The IEA examines the full spectrum of energy issues including oil, gas and coal supply and demand, renewable energy technologies, electricity markets, energy efficiency, access to energy, demand side management and much more. Through its work, the IEA advocates policies that will enhance the reliability, affordability and sustainability of energy in its 30 member countries, 7 association countries and beyond.

The four main areas of IEA focus are:

- **Energy Security**: Promoting diversity, efficiency, flexibility and reliability for all fuels and energy sources;
- **Economic Development**: Supporting free markets to foster economic growth and eliminate energy poverty;
- **Environmental Awareness**: Analysing policy options to offset the impact of energy production and use on the environment, especially for tackling climate change and air pollution; and
- **Engagement Worldwide**: Working closely with association and partner countries, especially major emerging economies, to find solutions to shared energy and environmental concerns.
1. Executive summary

Energy and climate policies in Finland have strongly evolved during the five years since the International Energy Agency (IEA) presented the last in-depth review (IDR) in 2013. As Nordic countries take leadership towards a low-carbon economy with ambitious climate targets, the government of Finland is placing greater emphasis on the mitigation of climate change and reducing the share of fossil fuels, while boosting economic growth and industrial innovation.

For this in-depth review, the government of Finland asked the IEA to review the lessons that Finland can learn from other countries’ experiences in the low-carbon transition. Specifically, the report highlights how the transport sector could be decarbonised and what role Finland’s domestic wood-based biofuels could play in it. The report also suggests how Finland could maintain energy efficient combined heat and power (CHP) production, which is challenged by the historically low power prices in the Nordic market.

Energy system transformation

Since the 2013 IEA review, the government has set out ambitious climate targets and policy action that are closely linked to energy. The 2015 Climate Act (2015) sets a goal for 2050, while specific actions are listed under the National Energy and Climate Strategy for 2030 (2016) and the Medium Term Climate Policy Plan (2017).

Under these plans, the government of Finland aims to i) reduce greenhouse gas (GHG) emissions by 80% by 2050 compared to 1990 levels; ii) reduce GHG emissions in non-ETS sectors by 39% in 2030; iii) phase out the use of coal for energy production by 2030; iv) boost the share of renewable energy to over 50% of final energy consumption during the 2020s; and v) increase the share of biofuels in road transport to 30% by 2030. Under the EU Energy Union Governance Regulation, Finland is finalising a National Climate and Energy Plan.

The power sector in Finland is largely decarbonised and covered under the EU Emissions Trading System (EU ETS). Finland’s electricity generation mainly consists of nuclear energy (34%), hydro (22%) and biomass (18%); the share of fossil fuels has significantly declined over the past years.

The government is placing the focus on the continuous decarbonisation of transport and residential (buildings/heating) sectors. Up to 2020, Finland is largely on track to achieve its targeted 16% reduction in GHG emissions in the non-ETS sectors, with the use of flexibility measures. For 2030 Finland has the objective of reducing non-ETS emission by 39% by 2030 (from 2005 levels). As transport emissions make up the largest share
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(40%) of non-ETS emissions, progress in the decarbonisation of that sector is critical to meeting the 2030 objective.

In the National Energy and Climate Strategy for 2030, Finland envisages reducing domestic oil use by 50% compared to 2005 through improved energy efficiency of the transport system, an accelerated vehicle stock renewal, a target of 250 000 electric vehicles and 50 000 gas fueled vehicles, boosting the share of biofuels in road transport to 30% and blending up to 10% bio liquids into light fuel oil for space heating.

Reaching these ambitious decarbonisation goals will require a strategy based on boosting energy efficiency and renewable energy besides contribution from fuel switching and nuclear energy.

Finland’s strategy raises a number of challenges with regard to the role of biomass, of CHP and the sustainability of biofuels as well as the overall approach to the future of transport. While the medium-term reliance on biomass and nuclear is a confirmed strategy of the government, such an approach might be compromised by delays in nuclear development or low availability of domestic biofuels or technologies which can meet sustainability criteria. Technology development is required for most of the second-generation biofuels. Finland can already benefit from significant cost reductions, notably in wind power, electric vehicles and batteries, and consumers are expected to move quickly into these technologies.

Finland does not have a national quantitative target set for energy efficiency efforts under its energy and climate strategy, but uses voluntary agreements with industry and has sector-specific targets for transport. Building codes set high energy performance standards for new buildings, but energy efficiency can improve further, particularly in the older building stock.

