



International  
Energy Agency

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## Energy Policies of IEA Countries

# Finland

## 2013 Review

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Finland's economy is highly industrialised. Yet with over one-third of its territory located above the Arctic Circle, the country is largely rural and sparsely populated, except for its southern tip. With its energy-intensive industries and its cold climate, Finland's energy consumption per capita is the highest in the IEA.

Finland is highly dependent on imported fossil fuels, and energy policy is at the heart of the government's concerns. The government's energy strategy aims to strengthen Finland's energy security, to move progressively towards a decarbonised economy, and to deepen its integration in the wider European market.

Finland has a very ambitious renewable energy programme, with a view to meeting 38% of its final energy consumption from renewable sources by 2020. Finland is the most forested country in Europe; biomass will thus play a central role in meeting the target.

Finland is one of few IEA countries with plans to expand its nuclear capacity, and the Parliament has approved the construction of two more nuclear power plants. If all planned projects are completed, the share of electricity produced by nuclear could double by 2025, reaching around 60%. This would contribute to diversifying Finland's energy security and meeting its low-carbon objectives.

Also, Finland participates in the Baltic Energy Market Interconnection Plan (BEMIP), which aims to further regional integration through EU-supported infrastructure projects.

This review analyses the energy policy challenges facing Finland, and provides sectoral studies and recommendations for further policy improvements. It is intended to help guide the country towards a more secure and sustainable energy future.



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*Finland*

2013<sub>Review</sub>



# INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 28 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

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Energy Agency**

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## 1. EXECUTIVE SUMMARY AND KEY RECOMMENDATIONS

### EXECUTIVE SUMMARY

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Finland's economy is highly industrialised, with sizeable high-tech manufacturing, electronics and chemical sectors operating alongside a significant forestry and paper industry. Yet with over one-third of the country located above the Arctic Circle, Finland is a largely rural and sparsely populated country, except for its southern tip. With its energy-intensive industries and its cold climate, Finland's energy consumption per capita is the highest in the International Energy Agency (IEA).

Finland is poorly endowed with indigenous hydrocarbon energy resources, thus placing energy policy, and particularly energy security, at the heart of the government's policy concerns. Finland notably leads all IEA member countries in terms of research and development funding for its energy sector. The focal points of the government's energy strategy are to strengthen its energy security, to move progressively towards a decarbonised economy, and to deepen its integration in the wider European market.

### CONSOLIDATING ITS ENERGY SECURITY

Finland is highly dependent on imported fossil fuels – namely oil, gas and coal – and will remain so in the long term. This poses a significant challenge in terms of energy security. The government has taken significant steps to address this concern.

As a first line of defence, Finland has sought to bolster its emergency response capabilities by building significant strategic reserves. According to the 1992 Act on Security of Supply, Finland's public stockholding agency, the National Emergency Supply Agency (NESA), must ensure that the country holds alternative fuels for oil and gas disruptions that match at least five months of consumption. Notably, this stockholding requirement is above the IEA oil stocks requirement of 90 days of net imports for all member countries.

A second line of defence is diversification. Finland has succeeded in developing a particularly well-diversified national electricity production mix, with roughly three equal thirds of its production coming from renewable, nuclear and hydrocarbon energies respectively. Its energy resilience has been further consolidated through deepened integration in the wider Nordic electricity market that notably includes its hydro-endowed Scandinavian neighbours. In 2012, the entire Nordic area had one common electricity price during 31% of the time, up from 25% in 2011 and 18% in 2010.

Another way to avoid dependence on energy imports is to reduce domestic demand, and Finland has been resourceful in initiating and implementing significant energy efficiency programmes. Finland's 2008 Climate and Energy Strategy sets as an overarching goal to reverse growth in final energy consumption, and an additional ambitious target to save approximately 11% of total final consumption by 2020 compared to the business-as-usual scenario. Given Finland's climate, building codes have been revised and subsidies to enhance the efficiency of existing building stock have been introduced. Efforts are also

planned in the transport sector, with the introduction of new private-vehicle technology and speeding up the renewal of the existing car stock by 2020. Yet its transport sector remains highly oil-dependent. Developing further efficiency innovations in the transport sector would enable Finland to reduce its exposure to imported hydrocarbons.

An inevitable characteristic of Finland's energy consumption structure is the high share of energy-intensive industry, as well as a long lighting and heating season. Yet the country has turned these vulnerabilities into strengths by developing one of the world's most extensive and efficient combined heat and power (CHP) industries and district heating networks. CHP accounts for over a third of total electricity production, well above the European Union (EU) average of 10%, and district heating provides almost half of the country's space heating.

Finally, Finland has sought to maintain what alternative, indigenous forms of hydrocarbon energy it possesses. It is one of only three IEA member countries with peat in its energy supply, and its use is a topic of much public debate because of its high-carbon intensity and negative environmental impact. Nonetheless, peat use accounts for 6% of total energy consumption, and about one million Finns have their homes and offices heated partly by peat-fired district heating systems. While subsidies have been abolished and the tax regime is increasingly burdensome for its longer-term use, peat nevertheless continues to benefit from a comparatively preferential tax regime because of its unique technical qualities in CHP co-firing with biomass, security supply benefits, widespread availability, price stability and its contribution to regional economic development. Nevertheless, because of its high emissions profile, the outlook for peat in Finland's future energy mix remains undecided and is a source of uncertainty.

While each of these elements contributes to ensuring the country's energy security, the government's principal long-term goal in terms of energy security is clearly intertwined with another key pillar of its energy policy – the “decarbonisation” of its economy, notably by developing cleaner means of energy production and consumption.

## PUSHING FOR PROGRESSIVE DECARBONISATION

Decarbonising the Finnish economy is a long-term objective, as is the case in other neighbouring Nordic countries. Finland has already one of the lowest shares of fossil fuels in its energy mix among IEA member countries, ranking fourth-lowest in 2011 (behind Sweden, France and Switzerland), and leads all IEA member countries in terms of biofuels share in its energy mix.

The recent economic crisis and the resulting structural changes in the underlying economy have had a positive impact on Finland's emission profile. Notwithstanding this, Finland has adopted a range of policies that have contributed to this reduction, including in those sectors which fall outside the European Union Emissions Trading Scheme, such as transport, domestic heating and agriculture. Finland is on track to meet its share of the ambitious, EU-wide greenhouse gas emissions reduction targets of 20% below 1990 levels for the 2013-20 period. Fiscal policy has also made a contribution: in 2011, the government modified the structure of energy taxes on fuel for transport and CHP plants, with the tax now being based on the energy content, carbon dioxide emissions and local particle emission levels that have adverse health effects. In terms of longer-term strategy, two cleaner sources have been prioritised – renewable energy and nuclear energy. Besides

the obvious benefits in terms of energy security, this two-pronged push to continue to develop renewable and nuclear energy has the additional advantage of decarbonising the economy and thereby meeting national climatic objectives.

Finland has a very ambitious renewables programme, with a view to meeting its binding EU target to increase the share of renewable energy to 38% of final energy consumption by 2020. Finland is the most forested country in Europe, with approximately 86% of the country covered with coniferous forests. The government has clearly indicated that forestry will play a central role in meeting its renewables target, with the sector having to contribute half of the additional 38 terawatt hours between 2005 and 2020. Measures implemented to attain the country's renewables target include promoting the use of forest chips and other wood-based energy, alongside wind power, the use of biofuels in transport, and the greater utilisation of heat pumps. Although the government is in favour of the requirement that biomass use be sustainable, there are serious concerns about potential EU schemes in this regard, which could bring about a great deal of administrative burden for their certification.

Finland has also developed a significant nuclear energy programme in order to contribute to diversifying its energy security and meet its low-carbon objectives. It is one of the few IEA European member countries with plans to expand its nuclear capacity. This success can be attributed to the government's effective and inclusive planning and consenting regime, and to the high level of trust that the population has in its government due to its top-of-the-league ranking in terms of transparency and absence of corruption. In 2010, in accordance with its Climate and Energy Strategy, the Finnish Parliament ratified favourable decisions-in-principle for two more nuclear power plants (in addition to Olkiluoto 3, which is already under construction). If all planned nuclear projects are completed, there will be seven nuclear plants in operation, bolstering the output share of electricity produced by nuclear from 28% in 2010 to over 30% in 2020 and potentially up to 60% in 2025. The government must ensure that lessons learned from the delays in the construction of Olkiluoto 3, now expected to enter commercial operation before 2016, are taken into account for new projects, so as to meet its 2020 and longer-term targets. Regulatory issues surrounding the availability of sufficient radioactive waste disposal facilities must also be addressed, if Finland's ambitious nuclear programme is to be successfully implemented.

## SUPPORTING REGIONAL INTEGRATION

Though somewhat isolated from the larger European continent, Finland's energy policies are well integrated with those of the European Union. Its energy targets are aligned with the Union's growing energy policy framework, and generally comply with EU legislation, particularly relating to the European Union's binding 2020 targets and to the third package for an internal EU gas and electricity market. The third package was adopted in 2009 with a view to ensuring the proper functioning of energy markets and enhancing cross-border trade and access to diversified sources of energy. At the heart of this legislation is the European Union's intention of ensuring and consolidating ownership unbundling, including new rules on network ownership and operation, rules strengthening the independence and the powers of national regulators and rules on the improvement of the functioning of retail markets to the benefit of consumers.

On the whole, Finland's electricity market has been largely liberalised, and it is well integrated within the competitive Nordic market, Nord Pool. Nonetheless, the European

Union has raised concerns regarding Finland's electricity market primarily relating to the lack of certification of the transmission system operator, Fingrid, and to the specific role and duties of the regulator.

In the gas market, however, Finland's present market arrangements stand in clear contradiction with the EU vision. Owing to the country's particular circumstances, Finland had received a derogation from the European Union's internal energy market rules regarding the opening of its market and opted for "regulated network access". This derogation applies as long as there are no direct connections to the gas network of any other EU member state and as long as Finland has only one natural gas supplier. At present, the gas market remains severely constrained by its undiversified import sources (one pipeline entry point from Russia) and the lack of supply infrastructure, while its sole importer, Gasum, both owns and operates the pipeline network. Nonetheless, Finland is exploring alternative supply routes.

Finland co-operates with other EU member states and regional neighbours in the context of the Baltic Energy Market Interconnection Plan (BEMIP), whose stated objective is to examine measures for improving energy interconnections between countries on the Baltic rim and thereby extending links within a wider EU energy network. Projects under consideration include a "Balticconnector" natural gas pipeline between Finland and Estonia and a liquefied natural gas terminal shared between Finland and the Baltic countries. Integration with the Baltic states would notably allow Finland to compensate for the absence of gas storage facilities by linking it to significant gas storage facilities in Latvia. The more diversified supply options associated with greater regional integration can provide significant energy security benefits for Finland. Accordingly, Finland must take decisive steps to amend its gas market structure and ensure its compliance with EU directives, so as to push forward with these regional opportunities.

## KEY RECOMMENDATIONS

*The government of Finland should:*

- ☐ *Continue to address energy security concerns in a comprehensive and sustainable manner, while pursuing its focus on its key policy pillars of bioenergy and nuclear energy.*
- ☐ *Maintain its drive to improve energy efficiency, notably through a stronger focus on efficiencies in the transport sector.*
- ☐ *Actively contribute to finding a mutually acceptable solution at an EU level regarding the discussion on sustainability criteria for biomass and the development of a robust certification scheme that does not create an unacceptable burden for small forest owners.*
- ☐ *Seek to develop the regional integration of its gas market, building on the example of its successful regional integration in electricity markets.*



**PART I**  
**POLICY ANALYSIS**

Figure 1. Map of Finland



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

## 2. GENERAL ENERGY POLICY

### Key data (2011)

**Total primary energy supply (TPES):** 34.7 million tonnes of oil-equivalent (Mtoe) (renewables 26.5%, oil 26.4%, nuclear 17.4%, coal 11.6%, natural gas 9.7%, peat 5.8%, other 3.6%), +7.8% since 2000

**TPES per capita:** 6.5 tonnes of oil-equivalent (toe) (IEA average: 4.6 toe)

**TPES per gross domestic product (GDP):** 0.2 toe per USD 1 000 of gross domestic product at purchasing power parity (GDP PPP) (IEA average: 0.14 toe per 1 000 USD GDP PPP)

**Electricity generation:** 73.5 terawatt hours (TWh) (nuclear 31.5%, hydro 16.9%, biofuels and waste 15.6%, coal 14%, natural gas 12.9%, peat 7.4%, other 1.7%)

**Inland energy production:** 17.1 Mtoe, representing 49% of TPES

## OVERVIEW

Given its geographic location, the country has long, cold winters and short, warm summers. Its 1 250 kilometres (km) of coastline are typically icebound in late winter, requiring icebreakers to clear port lanes. Finland's longest border is its 1 340 km eastern border with Russia. It also shares a 614 km border with Sweden and a 727 km border with Norway. Finland's territory is sparsely populated, and covered with lakes and coniferous forests, and most of the population resides in the southernmost tip of the country.

Finland has a population of 5.4 million. The Helsinki metropolitan area, including the capital city of Helsinki (population 604 000), Espoo (population 257 000) and Vantaa (population 205 000), has just over 1 million. The other major city is Tampere, also in the southern part of the country, with a population of 217 000. There continues to be a slow migration from the northern to the southern part of the country. Its total population has grown at an annual rate of 0.38% between 1990 and 2011, well below the Organisation for Economic Co-operation and Development (OECD) average of around 0.75%.

Limited by its climate, the country has a relatively small agricultural sector, but a highly industrialised, free-market economy. Its largest economic sector is manufacturing, particularly pulp and paper, metals, engineering, telecommunications and electronics. International trade is critical to Finland's economy, with exports of goods and services accounting for a third of GDP. Finland's nominal GDP was USD 266 billion in 2011, making it a relatively small European economy. Per-capita nominal GDP (around USD 49 600 in 2011) ranks high compared to most OECD and European Union (EU) member states, and similarly to other northern countries.

Finland – Suomi in Finnish – is a republic, with a unicameral legislature, the Parliament (*Eduskunta*). The head of state, the president, is elected by popular vote for up to two six-year terms, but the president's role is largely ceremonial. Finland is a parliamentary democracy, and the prime minister is the country's most powerful politician. The government

is a six-party majority coalition (composed of the National Coalition Party, the Social Democratic Party, the Left Alliance, the Swedish People's Party in Finland, the Green League and the Christian Democratic Party) and has been in office since June 2011.

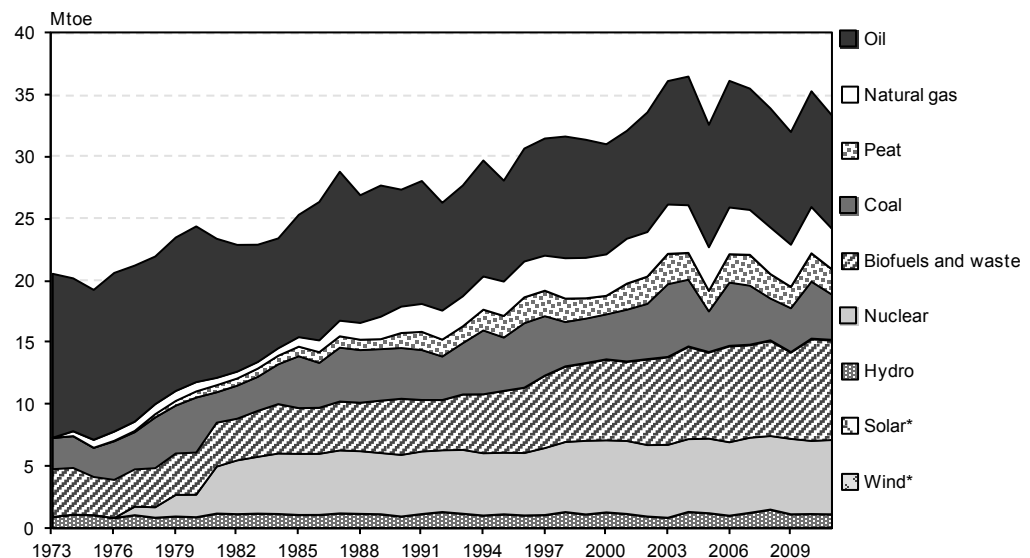
## SUPPLY AND DEMAND

### SUPPLY

Finland's TPES was 34.7 Mtoe in 2011, decreasing by 4.6% compared to the previous year. Energy supply has exhibited moderate volatility over the past decade, ranging between 32.2 Mtoe in 2000 and 37.3 Mtoe in 2006. Overall, TPES has increased at an annualised rate of 0.7% since 2000. According to government forecasts, TPES will continue to grow at a similar rate, reaching 38.2 Mtoe in 2030.

Oil and biofuels are the largest energy sources in TPES, both accounting for a similar share in 2011, namely 26.4% and 23.3% respectively. The share of oil in Finland's TPES is comparatively low compared to its OECD peers, and has been declining progressively in recent years, down from 27.6% of TPES in 2000. This decline in oil demand has been offset by the strong growth in biofuels demand, whose share is up from 20.3% of TPES in 2000.

Figure 2. TPES, 1973-2011



\* Negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012; and country submission.

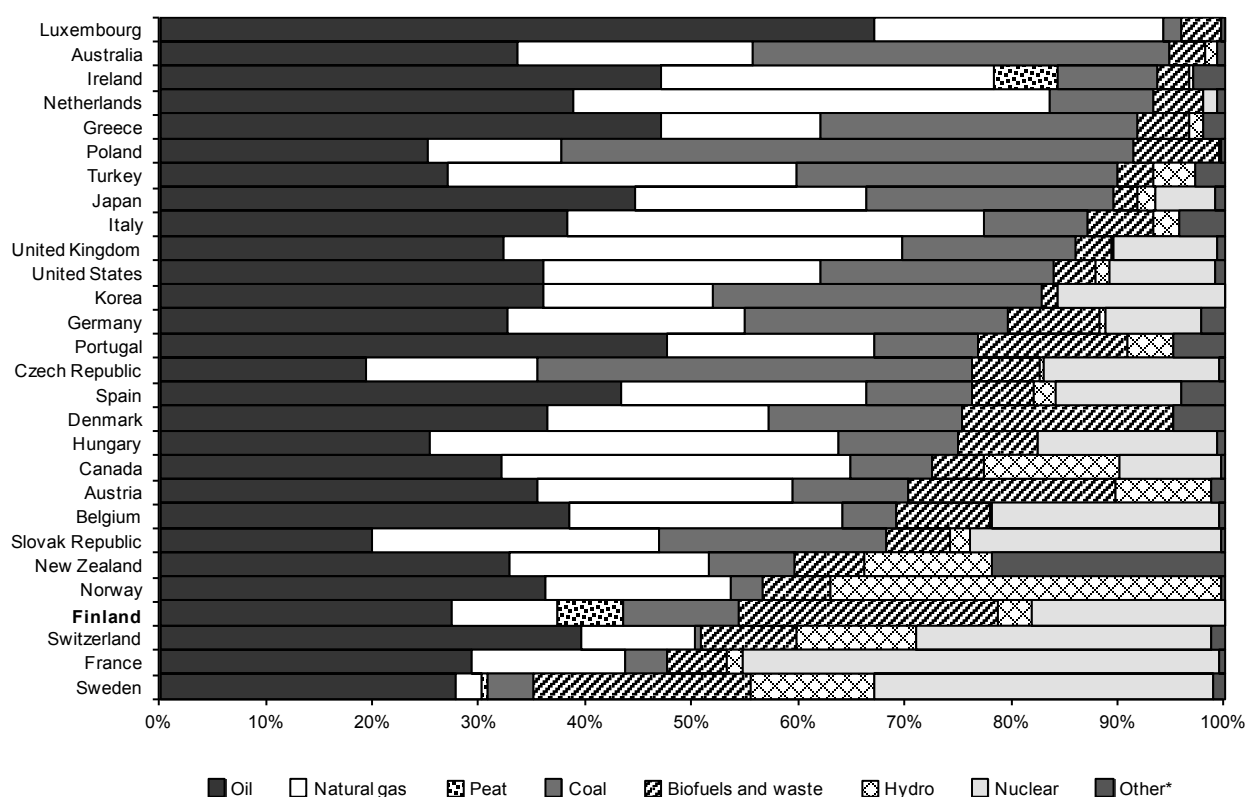
Nuclear represents 17.4% of TPES, followed by coal (11.6%) and natural gas (9.7%), with no changes in the share of energy supply since 2000. Peat represents 5.8% of total supply, also unchanged compared to 11 years before. Renewable sources other than biofuels are minor in the energy mix in Finland, with hydro accounting for 3.1% of TPES, and wind and solar exhibiting negligible levels.

Looking ahead to 2030, government projections indicate that nuclear energy will play a significant role in energy supply, increasing to 38.4% of TPES. The supply of wind energy

is also forecast to grow, reaching 1.6% of the total in 2030, up from a negligible level in 2011. Conversely, oil, coal, natural gas and peat are sources which are expected to reduce their presence in the energy mix in Finland. The share of biofuels is expected to remain constant, at around 24% of total TPES.

Finland is among International Energy Agency (IEA) member countries with the lowest share of fossil fuels in the energy mix, ranking fourth-lowest in 2011, behind Sweden, France and Switzerland. On the other hand, Finland has the largest share of biofuels in TPES among IEA member countries, followed closely by Sweden and Denmark. It is one of only three IEA member countries (along with Ireland and Sweden) with peat in its energy supply; Finland's share of peat is the highest among IEA member countries, standing at 5.8% of TPES.

Figure 3. Breakdown of TPES in IEA member countries, 2011



\* Other includes geothermal, solar, wind, and ambient heat production.

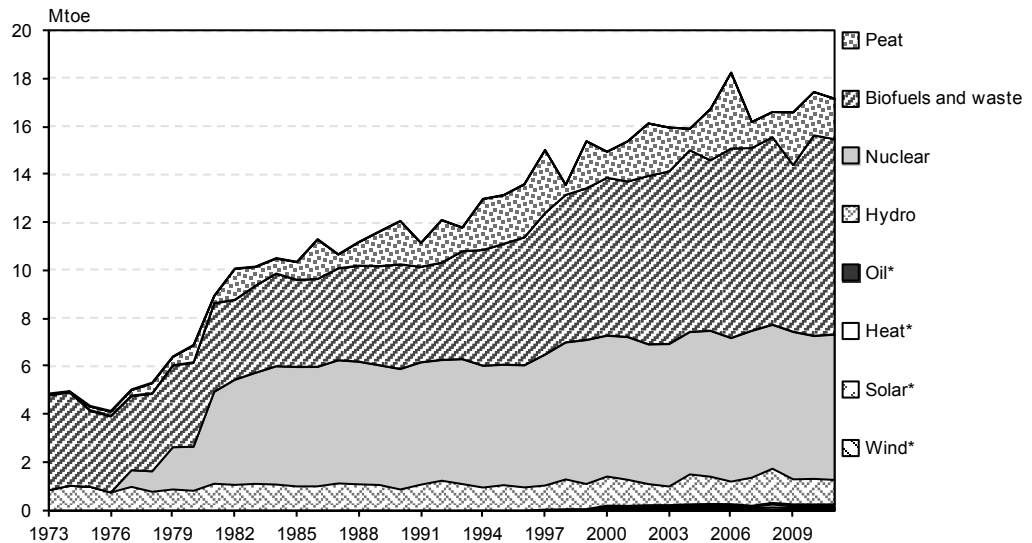
Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012; and country submission.

Although there is no oil and gas production, Finland nevertheless produces approximately half of its energy supply, with total inland energy production standing at 17.1 Mtoe in 2011. The largest inland energy source is biofuels and waste, accounting for 47.5% of production in 2011. This is a marginal increase from 44% of production in 2000. Nuclear is also a significant source of inland energy, at 35.4% of total production in 2011, down from 39.3% 11 years prior. Peat represents 9.9% of energy produced in Finland, while 6.3% comes from hydro.

Approximately 45.9% of energy produced was exported in 2011, with over 93% being oil and refined oil products. Despite its significant production of biofuels and waste, Finland

exports only 2.4% of supply. The majority of energy consumed locally is imported. Imports accounted for 77.8% of total energy supply in 2011. Some 64.2% of imports were oil and oil products, followed by coal (17%) and natural gas (12.4%). Since 2000, imports have increased from 73% of TPES, while exports have grown from 34.5% of production.

Figure 4. Energy production by source, 1973-2011



\* Negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012; and country submission.

## DEMAND

Because of its cold climate and energy-intensive industries, Finland has high per-capita energy use. In 2011, TPES per capita was 6.5 toe, the second-highest level among IEA European member countries, behind Luxemburg, and followed closely by Norway. Finland's energy supply per capita has increased from 6.2 toe in 2000, peaking at 7.1 toe in 2006.

Total final consumption (TFC) of energy in Finland was 25.2 Mtoe in 2011. Consumption decreased by 6% compared to the previous year, while growing at a marginal annualised rate of 0.2% since 2000. Similarly to TPES, consumption patterns have exhibited some volatility over the decade, albeit to a lesser extent. Since 2000, TFC has ranged from a high of 26.8 Mtoe in 2010 to a low of 24.4 Mtoe in 2009, notably because of the economic downturn.

Industry is the largest energy-consuming sector in Finland, accounting for 47.5% of TFC in 2011. This is one of the highest shares of industrial consumption within IEA member countries, second only to Korea. The median level of IEA member countries was approximately 36% in 2011. During the economic recession and since, the industry sector has reduced its consumption of energy; however, government projections indicate that industry will account for the usual level of around 50% of TFC in 2020 and 2030.

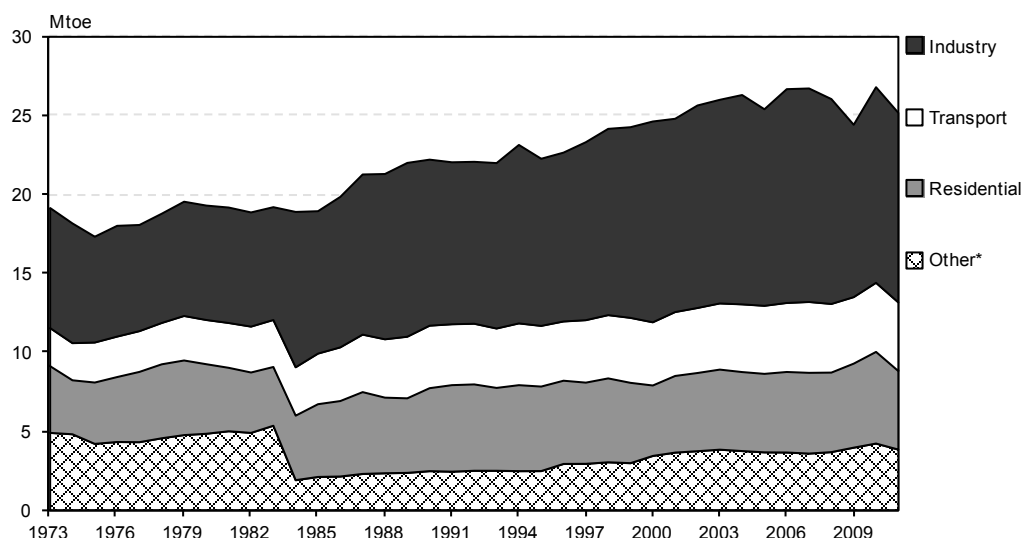
The residential sector accounted for 20% of TFC in 2011, up from 18.4% in 2000. Usage by the commercial and other services sectors also grew moderately from 14% of TFC in 2000 to 15.3% in 2011. Finland sits at a median level with IEA member countries with respect to energy usage by the residential and commercial and services sectors.



Transport accounted for 17.2% of TFC in 2011, the lowest percentage among IEA member countries. This is unchanged from ten years before; however, government forecasts indicate a reduction in the usage of energy by the transport sector, down to 12.6% of TFC in 2030.

Overall, the share of primary energy converted into heat in Finland was 16.2% in 2011, lower than the IEA average of 37% in the same year. This share has increased from 13.5% in 2000. Energy use in form of electricity was 27.4% of TFC in 2011, unchanged from ten years before, and higher than the IEA average of 22%.

Figure 5. TFC by sector, 1973-2011



\* Other includes commercial, public service, agricultural, fishing and other non-specified sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012; and country submission.

## INSTITUTIONS

### MINISTRY OF EMPLOYMENT AND THE ECONOMY

The lead government actor, the Ministry of Employment and the Economy (MEE), has the overall co-ordination and planning role in the energy policy field. More precisely, energy policy is the responsibility of the MEE's Energy Department, which consists of five divisions: Energy Markets Division, Emissions Trading Division, Energy Efficiency and Technology Division, Nuclear Energy Division and Renewable Energy Division.

The MEE also has specific implementing functions in the areas where no other suitable agencies are available. It works closely with other ministries, including those of finance (taxation, subsidies), the environment (climate policy, housing, building and planning), transport and communications (transportation), agriculture and forestry (sinks, energy use within agriculture, biofuels) and foreign affairs (international co-operation).

Under the MEE, a number of special agencies have major responsibilities in the energy sector, as described below. Further details regarding specific agencies can be found in the relevant chapters of this book.

## ENERGY MARKET AUTHORITY

The Energy Market Authority (EMA) is an expert body subordinate to MEE. It is the national energy regulator and the national emissions trading authority in Finland.

On 1 June 1995, it began operations, at the same time as the Electricity Market Act took effect, progressively opening the electricity market to competition. On 1 August 2000, the Electricity Market Authority became the EMA, at the same time as the Natural Gas Market Act took effect. In August 2004, the EMA also became the national emissions trading authority in Finland. EMA currently employs 54 people.

The mission of the EMA is to supervise and promote the functioning of the electricity and natural gas markets, as well as to establish preconditions for emissions trading. The EMA's principal task in electricity and gas markets is to supervise the pricing of transmission, distribution and other network services. It ensures that pricing of network services produced by distribution and regional network operators is reasonable and that access to the national grid is reasonable and non-discriminatory. Supervision takes place on an *ex post* basis, case-by-case. Cases are brought up either through complaints, or on the initiative of the EMA.

The EMA also promotes efficient competition in the electricity and natural gas trade, by intervening in the terms and prices of the network services that are considered to restrict competition. It produces and publishes real-time information on the pricing of both electric energy and its distribution. In the future, the EMA will publish the same type of information on the pricing of natural gas.

Electricity and natural gas network operations are subject to licence. The EMA grants network licences to organisations and utilities engaged in network operations, and building permits for constructing power lines with voltages of 110 kV and higher.

Since August 2004, the EMA has also acted as the national emissions trading authority. It grants emission permits, pursuant to which the installations have the right to emit carbon dioxide (CO<sub>2</sub>). It also supervises the monitoring and reporting of emissions data and maintains the Emissions Trading Registry of Finland.

## COMPETITION AUTHORITY

In addition to the EMA, the Finnish Competition Authority has regulatory responsibility in the energy sector, operating under the MEE. It has the objective of protecting sound and effective economic competition and increasing economic efficiency by promoting competition and abolishing competition restraints (such as under the Act on Competition Restrictions).

## MOTIVA OY

Motiva Oy is an impartial and state-owned joint stock company. Its principal objective is the implementation of government policies on energy conservation and the promotion of renewable energy sources. In practice, Motiva Oy disseminates information, develops and markets energy audits as well as other energy management procedures, and promotes energy-efficient technologies. Motiva Oy receives most of its funding from the MEE.

## NATIONAL EMERGENCY SUPPLY AGENCY

The National Energy Supply Agency (NESA) is tasked with ensuring the country's security of supply. Contingency planning and preparations are made in order to maintain the

transmission and distribution networks of electricity, natural gas and district heat at the present level of security of supply, even in the event of a prolonged crisis. According to the emergency reserve target set by the Finnish government, the country should hold a total of five months' stocks of imported fuel consumption of oil, natural gas and coal, some of which is held directly by NESA.

## **RADIATION AND NUCLEAR SAFETY AUTHORITY (STUK)**

The Radiation and Nuclear Safety Authority (STUK), under the Ministry of Social Affairs and Health, sets the regulations for the use of radiation and nuclear energy and supervises that these are followed. STUK is also an expert institute that carries out research on radiation and its effects, determines risks associated with radiation and monitors the radiation safety of the Finnish environment.

## **SAFETY TECHNOLOGY AUTHORITY**

Under the MEE, the Safety Technology Authority, Tukes, supervises the compliance of equipment with energy efficiency requirements.

## **STATISTICS FINLAND**

Statistics Finland is the public authority specifically established for statistics. It produces the vast majority of Finnish official statistics and is a significant international actor in the field of statistics. Statistics Finland operates as the national inventory unit for the evaluation and reporting of greenhouse gas (GHG) emissions.

## **TEKES**

The Finnish Funding Agency for Technology and Innovation, Tekes, finances research and development projects of companies, research centres and universities. The funds are awarded from the state budget via the MEE. Tekes also co-ordinates and finances Finland's participation in international technology initiatives.

## **TUKES**

The Finnish Safety and Chemicals Agency, Tukes, is the authority in charge of the market surveillance of both Ecodesign Directive and Energy Labelling Directive.

## **VTT**

The Technical Research Centre of Finland (VTT), is a state-owned non-profit organisation. It is the biggest multi-technological applied research organisation in Northern Europe. VTT has an energy research branch of more than 400 people. Its focus areas are new energy technologies, fuels and combustion, nuclear energy, engine technology and energy in transportation, pulp and paper industry, and energy systems.

## **KEY POLICIES**

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Though somewhat isolated from the larger European continent, Finland's energy policies are well integrated with those of Europe. In fact, much of its energy policy stems from

the EU's growing energy policy framework. Its energy markets are largely liberalised, with the electricity market well integrated with the competitive Nordic market, Nord Pool. On the other hand, the country's gas market is physically linked only with Russia, which supplies all its gas. With a general lack of domestic resources – apart from bioenergy and nuclear power – energy security and reducing dependence on hydrocarbons are obvious focal points of Finland's energy policy.

### 2008 CLIMATE AND ENERGY STRATEGY

Finland's energy strategy is set by its long-term Climate and Energy Strategy, first issued in 2001 and revised in 2005 before the current iteration was issued in 2008. This document, prepared under the steering of the government's Ministerial Working Group on Climate and Energy Policy, defines the principal objectives and means of Finland's climate and energy policy for the next few decades, within the context of the European Union and its objectives.

The strategy aims to fulfil Finland's EU 20-20-20 target. It sets targets and actions out to 2020 for meeting the government's goals of ensuring safe and secure energy supplies, promoting a sustainable energy future and supporting competitiveness, and takes account of the evolving EU framework. The strategy also includes visions to 2050.

In terms of the country's energy mix, a key aspect of the strategy is the sustained push to develop renewable energy (increase the share of renewable energy to 38% by 2020 from biomass and other sources) and nuclear power (decision-in-principle concerning the construction of new nuclear plants) concomitantly, thereby reducing the country's dependence on foreign energy imports. Energy efficiency is also of fundamental importance, with the strategy articulating an overarching goal to halt, and ultimately reverse, growth in final energy consumption.

The strategy is designed to provide a basis for the government's statements both in international contexts and in domestic policy preparation and decision making, providing guidelines and specific measure up to 2020, as well as longer-term visions for a further decrease in final energy consumption by 2050 of at least one-third of the 2020 level.

### POLICY DEVELOPMENTS SINCE THE 2008 STRATEGY

In October 2009, the Finnish government adopted the *Foresight Report on Long-term Climate and Energy Policy* to supplement the longer-term ambitions of the 2008 strategy. The result of two years of cross-disciplinary investigations and broad consultation with stakeholders and citizens, the *Foresight Report* reviewed ambitions for sustainable development from a global perspective and outlined possible paths to a low-carbon Finland by 2050. It sets a target for Finland to reduce its GHG emissions by at least 80% from the 1990 level by 2050, as part of a wider international effort.

#### **Box 1. Overview of the updated Climate and Energy Strategy in 2013**

In February 2013, the government's Ministerial Working Group on Climate and Energy Policy finalised an update of the 2008 national Climate and Energy Strategy, the aim being to ensure that the targets for energy consumption and climate set nationally for 2020 are achieved and to prepare for the long-term energy and climate targets. The updated strategy will now be submitted to Parliament for approval.

**Box 1. Overview of the updated Climate and Energy Strategy in 2013** *(continued)*

The strategy re-emphasises key themes in the 2008 version, notably the importance of cost-effectiveness, greater self-sufficiency in energy, and a reliable and steady supply of electricity at a reasonable price. The updated strategy will also clarify Finland's position on the European Union's energy and climate policy beyond 2020, the issue of energy efficiency, the prospect of further cuts in emissions, the additional measures required for promoting renewable energy, trends in the European and Finnish energy markets, safeguards on electricity self-sufficiency, and issues relating to district heating systems.

Finland's 38% renewable energy target for final energy consumption in 2020 is being met, exceeding the annual minimum targets set by the European Union. Finland has notably set a 20% target for renewable energy for fuels used in transport, enforced with a biofuel obligation scheme, which is twice as stringent as the European Union's 10% target. The 2008 target for wind power (6 TWh per year by 2020) is maintained, and a new target of 9 TWh by 2025 is added. The government has earmarked EUR 20 million for an offshore wind power demonstration project in 2015. Yet solutions will also have to be found to address obstacles other than those merely relating to finance. The updated strategy makes proposals for the construction of wind power plants that extend to improved design and permit procedures

Finland is implementing the European Union's 2012 Energy Efficiency Directive, and an Energy Efficiency Act and an energy efficiency implementation plan are under way. In addition, a long-term strategy to improve the energy efficiency of buildings and an energy savings plan for buildings used by central government are being drawn up, as well as plans involving local authorities and engaging energy companies.

Overall consumption of electricity in the 2008 strategy was estimated to grow to 98 TWh by 2020, but consumption in 2020 has now been revised down slightly, to 94 TWh. Yet Finland is still not self-sufficient in electricity consumption, and is heavily dependent on imported electricity during the coldest winter months. Self-sufficiency will only be achieved in the 2020s, if and when all planned nuclear power plant units start operating and renewable electricity generation increases.

The increase in final energy consumption (323 TWh in 2010) will start to ease off with improved energy efficiency, and the target is for consumption not to exceed 310 TWh by 2020. The target figure in the revised strategy is the same as that in the 2008 strategy, though changes in the way Statistics Finland compiles statistics mean that the target to be set now is 11 TWh more stringent than in 2008.

Emissions in 2011 were around 6% below the Kyoto Protocol target. Under the European Union's burden-sharing system, Finland has an obligation, based on the Kyoto Protocol, to stabilise its emissions in the period 2008-12 at 1990 levels on average. In the period 2008-11, emissions averaged out at about 1.5% below this level. Yet the European Union's present emissions target for 2020 is not consistent with the 2 °C warming target, and Finland is prepared to increase the emissions reduction target to 30% if other countries commit to similar efforts. Finland's long-term objective is a carbon-neutral society, and new 2025 targets for certain hydrocarbons are set in the 2013 update – to reduce the share of oil in Finland's total energy consumption to below 17% (from around 24% in 2011), and to cut the consumption of peat by a third. A strategy-based roadmap will be designed, focusing on increased energy efficiency and use of renewable energy, to ensure that Finland is on track for cutting GHG emissions by at least 80% by 2050.

Source: Ministry of Employment and the Economy.

Like many countries, Finland's economic outlook was affected by the financial crisis and ensuing eurozone crisis. The government intends to publish an update of its energy policy framework in early 2013, taking account of developments over the past few years since the publication of the 2008 Climate and Energy Strategy. The government indicates that the overriding objectives of Finnish energy policy will remain consistent; security of supply, competitiveness and environmental sustainability will continue to be the pillars of energy policy.

With regard to its EU commitments, Finland has also published a National Energy Efficiency Action Plan (updated in June 2011), and a National Renewable Energy Action Plan. These actions plans are described in further detail in Chapter 4 on Energy Efficiency and Chapter 9 on Renewable energy.

## TAXATION

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### TAX REFORM

The government changed the structure of energy taxes on fuel for transport and heat and power plants on 1 January 2011. The taxation now takes account of the energy content, CO<sub>2</sub> emissions and local/particle emissions that have adverse health effects.

In 2011, an additional EUR 730 million was collected in taxes on fuel for heat and power plants, and energy taxes on electricity. This increase is part of the structural reforms of the tax system, helping to offset the tax revenue losses incurred by the abolition of the national pension contribution for employers. The tax on natural gas is to be increased progressively until 2015. In addition, peat is now subject to a tax, starting at EUR 1.9 per megawatt hour (/MWh) in 2011, and rising to EUR 4.9/MWh in 2013 and EUR 5.9/MWh in 2015.

The purpose of higher energy taxes and structural changes to the tax bases is to mitigate GHG emissions and enhance environmental integrity. The tax increases seek to encourage the saving of energy and to improve energy efficiency. The tax increases for fossil fuels and peat improve competitiveness and promote the use of renewable energy. The new tax structure is objective and neutral in technical terms. It fosters fuels and technological solutions that result in lower emissions.

### ENERGY CONTENT TAX

The energy content tax has been adjusted to reflect the volumetric energy content of the fuel. The energy tax component is levied on both fossil fuels and biofuels (except solid biofuels), and based on the same taxation criteria. For the liquid fuels, the energy content is based on the heating values (megajoule/litre) used in Directive on Renewable Energy Sources (RES Directive 2009/28/EC).

### CARBON DIOXIDE TAX

The CO<sub>2</sub> tax is based on the CO<sub>2</sub> emissions of the fuel in question. The weight of levies on carbon dioxide has been raised from their 2010 levels. For fossil fuels, the CO<sub>2</sub> emission values (gram/megajoule) are based on the values used in the national fuel classification of Statistics Finland. The values used in the national fuel classification are based on values used in the IEA and Eurostat's Fuel Classification.



The evaluation of the CO<sub>2</sub> content of biofuels is based on their treatment in the RES Directive. A flat-rate tax reduction of 50% is applied to all biofuels that meet the sustainability criteria of the directive. The so-called second-generation biofuels, as defined in Art 21 (2) of the RES Directive (biomass originated from waste and residues, non-food cellulosic and lignocellulosic materials), is completely exempted from the CO<sub>2</sub> tax. The CO<sub>2</sub> tax does not apply to wood and other biomass (solid or gaseous) used in the production of energy.

From the beginning of 2011, carbon dioxide levies for fossil fuels used in combined power and heat production were lowered by 50%. This was done to minimise taxes overlapping with the EU-ETS and to improve the competitiveness of combined electricity and heat production relative to separate heat production.

## MOTOR FUEL TAXES

The changes in the taxation of fuel for transport were made as neutrally as possible in terms of the yield. No changes were made to the tax levels on gasoline. The EUR 0.08 tax increase in diesel from the beginning of 2012 is taken into account by lowering taxes collected on the basis of driving power applied to passenger cars and lorries. Adjustments to motor vehicle taxation for gas-fuelled and electric passenger cars will be introduced in 2013.

A system of quality gradation has been introduced for transport fuels that emit fewer local/particles that are harmful to health than other fuels. This system will apply to second-generation diesel. In the case of natural gas and biogas, the emission benefits to the local environment are taken into account in terms of a lower level of taxes.

Sulphur-free light fuel oil used in heating and machinery is taxed at a lower rate than fuel with sulphur. Taxation on gasoline used in small utility engines, such as chain saws and lawnmowers, is aimed at reducing the harmful health effects of the exhaust emissions of small utility engines.

## INDUSTRY AND AGRICULTURE

From the beginning of 2011, the electricity tax for industry (tax class II) has been raised from EUR 0.00263 per kilowatt hour (/kWh) to EUR 0.00703/kWh. Tax subsidies for renewable electricity production – *e.g.* electricity produced from forest chips, wind power, small hydro, biogas and recycled fuel – were discontinued.

Energy prices are market-based, and consumer prices reflect the changes in market prices. The government does not have any instruments to directly influence the price-setting of energy products. However, energy taxation advantages have been given to industry in the form of a lower electricity tax and a tax refund system for energy-intensive industries. In addition, farmers are entitled to excise duty refunds for electricity and oil products used for agricultural purposes, and the energy tax refunds for agriculture have been increased to offset the raise in taxation in the sector.

## ASSESSMENT

Finland is a small country in terms of population, yet it can claim numerous achievements when it comes to energy policy, often ranking high in terms of achievements among its EU peers. The main drivers of its sovereign energy policy are security of supply, self-

reliance and competitiveness. Finland's energy policy is now also closely correlated with its compliance with evolving EU legislation, particularly as it contributes to European Union's 20-20-20 targets and to the Third Internal Energy Market Package. An additional factor of energy policy is Finland's proactive contribution to achieving international climate change mitigation targets. Last but not least, Finland is a strong believer in the powers of market-based policies, both at national and international levels, as witnessed in its approach to projects such as the EU-ETS and the Nordic and EU electricity markets.

The government's 2008 national Climate and Energy Strategy remains the guiding strategy paper. Key decisions within this strategy include the government's favourable decision-in-principle regarding the development of nuclear power, the push to develop renewable energy, the encouragement of greater regional interconnections, the reform of energy and car taxation, the tightening of building regulations, and the implementation of energy efficiency measures.

The government is preparing an updated strategy, focusing primarily on 2020 as a target year, which it intends to finalise in 2013. Following the completion of the strategy update, preparations for the design of a comprehensive 2050 roadmap will begin. Modelling will play an important role in the outline of the forthcoming strategy, covering the whole of the Finnish energy production and consumption system, including industrial, residential, services and transport sectors, and allowing for the study of regional implications regarding energy and climate policy in Finland.

Responsible for the overall co-ordination of energy policy, including the EU-ETS, is the MEE with its Energy Department. However, some energy-related aspects are in the remit of other ministries. As part of the preparation process towards the long-term Climate and Energy Strategy 2008, the government established a Ministerial Working Group on Climate and Energy Policy with a preparatory body called the Climate and Energy Policy Network, comprising representatives of several ministries, including the MEE, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry, the Ministry of Education, the Ministry for Foreign Affairs, the Prime Minister's Office, the Ministry of Finance, and the Ministry of the Environment. This level of transversal co-ordination is commendable.

Meeting Finland's ambitious energy and climate policy targets will require continued co-operation between policy makers to manage the successful implementation of its objectives. A point of concern in some OECD countries is the sometimes contradictory agendas of the Ministry of the Economy and the Ministry of the Environment in their day-to-day activities, and while this issue is not acute in Finland, it is nevertheless notable with regard to forestry and peat. Experience in markets elsewhere suggests that a common institutional platform for comprehensive policy formulation and implementation would be useful for Finland to achieve the goals to which it aspires.

## RECOMMENDATIONS

*The government of Finland should:*

- ☐ *Ensure the completion of its comprehensive and scenario-based national Climate and Energy Strategy update, outlining how to meet the 20-20-20 targets and developing a vision for a Finnish energy and climate roadmap to 2030 and even 2050.*
- ☐ *Consolidate a common institutional platform for the formulation and implementation of overarching energy- and climate-related issues.*

### 3. CLIMATE CHANGE

#### Key data (2011)

**Total GHG emissions excluding LULUCF\*:** 67 Mt CO<sub>2</sub>-eq, -4.9% from 1990

**Total GHG emissions including LULUCF\*:** 42.4 Mt CO<sub>2</sub>-eq, -23.2% from 1990

**2008-12 target:** ±0% from 71 Mt CO<sub>2</sub>-eq in 1990

**CO<sub>2</sub> emissions from fuel combustion:** 55.6 Mt (+2.2% from 1990)

**Emissions by fuel:** oil 43.9%, coal 41.2%, gas 13.8%, other 1.1%

**Emissions by sector:** electricity and heat generation 44.8%, transport 22.1%, industry 17.7%, other energy industries 7.1%, services 5.8%, residential 2.5%

\* Source: Statistics Finland.

#### GHG EMISSIONS AND TARGETS

Finland is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and a party to the Kyoto Protocol. Its international commitment under the Kyoto Protocol is to limit its greenhouse gas (GHG) emissions to 1990 levels in the five-year compliance period 2008-12. Furthermore, the European Union has set out a mandatory target of 20% reduction by 2020, so-called “20-20-20” target. The EU-ETS is expected to deliver the majority of emission cuts in the European Union, but this is to be supplemented by measures in sectors not covered by the ETS. Finland’s obligation for the sectors outside the ETS is a 16% emissions reduction by 2020 compared to emissions in 2005.

The latest GHG emission figures published by Statistics Finland show that as a result of mitigation measures adopted and the impact of the economic downturn, Finland looks like it is on track to meet its commitments. In the first years of the Kyoto period, 2008 and 2009, GHG emissions were below the Kyoto target. Emissions increased by 11.4% in 2010. However in 2011 Finland’s emissions decreased by 10.1% compared to the previous year, down to 67 million tonnes of CO<sub>2</sub>-equivalent (Mt CO<sub>2</sub>-eq).<sup>1</sup> On average, GHG emissions in the four years to 2011 were 69.5 Mt CO<sub>2</sub>-eq, which is lower than the 71 Mt CO<sub>2</sub>-eq emissions in the base year.

