium. Without statistical transfers, Finland's share of renewable energy would have been 44.6 per cent in 2020. The majority of the growth has been related to the

increase in the use of wood fuels. In recent years, the number of other renewable energy sources, especially wind power, has been also growing rapidly.

This growth in renewable energy is also reflected in primary energy consumption, where it currently accounts for almost 40 per cent. Figure 9 illustrates the shares and modelled trajectories in recent years; in the policy scenario, the share will rise fairly rapidly to 50 per cent and also quickly to more than 40 per cent in the base scenario.

In its national energy and climate plan (NECP), Finland announced a national target of 51 per cent for 2030 of the total final consumption of renewable energy. In the policy scenario, this is clearly exceeded as the share reaches the level of 60 per cent in 2030.

Figure 9. Shares of renewable energy of primary energy in the base and policy scenarios.

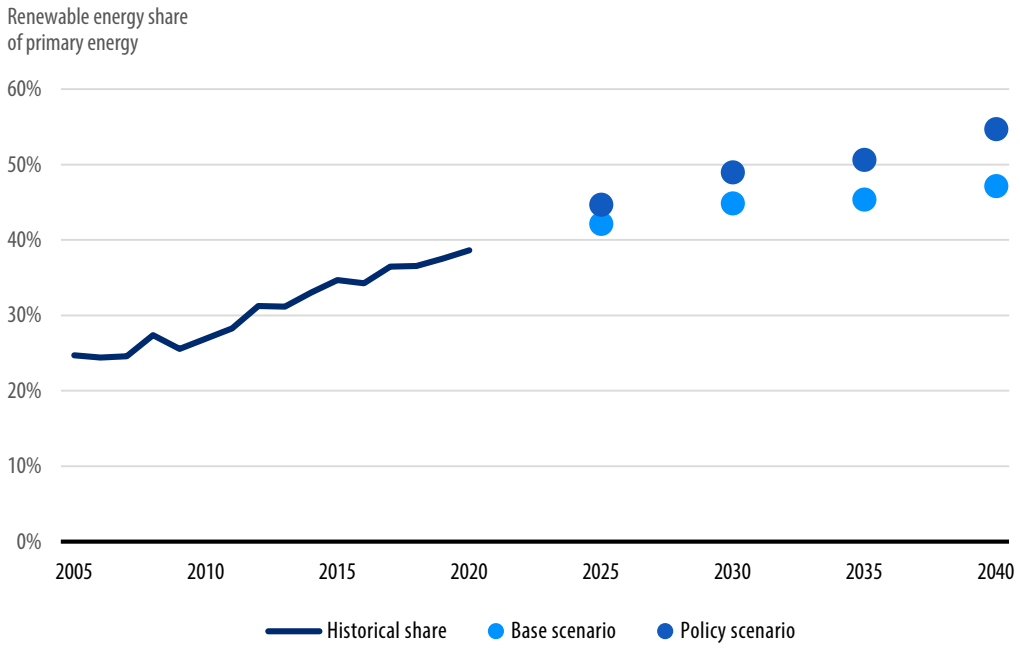


Figure 10. Supply of renewable primary energy in the base scenario.

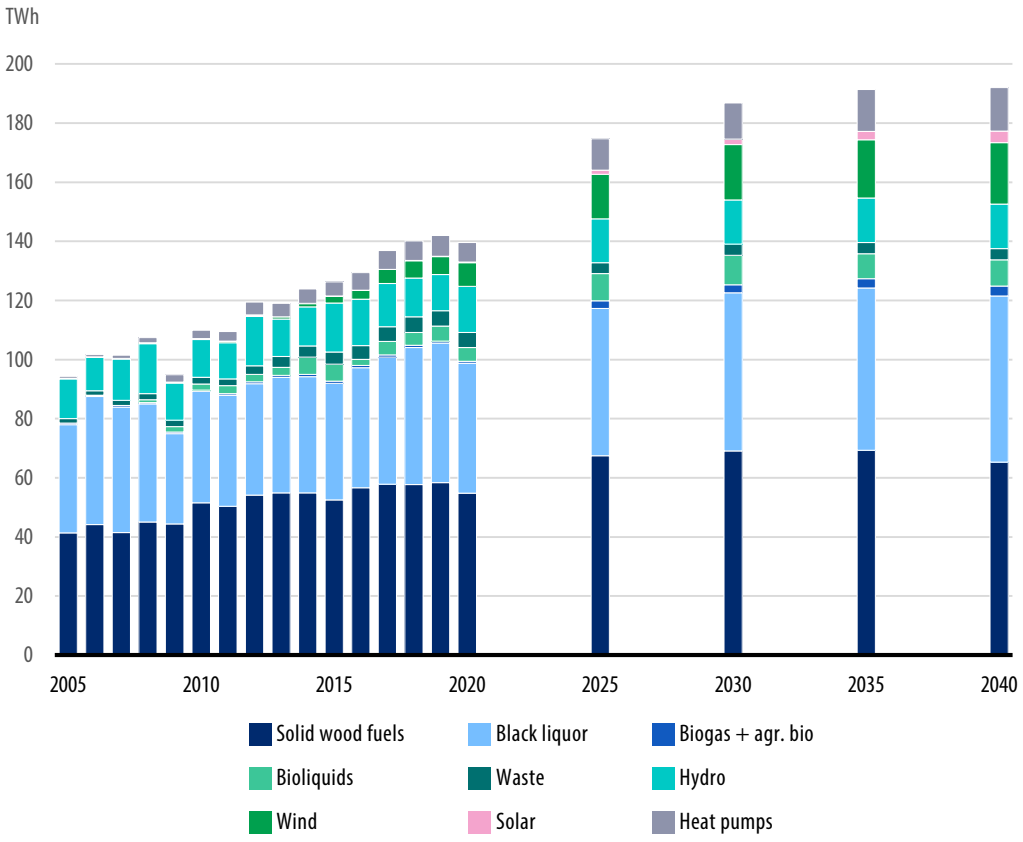


Figure 10 presents the supply of renewable primary energy by energy source in the base scenario. Its annual amount would increase from the current level of around 140 TWh to around 190 TWh by 2035. Most of the growth is explained by an increase in the use of wood fuels, wind power and heat pumps. The majority of the increase in wood fuel is a direct result of side streams from the growth of forest industry production. While some of this will be used by the industrial sector itself, there are also plenty of side streams for other uses. The use of forest chips will increase from the current level, although its use in heating and power plants will already start declining in the scenarios after 2025. Small-scale burning of wood in the heating of residential dwellings and service buildings will decrease at a steady rate throughout the period under review.

By sector, more than 80 per cent of electricity production is already CO_2-free (including nuclear power). A significant share of renewable energy remains bio-based. In Finland, the use of wood fuels in heating and power plants is mainly based on the use of forest industry side streams, i.e. black liquor and solid wood fuels, such as bark and sawdust. These account for more than 70 per cent of renewable energy production. In order

for bioenergy to be included in the EU's renewable energy targets, it must meet the sustainability requirements laid down in the EU Renewables Directive. With the revised Renewable Energy Directive (REDII), biomass fuels, i.e. solid and gaseous bio-based fuels, were also included in the sustainability criteria. The sustainability criteria of this directive have been implemented nationally in the Act on Biofuels, Bioliquids and Biomass Fuels (393/2013; a.k.a. *Sustainability Act*). Finnish forest biomass is considered to meet the requirements of the directive at the country level. However, the sustainability criteria have been reopened for examination in the Fit for 55 package. The proposed directive would tighten the sustainability criteria in certain respects. This would include, in particular, tightening the decree of the application related to size limits, extending the regulation of prohibited areas to include forest biomass, clarifications related to soil quality and biodiversity, and extending emission reduction requirements to existing installations. In addition, consideration has been given to the cascading use of wood, especially in aid schemes. It has also been considered important at the national level that high added value fractions should not be combusted. The amendments to the final directive must be integrated into national legislation by the end of 2024 with certain transitional provisions.

As industry, heating and transport become electrified, demand for electricity based on renewable energy sources will grow significantly in the future. The majority of production growth will be based on market-based solutions. Wind and solar energy will play an important role in the supply of renewable energy, especially in the policy scenario. However, it should be kept in mind that it is difficult to estimate where new wind power investments will occur in the Nordic market, which also makes the results uncertain in this respect. The calculation assumptions for the policy scenario took into account data based on Finnish investment decisions based on public sources ranging to 2024. A large number of projects are planned, which is why the actual development may prove to be faster than estimated here. As wind power and solar power increase, the importance of various flexible solutions gains emphasis. These include energy reserves and system integration solutions.

The trend towards renewable energy has also been accelerating in the heating sector. Major uses of coal and peat have already begun to be replaced by renewable energy solutions, and the number of projects based on solutions such as waste heat is increasing. In addition to separate properties, geothermal heating systems and other heat pump solutions are also becoming more common in industrial properties and district heating production.

However, most of the post-coal and post-peat era in the heat sector will be covered by increasing the use of wood fuels in the near future, as Figure 10 illustrates. Even though the results indicate that the demand for wood fuels will increase significantly in the base scenario by 2030, a large part of the growth will be directly generated by the

side streams of the forest industry and forest management. The scenarios assume that significant amounts of roundwood will not be burned for energy. While additional energy wood imports could lead to an increase in the use of roundwood for energy, based on sustainability perspectives, imports have been limited to a maximum of around 5 TWh compared to less than 4 TWh in 2020.

In particular, as a result of the increase in biofuel use, about one fifth of the transport sector is based on renewable energy. Finland is a globally leading country in the use and production of renewable energy sources in the transport sector. The role of liquid biofuels, biogas and e.g. new hydrogen-based, electrofuels will be emphasised especially in heavy road transport, maritime transport and air transport as passenger car transport becomes electrified.

4.3.2 On subsidy schemes

In Finland, a move has been made in government subsidies for renewable energy from production subsidies towards investment subsidies, and relatively more subsidies have been allocated to the promotion of new energy technology. The utilisation of bioenergy, especially in heat production, has been market-based for a long time by now, and production subsidies for forest chips, for example, have just been abandoned. The purpose of the subsidy was to replace peat in multi-fuel plants. Due to the high price of the emission allowance, there is no longer need for the subsidy. The feed-in tariff system for wind power was closed for new power plants in 2017 and only one tendering process was organised in 2018 under the premium scheme that replaced the system. This means that new wind power plants are now built without subsidies.

Most of the new energy production capacity should be based on market-based solutions, and direct subsidies should be avoided in the current situation, where also production technologies based on renewable energy sources can be primarily built without government subsidies. However, government subsidies are justified in situations where it is considered that technology or a concept could have a significant impact on long-term national targets, global demand or otherwise of exceptional significance, and such investments could not be launched without a government subsidy due to aspects such as a higher level or risks or poor profitability of first projects. The most important of such technologies are particularly concerned with renewable transport fuels and non-combustion-based heat production solutions. With regard to established technologies in particular, there is need to primarily assess the introduction of financial instruments rather than direct subsidies.

As the profitability of renewable energy production plants improves, more attention should be paid to other means of promotion. It is important to strive to create an investment-friendly atmosphere and an operating environment that contributes to reducing projects' risks. In practice, this means that regulation is not constantly changing and that regulation is predictable in the long term. It should also be ensured that private funding is available for renewable energy projects.

4.3.3 Energy aid

Energy aid may be granted to investment or study projects that contribute to:

1. the production or use of renewable energy;
2. the saving of energy, or more efficient generation and use of energy; or
3. transforming the energy system to become low-carbon in other ways.

Energy aid can be granted to companies, municipalities and communities. The aid is not granted to housing companies, residential properties or farms or to projects carried out in connection with these, with the exception of projects connected to a farm in which the energy produced is used outside agricultural production activities. The granting of energy aid is based on the Government Decree on General Terms of Granting Energy Aid (1098/2017), which lays down more detailed provisions on the aid scheme. Aid applications are primarily processed by Business Finland. The Ministry of Economic Affairs and Employment makes decisions on granting support for investment projects with eligible costs exceeding EUR 5 million and for projects related to new technology with eligible costs exceeding EUR 1 million. Typically, EUR 35 to 40 million per year has been allocated to energy aid, most of which is used for small-scale projects. Due to separate fixed-term additional aid, the grant authority for energy aid has far exceeded the above number in recent years.

The investment aid for large-scale demonstration projects was introduced in 2019 as part of energy aid. Large-scale demonstration projects refer to energy aid projects with investment costs of at least EUR 5 million and which contain new energy technologies. The aid is based on a competition between the projects. Projects are primarily assessed on the basis of their demonstration value, but the assessment also pays attention to the feasibility, energy impacts, cost-effectiveness and other impacts of the projects. In particular, the focus has been on renewable transport fuel production plant projects and non-combustion heat production projects. A total of EUR 200 million was reserved for the grant authority for energy aid for a four-year period.

The benefit of the aid scheme is that discretionary investment aid can be allocated efficiently on a project-by-project basis as needed and different emphases can be made flexibly. Investment aid paid in arrears and based on actual costs is also fairly risk-free for the central government. No aid is paid if projects are cancelled.

4.3.4 Ministry of Agriculture and Forestry's aid for energy sites

The measures of Finland's Rural Development Strategy for the period 2014–2022 and its transition period 2021–2022 will promote renewable energy and energy efficiency in rural enterprises and farms in different ways.

Investment aid for agriculture and rural business funding can be used to support investments in renewable energy plants. Micro and small enterprises located in rural areas that produce energy to be sold can apply for enterprise financing for their plant investments. Meanwhile, structural support for agriculture concerns investments in agricultural sites that produce the renewable energy needed for agricultural production or improve the farm's energy efficiency. The scheme can also be used to fund training, communication and cooperation projects that support, for instance, increased production and use of renewable energy, energy and resource efficiency or decentralised energy solutions. Energy advisory services tailored for farms are also supported through the scheme.

In December 2021, Finland submitted its proposal for the 2023–2027 CAP plan, which is a continuation of the current Rural Development Strategy to the Commission. The energy measures presented above for the current period are planned to remain largely unchanged. The exact content, the areas to be supported and aid percentages will be determined in autumn 2022 once the plan has been discussed and approved by the Commission.

4.4 Energy use and energy efficiency

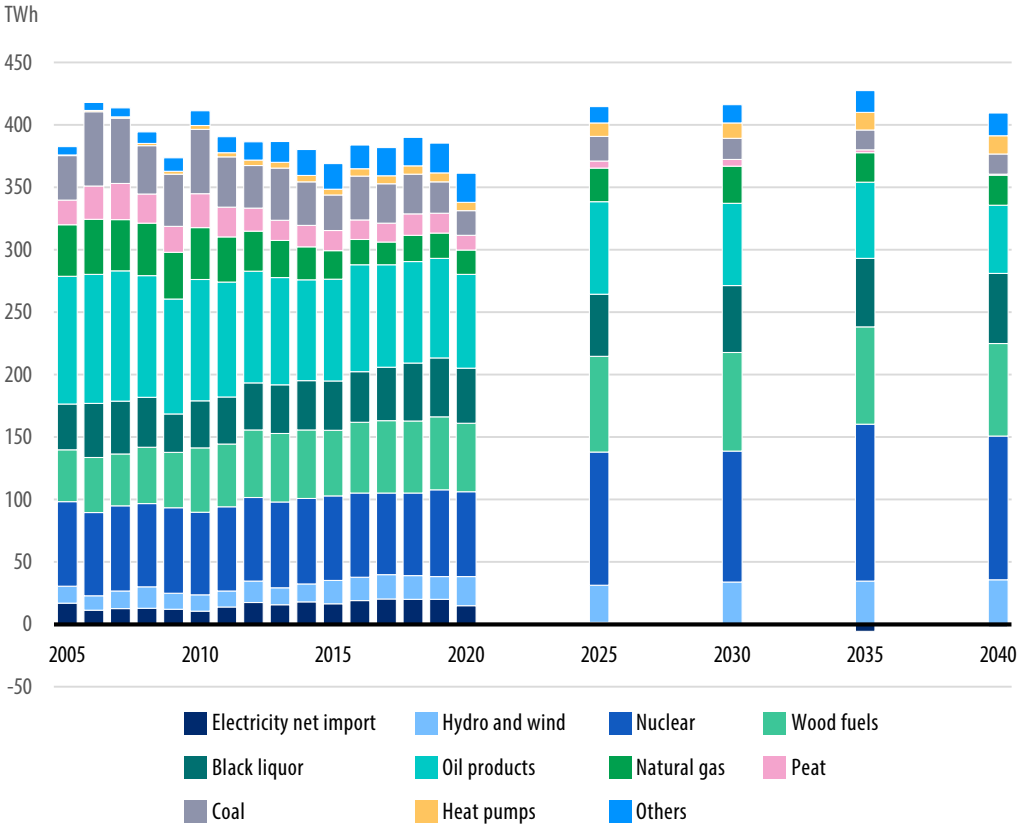
4.4.1 Primary energy consumption and final energy consumption

Figure 11 shows the total primary energy consumption and its supply by energy source in the base scenario. The maximum primary consumption will be over 400 TWh in 2035, after which consumption will begin to decrease. The new nuclear power plant units Olkiluoto 3 and Hanhikivi 1, which the scenario assumes to be introduced in 2022 and 2032, respectively, are the largest single factor increasing the amount of primary energy; in the policy scenario, the primary consumption will be about 2 per cent smaller than the

base scenario as a result of the increased efficiency achieved in the period 2030–2040. After the scenario calculation, Fennovoima Oy has submitted a notification to the Ministry of Economic Affairs and Employment by which it cancels the application for a construction licence for the Hanhikivi 1 nuclear power plant. Meanwhile, Fortum Power and Heat Oy have submitted a licence application for the continuation of energy production in the Loviisa 1 and 2 nuclear power units until the end of 2050 at the latest. In the scenarios, the changed nuclear power situation will have the greatest impact on energy supply and the total primary energy volume in 2035. After 2035, the extended use of Loviisa units will largely replace the lost production volume of Hanhikivi 1.

Fossil fuels and peat accounted for about 42 per cent of the total primary energy consumption in 2019, compared with around 54 per cent in 2010. In the base scenario, their share will continue to fall to around one third in 2030, to around one quarter in 2040 and to around 20 per cent in 2050. Similarly, the proportion of nuclear and renewable energy will increase. By 2030, the energy use of peat and coal will decrease most, but the total use of natural gas could even increase slightly from the 2020 level. However, the decline in the use of peat and coal is most reflected in an increase in the use of bioenergy, especially wood fuels.

Figure 11. Primary energy supply 2005–2020 and its development in the base scenario.

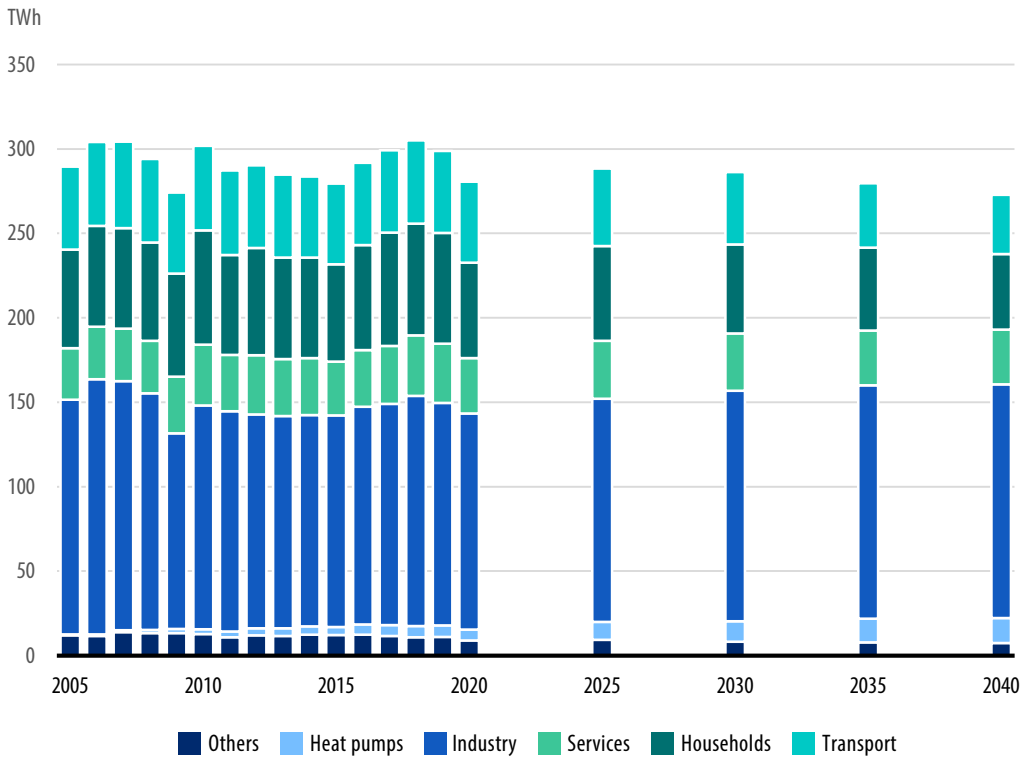


In recent years, final energy consumption in Finland has typically been less than 300 TWh, of which around 30 per cent has comprised electricity, slightly over 10 per cent heat and more than half direct fuel use. In the baseline scenario, total consumption will remain fairly constant until 2035. Electrification is a significant change trend in all sectors, both in the base and policy scenarios, leading to an increase in electricity consumption, a decrease in the use of fuels and heat and, ultimately, an increase in the efficiency of the final consumption of energy as a whole. As a result, total consumption will start to decrease after 2035. The final consumption of electricity will increase particularly significantly in transport and industry. The development of the hydrogen economy and electrofuels has a strong impact on electricity consumption. If commercial hydrogen technology solutions emerge rapidly, a significant amount of new clean electricity production will also be generated. The development of the hydrogen economy and electrofuels as well as emission-free electricity production is closely linked to companies investing in the hydrogen economy ensuring clean electricity production by concluding PPA agreements with electricity producers. In this case, the production volume of, for instance, wind power would grow considerably faster than in the policy scenario of the strategy. A survey financed by Sitra, "Enabling cost-efficient electrification in Finland"[22], assessed two scenarios. In 2050, 34 TWh of wind power would be used for the production of hydrogen in a scenario of direct electrification; the corresponding number is up to 60 TWh in a PtX scenario based on the hydrogen economy.

Based on an examination of the final energy consumption by sector in the baseline scenario (Figure 12), the energy use of transport and housing will become more efficient, which is reflected in a reduction in their total consumption. In services and industry, the increase in demand for useful energy output almost offsets the impact of efficiency gains, which means that total consumption will not change significantly. In the final consumption of housing and services, all energy use except for electricity will decrease as a result of a decrease in the specific consumption of heating, which is significant both in new buildings and also in older buildings thanks to relatively extensive energy renovation activities. In all scenarios, the key impacts on the industry include electrification in process heat production and the replacement of fossil fuels with biofuels. In Figure 12, energy from heat pumps is mainly used in residential buildings, although the biggest increase occurs in service buildings. Heat pump energy is not included in the final consumption definition in accordance with the EU energy efficiency target (4.4.6).

22 Enabling cost-efficient electrification in Finland, Sitra, 2021, https://www.sitra.fi/en/publications/enabling-cost-efficient-electrification-in-finland/

Figure 12. Final energy consumption by sector 2005–2019 and development in the base scenario.



