



## RENEWABLE ENERGY IN FINLAND



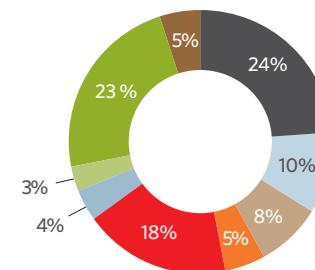
# ENERGY CONSUMPTION IN FINLAND



Due to Finland's northern location, there is a diverse need for energy. In the long, cold winter months, energy is consumed for lighting and heating. Uninterrupted electricity and heat production is the lifeblood of living. Long distances and dispersed settlements increase energy use in transport. The heavy industry in the country, especially the forest, metals and chemical industry, also use a lot of energy.

Energy generation plays a key role in the mitigation of climate change. The majority, about 80 per cent, of greenhouse gases that cause global warming, is the result of energy generation, consumption and traffic. Important means of combatting climate change include energy saving and energy efficiency and adopting more renewable energy sources.

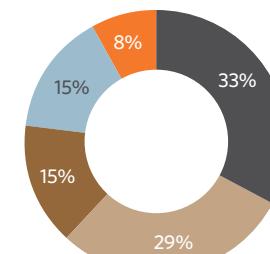
Distribution of total energy consumption by energy source in Finland in 2012



- Oil
- Nuclear power
- Hydro and wind power
- Other renewables
- Wood fuels
- Peat
- Net imports of electricity
- Gas
- Coal

Total energy consumption in Finland in 2012 amounted to 1 367 PJ

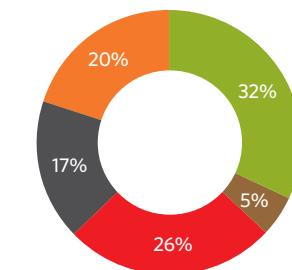
Renewable energy sources in 2012



- Black liquor and other concentrated liquors
- Industrial wood fuels
- Firewood
- Hydropower
- Others

Others is divided  
31% Other biofuels  
20% Recovered fuels (bio)  
6% Biogas  
38% Heat pumps  
5% Wind power

Electricity supply by source



- Renewable energy
- Fossil fuels
- Net imports of electricity
- Nuclear power
- Peat

Total electricity supply in 2012 was 85.2 TWh

# RENEWABLE ENERGY FOR THE BENEFIT OF THE CLIMATE

CO<sub>2</sub>

Finland aims for a carbon-neutral society by 2050. The vision is that 60 per cent of energy use will be based on renewable sources in 2050. Another target is to stop the increase in overall energy use and turn it into a decline. There are signs that the increase in overall energy use has already levelled off.



Finland's energy economy is based on exceptionally diverse energy sources. Wood-based fuels, hydro power, nuclear power, natural gas, coal, oil, and peat are currently used in the energy production. The efficiency rate of energy production is improved by the widely used combined heat and power production (CHP).

In its energy and climate strategy, which was updated in spring 2013, the Finnish government has defined how to achieve the EU target to increase the share of renewable energy in final consumption to 38 per cent by 2020.

There are many ways to achieve this target. In Finland, in addition to hydro power, the forests have an abundance of available renewable energy. It is possible to increase the use of wood-based energy, recycled waste-derived fuels, heat pumps,

biogas and wind power, making it possible to reach the renewable energy targets. Moreover, the introduction of renewable energy use has also been facilitated by rendering the subsidy and steering systems more efficient. Improvement of energy efficiency is also encouraged in order to reduce overall energy consumption.

Traditional use of small-sized wood in the heating of households is still common. Heat pumps are rapidly becoming more common, and solar thermal systems are following suit. Households also have solar panels and small wind turbines at their disposal, producing part of the electricity they need. Any surplus electricity can be fed into the electricity grid and sold to the energy company.

# WHY RENEWABLE ENERGY?

Today, there are many reasons for replacing the use of fossil fuels. The international community has agreed to measures aiming to limit the rise in average global temperature to two degrees. The use of fossil fuels is the biggest cause of greenhouse gas emissions that heat up the atmosphere.