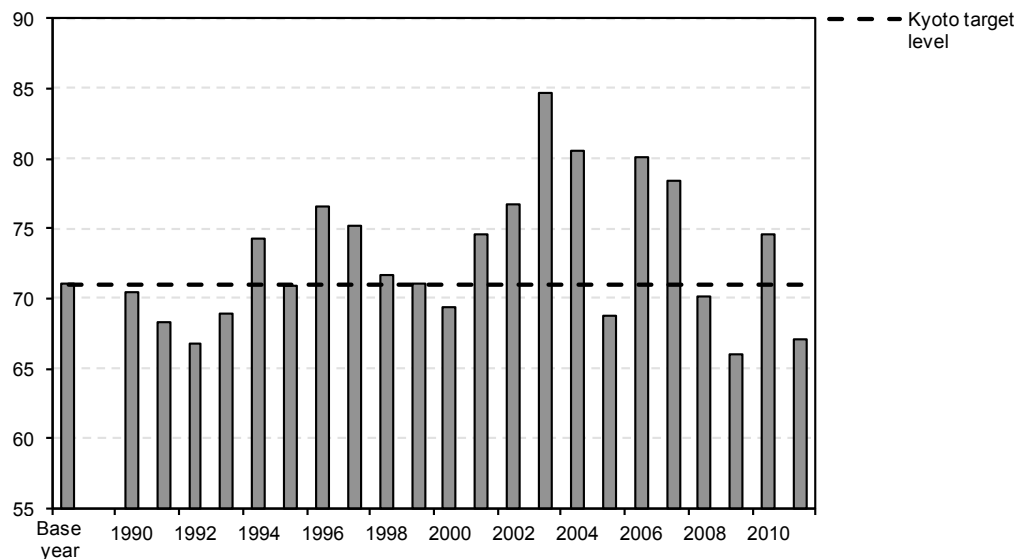
In Finland, the energy sector (emissions from fuels) accounts for around 79.6% of total GHG emissions. The agriculture sector is the second-largest sector, with 8.8% of total emissions in 2011, while industrial processes and waste account for 8.3% and 3.1% respectively.<sup>2</sup> This distribution is relatively similar to the EU-27 average, where the energy sector accounted for 82.2% in 2010 and the agriculture sector for 8.2%, while industrial processes and wastes respectively represented 6.5% and 3.1% of total GHG emissions. In

1. Statistics Finland, Greenhouse Gas Emissions in 2011, 15 April 2013.

2. Ibid.

Finland CO<sub>2</sub> represented 84% of total emissions in 2011, nitrous oxide (N<sub>2</sub>O) 8%, methane (CH<sub>4</sub>) 6% and others (hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride SF<sub>6</sub>) summed up to 2%. On average in the EU-27, these shares were respectively 81.4% of CO<sub>2</sub>, 10.5% of CH<sub>4</sub>, 5.5% of N<sub>2</sub>O and 2.6% of others.

Figure 6. **Commitment level of the Kyoto Protocol and Finland's greenhouse gas emissions, 1990-2011\***



\* Greenhouse gas emissions exclude the land use, land-use change and forestry (LULUCF) sector.

Source: Statistics Finland.

In announcing its 2013 Climate and Energy Strategy update, Finland indicated that its long-term objective was a carbon-neutral society. In order to achieve this aim, a strategy-based roadmap will start to be drawn up in 2013, focusing on better energy efficiency and increased use of renewable forms of energy by the year 2050. With these measures, Finland aims to cut its greenhouse gas emissions by at least 80% by 2050.

The IEA *World Energy Outlook* publication highlights the fact that the European Union's present target to cut emissions for 2020 is not consistent with the goal of limiting the average global temperature increase to 2 °C. Finland supports the EU policy drive to extend the EU emissions reduction target to 30% as long as the other industrialised countries commit to similar emissions cuts and the main fast-growing economies also take adequate action to do the same, where possible. Emissions reduction targets post-2020 must be in line with the 2 °C objective.

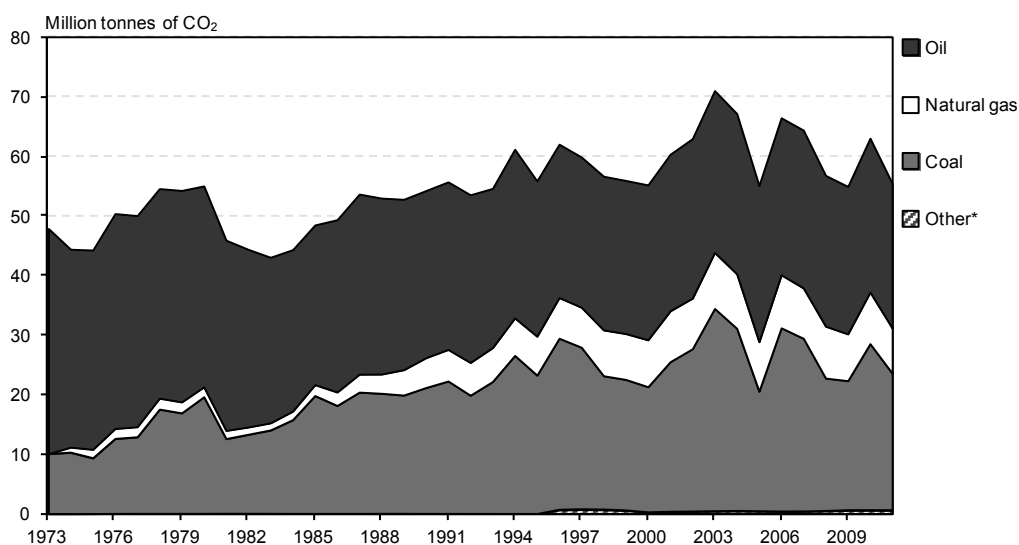
## CO<sub>2</sub> EMISSIONS FROM FUEL COMBUSTION

### SOURCES OF CO<sub>2</sub> EMISSIONS

Oil and coal are the largest sources of CO<sub>2</sub> emissions in Finland, as 43.9% of energy-related CO<sub>2</sub> emissions came from oil and a further 41.2% from coal in 2011. Coal's share

in total emissions has increased somewhat from 37.9% in 2000, while the share of oil has reduced from 47.2%. Natural gas accounted for 13.8% of total emissions in 2011, falling slightly from 14.4% Mt in 2000.

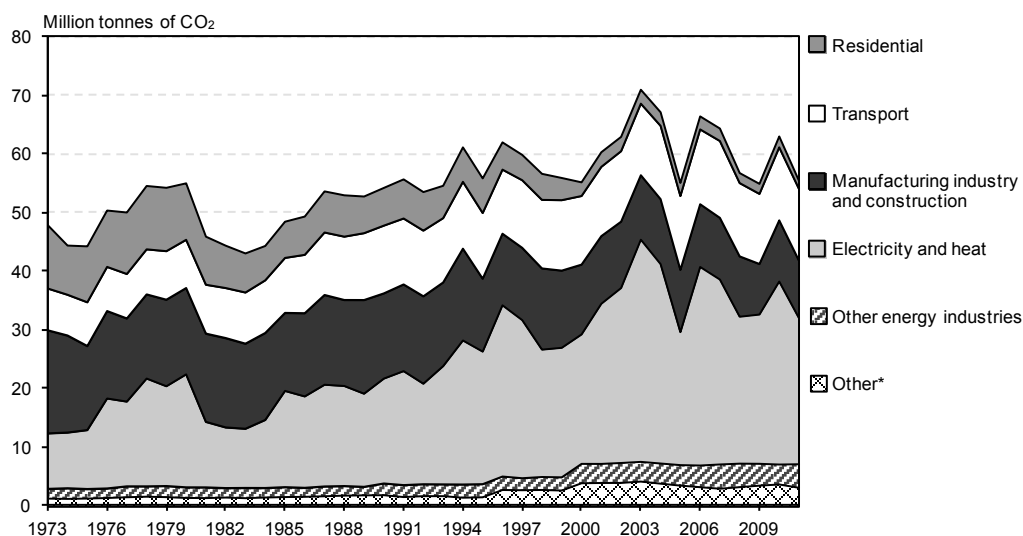
Figure 7. CO<sub>2</sub> emissions by fuel, 1973-2011



\* Other includes industrial waste and non-renewable municipal waste (negligible).

Sources: *CO<sub>2</sub> Emissions from Fuel Combustion*, IEA/OECD, Paris, 2012; and country submission.

Figure 8. CO<sub>2</sub> emissions by sector, 1973-2011



\* Other includes emissions from commercial and public services, agriculture/forestry and fishing.

Sources: *CO<sub>2</sub> Emissions from Fuel Combustion*, IEA/OECD, Paris, 2012; and country submission.

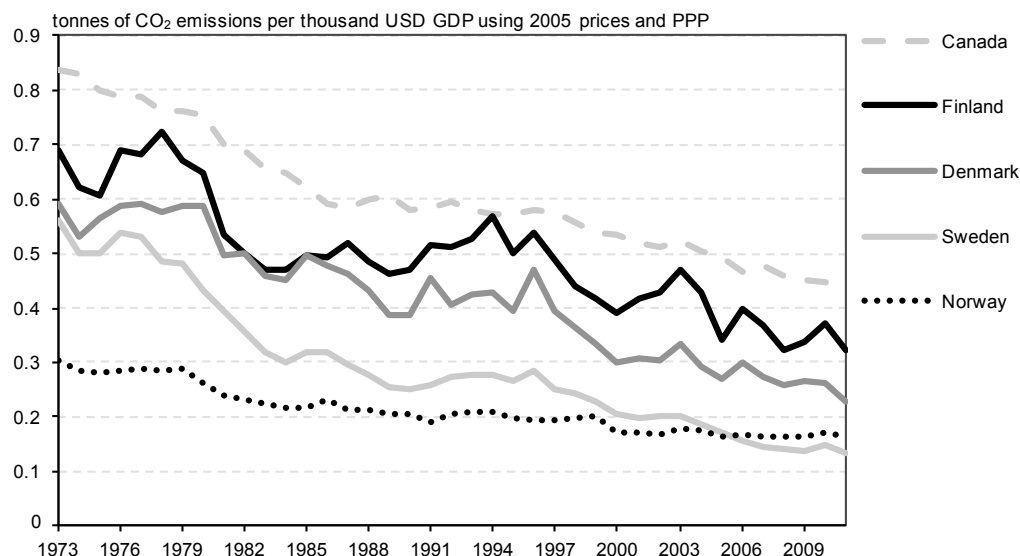
In terms of sectors, electricity generation is the largest CO<sub>2</sub> emitting sector, accounting for 44.8% of total CO<sub>2</sub> emissions from fuel combustion in 2011. Transport, the second-largest sector accounted for 22.1%, while the manufacturing industry and other energy

industries represented 17.7% and 7.1%, respectively. Residential, commercial and agriculture sectors added up to 8.4%. Since 2000, CO<sub>2</sub> emissions from electricity and heat generation have increased from 39.8% of the total, with emissions from the transport sector also increasing moderately from 21.4%. Manufacturing industries have reduced their shares of emissions, from 21.5% in 2000. Emissions from the residential sector have also declined over the years, falling from 4.2% of total emissions in 2000 to 2.5% in 2011.

## CARBON INTENSITY

The CO<sub>2</sub> intensity of Finland's economy, measured as the amount of CO<sub>2</sub> emissions as a proportion of USD GDP (kg CO<sub>2</sub> per 2005 USD and purchasing power parity), was 0.32 kg of CO<sub>2</sub> per USD of GDP PPP in 2011. This is higher than the IEA Europe average of 0.34 kg CO<sub>2</sub> per GDP. Finland's figure has decreased by 17.2% since 2000, despite an increase in overall CO<sub>2</sub> emissions. Real GDP at USD 2005 prices and PPP in Finland grew by 21.9% over the 11 years to 2011, while emissions growth was slower, at 0.5% over the same period.

**Figure 9. Energy-related CO<sub>2</sub> emissions per GDP in Finland and in other selected IEA member countries, 1973-2011**



Sources: *CO<sub>2</sub> Emissions from Fuel Combustion*, IEA/OECD, Paris, 2012; and *National Accounts of OECD Countries*, OECD, Paris, 2012.

Electricity generation is the largest sector in terms of emissions, and on average 199.2 grams CO<sub>2</sub> were emitted per kilowatt hour generated in 2011. CO<sub>2</sub> emissions per capita stand at 10.3 tonnes of CO<sub>2</sub> per inhabitant, which is above the IEA average of 9.1 tonnes of CO<sub>2</sub> per capita.

In 2010, Finland's electricity generation was well below the IEA Europe average of 418.0 g CO<sub>2</sub>/kWh; Finland had the tenth-least CO<sub>2</sub>-intense electricity generation among IEA member countries in 2010. Electricity consumption per capita was high in Finland, second-highest in 2010 after Norway, standing at 26.0 megawatt hours per capita compared to an IEA average of 10.3 MWh per capita.

## INSTITUTIONS

Finnish climate change policy is directed by the national **Climate and Energy Strategy**. Climate policy is led by the **Ministry of the Environment**, in close co-operation with the **MEE** which is responsible for the overall co-ordination of all elements of the national Climate and Energy Strategy. The Minister of Economic Affairs is chairing the Ministerial Working Group on Climate and Energy Policy. Energy is the key driver of climate policy in Finland, and with the energy production and industry sectors together producing 75% of emissions, cross-ministry co-ordination is central to developing Finland's climate policy.

The **Ministry of Environment** bears administrative responsibility for preparing the national position for European-level climate discussions and co-ordinating international climate negotiations under the UNFCCC, in which Finland follows the common positions of the European Union. These tasks complement other responsibilities associated with environmental protection and broader climate-related matters such as land-use planning.

Broad, cross-sectoral co-ordination is managed through a **Ministerial Working Group on Climate and Energy Policy**, a contact network comprising representatives of various ministries (foreign affairs, finance, trade and industry, agriculture and forestry, and transport and communications) which have responsibility for implementing emissions mitigation policies in their respective sectors. The working group aims to ensure that sectoral policy remains coherent with the strategy and with Finland's overarching climate goals.

Finland has also appointed an independent **Climate Panel** to support the government's decision making in climate policy by contributing a solid scientific basis to governmental discussions. It is further complemented by the work of **Statistics Finland**, the national entity responsible for compiling the Finnish GHG inventory reports and submitting the reports to the UNFCCC and to the European Commission. Finland's **EMA** manages implementation of the EU-ETS, under the direction of the MEE, and acts as the administrator of the national emissions trading registry under the Kyoto Protocol to the UNFCCC.

The **Ministry of Agriculture and Forestry** is responsible for the co-ordination of climate change adaptation at the national level.

## POLICIES AND MEASURES

### OVERVIEW

According to the burden-sharing agreement between EU member states, Finland committed under the Kyoto Protocol to bring national average annual GHG emissions down to their 1990 level (71 Mt CO<sub>2</sub>-eq per year) in the 2008-12 period. Emissions in 2011 were 67 Mt CO<sub>2</sub>-eq, around 5.6% below the Kyoto Protocol target and averaged out at about 2.2% below the 1990 level over the period. Final emissions for 2012 will be verified in 2014, when inventory data for the first commitment period is finalised.

The European Union has now formalised its participation in a second commitment period (2013-20) under the Kyoto Protocol, pledging an EU-wide quantified emissions reduction to bring emissions to 20% below 1990 levels. Finland supports the EU policy drive to move from a 20% reduction to a 30% reduction by 2020 compared to 1990 levels, provided

that other developed countries commit themselves to comparable emissions reductions and developing countries contribute adequately according to their responsibilities and respective capabilities.

Finland's approach to achieving its international GHG emissions reduction targets is three-pronged, relying on the EU-ETS, domestic measures in the non-emission trading sectors, and use of the Kyoto flexible mechanisms. It is as a result of measures in these areas, and in light of the impact of the economic recession, that Finland is on track to meet its 2012 Kyoto Protocol target. Final emissions for 2012 will be verified in 2014, when inventory data for the first commitment period are finalised.

The overall context for Finland's recent energy-related environmental policy was provided by its national Climate and Energy Strategy 2008 (now superseded by the 2013 revised strategy). The strategy projected that without new climate policy measures, Finland's GHG emissions would total some 90 Mt CO<sub>2</sub>-eq in 2020 (approximately 20% more than in 1990) and would be 30% more in 2050. This highlights the key role of the energy sector in curbing emissions. The strategy outlined Finland's climate and energy policy objectives, in the context of its commitments under the EU Climate and Energy Package<sup>3</sup> with the overarching goal of ensuring that Finland meets its international climate change mitigation obligations. The strategy sets an objective to reduce Finland's emissions outside the emissions trading sectors to 30 Mt CO<sub>2</sub>-eq by 2020.

Several important decisions related to the implementation of the Climate and Energy Strategy were taken during 2010, supporting the intensifying of energy efficiency, increasing energy production based on renewable sources towards Finland's 38% goal, promotion of biofuels, and facilitating the construction of two additional nuclear power plants. These are all dealt with in more detail in the specific chapters on these areas.

In October 2009, the Finnish government adopted the *Foresight Report on Long-term Climate and Energy Policy* to supplement the longer-term ambitions of the 2008 strategy. The result of two years of cross-disciplinary investigations and broad consultation with stakeholders and citizens, the *Foresight Report* reviewed the ambition for sustainable development from a global perspective and outlined possible paths to a low-carbon Finland by 2050. It sets a target for Finland to reduce its GHG emissions by at least 80% from the 1990 level by 2050, as part of a wider international effort and this ambition has now been restated in the 2013 Climate and Energy Strategy.

In practice, the achievement of this target requires achieving virtually zero-emission energy and road transport sectors in Finland in the long term, along with the reduction of energy use in the buildings sector and across the economy. The *Foresight Report* provides a strong aspirational basis for action on climate mitigation in Finland rather than providing concrete measures – which remains the role of the strategy and of the various ministries implementing it. In its 2013 Climate and Energy Strategy update, the government indicates that Finland, thanks to the decisions currently in place, is on track to attain its 80% reduction target by 2050. The strategy does not adopt a position on the further measures that will be needed beyond 2025 to ensure that the decrease in emissions remains on a path towards the 80% to 95% target for 2050 adopted by the European Council.

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3. EU 20-20-20 commitment arises in the EU Climate and Energy Package which sets EU-wide targets to reduce greenhouse gas emissions by 20%, to increase the share of renewable energy sources in final energy consumption by 20% and to improve energy efficiency by 20% across all European Union countries.



Finland's National Strategy for Adaptation to Climate Change was adopted in 2005 as an independent part of the then national long-term Climate and Energy Strategy. The strategy describes impacts – related to extreme weather events in particular – and potential adaptation measures in the energy sector to 2080. A 2009 evaluation of the strategy's implementation is contributing to the update being prepared over 2012/13.

## EUROPEAN UNION EMISSIONS TRADING SCHEME (EU-ETS)

The increase in Finland's emissions by 2050 projected in reference scenarios is almost entirely due to emissions from sectors covered by the EU-ETS sector. The EU-ETS, a mandatory cap-and-trade system established by the European Union in 2003 (Directive 2003/87/EC), sets limits on emissions from energy and emission-intensive sectors. The emissions trading sector in Finland, which includes coal- and peat-fired power plants, district heating (including co-generation plants), oil refineries and energy-intensive industry sectors (such as steel, and pulp and paper industries) collectively accounted for some 52.4% of total national GHG emissions in 2011.<sup>4</sup>

Finland's ETS sector emissions demonstrate large fluctuations between years due to variations in the Nordic electricity market, the impact of weather on hydropower and the state of the economy. According to Statistics Finland, the country's emissions under the Emissions Trading Scheme decreased by approximately 17.6% from 2010 to 2011. This is due in large part to the downturn in production in recent years as a result of the economic recession. While the current low price of emission allowances in the EU-ETS enables market actors to satisfy their ETS caps cost-effectively, this raises concerns over a lack of investment in new clean technologies, and lock-in of inefficient, high-emitting technologies. The effective participation by over 530 Finnish installations in the EU-ETS has been a policy priority since the system commenced in 2005.

Finland's emissions trading sector is expected to deliver an average of 8.7 Mt CO<sub>2</sub>-eq per year in reaching the 2020 target. The National Allocation Plan for Emissions 2008-12 allows Finland to allocate a total of 37.6 Mt CO<sub>2</sub>-eq in free allowances per year to participating facilities. This represents a 17% reduction from the 2005-07 allocation (45.5 Mt CO<sub>2</sub>-eq).

The revised EU-ETS Directive 2009/29/EC broadened the scope of the EU-ETS for the third trading period (2013 to 2020) to include aviation, the production of aluminium and chemicals and other emissions and Finland has implemented the latest EU directives primarily<sup>5</sup> by way of its *Emissions Trading Act 311/2011*.

As a result of the Commission Decision 2011/278/EU, national allocation plans will be replaced by a cross-sectoral EU-wide emissions cap determined by the Commission for the third allocation period from 2013 to 2020, and a new auction-based emission allocation procedure has been established.

Finland submitted its preliminary allocation proposal in February 2012 but final installation-specific emission allowances for the period 2013-20 are not expected to be issued by the European Commission before early 2013. The cross-sectoral EU-wide emissions cap determined by the Commission for the third allocation period of 2013-20 will ensure that the EU-ETS sector will reach its EU-wide target as set in the Climate and Energy Package.

4. Statistics Finland, Greenhouse gas emissions in 2011, 15 April 2013. [http://tilastokeskus.fi/til/khki/2011/khki\\_2011\\_2013-04-15\\_en.pdf](http://tilastokeskus.fi/til/khki/2011/khki_2011_2013-04-15_en.pdf).

5. The amendment to the Emissions Trading Directive to include aviation in the EU-ETS was implemented nationally by Finland's Act on Aviation Emissions Trading (34/2008).

## DOMESTIC MEASURES OUTSIDE THE EU-ETS

It is the responsibility of the individual EU member states to manage emissions from the non-emissions trading scheme sectors in their country. In Finland, the non-ETS sector represented 47.6% of total GHG emissions in 2011. Therefore, measures to mitigate emissions in these sectors (transport, buildings and agriculture in particular, along with small industry and waste) remain important in Finland.

The EU Effort Sharing Decision of the European Union's Climate and Energy Package sets a binding target for Finland's non-ETS sectors to reduce emissions by 16% from the 2005 levels during 2013-20. This equates to a reduction of 5.68 Mt CO<sub>2</sub>-eq on average across the period.

Unlike the emissions trading sector, the 2008 national Climate and Energy Strategy projected that emissions from non-ETS sectors will remain more or less constant until 2020. Economically cost-efficient emissions reductions available in the non-emissions trading sector were estimated to be on average 1 Mt CO<sub>2</sub>-eq per year. This indicates that the 2020 goal is achievable for Finland, provided measures outlined in the national Climate and Energy Strategy to support potential emissions reductions are effectively implemented.

According to the strategy, about one-third of the required reductions will be achieved with measures in the transport sector and one-third with measures that reduce the emissions from heating. The rest of the required emissions reductions will be achieved with measures in other sectors such as agriculture, F-gases and waste management. The government will prepare a proposal for, and take a separate decision on, the possible enactment of a National Climate Act. The Act would make emissions reduction measures more systematic and predictable in the non-ETS sectors.

### Transport sector

Transport accounted for 19.7% of Finland's total GHG emissions in 2011. The Ministry of Transport and Communications completed its Climate Policy Programme 2009-20 in March 2009, stating an objective to cut greenhouse gas emissions estimated for 2020 by 2.8 Mt CO<sub>2</sub>-eq (15% of the 2020 baseline), while maintaining the current level of transport service, and in the face of the increase in extreme weather phenomena. Key measures to achieve this, reiterated in the 2012 Government Report on Transport Policy, focus on renewal and replacement of the vehicle fleet; improving energy efficiency in transport; and significantly growing passenger traffic volumes in urban areas using more environment-friendly transport modes.

In particular, the 2011 Fuel Tax Reform is expected to play a key role in decreasing the emissions of new cars in Finland by linking the tax to the energy and carbon content of transport fuels through a triple CO<sub>2</sub>-based transport tax regime (discussed further in Chapter 4 on Energy Efficiency). This is supported by legislation implementing the EU-led obligation (1420/2010) for extension of biofuel distribution to 6% for 2011-14, followed by a phased increase to 20% by 2020. A working group of the Ministry of Transport and Communications is currently assessing the future role of different energy sources in transportation in Finland.

### Buildings sector

Finland's cold climate has driven its building stock to be relatively energy-efficient, making extensive use of energy-efficient technologies as well as a large district heating system,

75% of which is delivered by fuel-efficient combined heat and power generation (CHP) plants. Finland's renewable energy policy, in addition to the impact of the EU-ETS on certain district heating plants, has supported an increased role for biomass in place of coal in firing the district heating system and the associated reduction in GHG emissions.

Nevertheless, emissions from burning high-carbon heating fuels in non-district heated properties present a key climate change mitigation challenge in this sector. The Finnish government has various measures in place to encourage switching from oil-heating systems to district heating, wood-based boilers, or renewable energy sources such as ground-source heat pumps, biofuel oils and solar-powered heating. The switch is promoted through the energy advice system and the Höylä III Energy Efficiency Agreement and encouraged through a 2011 subsidy scheme whereby the government covers up to 20% of the cost of installing efficient or wood-fuelled heating systems.

In addition, Finnish taxes on heating fuels, traditionally very low, have been tripled since 2011 and, while peat receives special treatment as a key indigenous resource, taxes on coal, fuel oil and natural gas are set to increase gradually out to 2050.

These actions are supplemented by a range of policies to implement the latest EU Directive on the Energy Performance of Buildings, including new National Building Regulations, and in the 2013 Climate and Energy Strategy update, Finland announced its intention to prepare a long-term strategy for implementing the directive that all new buildings shall be "nearly zero-energy consumption buildings" by 31 December 2020 (discussed in more detail in Chapter 4).

### Other sectors

The rest of Finland's required emissions reductions are achieved in other sectors. In the agriculture sector, which contributed 8.8% of Finland's GHG emissions in 2011, energy management programmes such as the Farm Energy Programme and other agricultural investment aid schemes aim to reduce this contribution. These activities are supplemented by measures to implement the EU restrictions on F-gases in Finland and targeting waste management by applying and extending the EU waste regulations.

## INTERNATIONAL MEASURES

There are inevitable uncertainties in the actual amount of emissions reductions that can be achieved in the non-emissions trading sector; however, Finland's 2013 Climate and Energy Strategy anticipates that the emissions reduction target will be met without the use of the flexible mechanisms available under the Kyoto Protocol. These flexibility mechanisms allow for the purchase of emission allowances arising from emissions reduction projects implemented outside Finland to make up any shortfalls in reaching the emissions reduction target. This UN-sponsored system reflects the fact that while climate change mitigation efforts must be equitably shared, GHG emissions themselves are not limited by national boundaries.

The *Act on the Use of the Kyoto Mechanisms (109/2007)* lays out the administrative framework that enables both the Finnish government and other players to participate in project activities in accordance with the Kyoto mechanisms and to manage the acquisition of Kyoto emission units through these mechanisms.

Finland's purchase programme for allowances in the first (2008-12) commitment period under the Kyoto Protocol set a quantitative target to procure credits for 7 Mt CO<sub>2</sub>-eq, *i.e.* through the Clean Development Mechanism (CDM), Joint Implementation (JI) and international trading. Besides bilateral projects, Finland has invested in approximately six multilateral carbon funds. According to the most recent assessment, the international trading target has been met, with an average of 1 Mt CO<sub>2</sub>-eq purchased annually.

The government purchase programme for the second (2013-20) commitment period was also approved in 2008 by the Ministerial Working Group. In anticipation of a quantitative target being set for the post-2012 Kyoto Protocol commitment period, the budget for the acquisition of Kyoto mechanisms has been calculated to be around EUR 80 million. About EUR 21 million of this is allocated for purchasing credits over the post-2012 period. The economic downturn has implications for Finland's purchasing programme and recent projections suggest that purchasing requirements will be significantly less than originally anticipated in 2008. A separate strategy for the focus areas and timing of the sustainable use of flexible mechanisms over the period 2013-20 will be prepared during 2013.

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## ASSESSMENT

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Energy is the key driver of climate policy in Finland, and with the energy production and industry sectors together producing more than 80% of emissions, cross-ministry co-ordination has been central to developing Finland's policy in this area. The work of the Ministerial Working Group on Climate and Energy Policy has ensured Finland has met and pursued further ambitious targets for reducing GHG emissions. Providing a market mechanism to regulate Finland's heavily emitting sectors, the operation of the EU-ETS, in the context of Finland's second National Allocation Plan, has been key to ensuring Finland's achievement of its Kyoto targets. While targets have been reached cost-effectively in the context of the recent economic recession, the low price of emissions allowances in the market in recent years raises concerns about whether the sector has invested enough in clean technologies to support reaching longer-term targets. Finland should monitor investment plans for development of energy-sector infrastructure to ensure that these are consistent with Finland's 2020 and 2050 climate targets and, if they are not, consider what reinforcing policy measures may be justified. The intention, stated in the 2013 Climate and Energy Strategy, to develop a Clean Energy Programme involving a suite of additional measures to support achievement of the 2050 emissions target provides the opportunity to do so.

Another challenge in the third ETS period (2013-20) will be adapting to the new EU-wide harmonised rules for allocation, which will replace the National Allocation Plan that Finnish ministries have been working with to date. More importantly, the auctioning system which will gradually replace the free allocation mechanism of emission permits will have a considerable impact on carbon-intensive coal- and peat-fired power plants and gradually, depending on the development of the EU-wide allocation rules, its energy-intensive industries such as paper and pulp.

In addition to heavy reliance on the EU-ETS to reduce emissions, the Finnish government should focus its attention on reducing emissions in the sectors not covered by the ETS. Finland's 2020 target equated to reductions of approximately 6 Mt CO<sub>2</sub>-eq, or a 16% emissions reduction outside the ETS sector compared to 2005 emissions. In 2011, non-ETS emissions were 10.4% lower than in 2005. However, the transport sector still has

large potential for further emissions cuts, and about one-third of non-ETS reductions are to be achieved through domestic measures here. Finland has made good progress in implementing the EU directives regarding the progressive increase in the distribution of biofuels, and the reform of vehicle taxes on the basis of fuel efficiency is likely to have a significant impact.

A further third of Finland's emissions reduction is expected to come from measures promoting and implementing the phase-out of carbon-intensive oil heating in non-ETS sectors making use of Finland's well-developed energy efficiency agreements system. The remainder of the non-ETS mitigation effort is being pursued through measures in other sectors, in particular agriculture, and through implementation of the EU regulations on F-gases and waste management.

The Finnish government's revised energy tax system based on CO<sub>2</sub> emissions, energy content and local particle emissions is commendable. The tax applies to ETS and non-ETS sectors in accordance with EU rule against state aid. Finland has taken the opportunity to provide a 50% tax exemption for CHP to avoid overlapping CO<sub>2</sub>-based burdens and to improve the competitiveness of CHP relative to other heat production. While peat and natural gas are taxed at a lower rate, this rate is to increase incrementally to 2015.

Finland's forests play a major role in the country's energy generation which is traditionally, and increasingly, based on biomass. Although forest stock is expanding faster than it is being exploited, the Working Group on Energy and Climate should turn its attention to the impact of the use of biomass on Finland's carbon emissions trajectory and accounting for LULUCF. As the offsetting of deforestation emissions through forest sinks has been ruled out by the Parties to the UNFCCC, a decision on how carbon sinks will be treated in the European Union will be critical to Finland's 2020 emissions account.

According to the most recent assessment, Finland has met its target for the quantitative contribution of Kyoto mechanisms for the first commitment period of 7 Mt CO<sub>2</sub>-eq. A quantitative target has not yet been set for the second commitment period, but EUR 21 million has been allocated to the procurement of post-2012 credits and a strategy for use of flexible mechanisms is in preparation. At the most recent Conference of the Parties to the UNFCCC in Doha, Qatar in 2012, the Kyoto Protocol was amended to formalise the second commitment period. Finland has stated its support for the European Union's second commitment period target of a 20% reduction, together with the proposal for this to be increased to 30% provided other countries make similar pledges, both of which fit with Finland's national emissions reduction obligation out to 2020. Finland's 2013 Climate and Energy Strategy has formalised Finland's goal to reduce Finland's emissions by at least 80% by 2050, and this should provide new impetus for Finland to scale up national emissions reduction efforts in the next policy-planning round.

The 2013 Climate and Energy Strategy enshrines the ambitious targets anticipated by Finland's 2009 *Foresight Report*, which focused largely on broad range scenarios. A more detailed roadmap outlining a "Clean Energy Programme" of measures needed to achieve the 2050 targets will be prepared by the Ministerial Working Group at the beginning of 2013. Finland should take this opportunity to do thorough analysis of potentials and costs for emission reductions across sectors and provide more visibility as to the actual capacity of measures to deliver the major reductions needed. Such a document will be valuable to clearly map out a pathway for the achievement of Finland's ambition to place the decarbonisation of Finland's economy at the heart of its long-term energy policy.

## **RECOMMENDATIONS**

*The government of Finland should:*

- ☐ *In preparing the roadmap and Clean Energy Programme anticipated in the 2013 Climate and Energy Strategy, carry out more rigorous analysis of the emissions reductions that proposed measures can be expected to deliver and ensure that policy measures in the shorter term achieve their goals and set Finland on a path to meet the 2050 target.*
- ☐ *Enhance efforts to reduce carbon emissions in the transport sector, in light of its significant contribution to emissions among the non-ETS sectors, in particular in supporting alternative-fuel vehicles and increased promotion of modal shift.*
- ☐ *Continue to review and gradually develop the energy taxation regime to stimulate cost-effective emissions reductions and facilitate long-term planning of investment.*

## 4. ENERGY EFFICIENCY

### Key data (2011)

**Energy supply per capita:** 6.5 toe (IEA average: 4.6 toe), +3.6% since 2000

**Energy intensity:** 0.2 toe per USD 1 000 GDP PPP (IEA average: 0.14 toe per USD 1 000 PPP), -11.6% since 2000

**Total final consumption (TFC):** 25.2 Mtoe (oil 30.8%, electricity 27.4%, biofuels and waste 18.7%, heat 16.2%, natural gas 4%, coal 1.7%, peat 1.2%), +2.2% since 2000

**Consumption by sector:** industry 47.5%, residential 20%, transport 17.2%, commercial and other services 15.3%

## OVERVIEW

### FINAL CONSUMPTION BY SECTOR

In 2011, Finland's total final consumption (TFC) was 25.2 Mtoe. This is 6% lower than in 2010, while slightly higher than a sharp dip of 24.4 Mtoe in 2009. Finland's TFC grew at an annualised rate of 0.2% per year over the 11 years to 2011. The moderate growth in TFC in Finland can be primarily attributed to the exceptionally strong economic performance that Finland experienced until 2006-07, driven by growth in its dominant services and manufacturing sectors.

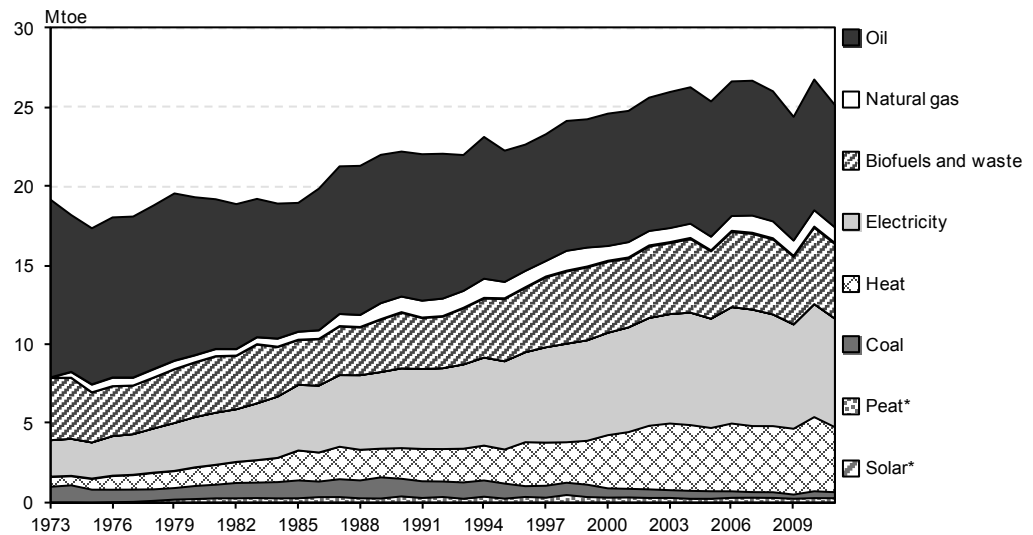
The industry sector accounted for 47.5% of TFC in 2011, the residential sector for 20%, while transport and commercial and other services represented 17.2% and 15.3%, respectively.

The share of industry in final energy consumption is significantly higher than the IEA average and amounted to 12 Mtoe in 2011, owing in part to Finland's high levels of energy-intensive industries such as paper and pulp as well as basic metals. While final energy consumption in Finland's industrial sector is set to increase (annual growth of 1.3% through to 2020), energy intensity in this sector is nevertheless gradually decreasing. This is largely due to the success of Finland's system of Voluntary Energy Efficiency Agreements for industry and business (discussed in more detail below).

Around 42% of the industry consumption came from electricity and heat, while biofuels accounted for 25.7% of energy usage in 2011. The remainder of energy consumption is supplied by natural gas, coal and peat to a smaller extent.

In the transport sector, final energy consumption amounted to 4.3 Mtoe in 2011. While the share of transport is low, the sector relies largely on oil, with biofuels representing just 4.2% of energy consumption in 2011, and electricity representing a negligible amount. Energy consumption in the transport sector had been on a steady rise since 2000, before a drop in 2008 and 2009. Final consumption in transport recovered in 2010 before a slight contraction again in 2011. TFC in transport is expected to contract by 1.9% per annum over the nine years to 2020, down to 3.7 Mtoe.

Figure 10. Total final consumption by source, 1973-2011



\* Negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012; and country submission.

The government indicates that Finland's buildings in general account for 38% of energy end-use, distributed between electricity for heating (12%), district heating (29%), oil and natural gas (14%), wood and pellets (12%), and electricity for other applications (approximately 33%).

In the residential sector specifically, oil consumption is expected to decrease by as much as 30% by 2015<sup>6</sup> as the impact of national energy efficiency programmes takes effect, and should continue a more gradual decline over following years as the role of biomass increases, along with other heating fuels which are expected to increase in line with total consumption in the sector. Overall, consumption is expected to drop by 20.2% in the residential sector by 2020.

## ENERGY INTENSITY

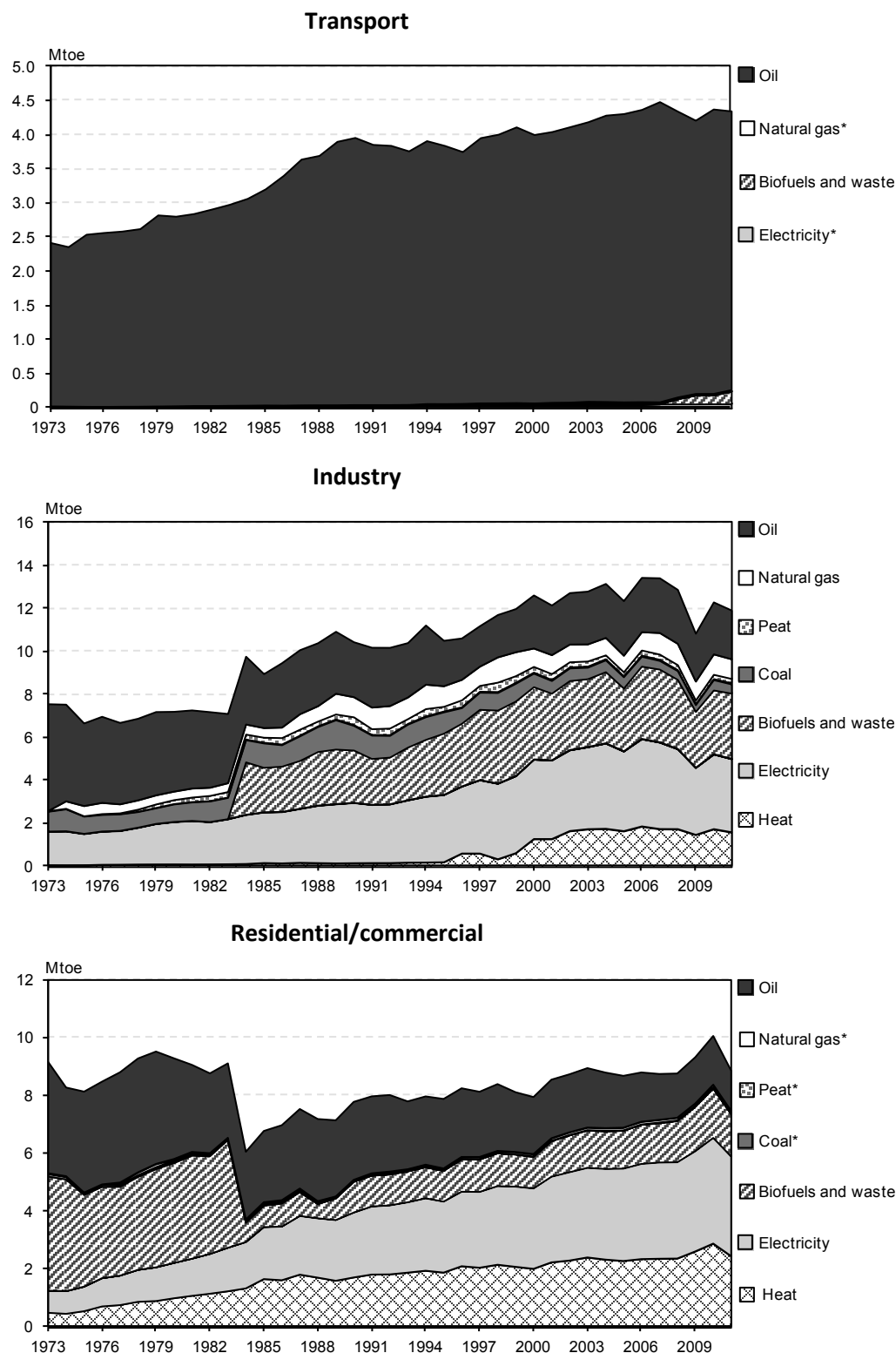
Finland is a highly industrialised mixed economy with a large share of heavy industries, long delivery distances and also high heating and lighting demand, which explains why Finland's energy intensity<sup>7</sup> was the second-largest among IEA member countries in 2011, behind Canada, at 0.2 toe per USD 1 000 GDP PPP. The IEA average for the same year was 0.14 toe per USD 1 000 GDP PPP. Finland has worked to reduce the energy intensity of its economy, aided by a gradual structural change of the national economy, and between 1990 and 2011, the rate of decline in aggregate energy intensity was 1.1% per year.

6. Based on projections in the *Nordic Energy Technology Policy*, "New Policies Scenario", in OECD/IEA, 2012.

7. The amount of primary energy used in a country per unit of USD GDP at 2005 prices and purchasing power parity (PPP).



Figure 11. Total final consumption by sector and by source, 1973-2011

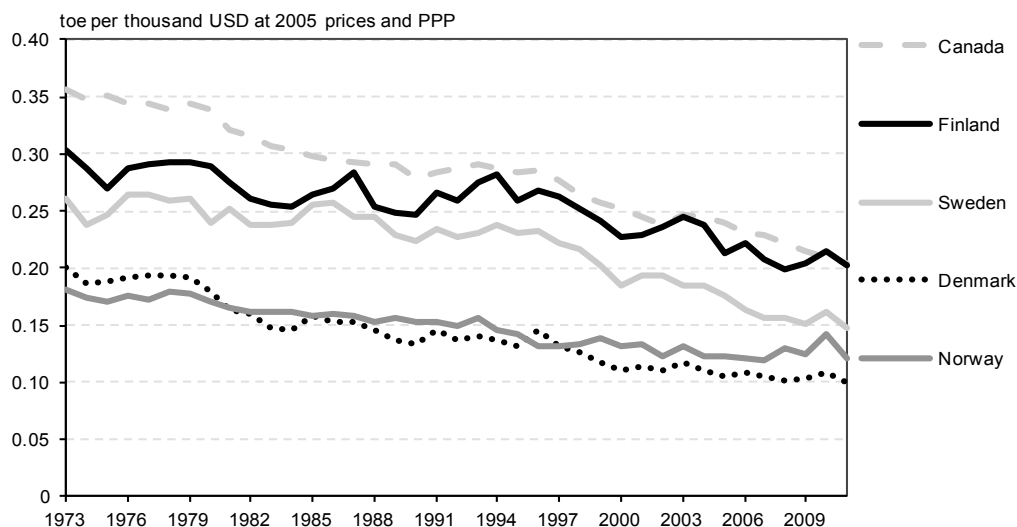


\* Negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012; and country submission.

In its Climate and Energy Strategy, the Finnish government indicated that if no further action was taken, total primary energy consumption in Finland was forecast to rise from 36.2 Mtoe (421 TWh in 2006) to 41.2 Mtoe (479 TWh) by 2020 and to 45 Mtoe (523 TWh) by 2050. The targets set by Finland's National Energy Efficiency Action Plan, (NEEAP) however, curb this trajectory, aiming to limit the increase in primary energy consumption to just 37 Mtoe (430 TWh) by 2020. Finland's updated Climate and Energy Strategy, released in 2013, indicates that primary energy consumption may not increase as strongly as previously expected, largely because of slower economic growth and also overall increases in energy efficiency across the economy.

Figure 12. Energy intensity in Finland and in other selected IEA member countries, 1973-2011



Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012; and *National Accounts of OECD Countries*, OECD, Paris, 2012.

The energy efficiency measures expected to have the greatest impact in delivering energy savings are those in Finland's buildings sector. Efficiency in this sector has been increasing for some time. Even so, the impact of past tightening of building regulations and support for efficient heating systems and other residential improvements are calculated to have delivered 0.5 Mtoe (6.6 TWh) in additional energy savings in 2010. Going forward, measures are estimated to deliver a 12% annual reduction in 2016, increasing savings to more than 15% in 2020 when they are expected to reach 1.6 Mtoe (18.6 TWh).

The second-biggest saving will come from the transport sector, where improvements in the energy efficiency of new cars, as the combined effect of several measures, are expected to deliver annual savings of 0.3 Mtoe (3.3 TWh) in 2016, and 0.5 Mtoe (5.9 TWh) in 2020.

## INSTITUTIONS

Finland's **MEE** has overall responsibility for the formulation of energy efficiency policy and co-ordinates the implementation of energy efficiency policy across ministries and other institutions. It manages the transposition of EU energy efficiency legislation into Finnish law alongside the development and periodic review of Finland's national Climate and Energy Strategy.

A **Ministerial Working Group on Climate and Energy Policy** has been co-ordinated to manage the Climate and Energy Strategy, and does so with the technical support of a

Climate and Energy Policy Network. The network comprises representatives of several ministries, including the MEE, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry, the Ministry of Education, the Ministry for Foreign Affairs, the Prime Minister's Office, the Ministry of Finance, and the Ministry of the Environment.

The second NEEAP (NEEAP-2) covers all sectors of the economy and responsibility for certain specific sectors is delegated to various ministries. The **Ministry of the Environment** has a central role in relation to buildings and building codes, ensuring the quality of the built environment and promoting sustainable communities.

The **Ministry of Transport and Telecommunications** has an important role in promoting energy efficiency in the transport sector, notably for achieving its central mission of providing Finnish people with opportunities for safe travel, in order to maintain the competitiveness of businesses in Finland and promote the mitigation of carbon emissions.

The **Ministry of Agriculture and Forestry** is responsible for energy efficiency in farms, alongside its responsibilities for scaling up biomass and renewable energy production in accordance with the Climate and Energy Strategy.

**Motiva Oy** is a state-owned company (since 2000), set up originally in 1993 as Finland's national energy agency with a mission to promote and assist with the development of sustainable energy. It is responsible for advising government on policies and measures including energy efficiency, implementing programmes agreed by government and stimulating sustainable energy policies and actions. Motiva Oy collects and evaluates information about the impacts of energy efficiency policy and promotes policies and new technologies through working with the business sector, local communities and individual consumers.

## POLICIES AND MEASURES

Finland's sizeable heavy industry sector has resulted in a high level of energy intensity for Finland overall. On a sectoral basis, however, Finland can boast some comparative advantages, as the cold climate has required a relatively high level of efficiency in the national building stock. Nevertheless, the government has worked systematically over time to realise additional energy efficiency potential across all sectors.

As a member of the European Union, Finland's energy efficiency policies are implemented under the framework of several key directives issued by the European Commission, namely the Energy Services Directive (2006/32/EC)<sup>8</sup> which provides the overarching targets for energy efficiency in the European Union; as well as the Ecodesign Directive (2009/125/EC)<sup>9</sup> and the Energy Labelling Directive (2010/30/EU)<sup>10</sup> which both relate to energy-using and energy-related products, the Energy Performance of Buildings Directive (2010/31/EU), the Fuel Quality Directive (2009/30/EC) and the Combined Heat and Power Directive (2004/8/EC).<sup>11</sup>

Finland is on a course to exceed the target set by the 2006 Energy Services Directive (ESD) which requires member states to reach a 9% energy savings target by 2016, having achieved savings of roughly double the interim target set for 2010. The ESD will be superseded by the new Energy Efficiency Directive (EED) which, when it takes effect in

8. Directive 2006/32/EC is set to be repealed by the new Energy Efficiency Directive.

9. Directive 2009/125/EC is set to be amended by the new Energy Efficiency Directive.

10. Directive 2010/30/EU is set to be amended by the new Energy Efficiency Directive.

11. Directive 2004/8/EC is set to be repealed by the new Energy Efficiency Directive.

2014, will provide new overarching energy efficiency guidelines for member states. Rather than binding energy savings targets, the EED focuses on binding measures, requiring certain actions in each sector in order to reach the collective target of making a 20% improvement in energy efficiency in the European Union by 2020. The EED requires member states to set their own targets for energy savings, supported by an energy efficiency plan.

As part of the government's push to implement the EED, Finland's 2013 update of the Climate and Energy Strategy contains numerous new entries on energy efficiency, stating its aim to promote the creation and growth of an international energy efficiency business. An Energy Efficiency Act and an energy efficiency implementation plan are in the process of being drafted, under the joint responsibility of the MEE, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry, the Ministry of Finance, and the Ministry of the Environment. In addition, a long-term strategy to improve the energy efficiency of buildings and an energy savings plan for buildings used by central government are being drawn up. Plans for energy efficiency on the part of local authorities are also being developed, and the possibility of a programme of commitment for energy companies is being looked into.