4.4.2 Energy efficiency

Finland has been purposefully investing in energy efficiency and energy savings for nearly 50 years, i.e. ever since the first energy crisis (1973-1974). Energy efficiency and energy savings are promoted in many ways and in all sectors. Industry is a major energy user, but also a major driver of energy efficiency measures. Energy efficiency is involved in transport in many ways. Taxation of the purchase of a vehicle is used to direct consumers towards selecting low-emission, i.e. energy-efficient vehicles. Energy efficiency can be taken into account in the selection and use of means of transport. Many measures to promote energy efficiency are also available to households and services.

The voluntary energy efficiency agreement system is Finland's most significant policy measure for promoting energy efficiency and energy savings. Energy saving agreements were already introduced in 1997. Extensive energy efficiency agreements were concluded for the period 2008-2016. The current agreements concern the period 2017–2025. Energy efficiency agreements cover industry, services, municipalities and properties as well as the oil heating sector. Finland has used voluntary energy efficiency agreements extensively to meet the Energy Efficiency Directive's (EED) provision on energy saving obligations

for energy sellers. Adequate reporting of energy efficiency agreements is an important condition for this.

Making energy efficiency measurements and comparisons between companies or countries is not an easy or unambiguous task. The parties to energy efficiency agreements report on their energy efficiency measures and investments. While these figures describe energy efficiency, they still do not lend themselves to making direct comparisons between sectors.

Various indicators have been proposed to describe energy efficiency, but these are not capable of monitoring major structural changes, which the Finnish economy has also been subjected to. Gross domestic product or added value do not describe anything other than a certain amount of money or changes in it. Even the tonnes produced are not always comparable. In conclusion, we may note that Finland has good energy efficiency, but there is nonetheless room for improvement.

Technology is constantly evolving and should be both user-friendly and sustainable at the same time. Unfortunately, not all consumer technology is particularly user-friendly, at least not at the outset. Consumers may also find it difficult to choose between various technologies. Regional, impartial energy advisory services provide solutions to these problems or direct consumers to sources that allow them to find a solution.

Traditionally, it has not been considered necessary to finance energy advisory services from the Budget. While energy use and reducing emissions have become an important and personally relevant topic to all citizens, the available options and their complexity prevent or slow down implementation. Neutral energy advisory services can utilise this potential. Energy advisory services have always been important, but as solutions and technologies become increasingly complex and the range of options grows, it is vital that citizens are provided with objective information on energy efficiency measures, the use of renewable energy and other activities and choices in line with sustainable development.

An Energy Efficiency First principle is strongly reflected in the new Energy Efficiency Directive proposal. It is a good idea, but not one that is always easy or straightforward to implement. Energy efficiency should be taken into account in all energy solutions, but from a climate perspective, the most important thing is to find low-emission solutions.

A large-scale energy efficiency measure, not typically perceived as such in Finland, is Combined Heat and Power (CHP). The efficiency of heat production is identical in a CHP power plant and separate heat production, but benefits emerge in electricity production. Most district heating comes from CHP power plants. In industry, especially the forest industry, the use of CHP power plants is self-evident because processes need both

electricity and heat, and fuel is produced as a by-product of raw material procurement (bark, sawdust, branches, tree crowns, etc.). A low electricity price has undermined the profitability of CHPs and therefore district heating companies have not renewed their CHP power plants.

Between 2008 and 2016, some 650 companies in approximately 5,000 places and 132 municipalities and joint municipal authorities participated in voluntary energy efficiency agreements. At the end of this contract period, the parties saved 15.4 TWh of energy and EUR 529 million in energy and fuel bills per year. The measures reduced emissions by approximately 4.6 Mt CO_2 eq.

Results for the 2017–2025 contract period have been obtained for the period- covering the years 2017–2020. Approximately 700 in around 6,700 places of operation have joined the agreements. At the end of 2020, the measures taken in the first four years of the agreement period had annually saved 8.9 TWh of energy, their monetary savings amounted to EUR 351 million and they accounted for about 2 Mt CO_2 eq. per year. Even though the amount of energy saved was higher than in the previous agreement period, the calculated emission reduction was lower, as the emissions from the use of electricity have been cut, among other things.

In its fourth National Energy Efficiency Action Plan (NEEAP-4), Finland announced to the Commission that it had achieved energy savings of 21.2 TWh in 2010, a total of 37.1 TWh in 2016 and estimated that it would achieve energy savings of 50.3 TWh in 2020. Energy saving impacts were calculated for a total of 32 energy saving and efficiency policy measures. In addition, 14 policy measures whose impacts could not be assessed or it was not appropriate to report them to the Commission. In accordance with Finland's national Energy Services Directive (ESD), the energy savings target for 2016 was exceeded by 35 per cent. Finland also achieved all three national energy savings and reductions targets under the Energy Efficiency Directive (EED) with a good margin: the indicative end use target for 2020, the binding energy savings target for the central government period 2014–2020 and the binding energy savings target for the cumulative period 2014–2020.

Finland has notified the Commission in its National Climate and Energy Plan (NECP) in 2019 that it will achieve energy savings of over 80 TWh by 2030. This is an estimate of the total sum of energy savings made in different sectors. The savings achieved through energy efficiency agreements are the easiest to verify. For other parts, the savings must be estimated. Energy efficiency measures and the resulting savings are broken down in Table 6.

Table 6. Energy efficiency measures and resulting savings in 2030.

Energy efficiency measure	Savings 2030 GWh/year
Energy efficiency agreements: Current status and continuation	25,770
Customer measures for energy efficiency agreements and the HÖYLÄ IV agreement	83
Energy efficiency agreements: Increase in coverage	1,095
Energy efficiency agreements: Development of reporting	1,078
Energy audits: Current state	1,420
Energy audits: Increasing volumes	1,817
Surplus heat	1,600
Renewable energy investments in agriculture (chip and solar power plants)	3,889
Land consolidation	278
Energy efficiency investments by farms	99
EU's binding CO_2 limit values: Cars	8,671
EU's binding CO_2 limit values: Vans	285
EU's binding CO_2 limit values: Trucks	604
Scrapping premium campaigns (in 2015 and 2018)	35
Support for fully electric cars (only until 2021)	0.1
Economic steering that affects transport performance (transport fuel taxation, passenger cars)	1,236
Mass and dimensional changes in heavy goods vehicles	20
Implementation of the Ecodesign Directive	7,075
Heat pumps for single-family and terraced houses	11,956
Construction regulations, energy efficiency in new construction	9,337
Construction regulations, energy efficiency in renovation	3,810
Total	**80,159**

4.4.3 Transport

The energy efficiency of means of transport

The renewal of the vehicle stock is a key factor in improving the energy efficiency of transport. On average, new cars are more energy-efficient than old cars, and the transition to new, more energy-efficient technologies, such as electricity, is mainly achieved through the purchase of new cars.

However, Finland's vehicle stock is very slow to renew. The number of first-time registrations usually varies between approximately 100,000 and 120,000 per year, whereas renewing the car stock would require the sales of around 150,000 cars per year. A significant number of used cars, approximately 35,000 to 45,000, are imported to Finland from abroad each year. Finland's car stock became increasingly outdated between 2010 and 2020. The positive development in the energy consumption and CO_2 emissions of internal combustion engine cars registered for the first time achieved in the 2010s has also slowed down. For diesel-powered cars, consumption and emissions have even started to grow, as the selection of smaller cars no longer includes diesel.

Although the energy efficiency of internal combustion engine cars has not progressed as expected in Finland, the electrification of transport will help to achieve the energy efficiency targets. The share of electric cars in new sales and used imported cars in Finland has been growing very rapidly in recent years. Electric cars accounted for about 7 per cent of newly registered passenger cars in 2019. The share was about 18 per cent in 2020 and about 32 per cent in 2021. The share of fully electric cars was about 10 per cent in 2021 and reached nearly 20 per cent in the year's fourth quarter. At the end of December 2021, there were 99,911 electric passenger cars, of which 22,921 were fully electric cars and 76,990 plug-in hybrids. Together, they accounted for 3.6 per cent of all passenger cars.

The main driver of rapid electrification of transport is the CO_2 limit legislation obliging EU car manufacturers. Under the existing legislation, the average CO_2 emissions from new passenger cars must be at least 37.5 per cent lower in 2030 compared to the 2021-level. According to a proposal submitted by the Commission in summer 2021, the obligation would be made stricter to pursue 55-per-cent lower emissions in 2030 compared to 2021. According to this proposal, all new passenger cars should be zero-emission in 2035 (either fully electric or hydrogen).

Taking into account the new limit values, the aim is to have approximately 750,000 electric cars, about 40,000 electric vans and approximately 8,000 electric lorries and buses in Finland in 2030. At least half of the electric cars and vans would be fully electric cars.

Sustainable modes of transport and shipping

Finland is a sparsely populated country and a car is an essential means of mobility for many people now and in the future. However, there are also alternatives, such as public transport, shared transport, walking and cycling, especially in urban areas and between cities. Through their actions, central government and municipalities can guide people to increasingly switch to these sustainable modes of transport. Delivery of goods can also be made more efficient or be transferred from roads to railways or waterways. Vehicle kilometres travelled will decrease as shipping becomes more efficient and shifts partly to

more sustainable modes of transport. Sustainable mobility or transport usually refers to travel that minimizes environmental hazards and resource use. In most cases, it includes at least pedestrians, cycling and public transport as well as other transport services in passenger transport as well as water and rail transport in the flow of goods.

In the transport in urban areas and between cities, there is a need for a purposeful transition from the current car-centric system towards a sustainable mobility system. This is a significant systemic change in the way people manage their travel and transport needs. A sustainable mobility system manages mobility and transport needs by utilising and combining several different modes of transport and different transport services. Digitalisation and transport-related data play a crucial role in this. Automation can also help achieving the emission reduction targets for transport if it can be used to improve the competitiveness and attractiveness of public transport, for instance.

Measures related to improving the efficiency of the transport system have been investigated in connection with the preparation of the National Transport System Plan. These have been supplemented in the roadmap to fossil-free transport, especially in relation to funding. Under the Highways Act, the National Transport System Plan must be consistent with the General Government Fiscal Plan. The National Transport System Plan examines the transport system as a whole, and in addition to sustainability, has objectives related to accessibility and efficiency.

The objective of the roadmap to fossil-free transport is that the transport performance of passenger cars (number of kilometres driven in passenger cars) will no longer increase in the 2020s. If people's movements and travel needs continue to increase, the aim is to direct this growth towards sustainable modes of transport in urban areas and between cities. This would mean an increase of about 10 per cent in the performance of each sustainable mode of transport in 2030. For individual households in rural areas, car performances may continue to increase, but as the population is increasingly concentrated in urban areas, the combined performances of households throughout the country will remain at the 2019 level.

A target set for the flow of goods is that the performance of vans and lorries will slow down in the 2020s compared to the development so far. The target does not entail a reduction in the transport of goods or economic activity, but instead aims to make the transport of goods more efficient in road transport or a shift to more sustainable modes of transport. Key means of achieving this goal include the digitalisation of logistics and HCT transports. The emissions trading system in road transport proposed by the Commission in 2021 would also have a strong impact on the use of heavy-duty vehicles in Finland.

4.4.4 Buildings and construction

Based on consumption data, buildings and construction account for about one third of Finland's greenhouse gas emissions. Some of these emissions are generated in the emissions trading sector (e.g. energy and part of construction products) and some in the effort sharing sector (e.g. the majority of construction products and emissions from transport, machinery and the treatment and recycling of construction and demolition waste).

For the decarbonisation of the existing building stock life cycle, a key measure involves improving energy efficiency. This involves reducing the energy needs of both heating and cooling without compromising the health of construction. In new energy-efficient buildings, a significant proportion of life cycle emissions are generated by the manufacture of construction materials. The share of heating in the lifecycle emissions of energy-efficient buildings has already fallen to less than half. Road construction involves transporting large masses of land, and emissions are caused by both transport and changes in the degradation of organic matter in the soil.

In order to better steer emissions generated by various sources and distributed over the long life cycle of the built environment, regulatory steering of low-carbon construction based on life cycle assessment has been prepared in accordance with the government programme. In accordance with the regulatory steering, new buildings would be subject to emission limits based on use categories, which would be reviewed periodically in connection with the monitoring of Finland's carbon neutrality target.

Wood construction systems and related expertise have developed significantly in recent years, and cost-competitive wood solutions and system suppliers are available in the market for all building types. Wood construction and the use of wood in construction support the achievement of climate objectives in many ways. The use of wood reduces the carbon footprint of construction. Industrial wood construction promotes the development of material use and work efficiency. Long-term timber products increase the carbon stock held in the building stock. The promotion of industrial wood construction must be continued through various development measures targeting the industrial sector as well as those more generally concerned with competence in the value network of construction. The competence in the procurement of wood and other biomaterials in the public sector must be promoted as part of green public and low-carbon procurement.

The assessment and notification rules related to the environmental data (including carbon footprint) of construction products will be included in the legislative steering at the EU level derived from the EU Construction Products Regulation (CPR) or alternatively from the Sustainable Products Initiative. The carbon footprint data of construction products will be used as the baseline data for assessing the carbon footprint of buildings. From Finland's

point of view, a more efficient and faster route would involve including the environmental data of construction products under the legal framework of the EU CPR rather than waiting for the legislative steering brought by the Sustainable Products Initiative.

Several European countries are developing legislative steering for low-carbon construction. France and the Netherlands have already introduced it. In Sweden, the regulations will enter into force in 2022 and in Denmark in 2023. The steering prepared in Finland has been carried out in cooperation with the other Nordic countries and the European Commission to ensure that the methods used for evaluation are consistent with the EU Level(s) framework. However, coordination of climate impact assessment is still needed between evaluation carried out at the product level, building level and plan level.

4.4.5 Energy efficiency in agriculture

In December 2021, Finland submitted a proposal for a CAP plan for the period 2023–2027 to the Commission. It proposes continuing various energy efficiency measures in farms, most of which have already been implemented in previous rural development programming periods. Among other areas, the plan includes investment aid for energy efficiency and renewable energy investments on farms and support for the costs of farm-specific energy advisory services. National funding also supports land consolidation and the development of the field property structure, which can be used to reduce the fuel consumption of machinery caused when moving it. A new energy efficiency agreement between the Ministry of Agriculture and Forestry and national agricultural and horticultural producer organisations is under preparation.

4.4.6 Energy efficiency targets

Final Energy Consumption (FEC) and Primary Energy Consumption (PEC) are defined as key figures for defining energy efficiency targets in the Energy Efficiency Directive. The definitions differ from the current definitions of energy statistics in several ways, and the total and final energy consumption figures presented in the base and policy scenario in section 4.4.1 cannot be directly compared with the energy efficiency targets.

The FEC and PEC figures do not include heat pump energy, but they include the fuel used by international aviation. The FEC key figure includes actual final consumption, such as electricity and district heating consumption, transport fuels and the fuel used in building-specific heating, but also the energy consumption of blast furnaces in the energy conversion sector.

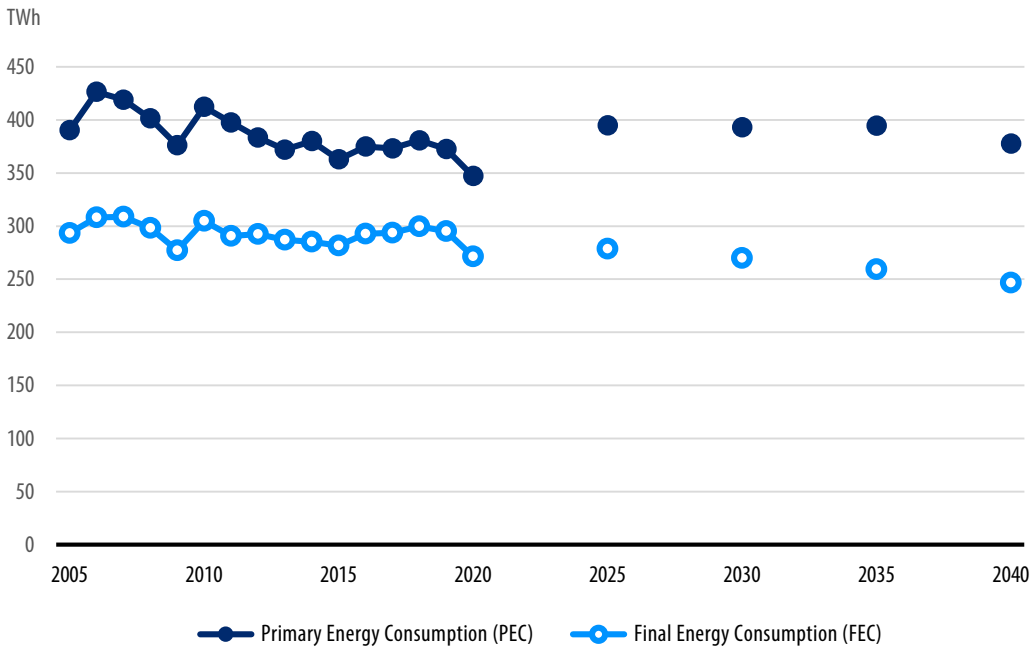
Figure 13 shows the Finnish FEC and PEC figures published by Eurostat for the period 2005–2020 and an estimate of the development of the figures in the policy scenario. In the last ten years, the final consumption figure has steadily remained at around 280 to 300 TWh. The exception is only the year 2020, when the FEC indicator was only 271 TWh. The low final consumption is explained by the exceptionally warm weather that year and the lower transport volumes due to the coronavirus pandemic.

According to a proposal included in the Fit for 55 package, an indicative EU-level target of improving energy efficiency, expressed as a FEC indicator, would lead to a target of about 250 TWh for Finland. In the policy scenario, Finland's final energy consumption in accordance with the EU calculation rules is approximately 275 TWh. The FEC figure in the base scenario exceeds this by just under 10 TWh. This means that the indicative target of around 250 TWh would not be achieved with the assumptions of the policy scenario. Indeed, it is expected that the carbon neutrality targets are difficult to reconcile with energy efficiency requirements despite significant efficiency gains in energy use in all energy sectors. The transformation of the energy system into emission-free energy and partly based on hydrogen and electrofuels requires an increasing number of energy transformations, which also consume energy. In any case, the key is to reduce emissions.

In the National Energy and Climate Plan submitted to the EU in 2019, a maximum of 290 TWh of final energy consumption was declared as the indicative EU target for Finland's energy efficiency for 2030. Taking this into consideration, the FEC key figure in the policy scenario is already clearly lower due to new policy measures and updated scenarios.

Over the years, the PEC depicting total consumption has varied more than the FEC key ratio. In the 2010s, it has been around 350–410 TWh with a slightly decreasing trend. Unlike final consumption, total consumption does not decline in the policy scenarios, but instead rises close to 400 TWh when additional nuclear power replaces imported electricity in the coming years. Nuclear power is calculated as primary energy by multiplying the generated electricity by three.

Figure 13. Key figures for energy efficiency 2005–2020 and estimated development in the policy scenario. Primary Energy Consumption (PEC) and Final Energy Consumption (FEC).



4.5 Energy security of supply and delivery reliability

4.5.1 General information on energy security of supply and delivery reliability

Due to its northern location, Finland needs a lot of energy. The amount of energy needed for heating per capita is among the highest in the world. The industrial sector also needs a lot of energy. Long distances mean that energy consumption in transport is also high.

Finland's energy supply is based on decentralised energy production, diverse energy sources and a reliable transmission and distribution system.

Delivery reliability is scaled to maintain society's functioning during incidents under normal conditions and in emergency conditions, including during prolonged crises due to political, economic and military pressure.

Preparedness to secure the supply of electricity is based on insuring an energy supply that is as uninterrupted as possible under normal conditions. Preparedness and emergency plans have been created in the sector to secure production, import, transfer and distribution networks and transport and storage systems.

The production readiness of companies in the energy sector, the administration of energy supply and delivery reliability obligations are guided by several acts, decrees and regulations, such as

- Government Decision on the Objectives of Security of Supply (VnP 1048/2018)
- Electricity Market Act (588/2013)
- Natural Gas Market Act (587/2017)
- EU Regulation concerning measures to safeguard the security of gas supply (2017/1938)
- The EU Directive (2009/119/EC) to maintain minimum stocks of crude oil and/or petroleum products
- Act on the Compulsory Stockholding of Imported Fuels (1070/1994)
- Act on Safeguarding Delivery Reliability concerning state emergency stockpiling (1390/1992)
- International contractual obligations (IEA, EU) concerning emergency preparedness of energy supply
- Separate instructions issued by the Ministry of Economic Affairs and Employment to power companies on the stockpiling of nuclear fuels
- Emergency Powers Act
- Act on Stockpiling of Fuel Peat (321/2007)

The National Emergency Supply Agency plays a key role in ensuring energy security. Its tasks include ensuring energy supply that is as uninterrupted as possible, monitoring the impact of the development of the energy market on the delivery reliability, promoting the consideration of the delivery reliability perspective in decision-making, developing new, effective means to ensure delivery reliability, and promoting overall preparedness and emergency planning in the sector.

Energy companies and other organisations play a key role in ensuring delivery reliability. Fingrid Oyj has been appointed as the regional network operator for the main electricity network in Finland and Gasgrid Finland Oy as the regional network operator for the gas transmission system. The regional network operator's tasks include ensuring the technical functionality of the network even during incidents and for investigating any disruptions and restoring the transmission system to its normal condition.

To prepare for any disruptions in the availability of energy and to meet commitments under international obligations, Finland keeps reserves of imported fuel covering on average the normal consumption of five months. The target is met by obligatory stockpiling maintained by companies and state emergency stockpiling.

The compulsory stockpiling of imported fuels applies to coal, crude oil and other feedstocks used in oil refining, essential petroleum products and natural gas.

For overall security, one aspect of climate change is its impact on the stability and security of societies. According to the Intergovernmental Panel on Climate Change (IPCC), the changing climate hinders industries, increases forced migration and may contribute to exacerbating conflicts. Climate change has consequences for tensions between population groups, international relations, the economy and security policy. As climate change has very wide-ranging and complex effects on security, related preparedness must also be multidisciplinary and multilateral. This topic has been examined in a publication by the Government's analysis, assessment and research activities, Climate change and Finland's security: Threats and preparedness in the model of comprehensive security[23].

