

Roadmap to a CO₂-free future

Fortum's long-term aspiration is to be a carbon dioxide-free power and heat company. In 2010 Fortum drafted a Roadmap to a CO₂-free future. The Roadmap describes Fortum's vision of the future energy system as well as Fortum's actions and development work to achieve its aspiration.

Climate change mitigation is one of the energy sector's biggest challenges globally. The energy sector's share of global CO₂ emissions is 60–70%, and emissions will have to be reduced by 30–40% by 2030 in order to limit the rise in the earth's temperature to 2°C compared to the pre-industrial level. By the middle of the century, an emissions reduction of as much as 80–90% will be necessary.

The efficient use and production of energy, CO₂-free energy production forms, and carbon capture and storage (CCS) are the energy sector's key solutions for mitigating climate change. Of these, according to the IEA, the biggest emissions reduction will be achieved by 2050 with energy efficiency.

Commitment to mitigating climate change

Energy has a central role in building a low-carbon future, and the energy sector has taken a proactive approach in addressing climate change mitigation and has formulated visions, shared goals and road maps to a low-carbon future. In 2009 Fortum and 60 other European electricity companies signed a declaration in which the sector aims for a carbon-neutral power supply by the middle of the century. Fortum's long-term aspiration is to be a CO₂-free power and heat company.

Emissions development within the next decade

Fortum's CO₂ emissions were 25.3 million tonnes in 2010. Close to 60% of these originated from Russia, where energy production is based on fossil fuels, natural gas (95%) and coal (5%). Russia's legislative and political operating environment related to the climate issue differs significantly from that of Europe. Fortum aims to actively develop the operating environment related to better energy efficiency in Russia, thereby making it possible to reduce emissions.

However, new capacity based on the decided investment programmes in Russia will increase Fortum's annual emissions by about six million tonnes. Improvements in energy efficiency can reduce annual emissions by hundreds of thousands of tonnes. The commissioning of new capacity will increase Fortum's specific CO₂ emissions in Russia in the medium term. The current investment programme extends to 2014. Consequently, specific CO₂ emissions of Fortum's overall energy production are likely to grow during this period.

Fortum's ongoing investment programme in Europe focuses on nuclear and hydro power and on combined heat and power (CHP) production. The new production capacity in Europe is mainly CO₂-free.

Emissions targets and emissions trading advance emissions reductions

Fortum has had separate targets for carbon dioxide emissions from electricity and heat production since 2007, and the emissions are reported quarterly. Target-setting was renewed in 2010 so that it now covers all of Fortum's operating countries and 100% of direct emissions. The target has been defined as specific emissions from total energy production. A target was also set for energy efficiency. The company's goals for the next five years, as five-year averages, are:

- *Specific CO₂ emissions from power generation in the EU area: <80 g/kWh*
- *Specific CO₂ emissions from total energy production <200 g/kWh*
- *Energy efficiency: total efficiency of combustion: energy production divided by the primary energy of fuel input >70%*

In the EU area 90–95% of Fortum's emissions are included in the EU's emissions trading scheme (ETS). It is a cap-and-trade scheme with a lowering cap for emissions, so the ETS achieves emissions reductions and the price of EU emissions allowances encourages investments in low-carbon and emissions-free energy production. As a general rule, there are no free emissions allowances for electricity production in the

2013–2020 period. There are derogations only for plants in Poland and the Baltic countries. The amount of free emissions allowances for heat production will also significantly decrease. Fortum's free emissions allowances for the 2013–2020 period will be 30–40% of the corresponding amount for the 2008–2012 period.

Long-term aspiration for a CO₂-free energy system

Fortum believes that the future energy system will be based on CO₂-free electricity production and energy efficiency. The energy system will gradually shift from today's traditional power plant technologies based on limited energy sources and fuel combustion to production forms based on inexhaustible and emissions-free solar energy.

In addition to direct solar electricity and heat, the solar economy also includes inexhaustible, renewable and emissions-free solar-based energy forms, such as hydro, wave and wind energy as well as geothermal heat and carbon neutral bioenergy. Solar energy technology is advancing quickly, and the use of solar energy for small-scale solutions is already cost-efficient in many countries that have plenty of sunshine. In the solar economy, electricity is produced in places where the conditions are the most favourable in terms of the primary energy source,

and it is stored and transferred even long distances. The development of smart grids is a prerequisite.

However, changes are slow in the capital-intensive energy industry, and the transition towards the solar economy will happen in phases. Significant interim solutions along the development path towards the pure solar economy include traditional emissions-free production forms, like nuclear energy and high-efficiency technologies, like gas- and multifuel-based CHP. In addition enhanced energy efficiency plays a key role. Traditional power plant technologies are likely to be needed still for a long time, and they can lead to significant improvements in energy efficiency and emissions reductions. Carbon capture and storage (CCS) is also a necessary interim solution.