Renewable energy is an indigenous energy resource, and therefore it reduces our dependency on imported energy. At the same time, it has created more jobs in Finland. In the future, new innovations may boost our exports even further and provide even more jobs. Reducing energy imports also improves our country's current account balance. There is only a limited amount of fossil fuels in the world. The rise in their market prices and the price of EU emission allowances will improve the competitiveness of renewable energy.

## RENEWABLE ENERGY IS REWARDING

- The use of renewable energy significantly reduces carbon dioxide emissions.
- The use of renewable energy is part of sustainable development.
- Domestic origin of energy reduces dependence on imports, boosts employment and enhances the security of supply.
- Renewability of energy is beneficial to the image of its producers and users.
- The use of renewable energy supports Finnish research and development work.
- When correctly planned and implemented, harvesting of energy wood increases tree growth in thinning stands and facilitates reforestation after felling.
- In most cases, renewable energy has positive impacts on the regional and national economy.



## WHAT ABOUT DISADVANTAGES?

- No energy production method is totally without disadvantages. When expertly implemented, the use of renewable energy results in fewer disadvantages than other known energy forms.
- Excessive clearing of harvest residues may slow down the growth of young woods but, for example, in peatlands the loss of nutrients can be prevented with ash fertilisation.
- In wood combustion, poor equipment and an incomplete combustion process may result in harmful hydrocarbon, carbon monoxide and particulate emissions.
- The construction and regulation of waterways for energy production have an impact on the aquatic environment.
- Without careful planning, wind farms may have a disturbing influence on local residents, the landscape and the environment.

# FINLAND PROMOTES RENEWABLE ENERGY IN MANY WAYS

Finland supports the reduction of greenhouse gas emissions and the promotion of energy efficiency and renewable energy with many different solutions. Energy taxation and subsidies have already been adapted to be more eco-friendly and to promote new technologies. Research and product development in the field are also supported extensively.

Electricity generation based on renewable energy is promoted in Finland, for example, a guaranteed price of electricity generation with a feed-in tariff, which was introduced in 2011. On certain conditions, electricity generated with wind power, wood and biogas is eligible for the feed-in tariff.

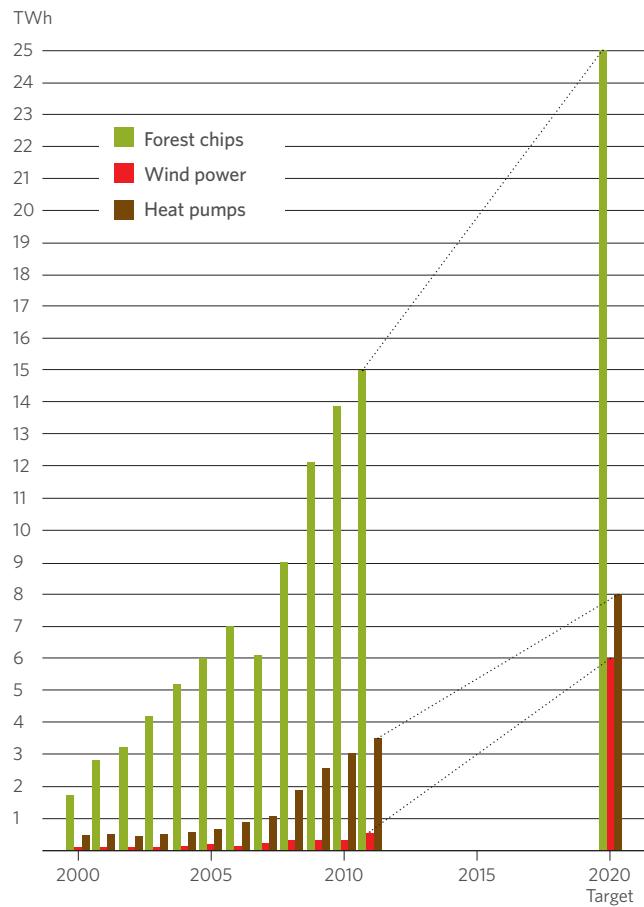
Introduction of renewable energy is also encouraged with energy support which, for example, aims to facilitate the launching of new energy technology. Energy support is also granted to companies, municipalities and other societies for investment and investigation projects that promote the production or use

**Energy produced by forests chips, wind power and heat pumps in Finland since 2000, and targets for their increase by 2020, terawatt-hours TWh**

*In addition, the target is to increase the volume of electricity produced by wind power to about 9 terawatt-hours by 2025.*

of renewable energy, increase the efficiency of energy saving, or reduce the environmental impacts of energy use and production.