4.5.2 Electricity security of supply

Adequacy of electrical power and transmission capacity

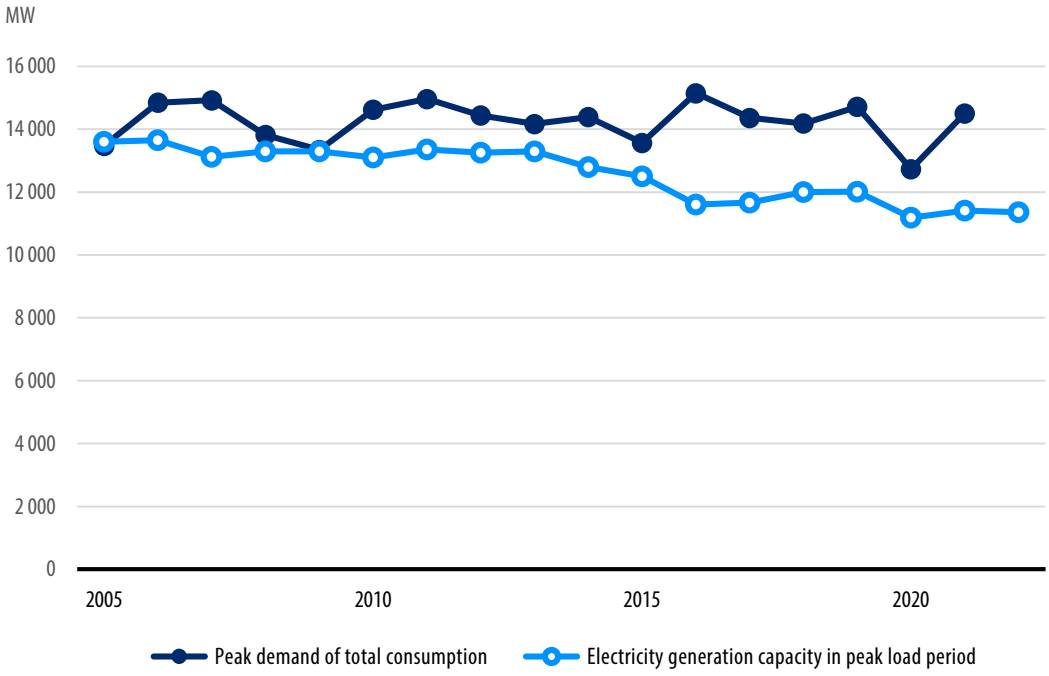
As Finland is a country dependent on imports, various individual disruptions have a significant impact on the sufficiency of electricity in the country. Weather conditions, especially temperature, also have a significant impact on the sufficiency of electricity. Electricity consumption is highest during the cold winter months in Finland. The hourly peak electricity consumption varied between 13,300 MW and 15,100 MW in the period 2005–2019 (Figure 141414 MW). However, the Energy Authority has estimated that in the next few years, electricity consumption peaks may reach between 15,300 and 15,500 MW on cold winter days as electricity consumption increases. The peak consumption in winter 2020–2021 was in January 2021 at approximately 14,200 MW.

The electricity production capacity available in Finland is significantly lower than the peak electricity consumption. Although the total nominal power generation capacity of the power plants is approximately 17,500 MW, the electricity generation capacity available on the electricity market during the peak load period is highly probably less than 12,000 MW. This is due to the fact that the full production capacity is practically never available at the same time, as the production is affected by aspects such as weather and water conditions. Figure 14 shows the *electricity generation capacity in the peak load period* published by Statistics Finland and its development over the years. The difference with actual peak consumption has increased significantly since 2013 and is currently between 2,000 and 3,000 MW. Once the third Olkiluoto power plant unit becomes available for market use, the difference will grow significantly narrower again. The peak load period capacity figure

23 http://urn.fi/URN:ISBN:978-952-383-386-9

does not include system reserves, and the hydropower capacity corresponds to the capacity during a dry water year and includes 6 per cent of the nominal wind power.

Figure 14. Peak power of total electricity consumption and electricity generation capacity in the peak load period. Source: Statistics Finland.



Finland's international electricity transmission connections with the neighbouring countries amount to 5,100 MW, of which approximately 1,400 MW is with Russia. The transmission capacity between Finland and northern Sweden will be limited by approximately 300 MW when the third Olkiluoto power plant becomes operational due to requirements related to the technical stability of the electricity network. According to the current estimate, Olkiluoto's third power plant unit will be commissioned for commercial use in the summer of 2022. The national transmission grid companies of Finland and Sweden have decided to strengthen the alternating current connection between the countries by 2025, with a new capacity of 800 MW from Sweden to Finland and 900 MW from Finland to Sweden. Other significant changes in the volume of transmission capacity will not be known in the next few years.

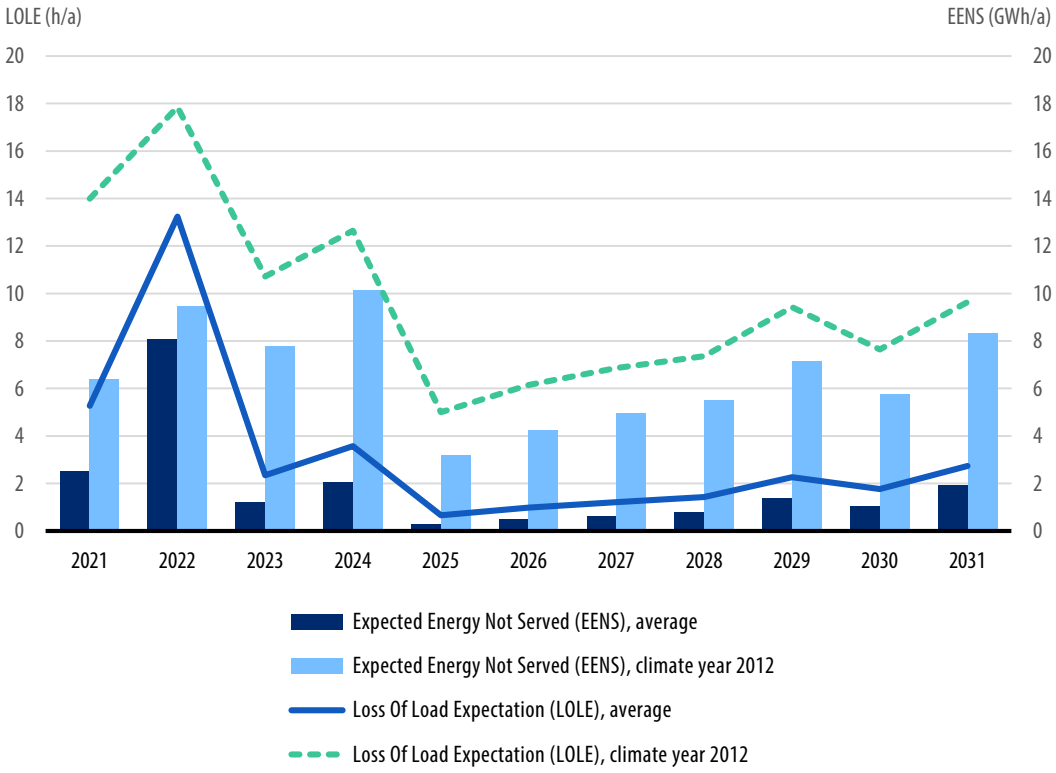
The Energy Authority has estimated that the production capacity no longer available in Sweden, especially in the SE3 price area, will affect the expected value of the power gap and the need for a peak-load reserve. While a situation in which electricity imports from

Russia or Sweden alone would be interrupted does not pose a major problem in terms of the adequacy of electricity on its own, if electricity imports from both sources were interrupted simultaneously, the risk of a loss of load would be significant. However, such situations are considered to be rare and of short duration. According to a decision made by the Energy Authority on the need for a peak-load reserve in 2019, the completion of the third power plant unit in Olkiluoto will have a significant positive impact on the sufficiency of electrical power in Finland. When the power plant is in operation during the winter months, there would be little risk of a loss of load; meanwhile, in an opposite situation, there is a justified concern for the adequacy of resources.

Finland has a peak-load reserve system that aims to ensure electricity security of supply during the winter if domestic electricity production and imported electricity are not sufficient to cover the demand for electricity. A key principle of the peak-load reserve system has been that it should have only limited effects on the price formation of the electricity market. In the period 2012–2020, the capacity of the maintained peak-load reserve for electricity production varied between 299 MW and 729 MW. The cost of the system has been around EUR 2 million per 100 MW during the last three tender periods. For the peak-load reserve period 2020–2022, the volume of the peak-load reserve is 611 MW and the costs remained at the previous level.

Fiqure 15 shows probability calculations of the sufficiency of energy supply until 2031 without peak-load reserve capacity. The figure shows the Loss of Load Expectation (LOLE), which reflects the number of hours at which there would be a shortage of electricity based on the probability calculation. The Expected Energy Not Served (EENS) illustrates the amount of energy not supplied during an electrical shortage. The figure shows the significant impact of the Olkiluoto 3 unit on LOLE, as well as the impact of the third alternating current connection to be introduced between Finland and Sweden in 2025. The figure also shows the impact of the cold and low-wind year (the weather year 2012) on electricity sufficiency. In general, Europe is aiming for the LOLE of approximately 2 to 5 hours.

Figure 15. Loss of Load Expectation and Expected Energy Not Served during an average weather year and a cold winter (weather year 2012). Source: AFRY. 2021.



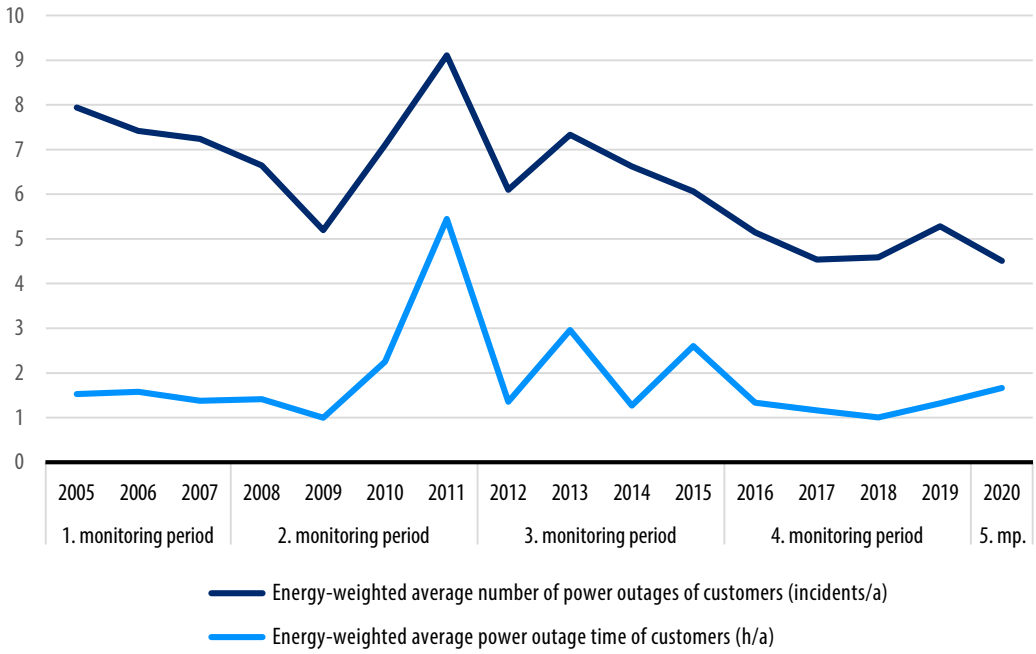
The EU Regulation on the internal market for electricity (2019/943), adopted in 2019, regulates the different reserve arrangements in detail. In accordance with the requirements of the Regulation, the Act on Peak-Load Reserve was amended at the beginning of 2022. In accordance with the requirements of the Regulation, the peak-load reserve system must also be approved as by the Commission as government support. This process is still ongoing in Finland.

Detailed EU regulation mainly concerns the definition of the need for the reserve and the principles for launching the reserve. In the future, the assessment of the need should be based on a European method, which also defines the situations that may cause concern in the Member States. The peak-load reserve can be launched when the electricity transmission system is likely to have used all its control resources. When peak-load reserve units are introduced, energy imbalances must be priced according to the undelivered electricity. In practice, this means that when the peak-load reserve system is launched, the price of electricity is so high for the party that caused the imbalance that consumers should not buy electricity. Changes in the operating rules and assessment methods undermine the usefulness of the peak-load reserve in preparing for different risk situations.

Security of supply of electricity distribution networks

The security of supply of electricity distribution networks and the quality of electricity are vital for the functioning of society as a whole. The development of the security of supply of electricity distribution networks during four monitoring periods of the Energy Authority from 2005 onwards is shown in Figure 16 The figure shows key ratios of security of supply; the average interruption period for the customer and the average number of interruptions for the customer with weight on energy.

Figure 16. The key figures for the security of supply of electricity distribution networks in the period 2005–2020.



There is considerable annual variation in the number and time of interruptions as well as between the networks of different electricity distribution system operators. Factors affecting interruptions include network structure, location, climate conditions and, for example, the amount of backup connections and degree of automation.

A high number of interruptions usually indicates exceptionally severe storms or heavy snow loads in the distribution system operator's area. Overhead wires, which are particularly susceptible to climate fluctuations, are more sensitive to faults in such circumstances.

Examples of storms that caused extensive interruptions include the winter storms named Tapani and Hannu, which hit large areas in the southwestern and southern Finland in December 2011. Damage to overhead wires caused by trees falling down during the storms resulted in extensive and partly long-term power cuts in sparsely populated areas and rural agglomerations. The power cuts caused by the storms affected a total of 570,000 electricity users, amounting to about 17% of all electricity users connected to medium and low voltage networks. The maximum number of electricity users without electricity at the same time was 300,000, or approximately 9 per cent of all electricity users. The longest reported power outages lasted 15 days. Many functions of society, such as communications networks, were subject to interruptions caused by the power cuts. In the 2000s, storms or heavy snow loads that caused major disruptions or other major interruptions in the electricity distribution networks occurred at least in 2001, 2004, 2005, 2010 and 2011 as well as later.

The new Electricity Market Act (588/2013) entered into force on 1 September 2013. The Act included a new extensive set of provisions aimed at improving the security of supply of electricity networks and particularly distribution networks, and enhancing the preparedness of electricity network operators. The objective of setting the security of supply targets was to respond to the growing security of supply needs of a society increasingly dependent on electricity, to prevent repair backlog in electricity distribution networks, and to prepare for the increase in extreme weather phenomena caused by climate change.

Improving security of supply results in costs and some distributors of electricity and natural gas informed their customers of exceptionally high price increases in winter 2016. The price hikes by two distribution companies in particular triggered a large number of complaints submitted to the Consumer Disputes Board and the Consumer Ombudsman. Hundreds of thousands of customers were affected by these price increases. The development of the electricity transmission price is examined in more detail in Figure 21.

From the perspective of the reliability of electricity distribution, it is essential to make any overhead line sections in a high-risk environment, such as the forest, more reliable. Ground wires provide an efficient and widely used method for improving security of supply and meeting the quality requirements of distribution network operations. In addition to ground wiring, there are other options to improve security of supply and different electricity distribution system operators use different means to meet the quality requirements of the networks.

In their development plans submitted to the Energy Authority every two years, network operators report on goals set for issues such as the ground wiring of the medium voltage grid and report on the share of ground wiring used. According to Energy Authority data,

the share of ground wiring in the medium voltage network in Finland almost doubled between 2016 and 2020, while the share of the overhead lines in forests, roadsides and other open areas has decreased. The share of ground cables has already been higher in the low-voltage network, so growth has not been quite as high. For most network operators, the target for ground wiring is less than 50 per cent.

Due to security of supply investments, there has been a decrease in the variation and level of the average interruption period in recent years.

4.5.3 Heating delivery reliability and security of supply

Heating delivery reliability and security of supply in Finland is currently largely based on the availability of wood fuels, oil, natural gas and coal. In the short term, there may be changes or at least strong price fluctuations in the availability of oil and particularly natural gas. The availability of energy peat has been continuously declining on market terms as its use and production have declined, and its significance for the delivery reliability has also declined. However, for the time being, it appears that some energy companies still have a desire and boiler capacity to use energy peat at least in the 2022–2023 heating season due to a poorer outlook for the availability of imported chips. The energy use of coal will be abandoned by 2029 and effectively largely by 2025, and will be compensated by developing the supply chains for forest biomass.

Overall, the energy use of peat will already fall below the minimum target level set for 2030 in the government programme on market terms. This will be due to an increase in the price level of the emission allowance that far exceeds the forecasts and will also have an impact on delivery reliability and security of supply in the next few years. Nowhere near all heat producers that need to use peat (usually in co-combustion) in their boilers will be able to make the necessary investments for abandoning peat on such a fast schedule. As a result, in the mid-term policy review of spring 2021, it was decided that the upper limit for tax-free energy use of peat would be raised from the former 5,000 MWh per year to 10,000 MWh and to extend it to cover also the annual use of more than 10,000 MWh. This is a fixed-term measure that aims to provide cost relief to the heat producers until they fully abandon peat.

As the price of the emission allowance is expected to remain high and the floor price mechanism decided in autumn 2020 will increase the peat tax when the price of the emission allowance is low, the upper limit of tax-free use is not expected to have a significant impact on the use of energy peat in the emissions trading sector. Outside the emissions trading system (which includes the peat boilers of many small municipal energy companies), the measure aims to somewhat slow down a severe collapse in peat demand

and production, therefore safeguarding security of supply in the next few years before all peat-fired boilers have been replaced by other alternatives. If successful, the measure would also have an impact on the delivery reliability, as the above boilers are usually based on the co-combustion of peat and biomass. For example, if the availability of forest biomass was temporarily restricted, more peat than in the normal co-combustion method could be burned in the boilers during this exceptional situation until replacement by a new heat production capacity. However, demand for peat has recently fallen so rapidly and dramatically that the availability of peat and therefore also its role as a long-term delivery reliability fuel is beginning to be threatened. The rapid decline in peat production and demand also significantly undermines the functioning of the security stockpiling system for peat referred to in the Act on the security stockpiling of fuel peat (321/2007).

To ensure the delivery reliability of heat, new operating models should be considered to prepare for changes in the fuel market and variations in production conditions. The National Emergency Supply Agency is establishing an emergency stockpile for energy peat. This is particularly due to the end of Russian chip imports in March 2022 and the time required for the development of new forest chips supply chains.

However, despite the above measures, in the longer term there is a risk that the use of peat for energy and, as a result, also production, will collapse to such an extent that significant amounts of energy peat will no longer be available, even in exceptional circumstances. As a result of the decline in the use of peat and coal for energy, forest chips alongside oil and gas gain more emphasis in delivery reliability and security of supply.

The share of forest industry side streams and forest chips as a source of energy for district heating has been growing annually to 37% in 2021, reflecting the significant role of wood fuel in heat production. Abandoning the use of coal and peat will reduce fuel alternatives for heat supply and significantly increase the need to increase the use of energy wood as early as in the next few years. According to several scenarios, the significance of wood fuels in energy production will remain high for at least 20 to 30 years, if not longer, as non-combustion technologies are still developing.

From a delivery reliability perspective, the extensive use of forest chips poses challenges. Forest chips lose some of their heating value when stored, and stockpiling takes up a lot of space due to this, rather low, heating value. The raw materials for forest chips must usually also be dried over the summer, unless it makes sense to use moist chips in a heating or power plant, for example because of the use of a flue gas scrubber. However, on average, the increase in biomass production includes a significant delay from the perspective of delivery reliability, which in practice means that increasing the production of forest chips can only partly affect the situation during the next heating season. There is no statutory requirement for the obligatory or security stockpiling of forest chips similar to that for coal

and energy peat; instead, preparedness is based on measures taken by energy companies and fuel suppliers. In order to improve the supply of Finnish forest chips, the collection of small-diameter wood at young forest management sites will be promoted as part of the current Kemera support system and the possibility of including the subsidy in the new incentive scheme for sustainable forestry after 2023 will be assessed. The primary purpose of the subsidy is to encourage timely forest management, taking into account the EU's guidelines on government support as well as biodiversity perspectives.

Storage and transport in supply chains are important factors in the supply chain for forest chips. Chips cannot be stored for long periods due to the deterioration of quality. On the other hand, from a final use perspective, chips provide the most effective way to transport forest biomass intended for energy use. So far, the availability of forest chips has been good compared to demand in most of Finland compared to demand. As a result, roadside chipping has served as a generally functional supply chain, ensuring sufficient and affordable security of supply; meanwhile, terminal chipping requires a higher volume and good transport connections to users. However, the growing demand for forest biomass in energy production is likely to change the situation in the future, as demand in some areas exceeds the supply in the nearby region. In this case, security of supply will become a more critical factor, and forest biomass must be imported from further away than before and stored to ensure steady year-round availability.

A forest biomass supply chain based on a terminal network would enable better storage of energy wood and logging residues, cost-effective chipping and transport as chips, although the transfer of biomass in the terminal would also increase costs in the chain. In addition to improving the availability of domestic solid wood fuel fractions, efforts will be made to examine the possibility of strengthening the network of biomass terminals and loading points and improving the condition of related routes, which are important for the delivery reliability and are operated year-round. Biomass terminals must already be taken into account in regional land use plans or national land use targets and by harmonising plan notations. The environmental permit process will be developed to ensure that biomass terminal projects important for the energy delivery reliability will not fail due to the excessive duration of the permit process.

As the total use of wood fuels increases, imports of forest chips have also grown since 2017, accounting for 24 per cent of the total amount of chips used in energy production in 2020. The high share of wood chip imports can be considered a risk to the energy delivery reliability. The consulting company AFRY modelled this issue in its report on the availability of forest chips published in spring 2021. Based on the modelling results, the use of imported biomass in energy production is mainly concentrated on the eastern border and coastal installations. While imports reduce Finland's energy self-sufficiency, they also enable larger one-off shipments and diversify the risk associated

with availability. In principle, energy wood purchased from the Baltic countries can be considered to contain similar risks related to the market and temporary disruptions as in the Finnish market. For biomass imported from Russia, the supply includes not only the above-mentioned factors but also the political risk and uncertainty that has already been realised. Even if Finland had sufficient resources to replace imported biomass in the eastern region, domestic supply chains are hardly prepared for a rapid increase in supply volumes, at least at the moment, due to rapid changes in the availability of imported energy wood. For this reason, some energy companies have already announced that they will replace forest chips with energy peat in the heating period 2022–2023. Therefore, the use of imported chips also stands in favour of the argument that there is need to pay more attention to the functioning of energy wood stockpiling and supply chains.

On the other hand, Finland's carbon neutrality target also requires transitioning to electricity-based solutions in the heating sector (such as using waste heat with heat pumps and geothermal heat). Delivery reliability and security of supply are expected to remain good if the demand for electricity is moderate, but the situation may be considerably more difficult if the demand for electricity increases significantly and the volume of so-called baseload production decreases and is increasingly replaced by wind power, for instance. This may increasingly lead to a situation in which periods of very high electricity prices recur in the market. In this case, the heating sector will probably need to prepare for these periods by means of long-term storage of heat, which is already increasing, as well as sufficient reserve capacity with low investment costs due to low utilisation rates (currently in practice oil and natural gas boilers and in some cases also boilers using pellet or other biomass).

4.5.4 Security of gas supply

Most of the gas entering Finland is fed from Russia via the Imatra border point. The connection's feed capacity is 220 GWh/d. In addition, the Balticconnector gas pipeline has been constructed between Finland and Estonia (capacity 55 GWh/d in winter), also enabling the supply of gas from other sources. The connection capacity will increase to 80 GWh/d over the next few years as a result of investments in the Baltic countries. In addition, an LNG terminal is being completed in Hamina in the summer of 2022, from which gas can be fed into the network at 5 GWh/d. The terminal has a technical reserve of +15 GWh/d for additional evaporators, which would allow increasing the capacity to 20 GWh/d.

According to a government decision (1048/2018), for Finland to be prepared for disturbances in the availability of imported energy and to meet the commitments under international agreements, the National Emergency Supply Agency holds imported

fuels in state-owned reserves to last for the normal consumption of an average of five months. These reserves are dimensioned to only take into account the use of oil products as a back-up fuel for natural gas in the energy supply of communities. The obligatory stockpiling of imported fuels that applies to companies importing natural gas in accordance with the Act on Compulsory Emergency Stocks of Imported Fuels is used to cover an amount equal to the average fuel use of three months. In 2021, the obligation covers 2.1 TWh. The obligatory stockpiling and emergency stockpiling does not apply to the industrial use of natural gas, in which case the industry takes care of the necessary backup arrangements at its own discretion. The obligation stockpiling of natural gas is mainly carried out with coal and oil, but to a lesser extent also with peat and LNG. In the future, the Hamina LNG terminal will make it possible to increase the role of LNG in preparing for disruptions in gas imports.