### LONG-TERM CLIMATE AND ENERGY STRATEGY (2013)

Finland's own energy savings target is set by its long-term Climate and Energy Strategy, first issued in 2001 and revised in 2005 and 2008 before the current iteration was issued in 2013. This document, prepared under the steering of the government's Ministerial Working Group on Climate and Energy Policy, defines the principal objectives and means of Finland's climate and energy policy for the next few decades, within the context of the European Union and its objectives, and with the stated goal of implementing the new requirements of the EED. The strategy articulates an overarching goal to halt, and reverse, growth in final energy consumption. It sets an ambitious target to limit final energy consumption to 310 TWh in 2020.

The strategy is designed to provide a basis for the government's statements both in international contexts and in domestic policy preparation and decision making, providing guidelines and specific measure up to 2020, as well as longer-term visions for a further decrease in final energy consumption by 2050 of at least one-third of the 2020 level. The outlook to 2050 was further expanded upon in the government's *Foresight Report 2009* and will be developed into concrete actions by way of Finland's forthcoming roadmap to 2050 and Clean Energy Programme (this is dealt with in more detail in Chapter 3 on *Climate Change*).

### GOVERNMENT DECISION ON ENERGY EFFICIENCY MEASURES (2010)

In April 2008, the MEE convened a cross-sectoral Energy Efficiency Committee tasked with proposing new measures in relation to energy saving and energy efficiency. The committee delivered a report in June 2009 which, after scrutinising a broad range of issues, primarily focusing on sectors not covered by the Emissions Trading Scheme, proposed 125 new or significantly expanded energy saving and energy efficiency measures needed between 2009 and 2020 in order to reach the objectives set by the 2008 Climate and Energy Strategy. The report forecast the potential impact of these measures and proposed an organisational structure to facilitate their implementation. The proposals made by the Energy Efficiency Committee, were considered by the ministry, which then issued a formal Government Decision on Energy Efficiency in February 2010.

The decision sets out a cluster of essential measures intended to stimulate the fundamental change needed to realise Finland's energy efficiency goals and provide the basis for more detailed activities – these measures relate to changing the community structure, education, research and development, advice and communication. It then sets out detailed measures in each sector. Measures projected to yield the greatest annual energy savings in 2020 include:

- introducing new private-vehicle technology and speeding up the renewal of the existing car stock;
- standards for new building projects and renovations;
- challenging energy efficiency agreements outside the emissions trading sectors;
- energy efficiency requirements for equipment.

The energy-conserving effect of these four groups of measures is projected to amount to 1.6 Mtoe (18.3 TWh) in 2020, equivalent to half of the saving target. The other half is to be achieved through savings in sectors covered by the EU-ETS and a range of additional measures. These measures will likely be translated into concrete policies in Finland's Energy Efficiency Act, which was announced in the 2013 update of the Climate and Energy Strategy and is currently in preparation.

## NATIONAL ENERGY EFFICIENCY ACTION PLAN 2011 (NEEAP-2)

According to Article 14(2) of the EU ESD, member states are required to adopt and achieve an indicative energy savings target of 9% by 2016. The ESD will be repealed in July 2014 by the new EED, which sets out goals for 2020. For Finland, the new directive translates to an indicative target (excluding industrial sectors covered by the ETS, the aviation and maritime sectors) of 1.5 Mtoe (17.8 TWh) savings by 2016 (based on the mean energy end-use for 2001-05), and an interim target for 2010 of 0.5 Mtoe (5.9 TWh). The directive required member states to submit NEEAPs for achieving this target, and the superseding EED (2012) maintains this requirement.

Finland's first NEEAP (NEEAP-1) was published in 2007 setting out 90 actions that Finland planned to roll out across the public, business, residential and transport sectors, with a view to meeting the energy efficiency target of achieving 9% energy savings across the economy by 2020. By 2010, energy savings of 1.0 Mtoe (12.1 TWh) had been achieved, approximately double the interim target set by the ESD.

Finland's current NEEAP-2 was submitted to the European Commission in June 2011 updating the 2007 Plan. The second action plan proposed 36 energy efficiency activities supplemented by approximately 50 other activities to promote energy efficiency. The plan calculates the energy conservation effects of the 36 measures at 2.1 Mtoe (24.7 TWh) by 2016, which will correspond to an energy saving of approximately 12.5%, using the calculation method of the ESD. Should all measures detailed in the action plan reach their full potential by 2020, then energy savings will need to improve by 17% over the next decade, amounting to 2.9 Mtoe (33.7 TWh) per year in 2020.

Finland is currently drafting its next NEEAP under the EED, to be sent to the Commission in April 2014.

## VOLUNTARY AGREEMENTS

A framework of Voluntary Energy Efficiency Agreements provides the backbone to Finnish energy efficiency policy, and an effective alternative to regulatory steering for engaging

actors in a range of sectors in taking energy efficiency actions. First experiments with voluntary agreements began in Finland as early as 1992. A broad Voluntary Energy Conservation Agreement scheme, with industrial, commercial and public organisations, was launched in 1997. The scheme was supplemented in 1999 by agreements in relation to buildings and in the transport sector. Their use has since expanded to the point that the voluntary agreement framework now comprehensively covers the industrial (industry, energy sector, services sector), municipal, property and building, oil (oil-heated properties and transport of heating and transport fuels), goods and public transport, and agricultural sectors.

Agreement parties are ministries, industry associations, companies and communities. Subscribers to the agreements undertake to carry out energy audits or analyses in their own properties and production plants, to draw up an energy efficiency plan, and to implement cost-effective conservation measures, as well as reporting annually to the sector organisation concerned. The MEE, in turn, undertakes to subsidise energy audits and analyses, as well as energy efficiency investments fulfilling certain criteria through its Energy Aid Scheme and Energy Audit Programme. In 2008-11 subsidies for energy auditing were about EUR 8 million and for energy efficiency investments about EUR 43 million in total.

When, at the end of 2005, most of the Finnish government's voluntary energy conservation agreements were due to expire, an evaluation of the agreement scheme returned such positive results that parties to each of the agreements elected to extend them. From 1997 to 2006, the agreement scheme covered approximately 60% of Finland's total energy consumption (407 TWh in 2010) and from 2008 to 2010 this extended to 80%. Energy efficiency measures implemented in 2008-10 in the industrial, municipal, and property and building sectors reduced Finland's annual energy consumption by a total of 3.8 TWh. The savings equal almost 1% of Finland's total energy consumption. They reduce annual carbon dioxide emissions by approximately 1.3 Mt and energy costs by a total of approximately EUR 130 million.

A third generation of Voluntary Energy Efficiency Agreements was launched in 2008 for the period until 2016, pursuing the goal of continuous improvement in energy efficiency.

## CONSUMER ADVICE ON ENERGY

Among the measures prescribed by the Government Decision on Energy Efficiency are measures for consumer awareness-raising and advice, which seek to capture the significant additional energy savings potential that can be realised through changes in energy-user behaviour. A draft "architecture" for the nationwide consumer advice system on energy was produced in 2009 with the intention of ensuring that Finnish consumers receive reliable energy advice by phone, web or face-to-face, co-ordinated by one advice centre. In 2010, 14 pilot projects, primarily providing travel guidance, commenced throughout Finland with the financial support of the MEE and Sitra, the Finnish Innovation Fund. Finland's energy efficiency implementation agency, Motiva Oy, co-ordinates the activities and supports the projects by organising networking events, producing common tools and communication facilities, and contributing expertise as well as carrying out process monitoring and impact assessment.

## PUBLIC SECTOR

The Finnish public sector is divided into public-sector organisations under municipalities on the one hand and the state on the other. The Government Decision of 2010 on

energy efficiency imposes an obligation on state organisations to prepare energy efficiency plans by the end of 2012 and to set their own energy savings targets. The two most significant energy-saving measures by local government are the Voluntary Energy Efficiency Agreement scheme for local government and energy audits of local government service buildings. These measures generated an energy saving of 289 GWh in 2010, corresponding to approximately 2.5% of all energy used in local government.

Furthermore, it is estimated that the energy saving in the public sector will increase to approximately 5% by 2016. In keeping with the requirement in the ESD for the public sector to play an exemplary role in energy efficiency, and requirements of the new EED, Finland is updating its Guidelines for Energy Efficiency in the Public Procurement, creating an obligation for state organisations to actively promote “cleantech” and green procurement. The same will be encouraged at local government level, and emergence of pioneering municipalities in energy efficiency will be promoted with the help of energy efficiency agreements and energy programmes for the local government sector. An energy conservation plan for central government buildings will also be prepared and its monitoring and implementation will be incorporated into corporate-level financial planning and management.

## TRANSPORT

The relatively large size of Finland’s territory, located far from the main transport and logistic arteries of central Europe, poses major challenges to transport policy. Industrial – and to a lesser extent residential – development is dispersed widely throughout the country, and the key economic role of forest and metal industries, which transport large quantities of heavy products, means that transport policy in Finland is treated as part of a larger whole, comprising businesses, the economy, employment and regional development. This approach was recently stated in the government report on transport policy submitted to the Finnish Parliament in 2012 entitled, *Competitiveness and Well-Being Through Responsible Transport*, which canvasses various approaches to improving driver and traffic efficiency and promoting the use of public transport.

### Box 2. IEA 25 energy efficiency policy recommendations 2011

To support governments with their implementation of energy efficiency, the IEA recommended the adoption of specific energy efficiency policy measures to the G8 summits in 2006, 2007 and 2008. Recently updated in 2011, the consolidated set of recommendations covers 25 fields of action across seven priority areas: cross-sectoral activity, buildings, appliances, lighting, transport, industry and power utilities. The fields of action are outlined below.

1. The IEA recommends action on *energy efficiency* across sectors. In particular, the IEA calls for action on:

- data collection and indicators;
- strategies and action plans;
- competitive energy markets, with appropriate regulation;
- private investment in energy efficiency;
- monitoring, enforcement and evaluation.

**Box 2. IEA 25 energy efficiency policy recommendations 2011 (*continued*)**

2. *Buildings* account for about 40% of energy used in most countries, including Finland. To save a significant portion of this energy, the IEA recommends action on:

- mandatory buildings codes and minimum energy performance requirements;
- net-zero-energy consumption in buildings;
- improved energy efficiency in existing buildings;
- building energy labels or certificates;
- energy performance of building components and systems.

3. *Appliances and equipment* represent one of the fastest growing energy loads in most countries. The IEA recommends action on:

- mandatory minimum energy performance standards and labels;
- test standards and measurement protocols;
- market transformation policies.

4. Saving energy by adopting efficient *lighting technology* is very cost-effective. The IEA recommends action on:

- phase-out of inefficient lighting products;
- energy-efficient lighting systems.

5. To achieve significant savings in the *transport sector*, the IEA recommends action on:

- mandatory vehicle fuel-efficiency standards;
- measures to improve vehicle fuel efficiency;
- fuel-efficient non-engine components;
- transport system efficiency.

6. In order to improve energy efficiency in *industry*, action is needed on:

- energy management;
- high-efficiency industrial equipment and systems;
- energy efficiency services for small and medium-sized enterprises;
- complementary policies to support industrial energy efficiency.

7. *Energy utilities* can play an important role in promoting energy efficiency. Action is needed to promote:

- utility end-use energy efficiency schemes.

Total energy consumption in Finland's transport sector amounted to 60.6 TWh in 2010. In the revised NEEAP-2, Finland has set targets to achieve energy savings of 3.3 TWh in 2016, increasing to nearly 10% (5.9 TWh in 2020). Meeting these targets will require full exploitation of advances in vehicle and fuel technologies, including increased use of biofuels, and a reduction of transport needs by means of transport system and land-use planning and promotion of sustainable transport modes. The two voluntary agreements



in this sector – Sustainable Community Technology Programme (2007-12) and Strategy for Intelligent Transport (2009) – have attracted limited participation to date and efforts will be required to review and scale up their impact. Instead, Finland's key activities in this sector are largely driven by the development of EU legislation; of taxation; and of guidance through information. Finland has made good progress with the implementation of the European Commission Fuel Quality Directive (2009/30/EC) which requires the carbon intensity of fuel in member states to drop by 10% by 2020 and sets sustainability criteria for biofuels. Implementation of other EU directives is also well advanced, in particular in relation to standards and labelling of vehicles and components, and in setting the average emissions target for new passenger vehicles at 130 g CO<sub>2</sub>/km, by 2015.

A triple CO<sub>2</sub>-based transport tax regime, subjected to regular reform, plays an important role in enhancing energy efficiency in Finland. Transport taxes comprise the registration tax to be paid when a vehicle is first registered, the circulation tax to be paid annually, and fuel tax on transport fuels. The registration taxes were restructured in 2008 to take account of the energy and carbon emissions of a vehicle and a similar structure was applied to the annual circulation tax in 2010. This approach was broadened in 2011 by the implementation of a *Fuel Tax Reform* which also links fuel to the energy and carbon content of transport fuels. These amendments extend larger tax breaks to low-emitting vehicles (5% of the retail value of the car for zero-emission cars) and impose a higher tax on high emissions (50% of the retail value of the car for emissions of 360 grams per kilometre or more).

A total of EUR 1 936 million of funding was granted to the transport sector in the government's budget for 2012. In drafting the 2013 update of the national Climate and Energy Strategy, a working group of the Ministry of Transport and Communications assessed the future role of different energy sources in transportation in Finland. As a result, the strategy proposes to consider the use of energy subsidies to improve the energy efficiency of public transport and goods transport, as well as incentives for the acquisition of vehicles that are more energy-efficient. An assessment of these options will be carried out as part of the implementation of a programme to reduce mineral oil consumption.

Table 1. Examples of some taxes on fuels

Fuel	EUR/litre
2012 gasoline	0.6504
Bioethanol (normal)	0.4292
Bioethanol (double-counted)	0.3373
Diesel	0.4695
Biodiesel (paraffinic and double-counted)	0.2435
Biogas (not taxed)	0
Natural gas (taxed by energy content, but no additional tax for use in transport)	n/a

Source: Ministry of Transport and Communications, 5 March 2012, Information on energy efficiency actions and taxation on transport sector.

In doing so, special consideration should be given to the heavy-duty vehicle sector – of particular relevance as Finland's biomass industry grows. Finland currently complies with

the EU directives and regulations setting emissions standards for heavy-duty vehicles,<sup>12</sup> but should take a proactive approach to any new guidance which should emerge from the new EU strategy on passenger and freight vehicles which is currently under preparation.

## BUILDINGS

Finland's building stock is relatively energy-efficient as the cold climate has naturally encouraged the adoption of energy-efficient technologies such as double-glazing (most windows are even triple-glazed today), minimum efficiency performance standards (MEPS) for building components, and extensive use of fuel-efficient combined heat and power generation (CHP) plants for district heating. Improvements in the energy efficiency of buildings in Finland have been guided by national legislation since 1976. Currently under the responsibility of the Ministry of the Environment, the National Building Code (SRMK) sets requirements for the energy consumption of Finland's building stock in accordance with the European Union Directive on the Energy Performance of Buildings (EPBD, 2010/31/EU). The energy performance requirements contained in the building code have been increased by increments of 30% several times, in 2003, 2008 and 2010.

The most recent amendments, set out in the 2010 Programme for Energy-Smart Built Environment, came into effect in June 2012 transposing the new requirements of the EPBD and pushing Finland's already stringent energy performance requirements up by a further 30%. Under the new regulations, an upper limit is set for buildings' total energy consumption (heating, cooling and electrical energy), depending on the type of building. Expressed as an "E ratio", the source of the energy used by the building is also now taken into account. This tacit promotion of renewable energy sources is supplemented by subsidies for retrofits, for installation of renewable energy sources, as well as efficient heating devices and other energy efficiency improvements.

In 2011 and 2012, a government subsidy scheme, with EUR 60 million of funding, covered up to 20% of the costs when a residential building changes to renewable sources of heating through a ground source, or air-to-water heat pump, or heating using pellet- or other wood-based fuels. A smaller amount (EUR 14 million in 2011) has been reserved for other forms of energy assistance in residential buildings, EUR 2 million of which is allocated for needs-assessed energy assistance for single-household dwellings.

Minimum energy requirements have applied to all new buildings since 2008, and *energy performance certificates* have been required for existing buildings, at the time of notification for sale or rental, since 2009. Energy certificates provide a calculation of energy performance based on the yearly net final energy consumption of the building per square metre of floor area (kWh/m<sup>2</sup>/year) and usually include recommended improvements that need to be carried out before a certificate is renewed. Uptake of energy efficiency measures recommended in energy certificates has been good, with 60% implementation recorded in 2010. In accordance with the EPBD, the latest amendments to Finland's buildings regulations require that a certificate also be obtained on the occasion of major renovations or when building use changes. Finland is currently considering extending requirements on renovated buildings further.

The EPBD sets a new target for member states that all new buildings shall be "nearly zero-energy consumption buildings" by 31 December 2020. Finland is developing a long-

12. Directive on Heavy Duty Vehicles (trucks and buses) (2005/55/EC).

term strategy to define the dates and interim targets for using the building regulations to phase in the targets for 2018 and 2020 but firm measures are yet to be decided. This effort is supported by an information campaign led by Motiva Oy to promote these goals, beginning in 2012.

## APPLIANCES, EQUIPMENT AND LIGHTING

EU regulations under the Ecodesign Directive (2009/125/EC), most recently renewed in 2011, have to a large extent harmonised national measures relating to minimum energy performance requirements for appliances and equipment. The recently revised Labelling Directive (2010/30/EU) imposes a mandatory requirement for the clear display of information on the energy consumption of all energy-related products placed on the EU market. Finland has transposed these requirements by way of its Act Imposing Requirements on Ecological Design and Energy Labelling (1005/2008) which entered into force on 1 January 2009 and was amended in 2010.

These regulations require manufacturers to declare the energy efficiency of products by using an A to G scale. The new labelling system allows up to three classes (A+ to A+++) to be added on top of class A to accommodate higher efficiency products. Labelling enables consumers to consider energy performance in their spending decision and thereby encourages manufacturers to pursue innovations beyond minimum energy efficiency requirements.

In 2009, an impact on savings was calculated for 13 different product groups in Finland, as part of the impact assessment for proposed measures to improve energy efficiency. The most significant impact was projected for lighting, where, as filament bulbs have been eliminated from the market since September 2012, a reduction in electricity demand of 1 135 GWh is expected in 2020. In several of these product groups, even the current class A of these products will be eliminated from the Finnish market by the end of 2013 and, considering the usable lifetime of the range of equipment, one-third of the savings projected for 2020 should be achieved by 2016.

Finland's 2013 Climate and Energy Strategy specifically addresses the energy consumption of information and communications networks and information technology infrastructures, areas where energy consumption is rising fast, stating that definite energy efficiency targets will be set.

Tukes (the Finnish Safety and Chemicals Agency) is the authority in charge of the market surveillance under both Ecodesign Directive and Energy Labelling Directive.

Motiva Oy manages a consumer information campaign to promote the goals of the Ecodesign and energy labelling measures through publication of guidebooks and maintenance of online information and training courses.

## INDUSTRY

The energy intensity of Finland's industrial sector has traditionally been significantly higher than that of its neighbours. Largely as a result of a change in industry structure towards less energy-intensive activities, the energy intensity of Finland's industrial sector has been decreasing steadily for some time. Energy intensity in Finland, 0.2 toe of total energy supply over USD 1 000 PPP, fell by 28.7% over the 1994-2011 period. In 2010, energy consumption in industry had rebounded to 12.3 Mtoe – a resurgence of 13.5% on 2009 figures.

Voluntary Energy Efficiency Agreements play a key role in realising energy efficiency improvements in industry by encouraging energy auditing, energy analysis and development of energy management systems, further supported by an effective Energy Aid Scheme which provides subsidies for such activities. The industrial sector accounts for some 95% of all energy savings generated by these agreements across Finland's economy. The latest round of 2008-16 agreements comprehensively covers the industrial, energy and service sectors; 247 small and medium-sized industrial businesses, 94 energy services companies and 40 energy-intensive industry players have joined specific programmes. This represents practically all energy use in energy-intensive industry and around 90% of all energy services activity in terms of electricity distribution and sales, and district heating sales. The impact in terms of actual energy savings, monitored separately for industrial players falling under the Emissions Trading Act, was approximately 8% in 2010. Finland's government plans to increase the ambition and scope of energy efficiency agreements over time, with a linkage to research and innovation activities.

Beyond this, Finland relies heavily on the functioning of the ETS to deliver energy savings in the industrial sector. As part of Finland's target to reduce energy consumption by 37 TWh by 2020, the industrial sector is expected to deliver 8 TWh through the functioning of the EU Emission Trading Scheme.

Finland, like its neighbours Denmark and Sweden, has made extensive use of district heating, 75% of which is produced by extremely fuel-efficient combined heat and power generation (CHP) plants. Such a large share of the electricity market taken up by CHP generation helps to bolster Finland's overall energy efficiency.

Subsidised energy audits also play a major role in identifying energy efficiency improvement opportunities in medium-sized and energy-intensive industry in Finland. This procedure is linked to the voluntary agreement scheme and the majority of industrial premises have already been audited at least once. These audits yielded nearly 1 500 GWh/year energy savings in both ETS and non-ETS sectors in 2010. Finland plans to further develop energy auditing procedures over the coming years, with further savings of a similar magnitude expected to be identified and realised out to 2020, and is also investigating the possibility of establishing an energy efficiency obligation scheme for energy companies.

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## ASSESSMENT

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Despite its relatively high energy intensity, Finland has made commendable efforts in improving its energy efficiency, evaluating the effectiveness of existing measures and periodically increasing the ambition of energy efficiency targets. Finland has updated most of its key legislation, implementing a range of proposals made by the specially mandated Energy Efficiency Committee through a Government Decision on Energy Efficiency in 2010, and issuing its second NEEAP in 2011.

Finland's 2008 long-term Climate and Energy Strategy set an overarching goal to reverse growth in final energy consumption, and an ambitious target to save approximately 11% of total final consumption by 2020 compared to the business-as-usual scenario. The 2013 update of the Climate and Energy Strategy will ensure the implementation of the European Union's new EED and states that an Energy Efficiency Act and an energy efficiency implementation plan will be prepared without delay. In doing so, Finland should define specific measures which are capable of realising increasingly ambitious

targets in order to further reduce the country's dependence on imported energy resources and secure a low-carbon path.

Voluntary Agreements made between government ministries and industry associations, companies and communities are used extensively in Finland and continue to form the backbone of energy efficiency improvements. The regular evaluation and review of these agreements is exemplary and the latest round of agreements, signed in December 2007 for 2008-16, draws on lessons learned in the previous evaluation. Targets should continue to be reviewed and extended, particularly in light of new requirements in the EU EED.

Led by Motiva Oy, the communication of the energy efficiency ambition to energy users is extensive and effective. Since 2010, the energy advice system for consumers and the organisation of pilot projects on energy advice have been effective tools supporting improved energy efficiency, as well as providing a vital channel for gathering monitoring and evaluation data after the implementation of energy efficiency measures.

Like in other OECD countries, implementing efficiency measures in the transport sector is often more problematic. Nevertheless, Finland is making good progress with implementing EU regulations. For example, the Ministry of Transport has plans to promote a 20% increase in usage of environment-friendly modes of transport and to study the possibility of a road pricing system in and around Helsinki. The recent amendment to the transport tax structure to reflect carbon emissions is also very positive. This should reinforce the Technology Development Programme for Electric Vehicles 2011-15 in the scaling up of electric mobility in Finland, which is currently limited. The success of these measures and new measures anticipated by the 2013 update of the Climate and Energy Strategy will be crucial in order to reach the 2020 targets and should be closely monitored.

Trucks and heavy-duty vehicles represent an important and growing part of the transport stock, and Finland should turn its attention to reducing energy consumption in this area, through improving logistics management and supporting improvements in fuel efficiency of heavy-duty vehicles. Efforts to engage enterprises in the Voluntary Agreement on Goods Transport and Logistics should be scaled up in order to engage an appropriate proportion of the haulage enterprises in Finland. A coherent approach to absorbing the impact of the growing use of biomass in energy production, which will necessitate an increase in haulage from dispersed forest stocks in Finland, should also be explored, with particular reference to the EU strategy currently under discussion in this area.

Finland's building stock is relatively energy-efficient because of the cold climate which has naturally promoted efficient technologies and increasingly stringent energy performance requirements. Nevertheless, many opportunities remain and the greatest energy savings delivered by Finland's NEEAP-2 will be in the buildings sector. The 2010 Programme for Energy-Smart Built Environment, which tightened the energy efficiency requirements of new building codes based on calculations of total energy performance standards. Likewise, the government is planning to extend requirements for buildings undergoing renovation and is drafting a long-term strategy on improving the energy efficiency of buildings. Proposals to promote Nearly Zero-Energy Buildings and Positive Energy Homes through financial incentives should also be implemented in support of the roadmap targets, and in line with indications in the latest EED.

Finland's extensive use of district heating and fuel-efficient CHP generation plants bodes well for its energy intensity. The new fuel taxation structure and continuing energy audits should encourage efficiency improvements on the production side, but because usage of district heat is metered at the building level, customers have limited incentive to manage

the impact of their own usage. Although separate metering may not be appropriate in all multi-unit buildings, opportunities for installing meters at the individual customer level to measure heating usage by both district and central heating systems, for example during deep retrofits and in new buildings, should be explored. Broader separate metering can encourage customers to manage their heating usage behaviour and limit unnecessary heat demand and its potentially distortive effect on the electricity market.

In industry generally, by far Finland's largest end-use sector, the functioning of the EU-ETS is supplemented through a system of Voluntary Energy Efficiency Agreements between the MEE and industry. These agreements, an extremely effective driver of energy efficiency improvements in this sector, were renewed in 2008 for a third period to 2016. Nevertheless, some opportunities remain for energy efficiency improvements outside these agreements. For example, the government could examine the barriers to the optimisation of energy efficiency in electric motor-driven systems and design, and implement comprehensive policy portfolios aimed at overcoming such barriers. For small and medium-sized enterprises, Finland could implement a package of policies, including the provision of energy performance benchmarking and increase incentives to adopt least life-cycle cost capital acquisition and procurement procedures.

Finland should continue to gradually increase its ambitions in the field of energy efficiency and take planned measures through to the implementation phase in a timely manner. The government should also continue its take-up of the IEA *25 Energy Efficiency Policy Recommendations*, as updated in 2011 (see Box 2). Significant opportunities remain in the buildings sector and industrial sector in particular.

Implementation of IEA energy efficiency recommendations can lead to huge cost-effective energy and CO<sub>2</sub> savings. The IEA estimates that, if implemented globally without delay, the proposed actions could save around 7.6 Gt CO<sub>2</sub> per year by 2030. In 2010, this corresponded to 17% of annual worldwide energy consumption. Taken together, these measures set out an ambitious roadmap for improving energy efficiency on a global scale.

## RECOMMENDATIONS

*The government of Finland should:*

- ☐ *Regularly monitor and evaluate the effect and economic costs and benefits of energy efficiency measures to ensure that requirements are realistic and achievable and allow for regular adjustment of requirements where necessary.*
- ☐ *Maintain a strong focus on developing efficiencies in the transport sector, including efforts to reduce the energy consumption of trucks and heavy-duty vehicles.*
- ☐ *Focus on areas where significant energy savings opportunities still remain, such as in electric motor-driven systems in industry.*
- ☐ *Further improve the well-functioning district heating system, by exploring opportunities where customer-level metering of heat usage would be appropriate.*
- ☐ *Explore concrete measures to promote Zero-Energy Buildings and Passive Energy Homes in line with targets set in Finland's roadmap to 2050.*

## **PART II**

### **SECTOR ANALYSIS**





## 5. OIL

### Key data (2011)

**Crude oil production:** None

**Crude oil imports:** 11 Mt (from Russia 88.9%, Norway 10.6%, Belarus 0.3%, Kazakhstan 0.2%)

**Share of oil:** 26.4% of TPES and 0.6% of electricity generation

**Total final consumption (TFC):** 9.2 Mtoe (transport 44.5%, industry 24.9%, commercial 10.7%, other services 11.8%, residential 4.5%, power generation 3.6%)

### SUPPLY, DEMAND AND IMPORTS

Oil remains the primary energy source in Finland, representing over 26% of the country's TPES. Finland does not have domestic production of crude oil, and geological studies indicate that the country has no exploitable oil resources.

#### OIL IMPORTS

Finland is entirely dependent on imports for its oil supply. Most oil imports are in the form of crude oil, which is then processed by two refineries. Finland's oil imports in 2011 stood at 343 thousand barrels per day (kb/d), consisting of about 217 thousand barrels per day (10.7 million tonnes) of crude oil, 16 kb/d natural gas liquids (NGLs) and feedstock, and some 110 kb/d refined products, primarily middle distillates.

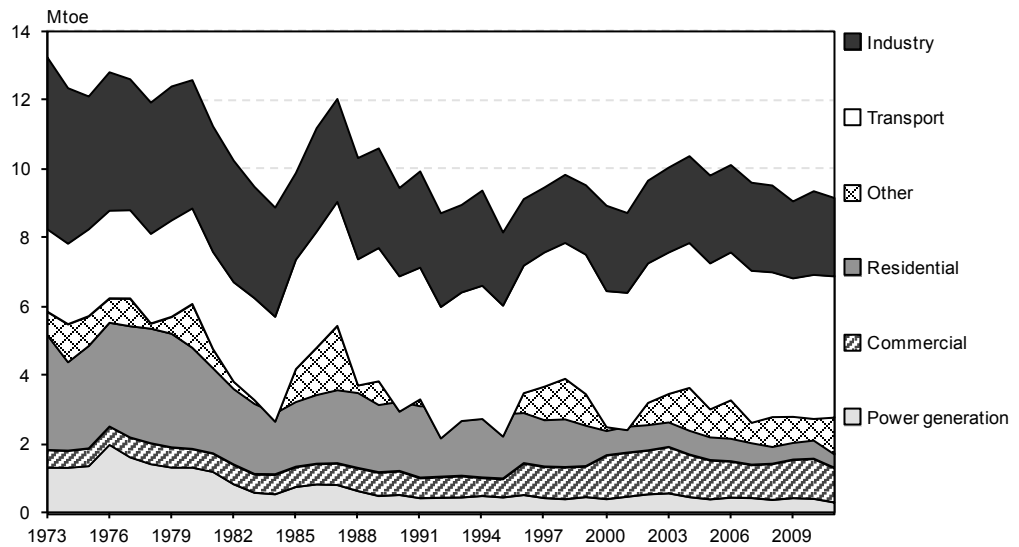
Concerning crude import sources, Finland is highly dependent on Russia, which accounted for 88.9% of the total crude oil imports in 2011. The rest was imported from Norway 10.6%, with Belarus and Kazakhstan providing only 0.5% of total imports. The import dependence on Russian crude oil significantly increased from 43.3% of total crude oil imports in 2000 to 88.9% in 2011, with a compound growth rate of 6.6%. The high dependence on Russian crude oil derives from economic reasons, including the short distance between the Russian oil port Primorsk and the relevant terminals in Finland, and the relatively cheaper cost of Russian oil in comparison to lighter North Sea crude oil.

In 2011, refined product imports came mainly from Russia (50.6%), Sweden (9.1%), India (7.7%), Kazakhstan (7.3%) and the Netherlands (4.1%). However, with two refineries and a total crude distillation capacity of around 261 kb/d, Finland is a net exporter of refined products, exporting around 154 kb/d of refined products in 2011, 30% of which was shipped to Sweden.

#### OIL CONSUMPTION

Finland's oil demand increased slightly from 202 kb/d in 2000 to 223 kb/d in 2007, before dropping again somewhat to 209 kb/d in 2011.

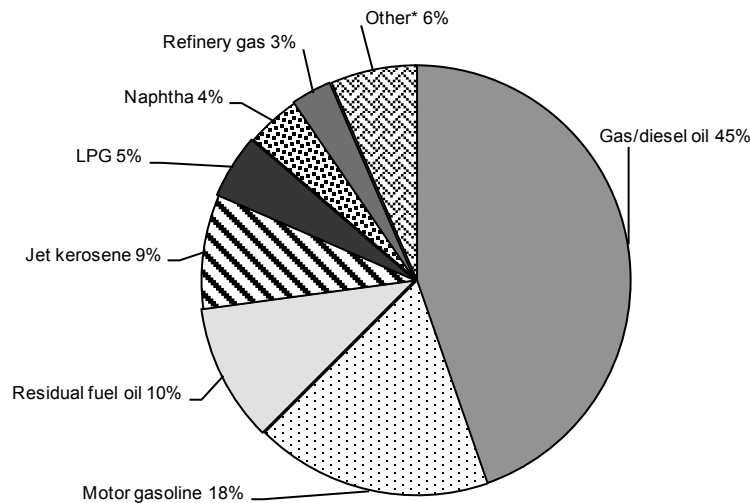
Figure 13. Oil supply by sector\*, 1973-2011



\* TPES by consuming sector. *Industry* includes non-energy use. *Other* includes other transformation and energy sector consumption. *Commercial* includes commercial, public services, agriculture/forestry, fishing and other final consumption.

Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012; and country submission.

Figure 14. Oil consumption by-product, 2011



\* *Other* includes bitumen, biogasoline, lubricants, white spirit, biodiesel, petroleum coke, paraffin waxes and aviation gasoline.

Source: *Oil information*, IEA/OECD Paris, 2012.

In 2011, 44.5% of Finnish total oil demand was consumed in the transport sector, while the industry sector and the transformation/energy sector accounted for 24.9% and 3.6% respectively. In terms of oil demand by-product, demand for diesel increased substantially, by 26%, between 2002 and 2011, whereas demand for gasoline decreased by 12% over the same period. Demand for heating oil/other gasoil and residential fuels dropped by 26% and 39% respectively, and demand for naphtha, kerosene and liquefied petroleum gas (LPG) increased by more than 40% during the same period.

According to government forecasts, total oil demand is expected to decrease to 6.8 Mt (139 kb/d) by 2020 and to 6.2 Mt (126 kb/d) by 2030.

## BIOFUELS BLENDING

As in other European countries, Finland is progressively introducing biofuels into motor fuels and heating gasoil. Its liquid biofuel-producing capacity is limited, and most raw materials are thus imported.

The main instrument to increase the use of biofuels is the Law on the Promotion of Biofuel Use in Transport (446/2007), which puts an obligation to companies delivering transport fuels to the Finnish market to meet the required biofuels share in their total deliveries. This legislation came into force in January 2008 and was revised in 2010 on the basis of the European Union's Directive on Renewable Energy Sources.<sup>13</sup> The revised law came into force in January 2011, outlining new annual biofuel obligation levels until 2020 (outlined in Table 2).

Table 2. The new biofuel obligation levels until 2020

Year	Biofuel obligation (energy basis)
2011	6%
2012	6%
2013	6%
2014	6%
2015	8%
2016	10%
2017	12%
2018	15%
2019	18%
2020	>20%

Source: Ministry of Employment and the Economy.

With an actual blending target of 6% of energy content since 2011, Finland's legislation is ahead of that of most European peers. The decision to set a higher national obligation than the RES Directive requires (10% in 2020) was based on the assessment that Finland has good prospects to start commercial-scale second-generation biofuel production around mid-decade. The obligation is based on the total amount of biofuels delivered. Thus, companies can freely choose the distribution of biocomponents between gasoline and diesel volumes, if the total volume of biocomponents for a company's sales remains within the blending limits.

As of January 2011, Finland has switched its entire distribution of 95-octane gasoline to E10 (gasoline with a 10% ethanol blend). Some 25% of the passenger car fleet is reportedly incompatible with the fuel, which poses some short-term concerns with regard to supplying the country's vehicle fleet.

13. Directive on the Promotion of the Use of Energy from Renewable Energy Sources (RES), 2009/28/EC. See Chapter 9 for details.

## INFRASTRUCTURE

Finland is overwhelmingly dependent on oil supplies from the Baltic Sea, with all of its refining and storage infrastructure located on the southernmost coast, close to its key demand centres. Finland is dependent on shipping for access to its oil supplies. Distribution inland from ports is dependent on road transport, given that there is no inland pipeline distribution.

## REFINING

There are two refineries in Finland, with a total crude distillation capacity of around 261 kb/d – 205 kb/d for the Porvoo refinery and 56 kb/d for the Naantali refinery. The refineries can also process feedstocks directly in secondary units, with a total vacuum distillation capacity of around 100 kb/d.

Although the refineries started operation in the mid-1960s (for Porvoo) and in the late 1950s (for Naantali), they are equipped with complex units as a result of investments made in 1990s and 2000s, allowing them to process heavier (and notably Russian) crudes. Russian export blend accounted in 2011 for 61% of refinery feedstock inputs at Porvoo, and for 91% at Naantali.

In 2011, total crude throughput averaged 231 kb/d, resulting in an overall capacity utilisation rate of over 85%. In the same year, the refined product output from the two domestic refineries totalled 302.5 kb/d. Primarily thanks to Porvoo's sizeable hydrocracking capacity, middle distillates account for over half of the refineries' product yields, with gasoline accounting for another third.

With the exception of naphtha, residual fuels and other products, domestic refinery production is sufficient for meeting demand in the country. In 2011, domestic production of naphtha was able to meet 55% of domestic demand, while residual fuels amounted to some 84%, requiring imports to meet the remaining share. Nearly half of the refined oil products output (44%), including primarily gasoline and diesel oil, was exported in 2011.

## PORTS

Finland has neither cross-border oil pipelines nor domestic oil pipelines. The imports of crude oil and petroleum products are mainly undertaken by tanker fleets, rail and trucks.

In 2011, Neste Oil's two refineries received 91% of their feedstocks by sea, and a further 7% by rail. Some 70% of Neste's refined products were shipped to domestic customers by sea, with road and rail transport accounting respectively for 19% and 11% of product shipments.

Crude oil and refined products are imported through Finland's six main oil import terminals. Among them, only Porvoo and Naantali terminals, owned by Neste Oil, can import crude oil, with a total crude oil import capacity of 19 Mt per year (385 kb/d, of which 304 kb/d in Porvoo and 81 kb/d in Naantali). Russian crude oil is imported from the nearby Russian oil port of Primorsk, which is located 270 km from the Porvoo terminal.

## STORAGE

Finland has a total storage capacity of over 63 million barrels (10 million cubic metres), located mainly in 25 coastal and inland storage facilities. Major seaside terminals are located at the refineries in Porvoo (44 mb, or 7 mcm) as well as in Naantali (6 mb, or

1 mcm), and in Inkoo (3.1 mb, or 0.5 mcm), Kokkola (2.5 mb, or 0.4 mcm), Kemi (1.6 mb, or 0.2 mcm) and Hamina (0.6 mb, or 0.1 mcm). Around two-thirds of all storage facilities are in the form of underground rock cavern storage.

## RETAIL MARKET STRUCTURE

Neste Oil Oy, a majority state-owned company, is a key player in the domestic market and the sole importer of crude oil, being the owner of both of Finland's refineries.

Finland's downstream oil industry is fully privatised, liberalised and deregulated. The market is comparatively small in terms of size.

In the Finnish retail market, the share of Neste Oil Oy was around 33%, followed by Teboil (25%), St1 (12%) and ABC (11%). In addition, North European Oil Trade Oy (NEOT) – owned by SOK (66% stake) and St1 Oy (34% stake) – acts as a wholesale company which deals with procurement and logistics of oil products for some retail companies, including St1 and SOK (which owns ABC).

Five oil retail companies operate 1 947 filling stations in Finland as of December 2011. The largest are St1 (531 stations, including those of Shell which was incorporated with St1 in 2010), Neste Oil (481), ABC (423), Teboil (337) and SEO (186).

The Finnish Petroleum Federation (FPF) acts as an umbrella organisation for the oil industry operating in Finland, representing around 95% of oil products sold on the domestic market.

## EMERGENCY RESPONSE POLICY AND RESERVES

### LEGISLATION

The Act N° 1390/1992 on the Security of Supply (1992) and the Act N° 1070/1994 on the Compulsory Stockholding of Imported Fuels (1994) provide the legal basis for Finland's emergency policy.

The Security of Supply Act forms the basis for Finland's emergency response policy. It provides the government with the statutory powers to release public stocks in case of emergency. Under this Act, Finland's public stockholding agency, the National Emergency Supply Agency (NESA), manages public oil emergency reserves.

The Act on the Compulsory Stockholding of Imported Fuels lays down standards for the industry stockholding obligation of fossil fuels, including crude oil, oil products and natural gas. NESA is responsible for the enforcement of this Act and annually decides shares of storage obligations and the obligation to monitor the stocks and their use.

### EMERGENCY RESPONSE POLICY

Security of supply is promoted by means of diversified energy sources, increased indigenous energy production, including peat- and wood-based fuels, and the oil stockholding system in Finland.

Finland meets its stockholding obligation to the European Union and the IEA by holding government stocks and by placing a minimum stockholding obligation on industry. Under

the relevant acts, NESÄ, founded in 1993, manages the public oil emergency reserves and is responsible for ensuring the implementation of the oil stockpiling obligations. Oil importers are obliged to hold at least two months of stocks calculated as an average of their imports from the previous year.

In terms of emergency response policy for oil supply disruptions, the use of emergency oil stocks is central to Finland's emergency response policy. Finland is most likely to contribute to an IEA collective action by releasing public stocks. In addition, a revision of the Act on the Compulsory Stockholding of Imported Fuels is under way in order to allow the ministry to lower temporarily the compulsory stock obligation of industry in connection with a collective action. Demand restraint measures would also be considered in order to complement the emergency stock release, whereby the specific measures and the degree of implementation would be adjusted according to the severity and anticipated duration of a crisis.

The Government Decision on the Objectives of Security of Supply, issued on 21 August 2008, states that because of Finland's geographical circumstances, the level of energy security required is higher than that required by its international commitments to the European Union and the IEA. As such, Finland has the objective of maintaining stocks of imported fuels at a level of five months' average consumption to secure fuel supplies.

## EMERGENCY OIL RESERVES

According to the emergency reserve target set by the Finnish government, the country should hold a total of five months' stocks of imported fuel consumption of oil, natural gas and coal. Even though there is no official objective for each imported fuel, the government makes efforts to keep a stockholding level of each fuel close to five months of consumption.

While oil importers are required to maintain compulsory oil stocks corresponding to two months' imports equal to the average of the previous year, NESÄ holds public stocks corresponding to the remaining balance of the stockholding target. The stockpiling obligation applies to the imports of crude oil, other condensates for refineries, diesel oil, light fuel oil, gasoline (motor and aviation) and jet fuel. Oil importers that annually import less than 39.5 kb (5 000 tonnes) of kerosene/jet fuels, less than 84.5 kb (10 000 tonnes) of motor gasoline, and less than 147.5 kb (20 000 tons) of crude oil or other products are exempted from the stock obligation. As a result, only four or five oil importers are obliged to hold compulsory stocks.

At end-2011, total oil stocks held in Finland for emergency purposes accounted for about 29 million barrels, of which 10 mb were held by NESÄ as public stocks and 19 mb were held by industry. As of June 2012, Finland held oil stocks equivalent to a total of 142 days of net imports,<sup>14</sup> of which 56 days were public stocks owned by NESÄ.

At end-2011, around 70% of the reported oil stocks were held in the form of oil products. Middle distillates accounted for 67% of the total public stocks, followed by crude oil (22%), motor gasoline (6%) and residual fuels (5%). Public crude oil stocks are located in both refineries, but most of them are stored in the Porvoo refinery. In terms of industry stocks, the middle distillates category was also the main product held, followed by crude oil and motor gasoline. Compulsory stocks are commingled with commercial and operational stocks.

14. According to the IEA calculation method.

A crude oil importer has an obligation to hold stocks in the form of crude. However, it can apply for a permission from NESAs to substitute up to 50% of this crude oil stock obligation with oil products. Likewise, importers of oil products have an obligation to hold stocks of the same products, but can apply for a permission to substitute their obligation for a particular product by other finished products. Substitution of oil products with crude oil is not allowed.

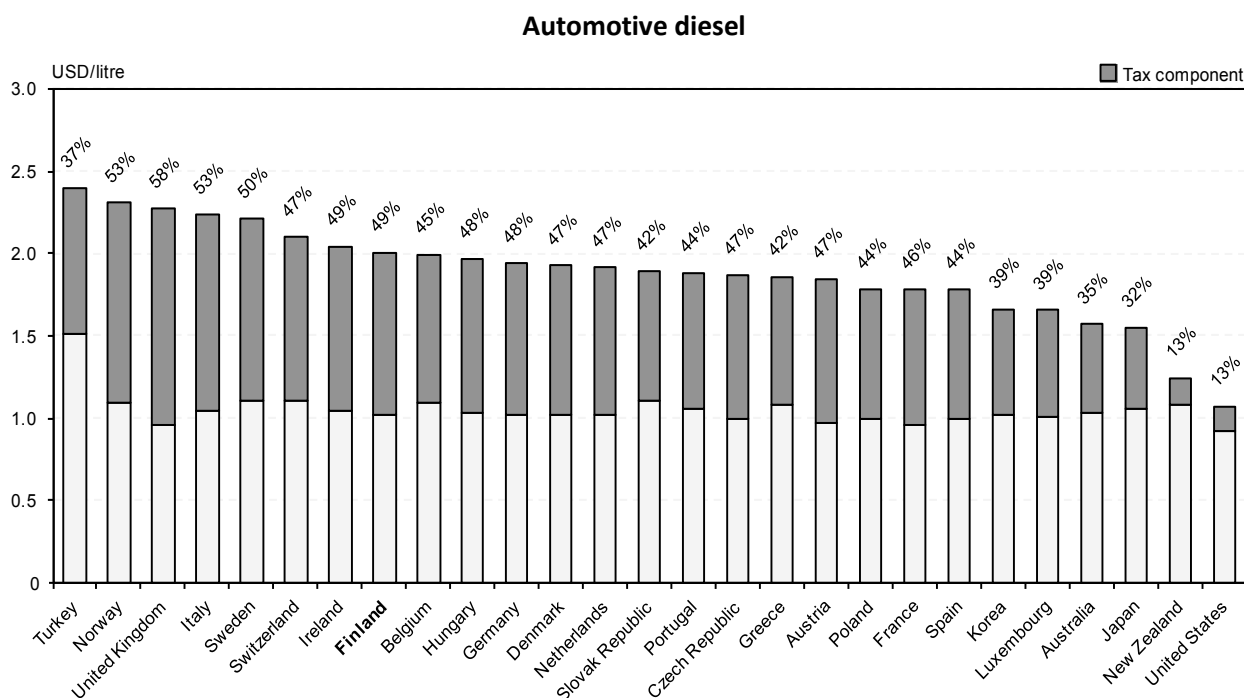
Finland has bilateral agreements with Sweden, Denmark, Estonia and Latvia. At the end of December 2011, Finland held some emergency oil stocks for Sweden (874 kb), Denmark (118 kb) and non-member countries such as Estonia (521 kb). Although Finnish oil importers may hold up to 20% of stocks in the countries which have concluded bilateral agreement with Finland, no compulsory stocks are held abroad as of March 2012. Public stocks maintained by NESAs are not allowed to be held outside the country.

## PRICES AND TAXES

Finland's diesel and gasoline prices are around the IEA average, with taxation or excise duty on the main energy fuels also within the IEA average.

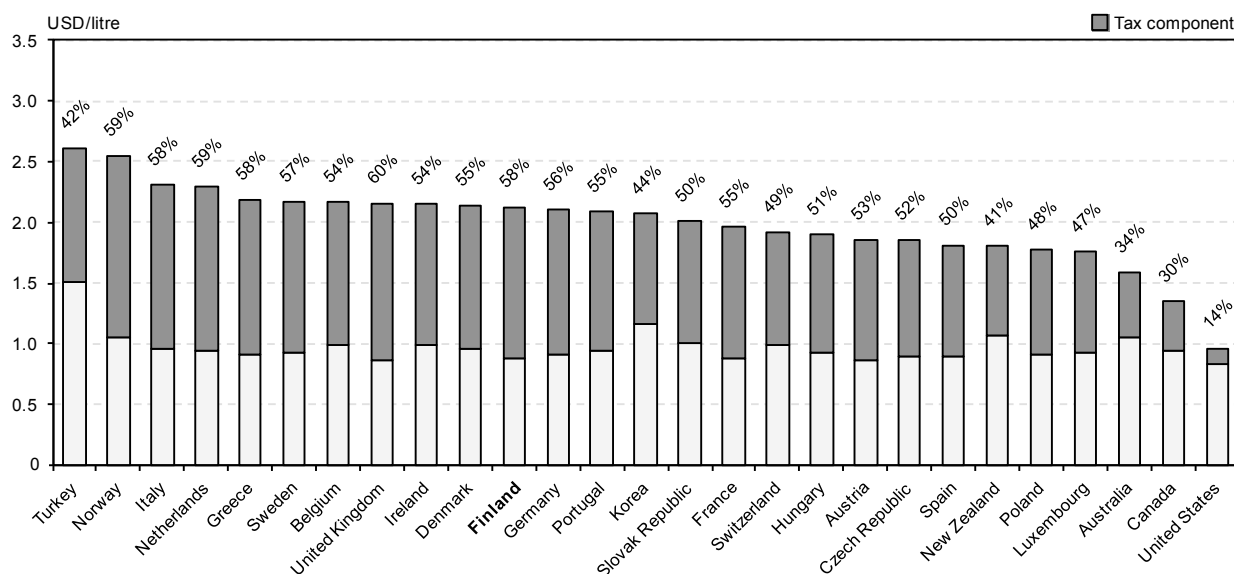
The oil product market is fully liberalised. Wholesale and retail prices are mainly influenced by the relevant quotation prices and exchange rates, which are driven by the global market fundamentals and expectations. Government interference is limited to determining the level of the excise tax and value-added tax. In addition, a stock fee is levied on the consumption of oil products (as well as on natural gas, coal and electricity) in order to finance the public stockpiling system.