It is possible to increase renewable energy in all sectors of heat and power production. The regulations concerning the energy efficiency of new constructions were made more stringent in 2012, and they are estimated to improve the energy efficiency of buildings by 20 per cent. The energy certificates required for buildings also have an impact on the use of renewable energy as they can improve the property's energy rating. In building renovations, energy subsidies for the improvement of energy efficiency are granted for residential buildings, mainly for apartment blocks and terraced houses. Refurbishments of energy systems in detached houses may be eligible for tax credit for domestic costs.





# RENEWABLE ENERGY SOURCES IN FINLAND



## Versatile bioenergy from forests

In Finland, increasing the use of forest-based biomass is a cost-effective way to raise the share of renewable energy in energy production. Forest management and wood harvesting create a lot of wood material, which is not suitable for use as raw material in the wood processing industry. Biomass collected and chipped from tree branches, crowns, stumps and root stock is called wood chips. The forest industry has leftover biomass, such as wood bark, sawdust, other wood residue, as well as black liquor produced in pulp production. These are utilised in Finland either in the incineration boilers of the industrial facility itself or in other power plants and heating plants.

Wood chips can be used in combined heat and power production and as raw material in liquid biofuels. Finland aims to produce 25 terawatt-hours of electricity and heat with wood chips by the year 2020. The most efficient way to reduce carbon dioxide emissions is the use of forest-based biomass instead of coal in combined heat and power generation. In compliance with the government's energy and climate strategy, Finland aims to phase out all coal use in power plants by 2025. Coal can be replaced, for example, directly with wood-based biocoal suitable for coal combustion boilers or by investing in ancillary equipment that can be used for the combustion or gasification of bio-based fuels.

## Bioenergy from farms

Farms produce numerous raw materials suitable for renewable energy production. Energy can be produced from plant- and animal-derived biomasses, such as field biomass, manure or various wastes, through combustion, by digesting biogas or by refining them into liquid fuels.

In addition to farms, biogas is also produced by digestion in wastewater treatment plants and landfills.



## Bio-alternatives in heating

District and local heating is produced with renewable fuels to an increasing extent: in 2012 their share was 23 per cent, or approximately 87 terawatt-hours (TWh). In the heating of smaller properties, fossil light or heavy fuel oil can be replaced with bio-based fuels that are produced, for example, from wood or waste. The government aims to reduce the use of mineral oils in heating.

In households, conventional wood heating is still popular, and it will maintain its strong position in the future, too. Heating with wood is regarded as a secure and economic method of producing main and extra heat especially during the cold winter months. Correct use of wood-burning heaters, clean and dry wood and good fireplaces as well as boilers play a key role in the reduction of particulate emissions and increasing the efficiency of wood burning.

Wood pellets are also used for heating to an increasing extent. Pellets are compressed mainly from the residues of mechanical wood processing, and they can be used in power plants and heating plants, and in the heating of detached houses. A modern pellet-based heating method is fairly easy to use.

A total of some 13 terawatt-hours of heat is produced by firewood in households.



## Transport fuels from wood, waste and field biomass

In transport biofuels, Finland promotes the use of so-called second-generation liquid biofuels. These biofuels are produced from products that are not suitable as food, such as wood, waste and field biomasses. Transport biofuels may be either liquid or gaseous. In practice, increasing their use takes place through the distribution obligation so that more and more bio-based alcohols or biodiesels are blended with petrol or diesel. The share of renewables in 2013 is eight per cent, and it will increase to 20 per cent by 2020. Biofuels have also been tested in aviation.

In accordance with a proposal by the European Commission, the share of renewable energy in transport, including renewable electricity, must be at least 10 per cent by 2020. Finland has doubled this target.