Fortum's strategy is consistent with its vision of the future energy system, and Fortum's business development is based on CO₂-free nuclear and hydro power and on energy-efficient CHP production. The ongoing investment programme in Europe focuses on these technologies, and significant growth is expected in these strategic areas. Fortum is increasing the use of local fuels, like waste-derived fuels and forest biomass, in CHP production.

Research and development activities are focusing on advanced CHP and nuclear power technologies and on the most promis-

ing solar-economy energy solutions (e.g. solar and wave power). Fortum is developing new biofuels (e.g. pyrolysis oil) for use at CHP and heating plants.

Implementing the company's strategy will gradually lead to the long-term aspiration of being a CO₂-free company. However, progress will take time because investment cycles are long. The fundamentals of the energy system will not change significantly during the next 10–20 years, even though new innovations will most likely be adopted. Along with technology development, changes in energy markets and energy policy are central. Social and political acceptance, which ensures a stable, consistent and market-driven investment environment, is an absolute requirement for the new investments needed to achieve climate targets.

Enabler of a low-carbon society

In addition to changes in energy production, mitigating climate change requires significant emissions reductions in other industry sectors. Fortum wants to build a low-carbon society in collaboration with other sectors of society. Fortum believes that electricity will have a significant role in tomorrow's society and that it will replace the use of traditional fuels.

Fortum is developing solutions to reduce the climate impacts of energy use in housing, transportation and electricity

distribution. Tomorrow's eco-cities will be based on smart grid solutions, eco-efficient construction, electric transportation and sustainable heating solutions. Already today smart meters are helping consumers monitor electricity consumption and conserve electricity.

New types of energy-efficiency services, smart grids, distributed energy systems and large-scale infrastructure for recharging electric vehicles are the cornerstones of the sustainable energy system Fortum is building. Fortum is taking an active role in realising sustainable cities and in developing the necessary technologies. Fortum offers its customers eco-efficient heating and cooling solutions and climate-benign electricity and heat products.

The next spread "Towards an emissions-free future" describes Fortum's vision of the future energy system and Fortum's actions and development work to achieve its aspiration.

TRADITIONAL ENERGY PRODUCTION: EXHAUSTIBLE FUELS AND PRODUCTION THAT BURDENS THE ENVIRONMENT

The traditional energy system is based primarily on limited energy sources and the combustion of fuels and applies traditional power plant technologies. Production is adjusted with load-following and peak-load power plants based on electricity demand. Fuels are often transported long distances from the site of sourcing to the energy production plants. The produced energy is transmitted relatively short distances from the production plant to the point of usage. The energy production efficiency – energy produced divided by the primary energy of fuel input – of condensing power plants is only about 40%, but the efficiency of combined heat and power production (CHP) can be as high as 90%. The carbon dioxide emissions caused by production depend on the carbon content of each fuel source.