Clean energy technology innovation is a critical success factor for reaching the long-term decarbonisation goals. Finland has been a leader among IEA member countries, when it comes to government energy research, development and demonstration (RD&D) spending (as a ratio of gross domestic product (GDP)), private sector innovation and spending, and international engagement. Under M:I Finland leads on the demand response taskforce with Denmark (under the Smart Grids Innovation Challenge), and supports the Sustainable Biofuels Innovation Challenge and the Affordable Heating and Cooling of Buildings Innovation Challenge. Finland should aim to maintain a significant public RD&D spending for the energy sector. In addition, amid decreased public RD&D spending, future contributions from the private sector need also to remain strong, as Finland aims to meet its Mission: Innovation (M:I) goals. The government should present a long-term low-carbon strategy to further support Finland’s innovation potential.

As an Arctic country, Finland faces rapid changes in its climate, with potential consequences for, among others, forest growth and the occurrence and strength of winter storms. Finland’s most recent National Climate Change Adaptation Plan was adopted in 2014 and a range of measures have been put in place to strengthen the resilience of the electricity distribution networks.

During 2017-19, Finland chairs the Arctic Council, an opportunity to scale up actions aimed at higher adaptation, resilience and GHG emissions reductions, notably methane and black carbon in the Arctic.
Energy security

By international comparison, Finland’s primary energy supply continues to be well diversified with a large role for biomass (28%), oil (26%) and nuclear (17%), and smaller shares for coal (8%), natural gas (6%) as well as from domestic peat, hydro, and wind. With hardly any domestic fossil fuel resources, Finland imports all of its natural gas, and a large part of its oil, coal and nuclear fuel from the Russian Federation. ¹ Finland has a cross-sector approach to energy security, relying on stockpiling of coal, oil, nuclear fuel and domestic peat.

Oil security continues to be robust. A member of the IEA since 1992, Finland’s oil stocks equal 240 days of 2017 net-imports, much beyond the minimum of 90 days required. New natural gas infrastructure is being built; both liquefied natural gas (LNG) and pipelines, and the currently isolated Finnish gas market will be opened to competition under the New Natural Gas Market Act by 2020. Investment in small LNG terminals flourishes, mainly serving local industrial and maritime uses with two LNG import terminals (in Pori and Tornio) and a third under construction. Supported by EU funding, the Balticconnector pipeline will connect the isolated Finnish gas network to Estonia, the Klaipeda LNG terminal in Lithuania and the Baltic gas storage in Latvia (Inčukalns) by late 2019. Besides infrastructure, gas market rules need to be put in place by 1 January 2020, under EU rules for the internal gas market. These rules include the unbundling of commercial and transmission operations, the end of gas price regulation and the creation of a common gas market area with the Baltic states which will also require clarifications of how the Balticconnector pipeline and the Russian gas imports will be operated and regulated in Finland.

Energy security remains a strong priority for Finland. The reliance on imports from the Nordic market and Russia has remained high and is on the rise, in part because the 1.6 GW Olkiluoto 3 NPP has been delayed, but the project is expected to finally come online in 2019-20.

Finland’s nuclear power plants have operated for around 40 years and their licenses need to be renewed. The construction of Olkiluoto 3 is still ongoing, and so is the licencing procedure for another NPP, Hanhikivi 1. Both the projects are co-owned by utilities and industrial power users, a model which is based on long-term bilateral contracts. Nuclear investment is driven by industry, and the government role is to ensure laws and regulations are in place and followed. Concerning new reactor designs, the government should actively participate in the multinational efforts to progress the international harmonisation of nuclear safety standards and licensing frameworks to leverage the resources and knowledge of national regulators. Finland is leading on nuclear waste management. Commendably, in 2015, the government has granted the construction license for the final nuclear repository of spent nuclear fuel, the first one in the world. Nuclear operators TVO and Fortum have worked together through their subsidiary Posiva to fund the R&D efforts and to construct this facility for high-level nuclear waste, which is planned to begin operations in the early 2020’s.

¹ Hereafter, “Russia”.