4.5.5 Abandoning Russian fossil energy

Measures by the EU

An increasingly tense geopolitical situation and rising energy prices have highlighted the importance of delivery reliability and security of supply as well as the cost-effectiveness of the energy system alongside the climate perspective. Following the Russian invasion of Ukraine, the EU imposed severe economic sanctions on Russia.

On 8 March 2022, the EU Commission published a REPowerEU communication to make Europe independent from Russian fossil fuels before 2030. In its session in March 2022, the Council of Europe outlined that efforts should be made to make Europe independent from Russian imports of gas, oil and coal as soon as possible. A European Commission communication of 18 May 2022 on the REPowerEU plan contains proposals for amendments to existing legislation, as well as recommendations, strategies and communications. The proposals include measures to save energy, diversify energy sources and rapidly replace fossil fuels. The plan also contains measures related to funding.

The REPowerEU plan is based on the full implementation of the Fit for 55 package. The package does not change the 55-per-cent greenhouse gas emission reduction target by 2030 of the Fit for 55 package, nor does it change the European Green Deal climate neutrality target for 2050. However, according to the Commission, a rapid withdrawal from Russian energy requires rethinking the renewable energy and energy efficiency targets. Among other things, the Commission proposes to expand the Renewable Energy Directive to raise the renewable energy target from the 40 per cent proposed in the Fit for 55 package to 45 per cent in the EU by 2030. The Commission also proposes changes to speed up and simplify licencing procedures. In the area of energy efficiency, the Commission proposes that the Energy Efficiency Directive's target for 2030 in reducing

energy consumption at the EU level be made stricter, from -9% in the Fit for 55 package to -13%. The stricter energy consumption target means that the final energy consumption in Finland would be at most 239 TWh in 2030, while the 9-per-cent target proposed in the Fit for 55 package would mean that Finland's final energy consumption would be 250 TWh. The Commission also proposes an amendment to the Energy performance of buildings directive to ensure a solar energy capacity for new buildings and the installation of solar energy equipment in buildings.

As regards funding, the Commission proposes that the RRF should act as a framework for channelling REPowerEU funding and implementing projects. Member States' recovery and resilience plans should include a separate REPowerEU section. The new REPowerEU section should include reforms and investments to diversify energy sources in the Union or reduce dependence on fossil fuels before 2030. The grant-type funding for REPowerEU projects would consist of new funding amounting to EUR 20 billion, which would be transferred from the revenue from the sale of emission allowances in the EU ETS market stability reserve.

RePowerEU also contains several communications and recommendations aimed at saving energy, diversifying sources of energy supply and swiftly replacing fossil fuels. The Commission also proposes a series of measures to increase the production of biogas and replace it with natural gas.

Situation in Finland

A significant amount of energy has been imported to Finland from Russia. Especially the oil and coal imports have been based on a competitive price and a short transport distance rather than Finland's dependence on Russian energy in particular. Crude oil imported from Russia has been processed in Finland to meet the domestic demand for petroleum products, but also largely for exports of petroleum products to the global market. Table 7 shows a summary of Finland's energy imports from Russia.

Table 7. Finland's energy imports from Russia, EUR million.

Value of energy imports, in total of all countries, EUR million			From Russia, EUR million		Russia's share, %	
	2020	2021 preliminary data	2020	2021 preliminary data	2020	2021 preliminary data
Carbon	258	345	75	126	29%	36%
Natural Gas	396	1015	270	760	68%	75%
Oil	5148	6856	2979	3817	58%	56%
electricity	625	1730	93	563	15%	33%
Nuclear fuel	84	151	27	32	32%	21%
Total	**6512**	**10097**	**3445**	**5296**	**53%**	**52%**

Oil and coal are global fuels with several sources of supply. Several companies, such as Neste and Helen, have announced that they are rapidly changing their own sources of supply. As a result, the import of crude oil and coal from Russia to Finland will end at the end of the existing procurement contracts. Finland has obligatory and emergency stockpiling arrangements for oil and natural gas. However, the situation for natural gas is still challenging, even though natural gas accounts for only 5 per cent of Finland's total energy consumption. Natural gas pipeline delivery to Finland in accordance with Gasum Oy's procurement agreement was interrupted on Saturday 21 May 2022 at 7 a.m. The Balticconnector gas pipeline between Finland and Estonia, commissioned two years ago, provides Finland with an alternative route for gas supply, and the existing LNG infrastructure can also be utilised. However, these sources do not cover the entire demand for natural gas. It is particularly difficult to replace the natural gas used by industry in the short term. On 20 May 2022, Gasgrid Finland Oy and Excelerate Energy, Inc., from the United States, signed a ten-year lease agreement for the floating LNG terminal vessel Exemplar. The intention is to get the vessel running in the winter of 2022/2023. The terminal vessel will be located in Southern Finland. The necessary harbour facilities will be built for the ship on the coasts of both Finland and Estonia. If construction is completed in Estonia before Finland, the terminal ship can be temporarily placed on the Estonian coast until the required infrastructure in Finland is completed.

While oil and coal as global fuels have several sources of supply, the availability of forest chips and peat is strongly based on the domestic market in the changed situation. About a quarter of the chips have been imported from Russia. On 10 March 2022, the Russian Government published its regulation 313, according to which the export of chips (customs codes 4401 21 and 4401 22), raw timber (4403) and veneer sheets (4408) for plywood will

be banned to so-called "unfriendly countries", including Finland. International certification schemes PEFC and FSC have already previously reported the definition of Russian wood raw material as conflict timber leading to decisions by companies to suspend imports of raw timber, including energy chips, from Russia. The disruption of imports must be covered by increasing the domestic supply of chips and the use of peat. In April 2022, the Ministerial Working Group on Preparedness agreed on a set of urgent measures to ensure national delivery reliability in a rapidly changing security environment and to safeguard the production and availability of affordable energy in the current situation and in the near future. The measures include increasing the availability of forest chips and ensuring peat production to safeguard the delivery reliability. The National Emergency Supply Agency decided to establish an emergency reserve for peat.

Imports of electricity from Russia ceased on 14 May 2022. Even before that, Fingrid had announced that it would limit imports of electricity from Russia to 900 MW. According to reports[24], the end of electricity imports from Russia would increase the price of electricity in Finland annually by approximately EUR 4–5/MWh in a situation where fuel prices would be at around the 2021 level. The end of Russian electricity imports also roughly doubles the likelihood of electrical shortages, which is at a fairly high level before the full implementation of Olkiluoto 3. Electricity shortages are most likely to occur during the winter season, so for 2022, security of supply will remain at a sufficient level despite the end of electricity imports. Olkiluoto 3 should be running in winter 2022–2023, which will fully replace the Russian imports.

Olkiluoto 3 started electricity production on 12 March 2022. During the test phase, the power of the OL3 plant unit is increased gradually to 1,600 MW. The production volume during the testing period is high, around three to four terawatt hours, which accounts for about 10 per cent of Finland's electricity demand. Power levels vary significantly during the testing phase. In addition, nearly 2,000 MW of wind power will be completed in Finland on market terms during 2022, which will further improve the situation.

In April 2022, the Ministerial Working Group on Preparedness also agreed on a set of measures aimed at significantly accelerating the abandonment of fossil energy and supporting the adoption of new technologies. The measures include accelerating energy investments, abandoning fossil fuels in transport and heating solutions for single-family houses and public properties.

24 Report on the impact of the carbon limit mechanism on the price of electricity, AFRY 29.3.2022. https://tem.fi/documents/1410877/2132100/Loppuraportti_Selvitys+CBAM-maksun+vaikutuksesta+sähkön+hintaan_29032022.pdf/

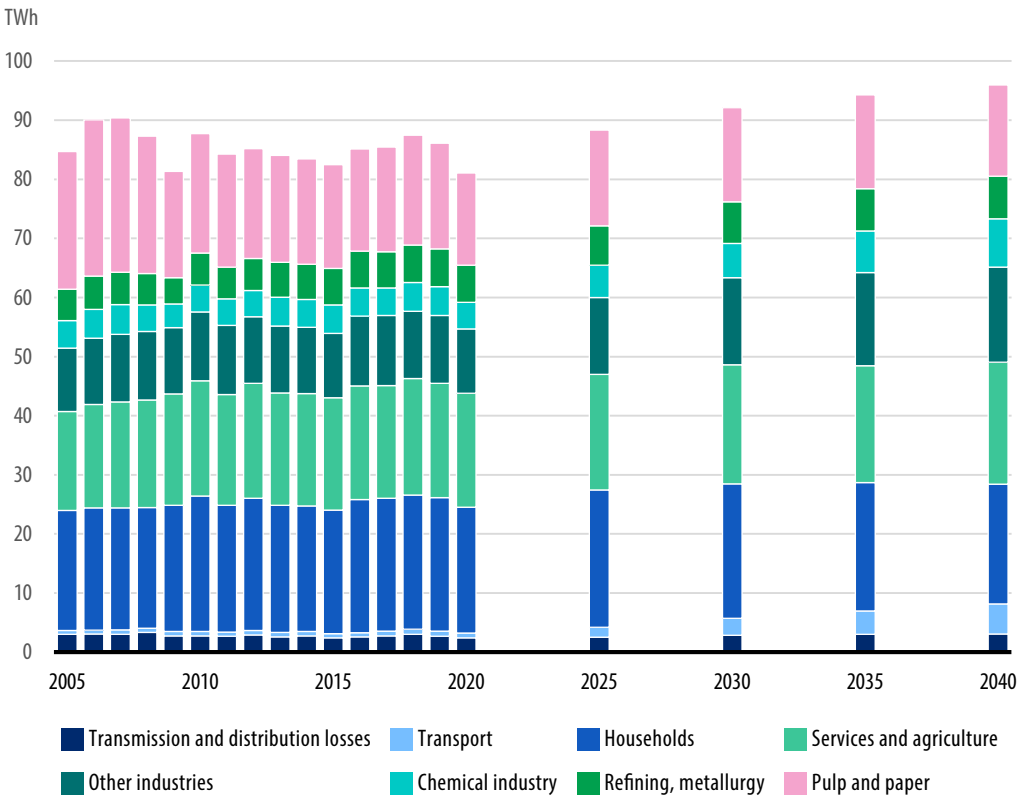
4.6 Energy markets

4.6.1 Electricity market

Current state and development of electricity use and supply

Since the early 2000s, electricity use has varied between 80 and 90 TWh. Annual fluctuations are mainly caused by fluctuations in heating demand, economic situation and industrial production. Electrification is a key change trend in all sectors. In the base scenario, electricity consumption is expected to increase to 92 TWh in 2030 and 96 TWh in 2040 (Figure 17). The increase in consumption is only partially compensated for by more efficient use of energy. The final consumption of electricity will increase particularly significantly in transport and industry. New electricity consumption will emerge due to issues such as digitalisation, energy stockpiling and the expansion of the processing of carbon-neutral electrofuels.

Figure 17. Electricity consumption 2005–2020 and development in the base scenario 2025–2040.

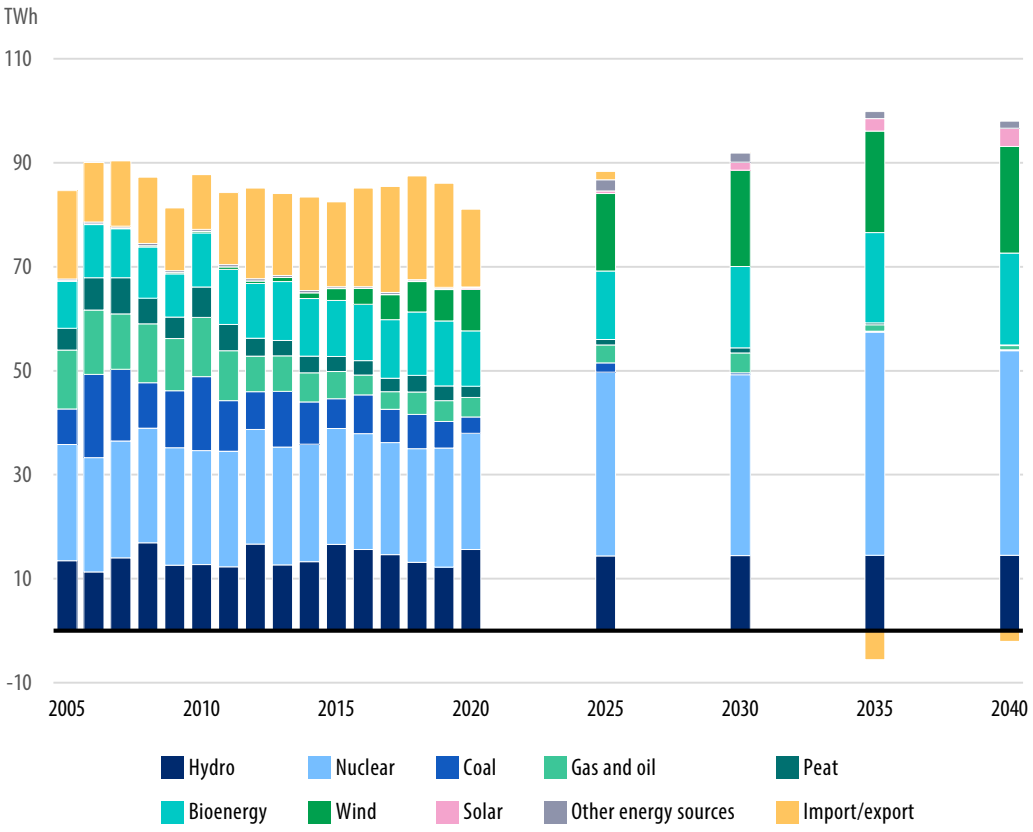


Traditionally, electricity supply in Finland has been diverse when it comes to both energy sources and production technology (Figure 18). Electricity production is currently undergoing a major change both in the common European electricity market and in Finland. The profitability of condensing power plants has collapsed; indeed, most of the plants in Finland have been decommissioned. The combined heat and power production of communities is also declining. The ban on coal will cease its use in electricity and heat production by 2029 at the latest. Electricity production from renewable energy sources has grown steadily and now accounts for about half of all electricity production. The share of electricity imports has been quite high for the past ten years – on an annual basis, about one fifth of the total supply has been covered by imports. This will already change in the next few years, as the Olkiluoto 3 nuclear power unit, currently under construction, will enter market use and more wind power is constantly constructed.

In the base scenario, the growing electricity demand is mainly covered by nuclear and wind power. Domestic electricity production will increase so much that Finland will become self-sufficient in electricity supply by 2030 and even a net exporter after that.

In the scenario, nuclear power generation will be 43 TWh in 2035, and Finland will be a net exporter of electricity by 6 TWh annually. The scenario calculation does not take into account the information about Fennovoima Oy's decision to withdraw the construction licence application for the Hanhikivi 1 nuclear power plant, which was revealed after the scenario calculation. Without Hanhikivi 1, the nuclear power volume will be about 10 TWh lower, and Finland will have slight electricity net imports in 2035. The continuation of the production of Loviisa units until 2050 will approximately replace the lost production volume of Hanhikivi 1, which will make the impact of the changed nuclear power situation on the scenario minor from 2040 onwards.

Figure 18. Total supply of electricity 2005–2020 and development of supply in the base scenario 2025–2040. Electricity exports are indicated as negative figures at the bottom.



The policies presented in the strategy are expected to increase the demand for electricity, especially after 2030. In the policy scenario, electricity consumption will be 95 TWh in 2030 and 104 TWh in 2035, which is 3 TWh and 9 TWh more than in the base scenario. Relative growth is highest in electricity use and fastest in transport. Quantitative growth is the highest in the industrial sector. Electricity consumption in households and the services sector remains at around the current level: while the share of electricity of purchased energy used for heating buildings continues to increase, energy consumption for heating becomes more efficient thanks to the increasing utilisation of heat pumps and technological advances. In the energy industry, electricity consumption will increase as a result of the introduction of new fuel processing and storage technologies and the utilisation of heat pumps and electric boilers.

The electrification of the energy economy and the abandonment of fossil fuels, which is faster in the policy scenario than the base scenario, are reflected especially in the use of wind power but also solar power. The annual production of wind power will multiply

from the current amount in the policy scenario to 23 TWh in 2030 and 30 TWh in 2035. The corresponding figures for solar power are 2.4 TWh and 3.4 TWh. Electrification and increased emission-free production go hand in hand. A failure to electrify energy use processes would mean no more production and vice versa.

Development of electrical energy prices

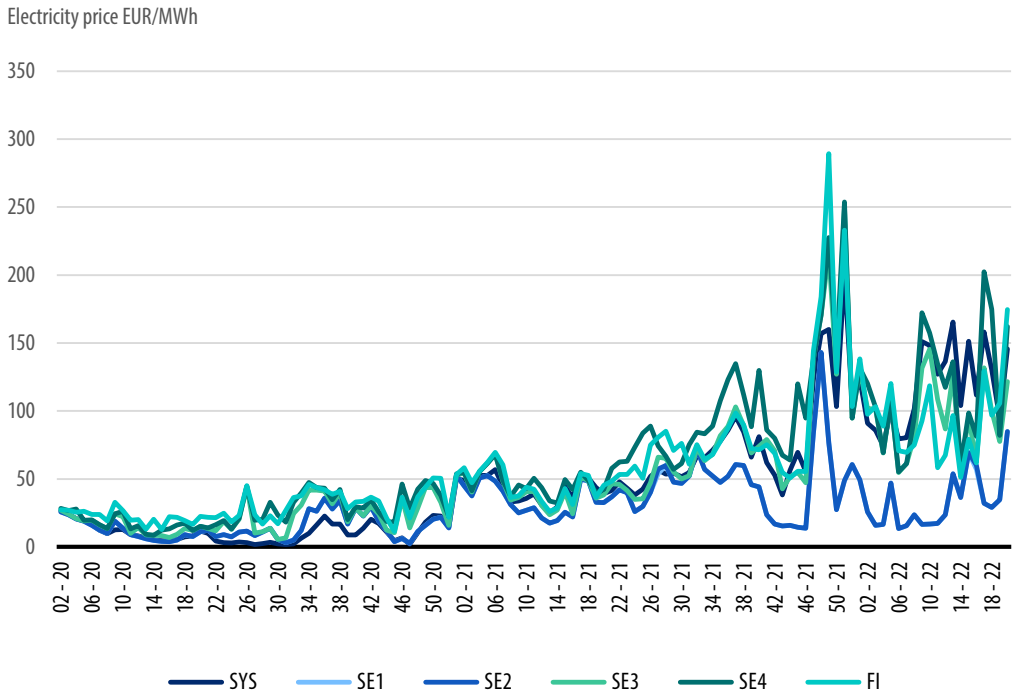
In the electricity market, prices are based on demand and supply for each hour on the basis of the cost of the most expensive form of production. This gives producers an incentive to offer their capacity to the market in line with the changing costs of production facilities. This system has been considered to be the most efficient way of ensuring that the market price covers the investment costs and operating costs of operators while ensuring the lowest possible cost to consumers.

The changing costs of power plants are significantly affected by the fuel and emission allowance costs of the plants. While variable production costs are low for wind, solar, water and nuclear energy, their investment costs are high. If these forms of electricity generation can meet the demands, the market price will remain low. This was the case, for example, in spring 2020, when the demand for electricity was low. When demand exceeds the production volume of electricity produced by clean energy sources, the additional production required is largely based on power plants using fossil fuels. The variable costs of these plants mainly consist of the costs of fuel and emission allowances.

In Central Europe in particular, coal and gas play a key role in electricity production, and the increase in the price of these fuels is also instantly reflected in the price of electricity. The significance of the emission allowance for the electricity production costs of a gas-fired power plant at current price levels is less than 10 per cent. In the Nordic countries, the price is primarily influenced by the availability of hydropower and wind power. As last year was dry throughout the Nordic countries, hydropower reserves remained significantly lower than average. In this case, power plants operating with fossil fuels in the Nordic countries have often set the market price. The impact of wind power was most visible around mid-January when electricity prices dropped to a very low level for several days in the entire Nordic region due to strong winds.

The figure below shows the evolution of the electricity exchange price in Finland and Sweden as well as the system price in the Nordic electricity market as weekly averages from the beginning of 2020. After the low prices in 2020, prices started to increase in 2021. At the end of the year, prices rose to a very high level in almost the entire Nordic region, momentarily up to approximately EUR 1,000/MWh. Prices in Finland, southern Sweden and southern Norway have been very similar throughout the winter.

Figure 19. System spot price of electricity (SYS) and market price in Finland (FI) and in Swedish price areas (SE1, SE2, SE3, SE4) 2020–2022 (nominal weekly average prices). Source: Nordpool.

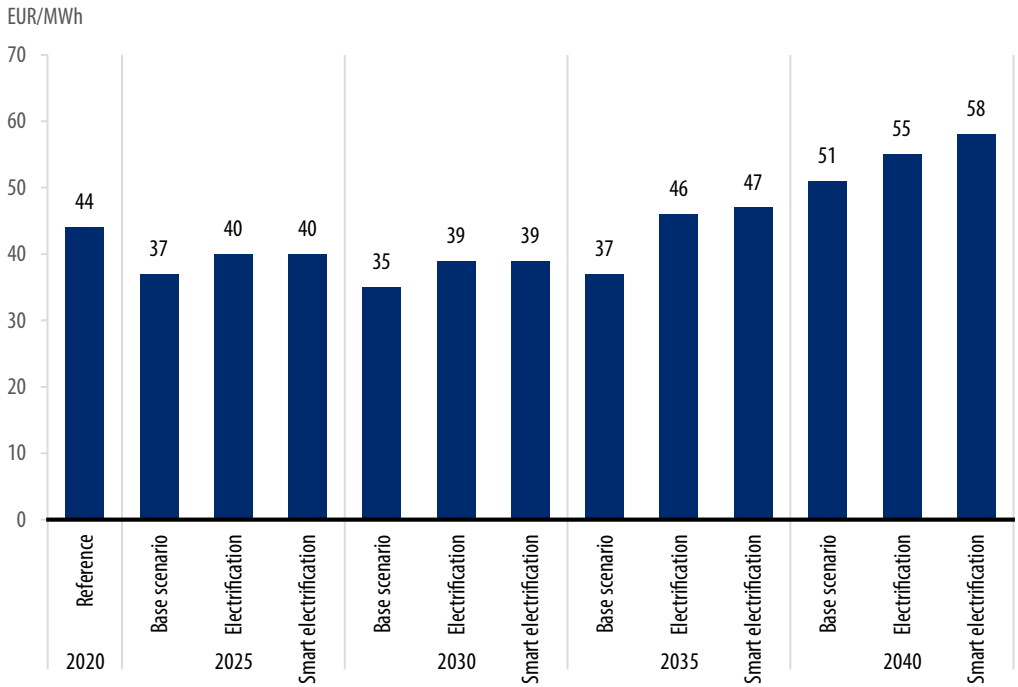


The increase in wholesale electricity prices has also been reflected in retail market prices. The biggest impact has been seen by customers who have selected either an open-ended or market-price-dependent electricity contract. These customers have seen a major price hike caused by the high market-price electricity prices. During the autumn, many customers have moved to fixed-term contracts to protect themselves against price fluctuations. According to the Energy Authority's price statistics, 52 per cent of customers had a fixed-term contract, 40 per cent had an indefinite contract and 8 per cent had a market-price-dependent contract in 2020.