Figure 15. IEA fuel prices and taxes, fourth quarter 2012



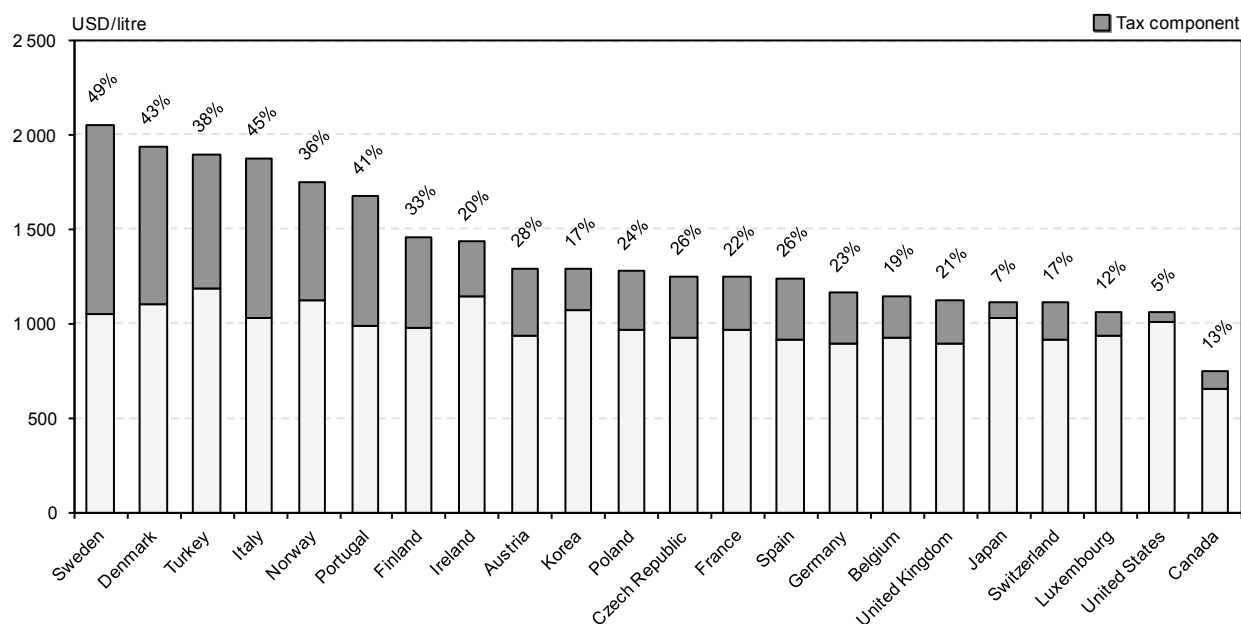
Note: data not available for Canada.

### Premium unleaded gasoline (95 RON)



Note: data not available for Japan.

### Light fuel oil



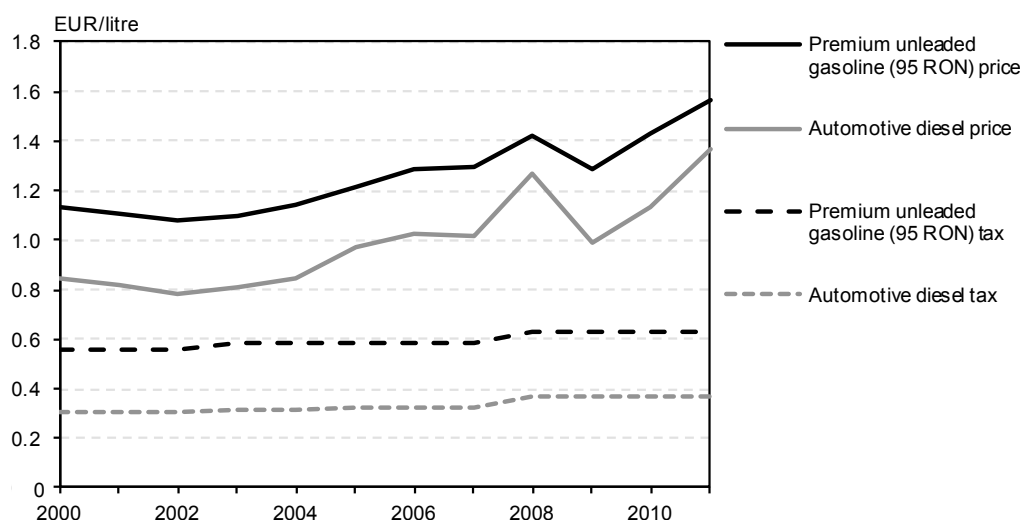
Note: data not available for Australia, Greece, Hungary, the Netherlands, New Zealand and the Slovak Republic.

Source: IEA Energy Prices & Taxes, IEA/OECD, Paris, 2012.

As of the fourth quarter of 2012, while the share of all tax components in the retail price is some 58% for premium unleaded gasoline, the share of all tax components is some 45% for automotive diesel (for non-commercial purposes), and about 33% for light fuel oil. Whereas there are no plans to increase taxation on gasoline, Finland increased the tax on diesel by EUR 0.10 in early 2012 in order to curb the rising growth trend in demand for diesel.



Figure 16. Gasoline and diesel prices and taxes in Finland, 2000-11



Source: IEA Energy Prices & Taxes, IEA/OECD, Paris, 2012.

As of January 2011, the taxation of various fuels has been modified to take into account the energy content of the fuel, with the stated aim of making biofuels cheaper than conventional fuels. Biofuels are now also favoured by means of a differentiated CO<sub>2</sub> tax. Furthermore, biogas for transport and heating are exempt from taxes.

## ASSESSMENT

Oil remains the primary energy source in Finland, representing over a quarter of the country's TPES. Nevertheless, the share of oil in Finland's TPES (26.4% in 2011) is relatively small when compared to many of its OECD peers. In its 2013 Climate and Energy Strategy update, Finland indicated that it intends to reduce the share of oil in its energy mix to below 17% by 2025. The strategy highlights the statutory biofuel blending obligations, more efficient use of energy in vehicle traffic, improving energy efficiency in general and promoting transport based on electricity or other power sources as key measures for meeting this target.

Finland does not produce any domestic crude, and imports all its crude and feedstock needs. The country nonetheless possesses a strong refining sector, with two Neste-owned refineries with a combined topping capacity of 261 kb/d. With a relatively sophisticated refining portfolio, Finland is able to process comparatively heavier and cheaper Russian crudes alongside North Sea crudes at its refineries, with Russian crudes accounting for most of Finland's total crude intake. The crude slate is unlikely to change in the medium term as no major investments are planned at the Finnish refineries. The two refineries produce large volumes of gasoil and gasoline, including high quality motor fuels that meet the European Union's tight fuel specifications, which it exports to neighbouring countries and even to North America in the case of gasoline.

The refineries benefit from coastal logistics, facilitating frequent transfers between the plants and allowing Neste to maintain supply and production during maintenance shut-downs

or other down-time at one of the plants. However, both refineries can be hindered by the freezing of their harbours during the winter. Of note, up to 15% of Finland's annual crude deliveries are done by rail rather than by sea.

Because of its position as the only refiner and main storage operator in the country, Neste holds a high level of control over the wholesale market, particularly in the gasoline segment. However, Lukoil is able to bring significant volumes of high-grade diesel from its Perm refinery in Russia. Finland's retail market is competitive, with five operators each controlling more than 10% of motor fuel sales.

An important development in the downstream market is the introduction of biofuels into motor fuels and heating gasoil. In January 2011, Finland switched its entire distribution of 95-octane gasoline to E10 (gasoline with a 10% ethanol blend). Some 25% of the passenger car fleet is reportedly incompatible with the fuel, and this will bring about a welcome change in the vehicle fleet. In the meantime, affected motorists are advised to switch to 98-octane.

## RECOMMENDATIONS

*The government of Finland should:*

- ☐ *Maintain measures to ensure that oil supply logistics are not disrupted during the winter months, despite the difficult climatic conditions.*
- ☐ *Ensure that the ambitious levels of biofuel blending, while commendable, do not have an undesirable impact on prices and supply logistics for the vehicle fleet.*

## 6. NATURAL GAS

### Key data (2011)

**Production:** None

**Net imports:** 4.1 billion cubic metres (bcm) from Russia 100%, -2.2% since 2000

**Share of natural gas:** 9.7% of TPES and 12.9% of electricity generation

**Inland consumption:** 4.1 bcm (power generation 60.6%, industry 27.4%, energy sector 9.5%, services and other 1.2%, residential 1%, transport 0.3%)

## SUPPLY AND DEMAND

Natural gas accounts for 9.7% of TPES in Finland, which is low in relation to IEA member countries in terms of reliance on gas for energy supply. The IEA median is 22.1% and Finland's share of natural gas in TPES ranks second-lowest, behind Sweden.

## SUPPLY

Apart from a small amount of biogas production, Finland has no domestic production of natural gas. It has no natural gas reserves. The Finnish gas market is isolated, and there is no transmission connection to other EU member states. Finland is connected to the Russian transmission system via a single twin pipeline, and has been importing all of its natural gas from Russia since 1974.

The amount of natural gas imported from Russia is virtually equivalent to the domestic consumption. Finland's imports of gas amounted to 4.1 billion cubic metres (bcm) in 2011, which is 12.5% lower compared to the 4.7 bcm of natural gas imports in 2010.

A single importer in the country, Gasum Oy, concluded a long-term gas supply contract with Gazprom Export to import Russian gas to Finland until 2026, linked to oil, coal and domestic energy prices. Maximum annual importing volume of the contract is 6 bcm with a maximum pipeline import capacity of 7 bcm. Gasum Oy is currently under negotiation with Gazprom to make the annual contract more flexible, taking into account the downward trend of domestic gas consumption and higher peak demand. It also aims to diversify natural gas sources with a plan of constructing a liquefied natural gas (LNG) terminal and increasing biogas production, even if on a small scale.

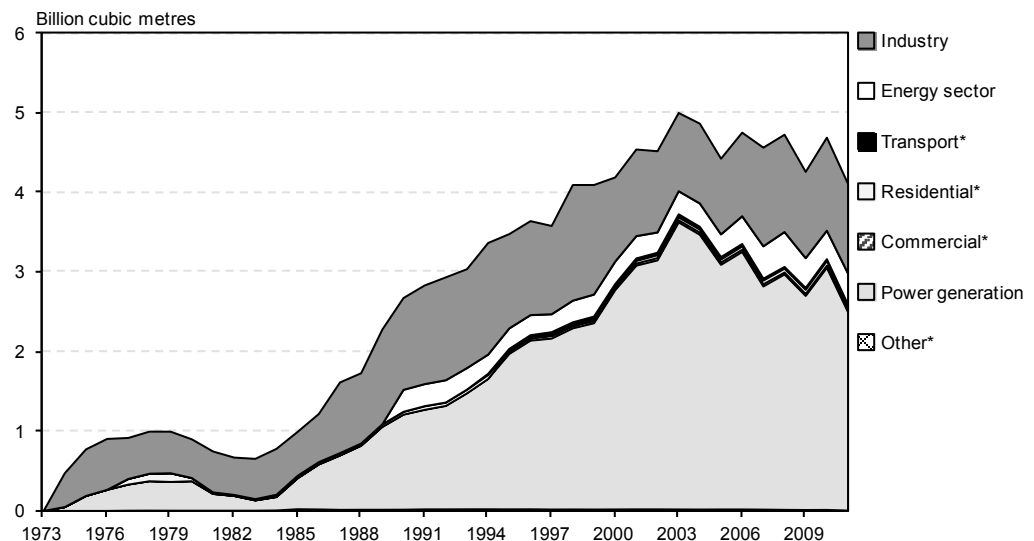
Biogas production was 145.5 mcm in 2011. Around 79% of production was consumed in the country, while the other 21% was flared in 2011. Although there are 76 biogas plants (39 landfill plants and 37 reactor plants, including wastewater and farms), more than 70% of the biogas was produced in landfill gas recovery plants. In addition, several projects to establish biogas production plants, with total annual production capacity of 185 gigawatt hours (GWh) or around 17 million cubic metres (mcm), are expected to be completed by 2014.

## DEMAND

Finland's demand for natural gas increased from 0.5 bcm (1.3 million cubic metres per day) in 1974 to 5 bcm (13.7 mcm/d) in 2005, before decreasing slightly to 4.1 bcm (11.3 mcm/d) in 2011.

The breakdown of sectoral gas demand in Finland is quite different from gas demand in other IEA member countries. In Finland, the share of domestic use is only 1%. Most of the natural gas is used in big units in district heating boilers and district heating CHPs or industrial boilers and industrial CHPs. Approximately 54% of all natural gas is consumed by CHP plants. Taken together, the power generation sector is the largest consumer of natural gas in Finland, representing 60.6% of the country's total gas consumption, while the industry and the energy sector represented 27.4% and 9.5%, respectively (2011 figures). Commercial and other services use is 1.2% while transport uses only 0.3% of total natural gas.

Figure 17. Total gas consumption by sector, 1973-2011



\* Transport, Residential, Commercial and Other are negligible. Other includes other transformation, agriculture/forestry, fishing and other final consumption.

Sources: *Natural Gas Information*, IEA/OECD, Paris, 2012; and country submission.

Gas demand in Finland peaks in winter when gas consumption significantly increases for electricity, combined heat and power (CHP) and heat plants. The Finnish daily peak gas demand stood at some 22.1 mcm/d on 18 February 2011 (when temperatures averaged about -25 °C), and the hourly peak consumption was 0.96 mcm/h on 8 January 2010.

The government estimates that gas demand will remain at the current level or decline during the next decade because of relatively high oil-indexed gas prices, which could lower its competitiveness against other energy sources. The increased use of renewable energy sources, the increased levels of energy efficiency and the future increase in nuclear power production can also be expected to have an impact on future gas consumption.

## REGULATORY AND LEGAL FRAMEWORK

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### INSTITUTIONS

The Ministry of Employment and the Economy (MEE) is the lead government ministry with responsibility for energy policy. In the natural gas sector, the ministry determines policy in relation to security of energy supply and the functioning of the market. The ministry is responsible for transposing EU gas directives into national law and is responsible for the financial oversight and corporate governance of the state-owned energy companies.

The natural gas market regulator is the Energy Market Authority (EMA). The regulator issues licences for gas network operators and ensures that gas market actors fulfil the requirements of the Natural Gas Market Act. The market actors can appeal against the decisions of the regulatory authority. The basis for full market access is weak, since there is only one supplier and the network is not connected to the European gas network. Large gas customers may trade in the secondary gas market. The EMA grants licences for cross-border pipelines.

### INFRASTRUCTURE

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#### TRANSMISSION AND DISTRIBUTION

Finland's gas transmission system operator, Gasum, is vertically integrated and the shareholders are Fortum (31%), Gazprom (25%), the State of Finland (24%) and E.ON Ruhrgas (20%). No changes in the shareholder structure are envisaged. Due to its market isolation and absence of competition in the wholesale market, Finland had until recently received a derogation from the Gas Directive exempting it from legal and operational unbundling (Article 49). However, the lack of unbundling in the Finnish gas market at present conflicts with the European Commission's plans for greater regional integration. Finland will have to unbundle its gas market if another gas source is developed, or if Finland is connected to a wider European gas network.

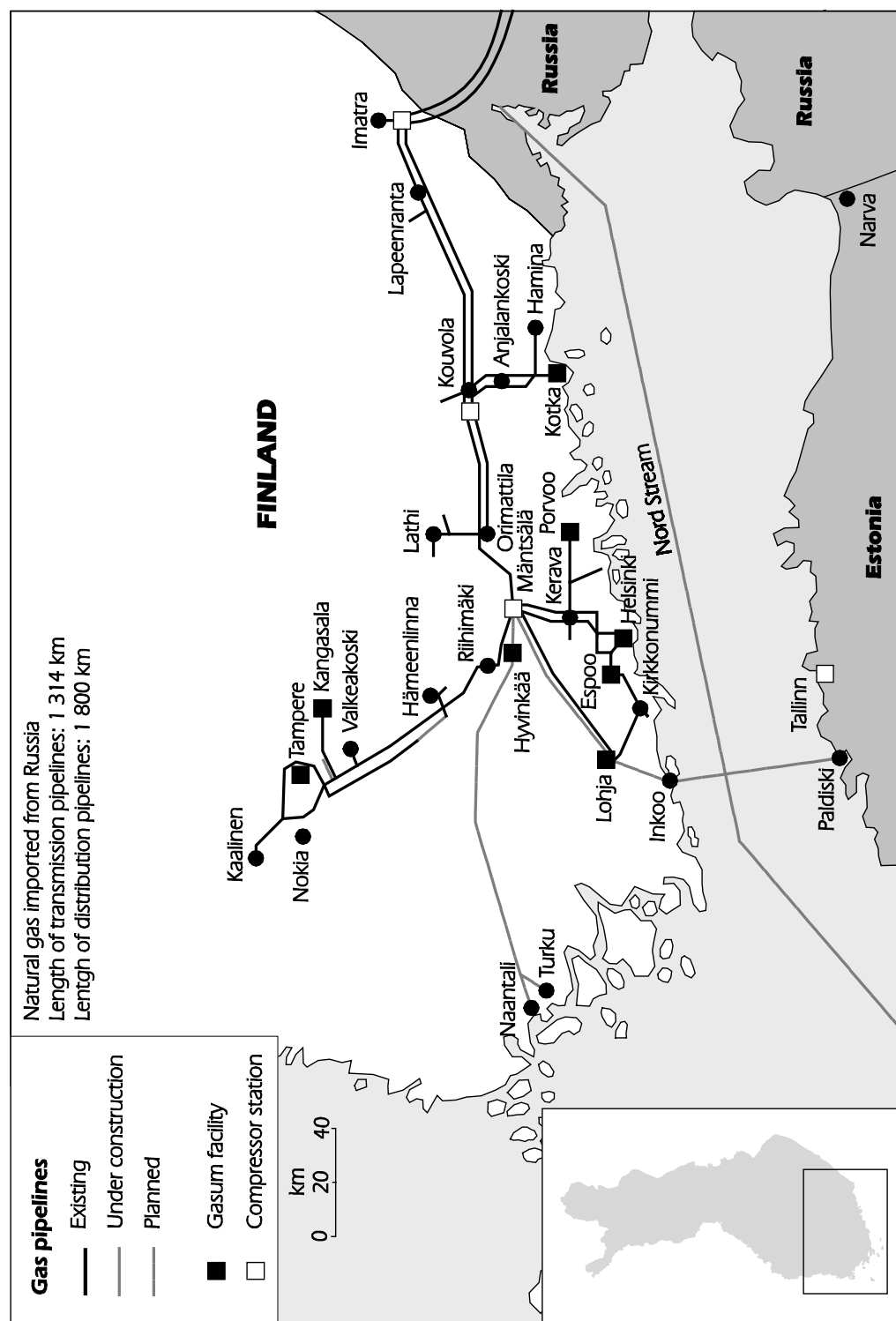
The gas grid is limited to the southern region of Finland. The transmission system, which is operated by Gasum Oy, has approximately 1 314 km of pipeline within Finland. With the distribution grid included, the total length of the gas grid is 3 100 km. In 2011, new gas transmission pipelines were completed between Lempäälä and Kangasala (34 km), and between Mäntsälä and Siuntio (89 km).

Gasum Oy is planning to expand its natural gas transmission network to the western part of Finland, mainly to the cities of Turku and Naantali. The length of the pipeline extension would be about 200 km.

The system has three gas compressor stations with a compressor capacity of 64 megawatts (MW). In Imatra, there is a natural gas receiving station, where the amount of natural gas brought into the country is measured.

The other compressor stations are located in Kouvola and Mäntsälä. The central control centre is located in Kouvola. Gas pressure of the existing pipelines is 30 bar to 54 bar pressure. There are around 200 interfaces which connect with transmission pipelines, 131 of which are pressure reduction stations in the network. New pipelines are being constructed for 80 bar pressure of gas.

Figure 18. Natural gas infrastructure in Finland



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Sources: Finnish government; and IEA.

Of note, a small biogas production plant in Kouvola was connected to the natural gas transmission network in October 2011. The plant's biogas production capacity is about 0.6 mcm (7 GWh) per year.

## INTERNATIONAL PIPELINES

All natural gas is imported through a twin pipeline system from Russia. The two parallel pipes can be operated separately. The maximum annual import capacity of the pipeline of around 7 bcm (19.2 mcm/d) in the domestic network is determined by a domestic compression centre.

The hourly peak utilisation can exceed the maximum import capacity in mid-winter, and stood at around 0.96 mcm/h in January 2010. In such situations, linepack gas is used, particularly as the normal utilisation rate of the Finnish gas pipeline network is about 85%. Finland has experienced a gas supply disruption only once during the past 20 years, lasting for one day, because of a pipeline accident near Saint Petersburg in the summer of 2007.

### Box 3. Baltic Energy Market Interconnection Plan (BEMIP)

On 17 June 2009, eight Baltic Sea member states signed a Memorandum of Understanding on the BEMIP. The objective of BEMIP is to look at concrete measures for improving energy interconnections between countries on the Baltic rim and thereby extending links with wider EU energy networks.

The work on gas is focused on the following main objectives:

- Identify the most economical, minimum infrastructure necessary to diversify gas supplies in Finland and the three Baltic states and to end isolation and, consequently, derogations in Eastern Baltic Sea region;
- Launch a taskforce to identify a regional LNG terminal in the Eastern Baltic Sea;
- Find ways to additional gas sources to compensate for depletion of Danish fields and diversify sources and routes for Poland, Germany, Denmark and Sweden.

The Polish-Lithuanian gas interconnection (GIPL), Balticconnector between Estonia and Finland and a regional LNG terminal have been identified as important infrastructure projects in the Eastern Baltic Sea region.

Source: European Commission.

Finland is co-operating with the Baltic states and Poland in the context of the BEMIP initiated by the European Commission in 2008 (see Box 3). A new infrastructure development study under way in 2012 includes a pipeline connection between Poland and Lithuania, improved connections between the Baltic states, a regional LNG terminal and a 2 bcm pipeline connection "Balticconnector" between Estonia (Paldiski) and Finland (Inkoo). The ongoing study, that was to be finalised in late 2012, includes cost-benefit analyses of the proposed gas infrastructure investments. The total cost of the Balticconnector is estimated at approximately EUR 96 million, corresponding to a price of EUR 1.2 million per kilometre.

There is no third-party access to the gas pipelines, and Finland has been granted an exemption from the European Commission regarding third-party access as there is no interconnection to other European countries. However, third-party access would be required

if the Finnish gas network were connected to Baltic countries and other European countries, or if more than 25% of gas were supplied by another importer.

## LNG TERMINAL

Gasum Oy opened a small-scale, off-grid LNG production plant in Porvoo in June 2010. Annual LNG production capacity is about 20 000 tonnes (or 27 mcm of natural gas). There is also 2 000 m<sup>3</sup> LNG storage for produced LNG. As it is quite small, the LNG is used for back-up fuel during maintenance breaks, fuel of cruise ferries and industry. As this plant is not equipped with any sending capacity to the gas network, the produced LNG must be delivered by trucks or fed into the network through mobile LNG vaporisers with a capacity of 0.18 mcm/d.

There is no large LNG import terminal in Finland at present. However, as an alternative to joining the Eastern Baltic regional gas market, the Finnish gas company Gasum Oy is assessing the feasibility of direct LNG imports to Finland, by building a large LNG import facility in the southern part of Finland (either in Inkoo or Porvoo). The environmental impact assessment procedures for the potential sites began in April 2012. The terminal would allow for the import of between 0.9 and 1.8 bcm of natural gas or LNG imports per year, with an injection capacity into the gas transmission networks of 12 mcm/d to 14 mcm/d. This project would also include a storage capacity of 300 000 cubic metres of LNG (185 mcm of natural gas). The company aims to complete construction of the LNG terminal for full import, storage and network injection capacity by the end of 2018 (in which case LNG imports for users such as shipping companies could start at the end of 2015). Alternatively, if an LNG import terminal were built in one of the Baltic countries (Lithuania at present is the most likely location), Finland would be able to access it through the Balticconnector pipeline.

## STORAGE

Finland has no large-scale gas underground storage capacity in the country. All natural gas storage facilities are in the form of pipelines and spherical storages for daily balancing and peak shaving, which amounts to around 10 mcm to 14 mcm. In addition, Gasum Oy operates an LNG storage facility with a capacity of 2 000 cubic metres for its off-grid LNG terminal in Porvoo.

A potential future connection to the Baltic countries via the Balticconnector project could create possibilities to use the significant gas storage facilities in Latvia, as Finland's geological structure makes domestic storage very expensive to build.

## BIOGAS

In Finland's 2013 Climate and Energy Strategy updated, the government indicates a target for 10% of natural gas consumption to be replaced by synthetic natural gas (made from Finnish wood) by 2025.

In line with this objective, in March 2013 the world's largest biomass gasification plant, with a capacity of 140 MW, was inaugurated in Vaasa. Located next to Vaskiluodon Voima's existing Vaskiluoto two coal-fired plant, the biomass gasification plant will produce biogas from wood – primarily from forest residue – to generate electricity and provide heating for the residents of Vaasa.



## SECURITY OF SUPPLY

Finland is vulnerable to a supply disruption, as 100% of gas supplies are imported through a twin pipeline system from Russia. This vulnerability is exacerbated by the fact that Finland has no sizeable gas storage capacities.

### GAS SECURITY POLICY

Owing to the absence of gas storage in Finland, gas supply security is ensured by legally obliging key consumers to hold – and be able to switch to – alternative fuels, usually fuel oil.

The Act on Compulsory Stockholding of Imported Fuels (1994) sets the standard of gas supply security for suppliers. The gas importer (Gasum Oy) and major gas plants (both CHP and conventional power plants – but not industrial gas users) are required to hold alternative-fuel stocks corresponding to three months of natural gas imports/consumption. Municipal users consuming over 15 mcm of natural gas per year are also obliged to hold alternative stocks corresponding to three months of consumption. The obligation can be fulfilled by stockpiling any oil product, coal or other back-up fuel, but substitute fuels are most often light or heavy fuel oil and/or propane gas. The stockpiling obligation does not concern industrial users of gas.

According to the Act on Security of Supply (1992), Finland's public stockholding agency, NESÄ,<sup>15</sup> is required to hold alternative fuels for gas disruptions, up to a level that brings total stocks of the country close to the equivalent of five months of consumption for natural gas. An emergency supply fee of EUR 0.00084 per cubic metre (EUR 8.4 per MWh) is levied on natural gas users in order to maintain the public stocks of alternative fuels.

Supplies to customers that can only use gas are secured by a propane-air production plant. Gas importers (namely, Gasum Oy) are obliged to maintain reserve fuel storages for small gas customers using less than 15 mcm of gas per year. All other natural gas users are primarily responsible for their own contingency plans and the associated emergency fuel supply systems, emergency fuel reserves and fuel transport. NESÄ's public oil emergency stocks also include oil products, which could be used as substitute fuel for gas.

### EMERGENCY RESPONSE MEASURES

The Finnish transmission system operator (TSO), Gasum Oy, has an early warning system deployed with a Russian control centre located 150 km inland from the Finnish border. Thanks to another data connection system with Russia, Gasum Oy is able to follow pipeline developments up to 500 km inside Russia, allowing for the real-time monitoring of gas flows in Russia.

In the initial stage of a gas emergency, when a shortage of gas supply is anticipated, the TSO will first endeavour to curb consumption by increasing the price for excess gas and implementing a buyback system through the Gas Exchange (see "Market structure" sub-section below). Price increases to balance gas supply and demand were used for peak-shaving purposes in 2010.

If these measures are insufficient for mitigating the impact of a gas disruption, the TSO can reduce the contractual capacities of all its customers on a pro-rata basis, with the

15. National Emergency Supply Agency.

exception of protected customers (detached houses and other residential properties that directly use natural gas), as most residential buildings cannot use substitute fuels. Consumers that reduce their own consumption beyond levels required by the TSO can sell their surplus quota to other customers through the secondary market trade.

In the event that the natural gas supply is completely interrupted, the government can order the use of alternative stocks, and release compulsory stocks in the form of alternative fuels. It is estimated that over 40% of natural gas consumption can be switched to light fuel oil within eight hours if the government were to order full fuel switching measures.

The Porvoo refinery is one of the largest consumers of natural gas, using 0.675 bcm (1.85 mcm/d) of natural gas or 14% of the country's gas use, which also accounts for around 60% of its total fuel use for energy and hydrogen. An air-propane mixing LPG plant has been built in Porvoo in order to provide protected customers with air-mixed propane gas. The air-propane plant can only be activated when the pressure in the transfer pipelines has fallen below seven bars. The gas mixture capacity of the plant is equivalent to 0.84 mcm/d, by which gas demand of protected customers (0.48 mcm/d) can be covered.

Small quantities of LNG stored in Porvoo can also be available during a gas disruption. However, as the LNG production plant is not connected to the gas network, the LNG would have to be delivered by trucks and fed into the network through mobile LNG vaporisers with a capacity of 0.18 mcm/d from the LNG storage facility, which has a capacity of 2 000 cubic metres.

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## SUPPLY AND RETAIL

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### MARKET STRUCTURE

Gasum Oy is responsible for imports, transmission system operation and wholesale trading of natural gas in Finland. It is the sole importer and wholesale supplier. The company is owned by a consortium of Fortum (Finland's electricity company: 31%), OAO Gazprom (25%), the government of Finland (24%) and E.ON Ruhrgas International GmbH (20%).

A subsidiary of Gasum Oy runs a secondary market called Gas Exchange (Kaasupörssi – since 2002), where customers can make direct transactions with one another. This market is open to gas users procuring over 5 mcm per year and certain retail sellers. Around 5% to 10% of total gas consumption is traded on the Gas Exchange. Although there are no interruptible contracts in the country, the “Gasum Miinus” programme allows Gasum Oy to buy back fixed deliveries through the Gas Exchange in order to reduce contractual volumes. The TSO, Gasum Oy, acts as a clearing house to monitor the market.

Concerning the retail market for gas in Finland, there are over 30 regional distribution companies selling gas to regional consumers and to small-scale users. Owners are mainly local electricity companies. Some distributors are partly owned by Gasum Oy. Natural gas users with a consumption of more than 5 mcm can trade on the secondary gas market since 2002. The traded volumes are very small, accounting for only about 2.1% of Finland's natural gas consumption.

The Finnish gas association has 63 actual members, including the gas importer (Gasum Oy), gas distribution companies and big gas consumers.

## WHOLESALE MARKET

Finland does not produce gas, and the sole importer, Gasum Oy, is thus the only party active on the wholesale market. Gasum also operates the transmission system, and also acts as a distribution system operator (DSO) and supplier (in competition with other DSOs and suppliers).

Most of Gasum Oy's gas wholesale contracts are based on a public tariff, and are renewed every four years. Yet Gasum Oy also offers shorter-term products on the Kaasupörssi Oy Gas Exchange.

## RETAIL MARKET

Retail market concentration is limited, with the share of the top three retail suppliers accounting for around half of total gas volume. However, Finnish retailers generally have a monopoly within their own distribution network. The European Commission indicates that there were 23 natural gas suppliers (*i.e.* the DSOs) in 2010, most of whom had only a dozen customers.

A notable fact of Finland's retail/distribution market is that it only accounts for around 5% of total gas consumption. In 2010, there were around 37 000 customers of natural gas, around 92% of which are households which use gas for cooking. However, the size of those consumers as a share of total consumption is low, standing at around 2%. Gas consumption is concentrated among large users in the power generation and industrial sectors. The Porvoo refinery, owned by Neste Oil Oy, is one of the largest consumers of natural gas.

## TARIFFS

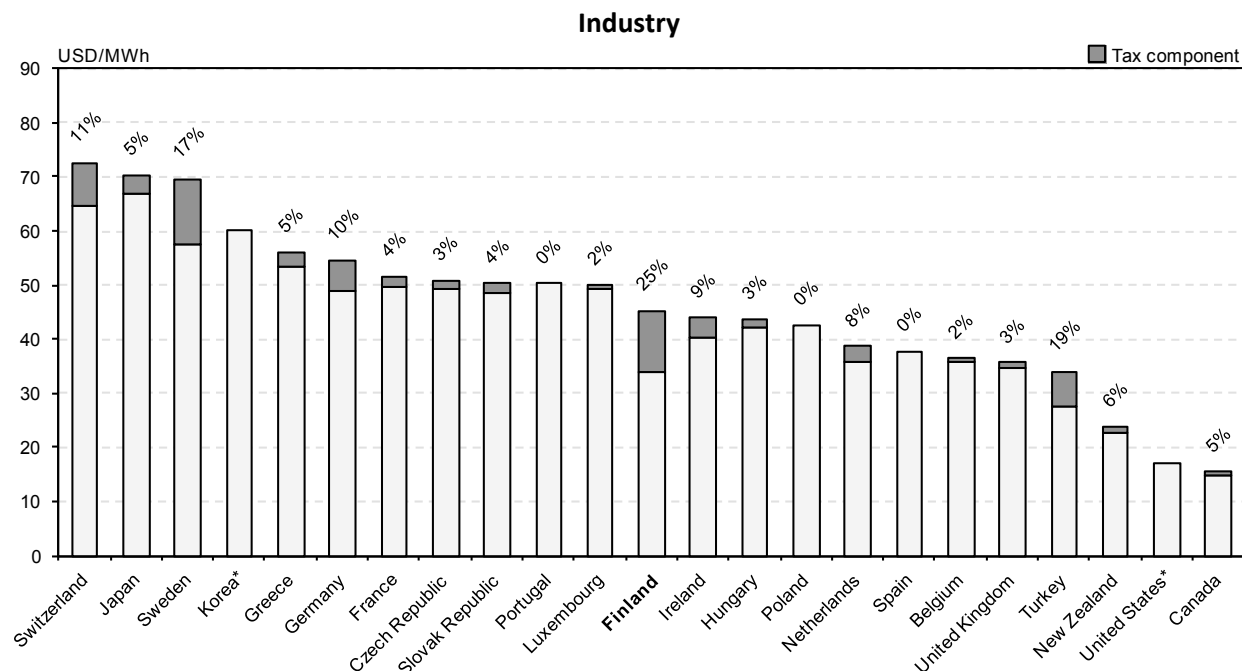
EMA is responsible for the regulation of gas transmission and distribution tariffs. According to the Natural Gas Market Act, network operators are able to set the actual network tariffs themselves. There is no *ex ante* approval of tariffs or prices of network services by authorities. However, the regulator confirms *ex ante* the methodology to be used in setting both transmission and distribution network tariffs. Network costs are reviewed every four years – the first regulatory period covered the years 2006-09 and the second 2010-13 – and are used to establish maximum allowed revenues for Gasum's transmission and distribution activities. The allowed revenues are used to determine the network tariff each year.

## RETAIL PRICES

The largest component of gas prices is the wholesale cost of gas, which Gasum purchases from Russia under a long-term contract that expires in 2026. Because Finland's gas grid is not connected to the wider European gas market, its prices are not correlated.

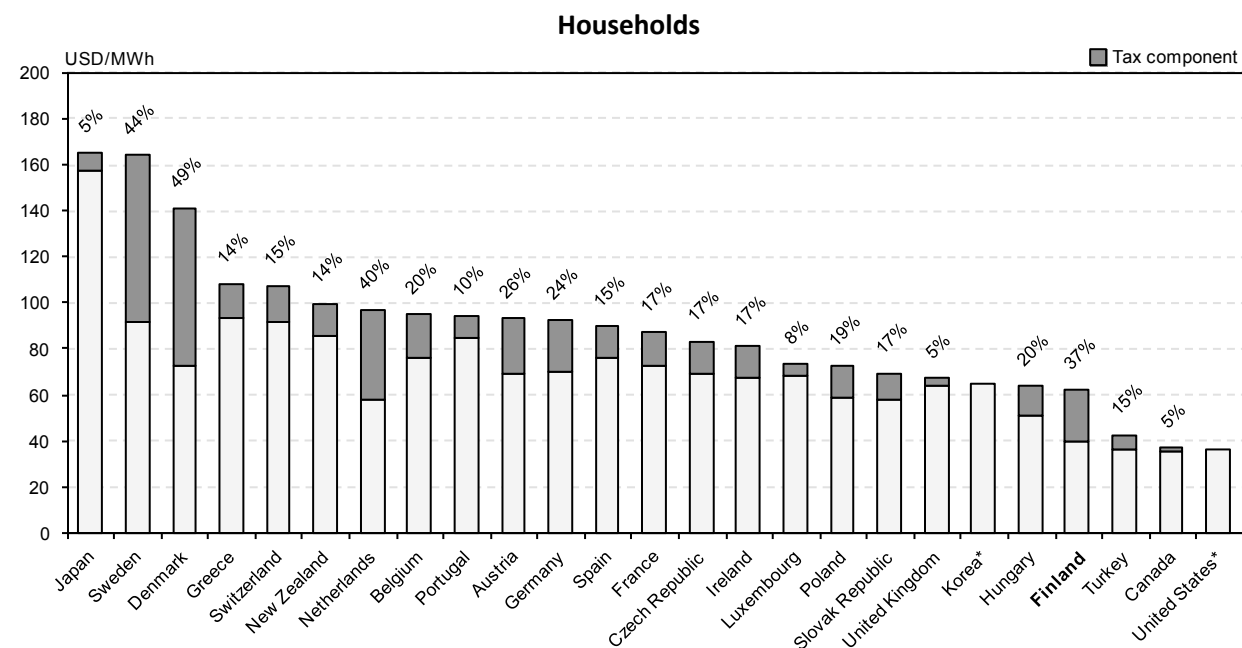
There are no price caps or prices determined by the regulator, but prices have to be "reasonable". In March 2008, the regulator decided that the pricing by Gasum Oy of the wholesale supply of natural gas during the years 2006 and 2007 was excessive, and ordered Gasum to change its pricing policy starting from financial year 2008. The regulator opted for using the gas supply margin as the measure for assessing the reasonable level of pricing, using EBIT (earnings before interest and taxation) as an indicator. Even though Gasum Oy has appealed the decision to the Market Court, the court overruled this appeal in 2009. The case was finalised in 2012 and Gasum Oy has to price its gas according to set EBIT margin.

Figure 19. Gas prices in IEA member countries, 2011



\* Tax information not available for Korea and the United States.

Note: data not available for Australia, Austria, Denmark, Italy and Norway.

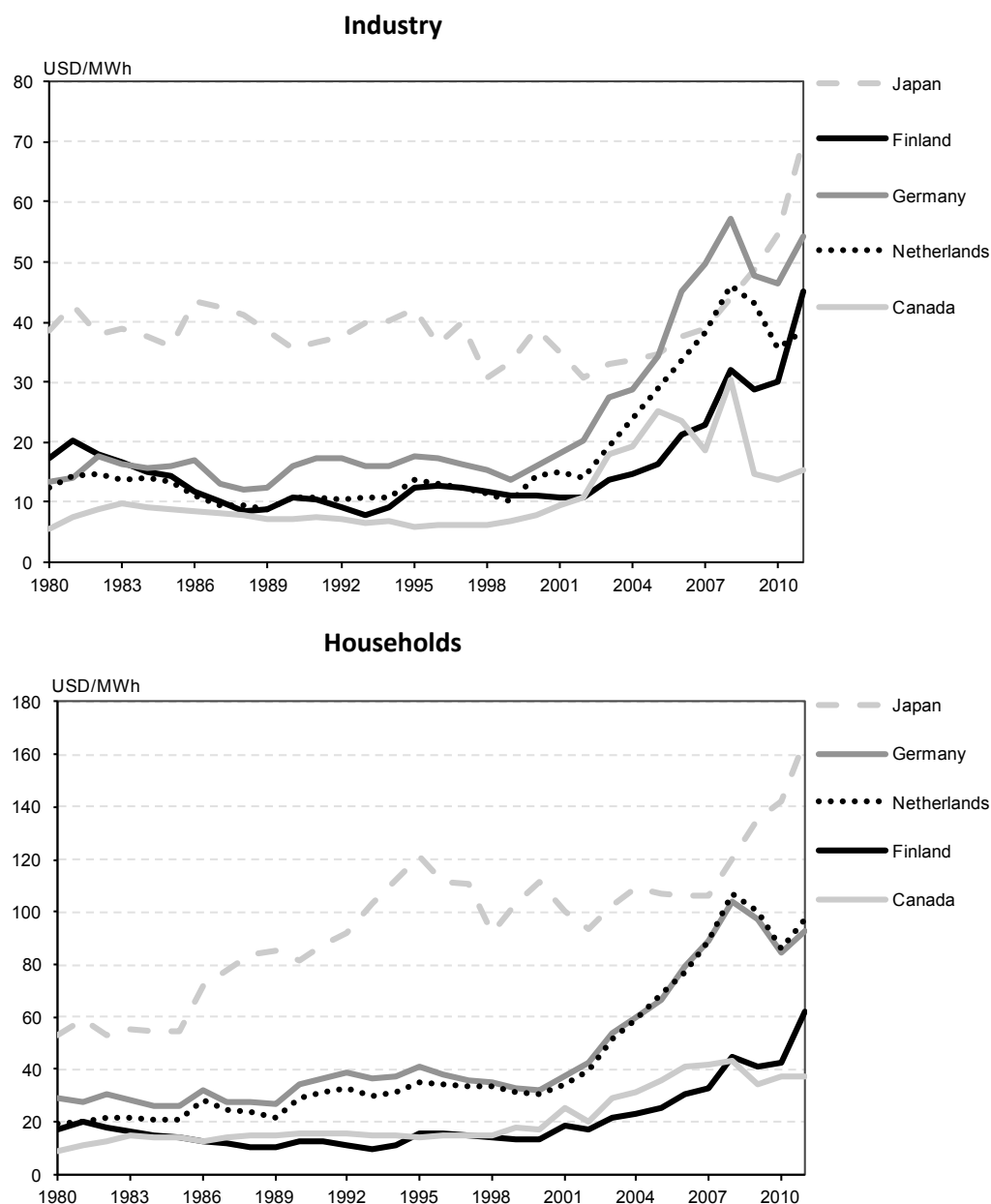


\* Tax information not available for Korea and the United States.

Note: data not available for Australia, Italy and Norway.

Source: *Energy Prices and Taxes*, IEA/OECD, Paris, 2012.

Figure 20. Gas prices in Finland and in other selected IEA member countries, 1990-2011



Source: *Energy Prices and Taxes*, IEA/OECD, Paris, 2012.

## ASSESSMENT

The role of natural gas is fairly limited in Finland's energy policy, with consumption standing at between 4 and 4.7 bcm over the last decade. In 2011, natural gas accounted for 9.7% of Finland's total energy consumption and 12.9% of the electricity production. Approximately 61% of the natural gas is used by energy and power companies, whereas pulp and paper and chemical industries account for 22.6% of its use. Petroleum refineries represent 9.5% of demand, while gas use in residential sector is very limited.

It is likely that, in the future, natural gas will continue to play a limited role in the energy sector, particularly if the country successfully implements its renewable energy targets and if the planned nuclear capacity comes on stream. Nonetheless, the gas industry sees some opportunities for increasing LNG deliveries to customers not connected to the grid, marine LNG, and biogas production and distribution. An interesting development is the fact that Finland's 2013 Climate and Energy Strategy update aims for 10% of its current gas consumption to be replaced with biomass-based solutions by 2025.

The gas grid is currently confined to the southern region of Finland, but there are plans to extend the network to the south-western part of the country, mainly to the cities of Turku and Naantali. Pipeline imports from Russia account for all of Finland's gas supplies, under a long-term contract that expires in 2026. The Finnish gas company, Gasum Oy, is the sole importer and wholesale supplier, and acts as the TSO.

Natural gas prices in Finland have grown substantially in the last two years, affected by higher global prices for oil and coal and also by the introduction of a new excise duty on natural gas in 2011, which will gradually increase until 2015. The growth in prices as well as low electricity prices in the Nord Pool Spot have negatively influenced the competitiveness of natural gas compared to other competing fuels, despite its lower greenhouse gas emission profile.

Only 12.9% of electricity was produced from gas in 2011, meaning that Finland's security of supply exposure to a gas disruption is comparatively contained; and although there have been no major supply interruptions during Finland's history of natural gas use, security of gas supply is a concern because of Finland's reliance on one single supplier, Russia.

Because of the country's particular circumstances, Finland has received a derogation from the European Union's internal energy market rules and did not have to open its market in line with the relevant legislation, and Finland has opted for regulated network access. This derogation applies as long as there are no direct connections to the natural gas network of any other EU member states and as long as Finland has only one natural gas supplier. Yet Finland is now exploring alternative supply routes.

The government is co-operating with other EU member states in the context of the BEMIP, which examines possibilities to construct a natural gas pipeline between Finland and Estonia (Balticconnector), and the possibility to construct a shared LNG terminal for Finland and the Baltic countries, with a view to benefiting both security of supply and competition in the region's gas sector.

Finland must continue to ensure compliance with EU legislation, and particularly the European Union's Third Energy Package. While Finland has benefited from a derogation from the European Union's internal energy market rules until recently, the European Commission's aforementioned plans for greater regional integration conflict with the lack of unbundling in the Finnish gas market at present, because of the monopolistic and vertically integrated nature of Gasum's operations. As of December 2012, the European Commission has opened infringement procedures against Finland for only partially transposing the necessary measures.

**RECOMMENDATIONS**

*The government of Finland should:*

- ☐ *More actively support the development of international gas infrastructure connections, when economically reasonable, particularly within the framework of the Baltic Energy Market Interconnection Plan, in light of potential benefits to diversity of supply and competition.*
- ☐ *Monitor the developments in the gas market and ensure the updating of the legal and regulatory framework if investment decisions to create new international gas connections are taken.*
- ☐ *Continue to monitor and enforce compliance with domestic and EU gas security of supply regulations.*
- ☐ *Take urgent measures to ensure full compliance of the Finnish gas market with the EU Third Energy Package.*





## 7. COAL AND PEAT

### Key data (2011)

#### COAL

**Production:** None

**Share of coal:** 10.6% of TPES and 14% of electricity generation

**Net imports:** 7 Mt of hard coal, from Russia 75.3%, United States 7.3%, Canada 6.9%, Australia 4.2%

**Inland consumption:** 5.6 Mt of hard coal (power generation 72.7%, coke ovens 23.4%, industry 3%, other 0.9%)

#### PEAT

**Peat production:** 6.9 Mt

**Share of peat:** 5.8% of TPES and 7.4% of electricity generation

**Inland consumption:** 8.3 Mt (power generation 85.8%, industry 11.6%, commercial and other services 2.2%, residential sector 0.4%)

## COAL

Coal (excluding peat) plays a rather small role in Finland's energy mix compared to many other IEA member countries. In 2011, coal represented around 11% of TPES and total coal consumption was 3.7 Mtoe (5.6 million tonnes) in 2011, down by 20.5% compared to 2010 but 3.2% higher than in 2009.

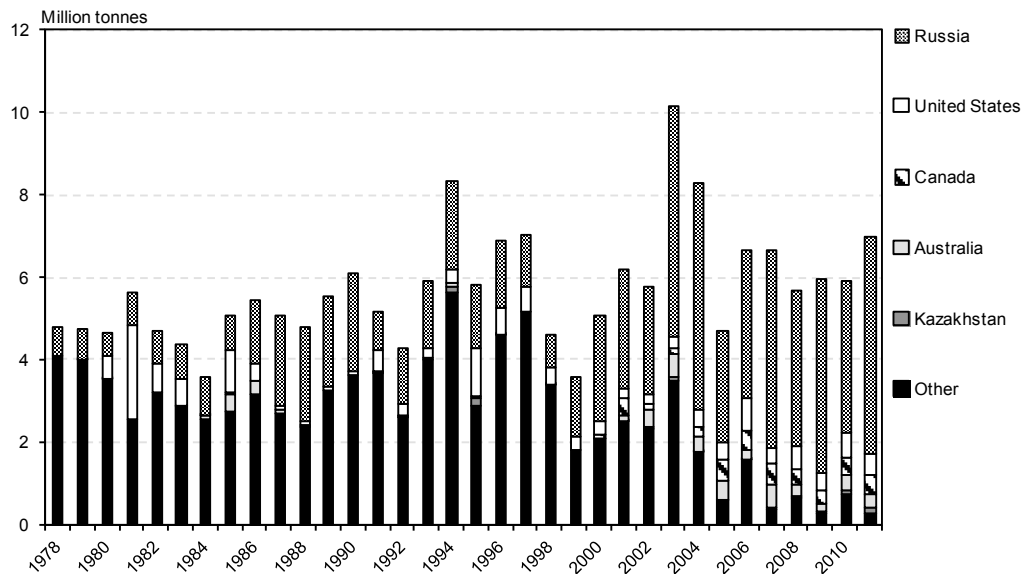
## SUPPLY

The entire supply of coal is imported, as there is no inland coal production. Russian coal (primarily steam coal) accounts for around three-quarters of all coal imports, the vast majority of which is steam coal. Russian coal supply is attractive both in terms of price competitiveness and flexibility of shipments. Russian coal can be shipped from nearby Baltic Sea harbours to many Finnish harbours in small vessels.

Coal can be imported in larger quantities from further afield, but there are port constraints. Only Pori can accommodate cape-sized vessels, and Inkoo can accommodate Panamax-size ships. North America is the second-largest source of supply (primarily coking coal) after Russia, with Canada and the United States each accounting for 7% of Finland's coal imports in 2011. Australia accounted for a further 4% of (coking) coal imports.

Trucks are used for inland transportation. Rail transport of energy coal is hardly used.