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To boost electricity security, Fingrid has made significant investments in strengthening the interconnections with Sweden, the integration with the Baltic states and in removing internal bottlenecks in the Finnish system and is working also on smarter grids with a data hub in Finland. Collaboration across the Nordic countries is progressing towards a new regional market design, notably among transmission system operators (TSOs) and utilities. The government of Finland should support the regional orientation of energy and climate policies, a key feature of the Ollila report “A vision for Nordic energy cooperation”, as these policies will be the fundamental drivers for the future electricity market. Nordic power market design will need to evolve towards competitive and efficient intra-day markets, reserve products and balancing services across the region, supported by greater security collaboration among TSOs, notably when it comes to adequacy assessments and strategic reserves.

Special focus 1: The future role of biomass

Well-endowed with forest resources, Finland has a strong export-oriented forest industry, ranging from timber to pulp and paper. The by-products and wood residues are used as fuels in power and heat generation or processed to second-generation biofuels, notably biodiesel where Finland’s industry is leading globally. Since 2007, the supply of biofuels and waste increased by 30% whereas oil supply dropped by 9% and the supply of coal, natural gas and peat declined by almost 50%. Global demand for Finland’s forest-based products is growing and, as a consequence, so is the supply of these wood-based energy sources. This has several implications for Finland.

First, forests are a major carbon sink and under new EU rules for emissions from non-ETS sectors, Finland will need to compensate for the impacts of forest management on land use, land use change and forestry. Second, the by-product wood may not be enough to meet Finland’s ambitious biofuels targets in a sustainable manner and biofuel imports may be necessary. Technologies are not yet fully commercially available to produce second-generation biofuels. Third, biomass, such as woodchips, will be needed to support the phase-out of coal and heating oil in CHP and district heating.

District heating (DH) accounts for about half of all space heating in Finland. Peat and biomass are used in the centre and north of the country, while coal is still used in the cities with access to ports along the coast. Under the Powering Past Coal Coalition, which was adopted at the One Planet Summit in Paris in 2015 by 34 countries, cities and companies, Finland plans to close coal-fired CHP plants gradually by 2030 and supports operators financially that switch to efficient biomass CHP and new heating technologies already by 2025.

Special focus 2: The future of combined heat and power

Finland is well placed to make best use of its efficient CHP and related district heating and cooling (DH/C), which remain among the best ways to improve energy efficiency, help renewables and link heating with electricity for flexibility (so-called sector coupling).
However, the traditional role of CHP in Finland is impacted by the power system transformation in the Nordic market, stemming from the deployment of rising shares of wind power and low power prices. The economics of CHP is under pressure in Finland, but also Denmark and Sweden, with a trend towards heat-only boilers. At the same time, since 2008, Finnish DH prices have increased rapidly, much more than in other Nordic DH markets.

The economics of CHP are not only influenced by the low electricity prices, but also by the taxation and support schemes in Finland for CHP, electricity generation and heat production, which vary depending on the fuels used. In Finland, CHP is fired by coal, natural gas, biomass and peat. Power generation is covered under the EU Emissions Trading Scheme (EU ETS), and is priced around EUR 20 (Euros) per ton of carbon dioxide (CO2) emitted in 2018. As the CO2 price is rising and power prices remain low, the economics of heat-only production remain strong. Heat production, on the other side, is taxed based more on its energy and less on its CO2 content; it favours domestic peat co-fired with biomass. If energy taxation were to be fully related to the CO2 content, there would be more incentives for entry of lower cost and cleaner alternatives, supporting the goal of phasing out coal use in CHP by 2030. On the subsidy side there are also different schemes for different production methods of heat and power. Electricity generated from woodchips also receives subsidies.

To date, the government has focused on the reform of renewable subsidies; the most recent tax reform dates back to 2011. In 2018, the government reformed the renewable support scheme towards competitive tenders (for a targeted production of 1.4 TWh for 2018-20). Subsidies are focused on district heating companies that commit to phase out coal by 2025 and as a part of energy aid for new technologies, public support of EUR 90 million is made available to support biomass CHP, with EUR 45 million dedicated to non-combustion technologies, such as heat pumps (which are for instance used in Denmark at CHP plants to increase performance) or storage.

This is a welcome approach and much in line with regional trends, as thermal energy storage is an enabler of flexibility, renewable energy and energy efficiency (hourly/season; pilots under planning). To improve the economics of combined power and heat production, Denmark and Sweden have already reformed the taxation system and improved the flexibility of CHP plants, through more flexible contracts and integrated storage (heat accumulators).