The authorities do not prepare forecasts for the development of fuel or electricity prices. Following the development of the prices of products in the derivatives market provides an idea of price development trends. The derivatives market has been marked by great uncertainty throughout 2022. The market has been quick to respond, especially to changes in the gas market. At the end of May 2022, based on the derivatives market, it appears that the high prices will continue until at least in early 2023 (system price Q1/2023 approximately EUR 120/MWh) and electricity prices would stabilise during 2024 (annual price EUR 48/MWh in 2024).

A study on the impact of the carbon neutrality target on the power system by AFRY[25] examined possible price developments and changes in price fluctuations in different scenarios. The study created different scenarios for increased electricity use and the flexibility of consumption. The figure below shows the modelled price development in different scenarios. The figure shows that the annual average price of electricity in Finland would decrease slightly from the reference level modelled in each scenario by 2025 and 2030. The price of electricity will be increased by rising fuel and emission allowance prices by 2030 and decreased by the entry of nuclear and wind power into the market by 2025 and 2030. Nuclear and wind power production have low marginal costs and reduce the need for Finland (and the Nordic countries as a whole) for production with higher marginal costs, lowering the price of electricity.

Figure 20. Annual average electricity spot market price in Finland in different scenarios 2020–2040. Source: AFRY 2021.



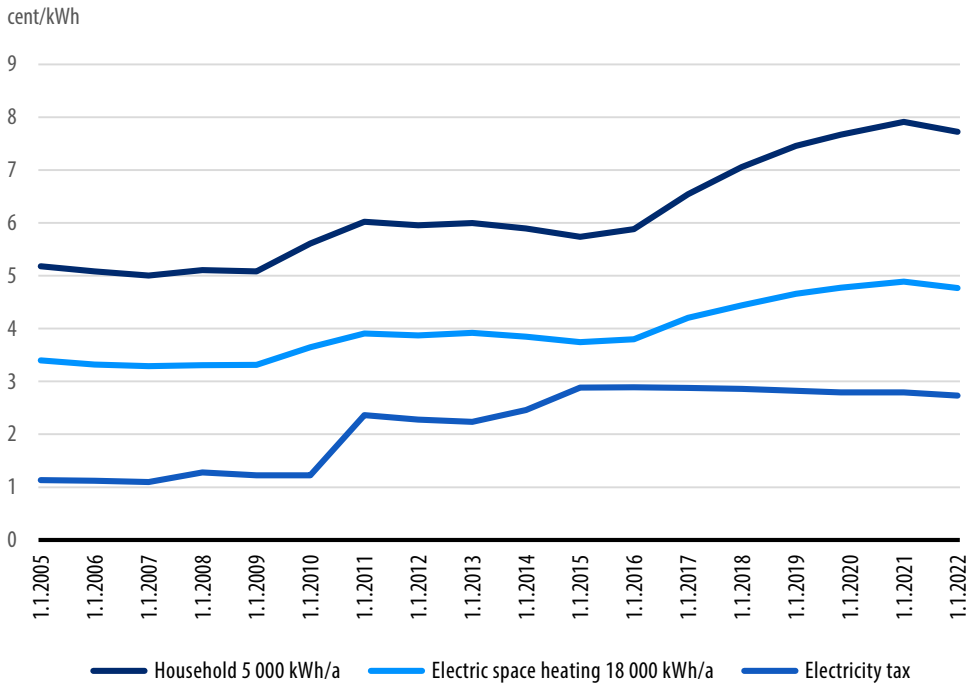
25 Impact of carbon neutrality target to the power system, AFRY 2021, http://urn.fi/URN:ISBN:978-952-383-029-5

Development of transmission prices

The transmission charge for electricity distribution typically consists of two components; a basic charge and the energy charge. Transmission charges vary depending on the distribution network. Through the basic charge, all electricity system users participate in maintaining the costs of the electricity system in a fair and equal manner. It is important to cover the costs of the electricity system equally, as the energy transition will continue to require large investments and as all network users will benefit from the renewal of the electricity network. For large customers, additional components of the transmission charge include power and reactive power charges. The power charges used in transmission charges have also been developed for minor customers in recent years. The structure of transmission charges does not affect the total turnover allowed for the network operator, but power charges, for example, steer network use away from peak consumption hours and reduce the need for investment in the network.

The development of electricity transmission prices (excluding electricity tax) for the period 1 January 2005 to 1 January 2022 is presented in Figure 21. The figure also shows the amount of electricity tax during the same period. Between 2010 and 2020, the total electricity price, including transmission, energy and tax, increased by about 25 per cent and the transmission price by 30 per cent. At the same time, the transmission price including excise tax and VAT increased by almost 50 per cent. In particular, security of supply requirements laid down in the Electricity Market Act in 2013 created pressure to increase transmission prices, which has led to more investment needs for electricity companies: it was estimated that the security of supply requirements would require additional investments of approximately EUR 3.5 billion in 15 years (HE 20/2013 vp).

Figure 21. National average transmission price with value added tax and electricity tax in the period 2005–2021 (2020 real price). Source: Energy Authority.



Electricity prices for households including taxes started to decline in 2021 due to new policy measures. A legislative amendment on curbing transmission prices in the electricity market entered into force in August 2021. Due to legislative amendments, the Energy Authority has updated the monitoring methods for electricity distribution. After updating the calculation methods, the profits made by distribution system operators drop by about 40 per cent of the 2020 level in 2022. Distribution companies could collect EUR 378 million less in distribution fees from their customers in 2022 than in 2020. The change in the control mechanism improves the cost-effectiveness of investments by updating the unit prices of network components and lowers the permitted reasonable profits by extending the timetable for the implementation of security of supply requirements and by requiring that risk-free interest rates reflect changes in market interest rates quickly enough. As a result of the change in the control model, transfer prices will decrease gradually.

The amendment also reduces the permitted one-off increases from 15% to 8%. The pressure to increase prices was eased by extending the implementation period of the security of supply requirements for electricity distribution by eight years until the end of 2036, mainly for distribution system operators operating in sparsely populated areas, which will have to make major changes in the structure of their networks in the 2020s.

The Act also requires the network operators to ensure cost-effectiveness in the planning, construction and maintenance of the electricity network.

4.6.2 Gas market

Finland's natural gas market was opened up to competition in accordance with the provisions on the European Union's internal market in natural gas with the introduction of the Balticconnector pipeline connection from Finland to the Baltic gas network at the beginning of 2020. The opening up of the market will foster an increasingly versatile supply of natural gas, as along with biogas and LNG, the alternatives to Russian pipeline gas include the supply of natural gas from the Baltic states and also from Central Europe following the completion of a gas interconnection between Poland and Lithuania. The interconnection Poland–Lithuania is expected to be completed in mid-2022.

Key changes related to opening the market included open access to the network in natural gas transmission and distribution networks, open access to LNG facilities located outside the natural gas network, and separation of natural gas transmission network activities from the supply and production of natural gas. The regulation of the wholesale and retail sales of natural gas was also eased and the special regulation of wholesale and retail sales of natural gas was largely abandoned.

Since the opening of the market, Finland has been actively involved in creating the regional gas market with the Baltic countries. As a concrete result of the opening of the market from the beginning of 2020, Finland, Estonia and Latvia formed a common market area in which uniform feed-in and feed-out tariffs are used in the gas transmission network. This market area is the first multi-country gas market in Europe. Lithuania is also in the process of joining the market.

A regional coordination group has been created to develop the market area, involving the relevant ministries, regulators and main grid operators in each country. The coordination group has created a roadmap for market development, which has been approved by all parties.

4.6.3 Heat market

The current status, challenges and development needs of Finland's district heating market

District heating has been the most common type of heating in Finland for a long time, responding to just under half of the heating needs of buildings. District heating

operations have been established in Finland for decades. District heating is typically combined heat and power plants and separate production buildings for thermal energy and is not dependent on a single heat source. According to Statistics Finland's electricity and heat production statistics, the amount of district heating produced in Finland in 2020 was 35.1 TWh, of which the share of renewable fuels was 44 per cent. Industrial heat production in 2020 was 51.1 TWh, 77% of which was based on renewable fuels. Overall, 63 per cent of district heating and industrial heat production was produced using renewable fuels. Carbon dioxide emissions from district heating have decreased by half in ten years and will decrease by one third in the next 10 years. According to the energy sector roadmap update of spring 2021, emissions from district heating will fall by about 80 per cent by 2030 compared to 2017. District heating companies have in recent years updated their systems to be more efficient and low-emission. Many district heating networks already offer carbon-neutral district heating, and emissions in the remaining district heating networks will be very low by 2030. According to the energy industry, emissions will decrease particularly rapidly in 2021–2024. The timetable for reducing emissions has become increasingly tight and must be sped up by five years since spring 2021; the 2030 projection would be reached in 2025 and the 2035 projection in 2030.

In Finland, heating systems can be roughly divided into two parts: district heating and separate heating of properties. However, competition in the heating market has intensified in recent years due to the technological development of different forms of heat production, the narrowing selection of fuels available for heat production and a strong increase in emission allowance prices, as well as increasing interest among customers in their own carbon-neutral production and more predictable costs.

There are well-functioning international market mechanisms for electricity and gas. When the mechanisms work well, energy forms can be changed on a market basis and benefits can be produced for different energy systems. When energy systems are integrated, low-emission electricity generation enables both other types of low-carbon energy as well as increase the production of renewable electricity through the flexibility of other sectors. Joining industrial, transport and heating energy networks enables effectively balancing the consumption and production of different sectors.

As district heating systems in Finland are closed and use fixed prices, the utilisation of the flexibility potential of district heating systems or the integration of energy systems may not be optimal at present. In recent years, energy companies have sought competitive heat production and supply methods and developed different business models, such as two-way and open distribution of district heating through bilateral agreements. In addition, low-temperature networks and the reduction of the temperature of the district heating network have been examined.

In the future, there will be more operators and heat production methods in the heating sector, and new business and pricing models will be required to reconcile interests. This also requires the willingness of operators to start building a flexible district heating system that does not exclude future technologies and operators. For this reason, there has been a need to explore alternatives and operating methods in which the heating market would develop in a direction that would be more flexible in taking into account the integration of different energy systems, renewable heat production not based on combustion, new technology and the utilisation of waste heat as efficiently as possible. In the heating sector, encouraging developments include the evolution of new technology and system integration solutions that can combine both district heating and other heat sources, such as energy production in buildings, optimising their use.

The Ministry of Economic Affairs and Employment is examining alternatives and operating methods to allow more flexible consideration of non-combustion renewable heat production and waste heat, utilisation of demand response and integration of different energy systems in the district heating market. The Ministry of Economic Affairs and Employment is also responsible for ensuring that Finland continues to meet the requirements of EU legislation. In this context, in autumn 2021, the Ministry of Economic Affairs and Employment commissioned a study on cost-effective alternatives and operating methods to improve the operating conditions of district heating and to include renewable and other emission-free energy and waste heat to the district heating network. The report provides a versatile picture of possible alternatives for developing system integration and solutions.

4.6.4 Energy poverty

There is no single definition of energy poverty, but the term is used to refer to issues such as deficits in meeting basic needs due to high energy costs. In some contexts, energy poverty is defined as a relative share of energy expenditure of disposable income. In Finland, energy poverty mostly manifests as financial difficulties in coping with the energy costs caused by housing and transport.

In accordance with Article 3.3 d) of the Regulation of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action (2018/1999) adopted in late 2018, Member States are required to "assess the number of households in energy poverty", and if the Member State "has a significant number of households in energy poverty, on the basis of its assessment of verifiable data, it shall include in its plan a national indicative objective to reduce energy poverty". There are no national targets related to energy poverty in Finland.

In Finland, energy poverty has been studied in two different studies[26] [27], which revealed that energy poverty is not a major problem in Finland. Issues related to energy poverty have been addressed in Finland as part of social policy, and extreme forms of energy poverty, such as insufficient heating, do not occur in Finland because of the support networks of society. Indeed, in Finland, the phenomenon of energy poverty is partly concealed by paid housing and social assistance, among other things. Of those living in owner-occupied dwellings, the risk of energy poverty occurs among low-income households living in unrenovated blocks of flats built in the 1960s and 1970s, and low-income households living in unrenovated single-family houses built before 1980.

In Finland, both legislative and voluntary measures are used to prevent energy poverty, such as the exact issues to be taken into account for the energy company specified in the Electricity and Natural Gas Market Act before the energy distribution is cut off from households with financial difficulties. The legislation is also based on subsidies that reduce housing costs and secure livelihoods, which ensure adequate heating of housing for those in with a poor financial status and guarantee access to electricity. According to a study conducted by the ASSIST – Support Network for Household Energy Saving (2018), Finland has a comprehensive social security system which contains different forms of support targeted at housing costs to reduce energy poverty[28].

4.7 Research, innovation and competitiveness

4.7.1 Low-carbon solutions and carbon handprint

The market for clean solutions is growing at an accelerating pace worldwide. Finland is one of the most interesting innovation countries in the field, and there is global demand for its expertise. The preparation of industry-specific low-carbon roadmaps has shown that low-carbon technology will be a significant competitive advantage for Finnish companies in the future. According to the Government's sustainability roadmap, sustainable solutions for Finnish exports are based on clean energy and low-carbon solutions, renewable raw materials, the circular economy, clean food, improving quality of life and wellbeing, and related technologies. Finland is one of the world's leading countries in the circular economy, high added-value bio-products, low-emission energy systems and climate and environmental solutions.

26 Oja, L., Vaahtera, A., Vehviläinen, I., Ahvenharju, S., Hakala, L. 2013. Selvitys energiaköyhyydestä. Kotitalouksien energiakustannukset. https://julkaisut.valtioneuvosto.fi/handle/10138/41424

27 Runsten, S., Berninger, K., Heljo, J., Sorvali, J., Kasanen, P., Vihola, J., Uotila, U. 2015. Pienituloisen omistusasujan energiaköyhyys. https://julkaisut.valtioneuvosto.fi/handle/10138/153653

28 http://www.assist2gether.eu/news-95-tilastoja_energiakoyhyydesta

Finland and Finnish companies are larger than their size in the global low-carbon solutions market. These solutions generate significant new business and new growth stories for the Finnish industry. For example, the Province of Aland offers a functional platform for piloting and testing new energy technologies, and solutions developed in Aland can be scaled to international markets. According to the low-carbon roadmap for the Finnish technology industries, global demand for low-carbon solutions will increase by at least 20 per cent annually to implement the climate commitments already made. This would mean an increase of more than EUR 3 billion for Finland's annual exports. As a result of the post-COVID-19 recovery measures, the demand for low-carbon solutions might even double, which will increase Finland's annual export potential to more than EUR 30 billion. The internationalisation of solutions developed in Finland is promoted by Team Finland actors, such as the Ministry of Economic Affairs and Employment, the Ministry for Foreign Affairs and Business Finland.

The carbon handprint describes the climate benefit of a product or service, i.e. the potential for reducing emissions for the user. The emission reductions by the solution provider are not included in the handprint, but it only includes those produced by others. In particular, companies at the forefront of low-carbon technology development have high handprint potential and significant export potential. Operators have an opportunity to increase their handprint by scaling innovations in the global market. The larger the handprint effect of Finnish companies' solutions, the greater the potential of these solutions for creating new jobs. While Finland and Finnish companies may not take possession of hundreds of billions of euros in mass markets, specialisation may open up significant opportunities, for example in offshore wind power in severe ice conditions.

In sector-specific low-carbon road maps, the forest industry estimated the handprint effect to be 16 Mt CO_2 eq./year, the chemical industry 21 million tonnes Mt CO_2 eq./year and the technology industry 20 Mt CO_2 eq./year as the potential handprint effect of its export products. Technology industry estimates that new solutions can increase the handprint by more than 50 Mt CO_2 eq./year. The estimate of the handprint potential of key industrial sectors is considerable compared to Finland's current greenhouse gas emissions.

The value chain of the battery industry in Finland will also have a significant handprint effect in the EU, as internal combustion engines will be replaced by battery-based solutions in the transport sector. In 2020, Finland prepared a national battery strategy, the key objective of which is to make Finland a leading country in sustainable and responsible battery production. Finland has an exceptionally good starting point for battery production, as the country's soil contains significant amounts of key minerals needed in lithium-ion batteries, i.e. lithium, nickel and cobalt. Finland also has strong expertise related to metal refining and the circular economy.

4.7.2 International cooperation on clean energy

Finland is closely involved in international cooperation on clean energy. The Clean Energy Ministerial (CEM) is a clean energy forum established in 2010 where the G20 and Nordic countries work together to accelerate the transition to a global clean energy economy by sharing the best solutions and common approaches. The CEM countries are responsible for 75 per cent of global greenhouse gas emissions, but also 90 per cent of global clean energy investments. CEM's practical work is based on projects related to electric transport, hydrogen and a flexible electricity system, among other things.

In the area of clean energy, CEM has several cooperation initiatives, in which each country decides on participation and investment based on its own interest. The secretariat funded by CEM member countries currently operates in the context of the IEA.

A key part of CEM's operations revolve around initiatives that cover themes such as bioenergy, carbon capture, electric transport, hydrogen solutions, renewable energy, energy efficiency, smart grids, sustainable development, and women and energy. The initiatives that Finland participates in include ones related to electric cars and smart grids. Finland has also joined the Equal by 30 campaign, which promotes the status of women in the energy sector, with the aim of ensuring uniform opportunities for studies and careers in the energy sector.

Finland is also involved in the Mission Innovation Initiative (MI). This is a global initiative aimed at accelerating clean energy innovation and projects to improve access to clean energy. Mission Innovation, an international initiative published in connection with the Paris climate negotiations in December 2015, is aimed at increasing clean energy innovations to mitigate climate change and to secure clean energy sources. Finland joined in September 2016. The Mission Innovation cooperation will be used to promote the networking of Finnish cleantech companies and research institutes in the field and to create partnerships. CEM and MI offer Finland opportunities to highlight competence related to e.g. system integration and hydrogen.

5 Regional plans and regional development funds

The Government's regional development decision 2020–2023[29] aims at sustainable and viable areas. The regional development decision contains the priorities falling under the Government's remit during the government term and the central government level objectives to which the ministries have committed themselves. The regional development decision steers the development of the different administrative sectors and regions in the provinces, and how their measures are coordinated One of the focus areas of regional development is mitigating climate change and safeguarding biodiversity.

- Regional development efforts will be strengthened to mitigate climate change and the transition to a carbon-neutral circular economy. Regional measures will be used to cut emissions, increase carbon sinks, promote the sustainability of the use of natural resources, and increase competitiveness.
- Attention will be paid to the impacts of climate change both nationally and in regions in strategic decision-making and the planning of operations. Preparedness and adaptation require risk analysis and anticipation of impacts.
- Cooperation between regional development agents will be strengthened to halt biodiversity loss. Safeguarding biodiversity will be taken into account preventively in the preparation of projects and plans, and related decision-making.
- The assessment and monitoring of climate impacts will be included in the implementation of regional development

Regions can finance their climate action through the Innovation and skills in Finland 2021–2027 EU regional and structural policy programme[30]. The aim is to promote energy efficiency, the circular economy and adaptation to climate change and to reduce greenhouse gas emissions. The regions have also been granted a national Aid for sustainable growth and vitality (AKKE) appropriation, the use of which is decided by the

29 The regional development decision 2020–2023 – Sustainable and vital regions https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/162313/TEM_2020_21.pdf?sequence=1&isAllowed=y

30 https://valtioneuvosto.fi/-//1410877/uudistuva-ja-osaava-suomi-2021-2027-ohjelma-edistaa-alueiden-elinvoimaa-tyollisyytta-ja-hyvinvointia

regions themselves. This appropriation may also support the efforts to combat climate change and the green transition in the regions.

The counties' climate road maps aim at carbon neutrality by 2030 or by 2035 at the latest. The counties that aim at carbon neutrality, i.e. the Hinku counties, together with the Hinku municipalities in the region, have committed to reducing greenhouse gas emissions in the region by 80 per cent by 2030 from the 2007 level. The counties that do not yet have a climate roadmap are currently in the process of preparing a climate roadmap. The counties' means used to pursue the aim of carbon neutrality include versatile production of fossil-free, emission-free and renewable energy, decentralised energy production, smart energy systems and networks, and energy efficiency.

Municipal decision-makers see promoting energy efficiency and increasing the use of renewable energy as the most effective climate action in municipalities[31]. The Energy Efficiency Agreement for Municipal Sector (KETS) is an agreement between the Ministry of Economic Affairs and Employment, the Energy Authority and the Association of Finnish Local and Regional Authorities on the more efficient use of energy in the municipal sector in the period 2017–2025. More than 120 municipalities and joint municipal authorities are committed to the energy efficiency targets set in the agreements. The parties to the agreements report annually on the energy efficiency measures they have taken and other activities aimed at improving energy efficiency.[32]

More than 80 municipalities are part of the Hinku network, which aims to reduce emissions by 80 per cent by 2030 from the 2007 level. The municipalities in the network draw up an annual plan for investments that reduce emissions and measures to reduce greenhouse gas emissions and report on the measures taken.[33]

Kestävää tulevaisuutta tekemässä – ihmisten ja alueiden parhaaksi (making a sustainable future – for the best for people and regions) is the join 2020–2023 strategy of the Regional State Administrative Agencies and ELY Centres for. One of the strategic priorities is the objective of carbon neutrality. Agencies must identify the impacts of their activities in different areas and on different groups of people and companies. The implementation of the strategy will be monitored annually.[34]

31 Lehtonen et al. (2020): Ilmassa ristivetoa – Löytyykö yhteinen ymmärrys? https://www.uwasa.fi/sites/default/files/2020-11/Ilmassa_ristivetoa%20loppuraportti_30_11_2020.pdf

32 https://energiatehokkuussopimukset2017-2025.fi/

33 https://hiilineutraalisuomi.fi/fi-FI/Hinku

34 https://valtioneuvosto.fi/-/10623/aluehallintovirastojen-ja-ely-keskusten-yhteinen-strategia-antaa-suunnan-valtion-aluehallinnon-toiminnalle

6 Adaptation to climate change

Risk management and adaptation related to the impacts and consequences of climate change are a key part of climate policy as a whole. Achieving a climate-resilient society requires us to reduce emissions and prepare for the increasing impacts of the ongoing climate change. The global success of mitigation measures also determines for what kinds of impacts Finland needs to prepare on different time spans.

By the end of the century, Finland's average temperature has been estimated to increase by 2–6 degrees from the 1981–2010 average, depending on global trends in greenhouse gas emissions. Rainfall is expected to increase. However, climate change does not eliminate weather fluctuations that are part of the Finnish climate, so cold and dry periods can also still be expected to occur alongside changes in average temperature and precipitation in the future. However, climate change makes weather and water conditions more extreme. This will increase and change the weather and climate risks affecting the energy sector, industry and business, both directly and through different impact chains across sectoral boundaries.

As the climate changes, assessing and preparing for weather and climate risks is increasingly important to support the planning and decision-making related to mitigation measures. Climate change will have an impact on the production of renewable energy, among other things. Increasing rainfall may increase the production potential of hydropower, and a longer growing season may increase forest biomass production, which would improve delivery reliability and security of supply. On the other hand, changing climatic conditions may impair the health of forests due to disease and pest risks and make timber harvesting more difficult. In addition, climate change affects energy distribution infrastructure and delivery reliability and security of supply as extreme weather events change. Changes in the energy consumption of buildings can also be expected as the need for heating decreases and the need for cooling increases. The mid-term review of the National Climate Change Adaptation Plan concludes that there are shortcomings in the energy sector and industry when it comes to the vulnerability assessments of private actors.