Figure 21. Finland's hard coal imports by country of origin, 1978-2011

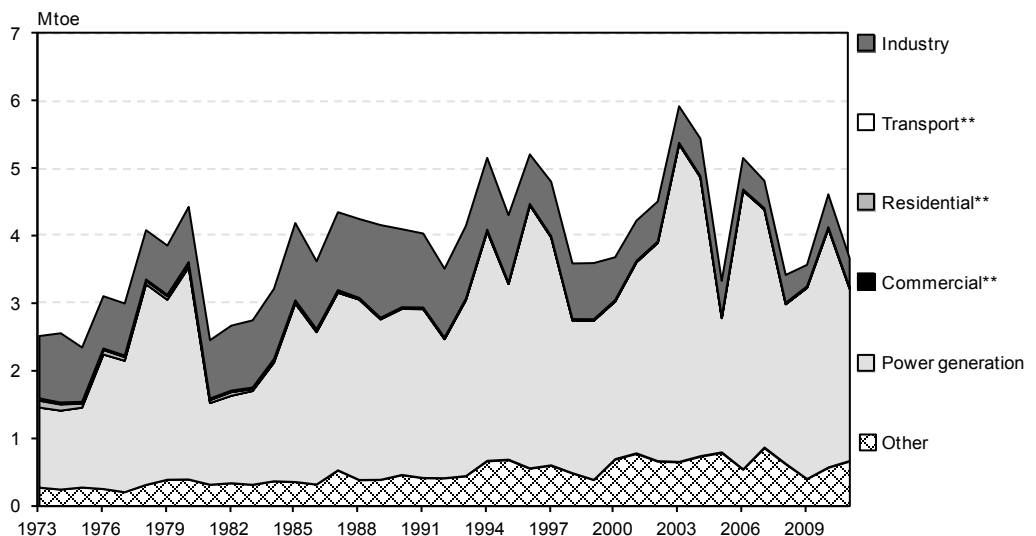


Source: *Oil, Gas, Coal and Electricity Quarterly Statistics*, IEA/OECD, Paris, 2012.

## DEMAND

Coal use in Finland has stood at around 5 Mt per year on average over the past 30 years, but has varied between 3 Mt and 9 Mt depending on demand for coal-fired power generation. The majority of all consumption is in the electricity and heat sector. In 2011, about 48% of all steam coal was used in conventional coal-fired power plants and over 46% was used for district heating in combined heat and power (CHP) plants. Around 4% of all coal is used by industry, half of which is consumed in the iron and steel industry.

Figure 22. Coal supply by sector\*, 1973-2011



\* TPES by consuming sector. *Industry* includes non-energy use. *Commercial* includes residential, commercial, public services, agriculture/forestry, fishing and other final consumption. *Other* includes other transformation and energy-sector consumption.

\*\* Negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012 and country submission.

Coal's use in CHP plants for district heating is generally concentrated in large cities, and particularly in those near import harbours. Coal demand for CHP plants is generally quite stable (around 2 Mt per year) and is easier to predict than the coal use in condensing coal-fired electricity generation. The key factors affecting variation are the weather and the price of natural gas, since most coal-fired CHP plants can also be fired with natural gas.

Large coal-fired condensing plants are located at Inkoo (2x250 MW) and Pori (500 MW) and play an important role during peak demand of electricity in cold winter weeks. Driven by hydrological conditions in Nordic countries, consumption of coal varies considerably from year to year. Coal-fired generation is required to balance supply and balance in the Nordic system in a context of low hydropower supply and cold winter weather.

There are no subsidies or incentives applicable to coal. Consumption of coal is expected to decline progressively if the European Union Emissions Trading Scheme (EU-ETS) is tightened after 2012.

## PEAT

Unlike in most IEA member countries, peat is a significant energy source in Finland. Peat is a valued domestic source of energy, which contributes to the security of supply and the diversification of the energy sources in Finland.

In 2011, the total supply of peat was 2 Mtoe (7 Mt), representing 5.8% of Finland's TPES and 7.4% of its electricity supply. Peat production has increased substantially over the past three decades (up from 1.5 Mt in 1981, 4 Mtoe in 1991 and 6.9 Mtoe in 2001). This rapid rise after the two oil crises in the 1970s is the result of government support and policy to maintain the domestic resource in the fuel mix.

Peat harvesting is important for the local economy and employment in northern, eastern and central Finland, accounting for an estimated 4 000 man-years of employment. There are over 200 companies and hundreds of entrepreneurs in peat production.

The rate of depletion of peat far outpaces its natural replenishment at mine sites. Thus, peat is not considered a renewable fuel. Finland classifies peat as a "slowly renewing biomass fuel".

## SUPPLY

Finland has vast peat resources, with peatlands covering around 9.3 million, equivalent to around a third of Finland's territory. Around 0.6% of the peatlands, or approximately 60 000 hectares, is currently harvested. About three-quarters of peat production sites currently in activity was drained for some other usage, mainly for forestry, before peat production actually began.

The availability of peat is secured by reserving adequate peat production areas, taking into account land-owner perspectives and natural state grading. Additional land needed for peat production will be 58 000 hectares by 2020. At present there are 550 separate production sites in Finland. An average production site is about 110 hectares large.

The amount of peat produced in a given year heavily depends on weather conditions, with production being significantly higher in drier years than in rainy years. The average moisture for peat destined for fuel consumption is 40% to 45%. Average yearly production in the past decade stood at around 7.3 Mt, but production can vary significantly, with annual fluctuations from 3.7 Mt to 13 Mt.

There are two large peat producers in Finland: Vapo Oy, which is 50.1% owned by the state, and Turveruukki Oy, which is jointly owned by a group of municipalities. There are also approximately 200 to 250 small-scale producers, which share roughly 10% of total production.

## DEMAND

Peat has low energy and high moisture content, making it uneconomic to transport over great distances. It is, therefore, generally used locally for electricity and heat production, and is neither imported nor exported for fuel use. The energy sector accounts for 90% of sales.

Peat is primarily used as a co-generation fuel with wood/biomass in CHP plants, accounting for 17.6% of all fuels used (in TWh) in CHP plants in 2011. It is often used inland, competing with coal and biomass, as natural gas does not currently penetrate inland Finland.

There are about 55 large peat-fired CHP power plants, with an installed capacity varying from 20 MW to 550 MW. Peat is commonly used in power plants because of its reliable supply, its year-round availability, the stability of its price and its usefulness in optimising the efficiency of biomass combustion. Furthermore, its technical qualities make it particularly desirable for co-generation purposes with wood. Peat-fired power plants are municipal or industrial plants, though some serve both sectors. Industrial power plants exist mainly in the forest sector, where peat is used to improve the heat value of biomass by-products from the sector. Of note, the co-firing of peat and wood in CHP plants reduces the sulphur dioxide emissions of peat combustion.

District heating with CHP is also a sizeable source of demand, accounting for 61.3% of peat consumption, as around one million Finns have their homes and offices heated by peat (and wood) through CHP-fuelled central heating. Condensing power accounted for 24.5% of peat consumption, and industry accounts for another 11.6%. The remaining 2.6% is used for example in households in the form of peat briquettes.

The Technical Research Centre of Finland, VTT, published a study in 2012 forecasting the further development of electricity co-generation based on wood chips, forest industry by-products and peat in power plants and CHP plants over the 2010-20 period. While the use of wood chips could double by 2020, reaching up to 25 TWh according to national renewable targets, peat use is expected to remain stable at some 23 to 25 TWh annually, of which 6 TWh would be used in condensed electricity production.

## ENVIRONMENTAL CONSIDERATIONS

In response to concerns regarding the environmental consequences of large-scale peat use, the government made a decision-in-principle on the Peatland Strategy in August 2012, which stipulates that the government will “allocate the use of mires and peatlands to such mires and peatlands which have been drained or whose natural state has otherwise been significantly altered” and that “the strategy presents measures to allocate activities which considerably change the mire and to reconcile the different uses of mires and peatlands”. Sustainable and responsible use of mires and peatlands applies the perspective of ecosystem services to reconcile the ecological, social and economic objectives. According to the Peatland Strategy, the use of peat for energy purposes is to remain relatively stable through to 2020, at around 1.7 Mtoe.

Some measures are needed to address challenges, and notably to ensure competitiveness of peat against imported fossil fuels. The main challenge to the sustained use of peat in

Finland's energy mix is of course the high level of CO<sub>2</sub> emissions for peat combustion, which stands at 106 g CO<sub>2</sub> per megajoule (MJ).<sup>16</sup> However, blending peat volumes with some 30% of wood-based biomass, as is now common in Finland, brings emissions proportionally down to 74.2 g CO<sub>2</sub> per MJ. The possible tightening of the EU-ETS would have a further impact on the relative competitiveness of peat.

## PEAT-RELATED POLICIES

Because peat is an indigenous energy source and introduces diversity in the energy mix, it therefore provides a degree of additional energy security for Finland. With this in mind, the government has maintained a support scheme for peat-fired electricity generation.

To counteract the effect of the EU-ETS, the government initially implemented a peat promotion scheme from 2007 to 2010 in the form of a premium tariff for peat used in conventional power plants, whereby the network operator, Fingrid, paid qualified facilities an additional premium for any electricity sold into the market. This premium paid to qualified peat-fired generators did not directly affect the market price within Nord Pool, the Nordic electricity market of which Finland is a part. This special tariff for peat was terminated in 2010.

Peat currently benefits from a tax break in terms of heat production. However, this tax is set to rise from EUR 1.9/MWh in 2012 to EUR 4.9/MWh in 2013 and EUR 5.9/MWh in 2015. Nevertheless, the 2015 outlook on the energy content tax on heat remains lower for peat than it is for other hydrocarbon fuels.<sup>17</sup>

Taxes on fuels are only set on heat production. In the case of electricity production, the fuel inputs are tax-free, but taxes are set on electricity consumption. However, the EU Emissions Trading Scheme (see Chapter 3 for details) is a fiscal burden for electricity and heat producers, creating an incentive to use renewable fuels. Yet, over 90% of peat is used in plants which are part of the scheme.

In order to promote and secure the use of forest chips in electricity and CHP production, operational aid is provided for electricity produced from forest chips. The aid compensates for the difference in fuel costs between using forest chips or peat. The aid schema takes into account existing tax levels on peat and the emissions allowance price.

## ASSESSMENT

Coal accounts for around 11% of Finland's TPES, but there is no domestic coal production. Close to two-thirds of Finland's coal supply is imported from Russia, owing to its price competitiveness and the flexibility of the supply logistics, as Russian coal can be shipped from its nearby Baltic Sea harbours to many Finnish harbours in small vessels. The international coal market is considered more secure in terms of reliability of supply and prices than oil and gas.

16. Coal emissions stand at 94.6 g CO<sub>2</sub>/MJ and natural gas at 56.1 g CO<sub>2</sub>/MJ.

17. In 2015, in CHP-production taxes for heat are set at EUR 5.9/MWh on peat, EUR 10.1/MWh for natural gas and EUR 12.6/MWh for coal.

Coal consumption in Finland has been around 5 Mt per year on average over the last 30 years with variation between 3 Mt and 9 Mt. Annual coal consumption varies considerably on a year-on-year basis because of hydrological conditions in Nordic countries, with coal replacing missing hydropower during drier years.

Unlike in most IEA member countries, peat plays a significant role in Finland's energy mix, accounting for 6% of total energy consumption and 7.4% of electricity supply in 2011. Despite its carbon intensity, peat has the distinct advantage of being domestically produced. It is Finland's largest indigenous resource, with around a third of the country's land mass consisting of peatlands. Its widespread domestic availability makes it a valuable element in terms of security of supply, and its continued use appears to be quite widely supported in Finnish society, notably as its harvesting provides a means of employment in certain rural areas. It is used for producing electricity and heat, mainly for co-generation.

After the oil shocks of the 1970s, the government actively promoted the production of Finland's domestic peat resource as a part of the country's energy mix, and notably its use in power and heat generation. The likely tightening of the European Trading Scheme is expected to have a negative impact on peat use, because of its carbon intensity. The government has phased out the "premium tariff" subsidy provided to peat-fired condensing power generation in 2010, and the IEA commends the government for progressively lowering subsidy levels for peat up to 2015, as this will contribute to promoting the use of renewable energy. Nevertheless, the 2015 outlook on the energy content tax on heat remains lower for peat than it is for other hydrocarbon fuels.

Coal and particularly peat play an important role as feedstock fuels for district heating, because of their use in CHP plants. In biomass combustion systems, which are encouraged by a government subsidy scheme, currently about 70% of the fuel input is forest biomass and the remaining 30% is peat. The subsidy scheme strongly encourages the use of forest biomass. However, technical restrictions limit the share of biomass resources that can be used in boilers, and furthermore the share of forest biomass is sometimes constrained by its local availability. Peat is often co-fired with wood, as the co-firing has energetic and environmental benefits in that it increases the energy output while reducing the sulphur dioxide emissions of peat combustion. Of note, the western coast of Finland, as well as central and northern Finland, are currently not supplied with natural gas, and thus rely exclusively on coal- and peat-firing.

A strategy for the sustainable and responsible use of mires and peatlands was drafted in 2011, and further outlined through the government's decision-in-principle on its Peatland Strategy in August 2012. In the 2013 Climate and Energy Strategy update, the government indicated that it aims to reduce the consumption of peat by a third by 2025. The IEA understands that peat will continue to be needed in the energy mix of Finland to a certain extent. Nevertheless, its particularly high CO<sub>2</sub> intensity has negative impacts on the country's carbon balance, and its use will become increasingly costly if tighter CO<sub>2</sub> emissions reduction targets are set in the future.

Coal and peat make an important contribution to the diversification of Finland's electricity mix and to its energy security. Some further efficiency (over the whole life cycle) in the use of coal and particularly peat could possibly be improved through further research, development and demonstration activities, although Finland's geology does not favour carbon capture and storage projects as a feasible option for reducing CO<sub>2</sub> emissions from coal- and peat-fired plants. In order to maximise its benefits and minimise its costs, Finland's society should continue to make efforts to define the best role of coal, and particularly peat, for the longer term.

In the longer term, most coal- and peat-firing is likely to be replaced by biomass. This will have two main benefits for Finland's energy: it will maintain levels of electricity system stability with a predictable renewable energy source, and it will reduce carbon intensity.

## **RECOMMENDATIONS**

*The government of Finland should:*

- ☐ *Outline a clear vision regarding the future of coal and peat in Finland's energy mix, while continuing research into the development of new efficiency technology opportunities.*
- ☐ *Continue to assess the importance of the indigenous energy source that is peat for co-generation purposes, while paying particular attention to environmental impacts.*





## 8. NUCLEAR ENERGY

### Key data (2011)

**Gross nuclear electricity production:** 23.2 TWh

**Share of nuclear:** 17.4% of TPES and 31.6% of electricity generation

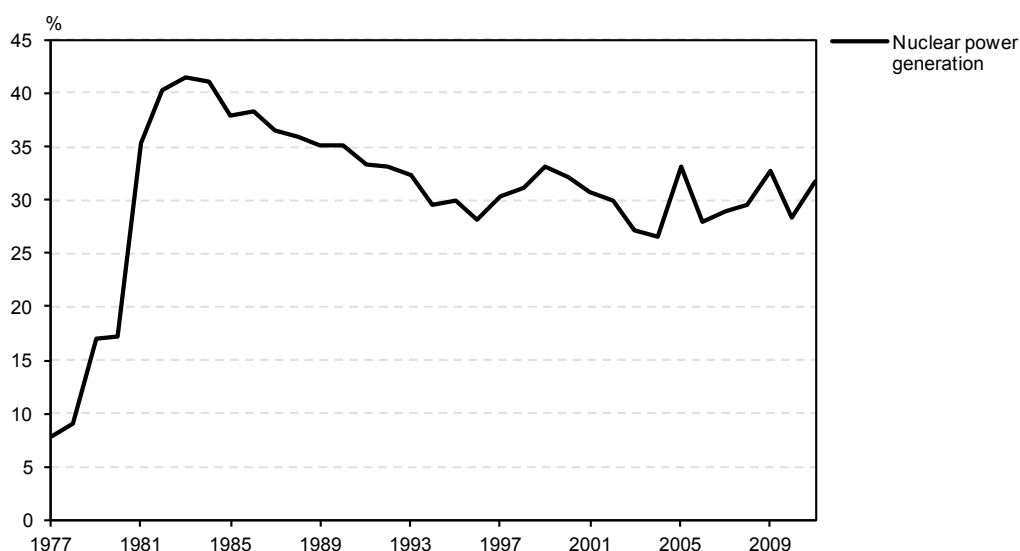
**Number of plants and units:** two nuclear power plants, Loviisa (two modified VVER-440 units in operation) and Olkiluoto (two BWR units in operation, one large PWR under construction)

**Net nuclear capacity:** 2.7 GW in operation, additional 1.6 GW to be connected in 2015

### OVERVIEW

Nuclear power plays a major role in Finland's energy sector, as the biggest single source of energy in the country's power production (and therefore the largest source of low-carbon electricity) and in terms of its contribution to the country's security of energy supply. Finland's two nuclear power plants, each with two reactor units in operation and situated in Loviisa (modified Russian VVER 440 design, operated by Fortum) and Olkiluoto (Swedish boiling water reactor design, operated by TVO), provided in 2011 31.6% of the domestic electricity production (see Figure 23) and 28% of the total electricity supply (the country imported 17% of its electricity from neighbouring Russia and from Nord Pool, the Nordic Power Exchange market).

Figure 23. Share of nuclear power in electricity production, 1977-2011



Sources: IAEA/PRIS; and Statistics Finland.

The share of nuclear-based electricity is set to increase to over 30% by 2016 with the start of commercial operation of Olkiluoto 3 (OL3), the first Generation-III reactor to be constructed in OECD Europe. This fifth reactor, almost double the size of the country's largest existing reactors, will reduce Finland's net imports as well as reduce the share of coal-fired condensing power plants which today account for around 15% of the electricity supply.

## **REGULATORY FRAMEWORK**

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The Radiation and Nuclear Safety Authority (STUK), the regulator, plays an important role in ensuring the safe operation of nuclear power. It is an independent body which is part of the administration of the Ministry of Social Affairs and Health. On 15 March 2011, the MEE requested STUK to prepare a report on how Finnish nuclear power plants could withstand extreme flooding and loss of external power and ultimate heat sink. STUK reported two months later that no immediate safety improvements were necessary at the nuclear power plants, but recommended that investigations be carried out to improve the preparation for certain exceptional natural conditions. Stress tests were also carried out within the framework set by the European Nuclear Safety Regulators Group (ENSREG). The Finnish stress test report was sent to the European Commission in December 2011, and international peer reviews are now completed. STUK organised in May 2012 a public hearing on the stress tests, which was webcasted and involved members of the public and non-governmental organisations (NGOs).

Safety improvements have been implemented continuously in Finnish nuclear power plants, with lessons learned from international operational experience being taken into account. Power uprates were also applied to both Loviisa and Olkiluoto plants (see below), resulting in increased power output. At the same time, Finland's reactors have been operating with very high load factors. Both the utilities and the government recognise that ensuring the highest levels of safety has also resulted in the best economic performance.

Under the Finnish Co-operation Programme for Nuclear Safety, STUK is also supporting Russia and Ukraine to improve the operational safety of their operating nuclear power plants, especially with regard to Russian RBMK and VVER reactors that are located close to the Finnish borders, in the Saint Petersburg area and Kola Peninsula. Co-operation includes visits of experts, transfer of know-how and sometimes delivery of safety-related hardware equipment.

## **POWER UPRATES, SAFETY UPGRADES AND LONG-TERM OPERATION**

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Finnish reactors have regularly been upgraded in terms of safety features to reflect the latest requirements, and have also undergone power uprates. For instance, the Olkiluoto 1 and 2 units, which were connected to the grid in 1978 and 1980, were rated at 658 MW each. Thirty years later, they are rated at 880 MW (+33%) and the operator TVO intends to further uprate the units to 1 000 MW. Their operating lifetime was also extended to 60 years, subject to safety evaluations every decade, with TVO claiming always to have "40 years of remaining technical lifetime". The shut-down of Olkiluoto units 1 and 2 is now forecast for 2039 and 2042 respectively.

Fortum's Loviisa VVER units, whose original design lifetime was 30 years, were also uprated from 445 MW net power to 488 MW net, and in 2007, the regulator STUK granted a 20-year lifetime extension subject to safety evaluations in 2015 and 2023. The shut-down of Loviisa 1 and 2 is now expected in 2027 and 2030 respectively.

Figure 24. Location of current and planned nuclear power plants



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Source: country submission.

## NEW BUILD: CURRENT AND PLANNED

The start of the construction of the Olkiluoto 3 reactor (AREVA's European pressurised water reactor) in 2005 under a turn-key contract between the operator TVO and a consortium led by AREVA and Siemens companies, represented the first Generation-III new build project to be launched in OECD Europe. Initially planned to be completed in 2009, the construction has suffered numerous delays and cost overruns, and the new unit is now expected to enter commercial operation in 2016. Construction delays for first-of-a-kind projects are not unexpected and reasons can include problems in setting up the supply chain, design and licensing issues, and management problems.

Lessons learned from first-of-a-kind projects are beneficial to subsequent projects, whether in the same country or in other countries for reactors of similar design. If future new build projects are to go ahead in Finland, it is therefore essential that lessons learned from the OL3 project are taken into account by the different stakeholders.

Table 3. Reactors in operation, under construction and planned

Plant and unit	Operator	Status	Type	Original net capacity (MW)	Current net capacity (MW)	First power	Expected shut-down
Loviisa 1	Fortum	In operation	Modified VVER-440/V213	445	488	1977	2027
Loviisa 2	Fortum	In operation	Modified VVER-440/V213	445	488	1980	2030
Olkiluoto 1	TVO	In operation	BWR	658	880	1978	2039
Olkiluoto 2	TVO	In operation	BWR	658	880	1980	2042
Olkiluoto 3	TVO	Under construction	PWR	1 600	-	2016 (planned)	2075
Olkiluoto 4	TVO	Planned	PWR or BWR	Range 1 400-1 600	-	2020 (planned)	2080
Hanhikivi 1	Fennovoima	Planned	PWR or BWR	Range 1 400-1 600	-	2020 (planned)	2080

Note: BWR = boiling water reactor; PWR = pressurised water reactor; VVER = water-water energy reactor.

Sources: WNA, IAEA; and other media sources.

The utilities are ensuring that the Finnish workforce that would be involved in the projects will be much better prepared to deal with them by taking several actions such as organising training sessions. With respect to the licensing process, STUK has evaluated its own processes and found that they were already streamlined. International co-operation within initiatives such as MDEP (Multinational Design Evaluation Programme), which leverages the resources and knowledge of national regulatory authorities involved in reviewing new reactor plant designs, is seen by STUK as a means to accelerate the future licensing of reactors.

In May 2010, the government made positive decisions-in-principles (DIPs) for the construction of two further units, TVO's Olkiluoto 4 unit, and a unit in either Pyhäjoki or Simo to be

operated by a newcomer on the market, Fennovoima (in May 2011, Fennovoima announced that it had chosen the site of Pyhäjoki, with the planned unit to be called Hanhikivi 1). On the other hand, the proposal of Fortum to build a third unit in Loviisa was turned down. The Parliament ratified these decisions in July 2010. Criteria that were taken into account when making DIPs include the energy needs of the country, the suitability of sites and their environmental impacts, and the existence of plans for the management of nuclear fuel and waste.

TVO and Fennovoima are power companies which operate under the so-called Mankala principle,<sup>18</sup> namely the production of electricity at cost for its shareholders, which include industry companies, and regional and local power companies (supplying municipalities). The Parliament approved these DIPs with almost a two-thirds majority. Arguments stated by the government to support this decision included climate and energy strategy targets such as overall reduction of greenhouse gas emissions and self-sufficiency in electricity production, and the improved competitiveness of Finnish industry, which is highly energy-intensive (the wood and paper industries alone represent 25% of the electricity consumption), since electricity from these two units will be provided at cost to their owners. If these two projects are completed, nuclear power will represent almost 60% of Finland's electricity demand by the mid-2020s. This share would then decrease as the oldest units, Loviisa 1 and 2, reach the end of their extended lifetime in 2027 and 2030.

For its Olkiluoto 4 project, TVO is considering five designs, which will be either BWR designs (Toshiba/Westinghouse ABWR or GE Hitachi's ESBWR) or PWR designs (AREVA's EPR, KHNP's APR1400 or Mitsubishi's APWR), with bids to be submitted in early 2013. For Hanhikivi 1, Fennovoima received bids from two vendors in early 2012, and will select either Toshiba's ABWR or AREVA's EPR in early 2013. Table 3 summarises the status of the current and future nuclear reactor fleet in Finland, and Figure 24 shows the location of these plants.

## NUCLEAR WASTE MANAGEMENT AND FUNDING

The spent fuel policy was set up several decades ago, with the decision by the government in 1983 to consider deep geological disposal as the solution for high-level radioactive waste management. According to the Nuclear Energy Act of 1987, decisions-in-principle regarding nuclear energy activity should be made taking into account the energy needs of the country, the suitability of sites and environmental impacts associated with the activity, and the existence of a nuclear fuel and waste management plan.

The Posiva Company was set up in 1995 as a subsidiary of the country's two nuclear operators, TVO (60%) and Fortum (40%), to manage the spent fuel from the existing four reactors. The existence of a solution to spent fuel management was seen as a key factor enabling the DIP regarding the Olkiluoto 3 project. The current plan for the deep repository (over 400 metres below the sea level) to be built in Olkiluoto, addresses the needs of Olkiluoto units 1 to 4 and Loviisa 1 and 2, namely a capacity of around 9 000 tonnes of uranium (tU).

18. The Mankala-principle is a widely used business model in Finland, and notably in the electricity sector, whereby a company operates like a zero-profit-making co-operative for the benefit of its shareholders. The costs are distributed in proportion each shareholder's stake in the company, and ownership gives each shareholder a proportional share of the produced electricity.

The application for the construction licence was made in 2012, with the disposal of spent fuel to start in 2020. A DIP to consider the extension of the geological repository's capacity to 12 000 tU, also accounting for the additional waste that would be generated from a future reactor, Loviisa 3, was rejected.

When operational in 2020, the repository will be the world's first deep geological disposal for high-level waste. Sweden's waste disposal site is planned to begin operation in 2023, and France's site in 2025. Finland's waste management programme has so far been exemplary in the way stakeholder involvement was incorporated in the decision-making process. From a technical point of view, cost-sharing co-operation with Swedish waste company SKB has also been beneficial to improve the knowledge and technology associated with deep geological disposal of nuclear waste.

A large share of Finland's nuclear energy research (see below) was also devoted to waste management. Posiva is also involved in EU research initiatives such as promoted by the Implementing Geological Disposal of Radioactive Waste Technology Platform (IGDTP). Every three years, operating licence holders are required to present a six-year research plan (detailed for the first three years), and these research, development and demonstration (RD&D) programmes are evaluated every year by the regulator STUK.

As mentioned above, a positive DIP was made in 2010 concerning a new reactor unit to be operated by Fennovoima, which has since chosen the site of Pyhäjoki. The DIP was conditional on the utility providing a spent fuel management plan by 2016. Fennovoima has to present either an agreement on nuclear waste management co-operation with the current parties liable for nuclear waste management or an environmental impact assessment (EIA) programme of its own regarding the final disposal facility for spent nuclear fuel.

The MEE has set up a steering committee involving Posiva, its shareholders, and Fennovoima, tasked to collect existing material for comparison, to perform a preliminary comparison of the final disposal alternatives and to give recommendations for further work by the end of 2012. As a last resort, the government can enforce a decision concerning the way to address the waste management needs of Fennovoima.

Nuclear power companies in Finland contribute to the State Nuclear Waste Management Fund which covers treatment, storage and final disposal of spent fuel and other radioactive waste, as well as the decommissioning of the nuclear facilities. The cost of nuclear waste management and decommissioning amounts to about 10% of the total electricity production cost.

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## URANIUM MINING

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All the uranium used in Finland's nuclear reactors is imported, in the form of manufactured fuel assemblies. Both Russian and Western companies supply VVER fuel for the Loviisa nuclear power plant. German, Swedish and Spanish companies manufacture the BWR fuel for the Olkiluoto 1 and 2 units, with uranium originating from the main producing countries – notably Canada, Australia and Niger – and enriched in Russia or in Western Europe.

Finnish nickel- and zinc-mining company Talvivaara was planning to start producing uranium as a by-product from its mine in the north-east of Finland as of the end of 2012, with the technical assistance of uranium-mining company Cameco which has agreed to buy the

production until 2027. Talvivaara estimates that it could produce up to 350 tonnes of uranium metal per year, which would roughly double Europe's production (essentially located in the Czech Republic at present), which represents about 1% of the world's production. In addition to the licensing based on the Mining Act and other legislation (relating to environmental protection, nature conservation, land use and building, etc.), production of uranium also requires a licence from the government according to the Nuclear Energy Act. This licence was granted by the Finnish government in March 2012. The licence decision has, however, been appealed and the decision of the Supreme Administrative Court is still pending. Furthermore, the granting of the environmental permit to mine, which was expected later in 2012, has been delayed because of a large number of appeals by citizens and NGOs, and is now expected in early 2013, delaying by some months the production plans of Talvivaara.

## HUMAN RESOURCES, EDUCATION, TRAINING AND RESEARCH

The planned expansion of nuclear power in Finland will require significant human resources, especially given the ageing of the current workforce in the Finnish nuclear sector, estimated today at around 3 000 by the MEE. In a recent report, the ministry has evaluated that around 2 400 new persons will need to be hired in the nuclear energy sector by 2025, covering all levels of qualification, from vocational level to higher university level. Universities offering educational programmes in the area of nuclear energy, such as the University of Lappeenranta, are confident that the growing nuclear power sector and the promise of jobs it offers will attract large numbers of students to educational programmes of nuclear energy-related courses. The country also expects to attract needed skills from abroad, in spite of the language barrier.

To support the development of nuclear energy, continuous efforts in R&D are needed in all areas of the sector, from operational safety to waste management and decommissioning. Today, Finland's research effort (EUR 73.5 million in 2010) is largely funded by the power companies (about 72%), and is essentially dedicated to applied research in waste management (68%) and reactor safety (20%). Responding to the Fukushima Daiichi accident, the Finnish research stakeholders have decided to focus more research efforts on beyond-design accidents. Funding for basic research as well as for advanced nuclear technology such as Generation-IV fission systems has been more limited. This will need to be increased, as a means to create competence and to attract skills from within the country and abroad.

## INVESTMENT FRAMEWORK AND TAX ENVIRONMENT

Although responsible for setting the overall institutional framework necessary for the safe operation of nuclear reactors, the Finnish state is not involved in the investment decisions taken by the utilities, nor does it provide subsidies. The decisions to invest in nuclear power are taken by the utilities on economic grounds. The Mankala principle which allows investment risks to be shared by the utility co-owners, can be seen as an effective way to address the challenge of financing the large capital investment costs that characterise nuclear new build. This co-operative model is a unique funding mechanism that has been and continues to be used in Finland, and is being studied by other countries.

The entry into force of the EU Emissions Trading Directive in 2005 brought significant extra profits, especially for hydropower and nuclear power producers. Since 2006, there are plans to tax these windfall profits. Introduction of a windfall profit tax is now included in the government programme. The tax revenue target for the windfall tax is set at EUR 170 million per year. The tax is not aimed at reducing the viability of ongoing or future investments in low-emission technologies.

Therefore, the tax is limited to the hydropower and nuclear power production capacity that was in place before the Kyoto agreement and the EU Emissions Trading Directive. Later investments would not be subject to the windfall tax. Thus, the contradiction between the tax and the promotion of low-carbon energy technologies is avoided. In 2005, it was estimated that the windfall profits totalled EUR 500 million, based on the Nordic production capacity and a carbon price of EUR 15 per tonne of CO<sub>2</sub>. Now, as the carbon price is around EUR 3 per tonne of CO<sub>2</sub> (as of late April 2013), the windfall profits are much lower than estimated.

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## ASSESSMENT

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Finland's approach to the use of nuclear energy is commendable in many respects: a high level of transparency, extensive consideration for stakeholder involvement in decision-making processes, high safety standards promulgated by the independent regulator and implemented by the nuclear operators, efficient operation of the nuclear power plants which have among the world's highest load factors, and a well laid-out strategy for the management of high-level radioactive waste.

The long-term plans for the use of nuclear power have been clarified with positive DIPs concerning the construction of two additional units beyond the completion of the Olkiluoto 3 project, which, if realised, could raise the share of nuclear electricity to 60% in the mid-2020s, and help the country achieve its objectives in terms of reduction of greenhouse gas emissions and security of energy supply.

The government does not intervene directly in investment decisions taken by nuclear operators, nor does it provide any subsidies. Decisions are left to utilities, which have also the responsibility for the management of spent fuel. The current nuclear operators, TVO and Fortum, have worked together through their subsidiary Posiva to fund the R&D efforts to construct the world's first geological repository for high-level waste. At the same time, this set-up may limit the ability of newcomers such as Fennovoima to enter the market, since any future licence for the construction of a nuclear reactor will require the existence of a plan for the management of the spent fuel, including access to deep repository space.

Given the size of the country, the ambitious nuclear energy development plans require the availability of adequate human resources. The Finnish government has addressed the question with a detailed analysis of required skills and competences, taking into account the future retirement of part of the existing workforce. In terms of supporting R&D, greater public support to fission research activities, including for the long term, would complement the current efforts by industry to ensure that Finland possesses the highly skilled professionals needed across the nuclear sector.



**RECOMMENDATIONS**

*The government of Finland should:*

- ☐ *Continue to promote education and training to provide the necessary skills to address the needs of the growing nuclear energy sector and the challenge of an ageing workforce; provide a framework to attract skilled personnel from abroad; and further support research in areas that are needed to develop a broad competence base.*
- ☐ *Continue to promote discussions between the Finnish nuclear actors to come to a solution regarding the spent fuel management for all existing and future nuclear reactors that is acceptable to all stakeholders, and above all, does not undermine public confidence in a technical solution that is essential to the public acceptance of nuclear energy.*
- ☐ *Continue to encourage the Finnish nuclear utilities, the waste management company and the regulator to share best practice experience with their international counterparts, including public stakeholder involvement in decision-making processes.*
- ☐ *Clarify quickly the conditions under which a tax on windfall profits, if established, would be applied to nuclear power generation, and whether such a tax could apply to new reactors, taking into account the potentially detrimental effects on the fulfilment of the country's climate change goals.*



## 9. RENEWABLE ENERGY

### Key data (2011)

**Share of renewables:** 26.5% of TPES and 33.6% of electricity generation (IEA averages: 8% and 19%)

**Hydropower:** 3.1% of TPES and 16.9% of electricity generation

**Biofuels and waste:** 23.3% of TPES and 15.6% of electricity generation

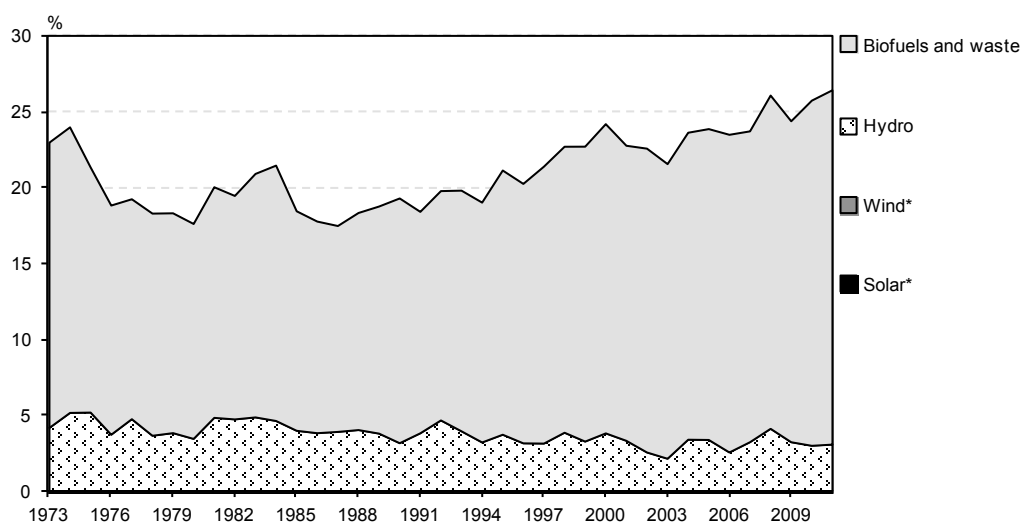
**Wind:** 0.1% of TPES and 0.7% of electricity generation

## SUPPLY AND DEMAND

### RENEWABLE ENERGY SUPPLY

The share of renewable energy in Finland's TPES was 26.5% (9.2 million tonnes of oil-equivalent (Mtoe) in 2011 (Figure 25). Finland thus ranks fifth in terms of the share of renewable energy among IEA member countries (Figure 26).

Figure 25. **Renewable energy as a percentage of TPES, 1973-2011**



\* Negligible.

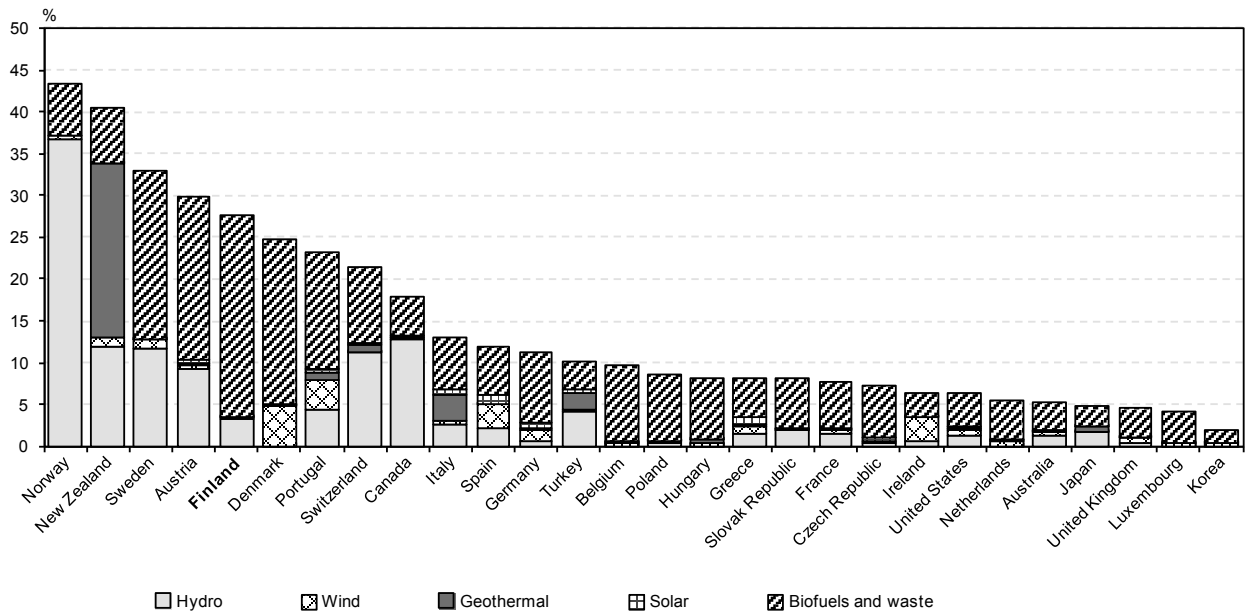
Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012; and country submission.

Biofuels and waste were the largest category of renewable energy in Finland, at 8.1 Mtoe, 23.3% of TPES in 2011. Finland ranks first among its IEA peers in terms of its share of biomass in TPES. Biofuels and waste can be broken down into primary solid biomass

(93.1%), industrial and municipal wastes (3.6%), liquid biofuels (2.8%) and biogases (0.5%). The share of solid biomass is particularly high compared to most IEA member countries; solid biomass contributes 22% of TPES, while the IEA average is around 3%.

The second most important renewable energy source is hydropower, accounting for 3.1% of TPES in 2011. The amount of energy generated from wind (0.1% of TPES) is small in comparison, but has been growing steadily over the last years. Other renewable energy sources made a negligible contribution to the total energy mix: solar energy represented 0.003% of TPES in 2011, and there is no generation of geothermal energy.

Figure 26. Renewable energy as a percentage of TPES in IEA member countries, 2011



Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012; and country submission.

## ELECTRICITY, HEAT AND TRANSPORT

Renewable energy sources represented 33.6% (24 TWh) of total electricity supply in 2011, virtually unchanged from 23 TWh in 2000 and in line with the ten-year average of 23 TWh per year. Finland ranks ninth among IEA member countries in terms of the share of power generated from renewable sources (see Figure 27).

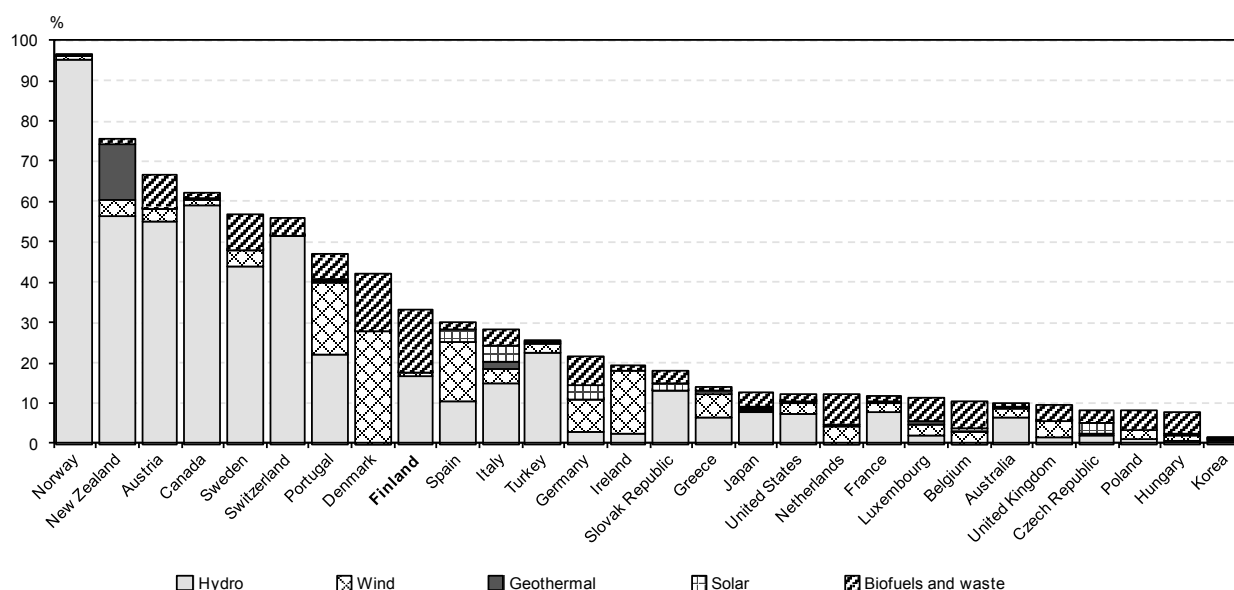
Hydropower was the most important source of renewable electricity in 2011, accounting for 50% (12.5 TWh) of total renewable electricity generation, followed by solid biomass at 43% (10.6 TWh). Total biofuels accounted for 46% of renewable electricity generation (11.4 TWh). Although electricity generation from wind grew rapidly from 80 MWh in 2000 to 480 MWh in 2011, it plays only a minor role in Finland's electricity supply to date (2% of renewable electricity supply in 2011), as do other renewable sources.

While the potential for further expansion of hydropower in Finland is very limited, electricity generation from biomass and wind are expected to increase considerably until 2020.

Renewable sources accounted for 36.4% (67.6 PJ) of Finland's heat production in 2011, up from 23.3% (34.9 petajoules) in 2000. Solid biomass, used for electricity generation in more than 400 medium- and large-scale biomass CHP plants and to a smaller extent in

heat-only plants, accounted for 98.2% (66.4 PJ) of total renewable heat production in 2011. Municipal solid waste (3.8 PJ) was the second-largest source of renewable heat, followed by sludge and landfill gas that together accounted for 0.3 PJ, or 0.5% of total renewable heat production.

Figure 27. Electricity generation from renewable sources as a percentage of all generation in IEA member countries, 2011



Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012; and country submission.

In the transport sector, the government has set a non-binding 6% biofuels target for the 2011-14 period. Biofuels accounted for 4.2% (182 000 tonnes of oil-equivalent) of total transport fuel in 2011. In road transport specifically, the target or distribution obligation for biofuels in 2010 was 4%. Data from Statistics Finland indicate that biofuels accounted for 4.2% (7 042 terajoules or 168 ktoe) of total road transport fuel in 2010.

## INSTITUTIONS

The **Ministry of Employment and the Economy (MEE)** is responsible for policies relevant to the support of renewable energy in general. The ministry takes decisions on the provision of the Energy Aid (investment subsidy) for large projects and projects with new technology. There are 15 Centres for Economic Development, Transport and the Environment that manage the regional implementation and development tasks of the state administration, and as such are responsible for taking decisions on smaller renewable energy projects.

The **Energy Market Authority (EMA)** enhances and monitors the activities of the electricity and natural gas markets and enhances the realisation of climate goals. The renewable energy unit within the EMA designs, implements and administrates the feed-in premium system for electricity. Subordinated to the MEE, the EMA fulfils its supervision task in co-operation with the ministry, the **Finnish Competition Authority** and various other authorities.

The **Ministry of Agriculture and Forestry** is responsible for procedures concerning the production of forest and agricultural biomass and is also in charge of support schemes for renewable energy on farms.

The **Ministry of the Environment** is responsible for the Land Use Planning and Building Act, the general law concerning spatial planning. It is also in charge of the Land Use and Building Decree and the Act and Decree on Environmental Impact Assessment Procedure that defines the prior assessment of environmental impacts in cases where the project involves significant adverse impacts on the environment.

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## POLICIES AND MEASURES

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### OVERVIEW AND TARGETS

Finland's renewable energy policy is mainly driven by EU policies. Under the EU Renewable Energy Directive,<sup>19</sup> Finland is required to increase its share of renewable energy from 28.5% of gross final consumption in the base year 2005 to 38% in 2020. This is the third-highest share among EU member states. In the transport sector, Finland has adopted an ambitious target of 20%<sup>20</sup> renewable energy by 2020, twice the mandatory share defined under the EU Renewable Energy Directive.

While the 38% renewable energy target is binding, the manner in which an individual member state achieves it is left to its own discretion. The directive obliges member states to develop a National Renewable Energy Action Plan (NREAP). Finland's NREAP indicates that 124 TWh of renewable energy will be needed to meet the 2020 target. More specifically, 47% of gross final energy consumption in heating and cooling and 33% of electricity consumption should be met with renewable sources in 2020, in addition to 20% renewable energy in transport. The share of renewable energy in the country's energy mix has been increasing steadily in recent years and, according to the government's internal scenario, Finland is currently on track to meet its 2020 targets for renewable energy supply.

The NREAP specifies that biomass will be a key component to reach the 2020 target, accounting for a total of 103 TWh of final energy consumption. This will require a total increase of 27 TWh compared to 2005 levels, most of which is expected to come from domestically produced wood chips. Domestic resources in form of residues from the pulp and paper industry, as well as small-diameter wood from thinning of young stands, seem to be sufficient to provide the biomass supplies required to meet the 2020 targets. However, the reliance on the pulp and paper industry to provide biomass in the form of by-products is a potential problem, given the uncertain future of the sector. Supplies of small-diameter wood are also subject to some uncertainties, mainly with regard to the relatively high harvesting costs. The 2013 national Climate and Energy Strategy, therefore suggests to further develop the logistics of harvesting and transporting forest biomass in order to create viable supply chains.

In addition to the EU 2020 targets, the strategy sets a very ambitious target for replacing 10% of natural gas with bio-synthetic natural gas (bio-SNG).

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19. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources, amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

20. This takes into account the double-counting provisions under the EU RED that allow for advanced biofuels from wastes and ligno-cellulosic materials to be counted twice against the target.

With most of the economic potential already exploited, and nature conservation rules preventing new construction of large hydro projects, the potential for expanding the current 3 140 MW of installed hydropower capacity is limited. Finland's NREAP therefore indicates that by 2020, hydropower would have to contribute 14 TWh, compared to 13.6 TWh in the 2005 base year.

Wind power, on the other hand, is currently underdeveloped compared to the potential for this resource. The government has introduced a target of 6 TWh of wind-generated electricity by 2020, which requires a total of 2.5 GW of wind capacity, a considerable increase compared to the 200 MW installed by the end of 2011.

In its 2013 Climate and Energy Strategy update, the government indicated that it was setting a new target of 9 TWh of wind-generated electricity by 2025. The government recognises that solutions will have to be found to address obstacles other than those merely relating to finance, and the updated strategy makes proposals for the construction of wind power plants that extend to improved design and permit procedures.

## ELECTRICITY

Finland has introduced the Energy Aid Scheme that provides direct financial support for projects using innovative renewable energy technologies, and energy efficiency measures in power generation as well as for heating and cooling. The funding for plants which are part of the EU Emissions Trading Scheme is limited to the share of new technology used in the plant. The amount of support provided is maximum 40% of total investment for new renewable energy technologies (30% in the case of solar photovoltaic; and 25% in the case of small wind power) and depends on the size of the project, the specific technology used, and the cost-effectiveness of the project. In 2008-11, around EUR 240 million were distributed to renewable energy projects, roughly half of which was allocated to projects using wood biomass.

Under the Electricity Market Act, Finland provides guaranteed network access to all electricity installations, including renewable energy installations. The systems operator, Fingrid, is obliged to connect all power generating installations that meet technical requirements. Grid connection costs are to be paid for by project developers, whereas costs for grid reinforcements are to the largest extent possible socialised.

In January 2012, the fixed production support for existing and/or small hydropower, wind power, power from biogas and power from wood chips was abolished. One of the key incentives to promote the generation of electricity from renewable sources is now a market-based feed-in premium for renewable electricity. The premium was introduced in March 2011, and guarantees a price of EUR 83.5/MWh. Two types of feed-in premium exist, one of which is provided for electricity generated from wind, biogas, and small CHP plants using wood fuel. This premium covers the price difference between the technology-specific target price for electricity (see Table 4) and the three-month average spot market price. An additional heat bonus is provided for biogas and small wood-fired CHP plants (see below). The premium is guaranteed for 12 years, and can only be amended with a two-year advance notice.

A capacity cap has been established for different technologies that limits the maximum capacity of wind power eligible to the feed-in premium to 2 500 MW, that of biogas digesters to 19 MW, and that of small wood-fired CHP plants to 150 MW.