*Oil is produced with microbes, for example, from straw at the Neste Oil pilot plant. The objective is to expand the raw material base for NExBTL biodiesel.*



## From waste to energy in a sensible way

Prevention of waste accumulation is the most sustainable measure in terms of the environment. It is worth using for energy production only the part of waste that cannot be recycled or otherwise reused in a sensible way. About half of municipal waste consists of biowaste, which can be digested into biogas.

Finland's target is to increase the use of recycled fuels, for example, fuels produced from waste, by at least 1.5 times by 2020. Biogas produced by digestion can be used in electricity and heat production and, cleaned, as gaseous transport fuel. Waste combustion in heat and power generation is also increasing.



## Power from the wind

Finland has good conditions for wind power production. The majority of wind farms have been built along the coast, but there are also good wind conditions inland, where wind farms are currently under construction and being planned.

For the time being, the scale of wind power production in Finland has been small, and therefore there is scope for growth. Wind power is supported, for example, with the feed-in tariff scheme, which entered into force in 2011. The wind farm investments accepted for the scheme receive from the government a feed-in tariff tied to the electricity market price for 12 years. The government also aims to fund an offshore wind demonstration project with EUR 20 million in 2015.

In the online Wind Atlas, you can examine the wind conditions of different areas and the electricity production estimates of wind farms. Designed by the Finnish Meteorological Institute, the Wind Atlas is based on computer modelling and it enables increasingly reliable comparison of wind conditions. An Icing Atlas has subsequently been included in the Wind Atlas.

For the present, Finland is among the EU countries with a small installed wind power capacity. At the end of October 2013, Finland had 192 wind farms with a total capacity of 366 megawatts. By that time, the capacity had increased by 78 megawatts since the end of the previous year. The target is to increase



the volume of electricity produced by wind power to about 9 terawatt-hours by 2025. This will require more large-scale investment as the annual production in 2013 totalled approximately 0.5 terawatt-hours. Achieving the target will require the construction of about one thousand wind turbines of at least three megawatts.

## More hydro power by upgrading old power plants

After bioenergy, hydro power is the second-biggest source of renewable energy in Finland. In 2012, there were over 220 hydroelectric power plants in Finland, meeting almost 20 per cent of total electricity demand.

The biggest waterways are already harnessed and, due to environmental protection concerns, construction of new hydro power is not probable. Hydro-power production is mainly increased by upgrading current plants. The potential annual hydro-power production is estimated to increase to over 14 terawatt-hours.



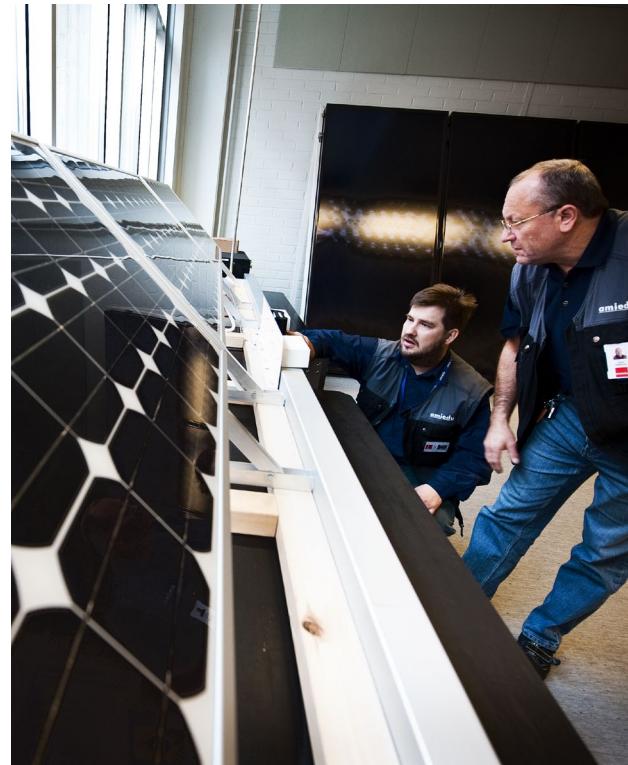
# TWh

## Energy from the sun

Utilisation of solar energy is sensible, also in Finland. In these latitudes, only in the middle of the winter is the sun so low in the sky that it provides hardly any power for heat or electricity generation. Including solar energy systems, such as solar panels and solar thermal collectors, as part of the construction technology and using them to replace certain surface materials will make solar energy more economically viable.