Climate change also increases the likelihood of risks that are reflected in Finland through cross-border impacts. Finland must therefore also prepare for spill-over effects from the rest of the world in addition to the impacts and consequences from within the country's

borders. Climate change can affect, for example, global and regional raw material and energy production and supply chains and through them, the security of energy supply. Based on the results of the mid-term evaluation of the National Climate Change Adaptation Plan, the connections and dependence of the energy sector and industries on the international market gain emphasis as a risk factor.

7 Special themes

This section describes key new and emerging technologies and solutions needed in the transition to a carbon-neutral and subsequently carbon-negative society. Ultimately, the extent to which the solutions can be applied in the long term is determined by scalability, commercial competitiveness and profitability, which are difficult to predict. In any case, Finland should be ready and enable the swift implementation of these solutions if necessary.

New technologies can be promoted, for example, through demonstration aid and regulation. However, it is not up to the government to choose winning solutions. Technological neutrality is an important principle, as all clean solutions are necessary for reducing emissions.

7.1 System integration and electrification

The growing importance of electricity in the energy system

Emission-free and cost-effective electricity production makes it possible to reduce emissions by increasing the share of electricity in final energy consumption. According to the International Energy Agency (IEA), the share of electricity in the final energy consumption has grown in the 2000s, but remains below 20 per cent. According to the IEA's scenarios, a global carbon-neutral energy system is possible when the share of electricity in energy consumption rises close to 50 per cent. Similar developments have been anticipated in Finland, for example in low-carbon road maps. Increasing the use of electricity can reduce the use of fossil fuels in industry, transport and heating of buildings, which are the most significant energy use sectors in Finland.

Electrification in industry

The industry uses approximately 45 per cent of energy in Finland (end use). The energy consumed by industrial processes such as drying, heating and evaporation processes, steam production and industrial furnaces can be partly or fully electrified, which reduces the use of fossil fuels. In industry, electricity is mainly used for various heating processes.

Technical solutions are related to so-called direct electrification or indirect electrification. Direct electrification refers to the use of electricity in the industrial process, for example through electrical resistors, electric boilers and heat pumps. Indirect electrification means the utilisation of raw material or fuel produced by electricity, such as hydrogen or electrofuels.

Electrification in the heating of buildings

The carbon footprint of buildings and the broader built environment mainly consists of energy consumption in Finland. The heating of buildings uses about 26 per cent of energy in Finland (final use), most of which is consumed in residential buildings. In buildings, energy is used for heating, domestic hot water production, operating electricity and cooling.

Heat pumps can be considered an example of system integration and electrification. Heating based on heat pump technology has grown significantly. This is visible in the energy statistics for housing as an increase in both heat pump energy and the electricity consumption of heat pumps. Heat pumps can also be used to produce district heating and cooling. Among other things, heat pumps enable the utilisation of surplus heat and geothermal heat. Heat pumps enable reducing the use of fossil fuels while facilitating heat production that is more energy efficient than direct electric heating or electric boilers.

In the future, heat pumps will become more common both in building-specific heating and in district heating production. Potential heat sources include surplus heat, soil (geothermal), air (air/air or air/water source heat pump).

Electrification in transport

The roadmap to fossil-free transport, i.e. the Government resolution on reducing domestic transport's greenhouse gas emissions and other measures related to the climate targets for transport, promotes the electrification of transport and the replacement of fossil fuels with other alternative fuels.

Electric vehicles are quickly becoming more common at the moment. According to the Finnish Information Centre of Automobile Sector's statistics (April 2016), the share of plug-in hybrids, fully electric cars and gas cars of the first registered passenger cars was around 1 per cent in total. In 2021, 31.7 per cent of first registered passenger cars operated with alternative power sources (electricity, plug-in hybrids and gas and hydrogen). The increase in the number of electric cars increases people's interest in opportunities for charging their electric vehicles as a form of flexibility.

In heavy-duty transport, waterborne transport and aviation, electrification occurs more slowly than in passenger car transport due to issues such as technical restrictions. For example, in heavy-duty transport, hydrogen and electrofuels may be future solutions utilising system integration instead of or in addition to direct electric use. Similarly, hydrogen and the ammonia or methanol produced from it can be used to replace fossil fuels in waterborne transport.

The flexibility of the electrical system

In addition to ensuring low-carbon electricity and curbing the costs of electricity, the security of supply must also be ensured in all circumstances. Growth in weather-dependent electricity generation requires solutions that increase the flexibility of both production and consumption. An increase in weather-dependent generation causes needs for flexibility, especially in cold and windless periods. Demand response improves the system's security of supply but also its cost-effectiveness, as it enables a lower average electricity price. At the same time, however, it is important to ensure that flexible resources for electricity production are also available. For a long time, hydropower will continue to be the most important flexible resource in the electricity system, and it plays a key role in enabling the growth of weather-dependent electricity production.

Future needs for flexibility are illustrated by the 6 GWh change in electricity consumption described in the smart electrification scenario in a Government's analysis, assessment and research activities report, "Impact of carbon neutrality target to the power system" (AFRY, 2021). Such significant changes in demand require increased consumption flexibility. The total peak power demand in Finland is now about 15.1 GW at the coldest time of the year, and the market-based production capacity during peak consumption is about 10.8 GW.

Cold and windless periods cause most challenges, as the demand response system is often clearly easier to implement in the short term than in the long term. In such periods, a very high electricity price should enable the profitability of the production whatever the weather.

Dynamic electrical systems and flexible management enable new ICT solutions in the form of better measurement and control possibilities. The system of the future will produce significantly more data from different levels of the system, providing opportunities for applying new technologies, such as artificial intelligence. On the other hand, a challenge for the implementation of the demand response system may emerge related to the different interfaces between the demand response sites.

The market conformity of the demand response system is an important issue, as it enables voluntary demand response based on the weighing of benefits and costs. Ensuring

sufficient flexibility requires active efforts by market players to respond to price signals. This also requires taking flexibility into account already in the investment phase.

For example, in the industrial sector, the demand response system must take into account the requirements of the primary process. Identifying and utilising demand response in industry always requires a good understanding of industrial processes and operating environments.

Different hydrogen or power-to-X processes may play a major role as a source of demand response. This is largely an economic optimum for the operation of the industrial process, as there will only be an incentive for demand response if the demand response is more profitable as a whole than the continuous use of the process.

Regional questions related to zero-emission electricity production, transmission and consumption

The progress of system integration requires an increase in clean electricity production. The currently planned new wind power projects are typically located on the coast of the Gulf of Bothnia and in Lapland. Areas favourable to wind power production are also located in northern Sweden and northern Norway. A significant amount of other kinds of electricity production, including production already in operation and planned production, is also located in the area. Meanwhile, electricity consumption is concentrated in southern Finland. To realise the potential for increasing wind power production, it is essential to secure adequate electricity transmission connections between northern and southern Finland as well as between Finland and other Nordic countries. In Eastern Finland, wind power can be increased, taking into account the needs of the Finnish Defence Forces' radar surveillance systems.

It is important to ensure sufficient transmission system capacity so that the systems can facilitate a functioning market and encourage investment in production and consumption based on their profitability. The aim is to keep Finland as a single-price area in the future, which would mean that the regions will be equal from the perspective of electricity prices. This makes long-term planning of the electricity system both important and challenging: in terms of new production and consumption, it is necessary to anticipate where and when they will be installed, and what their production or consumption profiles are like. For example, large-scale industrial solutions and related choices between full electrification and hydrogen can be very significant in this context. Power grid reinforcements must be designed based on this information, which emphasises the importance of effective information exchange and cooperation. It is also important to note that bottlenecks may also occur in neighbouring countries, in which case it will not be possible to transmit the desired amount of electricity either to or from Finland despite cross-border transmission capacity.

The adequacy of the capacity of electricity distribution networks may become a challenge for some properties around some city centres with insufficient connections in relation to the electricity demand caused by the charging of electric cars. This is because electricity consumption has previously been mainly limited to real estate electricity.

7.2 Hydrogen and electrofuels

Background

Hydrogen can be utilised in a variety of ways. It can be used in a versatile manner as raw material, fuel, energy carrier and energy storage medium. Hydrogen can replace the use of fossil raw materials and energy sources in several applications if hydrogen is produced without emissions. Emission-free hydrogen requires the production of hydrogen by electrolysis using emission-free electricity or other processes from bio-based raw materials. Carbon capture and storage is also an option during the transition period when natural gas is still used.

A colour spectrum is used to refer to different types of hydrogen based on production methods and source energy. Grey hydrogen is produced from natural gas by releasing CO_2 into the atmosphere. If the CO_2 is recovered and stored, we can talk about blue hydrogen. In the future, electrolysis will emerge as the most important method of producing hydrogen, in which the water is electrically decomposed into hydrogen and oxygen. Other hydrogen production methods are also explored.

If the electricity used in the electrolysis process is generated with renewable energy, the term green hydrogen is used. Green hydrogen includes various shades depending on which sources of renewable energy are used or the additionality of electricity generation. In addition to the colour spectrum, we talk about clean hydrogen. Clean hydrogen refers to hydrogen produced by electrolysis with emissions-free electricity: it is produced either with different renewable production methods or by nuclear power. The part of clean hydrogen that is not renewable (as defined in EU legislation), i.e. has been produced with other renewable energies or nuclear energy, is referred to as low-carbon hydrogen. Renewable and low-carbon are becoming established attributes in EU legislation, but green and clean have also been used in, for instance, the names of programmes or organisations.

Faced with the challenge of climate change, the energy economy is encountering a major transition, which has resulted in broad interest in hydrogen as one possible solution fostering a low-carbon economy. The Intergovernmental Panel on Climate Change (IPCC) and the International Energy Agency (IEA) have examined hydrogen in their climate and energy scenarios. In addition, hydrogen has been examined in numerous international

energy scenarios by research institutes. Globally, the importance of emission-free hydrogen is only becoming increasingly important in the long term. So far, emission-free hydrogen is not economically competitive without significant support.

Hydrogen is not an energy source, but rather an energy carrier. Its clean production and transformation back into another form of energy, such as electricity and heat with fuel cells or more complex hydrocarbons, requires energy, which is lost in these transformations. Therefore, the use of hydrogen must not be an end in itself, but must rather be used in situations in which electricity or other emission-free energy cannot be used to provide the required energy.

Hydrogen offers an excellent alternative to energy storage and transport. It can replace fossil alternatives, for example in the manufacture of steel. On the other hand, hydrogen is a highly flammable substance with its own safety requirements.

In the wake of international interest, interest in hydrogen has also increased in Finland. In autumn 2020, VTT prepared a national hydrogen roadmap commissioned by Business Finland[35]. VTT has been conducting research on hydrogen technologies for a very long time, and prepared its first hydrogen roadmap already back in 2012. Electrofuels are also studied at other technical research institutes and universities, such as the Lappeenranta-Lahti University of Technology.

The AFRY consultancy company prepared an extensive Government TEAS report, "Hydrogen economy – Opportunities and limitations"[36]. The work was completed in March 2022. The main objective of the project was to create a broad picture of hydrogen technology and its current status. The report assesses the opportunities and limitations of hydrogen in Finland and internationally. The project produced hydrogen economy scenarios for Finland to serve as a basis for decision-making in the coming years.

The development of the hydrogen network and infrastructure, including the need to establish a national hydrogen enterprise, will be assessed in accordance with the autumn 2021 budget discussion in national preparatory work by the Ministry of Economic Affairs and Employment, the Prime Minister's Office and the Ministry of Finance.

In spring 2021, the *Finnish hydrogen network* was established in Finland. By October 2021, approximately 50 hydrogen companies had joined it. The hydrogen network aims for

35 National Hydrogen Roadmap for Finland, https://www.businessfinland.fi/4abb35/globalassets/finnish-customers/02-build-your-network/bioeconomy--cleantech/alykas-energia/bf_national_hydrogen_roadmap_2020.pdf

36 Hydrogen economy – Opportunities and limitations, http://urn.fi/URN:ISBN:978-952-383-413-2

Finland to be a global leader in developing and offering hydrogen solutions globally. The hydrogen network published a *white paper* on the promotion of the Finnish hydrogen economy in September 2021.

To promote hydrogen cooperation in the Baltic Sea region, the BothH_2nia brand was established in the spring of 2021. Its development has since been funded by the national hydrogen network.

Hydrogen as part of the EU's climate and energy policy

Several countries in Europe and the world have developed national hydrogen strategies and roadmaps in recent years. Some countries have already taken a long time to renew their strategies or roadmaps, as there is a great deal of attention and great expectations in the industry in addition to the right technological and economic developments. While there has been similar enthusiasm toward hydrogen and discussions concerning the hydrogen economy in previous decades, it has failed to catch wind in its sails. The good thing about the current debate is that it creates a concrete framework for hydrogen – as hydrogen is an energy transmitter, it requires a lot of energy and energy is lost in producing the variants, hydrogen and its variants are mainly only produced in areas where energy cannot otherwise be obtained more cost-effectively.

Potential applications for hydrogen include industry, transport, balancing energy systems and preserving variable energy production. In dwelling-specific gas heating, hydrogen or the synthetic methane produced from it are also considered to play a major role. Many countries see themselves as exporters of hydrogen and electrofuels as well as exporters of related technologies.

The European Commission published a hydrogen strategy for a climate-neutral Europe in July 2020. The hydrogen strategy aims to promote a favourable environment for the exploitation of hydrogen. Since then, some EU countries have published their own hydrogen strategies. In line with the Commission's hydrogen strategy, several EU countries see that hydrogen can play an important role as a part of energy solutions and a low-carbon future in the long term. In the RePowerEU package published in May 2022, the Commission approximately doubles the hydrogen targets set in the 2020 hydrogen strategy.

The Netherlands is proposing the use of low-carbon (blue) hydrogen by utilising carbon capture and storage solutions for natural gas, at least as a temporary solution. Meanwhile, Germany, Spain and Italy do find that blue hydrogen and CCS play a role. France's energy production continues to rely heavily on nuclear power, and hydrogen is planned to be produced by electrolysis mainly through nuclear electricity in the country.

Most EU countries are looking to develop hydrogen technology and promote technology exports. Germany in particular wishes to invest in technology leadership, but many other EU countries (France, Denmark, the Netherlands) also see opportunities in investing in technology. Technology exports is considered to carry potential for economic growth and increasing employment. Italy, Spain and Portugal have also published hydrogen strategies or roadmaps and Sweden updated and Denmark published its hydrogen strategy in late 2021. Different hydrogen strategies set targets for either the capacity of electrolysis equipment (MW) or the annually produced tonnes of clean or green hydrogen, typically for 2030.

In Norway, the hydrogen strategy published by the Government in 2020 was criticised for its lack of vision and concrete applications. The hydrogen roadmap published by the country's government in 2021 is a response to this criticism. The hydrogen roadmap presents the government's vision for the development of the hydrogen economy for 2025, 2030 and 2050 and presents concrete projects for the development of hydrogen technology.

According to the roadmap, five hydrogen concentrations, a hydrogen production plant and a research centre focusing on the exploitation of hydrogen and ammonia will have emerged on the Norwegian coast by 2025. According to the road map vision, hydrogen will be a genuine fuel alternative in shipping in 2030. In 2050, hydrogen will be used in industry, as fuel in ships and in heavy-duty road vehicles. Norwegian companies are already significant exporters of hydrogen technology (e.g. fuel cells), but according to the roadmap, they will later become internationally leading exporters of hydrogen and hydrogen technology.

To inform the promotion of battery technology, the Commission established the European Clean Hydrogen Alliance in December 2020, which includes not only Member States, regions, research institutes and universities, but also industry and interest groups. The Alliance has been launching an Important Project of Common European Interest (IPCEI) process focusing on hydrogen, which aims to launch hydrogen-related projects in the participating Member States with the support of public funding. Finland and Finnish companies in the field are involved in both the alliance and the hydrogen IPCEI process.

There are also plenty of other hydrogen consortia and research programmes around the world, such as the Clean Hydrogen Mission and Clean Energy Ministry (CEM) hydrogen initiative. The International Energy Agency (IEA) also plays an active role in matters related to hydrogen.

The Commission is also using regulation to create demand for hydrogen-based products. According to RED II, the Commission was to issue delegated acts determining the share

of renewable electricity in RFNBO fuels (Renewable Fuels of Non-Biological Origins, including hydrogen and electrofuels) and the methodology for calculating greenhouse gas emissions from fuels by the end of 2021. The Commission published a draft of that delegated act in May 2022.

RFNBO fuels are included in the national renewable fuel distribution obligation. The amendments to the Act on the Promotion of the Use of Biofuels for Transport entered into force on 30 June 2021. In accordance with the transitional provisions of the Act, RFNBO fuels will be added to the distribution obligation from 1 January 2023. The sustainable criteria for the production of hydrogen are also defined in the Taxonomy Regulation.

The proposals of the Fit for 55 package published in July 2021 affect the use of hydrogen in several sectors. For instance, the proposal includes a suggestion to build an ambitious hydrogen refuelling network and to take hydrogen more into account in energy taxation. In addition, new targets are proposed for the use of hydrogen in industry and heavy-duty transport. Regulations on the emissions trading system related to hydrogen will be developed.

In December 2021, the Commission issued an EU gas package proposal. In addition to natural gas, it also contains legislative proposals on the transport and storage of hydrogen gas. If adopted, these proposals will create a legal framework for the transport and storage of hydrogen and other clean gases. The regulations do not take a stand on the production of hydrogen itself.

Hydrogen value chains

Production

As electrolysis equipment is expensive, it needs to be used for a significant number of hours to write off the investment. Electrolysis equipment unconnected to the network, such as equipment connected to wind power, will be used for an insufficient number of hours, even if the users would save money in network access fees. Electrolysis equipment connected to the electrical power network uses electricity from the network. With an additional cost, hydrogen manufacturers can purchase and earmark any electricity production, such as wind power, if the customer wants hydrogen produced in this way. This sort of earmarking and ensuring that electricity from the network is sufficiently green is one of the issues to be resolved.

Electrolysis and fuel cell technologies have been known for a long time, but there is still a lot to develop: the equipment should be made cheaper, contain less valuable metals, be more efficient, have a longer life span and be less vulnerable to disruptions. The prices of electrolysis equipment have halved in the 2010s and are expected to continue to drop by

an additional 50 per cent in this decade. At the same time, equipment features, such as durability, are improving. It takes more than a year to two for these changes to occur, and prices can only drop if production volumes are high.

China has been determined and aggressive in the electrolysis equipment market. The same development can be expected in the sector as with solar panels: China produces cheap bulk goods and Europe is mainly competing in more expensive equipment. The Commission is trying to prevent this trend.

In practice, there are three main types of electrolysis equipment and fuel cells. Various types of equipment use different temperatures and are at different stages of development. The Finnish term for a fuel cell, "polttokenno", is misleading as it refers to the combustion of hydrogen in the equipment, which does not actually happen. The English term *fuel cell* is more apt. In electrolytic production, oxygen is produced from water alongside hydrogen and heat is also produced. The use of oxygen and heat, as well as the use of electricity in fuel cells, reduce costs.

Storage

While hydrogen is a good medium for energy transfer, its transfer and storage is challenging. Hydrogen is only liquefied at a very low temperature, -253 C. As a gaseous compound, it seeps through normal steel, causing it to embrittle. The transfer and storage of hydrogen is easier if it is converted into another molecule, such as methane or ammonia. However, energy is lost in the conversion. Even if hydrogen is produced without emissions, it still requires a lot of energy. Transforming hydrogen into hydrocarbons and possibly back into hydrogen consumes energy and increases costs.

It has been proposed that hydrogen should be turned into a synthetic methane (CH_4), and the carbon dioxide (CO_2) required in the process could be obtained from the use of biofuels. Direct air capture (DAC) will also be an option in the future. Another option is to produce ammonia (NH_3) in combination with nitrogen. Both methane and ammonia are used for e.g. large ship engines. Methanol (CH_3OH) can also be produced from hydrogen and carbon dioxide. It can be used as a feed in the chemical industry or also in engines. Higher hydrocarbons such as kerosene or diesel can also be made from hydrogen, but these products require even more energy than producing simpler methane or ammonia.

Conversion to electrofuels enables use in the existing motor stock. This is a benefit on one hand but on the other, it prevents or at least slows down the change in the engine stock. An internal combustion engine has a very poor thermal efficiency when compared to a fuel cell or an electric motor. When electricity is first used to turn water into hydrogen, convert it into electric fuel and ultimately convert it into mechanical energy by means of an internal combustion engine, most of the electricity from the source has disappeared.

Heat recovery is important at the different stages of the process. During the transition period, electrofuels will play a role alongside biofuels. Both are needed alongside direct electrification and the use of hydrogen alone, for example in transport.

Carbon Capture and Utilization (CCU) technologies are used to recover carbon dioxide from fire gases, for example, resulting from the combustion of biofuel. In addition to hydrogen technology (electrolysers, fuel cells, transfer and storage), these technologies are the targets of active research and development.

If there is no need to capture or use carbon dioxide, it can be stored in a geological storage, in which case we talk about Carbon Capture and Storage (CCS) technologies. If the stored carbon dioxide comes from biofuels, it is referred to Bioenergy with CCS. No legislation concerning BECCS has yet been adopted.

In the next few years, carbon dioxide recovered from industrial plants will be stored under the North Sea in natural gas and oil sources, at least in Norway, Denmark and the Netherlands. For a long time by now, the oil sector has been separating CO_2 from the source and pumped it back. From Finland, carbon dioxide would be transported to the storage site on ships, as Finland does not have its own geological storage for carbon dioxide. As with hydrogen technology and CCU, all the areas of CCS technology are also known, but CCS operations continue to be expensive.

Hydrogen transmission network

The transmission of low-carbon hydrogen will probably be launched as pilot projects where hydrogen is transferred over short distances, for example within an industrial area or between industrial plants located in the same municipality/region. Such projects may proceed as investments by individual companies. Similar projects may also emerge related to the transport of biogas, biomethane or carbon dioxide.

Later, if hydrogen production and consumption increase significantly both in Finland and internationally, large quantities of hydrogen may be transmitted over long distances. Pipeline transmission seems to be the most profitable way of transferring energy when the distances and quantities of energy are very large. Pipeline transmission also enables the formation of marketplaces and market prices.

In large pipeline networks, the non-discriminatory treatment of producers and users is important. Large pipeline networks play a very important role in the balance of the energy system. When the networks are expanded to other countries, agreements and project activities would be carried out in cooperation with the EU, other countries and state-owned enterprises in them. Extensive pipeline networks may be of interest to foreign states and organisations. Future EU regulation on the hydrogen market may

require a certain operations and ownership base for key operators involved in hydrogen transmission (e.g. so-called hydrogen TSO).

The establishment of a large-scale hydrogen transmission system requires extensive investments in electricity production, hydrogen production, hydrogen use and transmission. This is a vision spanning several decades. It is not worth investing in transmission pipes without significant certainty about the increase in hydrogen production and use.

Applications

Hydrogen is used in industry, transport and energy systems, mainly in balancing electrical power networks. In addition to these three sectors, potential applications perceived for hydrogen in Central Europe include gas heating and domestic use of gas. As the direct gas heating popular in Central Europe and the distribution of gas to households lends itself poorly to decarbonisation, hydrogen and particularly the synthetic methane produced from it are considered to provide a solution together with biogas.

In the industrial sector, hydrogen is widely used in oil refining, both in the manufacture of fossil fuels and biofuels. In addition, in the chemical industry, the production of fertilisers, mainly ammonia, is another significant hydrogen user. This hydrogen is currently produced from natural gas using steam reforming, which involves emitting the resulting CO_2 into the air.