Table 4. Summary of requirements and level of the feed-in premium for renewable electricity

	Wind power	Power from biogas	Power from wood chips	Power from small wood-fired
<b>Requirements</b>	>500 kVA (only new plants*)	>100 kVA (only new plants*); only from biogas reactors**); CHP generation optional	100 kVA (old and new plants***); plants do not receive subsidy as small wood-fired CHP	100 kVA <8 MVA; (only new plants*); CHP generation
<b>Receiver of the subsidy</b>	Power generator	Power generator	Power generator	Power generator
<b>Target price</b>	EUR 83.5/MWh; EUR 105.3/MWh maximum three years, until end of 2015	EUR 83.5/MWh + heat bonus of EUR 50/MWh (if CHP generation)	n/a	EUR 83.5/MWh + heat bonus of EUR 20/MWh (if CHP generation)
<b>Feed-in premium</b>	Target price – spot price of electricity	Target price – spot price of electricity	Premium depending on EU-ETS allowance price; EUR 18/MWh if <EUR 10/t CO <sub>2</sub> ; premium decreases linearly to EUR 0/MWh when allowance price is EUR 23/tCO <sub>2</sub>	Target price – spot price of electricity max EUR 0.75 million/year per plant

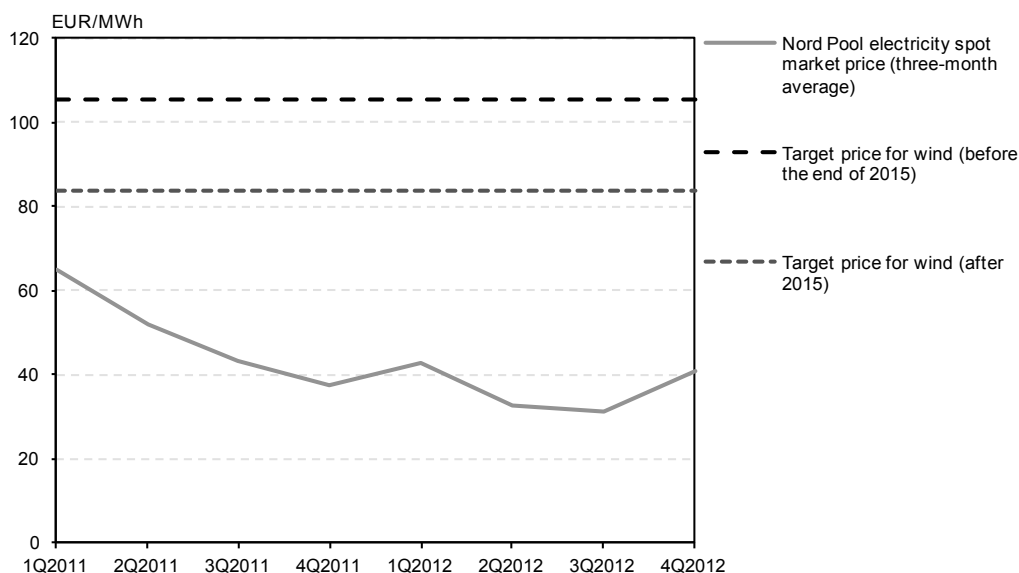
\* If commercial operation of the plant has started after 1 January 2009 and investment subsidies (if received) are paid back, plants are eligible to feed-in premium.

\*\* Biogas from landfills is not eligible.

\*\*\* Subsidy compensates only the difference between the running costs of wood chip fuels and peat/fossil fuels including CO<sub>2</sub> price. The subsidy does not cover the investments.

Note: for a more detailed table, consult the Energy Market Authority's website: [www.emvi.fi](http://www.emvi.fi).

Figure 28. Feed-in premium electricity target price compared to three-month average electricity spot market price, 2011-12



Note: A EUR 50/MWh heat bonus is granted for CHP operation for biogas and a EUR 20/MWh heat bonus for small-scale biomass.

Sources: Nord Pool Spot (2012); Elspot prices (2013); and Energy Market Authority (2010), Act on Production Subsidy for Electricity produced from Renewable Energy Sources.



A different type of feed-in premium is provided for electricity generated from wood chips. This premium aims at offsetting the cost difference between wood chips and peat so as to encourage the use of wood chips. The level of the premium is EUR 18/MWh if the emission allowance price under the European Emissions Trading Scheme is EUR 10/tCO<sub>2</sub> or less. It decreases linearly with an increasing emission allowance price, and is eliminated if the emission price reaches EUR 23/tCO<sub>2</sub> or more. The premium will be reduced as the tax on peat increases from EUR 1.9/MWh today to EUR 4.9/MWh in 2013 and EUR 5.9/MWh in 2015.

The feed-in premium system is financed by the government's budget, since the constitutional law in Finland does not allow for the costs to be paid by end-users. The total costs of the support scheme are monitored and are projected to increase from EUR 120 million in 2012 to EUR 250 million in 2020.

To spur the development of offshore wind installations, dedicated support of EUR 20 million will be provided so as to demonstrate the feasibility of offshore wind farms in Finland's harsh climatic conditions. According to government estimates, this support should lead to the deployment of at least 50 MW of offshore wind capacity in the next years.

## HEATING AND COOLING

Finland's 2020 renewable energy target of 47% of gross final energy consumption in heating and cooling will require a considerable increase in the use of renewables in this sector. Wood-based biomass will play an essential role in meeting this target.

Renewable heat is principally supported through two mechanisms. Under the feed-in premium scheme outlined above, a bonus for the production of heat is provided for generation of heat from CHP plants using biogas (EUR 50/MWh) and wood (EUR 20/MWh). The bonus is subject to minimum efficiency criteria of 50% overall conversion efficiency for plants smaller than 1 MW, and 75% for plants of more than 1 MW.

The Energy Investment Aid, under which financial support for renewable energy technologies is provided, promotes also the production of renewable heat. Finland's Progress Report 2011 to the European Commission (EC) states that the Energy Investment Aid has enabled significant support for the replacement of oil boilers with wood-fired heating systems.

According to the NREAP, renewable energy production by heat pumps will be increased to 8 TWh by 2020. Investments in heat pumps in renovated buildings will be supported with investment grants. According to the revised requirements concerning the energy efficiency of buildings which entered into force in 2012, heat generated by an air-source heat pump can be taken into account when calculating a building's total energy consumption. This should encourage the deployment of this technology.

On another note, the rapid deployment of smart electricity meters that allow for application of hourly electricity tariffs could promote the use of wood as a source of extra heating at times of high electricity prices.

In the 2013 Climate and Energy Strategy, the government mentions plans to explore the feasibility to introduce a mandatory biofuel distribution quota for heating oil.

## TRANSPORT FUELS

The domestic targets for biofuels are set through the Law on the Promotion of Biofuels Use in Transport (446/2007) that came into force in 2008, and was revised in 2011. The law sets the obligation for use of biofuels at 6% of transport fuel for 2011-14, rising progressively to 20% by 2020 (see Chapter 5 for details regarding motor fuel blending requirements). This is twice as high as the mandatory target under the EU Renewable Energy Directive. Biofuels accounted for 2.8% of total transport fuel, and 4.2% of road transport fuel in 2010.

A key element to meet this ambitious target is the use of biofuels produced from wastes and advanced (second-generation) biofuels, whose contribution can be counted twice towards the targets according to rules set out in the Renewable Energy Directive.<sup>21</sup> Finland was one of the first EU member states that adopted this double-counting rule for biofuels.

The use of biofuels is promoted by a 50% tax reduction of the CO<sub>2</sub> component compared to fossil fuels for conventional (first-generation) biofuels complying with the mandatory EU sustainability criteria. For advanced biofuels produced from wastes and residues, as well as ligno-cellulosic biomass, a 100% tax reduction of the CO<sub>2</sub> component is provided in addition to counting their contribution twice towards the blending mandate.

Since 2007, the development of advanced biofuel and biorefinery projects has been promoted through the “BioRefine – New Biomass Products”. The programme was launched by TEKES – the national funding agency for technology – and provides an estimated EUR 250 million of funding over the 2007-12 period. The aim of the BioRefine programme is to promote the commercialisation of biorefineries, by transferring existing biomass know-how and promote co-operation between companies in the energy and forestry sector into new areas.

Several innovative projects covering various parts of the biorefinery supply chain have been financed under the BioRefine project. Promising progress has been made with some commercial-scale advanced biofuel projects currently under construction, or in an advanced planning phase.

In October 2012, the European Commission presented a draft proposal for an amendment of the renewable energy target under the Renewable Energy Directive. The proposal aims at limiting the contribution of conventional biofuels to 5% of transport energy consumption. It also suggests that the contribution of certain biofuels produced from wastes and residues should be counted four times towards the targets. As the proposal is currently under review, it is unclear what the final legislation will look like and how it will impact Finland’s biofuel targets.

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## ASSESSMENT

Finland has abundant renewable resources, including biomass and hydro that have traditionally played an important role in the country’s energy supply. The targets for renewable energy adopted in line with the EU Renewable Energy Directive, will drive the expansion of biomass heat and electricity, as well as wind power in the next years, for both of which there is a considerable potential in Finland.

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21. The Renewable Energy Directive states that “the contribution made by biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material shall be considered to be twice that made by other biofuels” (Article 21[2]).

Since 2011, electricity generation from wind, biogas, and small CHP plants using wood fuel is supported by a market-based feed-in premium. Electricity generated from wood chips is supported through a premium that is based on the CO<sub>2</sub> emission allowance price under the ETS, and will be lowered as the tax on peat – a fuel directly competing with biomass – is progressively increased over the coming years. The occurring costs are covered by the government budget and total spending is monitored to avoid an unbearable financial burden for the public budget.

In addition, the Energy Aid Scheme drives innovation in renewable energy technologies, and helps strengthening energy efficiency efforts. It should therefore be continued, monitoring carefully the total costs of the scheme.

According to the Finnish Wind Atlas,<sup>22</sup> there is a considerable wind potential along the Finnish south-west coast that could be exploited by means of both onshore and offshore wind turbines. However, the current cap of 2.5 GW on wind capacity being eligible for the feed-in premium will limit the growth potential of the sector. While this could be desirable in order to keep overall spending on renewable energy within affordable limits, the cap should be revisited within the context of Finland's longer-term energy strategy, taking into account the fact that technology maturity will further reduce generation costs in the future.

Despite a solid potential, administrative obstacles – in the form of lengthy and complex permission procedures – currently slow down the wind sector's development. The government has recognised these challenges and pointed out concrete measures to facilitate the speeding-up of wind power construction in its report "Promotion of Wind Power", released in April 2012. An inter-ministerial working group has been formed to address and overcome the current challenges. The general view, including from industry, is that the envisaged 2.5 GW target for wind power will be achieved before 2020, and the integration of the envisaged amount of variable electricity into the country's electricity grid should pose no problem.

The support for demonstration of offshore wind projects should be effectively implemented, and possibly enhanced, since lessons learned from these projects would prove to be valuable for further offshore projects, notably in regions with similar wintry conditions, thereby creating new export opportunities for Finland's wind and marine industry.

Finland is to be commended for its extensive use of renewable heat, namely from biomass, in industry as well as in buildings. The use of renewable heat in the buildings sector benefits from the extensive district heating networks in many parts of Finland, and the considerable number of heating plants and CHP plants capable of burning biomass that feed their heat into the district heating networks.

The ambitious plans to meet 20% of its transport fuel demand with biofuels by 2020 (taking into account double-counting provisions for advanced biofuels, and biofuels produced from wastes) will require substantial amounts of advanced biofuels. Advanced biofuels projects have received considerable funding through Tekes's EUR 250 million "BioRefine – New Biomass Products" programme. However, the successful development of some commercial projects will depend on the reception of funds under the European

22. [www.tuuliatlas.fi/powerproduction/index.html](http://www.tuuliatlas.fi/powerproduction/index.html)

Union's NER300 funding programme.<sup>23</sup> In the first call for proposals, only one out of three advanced biofuels projects received funding, and it is not clear if the other two projects will be continued.

A delay or possible abandoning of the proposed advanced biofuels projects would have a significant impact on Finland's domestic biofuel supply, and would likely make the reaching of the self-imposed 20% biofuels mandate impossible. The government of Finland should investigate how the ambitious target could be met amid this situation, and if additional support measures for advanced biofuels need to be adopted. The continuation of the BioRefine programme after 2012 should seriously be considered.

As biomass will play a key role in meeting the targets set out in Finland's NREAP, domestic biomass resources in the form of residues from the pulp and paper industry, as well as small-diameter wood from thinning of young stands will be crucial for meeting the increased demand. The potentially available biomass seems to be sufficient to provide the required doubling of current biomass supplies. However, reliance on the pulp and paper industry to provide biomass in the form of by-products is a potential problem, given the uncertain future of the sector. Supplies of small-diameter wood are also subject to some uncertainties, mainly with regard to the relatively high harvesting costs. It thus needs to be ensured that the feed-in premium described above provides sufficient incentive to mobilise these biomass resources.

Discussions at an EU level to introduce mandatory sustainability criteria for solid and gaseous biomass used for electricity, heating and cooling have been a source of concern in Finland. Forest owners, energy utilities, as well as government officials fear that the introduction of such standards and the subsequent need for biomass certification could create a bureaucratic and financial burden for small forest owners. Since small, privately owned forests account for more than 50% of Finland's total forests, such a burden could prevent the mobilisation of wood reserves from these forests that are needed to meet the envisaged targets for bioenergy in heat and electricity production.

The Finnish government and other relevant stakeholders are generally in favour of applying solid sustainability criteria for forest biomass. However, the Finnish stakeholders see existing forestry legislation and certification schemes as sufficient to guarantee the sustainability of wood used for energy production. Since 95% of Finland's commercial forests are certified under the Programme for the Endorsement of Forest Certification (PEFC), there is a strong interest to use the existing certification scheme to ensure compliance with EU sustainability criteria.

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23. NER300 is a financing instrument managed jointly by the European Commission, the European Investment Bank and member states. The principle for financing the programme is laid out in Article 10(a)8 of the revised Emissions Trading Directive 2009/29/EC that contains the provision to set aside 300 million allowances (an allowance gives the right to emit one tonne of carbon dioxide) in the New Entrants' Reserve of the European Union Emissions Trading Scheme for subsidising installations of innovative renewable energy technology and carbon capture and storage (CCS). The allowances will be sold on the carbon market and the money raised – which could be EUR 2.4 billion, if each allowance is sold for EUR 8 – will be made available to projects as they operate. For further information see [www.ner300.com](http://www.ner300.com).

## RECOMMENDATIONS

*The government of Finland should:*

- ☐ *Develop a long-term strategy for wood biomass supplies, given their importance in meeting Finland's renewable energy targets, and evaluate if support measures currently in place are sufficient to offset the cost disadvantages of using small-diameter wood for heat and power production.*
- ☐ *Actively contribute to finding a mutually acceptable solution at an EU level regarding the discussion on sustainability criteria for biomass and the development of a robust certification scheme that does not create an unacceptable burden for small forest owners.*
- ☐ *Monitor the effectiveness of the established feed-in premium in ensuring deployment in line with 2020 targets, and assess related costs in order to adjust to changing market conditions as technologies mature.*
- ☐ *Review the current feed-in premium cap of 2.5 GW for wind power before the deployment level reaches the existing cap, and possibly allow for further sustained growth in the sector both onshore and offshore.*
- ☐ *Reduce administrative barriers in planning procedures for wind power and other renewable technologies, particularly with regard to shortening lead-times and enhancing certainty for obtaining necessary permissions, by developing closer co-ordination between relevant government departments and local authorities.*
- ☐ *Monitor that the announced advanced biofuel projects begin production in time, and that the produced biofuels are made available at retail level at costs close to those of conventional fuels, possibly by providing additional financial support measures for the first-of-a-kind production units.*



## 10. ELECTRICITY

### Key data (2011)

**Installed capacity:** 16.7 GW

**Total gross electricity generation:** 73.5 TWh, +5% since 2000

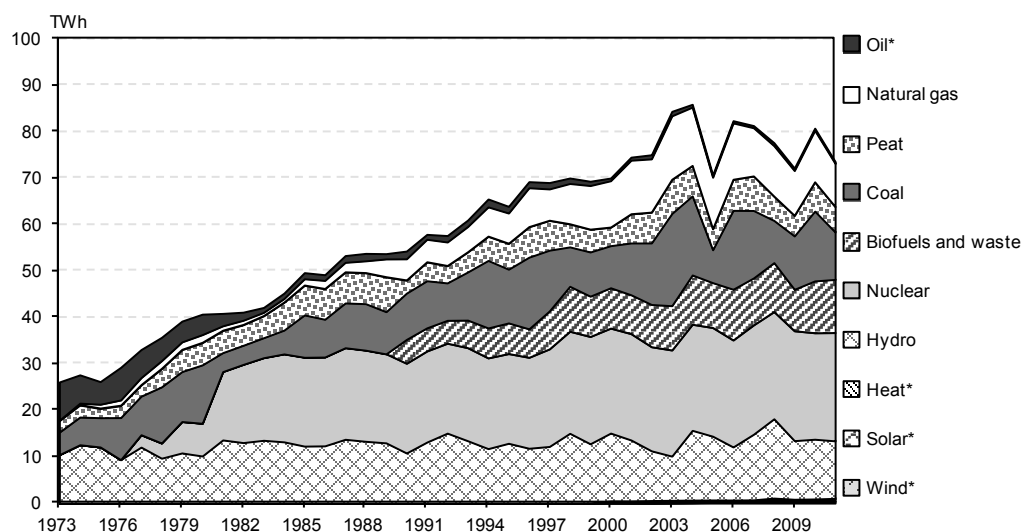
**Electricity generation mix:** nuclear 31.6%, hydro 16.9%, biofuels and waste 15.6%, coal 14%, natural gas 12.9%, peat 7.4%, wind 0.7%, oil 0.6%, other 0.3%

**Peak demand:** 15 GW

### SUPPLY

As a member of the Nordic electricity system, Nord Pool, Finland is part of a well-functioning, competitive market. It also relies on imports from Russia and Estonia and is, in general, a net importer. Unlike its neighbours, Finland's domestic resources rely to a relatively large extent on nuclear – and the share of nuclear is set to rise in the coming years – and less on hydro. It also relies heavily on combined heat and power (CHP), and notably on biomass feedstocks deriving from its sizeable forestry industry. The country has limited domestic grid congestion, but is working to expand transmission capacity at its borders in preparation for its new domestic capacity, among other things.

Figure 29. Electricity generation by source, 1973-2011



\* Negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012; and country submission.

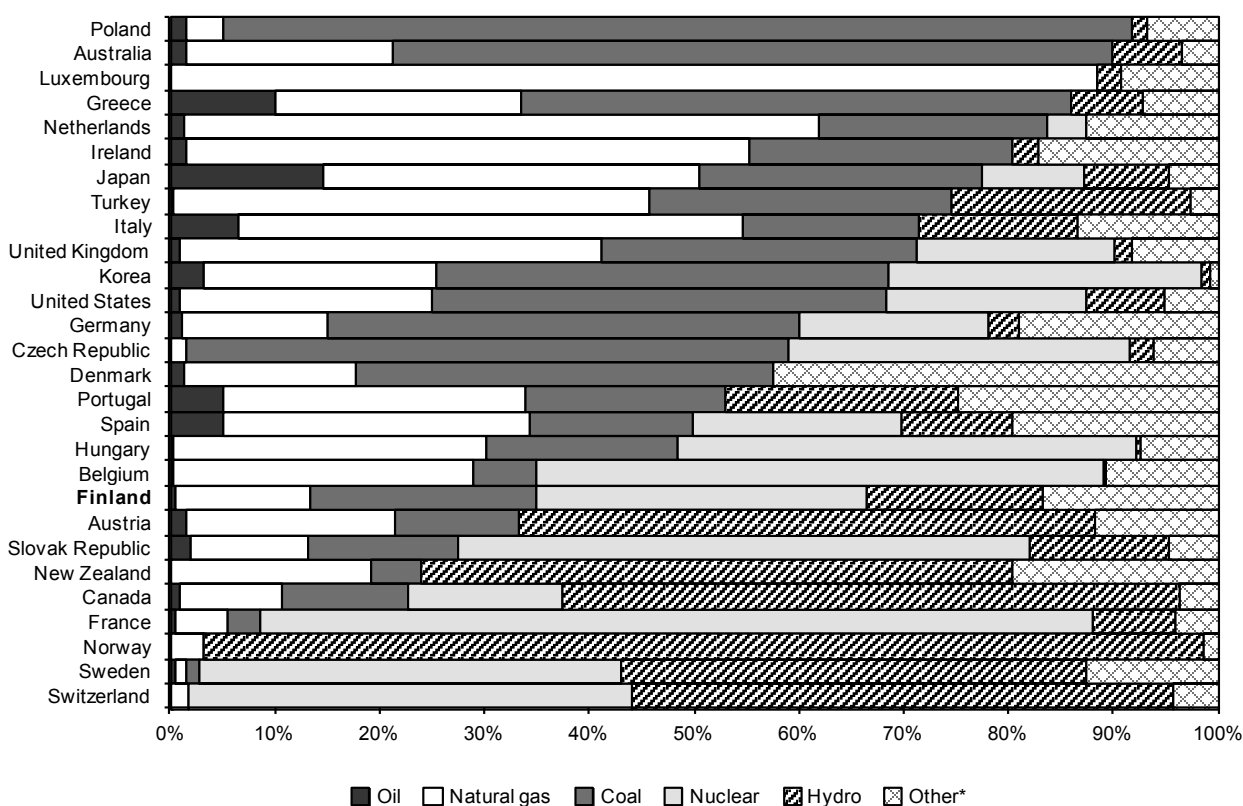
## DOMESTIC SUPPLY

Total electricity generation in Finland was 73.5 TWh in 2011, down by 8.9% from a high of 80.7 TWh in 2010, but 2% above 2009 levels (see Figure 29). Between 2000 and 2010, electricity generation grew by an annualised rate of 0.4% per year. The government forecasts that the electricity supply will continue to grow by approximately 1% per year, reaching 93.8 TWh in 2020 and 104.6 TWh in 2030.

Finland's power generation portfolio is very well diversified, compared to the relatively unbalanced energy profiles of many OECD peers. Taken together, renewable energy is the largest fuel for power generation in Finland, accounting for a total of 33.6% of total electricity generation in 2011 – hydro is the largest contributor (16.9%), followed closely by biofuels and waste (15.6%). Nuclear also plays a significant role, accounting for 31.6% of electricity production in 2011. Hydrocarbons play a comparatively low role in comparison to many OECD peers, but nevertheless remain important, with coal and natural gas contributing respectively 14% and 13% to the total output. Finland also has a unique indigenous resource, peat, which accounts for 7% of total electricity generation.

Finland's future electricity mix is expected to shift more towards renewables and nuclear, as the government pushes for a strong increase in forestry-related renewables and continues to support the construction of several new nuclear plants, due to come on line in the early 2020s.

Figure 30. Electricity generation by source in IEA member countries, 2011



\* Other includes geothermal, solar, wind, and ambient heat production.

Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012; and country submission.



## GENERATING CAPACITY

In 2011, total installed generating capacity amounted to 16 692 MW (see Table 5). Taken together, combustible fuels (thermal power) account for 64% of total installed capacity, with over 10 630 MW of installed capacity. A quarter of the combustible fuel plants are autoproducers, namely CHP plants whose primary function is to produce heat, generally for district heating purposes.

Hydroelectric and nuclear capacities are also sizeable, accounting for 19% and 16% respectively of total installed capacity. Wind capacity represents 1.2% of the total, however the installed capacity for variable other renewable sources is minimal in Finland, accounting for barely 0.01% of total installed capacity.

Table 5. **Maximum installed electricity capacity, 2011**

	Main activity producers (MW)	Autoproducers (MW)
Nuclear	2 700	
Hydro	2 961	195
Solar	7	
Wind	199	
Combustible fuels (thermal power)	8 418	2 212
<b>Total capacity</b>	<b>14 285</b>	<b>2 407</b>

Source: Ministry of Employment and the Economy.

Table 6. **Gross electricity production and average capacity factor, 2010**

	Gross electricity production (GWh)	Average capacity factor
Nuclear	22 800	96%
Hydro	12 922	47%
Solar	4	8%
Wind	294	18%
Combustible fuels (thermal power)	44 329	60%

Source: Ministry of Employment and the Economy.

Finland's nuclear capacity runs as baseload capacity, and thus runs at a high average capacity factor of 96%.<sup>24</sup> As a result, nuclear accounted for 28% of effective electricity production in 2010 and 32% in 2011.

Hydroelectricity production is however highly dependent on seasonal climatic conditions, which proved comparatively poor for hydro in 2010, resulting in an average capacity

24. Because of the cold climatic conditions, Finland's nuclear plants are generally able to run at a higher capacity factor than nuclear plants in warmer countries.

factor of 47%. Finland's limited variable renewable capacities (wind and solar) have a low capacity factor, standing at just 18% and 8% respectively.

The average capacity factor for thermal-powered plants is dependent on market conditions, including the need for heat (in the case of CHP plants), the price of electricity on the Nord Pool market, and the price of Russian electricity imports.

Some 2.5 GW of new capacity is expected to come on line over the 2012-16 period. With over 1.6 GW of additional capacity planned over 2012-16 thanks to the likely streaming of the Olkiluoto 3 plant, nuclear accounts for two-thirds of additional installed capacity. Projects still requiring permitting have not been included in Table 7. Nevertheless, the amount of wind power capacity is likely to exceed 132 GW over the coming years (see Chapter 9 for details).

**Table 7. Announced new power plant capacities by type of production, 2012-16 (GW)**

	Wind	Hydro	CHP (district heat)	CHP (industry)	Nuclear	Reserve (oil)
2012	125	19	76	12	16	300
2013	7	46	32			
2014		58	159		1 600	
2015		30	12			
2016		3				

Source: Ministry of Employment and the Economy.

## THE ROLE OF CHP IN POWER GENERATION

Total CHP generating capacity (available at peak load period) stands at 3 500 MW for district heating, with a further 2 350 MW operating for industry purposes. Co-generation for district heating produced 16.9 TWh and 14.8 TWh of electricity in 2010 and 2011 respectively, while generating 29.2 TWh and 27.8 TWh (calorific-equivalent) of district heat over the same years. Industrial CHP accounted for 11.1 TWh and 10.7 TWh of electricity over 2010 and 2011 respectively. Overall, CHP accounts for just over a third of total electricity generation in Finland.

Fifty-three new CHP plants were introduced during the first decade of the 21st century in Finland. Approximately 30% of these CHP plants are built to substitute ageing existing capacities, and 70% is new builds.

Fuel inputs for CHP are varied – natural gas, coal, peat, wood and oil products – reflecting a similar diversity to fuel inputs for the country's power production and TPES. For district heating purposes, natural gas and coal are the most commonly used fuels in southern Finland, whereas it is mainly peat and wood in the rest of the country. In (forest) industry it is wood – sawdust, bark, and black liquor – peat and natural gas. Industrial CHP production is particularly dependent on the forest industry, both for fuel inputs (often a forestry by-product) and most importantly for energy demand, as demand is strongly correlated with the economic situation.

Finland's energy policy favours CHP, but it does not receive any strong financial support as it is naturally favoured by Finland's (significant) heating needs, its economy (sizeable forestry

industry) and energy demand (large district heating network). Nevertheless, CHP does receive a small tax subsidy, in that the excise taxes on the fuels used in a CHP plant's heat production is applied to only 90% of the heat generated, and the CO<sub>2</sub> component of the tax is shared across both the heat and electricity outputs. Small-scale biogas- and biomass-fired CHP plants can also receive a subsidy via feed-in subsidy system (see Chapter 9 for details).

The electricity market regulation guarantees the open access to the network for all producers. There is thus no special priority network access for CHP producers of electricity. The dispatch is based on the price offers on the free market, and there is no priority based on production technologies.

## IMPORTS AND EXPORTS

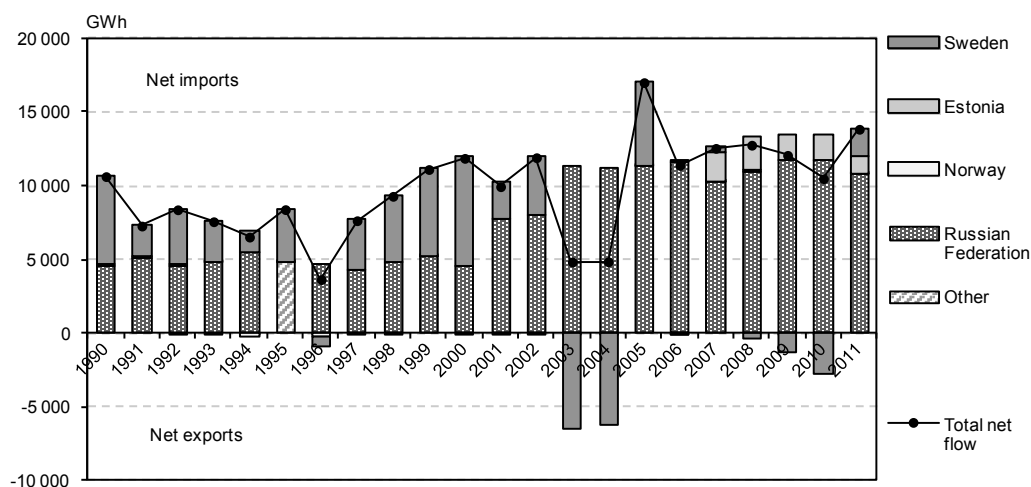
Finland has been a net electricity importer since the 1990s, importing from its Nordic OECD neighbours and from Russia.

Finland is part of the Nord Pool electricity market with Denmark, Estonia, Norway and Sweden, in which it is both an importer and exporter. On a yearly basis, approximately 19% of the Finnish electricity supply is imported. The yearly amount depends strongly on the hydro situation and electricity price in the Nordic electricity market.

Finland is further strengthening its cross-border infrastructure within the Nord Pool market. A new 650 MW direct current-interconnector to Estonia is under construction and expected for 2014. In 2011, Fenno-Skan 2, a DC-interconnector between Finland and Sweden, with a capacity of 800 MW, was completed.

Finland has also imported electricity from Russia since 1985. Import flows have risen from around 4.8 TWh in the 1990s to over 11.7 TWh in 2009 and 2010. In 2011, imports from Russia were 10.8 TWh.

Figure 31. **Exchange of electricity between Finland and its neighbouring countries**



Source: *Electricity Information*, IEA/OECD, Paris, 2012.

In its Climate and Energy Strategy the government states that the power supply should primarily be based on domestic production capacity. Furthermore, there should be enough domestic capacity to cover the demand during peak load and possible failures on international interconnectors.

The total generating capacity during peak load periods is today roughly 2 000 MW less than the peak demand. The situation will improve considerably when the nuclear power plant Olkiluoto 3 comes into operation by 2016. If all of Finland's nuclear projects are forthcoming, the country is expected to no longer require Russian electricity imports by the mid-2020s.

## DEMAND

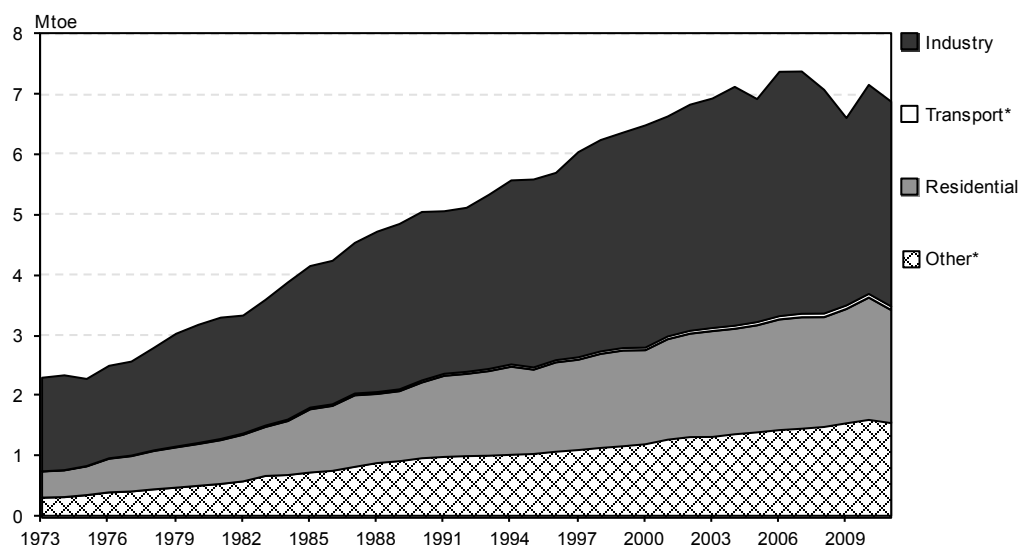
### OVERVIEW AND SECTORAL ANALYSIS

Total electricity consumption was 81.5 TWh in 2011, a decrease of 3.8% from 2010 (84.8 TWh) but higher by 4% compared to 2009 levels during the economic recession. Electricity demand is quite variable in Finland.

Compared to other IEA member countries, Finland has the second-highest electricity consumption per capita, after Canada. Electricity consumption per capita was 23.2 MWh in 2011, while the IEA average was 10.6 MWh per capita.

The main driver of electricity consumption is Finland's economic activity. The energy-intensive pulp and paper industry alone, whose electricity demand fluctuates considerably owing to economic factors, accounts for 20% to 30% of total electricity demand. Finland's industry as a whole accounted for 49.3% of total consumption in 2011.

Figure 32. Electricity consumption by sector, 1973-2011



\* Other includes commercial, public service, agricultural, fishing and other non-specified sectors. Transport is negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD, Paris, 2012 and country submission.

The electricity demand of the service sector is increasing and is expected to continue growing in the coming decades, along with the rapid growth of the service sector itself. The commercial and public services sector accounted for 22.6% of total consumption in 2011.

Although close to half of all space heating is covered by district heating, the total amount of electricity used within the residential sector is growing, and stood at 27.2% in 2011.

Growth is increasingly coming from the rising number of heat pumps, whereas electricity used for lighting, cooking and other household activities is expected to decrease.

The electricity use within the transport sector has been slowly increasing, and has stood at around 1% of total consumption in recent years. Electric vehicles are expected to increase the demand over time, but growth in this sector is expected to remain limited for the foreseeable future.

Forecasts for future electricity requirements are highly dependent on economic developments. Fingrid, the transmission system operator (TSO), forecasts a total electricity requirement of 94 TWh in 2020 and 102 TWh in 2030.

## MANAGING PEAK DEMAND

Electricity demand in Finland typically peaks during winter – because of low outdoor temperature and limited daylight hours – and is at its minimum in summer. On 18 February 2011, an all-time peak of 14 998 MW was observed. This record was caused by exceptionally cold weather conditions.

The difference between night and day consumption is relatively small, thanks to the common night-time automatic turn-on of water boilers and other electrical load such as accumulating heating at off-peak hours. This can be seen as a small peak around 10pm in the hourly load curve. The estimated annual peak load will be 15 700 MW in 2020 and 16 900 MW in 2030 according to the projections made for the Climate and Energy Strategy.

Demand-side response is an integral part of Finland's electricity balancing process. Many large electricity consumers can and will adjust their consumption according to the price of electricity, thereby attenuating Finland's peaks in demand.

Domestic electricity consumers with electric heating often have time-of-use tariffs, with tariffs varying between daytime and night-time. Sometimes the connection of the night tariff results in a small peak in consumption as heaters and other items will be connected at the same time.

Finland's electricity market legislation calls for the roll-out of smart meters by 2014, and over half of the country's 3.1 million metering points are now equipped with smart meters. The progressive roll-out of electricity meters with hourly metering and a remote-reading capability to Finnish electricity customers will ultimately also allow the residential and commercial customers to respond to and take advantage of advanced time-varying pricing of the electricity. Some degree of price-related consumer choice is possible (*e.g.* a customer's electricity price can vary on a monthly basis according to movements on the electricity stock exchange), but this remains relatively rare among residential customers. Thus far the deployment of smart metering has not yet had any significant effect on demand response behaviour.

## REGULATORY AND LEGAL FRAMEWORK

### INSTITUTIONS

The **Ministry of Employment and the Economy (MEE)** is the lead government ministry with responsibility for energy policy. In the electricity sector, the ministry determines policy in relation to security of energy supply and the functioning of the market. The ministry is

responsible for transposing EU electricity directives into national law and is responsible for the financial oversight and corporate governance of the state-owned energy companies, including the TSO, Fingrid, and the electricity generator Fortum (50.8% state-owned).

The **Energy Market Authority** (EMA) is the independent body responsible for overseeing and regulating Finland's natural gas and electricity markets and their day-to-day operation, and its role and functions have expanded over time. Finland's electricity market was gradually opened to competition after the passing of the Electricity Market Act (386/1995) in 1995. Since late 1998, all electricity users, including private households, have been able to choose their preferred electricity supplier. Aspects covered by the EMA include regulating the pricing and conditions of electricity transmission and distribution, granting licences for electrical power networks and construction of power lines, supervising the obligation to develop the electrical power network, monitoring the security of electricity supply, and gathering and publishing data on prices of network services and electrical energy. The EMA is empowered to supervise retail supply of electricity and is under the obligation-to-supply and to monitor security of supply.

The **Competition Authority** has a general mandate for supervising all sectors of the economy, including the electricity market, based on the Act on Competition Restrictions. As such, the EMA has partly overlapping jurisdiction with the Competition Authority.

Electricity network operation is run as a monopoly by **Fingrid Oyj**, for which it requires a grid permit from the EMA.

#### Box 4. **Fingrid**

The transmission network company Fingrid Oyj owns and operates the main transmission grid in Finland. The largest stakeholder is the State of Finland, with a 53.1% stake. Two mutual pension insurance companies, Ilmarinen and Varma, are the second- and third-largest stakeholders, with 19.9% and 12.2% stakes respectively.

The EMA controlling the Finnish electricity market has imposed system operator responsibility on Fingrid. Fingrid's task is to maintain national power balance management and to ensure that the Finnish electricity system is maintained and used in a technically appropriate manner. Fingrid is also responsible, together with the other Nordic grid operators, for safeguarding the necessary reserves for the operation of the electricity system.

Source: Ministry of Employment and the Economy.

## MARKET DESIGN AND REGULATION

### REFORM AND REGULATION

Reform of Finland's electricity market began in 1995 with the Electricity Market Act. The last major market reform was completed in late 1998, when small-scale customers were freed from the requirement to use hourly-metering equipment. Freedom from this requirement meant they could stay in the same grid tariff class; previously, there was a *de facto* tariff for switching retailers the first time. The market is now fully liberalised, with transmission fully unbundled from the other parts of the industry, all customers free to choose their own supplier, and a regulator in place to oversee market operations.

The EMA regulates electricity network operations and supervises the emissions trading. It is responsible for regulating 90 distribution network operators and retailers, 13 regional operators and one TSO, Fingrid.

Regulation since 1995 requires that generation, transmission, distribution and retail sales be account-unbundled. Furthermore, since 2007, network operations must be legally unbundled from other activities, with functional unbundling required for larger networks. In fact, transmission is fully independent in Finland. As a member of the European Union, Finland is bound by EU legislation. In September 2007, the European Commission adopted the third package of legislative proposals for electricity and gas markets, commonly referred to as the “Third Energy Package”, which member states are thereafter obliged to transpose into national legislation.

#### **Box 5. Non-compliance with the transposition of the Third Energy Package**

Despite the European Union having opened infringement proceedings in September 2011 for non-transposition, Finland has notified only partial transposition of the Third Package Directives. In November 2012, the European Commission referred Finland to the Court of Justice of the European Union for failing to fully transpose the European Union’s internal energy market rules of the Electricity and the Gas Directives. The Third Energy Package includes key provisions for a proper functioning of the energy markets, including new rules on unbundling of networks, rules strengthening the independence and the powers of national regulators, and rules on the improvement of the functioning of retail markets to the benefit of consumers. These directives had to be transposed by the member states by 3 March 2011. For Finland, the Commission proposes a daily fine of EUR 32 140 for the non-transposed Electricity Directive and a daily fine of EUR 28 569 for the non-transposed Gas Directive. The daily penalties would be paid as from the date of the court's affirmative ruling until Finland notifies the Commission that it has fully implemented the rules into national law.

The certification of Finland’s TSO, Fingrid, has not yet taken place. Also, articles relating to the role and duties of the regulator have not been implemented properly. Finland has indicated that the directive will be implemented during the first months of 2013.

## **MARKET DESIGN**

More than in the national context, the Finnish electricity system has to be considered as part of the regional Nordic electricity market, which comprises Denmark, Norway, Sweden and, since 2010, also the Baltic states and, through market coupling, the Central-West European markets. Virtually all power generated in Finland is sold and around three-quarters of national electricity consumption is purchased via Nord Pool Spot.

The Swedish, Norwegian, Finnish and East Danish power systems form one common synchronised zone at a frequency of 50 hertz. As part of the Nordic area, Finland forms a common bidding zone with at least one other power spot area. In 2012, the Nordic area had one common electricity price during 31% of the time, an increase from 25% in 2011 and 18% in 2010. This common price is a function of the hydrological balance, the availability of nuclear power, and demand for electricity in the Nordic countries.

In addition to being the platform for exchange of hourly physical and financial contracts for electricity, including spot and futures contracts, Nord Pool provides several other services.

It manages credit clearing for financial transactions and also operates an emissions trading market for EU-ETS credits. For more information about Nord Pool's main markets, see Box 6.

Electricity generation is dispatched according to a single market-clearing price. Capacity bids into the Nord Pool market and, transmission constraints permitting, the lowest-priced capacity is dispatched in each hour until total demand is met. The price of the last unit taken – the so-called marginal supplier – sets the price for all generation during that hour.

#### Box 6. Overview of Nord Pool: integrating the Nordic and the Baltic markets

A Northern European power market has been created over the past years through Nord Pool Spot AS as the marketplace for physical power contracts, with a spot market (Elspot) and an intra-day market (Elbas). The Nordic market is interconnected with Russia, Germany, the Netherlands, Estonia and Poland and is becoming increasingly integrated with other regional European markets, the United Kingdom, Belgium and the Netherlands, through new interconnections and market coupling – a development which will gradually lead to a Northern European and single European market for electricity.

Nord Pool has increased its share in electricity trade every year. In 2010, physical spot market trading amounted to 307 TWh, or 74% of total consumption in the four Nordic countries. In 2011, total traded volume fell slightly to 297 TWh, owing to the fall of electricity consumption in the Nordic countries. The market share of Nord Pool Spot AS is more than 50% in all the Nordic countries. In 2011, 370 actors from 20 countries were active on Nord Pool Spot's markets in the Nordic and Baltic regions, with 324 on Elspot and 95 on Elbas (in January 2011) and the United Kingdom market N2EX.

Nord Pool Spot AS is jointly owned by the Nordic TSOs, Statnett SF (28.2%), Svenska Kraftnät (28.2%), Fingrid Oyj (18.8%), Energinet.dk (18.8%) and the Baltic TSOs Elering (2%) and Litgrid (2%). The Latvian operator AST has an agreement in place to acquire 2% of Nord Pool Spot once the Latvian market is opened for trading.

On the spot market (**Elspot**), physical power contracts are traded hour by hour for delivery on the following day. The Elspot market comprises Denmark, Finland, Norway, Sweden, Estonia and, since 18 June 2012, Lithuania. Prices are determined on the basis of the balance between bids and offers from all market participants and implicit auctions are used to allocate cross-border capacity. The spot market price provides the basis for the TSOs when balancing the flow of power between the Nordic countries.

**Elbas** is the physical intra-day balancing market for trading in the Nordic countries, Estonia and Germany. If transmission capacity is available, neighbouring countries can trade on the Elbas market. It is the only cross-border intra-day market in the world, with a total volume of 2.2 TWh in 2009. TSOs publish their daily power transmission capacity on Elbas and contracts are hourly and traded continuously around the clock up to 30 minutes before delivery to adjust power production or consumption plans. The balancing market is used by power producers, energy-intensive industry, portfolio managers and traders. In January 2011, the Nordic system operators and regulators started work on a common Nordic balance settlement. In 2011 Elbas was licensed to APX-ENDEX as the intra-day market in Belgium and the Netherlands.



**Box 6. Overview of Nord Pool: integrating the Nordic and the Baltic markets** *(continued)*

There is financial trading on the Nordic power market on **Nasdaq OMX** with exchange of power derivatives and CO<sub>2</sub> allowances. Derivatives contracts can be made for up to six years with the Elspot system price used as reference price. Turnover on Nord Pool is dominated by the financial market, with financial trading reaching 2 108 TWh, an increase by 73% in comparison to 2009; 341 actors were active on the Nasdaq OMX in December 2010. Svenska Kraftnät and Statnett FT sold their financial operations to Nasdaq OMX in April 2010; Nasdaq OMX is now the sole owner of the financial market place. In 2010, N2EX market in the United Kingdom was launched by Nord Pool Spot and NASDAQ OMX Commodities.

On 9 November 2010, the Central-West Europe (CWE, covering Germany, France and the Benelux countries) price market coupling and the CWE-Nordic region Interim Tight Volume Coupling (ITVC) were launched, in a joint effort of 17 TSOs and power exchanges. This created a day-ahead market area with 1 800 TWh of annual power production, the largest of its kind in the world, and will lead to prices converging in the two areas.

Currently, the two market areas are connected by cables between Germany and Denmark, and Germany and Sweden. The NorNed cable between Norway and the Netherlands will be integrated into this system of implicit auctions of cross-border capacity.

Following the deregulation in Estonia and Lithuania in 2012, the Nordic and Baltic markets have been integrated. In March 2012 Estonian, Latvian and Lithuanian electricity TSOs Elering, Augstsprieguma Tīkls and Litgrid signed a Memorandum of Understanding on the purchase of the shares of the Nord Pool Spot. The Nord Pool Spot Lithuanian bidding area was put in place. Agreement on Power Exchange Operation in the Republic of Lithuania between Litgrid and Nord Pool Spot was signed. In Latvia, the certification procedure of AST as an independent system operator was to be completed in 2012 and AST was to acquire 2% of the shares of Nord Pool Spot. A project with Nord Pool Spot has been initiated towards launching a Latvian bidding area.

In addition to power trade, Nordic TSOs also co-operate on security of electricity supply within the Nordic Contingency Planning and Crisis Management Forum (NordBER), which includes cross-border contingency planning and crisis management; risk and vulnerability assessment; a mutual contingency plan; resource planning and sharing of information; communication and experience exchange; as well as a training programme.

Source: *Energy Policy of IEA Countries: Sweden 2013*, IEA/OECD, Paris, 2013.

The Nordic market is split into six market zones, with Finland considered a single zone for market purposes. If congestion arises within Finland, it is managed by using domestic counter-trade and balancing power. When transmission capacity is limited across Finland's international borders within Nord Pool, Nord Pool allocates the capacity by using implicit auctions. The transmission line with Estonia is a merchant line; there is no open access. However, the use-it-or-lose-it principle is applied. Transmission capacity on the import line from Russia is allocated on a pro-rata basis, not according to market-based mechanisms.

Fingrid, the TSO, purchases ancillary services. It runs the market for balancing services and also procures other balancing products and services out of the market through less transparent methods. One unique feature of Fingrid's procurement strategy is that it contracts with industrial users to provide frequency reserves. Fingrid also owns and operates its own open-cycle gas turbines (OCGTs) for balancing services. It is in the process of constructing an additional 100 MW OCGT. When this plant is completed, Fingrid will own 7% of Finland's installed net capacity.

## REGULATED PEAK RESERVE POWER

To ensure security of supply, Fingrid is tasked with regulating peak reserve power. Under the terms of the Security of Supply Act of 2006, in force from December 2006 until February 2011, Fingrid has designated three power plants with a combined capacity of 600 MW as necessary to maintain security of supply. These plants were designated according to an open tendering procedure and the agreements between Fingrid and the three plants run through to the end of February 2009. (Plants were not required to be offered through the tender.) These plants, which are not owned by Fingrid, are older plants that had been mothballed, though not decommissioned. According to the detailed terms for operations of the units, during winter months these plants are required to offer their capacity into the market when certain peak load conditions related to capacity – not price – are met. The terms of the system are regulated *ex ante* by the Energy Market Authority according to published terms. When these peak load conditions are met, the plants are bid into the system by the owners and the bids must not be above a floor price.

The floor price is determined according to a formula that includes the estimated variable costs of a conventional oil-fired power plant, including fuel and emission permit prices. As with all power plants, the bids are placed in the bid stack and dispatched according to their merit order; and if they are the last unit dispatched, they will set the market-clearing price for all power plants. Additionally, the plants can be started by Fingrid on a 12-hour notice if and when the grid operator deems it necessary. Under these circumstances, the power may be offered into the Elbas or real-time balancing markets, or paid according to a direct agreement with Fingrid.

Under the terms of the regulation, power plants called on through this arrangement are paid the extra costs directly by Fingrid. Fingrid pays to the plant owners the costs (based on the associated tendering process) that are incurred by keeping these plants in operation during winter periods instead of shutting them down. The system is financed through dedicated fees collected from transmission users and costs about EUR 10 million per year. As directed by the regulation, half the costs are allocated to electricity transmission from Russia and Estonia, and half to the transmission service in the main grid tariff.

This peak power load arrangement has been used once, during a cold-weather snap in February 2007. After the winter period, *i.e.* as of 1 March each year, plants can be called into service with a notice period of one month, as the plants are generally not staffed in the off-season. The power plants will again go into a starting readiness of a maximum of 12 hours from the beginning of the next winter period, as of 1 December.

Following the electricity spot price peaks during the 2009/10 winter, the Nordic regulators (NordREG) are now working closely to increase co-operation and reactivity on the issue of peak demand management.

## INDUSTRY STRUCTURE AND OPERATIONS

While activities across the electricity supply chain must be unbundled – through account, legal or functional unbundling – there is significant cross-ownership across all activities.

### GENERATION

There are over 100 power-producing companies in Finland, and many of these plants are municipally owned companies which produce electricity in CHP plants.

A significant proportion (around 42%) of Finland's power generation assets is co-owned by several production companies, resulting in an important amount of "cross-ownership" of power generation. Companies receive a share of the electricity output directly in proportion to the size of their equity share.