Solar thermal systems have been installed especially as a source of extra heat in properties heated with oil. It is worth utilising solar heat especially in the production of hot water as it is also needed in the summer.

With current technology, solar power production is still relatively expensive, but this has not prevented households and companies from investing in it. Companies also receive energy support for solar power and solar heat projects. If the costs of manufacturing solar panels continue to fall and their efficiency rate improves, solar power will become even more economically viable and popular. Electricity storage technologies and feeding of surplus electricity into the grid will also promote utilisation of solar power.



## Heat pumps provide heat from the environment

Heat pumps transfer solar heat stored in the ground, bedrock, water or air and use it for the heating of buildings and service water. At the same time, they reduce the need for other energy. Heat pumps have grown rapidly in popularity in the past ten years. Ground and air source heat pumps have been installed especially in new and renovated detached houses.

In industry, heat pumps can be used for capturing waste heat produced in industrial processes, which in turn can be reused in the heating of properties. District heat and district cooling are also produced with heat pumps, for example, from waste water.

The target is to produce five terawatt-hours of renewable energy with heat pumps each year by 2020.

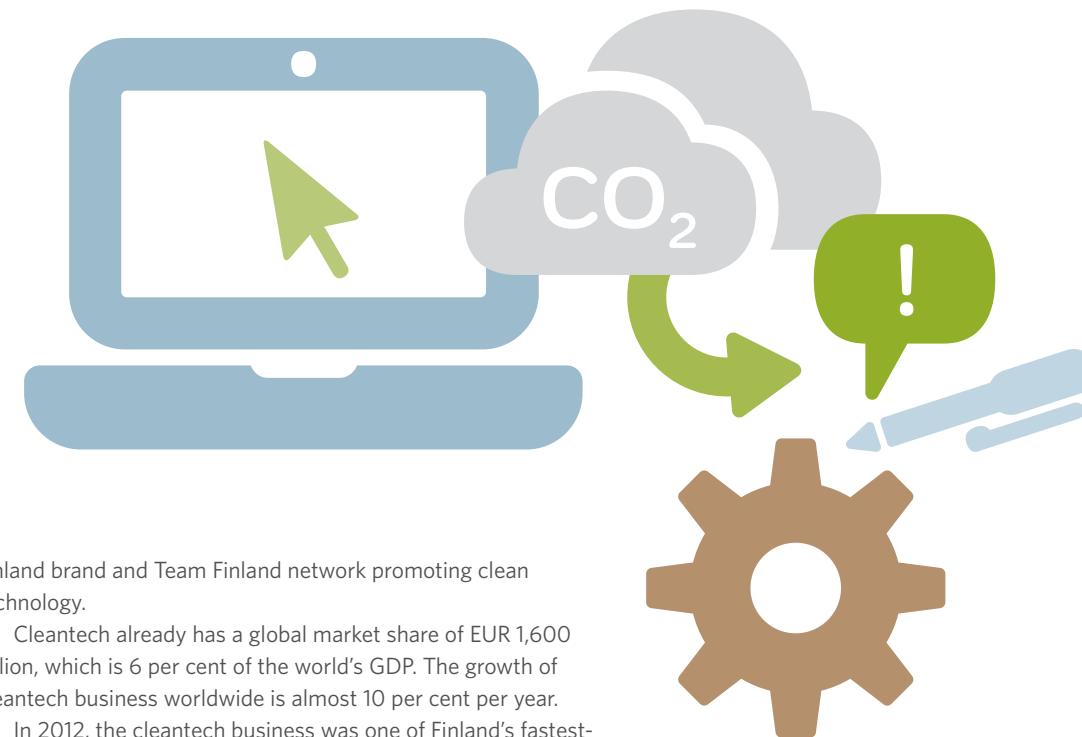
*Installers of renewable energy equipment have the opportunity to take part in updating vocational education to become certified installers.*

# MARKETING AND OPPORTUNITIES

Climate change mitigation requires a transition to a low-emission energy economy. In Finland, top research is being carried out in several universities and universities of applied sciences, as well as at VTT Technical Research Centre of Finland.