Steel production is piloting a solution in which pure hydrogen would be used for steel reduction instead of fossil coke. SSAB's Raahe steel plant is Finland's largest point source for CO_2 with emissions of approximately 4 million tonnes CO_2 per year and SSAB is currently piloting hydrogen reduction at its plants in Sweden. In Raahe, SSAB is considering reducing its emissions with so-called minimill-based production, which involves using electricity instead of hydrogen. Clean hydrogen can also reduce emissions in cement production.

In transport, hydrogen can be used either directly in fuel cells to produce electricity or with gas or liquid fuels made from hydrogen in piston engines. In addition, the opportunities for using ammonia or methanol produced out of hydrogen in ship engines is investigated in waterborne transport. In road transport, the high cost of building hydrogen filling stations is slowing down the use of hydrogen in road transport. There are hydrogen buses and lorries and a refuelling network for them in Central Europe.

It is likely that clean hydrogen will be first used in shipping, for example in ferries and other heavy-duty transport that is difficult to electrify.

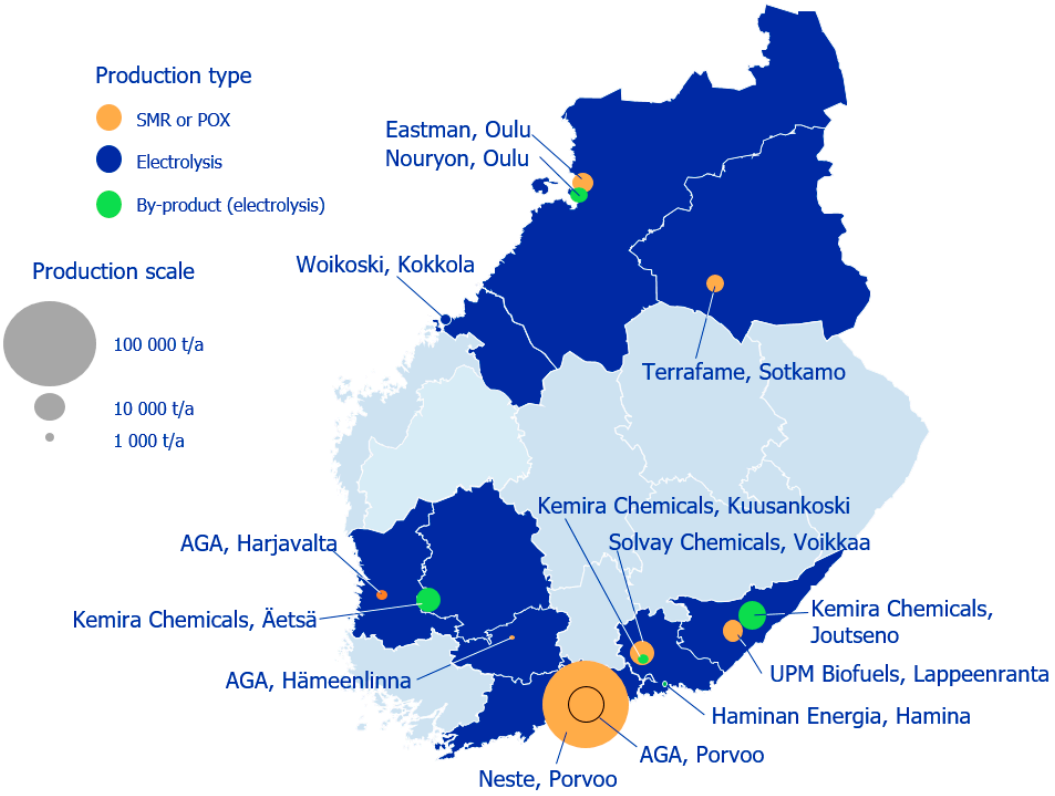
Production and use of hydrogen in Finland – current status and development outlook

Finland is currently producing between 140,000 and 150,000 tonnes/a (4.7 and 5.0 TWh) of hydrogen. Approximately 99 per cent of hydrogen is still produced from fossil sources, mainly natural gas. Small quantities of hydrogen are also produced in Finland for industrial needs in the northern parts of Finland. Producing all this hydrogen with electrolysers would require more than 7 TWh of electricity each year.

In Finland, 88 per cent of hydrogen is currently used for refining oil and biofuels. Major hydrogen users include Neste plants in Porvoo and the UPM biofuel production plant in Lappeenranta. In Finland, hydrogen is also produced as a by-product in various production plants in the forest and chemical industries. In the future, hydrogen production and use may increase significantly. New applications may be found in the chemical, metal and transport industries. If Neste significantly increased the use of hydrogen in its refinery area or if the SSAB's steel plant in Raahe transitioned to hydrogen reduction, the production of hydrogen would require more electricity in both cases, approximately 10 TWh per year.

Nearly 20 hydrogen projects are currently in the planning phase in Finland. The projects will be carried out around Finland, mainly in connection with the largest industrial areas near the southern and western coasts. There are also plans to establish hydrogen networks in Finland, including one known as *BotH$_2$nia* in the Bay of Bothnia's environment.

Figure 22. Hydrogen production and use today. Source: Hydrogen roadmap prepared by VTT.



According to Finland's national hydrogen network, the country's strengths include strong expertise in industry and the energy sector, such as the planning, production and implementation of extensive industrial processes, digitalisation and solutions that improve energy efficiency. Finland has strong expertise in areas such as fuels containing hydrogen, including electrofuels and fuel cells.

Finland has competence in various areas of hydrogen technology and also in the management of entire energy systems. Finland has been an active contributor to fuel cell technology for decades. In addition to clean hydrogen or electrofuels derived from it, Finland can export hydrogen technology. Hydrogen technology includes not only hydrogen but also the manufacture, transfer and storage of electrofuels. Many other countries have set their sights on the same goals, i.e. they want to export not only hydrogen and electrofuels but also hydrogen technology.

Public aid to promote the hydrogen economy

Research and development activities related to hydrogen solutions will be promoted with Business Finland's competitive RDI funding, in which the green transition is one of the main focus areas. Meanwhile, pilot, scaling and full-scale investment projects in the hydrogen economy are aligned with the current funding focus of Finnvera, Tesi and the Finnish Climate Fund.

In the *Sustainable Growth Programme for Finland*, EUR 150 million has been allocated to low-carbon hydrogen and carbon capture and utilisation. The programme also promotes research and development activities, and investments in energy infrastructure and new energy technology. As a whole, the programme provides a highly significant funding package that enables the promotion of hydrogen solutions at different parts of the value chain. In addition, hydrogen projects can be financed continuously with the *energy aid* of the Ministry of Economic Affairs and Employment.

Funding from the European Commission is available for example through the Innovation Fund, Horizon Europe, the hydrogen IPCEE and several other funding channels, depending on applications.

What these national and Commission funding instruments have in common is that they are mainly investment grants. The challenges of hydrogen production include, in addition to initial investments in the early years, high operating costs (electricity vs. an alternative source of hydrogen energy, e.g. natural gas). As a result, projects will also apply for alternative aid based on production. These could include subsidies granted through the Carbon Contracts for Differences (CCfD).

Conclusions

Public measures have the potential to create renewable low-carbon hydrogen production capacity and accelerate the utilisation of hydrogen in industry and transport, and in balancing energy networks, especially electrical power networks. Launching investments requires public funding, as the production of hydrogen with electrolysis with water and electricity is still expensive compared to producing hydrogen from natural gas.

Finland has the prerequisites to develop and commercialise hydrogen solutions for the global market. Sufficient production capacity for clean electricity and investments in the transmission system also make it possible for Finland to develop into an exporter of not only technological solutions but also hydrogen and electrofuels in the long term.

To promote the hydrogen economy, Finland signed the Manifesto for the development of a European "Hydrogen Technologies and Systems" value chain already back in December

2020 with 22 other EU Member States during the current government term to show its commitment to participating in the hydrogen IPCEI process. The Sustainable Growth Programme for Finland has allocated EUR 150 million to hydrogen projects and carbon capture and utilisation projects. A decision has been made to include electrofuels in the transport fuel distribution obligation from the beginning of 2023.

The policies for hydrogen and related electrofuels and other hydrogen technologies are presented in section 2.3 together with other energy and climate policies.

7.3 Future heating system

Development of the heating market

Electricity and heat production must be nearly emission-free in Finland by the end of the 2030s, taking into account delivery reliability and security of supply aspects. Under legislation, the use of coal as a fuel for the production of electricity or heat must end no later than 1 May 2029. The introduction and piloting of new non-combustion district heating production and storage methods will be promoted and the Nordic electricity market and the integration of energy systems will be developed.

In Finland, an increasing number of cities and municipalities have committed to carbon-neutral heating and have announced the closure of their final coal power plants in the next few years. The transition from primary fossil production towards carbon-neutral and non-combustion heat production has already begun. In the future, heat will be obtained from where it is most efficiently available, and it may not be produced in the same way as in previous decades. In future district heating, fossil fuel will be replaced by both smart and flexible electricity-based solutions that utilise waste heat, geothermal and marine energy as well as bioenergy-based solutions. In the future, it is possible that traditional heat consumers will also become heat producers, creating more flexibility through their decentralised solutions.

Heat pumps will play a major role in the utilisation of waste heat and a carbon-neutral energy system. In the future, the importance of heat pumps will increase as previously unprofitable heat sources become profitable due to changes in technology and the operating environment. The changes will increase system integration between the heating and electricity markets, which will enable not only the reduction of emissions but also the development of new energy solutions and increased competitiveness.

For system integration as a whole, future heating investments will have potential for combining district heating and other heating solutions, such as geothermal heating solutions. Such combined solutions could be used to produce heat for various sites in an

emission-controlled manner, both with district heating and locally with geothermal heat and other heat sources.

A heating model of the future will involve more parties than currently and new business frameworks will be needed to reconcile interests. This requires a shared intent to start building a flexible district heating system that does not exclude future technologies and operators.

As a result, there is reason to examine alternatives and operating methods that enable more flexible consideration of non-combustion renewable heat production and waste heat, utilisation of demand response and integration of different energy systems in the district heating market. In this way, future district heating networks could serve as platforms for optimised energy flows from different sources.

New solutions require significant investments in new heat sources and infrastructure, as heating systems and new operators that join the systems become more complex from the perspective of operating the network. As the number of controlled variables increases, the need for automation in energy infrastructure increases to maintain a balanced heating system.

Solutions replacing the energy use of coal in heat production

Phasing out coal in energy production and replacing coal with renewable energy sources will significantly reduce greenhouse gas emissions from heating. There are several potential solutions available for replacing the energy use of coal. In heat production, the aim is to replace coal primarily with non-combustion solutions, such as heat recycling, seawater heat pumps, energy storage, geothermal energy and waste heat. However, bioheating plants will still be needed in the future to safeguard the heat supply in Finland during winter temperatures. The most significant sources of renewable energy, which could be used more in heat production in Finland, are biomass and geothermal energy.

However, stopping the use of coal requires significant investments and investment aid for investment projects in new technology that will promote the commercial application of new solutions and boost new business in the future. Projects based on renewable energy and energy efficiency implemented through investment aid can contribute to achieving the targets set for reducing greenhouse gases, launch projects that would otherwise not be carried out and increase employment both during the construction and use of investments. In addition, new energy solutions will have great export potential, both related to expertise in heating systems and the development of equipment manufacturers and concepts.

However, not all solutions are yet mature enough to enter the market, and some of the potential alternatives are still only being analysed and piloted at this point and will therefore not replace the use of coal in 2029. Such solutions include small modular nuclear reactors. The solutions that will replace coal will consist of a combination of several sources of supply and will involve the application of both small and large solutions. It is important to assess the set of solutions as a whole, paying attention to the emissions target, the security of heat supply and the development of the future operating environment, markets and technology.

Opportunities for waste heat utilisation in the district heating network

In 2020, waste heat and the still unutilised waste heat potential in Finland was estimated to amount to around 130 TWh, of which the amount of waste heat currently utilised as district heating is around 3 TWh. The potential of waste heat that can still be recovered is estimated to amount to 35 TWh. By utilising waste heat, Finland could completely eliminate the use of coal.

Finland generates significant amounts of waste heat that could be utilised as district heating with reasonable technical ease. The greatest potential for waste heat occurs in nuclear power plants and industrial plants, whose combined technically feasible potential of approximately 30 TWh nearly corresponds to Finland's district heating consumption as a whole.

However, there are still challenges related to the potential of waste heat that can still be utilised related to profitability and business risks. The potential for waste heat recovery is also associated with major uncertainties concerning the availability of energy and the timing of production. The waste heat potential available for industrial plants amounts to approximately 15 TWh, its utilisation requires significant investments. However, there must be enough demand for district heating to make the investment in a waste heat solution profitable. In the utilisation of waste heat, a significant cost item consists of the construction of the transmission network and heat pumps. Opportunities for waste heat utilisation must always be assessed on a case-by-case basis. In 2020, waste heat accounted for 11 per cent of the total production of district heating in Finland. Surplus and waste heat utilised by heat pumps has significant additional potential.

Based on a report commissioned by the Ministry of Economic Affairs and Employment, waste heat should be utilised as comprehensively as possible in the most cost-effective heating systems. Other potential for boosting the efficiency of heating systems has been found in lowering the temperature of the district heating network and in heat storage. A lower temperature enables better waste heat utilisation. Meanwhile, district heating storages enable reducing the need for peak load boilers, which may reduce the need

for fossil fuels. Heating technologies based on electricity can also create flexibility in the power system, which is increasingly important for the system.

Finnish Energy has investigated lowering the dimensioning temperatures of the district heating network. New guidelines on temperature levels entered into force at the beginning of 2022. Lower temperatures enable better utilisation of waste heat, renewable energy and heat pump solutions. In addition, a lower temperature makes it possible to increase the construction rate of combined electricity and heat production. However, reducing the outgoing temperature of the district heating network from processing plants is primarily limited by the dimensioning temperature of existing customer equipment (heat distribution centre, heat exchangers) and partly also by the transmission capacity of the district heating network.

Regional utilisation of waste heat

Based on energy use, the largest industrial sectors in Finland are the forest industry, chemical industry and metal processing. The sectors cover approximately 90 per cent of energy use in the industrial sectors and also have major potential for waste heat. Installations in the industry include pulp mills, oil refineries and steel mills.

The utilisation of waste heat from the industrial area of Kilpilahti in Porvoo in the Helsinki Metropolitan Area has been investigated. Based on this work, this could reduce greenhouse gases by about 3–5 per cent of Finland's total emissions. In addition to Kilpilahti, Finland also has other potential combinations of industrial areas and cities that could allow for creating a link between industry and district heating.

The solutions for utilising waste heat provide employment for technology suppliers; labour impacts would primarily occur in the installation, maintenance and service of technology, and indirectly in technological development.

Geoenergy potential in Finland

The increase in the production potential of energy based on geoenergy is estimated to amount to around 2 TWh by 2030. The estimate is based on an assumption that Finland will by then have a few deep and medium-deep geothermal wells at its disposal.

There are currently increasing numbers of geoenergy-based projects in Finland, but no long-term experience has yet been gathered. Medium-deep geothermal energy wells have been completed or are currently under construction in Espoo, Mänttä-Vilpura, Tampere and Vantaa. A geothermal pilot plant is also currently being drilled in Ruskeasuo, Helsinki.

The ongoing projects will also develop drilling technology and heat collection system technology in an aim to collect heat with minimal heat losses. For the time being, all completed and ongoing projects have received government support. Government support measures will have a significant impact on increasing geoenergy by 2030.

Need for cost-effective alternatives to improve the operating conditions of district heating

There has been an active discussion in society on opening up the district heating market to competition and for it to provide a platform for new services. The hope is that opening the district heating market to competition will, among other things,

- lead to lower customer prices,
- lead to interest among operators to develop new solutions and services in the heating sector,
- promote better use of renewable energy and waste heat and improve the position of external heat producers,
- lead to more freedom for customers to choose a district heating supplier.

The European Commission published the Fit for 55 package in July 2021. According to the package, Member States may be obliged to open their district heating and cooling networks to third parties with certain exceptions. There is also a need to strengthen the cooperation between district heating and cooling companies and potential producers of waste heat as well as the main grid company and distribution system operators. To some extent, industry operators have already opened up their networks to heat production by third parties on a voluntary basis.

At present, competition in the heating market occurs between different forms of heating. In some district heating networks, the district heating market enables production by third parties by means of voluntary agreements based on a so-called single buyer model. However, there are currently no common public conditions for linking the production of third parties to networks. So far, no genuine competition has emerged in smaller localities due to the location-bound nature of the marketplaces for district heating and the low number of producers.

A report commissioned by the Ministry of Economic Affairs and Employment[37] presents alternatives and operating methods to increase renewable energy production and waste heat in district heating networks and to enable the heating market to be more flexible in

37 https://tem.fi/selvitykset-lampomarkkinat

taking into account the integration of different energy systems. The aim is also to assess whether the current model can be expanded, for example, by means of a regulated public obligation to connect the production and competitive tendering for new production, and whether this would significantly increase the production of renewable energy and waste heat in district heating networks. When considering models for opening the district heating market, there is a need for comprehensive data on the impacts of the changes on prices and consumers' choices. The aim is also to determine whether regulation can be used to guide users towards selecting combined energy solutions and whether it would increase system integration.

Reducing the dimensioning temperature of the district heating system

Reducing the temperature of the district heating network and storing heat have been identified as the most essential means of improving the efficiency of district heating systems. Lower temperatures enable better utilisation of waste heat, renewable energy and heat pump solutions.

Finnish Energy has examined the preconditions for lower operating temperatures in the district heating network and the impacts they may have on the customer. According to the report, district heating systems may function at lower temperature levels in the future, enabling the inclusion of new types of low-emission production in the district heating system. The first practical measure required for this is to change the dimensioning temperature of the heat distribution centres. The supply temperature of the distribution centres could be reduced from the current 115°C to 90°C without a need for investments in the internal heat distribution of the property. Reducing the supply temperature to a property requires increasing the heat transfer areas of the heat exchangers in the customer's heat transfer centre. According to the estimate, the cost of equipment procurement would increase by an average of five per cent. However, additional costs can often be avoided by systematic dimensioning of equipment based on the actual power demand of the building.

The new dimensioning temperatures of heat distribution centres will enter into force in February 2022. In new buildings, the change in the dimensioning criterion will be introduced immediately, and for existing district heating customers, the change will take place through the natural renewal of equipment. The change is easy for district heating customers. The heat distribution centre is delivered according to the new dimensioning values when equipment is replaced due to a fault or ageing. The transition to a new lower temperature level of district heating water will take place gradually until the end of the 2030s, and the schedule varies between district heating networks depending on the initial situation and needs. A Finnish Energy working group on heat consumption has been

preparing the change in the dimensioning temperature of the heat distribution centres in its publication K1/2020 "District heating of buildings, regulations and instructions".

In connection with lowering the temperature levels of the district heating network, the Ministry of Economic Affairs and Employment and the Ministry of the Environment are interested in examining how replacing customers' heat distribution centres could be carried out as quickly as possible and in a consumer-friendly manner, also taking other efficiency measures into account at the same time. In the future, it will also be necessary to examine whether reducing the temperature of the district heating network and better utilisation of waste heat can promote the introduction of large-scale demand response services related to heating and joint heating solutions, such as district heating combined with independent renewable production.

Connecting waste heat to the district heating network and related agreement

Finnish Energy and the Finnish Environment Institute (SYKE), in cooperation with customer stakeholders, are investigating ways to make connecting waste heat to the district heating network considerably easier. These include agreement-related practices and clear and transparent instructions and boundary conditions for connecting production to the district heating network. This would allow the customers connecting different types of production to assess, plan and develop their projects. By autumn 2022, Finnish Energy will complement and clarify the guidelines together with stakeholders in an aim to offer clear and transparent guidelines on joining and agreeing on waste heat and other renewable production in the future.

Energy taxation of heat pumps and data centres

The Government Programme set a target for Finland to achieve carbon neutrality in 2035. One way to promote this goal was to include heat pumps and data centres producing heat in the district heating network in the lower electricity tax category II. This measure aims at promoting non-combustion heat production methods and can contribute to the utilisation of waste and surplus heat.

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[38]. Electricity used in heat pumps outside these

38 With regard to heat pumps and electric boilers, the act is set to enter into force a decree on 1 July 2022.

networks and with a total power of at least 0.5 MW as well as in geothermal circulating water pumps will also be included in the lower electricity tax category in the future.

The sphere of data centres in the lower electricity tax category has been expanded to encourage more use of surplus heat. In the future, smaller data centres will also be entitled to acquire electricity in the lower electricity tax category if they meet the requirements based on server equipment efficiency, utilisation of surplus heat and energy efficiency.

Competitiveness of heat pumps and data centres

The cost of electricity used by heat pumps is one of the key factors affecting the profitability of heat pumps, and the share of electricity tax in the cost is often significant at the current level of electricity tax. The transfer of heat pumps used in district heating to the lower electricity tax category II lowers the average production costs of different heat pump solutions and may increase interest in their wider use.

Lowering the electricity tax on heat pumps supports the competitiveness of heat pumps and may partly compensate for other risks and uncertainties related to projects, such as security of supply and investment costs. The district heating network offers more flexibility in the energy system and an opportunity to partly store energy. Efficient utilisation of district heating and flexibility are important for the operation of the electricity network and the production of electricity.

By transferring district heating pumps and data centres to a lower electricity tax category, a larger share of the new district heating capacity, largely based on forest chips, can be replaced by heat pumps. This may to some extent reduce the pressure for increasing the price of forest chips. At the same time, new, affordable district heat production with heat pumps would keep the costs of district heat production at a lower level. Consequently, the transfer of district heating heat pumps and possibly other electric solutions to a lower tax category II may result in reducing the price of district heating.

The role of biomass in the future heating system

The security of energy supply in Finland is based on decentralised energy production and diverse energy sources. Domestic fuel resources are currently limited to bioenergy, peat and energy recovery of waste. Domestic fuels will also play a key role in the future heating system, which is discussed in more detail in section 4.5.3 Heating delivery reliability and security of supply.

7.4 Offshore wind power

Offshore wind power production is growing rapidly worldwide, and the EU strategy on offshore renewable energy sets ambitious targets for increasing offshore wind power capacity. The increase in the production of emission-free electricity will play a crucial role in the electrification of industry and transport. Finland has significant offshore wind power potential, and Finland's western sea areas are particularly favourable for wind power production. Project implementation is supported by good wind conditions, maritime areas whose depth is suitable for construction and existing port infrastructure. The freezing of seas in winter requires technical solutions suitable for Arctic conditions. Offshore wind energy projects may be located either in territorial waters closer to the coast or in an exclusive economic zone farther from the coast.

The target state is that by 2030, the first industrial-size offshore wind power projects in Finland would be in production, and by 2035, several projects would already have been built in both territorial waters and economic zones. As the offshore wind power sector grows, it will create more and more jobs for local companies, and expertise in offshore wind power, especially in Arctic conditions, will increase the export opportunities of companies with prior merits in the sector.

The increase in offshore wind power capacity is strongly linked to the increase in the economic profitability of projects as technology develops and the production of individual wind turbines increases. Finland does not consider it appropriate to grant extensive aid for offshore wind power projects; instead, capacity growth is based on market conditions.