The market is dominated by two large incumbents, Fortum (50.8% state-owned) and Pohjolan Voima (PVO), and the three biggest operators control approximately 58% of the total installed capacity. Industry itself, whose power is generated for its own use and not sold on the open market, accounts for some 15% of electricity produced. Of note, municipally owned companies (including Helsingin Energia) account for 20% of total production.

Finland's electricity market is integrated into Nord Pool wholesale market. Electricity is traded via Nord Pool (76% of total volumes in 2011) and bilaterally (24%). In terms of liquidity, in 2011, 51.1% of the country's gross inland electricity consumption was traded on the Nord Pool Spot. Given Finland's deep-rooted integration within Nord Pool, the larger market of the four Nordic countries is the relevant market area when looking at market concentration, particularly as Finland is a net importer of electricity. In this context, Finland's capacity and generation both make up 17% to 18% of the total. In some cases, cross-border congestion can isolate Finland, raising the ability of its dominant generators to exert market power. In the Nordic electricity markets, the four biggest companies – which together account for over 50% market share, without any specific company having a market share of over 20% – are Vattenfall (18% to 20%), Fortum (13%), Statkraft (12%) and E.ON (7% to 8%).

## RETAIL

Retail market supplies are generally integrated with distribution companies, though account unbundling is required. There are some 90 electricity distribution companies (of which over 50 are legally unbundled) and 13 regional network operators active in Finland. There are about five electricity retailers with a market share larger than 5% (by volume) and large retailers with more than 100 000 customers have been legally unbundled.

The three largest actors control around 35% to 40% of the market. Fortum Sähkösiirto Oy (part of the Fortum group) is the largest retailer, with 572 000 customers and 9.9 TWh of sales in 2011. Vattenfall Verkko Oy (fully owned by the State of Sweden) is the second-largest operator, accounting for 370 000 customers and 5.4 TWh of sales. Two municipally owned retailers are the third- and fourth-biggest retailers in the country – Helen Sähköverkko (owned by the city of Helsinki), with 4.3 TWh of sales, and Tampereen Sähköverkko Oy (owned by the city of Tampere), with 1.9 TWh of sales.

### Customers switching supplier

To enhance retail competition rules and regulations concerning customer switching technology, the Act on Electricity Settlement and Metering was amended in 2009. The EMA has developed the harmonised supplier switching model with other Nordic regulators, under the auspices of the NordREG organisation (Nordic Energy Regulators).

Within the Nordic electricity market, customer switching is traditionally higher in Norway and Sweden than in Finland. Yet more and more customers are switching supplier, with 7.6% of Finnish customers changing their supplier at least once in 2011 (down slightly from 8% in 2010). The switching rate for medium-to-large industrial users and companies (14.1%) was double that of small commercial and household customers (7%). Low retail

prices are a strong disincentive for the latter to change supplier. In total 232 700 customers switched supplier in 2011.

There are no maximum limits governing supplier switching and the EMA does not collect data on the average time required for switching. Retail companies are currently working to co-ordinate and modernise their switching technology and protocols. While the retail market is fully liberalised with respect to price and retailers can charge any price for retail supply, market regulations require that retailers send customers a letter one month in advance of any future price changes. The EMA publicises tenders from retail electricity providers in order for customers to compare tenders.

### Demand response

Finnish retail and distribution companies have a long history of offering different tariffs for daytime and night-time periods for interruptible load, developed especially for households with electric heating. Distribution companies are obliged to offer these tariffs to their customers. However, the liberalisation of the electricity market has reduced the use of these tariffs for interruptible load since the grid equipment cannot recognise who the supplier for electricity is. Currently, there are also some suppliers that offer products with flexible prices for retail customers, but demand for these products remains low at the retail level.

## NETWORKS

### TRANSMISSION

The transmission system forms the platform on which competition in the electricity market can take place. Unbundling of the monopoly activity of network operation from the competitive activities of electricity production and supply is vital to effective competition (see Box 7 for unbundling options provided for under EU legislation). Finland's current arrangements have not yet been certified by the European Commission, thereby putting Finland in breach of the EU Third Energy Package.

Table 8. Transmission line projects to be completed

	Completion year	Length
Renewal of Hikiä - Nurmijärvi 110 kV line	2013	28 km
Ylikkälä - Huutokoski 400 kV	2013	155 km
Hyvinkää - Hikiä 400 kV line	2013	17 km
Renewal of Tihisenniemi - Katerma 110 kV line	2014	69 km
Ulvila - Kristinestad 400 kV line	2014	112 km
Hikiä - Forssa 400 kV and 110 kV lines	2015	78 km

Source: country submission.

Finland's transmission system is owned and operated by Fingrid. It is owned collectively by the State of Finland (12%), Fortum (25%), PVO (25%) and a consortium of insurance

companies (38%). Fingrid began its operations in 1997; it was a new company formed by purchasing the assets of IVO (now part of Fortum) and PVO. Finland has not yet had its TSO certified by the European Commission, thereby resulting in infringement proceedings as of December 2012. The fact that two large electricity generators own 50% of the TSO is problematic with regard to the EU Electricity Directive's unbundling options (see Box 7). Fingrid has 4 100 km of 400 kV transmission lines, 2 350 km of 220 kV transmission lines, 7 500 km of 110 kV transmission lines and 113 substations (Figure 33).

#### **Box 7. EU Electricity Directive and unbundling of transmission system operation**

Unbundling refers to the separation of the monopoly activity of network operation and the competitive activities of electricity production and supply. The EU Electricity Directive sets out three standard models of unbundling for transmission system operation. Each model should deliver effective unbundling, albeit with a different mix of structural and regulatory solutions. The three models are:

- Full ownership unbundling, under which an undertaking which does not have production or supply interests owns and operates the transmission system. This entity carries out all the functions of a TSO;
- The independent system operator (ISO) model, under which an undertaking with production or supply interests continues to own the transmission system, but appoints an independent entity to carry out all the functions of the TSO and undertakes to finance the development of the transmission system;
- The independent transmission operator (ITO) model under which an undertaking with production or supply interests may continue to own the transmission system, but with stringent ring-fencing provisions based on a pillar of organisational measures and a pillar of measures related to investment. These are complemented by cooling-off periods governing the movement of staff between the TSO and the production or supply functions of the vertically integrated undertaking.

Article 9(9) of the Electricity Directive provides that member states may choose not to apply any of the three models described above, when as of 3 September 2009:

- the transmission system belonged to a vertically integrated undertaking;
- arrangements were already in place which guarantee more effective independence of the TSO than the specific provisions concerning the ITO model of Articles 17-23 of the directives.

Under the certification procedure of Article 10 of the Electricity and Gas Directives, the Commission must verify that the arrangements in place clearly guarantee more effective independence of the TSO than the provisions of the ITO model. Only if that is the case can the TSO be certified.

There is limited congestion within the domestic Fingrid network; the absence of locational marginal pricing (LMP) within Finland means that internal congestion is not reflected in price differentials.

Electricity-producing companies report their daily production plans to Fingrid on the preceding day for the grid operation planning. Fingrid has a right to interrupt or restrict transmissions because of a fault and maintenance work. The timing and volumes of known restrictions are negotiated with the customers in advance.

Figure 33. Electricity network in Finland



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Sources: Finnish government; and IEA.

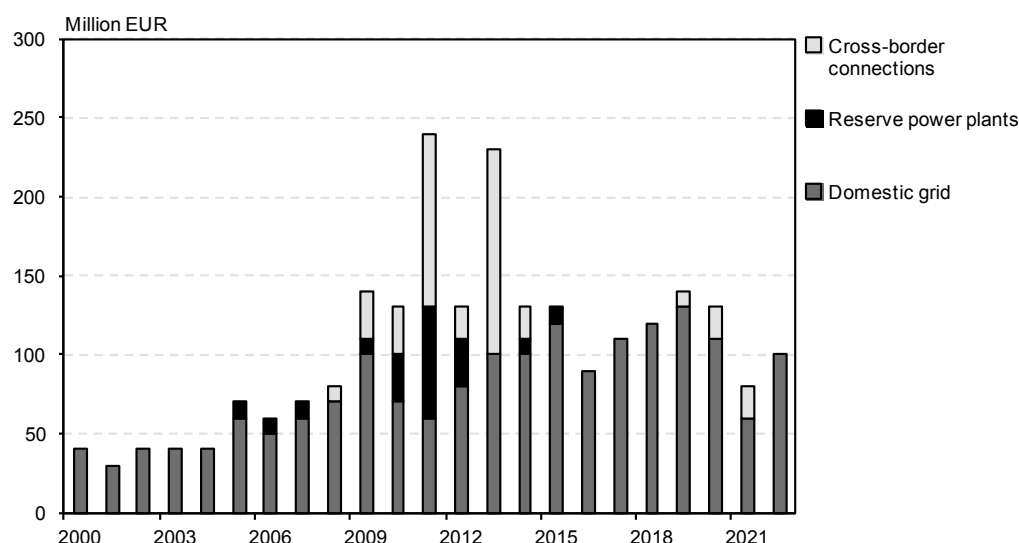
Table 9. Substation projects to be completed

	Completion year
Renewal of Huutokoski 400 kV substation	2013
Anttila 400 kV substation	2013
Renewal of Ylikkälä 400 kV substation	2013
Hikiä 400 and 110 kV substation and transformer	2013
Anttila second 400/110 kV transformer	2013
Kristinestad 400/110 kV transformer	2014
Renewal of Ulvila 400/110 kV substation	2014
Forssa 400 kV duplex substation	2015

Source: country submission.

Fingrid plans to invest EUR 1.7 billion in renovating and developing its network over the 2011-20 period in order to provide adequate grid capacity and ensure its ability to continue managing grid congestion.

Figure 34. Fingrid's investments over 2000-20



Source: country submission.

## VARIABLE RENEWABLE POWER INTEGRATION

Wind power generation is increasing progressively, reaching 0.3 TWh in 2010 and 0.5 TWh in 2011. Solar power remains rare with just 4 GWh of grid-connected generation in 2010. The impact of variable renewable power on the system is local and only noticeable on a distribution network level for the time being.

However, small-scale distributed generation is expected to increase, and notably to be integrated in buildings. In addition, bigger units such as wind farms connected directly to the grid are becoming more common.

Integration of distributed generation into the power system is today promoted through several means. For generation connected to the distribution network (voltage below 110 kV), the network fees are limited to a maximum EUR 0.0007/kWh, calculated as a yearly average.

According to the provisions of the Electricity Market Act, network reinforcement costs must not be included in the fee charged for the grid connection of an electricity production installation of 2 megavolt-amperes (MVA) or less. Acceptable reinforcement costs include the replacement of an existing power line with another with a larger cross-sectional surface, the construction of a parallel distribution network and the replacement of a transformer with a larger one.

In order to reduce costs, distributed generation that is connected to a consumption site does not have to be equipped with a separate meter if the fuse size of the site is 3 x 63 A or smaller. It is, however, required that the meter at the connection point be capable of storing separately the measured power flow fed into the grid and the power taken from the grid.

No electricity tax is charged for consumption that is supplied from own on-site generation with a capacity smaller than 2 MVA.

## INTERCONNECTIONS

The Finnish transmission grid is connected to Sweden, Norway, Estonia and Russia. Finland is well integrated with its neighbours, with 1 950 MW in both directions with Sweden, 100 MW in both directions with Norway, 350 MW in one direction from Estonia (the line was energised on 1 January 2007) and 1 460 MW in one direction from Russia. The operating procedures of the electricity market in these countries differ from one another, which is why there are also different modes of operation in cross-border transmission management.

Table 10. **Interconnections with neighbouring countries**

Yllikälä - Russian border	400 kV, import capacity 1 300 MW (Yllikälä and Kymi lines together)
Kymi - Russian border	400 kV
Petäjäskoski - Swedish border	400 kV, import 1 500 MW, export 1 100 MW (Petäjäskoski, Keminmaa and Ossauskoski lines together)
Keminmaa - Swedish border	400 kV
Ossauskoski - Swedish border	220 kV
Ivalo - Norwegian border	220 kV, import 120 MW, export 100 MW
Fenno-Skan 1, Finland-Sweden	HVDC, 550 MW
Fenno-Skan 2, Finland-Sweden	HVDC, 800 MW
Estlink1, Finland-Estonia	HVDC, 350 MW (owned by generators in Baltics and Finland, all transmission capacity reserved for market use)
Planned: Estlink2, Finland-Estonia	HVDC, 650 MW, commissioning in 2014
New AC line, Finland-Sweden	400 kV, commissioning in 2021

Note: AC = alternating current; HVDC = high-voltage direct current.

Source: country submission.



There is an agreement with the TSOs in Sweden, Norway and Denmark on shared grid operation rules, in order to ensure the security of the Nordic power system. The operation rules also specify a shared framework for congestion management. EU legislation provides the guidelines for congestion management, highlighting the importance of market information and market-focused solutions, which give a financial signal to the market.

While significant, though normal, levels of congestion are found throughout the major interconnections in Nord Pool, Finland's interconnections are relatively free from congestion. The Finland-Sweden interconnection, for example, was fully congested only 25% of hours in 2011, and up from just 6% in 2010 (before a temporary technical line problem in 2011).

However, owing to the forthcoming expansion of capacity from the new nuclear unit at Olkiluoto 3 and for other reasons, a new sea cable connection between Sweden and Finland, Fenno-Skan 2, is being constructed. It is expected to go on line at the end of 2010, increasing transmission capacity from Sweden to Finland by 500 MW and from Finland to Sweden by 800 MW.

### Nordic interconnections

The transmission capacity on the cross-border connections is made available fully to the electricity market through Elspot and Elbas, *i.e.* the market places of the Nordic electricity exchange Nord Pool Spot. The Elspot market follows the principle of implicit auctioning, where the energy and transmission capacity between various bidding areas is allocated in a single process to the parties of electricity trading. Capacity which has not been used on the Elspot market is offered to the Elbas market, where trading finishes no later than one hour before the hour of operation. The Elspot capacities for the next day are announced before noon, and the Elbas capacities in the afternoon.

The market has access to all cross-border lines to Sweden (normal transmission capacity from 2 300 to 2 600 MW). Elspot price area in Finland has a commercial connection to two Swedish price areas (Northern price area SE1 and Stockholm price area SE3), while the connection to Norway (normal transmission capacity from 50 to 100 MW) is used for securing local electricity transmission in northern Norway.

The issues considered in specifying the available transmission capacity include the operation situation of the grid, such as planned maintenance work as well as production and consumption situations. Changes in the transmission capacity are reported well in advance to the market; 100 MW of the transmission capacity is reserved as a transmission reliability margin (TRM) to cater for instantaneous fluctuations in electricity production and consumption. In potential grid disturbances, Fingrid guarantees the cross-border transmissions it has confirmed by means of counter-trading<sup>25</sup> by the end of the day of operation.

A forecast error of the market parties can result in exceeding the transmission capacity during the hour of operation. The exceeding is adjusted away by using the balancing power market.

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25. Counter trading is used for changing the geographical distribution of production of power plants determined on a market basis. For example, if electricity transmissions from northern Finland to southern Finland were too high, production is increased in the south of Finland and decreased in the north at Fingrid's request and expense. This brings the transmission flows within the limits, and the total power balance in Finland still remains the same.

### The Estonian connection

The Estlink1 DC link between Finland and Estonia became operative at the beginning of 2007, giving Estonia the opportunity to integrate with the Nord Pool market. Up to 365 MW of power can be transmitted over the link in both directions. The cable is owned by a Finnish-Baltic energy consortium.

The Finnish and Estonian TSOs have rented Estlink from the owners in 2010. Estonia is now a bidding area within Nord Pool Spot. Principles of congestion management on Estlink are the same as on Nordic interconnections. Interconnection capacity with the Baltic states remains insufficient, as Estonian and Finnish wholesale prices were different around half the time in 2011.

A second interconnection with Estonia, Estlink2 (650 MW capacity), is planned for early 2014. This additional interconnection will reduce congestion considerably between the Finnish and Estonian networks, and will improve Finland's integration with Central European markets. Estlink2 may also open up the possibility of exporting electricity to Russia.

### The Russian interconnection

Fingrid makes 1 300 MW of transmission capacity available to the electricity market on its 400 kV connections from Russia. Fingrid has reserved a volume of 100 MW to be used as a power system reserve. At present, the electricity link with Russia is unidirectional.

Electricity can be imported from Russia by customers who have made an agreement on a fixed transmission right with Fingrid and an agreement on energy purchases with a Russian organisation responsible for electricity sales.

Fingrid has a right to restrict imports in the event of faults in the grid in Russia or Finland and during other outages, or for some other reason occurring in Russia.

The two 110 kV lines connected to Fingrid's grid from Russia are not owned by Fingrid, and the owners of these connections are responsible for electricity transmission on them.

## DISTRIBUTION

The distribution network is the medium- and low-voltage electricity network used to deliver electricity to connection points such as houses, offices, shops, and street lights. The electricity distribution network contains approximately 400 000 km of predominantly overhead lines and some cables.

Network operators draw up for themselves written methods and principles of connection pricing, which shall comply with the pricing principles of low-, medium- and high-voltage connections and connections in production and small-scale production, as presented in the following.

The pricing principles for low-voltage networks include zone pricing, regional pricing and peak load connections. The pricing of low-voltage networks is mainly based on the costs arising from the building of the connection and on the capacity reservation for the existing electricity network. Zone pricing in the area of the existing low-voltage network is used as the main pricing principle. Regional pricing is used in the area of the rest of the network. A pricing principle based on capacity reservation, and building and connection costs, must be complied with for medium- and high-voltage networks.

The determination of the connection charge for generation units with apparent power exceeding 2 MVA shall be based on the costs of direct distribution network expansion arising from connection construction and the capacity reservation charge for the existing electricity network.

The determination of the connection charge for generation units with apparent power not exceeding 2 MVA shall be based on network expansion costs for direct distribution arising from connection construction.

### Smart metering

According to the government decree on settlement of electricity delivery and metering that came into force in 2009, the electricity distribution companies must offer hourly electricity metering and a remote-reading capability to at least 80% of their customers by the end of 2013. At the beginning of 2012, there were around 2 million electricity meters with hourly metering installed, accounting for around three-quarters of the meters that are to be installed by end-2013. Most distribution companies intend to install hourly metering for almost all the users, thus exceeding the obligation to provide smart meters for 80% of users. This means that, at the moment, there are still around 750 000 meters to be installed.

## PRICES AND TARIFFS

### NETWORK CHARGES

The network tariff regulation model is based on an *ex ante* regulation model, whose pricing methodology is re-evaluated every four years. After the regulator sets the pricing methodology, the regulator confirms the actual and reasonable profit for each operator during the entire period, taking into account incentives for effectiveness in investments.

The pricing methodology uses economic benchmarking according to a limited bonus-malus system, where operators are allowed to charge up to a limit set by a predetermined formula. The economic regulation provides incentives for reduced tariff rates, while still setting minimum quality standards. The bonus-malus system applies only to controllable operating costs; depreciation, uncontrollable operating expenses and a reasonable rate of return are determined according to a regulated formula. Tariff rulings can be appealed to the EMA's internal court and, at a higher level, to the Supreme Administrative Court.

Table 11. Fees for grid service

Unit prices, EUR per MWh	2012
Consumption fee, winter period	3.48
Consumption fee, other times	1.74
Output from the main grid	0.80
Input into the main grid	0.50

Source: Ministry of Employment and the Economy.

Fingrid charges specific grid service fees for consumption, for output from the main grid and for input into the main grid. The grid service fees are invoiced monthly, and Fingrid must inform customers of changes in the fees with justification and confirm the fee components and unit prices annually by the end of September. The consumption fee is specified separately for the “winter period” (1 November to 31 March) and for other times. Fingrid is responsible for arranging and maintaining the metering of electricity transmitted through connection points.

In 2011, network costs accounted for 27% and 43% of Finnish industrial and household electricity bills (without taxes) respectively.

## PRICES

The Nordic electricity system is primarily hydro-based, meaning that prices can be very variable, even on a monthly basis. On average, prices in the Nord Pool market tend to be low compared to prices in other IEA member countries.

Electricity prices for both households and industrial customers have increased progressively between 2005 and 2011, with industrial prices being lower and more stable than household prices.

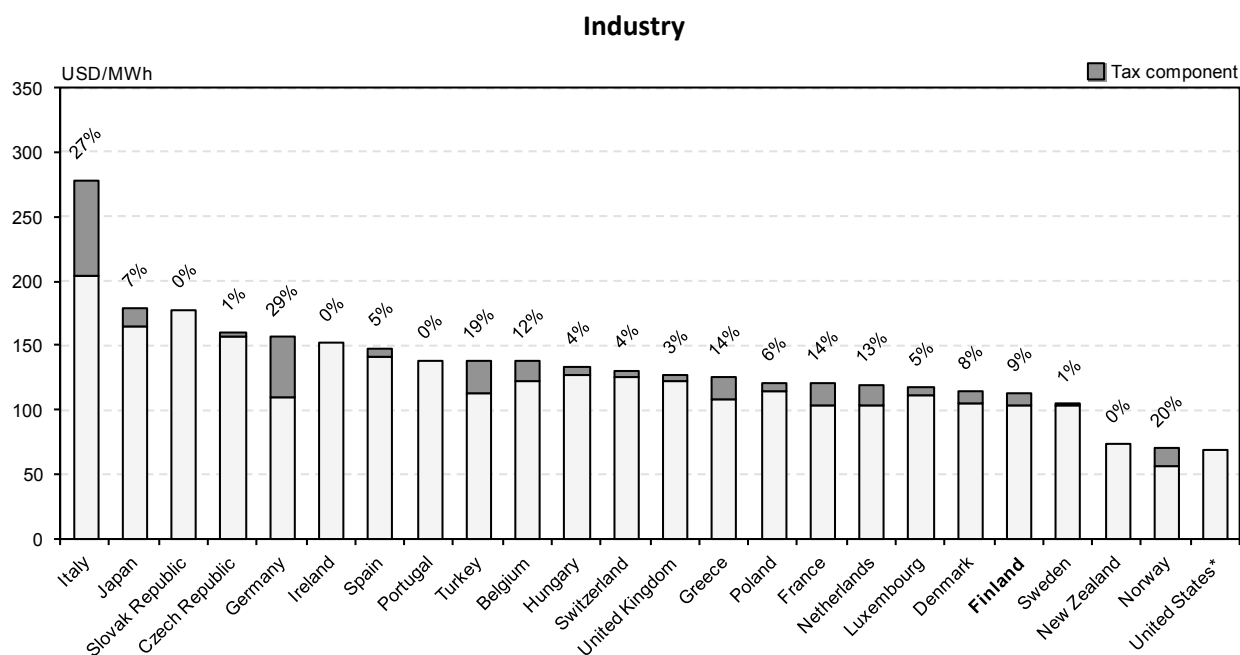
There are no regulated tariffs in Finland, and the retailing of electricity does not require any licence or registration at the Energy Market Authority. However, all operators are bound by the concept of public service obligation.

According to Section 21 of the Electricity Market Act, an electricity retailer in a dominant position within the area of responsibility of a distribution system operator (DSO) has an obligation to deliver electricity at reasonable prices to consumers and other users of electricity, whose place of use is equipped with main fuses of a maximum of 3x63 amperes, or whose site of electricity use receives annually no more than 100 000 kWh of electricity. If such a retailer as referred to above does not exist, the obligations of an electricity retailer in a dominant position shall be applied to an electricity retailer whose market share is the highest in the area of responsibility concerned (distribution network area).

An electricity retailer in a dominant position shall have terms of retail sale and prices (and the criteria underlying these) made publicly available to customers, and these must not include any unreasonable conditions or limitations that would restrict competition within electricity trade. The EMA can order the retailer to deliver electricity to the customers within the obligation to deliver.

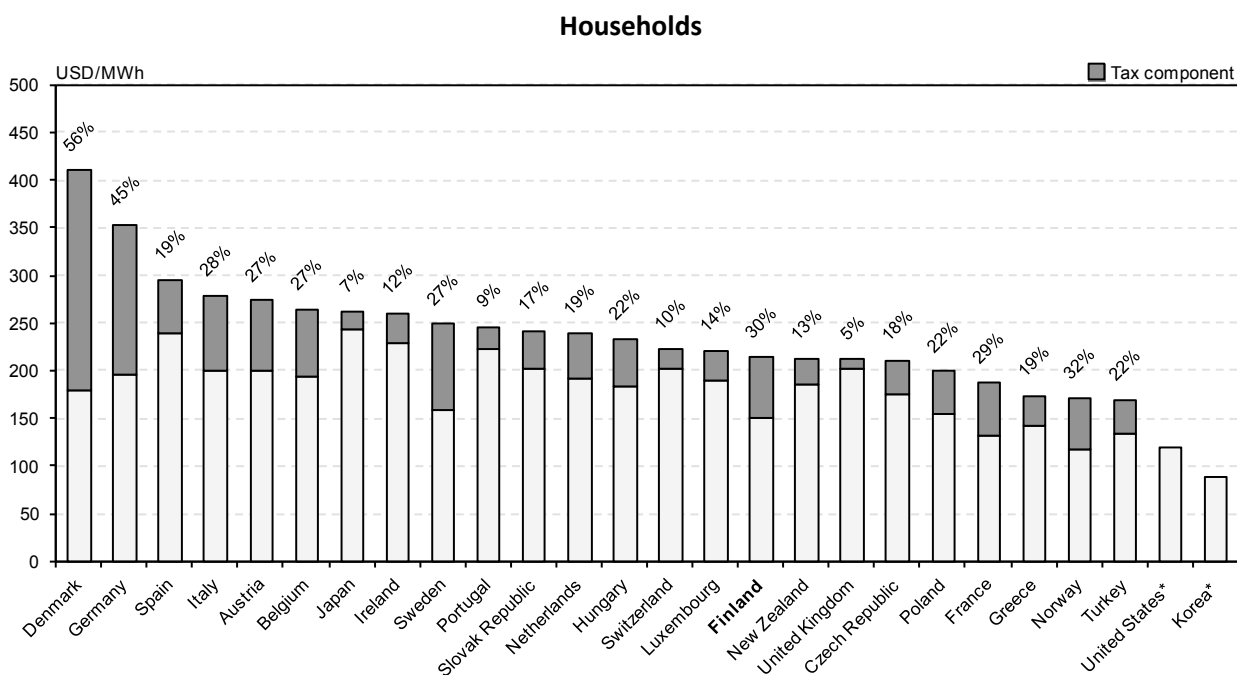
The prices of electricity offered within the obligation-to-supply system do not have to be approved by the regulator before the supplier takes them into use. However, on the basis of the Electricity Market Act (Section 21), the EMA may investigate such pricing, either on the basis of a complaint received from a customer or at its own initiative. There are no plans to phase out the obligation to deliver.

Figure 35. Electricity prices in IEA member countries, 2011



\* Tax information not available for the United States.

Note: data not available for Australia, Austria, Canada and Korea.

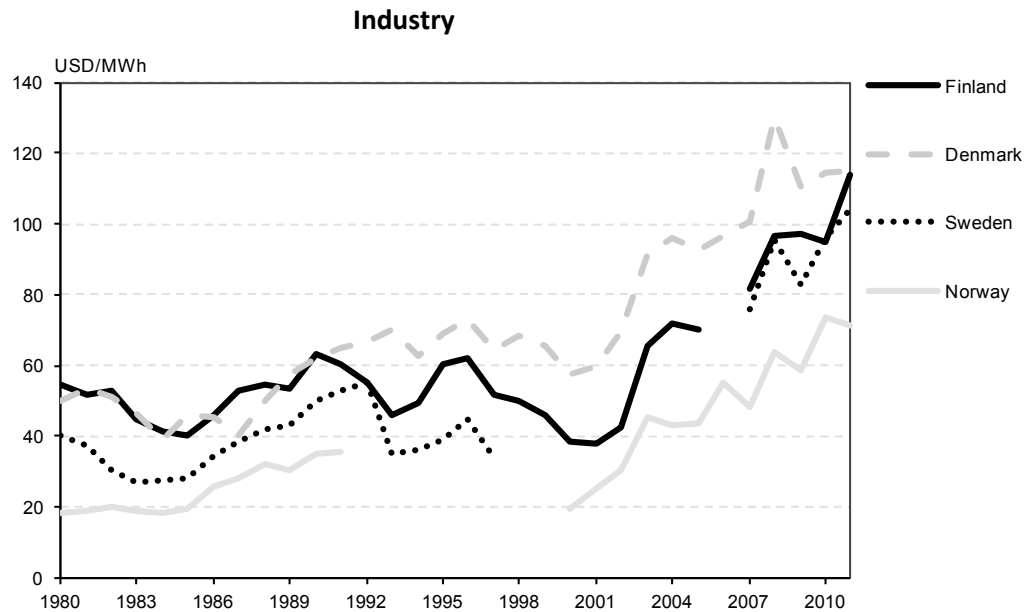


\* Tax information not available for Korea and the United States.

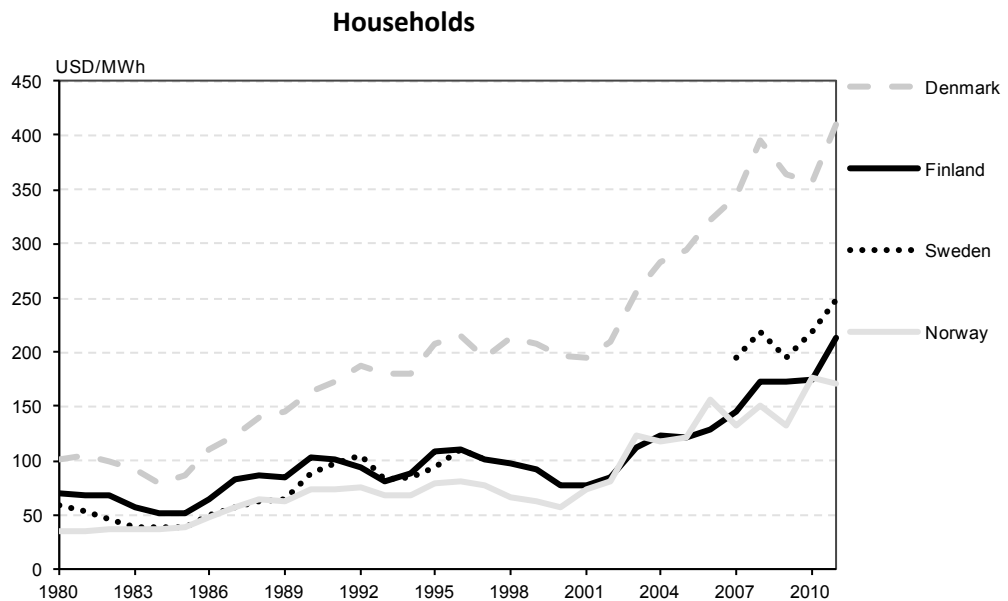
Note: data not available for Australia and Canada.

Source: *Energy Prices and Taxes*, IEA/OECD, Paris, 2012.

Figure 36. Electricity prices in Finland and in other selected IEA member countries, 1980-2011



Note: data not available for Finland in 2006, Norway from 1992 to 1999 and Sweden from 1998 to 2006.



Note: data not available for Sweden from 1998 to 2006.

Source: *Energy Prices and Taxes*, IEA/OECD, Paris, 2012.

## ASSESSMENT

Finland's electricity supply mix is very well diversified, with nuclear, hydro and bioenergy accounting for around 31.6%, 16.9% and 15.6% of electricity supply respectively, and gas, coal and peat also contributing to the energy mix. Furthermore, as part of the

Nordic electricity system, Finland is one of the most advanced electricity markets in the world. Yet security of electricity supply remains a high priority concern.

The Nord Pool market is highly dependent on hydro, and as such is vulnerable to drought conditions, which have become more common in recent years. While the Nordic market is well designed in terms of market signals and demand response-driven adjustment mechanisms, congestion remains a concern on certain parts of the Nord Pool grid.

The need to develop and modernise one's infrastructure is a challenge for many OECD countries, and like in other countries, the government must ensure that announced network investments are forthcoming. In order to strengthen market integration both with Nord Pool and the wider continental European market, Finland is continuing to develop its interconnections with neighbouring countries. Yet internal infrastructure is also a concern, and Finland must seek to reduce the reliance on overland lines, especially in the southern part of Finland, where the grid is vulnerable to snow and storms as demonstrated in several recent severe storms which affected very large parts of the country.

Supply concerns are exacerbated by the fact that Finland currently imports up to 2 000 MW of electricity from its neighbours during peaking hours, as domestic electricity supply is limited. Worries have been expressed in relation to imports from Russia, although these imports have been extremely stable for many years. Indeed, new support schemes intended to mitigate security of supply, particularly in the Saint Petersburg area, have caused imports from Russia to drop daily during peak load winter hours, causing high prices during these hours in the Finnish price area. Of note, as 80% of all Russian electricity that is exported to the European Union goes to Finland, the Finnish government and authorities have an important role to play in the development of rules for trade and congestion management with Russia in a developing European market for electricity.

Finland has undertaken steps to improve its resilience in recent years, and the government's 2008 national Climate and Energy Strategy states the objective of reducing the current supply deficit and achieving self-sufficiency by 2020. In 2010, the Parliament adopted decisions-in-principle for two new nuclear power stations, in addition to Olkiluoto 3 currently under construction. Finland hopes to achieve relative self-sufficiency, being able to cover peak load situations and possible disturbances of imports, through the development of biomass-fired power and particularly the construction of additional nuclear power capacity.

While greater capacity and transmission are important means of providing security of supply, it is often less expensive and more sustainable to do this through enhanced energy efficiency and demand-side management. In Finland, a key measure in this regard is the obligation for electricity distribution companies to offer electricity with hourly metering and a remote-reading capability for at least 80% of their customers by the end of 2013, allowing customers to take advantage of advanced time-varying pricing of the electricity. It is important that regulatory and institutional barriers to the effectiveness of demand-side measures continue to be investigated and removed insofar as possible.

Lastly, Finland must continue to ensure compliance with EU legislation. Important parts of the European Union's Third Energy Package have been transposed, and the government is clearly committed to a competitive electricity market with limited government interference – the network regulator, the EMA, is fully independent from the government, providing confidence to existing market participants and potential new entrants, and the power grid is open to all competitors on an equal footing, encouraging new entry and reassuring investors for the long term. Yet the Finnish TSO, Fingrid, has yet to be certified. Two dominant electricity producers, Fortum and TVO, continue to own 50% of the Finnish TSO,

Fingrid, which indeed raises questions as to the vertical unbundling and independence of Fingrid. As of December 2012, the European Commission has opened infringement procedures against Finland for only partially transposing the necessary measures.

### **RECOMMENDATIONS**

*The government of Finland should:*

- ☐ *Continue to support the development of the integrated European market and promote the further integration of electricity networks in the Baltic states, and also explore opportunities to develop market-based trade with Russia.*
- ☐ *Pursue demand-side management efforts, building on the successful roll-out of smart metering, to ensure that price signals and engagement of consumers bring about the desired energy savings.*
- ☐ *Take urgent measures to certify Finland's transmission arrangements and clarify the regulator's role, thereby ensuring compliance with the EU Third Energy Package.*
- ☐ *Ensure that the necessary technical competences are available in order to meet Finland's notable electricity infrastructure challenges in the coming years, notably at the distribution level.*



## 11. DISTRICT HEATING AND COOLING

### Key data (2011)

**Total production:** 34 TWh (co-generated heat 73%, separate heat 27%)

**Supply of energy to district heating and CHP:** 58.1 TWh (natural gas 31%, coal 23%, biofuels 22%, peat 18%, oil 3%, others 3%)

**Total consumption:** 31.2 TWh (residential 54%, industry 10%, other 36%)

Source: Finnish Energy Industries.

### SUPPLY AND DEMAND

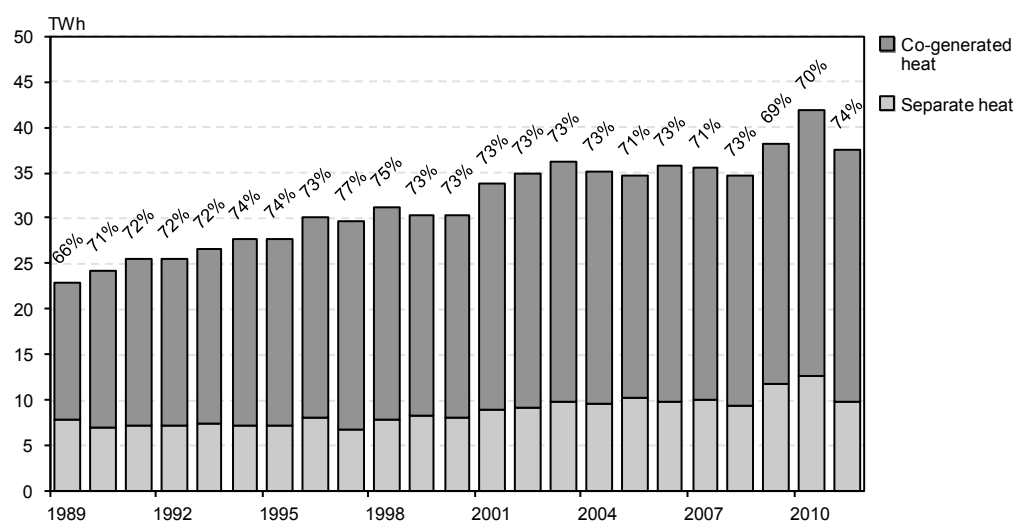
#### SUPPLY

Finland's cold climate has provided a strong incentive for the development of efficient heating solutions, and district heating first emerged in Finland in the 1950s.

The development of district heating has gone hand in hand with the development of combined heat and power (CHP), and together they form a very efficient backbone to Finland's overall energy system.

CHP plants tend to be larger in terms of capacity than standard heating plants and, as a result, approximately 73% of Finland's district heating was produced in CHP plants in 2011. The electricity generated from CHP plants accounts for around one-third of the national electricity supply.

Figure 37. District heat production and share of co-generated heat, 2000-11



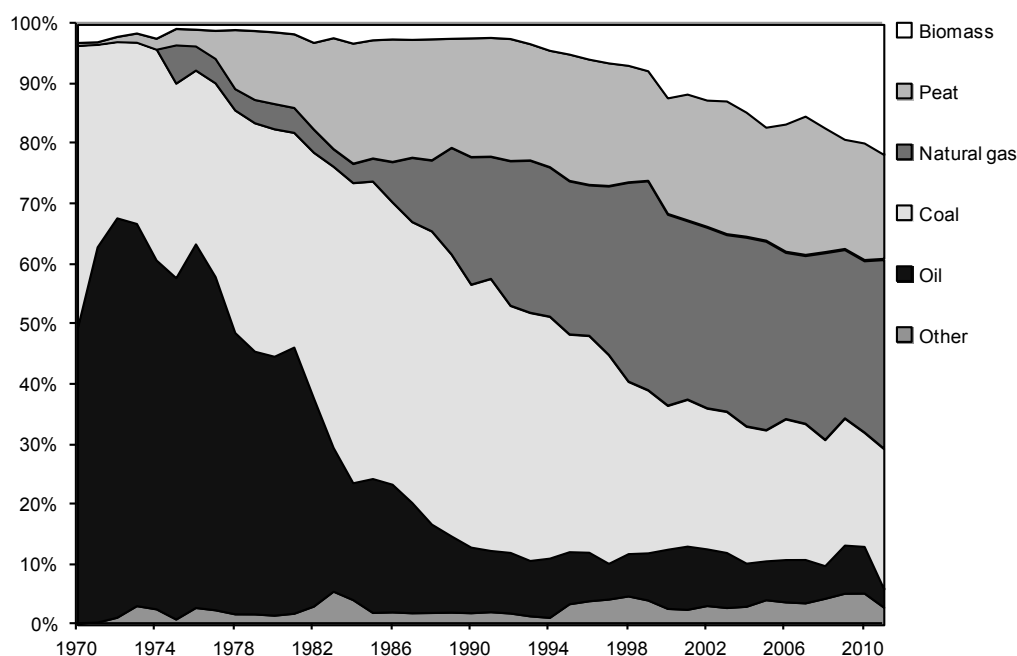
Source: Finnish Energy Industries.

District heating and CHP also offer the benefit of being able to operate on a wide selection of possible fuels, thereby lowering risk exposure in terms of security of supply, price and availability. Since the 1970s, there has been a major transition towards the use of renewable fuels, encouraged by the widespread prevalence of available biomass.

This structural shift towards the use of renewables has resulted in a low-emission profile for Finland's heat and power industry. District heating and CHP are widely seen as the best ways to increase the use of renewable and waste fuels. Finland is already the leading user of biomass in the European Union.

In 2011, district heat production totalled 34 TWh, where 72.5% represented co-generated heat and the remainder was separate heat. Some 58.1 TWh of fuels was consumed in the production of co-generated district heat and CHP, made up of mostly natural gas (31%), coal (23%) and biofuels (22%). A further 10.7 TWh of fuels was consumed for the production of separate district heat, mostly supplied by natural gas (28%), wood (22%), peat (14%) and oil (15%).

Figure 38. Share of energy inputs for district heating and related CHP, 1976-2011



Source: Finnish Energy Industries.

Figure 38 shows the energy supplied to district heating between 1970 and 2011. Thanks to improved technology and network utilisation as well as an increased proportion of ready heat,<sup>26</sup> distribution and conversion losses in the district heating system have decreased considerably over the years. Losses stand at around 9%.

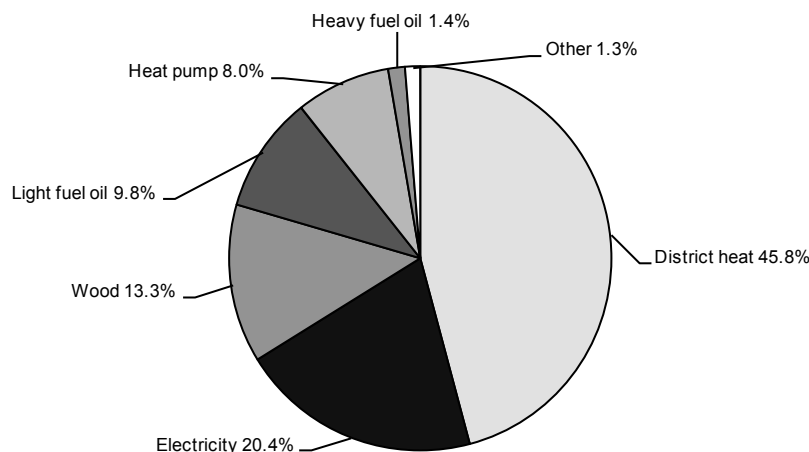
The Finnish district heating market is mature and no major changes have occurred over the past years. Existing district heating potentials are well exploited, and as a result there remains limited obvious room for expansion.

26. Heat produced on-site at the consumer's request.

## DEMAND

Around 46% of Finland's total heat demand for heating buildings and domestic warm water was satisfied through district heating in 2010. The total quantity of district heating delivered to end-consumers was 31.2 TWh in 2011. This is up from 24.4 TWh in 2002.

Figure 39. **Market share of space heating in residential, commercial and public buildings, 2011**



Source: Statistics Finland.

The main beneficiaries of district heating are urban communities, apartment buildings, public buildings and business premises. About 2.7 million people live in houses heated by district heat. District heating is the leading heating method for multi-dwelling buildings and commercial and public buildings, taking around 90% and 70% of the market shares respectively in 2011. In the market for detached and semi-detached houses, district heating has a share of 15%. Of note, the use of heat pumps has almost quintupled in recent years, from 0.6 TWh (2.3 PJ) in 2005 to 3.5 TWh (12.5 PJ) in 2011. Heat pumps now account for 8% of space heating in Finland.

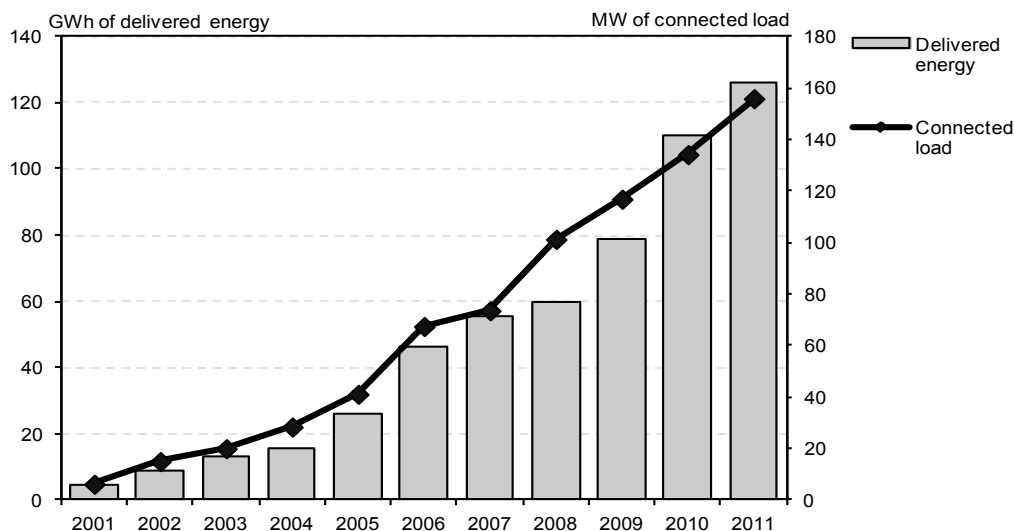
## DISTRICT COOLING

District cooling is a comparatively recent development, first introduced in the 1990s. It is mainly used for air conditioning in offices, shops and industrial processes. Growth has been strong in recent years, with total sales increasing from 16 GWh in 2004 to 79 GWh in 2009, and rising to 126 GWh in 2011.

Finland has a district cooling capacity of 123 MW, including absorption, compressor and heat pumps. The total free cooling capacity is 111 MW; however, these capacities are not all available at the same time. The government indicates that district cooling storage capacity currently stands at around 39 MW.

Because of the relative novelty of the industry, there is still considerable potential for further expansion in the cooling markets. District cooling, however, is not the focus of this chapter.

Figure 40. Delivered energy and connected cooling load in district cooling, 2001-11



Source: Finnish Energy Industries.

## INDUSTRY STRUCTURE AND LEGAL FRAMEWORK

### OWNERSHIP AND OPERATING OF THE INFRASTRUCTURE

The Finnish district heating network length was recorded at 13 058.4 km in 2011.

There are about 150 independent district heating companies. The size of the companies varies considerably, with annual district heating sales varying from under 5 GWh in small municipalities to over 7 000 GWh in the city of Helsinki. District heating companies are typically owned by municipalities, which account for 97% of companies and 86% of sales. Around 40 district heating companies operate as CHP plants, thereby also generating electricity.

One-third of all district heat is produced by a company other than the one distributing it. Of note, there is no third-party access to district heating networks, and heat supply is based on an agreement between the producer and the distributor.

### REGULATORY REGIME

Although the Fair District Heating quality label was developed by the industry and is administered by the Finnish Energy Industries, there is no overarching legislation or other regulatory framework that applies specifically to district heating and cooling, or to the CHP business. As such, general legislation pertaining to competition, consumer protection and safety across types of businesses is applicable. Only a few pieces of legislation have a direct impact on the district heating or CHP sectors – namely the Act on Competition Restrictions, the Electricity Market Act, the Act on Excise Tax on Electricity and Certain Fuels, the Act on Excise Tax on Liquid Fuels, and the Land Use and Building Act.

The Competition Act promotes the function of markets in general. It prohibits fixed prices, tender and price cartels, as well as cartels restricting production or dividing markets or

sources of procurement. According to the Act on Competition Restrictions, district heating utilities potentially hold a dominant market position, and the Finnish Competition Authority prohibits the abuse of such a position.

Yet there are no set or fixed levels for district heating pricing or profits, and “reasonable” pricing and profits are considered on a case-by-case basis. There have been very few annual customer complaints in recent years, despite the high proportion of customers connected to district heating.

In the Electricity Market Decree, based on the Electricity Market Act, it is stated that the pricing benefits related to CHP shall be allocated to both electricity and heat, but the method and share of allocation is left undetermined. Producers have to report the method used to the Electricity Market Authority.

The Fair District Heating quality label guarantees that operations are open, fair and informative. Some 41 companies have been granted the Fair District Heating quality label, and the total amount of sales by these companies accounts for 84% of district heating sales.

The Act on Excise Tax on Electricity and Certain Fuels and the Act on Excise Tax on Liquid Fuels determine the excise taxes on the fuels used for CHP-based heat production. The excise tax is calculated on the basis of 90% of the heat produced, and the CO<sub>2</sub> component of the tax is halved for fuels used for CHP-based heat production.

The current Land Use and Building Act gives municipal authorities the power to oblige buildings to connect to district heating under certain conditions. The obligation stands for new buildings that are located in the immediate proximity of district heating networks, and it does not apply to planned passive energy buildings or dwellings with heating systems based on renewable energy, *e.g.* ground heat pumps.

## CONSUMER RIGHTS

In signing a contract with a district heating company for the supply of heat, the customer pays a connection fee for joining the district heating network. The fee varies according to the location and the size of the connected building.

If the customer wishes to switch from district heating to another heat supply source, the contract can be terminated with one month’s notice for private consumers, and six months’ notice for other customers. In most cases, the termination of the contract would incur the reimbursement of the connection fee by the company, having deducted costs associated with physically cutting off the heating connection to the given location.

The customer owns the heat exchanger and installations needed for the heat distribution inside the building. Unless specific circumstances apply (as indicated above), in principle it is possible to replace district heating with another heat supply option, for example with a boiler or ground heat pump.

## PRICES AND TAXES

There are significant differences in the price of district heating. The price in the most expensive municipality is 200% more than the price in the cheapest. These price differences are due to factors such as ownership structures in the district heating companies, profitability requirements, the type of fuel (or fuel mix) used, and the

geographical conditions for district heating installations. A given customer's choice of options on the heating market is generally directly correlated to his geographical location. The lowest cost for district heating can be found in Haapajärvi (EUR 40/MWh) while the most expensive can be found in the municipality of Kristiinankaupunki (EUR 119/MWh) for multi-family houses. Between 2006 and 2011, prices rose on average by 48%.