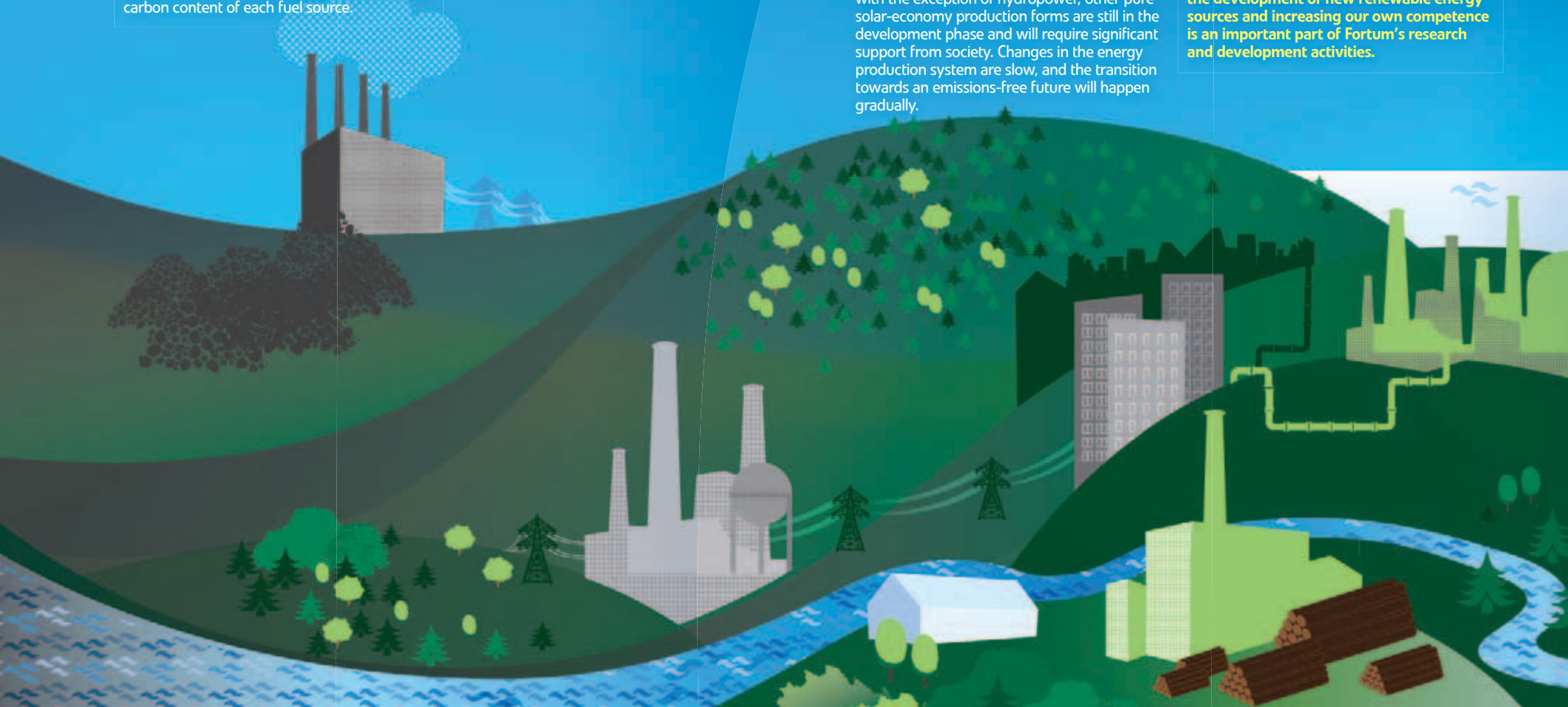
Fortum uses a diverse range of energy sources in its production. In 2010 the shares of different energy sources were: natural gas 40%, hydropower 18%, nuclear power 18%, coal 10%, biofuels 6%, oil 2%, waste fuels 1%, peat 1%, and heat pumps, wind power and other sources totalling 4%. In 2010 electricity produced at CHP plants accounted for some 30% of the total electricity production and CHP heat accounted for some 70% of total heat production. Fortum's total efficiency of combustion was 68% in 2010.

Towards an

TRANSITION PHASE: ENERGY-EFFICIENT, LOW-EMISSION PRODUCTION FORMS

The technology used today already boosts the efficient use of resources and reduces emissions. In this transition phase, the emphasis is on the traditional emissions-free production forms, like hydro and nuclear energy, and the high-efficiency technologies, like gas and multi-fuel CHP, which increase efficiency and decrease emissions. Carbon capture and storage (CCS) is also a central technology in the transition phase. Energy efficiency – both in production and in energy use – is emphasised. The role of new, renewable energy forms in production will still be minor in the near future: with the exception of hydropower, other pure solar-economy production forms are still in the development phase and will require significant support from society. Changes in the energy production system are slow, and the transition towards an emissions-free future will happen gradually.

Fortum's strategy is based on strong know-how in nuclear and hydro power and in CHP production. More than 80% of Fortum's electricity production in Europe is already based on nuclear and hydro power. Fortum is among the world's leading experts in CHP production and the fourth biggest heat producer. The company uses a wide range of fuels, such as waste, will become more significant in the years ahead. Fortum is developing multi-fuel CHP solutions that enable the use of a variety of fuels. Tracking the development of new renewable energy sources and increasing our own competence is an important part of Fortum's research and development activities.



emissions-free future

SOLAR ECONOMY: INEXHAUSTIBLE AND EMISSIONS-FREE, SOLAR-BASED PRODUCTION FORMS

The future energy system – the solar economy – is based on a completely emissions-free and inexhaustible energy source. In the solar economy, energy from the sun is utilised either directly as solar electricity or heat, or indirectly as hydro, wave, wind and bioenergy, and geothermal heat. The future energy system has an important role in securing the availability of natural resources for future generations. According to the IEA, the significance of electricity in tomorrow's society will grow, and it will replace the use of traditional fuels. In the solar economy, the electricity load adapts to production. Realisation of the future energy system requires the development of smart grids.

Fortum's mission is to create energy that improves life for present and future generations. Fortum is researching technologies that might be future breakthroughs in energy production and is participating in several projects to develop solar-economy technology. Fortum believes that tomorrow's ecocities will be based on smart grid solutions, eco-efficient construction, electric transportation and sustainable heating solutions, and is participating in the development of them.