However, aid is considered necessary for the first demonstration projects. In recent years, the costs of offshore wind power have declined rapidly globally, but production technologies are partly under development. The EU's maritime areas are also highly different, which means that the solutions that work in a particular area cannot be directly adopted by others. While Finland has individual wind turbine generator systems constructed in maritime areas, the country has only one offshore wind farm. In Finland, overall costs are particularly increased by the need for foundations that are sustainable in ice conditions due to the freezing of the sea. In addition, even though Finland has special expertise and infrastructure, for example in shipyards, there is need to increase competence related to offshore wind power as well as the infrastructure and activities related to construction and maintenance at sea. This development will be promoted by the construction of at least one demonstration project in the next few years. The aim is to support demonstration projects primarily through EU funding through the Finnish Sustainable Growth Programme or the Union's renewable energy funding mechanism.

The acquisition of land use rights and the permit required for research and construction differ significantly depending on whether the offshore wind energy project is located in territorial waters or in the exclusive economic zone. Metsähallitus is an essential actor in territorial waters. Metsähallitus manages Finnish territorial waters and can rent sea areas for wind power projects. Permits for operating in territorial waters are granted by municipalities and regional state administrative agencies, for example. A key player in the exclusive economic zone (EEZ) is the Ministry of Economic Affairs and Employment, which is responsible for the licencing concerning the utilisation of the EEZ.

In Europe and the Baltic Sea region, interest in offshore wind power and other offshore energy has clearly increased in recent years. The development of offshore energy networks and particularly offshore electricity transmission has emerged more strongly than before. In addition, joint transnational offshore wind and network projects have evolved and are under development in Europe. Such projects may also lead to new questions related to the energy system. Aland has extensive plans for the construction of offshore wind power, and if implemented, they may have a significant impact on the export and import of Finnish electricity and the structure of the main grid.

Offshore wind power projects are often significant in size, up to several gigawatts, which poses challenges in connecting them to the electrical power system. The electrical power system is prepared to allow the largest individual production unit to disconnect from the network without disturbing the operation of the electrical system. Units larger than this cannot be connected to the system unless it takes certain special measures. In Finland and the Nordic countries, the maximum capacity of units that may be connected to the system is 1,300 MW.

7.5 The role of nuclear energy in the energy economy

Ensuring electricity production with climate-neutral solutions in all conditions is important for society. This gains emphasis as we transition more to weather-dependent production. Nuclear power plays a role in facilitating this transition. Half of the EU Member States use nuclear energy as part of their energy mix and in pursuit of their long-term climate objectives. A prerequisite for the use is maintaining a high level of safety and making arrangements for nuclear waste management.

A comprehensive reform of the Nuclear Energy Act has been launched to enable the use of long-term nuclear energy and new technologies. The overall reform of the Nuclear Energy Act pays attention to the arrangements for nuclear waste management. The overall reform is very extensive and will take several years. The aim is to implement this reform

at the beginning of 2028. The reform of the Nuclear Liability Act will already take place in 2021, in relation to the ratification of the international Paris Agreement.

The use of existing power plants in Finland extends to 2038 with valid operating licences. The use of the latest power plant unit, Olkiluoto 3, is expected to continue until the 2080s. The planned service life of the unit in the construction licence application phase is approximately 60 years after commissioning. With regard to nuclear waste management, the final disposal facilities will operate for decades longer than the power plants until all fuel spent, nuclear waste and demolition waste from power plants has been disposed of. This means that the nuclear waste management of the currently operating power plants will extend as far as the 2120s.

7.5.1 Current status of the use of nuclear energy

In Finland, nuclear electricity accounts for about 34 per cent (2020) of total electricity produced and 28 per cent of total electricity consumed. There are four production units, two at Loviisa power plant and two at Olkiluoto power plant. All of the plants have been operating for more than 40 years. The deployment of the Olkiluoto 3 nuclear power plant will increase the share of nuclear energy in electricity production to more than 40 per cent in 2022.

The use and regulation of nuclear energy is based on safety, security arrangements and safeguards. These aspects are monitored in connection with the use of nuclear energy with the licences granted to nuclear power plants and the nuclear waste management obligation binding on licence holders as well as the obligation of contingency preparation related to the costs of nuclear waste management. It is also vital to maintain and develop competence in the industry. Continuous production and the use of a systematic approach at nuclear power plants support the security of supply of energy production.

Nuclear energy production is a form of base load power with steady production efficiency, with the exception of planned annual maintenance or downtime. Typically, the utilisation rate of nuclear power plants is very high in Finland (up to 95%). The current power plants produce electricity, and the plants have not been used for heat production. Economical district heating production would require establishing nuclear power plants near of cities.

In Finland, expertise in the nuclear energy sector has been maintained and increased through national research programmes. Finland also participates in major international research programmes (IAEA and OECD NEA) and Euratom research programmes.

7.5.2 Development of the use of nuclear energy

The most significant development work in the nuclear energy sector in Finland concerned the final disposal of used nuclear fuel. Power companies Fortum and TVO established Posiva Oy in 1995 to be responsible for the development of a final disposal concept and plant for used nuclear fuel, and the construction and commissioning of the plant in the 2000s. A licence was applied for Posiva's final disposal facility at the end of 2021, and Posiva is expected to be the first in the world to launch its disposal activities in 2025. This solution is very important for the sustainable production of nuclear energy and shows that the final disposal solution can be implemented during the operation of the power plants. There is need to support competence in nuclear waste management and export opportunities for official activities, as there is also international demand for competence.

In the 2020s, there has been a growing need to introduce reliable forms of energy production that replace new fossil fuels. At the global level, there is most interest in the development of nuclear reactor technology in so-called small modular reactors (SMRs). While SMR plants can utilise existing reactor technology, they are implemented on a smaller scale than the current power plants in serial industrial production and using a modular construction.

SMR technology would achieve benefits in coordination with increasing renewable and weather-dependent energy production, and would allow plants to also meet the needs for heat production or cogeneration. At the global level, the aim is to also utilise SMR technology to bring electricity to remote locations or meet the needs of hydrogen production, for example. To assess technology, a Government research project (VN TEAS) was launched in 2021 to develop the regulation of SMR plants.

The safe use and development of nuclear energy in the long term will require Finland's involvement in significant international development projects and the utilisation of international research infrastructures. Nuclear safety expertise in Finland is of a high standard, and selling it internationally is desirable both to increase competence at the national level and to improve international nuclear safety.

8 Appendices

8.1 Summary of the statements on the climate and energy strategy

The draft version of the national climate and energy strategy was submitted for a round of comments in the Lausuntopalvelu service on Thursday 14 April 2022. The deadline for comments is in approximately five weeks, i.e. from 14 April 2022 to 18 May 2022. During this period, a total of 149 comments were issued. The commentators represent a versatile range of the field of social, climate and energy policy. The comments are divided as follows:

The body that the commentator represents	Number of commentators
Ministry	5
Other state actor, e.g. agency	19
City, municipality or county	19
Company	21
Research institute, university or higher education institution	4
Trade or interest organisation	51
Individual person	12
Other	18
Total	**149**

The submitted open comments were particularly concerned with the reduction of greenhouse gas emissions, growing sinks, the promotion of renewable energy and energy efficiency. However, responses were evenly submitted on all sections of the strategy. This summary contains extracts from the summary of comments and discusses the statements given in further detail.

In the area of greenhouse gas emissions and increasing sinks, the commentators submitted statements on the land use and effort sharing sector in particular. However, the statements also emphasised **sector-specific low-carbon roadmaps**, which received mainly positive feedback. There were also some critical views regarding the roadmaps, for instance, in relation to the concise nature of the roadmaps or a lack of examination of certain areas in them. In relation to the **emissions trading system**, it was noted

that the system provided a cost-effective means of reducing emissions, and many comments mainly supported the emissions trading system. There were comments in favour and against the **use of the LULUCF flexibility mechanism**. Those in favour of the flexibility mechanism referred to cost-effectiveness or found that the mechanism could allow reaching the emission reduction targets set for the effort sharing system. Negative comments concerned areas such as the unfairness of the use of flexibility, a need to genuinely seek emission by means of reductions, or the uncertain nature of the use of the flexibility mechanism. The **targets for sinks in the land use sector and the targets for reducing emissions from agriculture** were also highlighted in the comments, particularly regarding the uncertainty of the targets, as there is uncertainty associated with issues such as the size of the sinks. On the **targets set for the sinks,** the commentators either expressed their support for increasing the sinks or stated that increasing the sinks cannot compensate for emission reductions. Some of the comments also called for the **clarification of the 2035 carbon neutrality target and keeping in mind the carbon negativity goal**, for example pointing out that the proposed measures are insufficient for achieving carbon neutrality and that further action is necessary, especially in areas that contain uncertainty. Some also expressed hope that the target for carbon negativity in 2050 would be kept in mind.

Concerning the promotion of renewable energy, the **non-combustion forms of renewable energy** were addressed in some responses. For example, comments were made on how the energy system should be based on non-combustion energy and, on the other hand, that technology neutrality and the magnitude of emission reductions should be a priority. **Felling and the use of wood** were also highlighted when the responses emphasised the need to examine the growth in felling and steer the use of wood from the perspective of bioenergy. While the **Government Decree on General Terms of Granting Energy** was considered to be primarily worthy of support, some responses called for a need to pay attention to what kinds of projects will be supported and a potential impact of the aid distorting competition in relation to the **allocation of the aid**. As regards the **distribution obligation**, it was mainly stated that the obligation should be raised after 2023, but some of the comments also contained criticism and development proposals for the future. The statements also emphasised **wind power, related harm and the balanced geographical distribution of wind power**. Other responses called for further examination of the opportunities for wind power in Eastern Finland and that wind power would be distributed more equally around the country. Wishes were also expressed regarding the promotion of offshore wind power. Some also called for taking the disadvantages caused by wind power into account.

Regarding hydrogen and electrofuels, it was pointed out that instead of merely expecting the **commercialisation of the hydrogen economy** to happen, there is need to **promote the hydrogen economy actively** through political measures. On the other hand, there

was also a comment on the **uncertainties related to the hydrogen economy** and the need to take these into account. Some of the comments also found that the **targets set for hydrogen** were too low and that there would also be potential for more substantial targets at the national level. The **choice of the hydrogen production method** was also highlighted in the comments, for example, when it was emphasised that the method of production influences whether we can refer to green hydrogen. Some of the responses pointed out that it should be mentioned that hydrogen produced with nuclear energy is also emission-free. The comments also called for paying attention to the **regional distribution of hydrogen, land use and land use planning**. Some commented that the policies failed to pay attention to land use planning and its significance, and that the regions should be provided with clearer information and understanding of the needs of hydrogen production plants and how these could be promoted.

In the context of the promotion of energy efficiency, several comments stressed the need for an **overall reduction in energy consumption and saving energy**; it was stated that the strategy should pay more attention to the overall reduction of energy use, and some commentators also pointed out that energy efficiency has been addressed in a comprehensive but one-sided manner in this respect. Some note that the significance of energy efficiency has not been fully recognised. **Energy advisory services received extensive support**, and the related comments were concerned with a need to ensure sufficient resources, regional distribution of advisory services, availability of services and the consideration of people with a poorer socio-economic status. Meanwhile, some noted that reducing transport emissions was not comprehensively addressed in the strategy, and requested that the means for **reducing transport emissions, improving energy efficiency and electrifying transport** should be taken into account. Some also felt that the proposed measures were unrealistic, for example in relation to electrification and regional distribution. Some responses pointed out that the **energy performance of buildings** is not comprehensively addressed and that the potential of the building stock is not fully identified. In this area, it was also noted that EU regulation should aim at identifying the best knowledge of the building stock in the Member States.

Positive feedback was provided on energy delivery reliability and security of supply. However, it was stated that **climate targets should not be jeopardised due to security of supply issues**. Issues addressed in this context also included that dependence on fossil fuels is a safety issue and it was considered important that security of supply should rely on diverse sources. Some of the comments pointed out that it should be possible to rely on domestic energy during the transition period. **Renewable energy sources, electricity, energy efficiency measures and energy savings** were considered to strengthen the security of supply according to comments, some of which highlighted the importance of the diversity of energy sources and approaches for the security of supply. Some also noted that electricity and a functioning distribution network are important for delivery

reliability and security of supply. It was also commented that there is **no reason to increase dependence on a specific energy source with regard to delivery reliability and security of supply**.

Both favourable and negative comments were submitted on nuclear energy. **Statements against nuclear energy point out that nuclear waste poses unresolved environmental risks, while those in favour of nuclear energy emphasise positive views regarding zero-emissions nuclear energy. The reform of the Nuclear Energy Act is supported and a separate decree is proposed to enable SMR plants.** Some comments also expressed negative views on the **extension of nuclear power plant licences**. A few comments concerning the **EIA process of nuclear power plants** pointed out that the process should be enabled after the choices made on business terms have been made.

In the energy market development section, particularly the **report on energy poverty received support**, but the responses asked for clarification on issues such as how energy poverty should be examined and what kinds of impacts it could have, and called for paying attention to the status of different groups of people. **Small-scale electricity production, smart grids, flexible electricity markets and energy communities** received support, and comments concerned topics such as the importance of increasing flexibility, providing choices to end customers and the single invoice model received some support. Some comments expressed support for **keeping Finland a single bidding area for electricity trade**, while other comments were submitted on the **development of the main grid**, especially regarding investments and the stability of future electricity production.

Research, innovation and competitiveness mainly received positive feedback. The comments recognised that a **shortage of experts could be a bottleneck for the green transition** and called for solutions to this problem; the **promotion of equality between women and men in the energy sector** was supported, and again, wishes for concrete solutions were expressed. The promotion of **basic and applied research** was also supported, and regarding the **support of standardisation work,** it was noted that the work also had an impact on the market and that standardisation should therefore be supported.

In the section on taxation, few of the comments concerned the same topics; instead, the responses were versatile and took a stand on various issues. Overall, the comments nonetheless pointed out that, for instance, **taxes harmful to the climate are not addressed in the strategy** and **that the investment environment should remain predictable and that competitiveness should be ensured.**

In terms of strengthening climate change adaptation, the responses did not emphasise certain perspectives or views, but were instead versatile and commented on various issues.

Influence within the EU was considered important in the responses, and Finland was hoped to have a strong influence and a consistent approach. Beyond this, the comments found different issues and views important.

Several comments were submitted on the impacts of the strategy's policies. As regards the **achievement of the climate targets**, it was stated that **uncertainty regarding the carbon neutrality and carbon negativity targets** should be taken into account and, if necessary, the need for additional measures should be examined. **In terms of the impacts on the national economy, a report on the impacts of employment and competence needs was requested.** A request was made to make the **cost-effectiveness of emission reduction measures** more specific while taking into account the **costs of inactivity, employment impact,** and it was noted that **changes in the operating environment affect the impacts on the national economy**. While **fundamental and human rights impacts and gender impacts** were found to be well identified, the responses also found that the identified impacts were **not sufficiently visible in the outlined measures** and **their targeting**, and attention was drawn to the **importance of a just transition**. Some also called for **assessing the impacts on children** and more extensive consideration of the **rights of the Sámi people** and highlighted the importance of discussing the **just transition for employees**. A broad range of opinions was expressed related to the **impacts of the energy system**.

With regard to Finland's hydrogen strategy, it was stated that the **hydrogen strategy should be ambitious, as the level of hydrogen targets also sends a message in the global context**, and it was also noted that the strategy could be more ambitious in the areas of **the hydrogen economy, electrofuels and carbon dioxide capture and utilisation**, and that there is no reason to lose potential technology exports related to these areas. Some of the comments also wished for a **separate national hydrogen strategy** and hoped that **investment needs would be investigated**. The **versatility of hydrogen** was also emphasised and it was noted that hydrogen could influence vitality, has storage capacity, could be used as raw material and also has an impact on reducing emissions.

8.2 Studies and events related to the preparation of the climate and energy strategy

- **Kick-off seminar for the preparation of the climate and energy strategy.** Kick-off seminar for the preparation of the climate and energy strategy was organised on 25 September 2020. The kick-off seminar was organised as a webinar and was aimed at stakeholders and experts. In addition to the speeches by the Minister of Economic Affairs Mika Lintilä and Minister of the Environment and Climate Change Krista Mikkonen, the event also included speeches from the ministries participating in the preparation of the strategy and VTT Technical Research Centre of Finland, which was responsible for carrying out background calculations. Expectations for the Climate and Energy Strategy were expressed by the Confederation of Finnish Industries EK, Finnish Energy, the Central Organisation of Finnish Trade Unions SAK, the Finnish Climate Change Panel and the Finnish National Youth Council Allianssi. The presentations and video recordings related to the event are available at the Ministry of Economic Affairs and Employment's website at https://tem.fi/tilaisuudet

- **Carbon neutral Finland 2035 – measures and impacts of the climate and energy policies (HIISI).** The objective of the Carbon neutral Finland 2035 – measures and impacts of the climate and energy policies (HIISI) project was to produce estimates of how Finland could sustainably achieve the national and European Union climate and energy targets in 2030, 2035, 2040 and 2050. The HIISI project provided a strong knowledge base for the comprehensive and long-term development of climate and energy policy and served research and analysis needs during the preparation of the national climate and energy strategy and the Medium-term Climate Change Policy Plan, which were drawn up around the same time. The project assessed both direct and indirect impacts on costs and the economy, greenhouse gas emissions and removals, the use of natural resources and the environment, health and the overall wellbeing of citizens. Two stakeholder events were organised in connection with the project on 16 February 2021 (climate and energy scenarios with current measures) and on 11 June 2021 (preliminary assumptions and results of the WAM scenario from the perspectives of the energy and national economy and in different emission sectors). http://urn.fi/URN:ISBN:978-952-383-257-2

- **HIISI follow-up project.** After the HIISI project, it was necessary to implement the HIISI follow-up project, which was completed in February 2022. In the budget session held in September 2021, the Government

outlined a number of new climate and energy policy measures, some of which could not be taken into account in the HIISI project due to scheduling reasons. In the budget session, the Government also made an entry on the assessment of the adequacy of climate measures for meeting climate targets using the means proposed in the Medium-term Climate Change Policy Plan (KAISU). The aim of the follow-up project was to assess the impacts of the Government's latest climate and energy decisions on Finland's greenhouse gas emissions and the energy and national economy. The report of the HIISI follow-up project only presents the base assumptions and results of calculations that differ from the premises drawn up in the HIISI project and are related to the development of the energy and national economy and greenhouse gas emissions. https://publications.vtt.fi/pdf/technology/2022/T402.pdf

- **Medium-term Climate Change Policy Plan (KAISU).** The medium-term climate change policy plan has been prepared in parallel with the Ministry of Economic Affairs and Employment's climate and energy strategy, and it describes the measures in the effort sharing sector that will allow Finland to achieve the 2030 emission reduction and carbon neutrality target in 2035. The views of different parties on the necessary emission reduction measures were collected for the preparation, including a citizens' panel formed by random sampling, stakeholder meetings, a roundtable on climate policy, events on fairness and equality, and at a meeting of the Sámi Parliament. Citizens' opinions on the measures included in the plan were investigated using an online survey, which received 18,000 responses. http://urn.fi/URN:ISBN:978-952-361-262-4

- **A Climate Change Plan for the Land Use Sector (MISU).** The Climate Change Plan for the Land Use Sector identifies the means for reducing climate emissions from the land use sector and for strengthening carbon sinks and storages. The plan contributes to pursuing Finland's goal to achieve carbon neutrality by 2035, and it also helps meeting the European Union's climate targets and complying with international commitments. The Climate Change Plan for the Land Use Sector includes measures targeting agricultural land carbon dioxide emissions, forests, land use change and climate wetlands. Coherence with the climate and energy strategy and the medium-term climate change policy plan will be taken into account when drawing up the plan. The plan makes use of the data that informed the above documents, such as the Carbon Neutral Finland 2035 (HIISI) project. Several public hearings and other participatory events have been organised in connection with the work. http://urn.fi/URN:ISBN:978-952-366-388-6

- **Roadmap to fossil-free transport:** The Government made a resolution on reducing domestic transport's greenhouse gas emissions on 22 June 2021. In accordance with the government programme, the Ministry of Transport and Communications has prepared a roadmap to fossil-free transport to reduce greenhouse gas emissions from transport. The roadmap to fossil-free transport includes three phases. In the first phase, the Government will implement a wide range of aids and incentives to promote emission-free transport. In the second phase, more measures will be added to the range of instruments. Further information will be needed on their effects on emissions before decisions can be made. In the third phase, the Government will assess and decide on a possible need for additional national measures related to transport. This will be done once there is knowledge of all measures at the EU level, processes decided on in other contexts and phases 1 and 2 as well as their impacts. http://urn.fi/URN:ISBN:978-952-243-588-0

- **Low-carbon roadmaps of the industries.** Four energy-intensive industries and nine other sectors have prepared roadmaps aiming at significant reductions in greenhouse gas emissions by 2035. The work around the roadmaps began in autumn 2019, and the sectors presented their results at the Ministry of Economic Affairs and Employment webinar on 9 June 2020. On 22 October 2020, the Ministry of Economic Affairs and Employment published a report summarising the main results of these roadmaps. The report also includes summaries of the published roadmaps, key conclusions of the project, a description of the work process and assessments of further work and how the provision of roadmaps is utilised in Finland's climate and energy work towards decarbonisation.
http://urn.fi/URN:ISBN:978-952-327-525-6
http://urn.fi/URN:ISBN:978-952-327-796-0
https://tem.fi/tiekartat

- **Working group on sector integration.** The working group on sector integration appointed by the Ministry of Economic Affairs and Employment examined opportunities and challenges for sectoral integration as well as options for measures to promote sectoral integration and submitted the final report at a publication event on 30 June 2021. The working group's main proposals are related to the introduction of new solutions in the district heating system, the introduction and scaling of hydrogen solutions, sectoral integration in buildings and joint planning of energy networks. The working group's proposals laid the foundation for the preparation of the climate and energy strategy, particularly the special section on the theme of sectoral integration. http://urn.fi/URN:ISBN:978-952-327-697-0

- **Broad-based working group on peat.** On 31 March 2020, the Ministry of Economic Affairs and Employment appointed a national broad-based working group on peat to prepare proposals for measures in line with the government programme to curb the negative impacts caused by reducing the use of peat for energy. The working group's mandate ended on 31 March 2021. The working group considered that, above all, it is worth noticing how quickly the demand for energy peat has started to decline just during the working group's mandate – especially as a result of the increase in the emission allowance price, which has been significantly faster than projected. The working group noted that the most significant challenges are related to improving the situation of peat entrepreneurs and safeguarding delivery reliability and security of supply in a situation where the use of peat for energy will be drastically reduced in the next few years. The proposals contained in the report consist of a package for those peat industry operators who will close down their operations, including various one-off compensations and financial aid provided to them to transfer to new business activities. In its mid-term policy review of 2021, the Government decided to introduce a scrapping aid for peat production machines, an aid for the abandonment of peat for entrepreneurs and the preparation of various new business advisory and development services. http://urn.fi/URN:ISBN:978-952-327-856-1

- **Working group on energy taxation reform:** The Ministry of Finance appointed a working group on energy taxation reform for the period 18 November 2019–1 September 2020. The working group's task was to conduct preparatory work for implementing the intentions of the Government Programme and to assess the development needs of the energy tax system. The working group submitted its proposal on the implementation of the intentions and targets of the Government Programme and on other forms of development of energy taxation. During the working group process, four public hearings and a written round of hearings were organised. The latter was participated by eight parties. An open questionnaire was also available in the otakantaa.fi portal during the working group's work. http://urn.fi/URN:ISBN:978-952-367-299-4

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