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## ASSESSMENT

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The district heating system can play an important role in reducing greenhouse gas emissions as well as improving security of supply. Given its climate, Finland's demand for heat is among the highest for IEA member countries, and the country has successfully deployed a comprehensive district heating system, accounting for almost 50% of the total commercial heating demand. Approximately three-quarters of district heating is produced by CHP plants and the electricity from those plants covers about one-third of total electricity supply. CHP generation is largely gas-fired in the south of the country, following on efforts to reduce the use of coal and fuel oil for environmental reasons. Biomass in combination with peat is increasingly being used to generate heat for district heating, via CHP and dedicated heating plants.

There are no support measures in place to promote district heating any further, and no quantitative national targets have been set. As the market is to a large extent mature, the scope for further extending the district heating network is limited. There is no specific legislation or other regulation in Finland only for the district heating or CHP business, neither is there a set or fixed levels for district heating pricing or profits. Finland has a competitive and well-monitored heat market.

Compared to district heating, Finland has a significantly shorter history regarding district cooling systems, which only really began to develop at the turn of the 21st century. District cooling has since been progressively deployed at a steady pace, and energy delivered via district cooling increased to about 120 GWh in 2011. There is still significant potential for the further development of cooling markets, and further expansion of the district cooling networks is anticipated.

CHP contributes to increasing the efficiency of energy use, and it is commendable that 53 new CHP plants were introduced during the last decade, particularly as approximately a third of these CHP plants are substituting older capacity. Nevertheless, there remains potential for replacing heat-only boilers with highly efficient CHP.

Finland is currently a leader among its peers in using biomass energy for CHP generation, and yet fossil fuels continue to form the basis of the CHP industry, with around 75% of fuel inputs. Progressively increasing the use of biomass, particularly as a substitution fuel for coal and peat, can reduce dependence on fossil fuels and help Finland to meet its ambitious targets regarding GHG emissions.

With regard to CHP's role in Finland's general energy policy strategy, this technology does not receive any strong financial support besides comparatively small tax subsidies. Excise taxes on the fuels used for CHP-based heat production are calculated on the basis of 90% of the heat produced, and the CO<sub>2</sub> component of the tax is halved for fuels used for co-generated heat. Of note, small-scale biogas- and biomass-fired CHP plants may receive a subsidy through a feed-in tariff subsidy system.

Since Finland's heat market is comparatively mature in terms of development, and potential demand appears to be well covered with existing capacities, no significant developments have occurred regarding the market size of the heat industry in recent years. However, further efficiencies could be implemented in the heating system, notably by means of RD&D activities which could be financed by some public support mechanisms.

In addition to district heat or CHP, heat pumps can support and facilitate more efficient use of heating. It is commendable that the use of heat pumps has almost quintupled from 2.3 PJ in 2005 to 11 PJ in 2010. The Climate and Energy Strategy outlines the stated aim of lowering the reliance on imported fuels while increasing the share of renewable energy, and heat pumps are expected to play a role in this regard. State grants are available to convert oil-fired heating systems to heat pumps, pellets or other wood fuels for all residential buildings and district heating systems in buildings consisting of more than two apartments. A programme to decrease oil dependence will be developed as part of the updated Climate and Energy Strategy. Ground heat pumps are particularly useful in that they can be used to moderate peaks in demand for heat during cold spells.

## RECOMMENDATIONS

*The government of Finland should:*

- ☐ *Continue to support RD&D activities for improving the efficiency of heat technologies through fiscal incentives and partnerships between industry, research institutes and academia.*
- ☐ *Further support the development of district cooling, in particular by enhancing public awareness of its benefits.*





**PART III**  
**ENERGY TECHNOLOGY**



## 12. ENERGY RESEARCH, DEVELOPMENT AND DEMONSTRATION

### Key data (2011)

**Government energy RD&D spending:** EUR 255 million

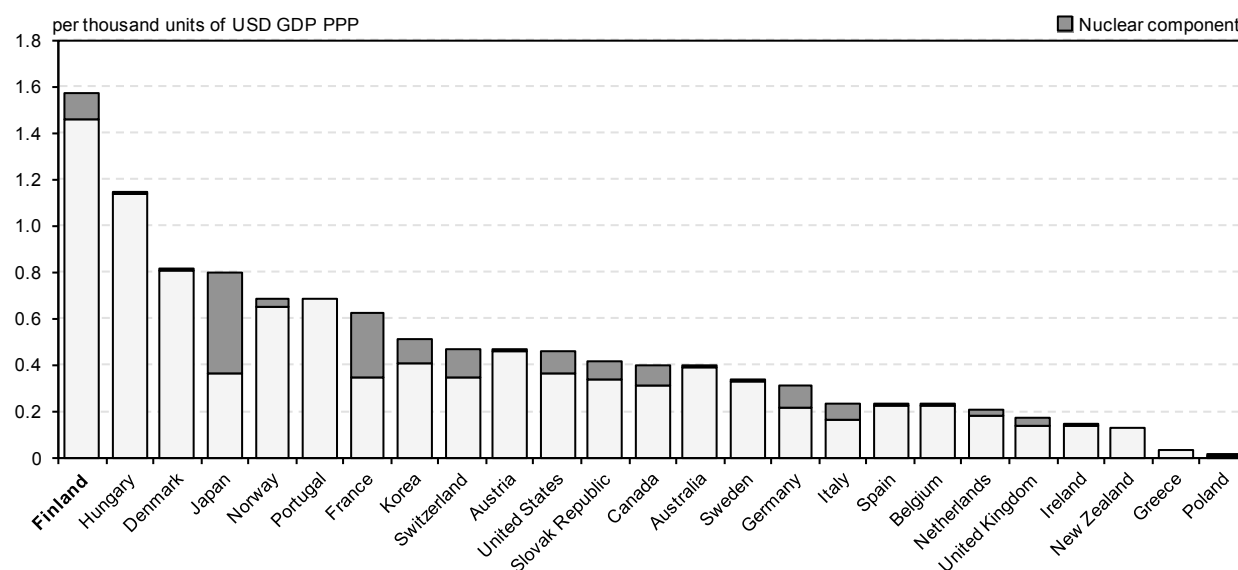
**Share in GDP:** 1.6 per 1 000 units of GDP (IEA median: 0.39)

**RD&D per capita:** USD 50.4 (IEA median: 14)

### OVERVIEW

Finland is one of the most research-intensive countries in the world. Public spending on research and development (R&D) in all sectors totals EUR 6.9 billion – or 3.9% of GDP. Furthermore, private business is a sizeable investor in RD&D, accounting for around 70% of total RD&D expenditure.

Figure 41. **Government RD&D budgets in IEA member countries, 2011**



Note: data not available for the Czech Republic, Luxemburg and Turkey.

Sources: *OECD Economic Outlook*, OECD, Paris, 2012; and country submission.

Energy and climate change research is a focal area in public research funding in Finland. Energy RD&D expenditure has steadily increased in recent years, reaching a peak in 2010 with approximately EUR 270 million in public expenditure, equivalent to 0.16% of GDP, ranking first among its OECD peers. In 2011, RD&D fell marginally to EUR 255 million.

Finland has a well-developed energy technology RD&D landscape, with stable funding, strong national and regional organisations (particularly Tekes and the Technical Research

Centre, VTT), active international collaboration and strong private-sector involvement in most aspects of the RD&D process. It also has consistent, systematic support in all aspects of energy RD&D: basic research, applied energy RD&D, demonstration, assistance in financing, and commercialisation and export of innovative technologies.

Technology development is one of the key activities in Finland's national energy policy. The objective of Finnish energy RD&D is to develop solutions that are competitive on the international market, as the domestic market is often too narrow. Energy technology research is linked to national policies on industry, energy and technology.

Long-standing focus areas in Finland are CHP, power generation by industry, distributed power generation and the efficient use of energy. In the area of renewable energy, Finland's focus is on the efficient and clean use of various biomass resources in existing and new product concepts, including the production of liquid biofuels for transportation. As for the nuclear sector, the main target of the research is to promote nuclear safety.

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## INSTITUTIONAL FRAMEWORK

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Science, technology and innovation are high priorities for the Finnish government and there appears to be strong co-ordination among the key research actors and stakeholders.

The **Ministry of Employment and the Economy (MEE)** oversees Finland's technology and innovation policy. The **Ministry of Education** is responsible for the country's science policy. RD&D policy is co-ordinated by the **Research and Innovation Council**, which is chaired by the prime minister.

The **Funding Agency for Technology and Innovation, Tekes**, is the most important publicly funded expert organisation for financing research, development and innovation in Finland. Acting under the MEE, the mission of Tekes is to boost the development of Finnish industry and the service sector through wide-ranging activities and technological innovations in research communities, industry and services sectors. It is hoped that this innovation will renew the economy and increase value, productivity and exports, thereby creating employment and enhancing well-being. Tekes awards its funding to companies, universities and research institutes operating in Finland. It funds RD&D in areas defined on the basis of clear user needs, including fields such as products and business models, the environment and energy, health and well-being, services, safety and security, and work and leisure.

The **Academy of Finland** is the primary funding agency for research in Finland, and belongs to the administrative branch of the Ministry of Education. Its mission is to advance scientific research and its application, to support international scientific co-operation, to act as an expert in science policy issues, and to allocate funding to research and other areas of science.

The **Technical Research Centre of Finland (VTT)** is a contract research organisation. The VTT portfolio is broadly to optimise energy systems, but also includes carefully selected topics for experimental RD&D: energy systems and smart grids, bioenergy and biorefining, wind power, innovative renewables, energy efficiency, clean fossil fuels, nuclear and solutions for operations and maintenance. VTT carries out technology development from bench-scale to pilot-scale to demonstration. VTT also provides technical expertise to the government (MEE), Tekes and private-sector actors.

The **Finnish Innovation Fund, Sitra**, is an independent public foundation that operates under the supervision of the Finnish Parliament. Its mission is to promote the economic prosperity and future success of Finland.

**Finnvera** is a specialised financing entity under the Finnish government. Finnvera has official Export Credit Agency (ECA) status; it provides businesses with loans, guarantees, venture capital investment and export credit guarantees.

At regional level, national technology policy is implemented by administrative agencies, called **Centres for Economic Development, Transport and the Environment**.

The new **Strategic Centres for Science, Technology and Innovation (SHOKs)** have been set up to advance RD&D in the energy and environment sector, and carry out long-term co-operation in fields most crucial for the future. SHOKs are public-private partnerships for speeding up innovation processes and carrying out long-term co-operation in fields most crucial for future developments. Their main goal is to thoroughly renew industry clusters and to create radical innovations. SHOKs offer top research institutes and businesses a new way of engaging in close, long-term co-operation. Energy-related SHOK programmes include Forestcluster (bioeconomy), Materials and Engineering Competence (FIMECC), Built Environment (RYM), and CLEEN Ltd. (Cluster for Science, Technology and Innovation for Energy and Environment).

CLEEN, established in 2008, aims to facilitate and co-ordinate world-class industry-driven research in the field of energy and environment between leading energy companies and research institutes. It provides a cutting-edge open innovation platform for market-driven joint research between industry and academia. The CLEEN research agenda focuses on the stage of RD&D between “science push” and “market pull”: smart grids and energy markets, future combustion engines and power plants; measuring, monitoring and environmental assessment; carbon capture and storage; and energy efficiency. For 2012, programmes include distributed energy systems, bioenergy, material efficiency and recycling, and solar energy and solar storage.

## POLICIES AND PROGRAMMES

### OVERVIEW OF PROGRAMMES

The general orientation of Finland’s RD&D programme is laid out by Tekes, within the Strategic Centres for Science, Technology and Innovation. There currently is no overarching, national energy strategy.

Tekes, the Finnish Funding Agency for Technology and Innovation, finances programmes between companies, research institutes and universities in Finland. The programmes are used to promote the development in specific sectors of technology or industry, energy among them, and to pass on results of the research work to business in an efficient way. The programmes have proved to be effective forums for co-operation among key national players in research, development and innovation. The funds are awarded directly from the state budget via the MEE. Tekes also co-ordinates and finances Finnish participation in international technology initiatives.

The programmes are planned in co-operation with companies, research institutes, and Tekes and launched by the Tekes Board. Each programme has a steering group, a co-ordinator and a desk officer within Tekes. The duration of the programmes ranges from

three to five years with budgets ranging from a few to several tens of millions of euros. Tekes usually finances about half of the programme costs, with the difference mostly provided by the participating companies.

A key benefit from the programmes is the close co-operation between research institutes and industry, the widespread involvement of small and medium-sized companies, and the high level of international co-operation.

Tekes directs around half of its total funding to focus areas that are expected to play a key role in the success of Finnish enterprises and research in all sectors. Natural resources and sustainable economy (along with intelligent environments) is the area most relevant to energy. Priorities in the energy field are:

- energy and raw material efficiency;
- renewable energy solutions;
- new forest and biomass solutions;
- sustainable solutions for mineral resource use and water consumption.

## OVERVIEW OF KEY PROGRAMMES

### **Built Environment 2009-14**

This SHOK programme focuses specially on renovation and refurbishment, construction for well-being concepts and infrastructure construction.

### **EVE – Electric Vehicle Systems 2011-15**

The aim of the Electric Vehicle Systems programme is to create a community of electric vehicle and support-system developers to deploy new technology, business and service competences.

### **Fuel Cell 2007-13**

This programme seeks to speed the development and application of innovative fuel-cell technologies for growing global markets. The focus areas include stationary fuel-cell applications, fuel-cell power modules for utility vehicles and portable low-power solutions. The programme seeks to link together key players along the fuel-cell value chain.

### **Functional Materials 2007-13**

The Functional Materials programme aims to develop new applications for Finnish industrial sectors requiring special or challenging environmental conditions (such as extremely high temperatures).

### **Green Growth – Towards a Sustainable Future 2011-15**

The aim of the Green Growth programme is to support the generation of innovations enabling significant leaps in energy and material efficiency and to create the foundation for the development of new value networks based on green growth.

### **Green Mining 2011-16**

The main objective of the Green Mining programme is to make Finland a global leader in sustainable mineral mining industry by 2020.

### **Groove – Growth from Renewables 2010-14**

The main objective of the Groove programme is to enhance the business capabilities of Finnish small and medium-sized companies working with renewable energy by improving their international competitiveness and developing networks with the financial community.

### **Safety and Security 2007-13**

The programme will help enterprises and researchers develop international business activity and competences in safety and security technologies.

### **Water 2008-12**

Finland's northern climate, relatively long distances and energy-intensive industries have spurred the development of efficient energy systems. With vast reserves of clean water in the country's 188 000 lakes, Finns are pioneers in water management.

The objective of the programme is to contribute to technology transfer, new applications development, business competence development, and overall competitiveness of the Finnish water sector in the international market.

### **Smart Grids**

Smart Grids and Energy Markets (SGEM) is one of CLEEN's five ongoing research programmes. Its aim is to develop international smart grid solutions that can be demonstrated in a real environment utilising Finnish research, development and innovation (RD&I) infrastructure. At the same time, the benefits of an interactive international research environment will accumulate the know-how of world-leading information and communication (ICT) and smart grid providers.

## **EVALUATION AND FUNDING**

### **Programme evaluation**

Evaluations and impact assessments are an integral part of Tekes's technology programmes. They provide feedback on whether the programme achieved the stated objectives and assessed impacts, as well as providing valuable information on the factors contributing to the success or failure dynamics of specific RD&D activities. This information is fed back into the strategic development of Tekes's operations.

The programme evaluations are carried out in-process (usually midway in the work programme) and *ex post* (either at the end of the programme or a few years after completion). The results of mid-term evaluation are used, for example, to expand or revise programme plans where necessary and as relevant.

Tekes's impact assessment unit co-ordinates the *ex post* evaluations of the programmes, while the evaluations are made by an external group of experts who provide diverse and independent views on the impact of each programme.

The same evaluation team may review multiple programmes treating the same technology area or cluster, having similar goals or some other common denominator. Co-funded programmes co-operate with the other funders also in evaluation.

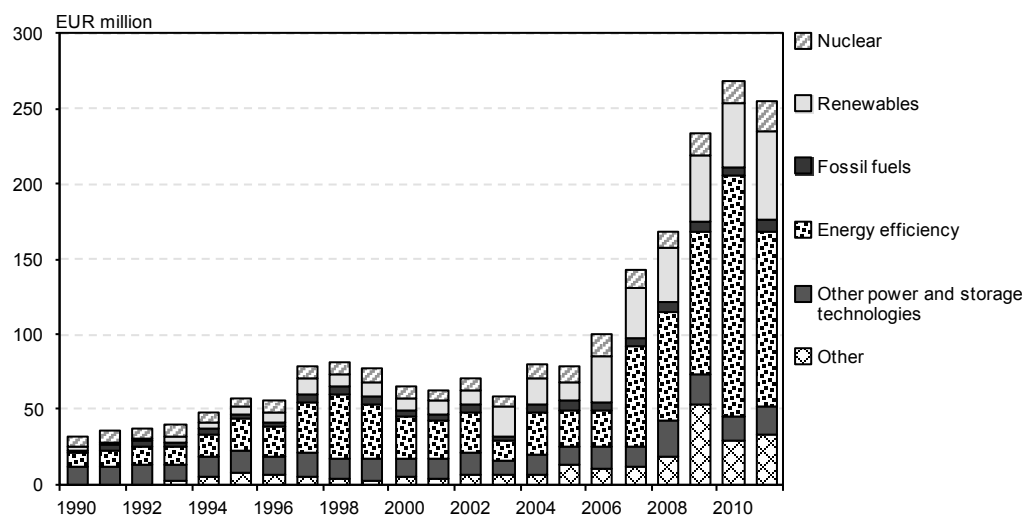
Responsibility for mid-term evaluation, planning, implementation and budgeting lies with the programme. Mid-point evaluation is carried out as a self-evaluation which, in some cases, can be supplemented by the work of an external evaluation group. To facilitate mid-term evaluations, an online tool has been developed for conducting and reporting surveys.

## Funding

As shown in Figure 42, Finland's public energy RD&D expenditures have grown substantially in recent years, totalling nearly EUR 255 million in 2011, with a peak of EUR 269 million in 2010 (this includes about EUR 67 million of loans). The bulk of RD&D expenditure in 2011 was allocated to energy efficiency programmes, which alone account for over EUR 116 million.

The major public RD&D funding actors in Finland in 2010 were Tekes (EUR 150 million), government research institutes (EUR 21 million), the Academy of Finland (EUR 0.8 million) and other organisations (EUR 7 million).

Figure 42. **Government RD&D spending on energy, 1990-2011**



Sources: Ministry of Employment and the Economy.

## INTERNATIONAL COLLABORATION

Given its relatively small size, Finland has by necessity designed the national energy RD&D framework with an outward focus. As such, international collaboration – in research, funding and other means – is important, and critical to the future growth of the country's energy industries.



Finland is a research leader in certain key sustainable energy technologies. This development has benefited from international collaboration in areas that are coherent with the national Climate and Energy Strategy and targets. Continuous international leadership will help Finland to solidify its role.

Finland has an active network of international collaboration in the area of energy technology RD&D. Tekes has built up a global partnership network of leading universities and other innovation partners around the world, including technology companies and research organisations. Tekes also funds collaborative RD&D projects and facilitates researcher mobility, and is also actively building partnerships with RD&D financiers in Europe, Asia and North America.

Tekes's global operations are part of the FinNode Innovation Centre network that boosts international RD&D co-operation and business. FinNode provides a gateway for international enterprises wishing to link to partners in Finland – whether they are looking for business contacts, cutting-edge research, or RD&D resources. At the moment FinNode operates in China, Japan, the United States and Russia.

Complementing this activity, the Academy of Finland co-operates with the Research Council of Norway, the Swedish Energy Agency and the Nordic Energy Research Institute to foster Nordic innovative and multidisciplinary basic research. The Academy of Finland is working with key developing countries, including China and Brazil, on bioenergy technology collaboration.

VTT actively networks with RD&D institutes and industrial partners worldwide to advance new technologies, particularly in the area of bioenergy.

Tekes is also the focal point of many European research activities in Finland, such as the EUREKA network, the European Union's 7th Research Framework Programme (FP7), European Co-operation in Science and Technology (COST) and the European Space Agency (ESA). Finland participates in the steering committee of the European Strategic Energy Technology Plan (SET-Plan) and the competitive research programmes of the European Union, including the Seventh Framework and Intelligent Energy for Europe Programmes. The Horizon 2020 programme to be launched in 2014 will be the successor to encompass these programmes. It envisages EUR 6.2 billion for energy RD&D programmes over seven years to 2020 (compared with EUR 2.3 billion in FP7).

Finally, Finland is a Contracting Party to 22 IEA Implementing Agreements, in all areas (cross-cutting, end-use, fossil fuels, renewables) except fusion, putting it in eighth place among IEA member countries in terms of participation.

## ASSESSMENT

Finland has an impressive history of supporting research, development and demonstration (RD&D) in general and in energy RD&D in particular. In 2010, Finland spent 3.9% of GDP on RD&D, of which 0.16% was specifically allocated to energy, placing the country above any other OECD country. Furthermore, Finnish industries also invest considerably in energy RD&D, particularly in the fields of energy efficiency and bioenergy, with funding levels exceeding those of the public sector.

Finland is ranked as one of the most competitive economies in the world, with well-functioning and transparent institutions and a top position in higher education and training. This has provided the workforce with the skills needed to adapt rapidly to a changing environment and has laid the ground for its high levels of technological adoption and innovation.

Energy technology plays an integrated role in Finnish energy policy. Finland systematically supports technology development at all stages, from basic research, development, demonstration and deployment, involving industry in early stages of the technology development.

Technology development in Finland plays an important role in deriving the most benefit from domestic renewable energy resources, curbing energy use and energy-related emissions. It also contributes to developing the competitiveness of Finnish industry and technology and building up the scientific knowledge base.

However, Finland has yet to develop a comprehensive, detailed national energy RD&D strategy. Such a national strategy would prioritise RD&D activities across a portfolio of technologies, irrespective of the institutional or financial responsibilities, or of technology maturity.

Rather, Finland has pursued a practice where the main funding body (Tekes) simultaneously responds to energy and industry needs by launching proactive as well as reactive technology programmes and initiatives. Tekes has listed “Natural resources and sustainable economy” as one of six focus areas for research activities. For energy, this includes: energy and raw material efficiency; renewable energy solutions; new forest and biomass solutions; and sustainable solutions for mineral resource use and water consumption. Within these overarching objectives, the energy sector and other funding agencies (such as the Academy of Science) may develop their own strategies and priorities, provided they are in accordance with the government’s long-term strategies for energy and climate. Overlaps and gaps may easily occur, for example in the field of necessary basic research for key enabling technologies such as materials science and ICT.

As it now stands, the *de facto* priority setting is based on a delicate balance between policy-driven, proactive technology programmes and bottom-up industry interests and involvement (one notable exception is the obligation for nuclear power companies to make RD&D plans for waste management). Thus, there is a variety of strategies developed by the energy sector and various clusters and institutions, with each pursuing its own strategic goals and interests. Nevertheless, some cross-cutting strategic initiatives are undertaken, such as the technology roadmap for the green economy which is led by Tekes and in close co-operation with stakeholders from industry, universities and other governmental bodies.

Public-private strategic technology partnerships, led by the Strategic Centres for Science, Technology and Innovation (SHOKs), develop strategies and action plans to guide the common investments and RD&D activities. The SHOKs are quite successful in committing both technology users and providers, small and larger companies, and the university and institute sector in setting strategic targets, defining practice and developing open research programmes, partly funded by Tekes. Initiated in 2006 by Tekes, there are currently six partnerships in the energy field covering energy efficiency, smart grids and markets; carbon capture and storage; combustion technology; biorefining; metals and engineering processes and competences; and the built environment.

To support the development of nuclear energy, continuous efforts in R&D are needed in all areas of the sector, from operational safety to waste management and decommissioning (see Chapter 8 for details). Today, Finland’s research effort in the area of nuclear energy is largely funded by the power companies (about 72%), and is essentially dedicated to applied research in waste management and reactor safety. Responding to the Fukushima Daiichi accident, the Finnish research stakeholders have decided to focus more research efforts on beyond-design accidents. Funding for basic research as well for advanced nuclear technology,

such as Generation-IV fission systems, has been more limited but could be increased, as a means to create competence and to attract young talents from within the country and abroad.

Whether carried out systematically or on an *ad hoc* basis, evaluations provide key information that enables more balanced, informed decision making, and, as a result, save precious resources. Regular evaluations of the overall energy RD&D investments and activities are important to ensure that RD&D objectives are achieved and that results build on and feed into current programmes. The last evaluation of energy RD&D was performed in 2005 by the Academy of Finland. The MEE has indicated that a comprehensive energy RD&D evaluation will soon be carried out.

Forestry is a core component of the economy, and Finnish companies and researchers are world leaders in biomass-related technologies, stemming from close co-operation between the energy and forest industries. Co-firing of biomass with coal and peat is growing, stimulated by a feed-in tariff for biomass. Finland is pioneering the concept of the biorefinery.

Given this national strength, broader, socio-economic research on the environmental and agricultural implications of biomass could be further developed, particularly as this research would be useful for other countries with bio-based economic goals. Biogas research could be further encouraged, as Finland is a gas-dependent country, and deploying biogas would be sensible from an energy security and environmental point of view.

Finland is actively involved in terms of international collaboration, most notably the European Union's Strategic Energy Technology Plan (SET-Plan), as well as its institutional pillars – the European Energy Research Alliance and selected joint programmes, and the European Industrial Initiatives.

The Academy of Finland is part of the Nordic Energy Research, a funding body among the five Nordic countries to support common RD&D projects, and other regional and bilateral collaboration schemes. Finland also participates in 22 IEA Implementing Agreements which are coherent and well aligned with national energy strategy and targets. The Finnish research community benefits from these various collaborations. In addition, Tekes's global operations are part of the FinNode Innovation Centre network that boosts international RD&D co-operation and business.

## RECOMMENDATIONS

*The government of Finland should:*

- ☐ *Consider developing a comprehensive, detailed national energy RD&D strategy.*
- ☐ *Maintain an ambitious and constant level of public RD&D expenditure and maintain the dedication to engage (also financially) the industry in RD&D.*
- ☐ *Perform regular evaluations of the energy RD&D programmes and funding mechanism.*
- ☐ *Continue to promote education and training so as to provide the necessary skills to address the needs of the growing nuclear energy sector and the challenge of an ageing workforce; provide a framework to attract skilled personnel from abroad; and further support research in areas that are needed to develop a broad competence base.*



## **PART IV ANNEXES**



## ANNEX A: ORGANISATION OF THE REVIEW

### REVIEW CRITERIA

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The Shared Goals, which were adopted by the IEA Ministers at their 4 June 1993 meeting in Paris, provide the evaluation criteria for the in-depth reviews conducted by the IEA. The Shared Goals are presented in Annex C.

### REVIEW TEAM

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The in-depth review team visited Finland from 21 to 25 May 2012. The team met with government officials, energy suppliers, interest groups and various other organisations. This report was drafted on the basis of these meetings, the team's preliminary assessment of Finland's energy policy, the government response to the IEA energy policy questionnaire and other information.

The members of the team were:

*IEA member countries*

Mr. Michael SCHULTZ, Germany (team leader)

Ms. Margareta BERGSTRÖM, Sweden

Mr. Håvard GROTHE LIEN, Norway

Ms. Birte HOLST JØRGENSEN, Denmark

*European Commission*

Ms. Olga SIHMANE

*OECD Nuclear Energy Agency*

Mr. Henri PAILLÈRE

*International Energy Agency*

Ms. Nina CAMPBELL

Mr. Anselm EISENTRAUT

Mr. Shinji FUJINO

Mr. James SIMPSON (desk officer)

The team is grateful for the co-operation and assistance of the many people it met during the visit, the kind hospitality and the willingness to discuss the challenges and opportunities that Finland is currently facing. The team wishes to express its sincere appreciation to Mr. Esa Härmälä, Director General of the Energy Department, and his staff at the Ministry of Employment and the Economy for their hospitality and personal engagement in briefing the team on energy policy issues. In particular, the team wishes to thank Mr. Ville Niemi and Ms. Maria Kekki for their unfailing helpfulness in preparing for and guiding both the visit and the entire review process.

James Simpson managed the review and drafted Chapters 1, 2, 3, 5, 6, 7, 10, 11 and 12 of the report. Other chapters were drafted by Nina Campbell (Chapter 4, and contributions to Chapter 3), Anselm Eisentraut (Chapter 9) and Mr. Henri Paillère (Chapter 8). Sonja Lekovic provided statistics-related sections for several chapters. Helpful comments were provided by the review team members and IEA colleagues, including Ulrich Benterbusch, Anne-Sophie Corbeau, Jason Elliot, Carlos Fernandez, Greg Frost, Rebecca Gaghen, Kijune Kim, Kieran McNamara, Yuichiro Nishida, Carrie Pottinger, Yamina Saheb and Robert Tromp.

Sonja Lekovic and Bertrand Sadin prepared the figures and maps. Karen Treanton provided support on statistics. Muriel Custodio, Astrid Dumond, Cheryl Haines and Angela Gosmann managed the editing and production process. Viviane Consoli and Rebecca Gaghen provided editorial assistance. Catherine Smith helped in the final stages of preparation.

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## ORGANISATIONS VISITED

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Ministry of Employment and the Economy  
Ministry of Agriculture and Forestry  
Ministry of the Environment  
Ministry of Transport and Communications  
Academy of Finland  
Association of Finnish Peat Industries  
Bioenergy Association of Finland  
Central Union of Agricultural Producers and Forest Owners  
CLEEN Oy  
Confederation of Finnish Industry and Employers  
Energy Market Authority  
Federation of Finnish Technology Industries  
Fennovoima  
Fingrid Oyj  
Finnish Association for Nature Conservation  
Finnish Competition Authority  
Finnish Energy Industries  
Finnish Forest Industries Federation



Finnish Oil and Gas Federation  
Finnish Petroleum Federation  
Finnish Wind Power Association  
Fortum  
Gasum  
Hakevuori Oy  
Helsingin Energia  
Keravan Energia Oy  
Lappeenranta University of Technology  
METLA, Finnish Forest Research Institute  
Motiva Oy  
NESA (National Emergency Supply Agency)  
Posiva Oy  
Rautaruukki Oyj  
Sitra, Finnish Innovation Fund  
Stora Enso  
STUK, Radiation and Nuclear Safety Authority  
Suomen ElFi Oy  
Tekes, Finnish Funding Agency for Technology and Innovation  
TVO  
VTT, Technical Research Centre of Finland



**ANNEX B:  
ENERGY BALANCES  
AND KEY STATISTICAL DATA**

		Unit: Mtoe						
SUPPLY		1973	1990	2009	2010	2011	2020	2030
<b>TOTAL PRODUCTION</b>		<b>4.9</b>	<b>12.1</b>	<b>16.5</b>	<b>17.4</b>	<b>17.1</b>	<b>22.0</b>	<b>28.0</b>
Coal		-	-	-	-	-	-	-
Peat		0.1	1.8	2.2	1.8	1.7	1.3	1.2
Oil		-	-	0.1	0.0	0.0	-	-
Natural Gas		-	-	-	-	-	-	-
Biofuels & Waste <sup>1</sup>		3.9	4.3	6.9	8.3	8.1	9.0	9.3
Nuclear		-	5.0	6.1	5.9	6.0	9.1	14.7
Hydro		0.9	0.9	1.1	1.1	1.1	1.2	1.3
Wind		-	-	0.0	0.0	0.0	0.5	0.6
Geothermal		-	-	-	-	-	-	-
Solar/Other <sup>2</sup>		-	-	0.1	0.1	0.1	0.8	1.0
<b>TOTAL NET IMPORTS<sup>3</sup></b>		<b>16.2</b>	<b>16.9</b>	<b>17.8</b>	<b>17.3</b>	<b>18.3</b>	<b>14.1</b>	<b>10.2</b>
Coal	Exports	0.0	0.0	0.0	0.0	0.0	-	-
	Imports	2.4	4.4	3.8	4.0	4.6	4.3	1.9
	Net Imports	2.4	4.4	3.8	4.0	4.6	4.3	1.9
Oil	Exports	0.2	1.7	6.7	6.9	7.3	-	-
	Imports	13.8	12.0	16.8	16.2	17.4	7.4	6.8
	Int'l Marine and Aviation Bunkers	-0.2	-0.9	-0.8	-0.7	-0.8	-0.7	-0.6
	Net Imports	13.4	9.5	9.3	8.6	9.2	6.8	6.2
Natural Gas	Exports	-	-	-	-	-	-	-
	Imports	-	2.2	3.5	3.8	3.4	3.0	2.5
	Net Imports	-	2.2	3.5	3.8	3.4	3.0	2.5
Electricity	Exports	0.0	0.0	0.3	0.4	0.3	0.5	1.0
	Imports	0.4	0.9	1.3	1.4	1.5	0.5	0.7
	Net Imports	0.4	0.9	1.0	0.9	1.2	-	-0.3
<b>TOTAL STOCK CHANGES</b>		<b>-0.1</b>	<b>-0.6</b>	<b>-1.0</b>	<b>1.8</b>	<b>-0.7</b>	<b>-</b>	<b>-</b>
<b>TOTAL SUPPLY (TPES)<sup>4</sup></b>		<b>21.0</b>	<b>28.4</b>	<b>33.3</b>	<b>36.4</b>	<b>34.7</b>	<b>36.1</b>	<b>38.2</b>
Coal		2.5	4.1	3.6	4.6	3.7	4.3	1.9
Peat		0.0	1.2	1.7	2.3	2.0	1.3	1.2
Oil		13.3	9.5	9.1	9.4	9.2	6.8	6.2
Natural Gas		-	2.2	3.5	3.8	3.4	3.0	2.5
Biofuels & Waste <sup>1</sup>		3.9	4.6	7.0	8.3	8.1	9.0	9.3
Nuclear		-	5.0	6.1	5.9	6.0	9.1	14.7
Hydro		0.9	0.9	1.1	1.1	1.1	1.2	1.3
Wind		-	-	0.0	0.0	0.0	0.5	0.6
Geothermal		-	-	-	-	-	-	-
Solar/Other <sup>2</sup>		-	-	0.1	0.1	0.1	0.8	1.0
Electricity Trade <sup>5</sup>		0.4	0.9	1.0	0.9	1.2	-	-0.3
<b>Shares (%)</b>								
Coal		12.0	14.4	10.7	12.7	10.6	12.0	4.8
Peat		0.2	4.3	5.2	6.2	5.8	3.7	3.1
Oil		63.0	33.3	27.4	25.7	26.4	18.7	16.2
Natural Gas		-	7.7	10.5	10.5	9.7	8.2	6.4
Biofuels & Waste		18.7	16.1	21.1	22.7	23.3	25.0	24.3
Nuclear		-	17.6	18.4	16.3	17.4	25.3	38.4
Hydro		4.3	3.3	3.3	3.0	3.1	3.4	3.3
Wind		-	-	0.1	0.1	0.1	1.4	1.6
Geothermal		-	-	-	-	-	-	-
Solar/Other		-	-	0.3	0.3	0.3	2.2	2.6
Electricity Trade		1.8	3.2	3.1	2.5	3.4	-	-0.8

0 is negligible, - is nil, .. is not available

Unit: Mtoe

DEMAND							
FINAL CONSUMPTION	1973	1990	2009	2010	2011	2020	2030
<b>TFC</b>	<b>19.2</b>	<b>22.2</b>	<b>24.4</b>	<b>26.8</b>	<b>25.2</b>	<b>27.1</b>	<b>27.2</b>
Coal	1.0	1.2	0.3	0.5	0.4	1.2	1.2
Peat	0.0	0.4	0.3	0.3	0.3	0.4	0.3
Oil	11.3	9.2	7.8	8.3	7.8	6.5	5.9
Natural Gas	-	1.0	1.0	1.1	1.0	1.1	0.9
Biofuels & Waste <sup>1</sup>	3.9	3.5	4.3	4.8	4.7	6.4	6.6
Geothermal	-	-	-	-	-	-	-
Solar/Other	-	-	0.0	0.0	0.0	0.0	0.0
Electricity	2.3	5.1	6.6	7.2	6.9	7.8	8.4
Heat	0.6	1.9	4.1	4.7	4.1	3.8	3.8
<b>Shares (%)</b>							
Coal	5.4	5.2	1.3	1.8	1.7	4.5	4.2
Peat	0.1	1.8	1.0	1.1	1.1	1.4	1.2
Oil	58.7	41.3	32.1	30.9	30.8	23.8	21.7
Natural Gas	-	4.4	4.0	3.9	4.0	3.9	3.5
Biofuels & Waste	20.5	15.8	17.5	18.0	18.7	23.7	24.3
Geothermal	-	-	-	-	-	-	-
Solar/Other	-	-	-	-	-	-	0.1
Electricity	12.1	22.8	27.1	26.8	27.4	28.8	31.0
Heat	3.1	8.6	16.9	17.4	16.2	13.8	14.1
<b>TOTAL INDUSTRY<sup>6</sup></b>	<b>7.6</b>	<b>10.5</b>	<b>10.9</b>	<b>12.3</b>	<b>12.0</b>	<b>13.5</b>	<b>13.8</b>
Coal	0.9	1.2	0.3	0.5	0.4	1.2	1.1
Peat	0.0	0.4	0.2	0.2	0.2	0.3	0.3
Oil	5.0	2.6	2.2	2.4	2.3	1.9	2.0
Natural Gas	-	0.9	0.9	1.0	0.9	1.0	0.9
Biofuels & Waste <sup>1</sup>	-	2.5	2.6	3.0	3.1	4.3	4.6
Geothermal	-	-	-	-	-	-	-
Solar/Other	-	-	-	-	-	-	-
Electricity	1.6	2.8	3.1	3.5	3.4	4.0	4.3
Heat	0.1	0.2	1.5	1.8	1.6	0.7	0.7
<b>Shares (%)</b>							
Coal	12.2	11.0	2.9	3.9	3.6	9.1	8.3
Peat	0.2	3.7	1.8	1.9	2.0	2.5	2.1
Oil	66.0	24.5	20.6	19.7	19.1	14.4	14.4
Natural Gas	-	9.0	8.1	7.7	7.7	7.3	6.2
Biofuels & Waste	-	23.4	24.2	24.4	25.7	31.8	33.0
Geothermal	-	-	-	-	-	-	-
Solar/Other	-	-	-	-	-	-	-
Electricity	20.5	26.7	28.6	28.1	28.4	29.7	31.0
Heat	1.0	1.7	13.7	14.3	13.5	5.1	5.0
<b>TRANSPORT<sup>4</sup></b>	<b>2.4</b>	<b>4.0</b>	<b>4.2</b>	<b>4.4</b>	<b>4.3</b>	<b>3.7</b>	<b>3.4</b>
<b>OTHER<sup>7</sup></b>	<b>9.2</b>	<b>7.8</b>	<b>9.4</b>	<b>10.1</b>	<b>8.9</b>	<b>10.0</b>	<b>10.0</b>
Coal	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Peat	0.0	0.0	0.1	0.1	0.1	0.0	0.0
Oil	3.9	2.7	1.6	1.7	1.4	1.4	1.3
Natural Gas	-	0.0	0.1	0.1	0.1	0.1	0.1
Biofuels & Waste <sup>1</sup>	3.9	1.1	1.5	1.7	1.5	1.7	1.6
Geothermal	-	-	-	-	-	-	-
Solar/Other	-	-	0.0	0.0	0.0	0.0	0.0
Electricity	0.8	2.2	3.5	3.6	3.4	3.7	3.9
Heat	0.5	1.7	2.6	2.9	2.5	3.1	3.2
<b>Shares (%)</b>							
Coal	1.1	0.1	0.1	-	0.1	-	-
Peat	0.1	0.2	0.6	0.6	0.6	0.3	0.3
Oil	42.0	34.6	17.1	16.7	15.7	14.4	12.6
Natural Gas	-	0.5	0.8	0.9	0.8	0.8	0.7
Biofuels & Waste	42.8	13.7	16.4	16.9	16.4	16.7	15.6
Geothermal	-	-	-	-	-	-	-
Solar/Other	-	-	-	-	-	-	0.2
Electricity	8.2	28.6	36.9	36.1	38.7	37.3	39.0
Heat	5.7	22.3	28.1	28.7	27.8	30.6	31.5

Unit: Mtoe

DEMAND							
ENERGY TRANSFORMATION AND LOSSES	1973	1990	2009	2010	2011	2020	2030
<b>ELECTRICITY GENERATION<sup>8</sup></b>							
INPUT (Mtoe)	3.4	11.8	16.9	18.9	17.2	19.7	22.6
OUTPUT (Mtoe)	2.2	4.7	6.2	6.9	6.3	8.1	9.0
(TWh gross)	26.1	54.4	72.1	80.7	73.5	93.8	104.5
<b>Output Shares (%)</b>							
Coal	18.7	18.5	16.1	18.8	14.0	14.5	3.0
Peat	9.4	5.1	6.1	7.8	7.4	3.6	2.7
Oil	31.6	3.1	0.7	0.6	0.6	0.4	0.3
Natural Gas	-	8.6	13.6	14.0	12.9	9.1	6.6
Biofuels & Waste	-	9.5	12.4	13.8	15.6	13.4	12.4
Nuclear	-	35.3	32.6	28.3	31.6	37.3	53.9
Hydro	40.3	20.0	17.6	16.0	16.9	15.1	14.2
Wind	-	-	0.4	0.4	0.7	6.4	6.7
Geothermal	-	-	-	-	-	-	-
Solar/Other	-	-	0.1	0.1	0.1	-	0.3
<b>TOTAL LOSSES</b>	<b>1.9</b>	<b>6.7</b>	<b>8.7</b>	<b>9.5</b>	<b>9.1</b>	<b>8.9</b>	<b>11.0</b>
of which:							
Electricity and Heat Generation <sup>9</sup>	0.6	5.1	6.4	7.1	6.6	8.4	10.4
Other Transformation	0.5	0.3	0.3	0.4	0.3	-	-
Own Use and Losses <sup>10</sup>	0.9	1.4	2.1	2.1	2.1	0.5	0.5
<b>Statistical Differences</b>	<b>-0.1</b>	<b>-0.6</b>	<b>0.1</b>	<b>0.1</b>	<b>0.5</b>	<b>-</b>	<b>-</b>
INDICATORS	1973	1990	2009	2010	2011	2020	2030
GDP (billion 2005 USD)	84.40	140.20	197.50	204.10	209.70	241.90	290.57
Population (millions)	4.67	4.99	5.34	5.36	5.39	5.60	5.85
TPES/GDP <sup>11</sup>	0.25	0.20	0.17	0.18	0.17	0.15	0.13
Energy Production/TPES	0.23	0.43	0.50	0.48	0.49	0.61	0.73
Per Capita TPES <sup>12</sup>	4.51	5.69	6.23	6.79	6.45	6.44	6.54
Oil Supply/GDP <sup>11</sup>	0.16	0.07	0.05	0.05	0.04	0.03	0.02
TFC/GDP <sup>11</sup>	0.23	0.16	0.12	0.13	0.12	0.11	0.09
Per Capita TFC <sup>12</sup>	4.11	4.46	4.58	5.00	4.68	4.85	4.66
Energy-related CO <sub>2</sub> Emissions (Mt CO <sub>2</sub> ) <sup>13</sup>	48.0	54.4	55.1	63.2	55.6	49.1	35.9
CO <sub>2</sub> Emissions from Bunkers (Mt CO <sub>2</sub> )	0.5	2.8	2.3	2.3	2.5	2.0	1.8
GROWTH RATES (% per year)	73-90	90-00	00-09	09-10	10-11	11-20	20-30
TPES	1.8	1.3	0.3	9.5	-4.6	0.4	0.6
Coal	2.9	-1.2	-0.3	29.9	-20.5	1.9	-8.2
Peat	22.6	2.1	1.6	32.4	-10.6	-4.5	-1.2
Oil	-2.0	-0.6	0.3	2.7	-2.1	-3.3	-0.9
Natural Gas	-	4.6	0.2	10.1	-12.4	-1.4	-1.8
Biofuels & Waste	0.9	3.7	0.8	17.8	-2.1	1.2	0.3
Nuclear	-	1.6	0.5	-3.1	1.7	4.7	4.9
Hydro	0.2	3.0	-1.6	1.8	-3.7	1.5	0.4
Wind	-	-	14.7	4.2	64.0	32.5	1.6
Geothermal	-	-	-	-	-	-	-
Solar/Other	-	-	2.6	8.7	-10.0	27.2	2.5
TFC	0.9	1.0	-0.1	9.7	-6.0	0.8	0.0
Electricity Consumption	4.7	2.5	0.2	8.3	-3.9	1.4	0.7
Energy Production	5.5	2.1	1.2	5.1	-1.5	2.9	2.4
Net Oil Imports	-2.0	-0.1	-0.1	-7.2	6.7	-3.4	-0.9
GDP	3.0	2.1	1.6	3.3	2.7	1.6	1.9
Growth in the TPES/GDP Ratio	-1.2	-0.7	-1.2	6.0	-6.7	-1.2	-1.2
Growth in the TFC/GDP Ratio	-2.1	-1.1	-1.6	5.6	-8.4	-0.8	-1.7

## Footnotes to energy balances and key statistical data

1. Biofuels and waste comprises solid biofuels, liquid biofuels, biogases, industrial waste and municipal waste. Data are often based on partial surveys and may not be comparable between countries.
2. Other includes ambient heat used in heat pumps.
3. In addition to coal, oil, natural gas and electricity, total net imports also include peat, biofuels and waste.
4. Excludes international marine bunkers and international aviation bunkers.
5. Total supply of electricity represents net trade. A negative number in the share of TPES indicates that exports are greater than imports.
6. Industry includes non-energy use.
7. Other includes residential, commercial, public services, agriculture, forestry, fishing and other non-specified.
8. Inputs to electricity generation include inputs to electricity, CHP and heat plants. Output refers only to electricity generation.
9. Losses arising in the production of electricity and heat at main activity producer utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of approximately 33% for nuclear and 100% for hydro, wind and photovoltaic.
10. Data on “losses” for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.
11. Toe per thousand US dollars at 2005 prices and exchange rates.
12. Toe per person.
13. “Energy-related CO<sub>2</sub> emissions” have been estimated using the IPCC Tier I Sectoral Approach from the Revised 1996 IPCC Guidelines. In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2010 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.





## ANNEX C: IEA “SHARED GOALS”

The member countries\* of the IEA seek to create conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and to the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants. In order to secure their objectives, member countries therefore aim to create a policy framework consistent with the following goals:

- 1. Diversity, efficiency and flexibility within the energy sector** are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group.
- 2. Energy systems should have the ability to respond promptly and flexibly to energy emergencies.** In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.
- 3. The environmentally sustainable provision and use of energy** are central to the achievement of these Shared Goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should respect the Polluter Pays Principle where practicable.
- 4. More environmentally acceptable energy sources** need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA member countries wish to retain and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.
- 5. Improved energy efficiency** can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.
- 6. Continued research, development and market deployment of new and improved energy technologies** make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

**7. Undistorted energy prices** enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

**8. Free and open trade** and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

**9. Co-operation among all energy market participants** helps to improve information and understanding, and encourages the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA Ministers at the meeting of 4 June 1993 Paris, France.)

\* Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States.

## ANNEX D: GLOSSARY AND LIST OF ABBREVIATIONS

In this report, abbreviations and acronyms are substituted for a number of terms used within the IEA. While these terms generally have been written out on first mention, this glossary provides a quick and central reference for many of the abbreviations used.

ABWR	advanced boiling water reactor
AC	alternating current
APR	advanced power reactor
b/d	barrels per day
bcm	billion cubic metres
BWR	boiling water reactor
CCS	carbon capture and storage
CDM	clean development mechanism (under the Kyoto Protocol)
CHP	combined heat and power production
DC	direct current
DSO	distribution system operator
EIA	environmental impact assessment
EMA	Energy Market Authority
EPR	European pressurised water reactor
ESBWR	Economic simplified boiling water reactor
EU-ETS	European Union Emissions Trading Scheme
GHG	greenhouse gas
IAEA	International Atomic Energy Agency
IPCC	Intergovernmental Panel on Climate Change
JI	joint implementation (a flexibility mechanism under the Kyoto Protocol)
kb/d	thousand barrels per day
kVA	kilovolt ampere
kWh	kilowatt hour
LNG	liquefied natural gas
LPG	liquefied petroleum gas
LULUCF	land use, land-use change and forestry
mb	million barrels
mcm	million cubic metres
MEE	Ministry of Employment and the Economy
MEPS	minimum energy performance standards
MJ	megajoule

Mt CO <sub>2</sub> -eq	million tonnes of carbon dioxide-equivalent
Mtoe	million tonnes of oil-equivalent
MVA	megavolt-ampere
MW	megawatt
MWh	megawatt hour
NAP	National Allocation Plan
NEEAP	National Energy Efficiency Action Plan
NESA	National Emergency Supply Agency
NPP	nuclear power plant
NREAP	National Renewable Energy Action Plan
OCGT	open-cycle gas turbine
SHOK	Strategic Centre for Science, Technology and Innovation
PPP	purchasing power parity: the rate of currency conversion that equalises the purchasing power of different currencies, <i>i.e.</i> PPP estimates the differences in price levels between countries
PWR	pressurised water reactor
RD&D	research, development and demonstration
RES	renewable energy sources
Sitra	Finnish Innovation Fund
STUK	Radiation and Nuclear Safety Authority
Tekes	Finnish Funding Agency for Technology and Innovation
TFC	total final consumption of energy
toe	tonne of oil-equivalent
TPES	total primary energy supply
TSO	transmission system operator
TWh	terawatt hour
UNFCC	United Nations Framework Convention on Climate Change
VTT	Technical Research Centre of Finland
VVER	water-water energy reactor



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