We have strong expertise in cost-effective use and utilisation of bioenergy in combined heat and power generation. New innovations and business activities are developed in Finland also for the wind, solar energy and fuel cell markets.

Enterprises, universities and research institutes have formed a close network of Strategic Centres for Science, Technology and Innovation (SHOK). CLEEN Oy, the energy and environment strategic centre for science, technology and innovation, brings together the research units and companies utilising the research results. Support in export endeavours is offered by the Cleantech



Finland brand and Team Finland network promoting clean technology.

Cleantech already has a global market share of EUR 1,600 billion, which is 6 per cent of the world's GDP. The growth of cleantech business worldwide is almost 10 per cent per year.

In 2012, the cleantech business was one of Finland's fastest-growing sectors, with total net sales of EUR 24.6 billion and 15 per cent annual growth. The target of the strategic cleantech programme of the Ministry of Employment and the Economy is to increase the net sales of the cleantech sector to EUR 50 billion and to create 50,000 new jobs in the sector by 2020.

# EXAMPLES OF RENEWABLE ENERGY UTILISATION



## Terraced houses buy heating from the heating entrepreneur

The old oil heating system for the 77 terraced houses of Joensuun Kodit Oy in Heinävaara were coming to the end of its road. Almost 30 years of age, the old oil boilers were due to be replaced, which sparked a discussion about changing the entire heating system. A decision was made to purchase the heat from the Kiihtelysvaara energy co-operative, which then built a wood-chip fired heating plant for the homes, fully replacing the old oil heating system.

Heating with wood chips is estimated to be about one-third cheaper than heating with oil. The wood chips are sourced from within a radius of 20 kilometres, mainly from the forests of local land owners.



## Diverse renewable energy sources for heating of the school

The Sakarinmäki school complex in Östersundom in Helsinki has decided to replace over 80 per cent of its old oil heating with renewable energy. The new heating system utilises geothermal heat, solar heat collectors and solar heat storage in the ground. All of these have been combined in the heating plant located at the school, where it will also be possible to burn sustainably produced bio-oil in the future.

Solar heat collectors are designed to meet about five per cent of the school's annual heating need. As the school is closed in the summer when the majority of solar heat is produced, the surplus heat is stored in the ground. It is estimated that the solar collectors will meet the school's need for hot service water between May and September.



## Office towers utilising solar power

The new office buildings of 19,500 square metres in Perkkää in Espoo are heated with geothermal heat pumps, in addition to which electricity is also generated by solar power. A total of 157 solar panels have been installed on the roofs of the office buildings of Derby Business Park, constructed by SRV. According to calculations, the panels produce about 35,000 kilowatt-hours of electricity per year. This corresponds to the annual electricity consumption of about four detached houses heated with district heat. The objective was to avoid energy price increases with self-produced solar electricity.



## Bio-oil produced in Joensuu

Bio-oil is produced from wood in Joensuu. The bio-oil plant built in connection with the energy company Fortum's CHP plant produces bio-oil from wood chips and other wood pulp, replacing heavy fuel oil at Fortum's heating plants.

The Joensuu bio-oil plant produces annually 50,000 tonnes of bio-oil named Fortum Otso. This amount corresponds to the annual heating need of over 10,000 detached houses.

Fortum estimates that replacing heavy fuel oil with bio-oil reduces carbon dioxide emissions by up to 90 per cent. According to Fortum, running the bio-oil production plant and collecting and transporting the raw materials provide 60–70 man-years of employment in the Joensuu region.

Fortum's Vermo heating plant in Espoo will be the first to introduce bio-oil, replacing heavy fuel oil in the peak heat consumption months of the winter.

## Torrefaction of biocoal is tested in Mikkeli

Finland's first biocoal pilot plant will be completed in Mikkeli during 2014. Biocoal will be produced by torrefaction from wood chips and other wood pulp, and it will be possible to combust it as such in coal-fired power plants. The heating values of biocoal are very close to those of coal. Technology required for the production of biocoal will be tested at the plant.