**Special focus 3: The transition to a low-carbon transport sector**

Finland is at the forefront of promoting low-carbon mobility based on a strong Nordic biofuels market and the concept of Mobility as a Service (MaaS). While Finland has targets for accelerating the vehicle stock renewal with a minimum of 250,000 electric vehicles and 50,000 gas-fuelled vehicles in 2030, their penetration remains low in comparison to other Nordic countries.

The targeted paradigm shift away from individual car ownership to MaaS is commendable, and so is the implementation of a legislative reform enabling this change. However, the growth of so-called connected automated vehicles (self-driving vehicles which can communicate with other cars/drivers/road side infrastructure) could undermine...
the use of public transport, a strong focus of Finland’s policies. It can also increase congestion, putting under pressure the transport system and raise emissions in the sector, notably if automated vehicles will not use low emission fuels.

Finland aims to halve oil consumption by 2030, i.a. through an obligation on fuel suppliers. Drop-in biofuels do not have blending limits, which makes their contribution to decarbonisation very valuable. However, any new obligation would need to be in line with high standards of sustainable biofuel production practices and availability of feedstocks. Finland is well placed to invest in advanced biofuel production from wastes and residues, but not all technologies are currently mature and RD&D investment is still needed for certain second-generation biofuels. Prioritising biofuels for long-distance modes, including aviation, can be a growth opportunity for the industry. The government also expects to see 50 000 gas-fuelled vehicles by 2030 on the road, as the number of biogas projects producing biomethane is increasing. The government has put forward a new aid scheme for alternative fuel infrastructure including gas filling stations. Today, biogas is mostly used for power and heat production.

Transport efficiency is a relatively low-cost measure with large impacts, while supply and blending obligations and biogas range at the higher end of the cost scale. To meet its ambitious decarbonisation targets for 2030 and 2050, the Finnish government should indeed take a holistic approach to mobility, focusing on raising vehicle efficiency, the rollout of zero emission vehicles, such as electric vehicles, including through a package of fiscal instruments and local traffic measures to ensure Finland has a largely decarbonised power sector and a strong biomass supply chain. Therefore, the government can benefit from a multidimensional approach to the decarbonisation of transport, based on ambitious biofuels and electrification targets.

Key recommendations

The government of Finland should:

- Guide the energy system towards a low-carbon future in the longer term towards 2050 through adaptive and robust policy frameworks that enable business to take long-term investment decisions, notably in energy technology innovation.
- Review the energy fuel taxation and subsidies to reflect their full carbon content to accelerate the switch to low emission technologies, notably in combined heat and power generation and the transport sectors.
- In the transport sector, raise the ambitions for vehicle efficiency and the rollout of zero emission vehicles, notably electric vehicles, and adopt a package of fiscal instruments and local traffic measures to ensure Finland can achieve targeted emissions reduction in transport and halve oil consumption by 2030 in a sustainable manner.
- Foster the dialogue with the Nordic and Baltic neighbours on the design and implementation of climate and energy policies, in particular with regard to cross-border implications of electricity security and adequacy.
Since 2016, the International Energy Agency’s (IEA) in-depth country policy reviews focus on key energy security challenges in fast-changing global energy markets as well as on the transition to clean-energy systems. This latest update on Finland’s energy policies therefore offers insights into three special focus areas – bioenergy, transportation, and combined heat and power (CHP) production.

With abundant forest resources, Finland is a global leader in developing second-generation biofuels. This report examines the impacts of greater biofuel use on sustainability and the country’s carbon sink, and it offers perspectives for Finland’s potential for innovation in heavy duty, aviation and maritime transport.

The country has aligned its climate and energy policies within a robust policy framework and set ambitious climate targets for 2030, such as cutting oil consumption in half and achieving 30% of renewables in transport by 2030. As the power sector is largely decarbonised, transport is a key sector for the country’s ambitious national climate targets.

Finland has been a leader among IEA countries in public and private spending on energy research, development and demonstration. A longer-term policy framework for 2050 will be pivotal to guide investments in clean energy technology innovation, a critical factor for reaching decarbonisation goals.

The report looks at the challenges Finland faces and provides recommendations for further policy improvements. It is intended to help guide the country towards a more secure and sustainable energy future.