The pilot plant will probably be followed by a commercial biocoal plant to be built in Ristiina at a later date. For example, Helsingin Energia, which is looking to phase out coal, has been interested in biocoal.

The Mikkeli pilot plant will be able to produce 10,000 tonnes of biocoal per year, but production volumes will be smaller in the initial stage. In terms of price, biocoal is more expensive than coal at least in the initial stage.



## High-quality bio boilers

Laatukattila Oy from Pirkanmaa has manufactured heating boilers for 60 years, since 1953. The work is now continued by the third generation in the family business.

As early as in the 1960s, the company focused on developing a cleaner and more efficient combustion technology. The result is a patented technology based on staged gasification combustion of biofuel. This ensures very low particulate emissions of flue gases. Another benefit of the gasification technology is the wide control range of the boiler, which means, for example, that there is no need to use oil in the summer.

The company has developed a fuel grabber equipped with radar equipment, programmed for major fuel warehouses. The radar identifies the fuel surface in the storage facility and the grabber can move the fuel directly into the feeder already inside the warehouse.

Laatukattila Oy also manufactures conventional grate boilers, but it specialises in delivering entire heating plants in Finland. Laatukattila's boilers are exported throughout the world, and the company's bioenergy heating plants have also been exported to Sweden and Lithuania. At best, up to half of all production is exported.



*Developed in Finland, gasification combustion of biofuel is energy efficient and low in emissions.*



## Information about renewable energy

Ministry of Employment and the Economy, [www.tem.fi](http://www.tem.fi)

Ministry of Agriculture and Forestry, [www.mmm.fi](http://www.mmm.fi)

Ministry of the Environment and the Regional Environment Centres, [www.ymparisto.fi](http://www.ymparisto.fi)

Ministry of Transport and Communications, [www.lvm.fi](http://www.lvm.fi)

Motiva, [www.motiva.fi](http://www.motiva.fi), [www.eneuvonta.fi](http://www.eneuvonta.fi), [www.bioenergiatieto.fi](http://www.bioenergiatieto.fi)

## Renewable energy associations

Bioenergy Association of Finland, [www.bioenergia.fi](http://www.bioenergia.fi), [www.pellettienergia.fi](http://www.pellettienergia.fi), [www.lampoyrittajat.fi](http://www.lampoyrittajat.fi)

Finnish Wind Power Association, [www.tuulivoimayhdistys.fi](http://www.tuulivoimayhdistys.fi)

Vindkraftföreningen rf, [www.vindkraftforeningen.fi](http://www.vindkraftforeningen.fi)

Finnish Heat Pump Association SULPU, [www.sulpu.fi](http://www.sulpu.fi)

Finnish Solar Technology Association, [www.aurinkoteknillinenyhdistys.fi](http://www.aurinkoteknillinenyhdistys.fi)

Small Hydro Association in Finland, [www.pienvesivoimayhdistys.fi](http://www.pienvesivoimayhdistys.fi)

Finnish Biogas Association, [www.biokaasuyhdistys.net](http://www.biokaasuyhdistys.net)

Finnish Local Renewable Energy Association, [lahienergia.org](http://lahienergia.org)

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National Energy and Climate Strategy. MEE Publication. Energy and Climate 11/2013

Energy Statistics 2013. Statistics Finland

Finnish Statistical Yearbook of Forestry 2012. Finnish Forest Research Institute (Metla)

Wind energy statistics in Finland. Technical Research Centre of Finland VTT



Photos: Kalervo Ojutkangas/Leuku, Rodeo, Juha Rautanen/Motiva, Neste Oil, iStockphoto, Kimmo Haimi/Motiva, Johanna Kokkola/Motiva, Helsingin Energia, SRV Rakennus Oy, Ville Kokko/Fortum Oy, Laatukatila Oy - Text: Noora Jussila och Motiva - Translation: Audipek - Layout: Vanto Design Oy - Printed by: Eweko Oy - Paper: Edixon offset 250 g/m<sup>2</sup> and 170 g/m<sup>2</sup> - Print run: 500 copies. Ministry of Employment and the Economy and Energy Authority have funded the publication of this leaflet. 1/2014

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