



# Four decades of clean power

LOVIISA NUCLEAR POWER PLANT 40 YEARS

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# Nuclear sector looks to the future

Finland took a leap in technology more than four decades ago when the Loviisa power plant's number one unit was connected to the national grid. The country's first plant unit producing nuclear power had been completed as an amalgamation of Eastern, Western and Finnish technology. The share of domestic development work in the project was so high that the plant is very deserving of its definition as "the first Finnish nuclear power plant".

Through the years, Fortum has continuously developed the Loviisa plant – both in terms of technology and in development of the personnel's know-how. In fact, for forty years, the power plant has maintained its position as a trusted player in our electricity system. An excellent operating track record, load factors on an international scale, and an outstanding safety record make it undisputedly one of the world's best nuclear power plants in terms of availability.

Loviisa has been successful, but the same can't necessarily be said about nuclear power as an industry sector in Europe. The entire energy sector is in the grips of enormous transition: The share of renewable energy in the system is growing at a fast pace and production is moving from big, centralised units to decentralised ones.

Additionally, digitalisation, a term frequently heard, offers huge opportunities for the energy sector. There have been doubts cast about nuclear power's ability to keep up with the fast-paced development. The production form has been described as being too rigid, expensive and big for the new energy reality.

We at Fortum believe that nuclear power will be needed also in this new world for a long time to come. As an emissions-free production form, it plays an important role in mitigating climate change and in the transition to a low-carbon energy system – alongside renewable energy.

At the same time, it is clear to us that in order to remain successful in its task in the future, the nuclear power sector must renew. Research and product development must generate standardised plant concepts, systems and components for the sector. Best practices – also outside the sector – must be utilised more widely. Sights must be focused on the future.

The nuclear power know-how we have in Finland is respected internationally. There is international interest in Finnish nuclear power plants and their high load factor and in the related best practices. We are the first in the world to be able to provide solutions for the final disposal of nuclear waste and

## Digitalisation offers huge opportunities also for the energy sector

for many other waste issues. I believe that we Finns have the know-how and the will to advance the development of the sector – also internationally – on the journey towards a cleaner energy future.



Tiina Tuomela  
Executive Vice President,  
Generation, Fortum

# Four decades of clean power

The Loviisa power plant has produced power equivalent to the annual consumption of over 17 million single-family homes heated with electricity.

Finland's first nuclear power plant, unit one of Fortum's Loviisa power plant, was connected to the national grid exactly 40 years ago, on 8 February 1977, and electricity production for commercial use commenced in May 1977.

Unit two was completed about three years later and was connected to the national grid in November 1980. Throughout its history, the Loviisa power plant has produced a total of 288.2 terawatt hours,

equivalent to the annual consumption of over 17 million single-family homes heated with electricity.

To date, the average lifetime load factor for unit 1 is 86.9% and 88.6% for unit two. The average load factor for both units is 87.7%. The load factor describes the plants' production during a certain period of time compared to the nominal capacity.

The nominal capacity of the plant units has been increased through several upgra-

**8.33 TWh**  
Production of  
Loviisa npp  
in 2016

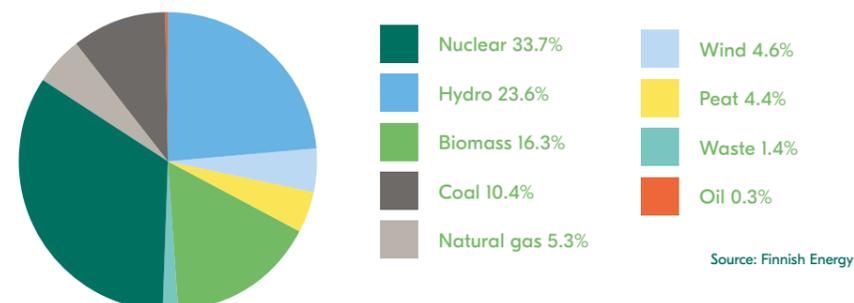
**13%**  
Share of  
power generation  
in Finland in 2016

des that have improved the plant's safety and reliability. Today each plant unit has a gross power capacity of 526 MWe; the original capacity of the units was 440 MWe.

The Loviisa Power Plant is developed in line with the continuous improvement principle. The plant's most extensive investment programme ever is currently under way and will secure safe, reliable and profitable electricity production to the end of the units' operating licenses, i.e. 2027 and 2030.

The modernisation programme of Loviisa power plant consists of three sub-programmes, namely the improvement of safety, the improvement of the turbine plant and its efficiency, as well as the basic improvement of the reactor plant. In 2016, Fortum invested approximately 100 million Euros in the Loviisa power plant.

### POWER GENERATION IN FINLAND IN 2016 (66.1 TWh)



# Nuclear power as part of Finland's electricity system

Nuclear power holds a critical position in ensuring energy supply, particularly during periods when electricity consumption is at a peak.

Nuclear power plays a key role in the functioning of our electricity system. Nuclear power plants produce electricity for the grid – steadily and independent of weather conditions. It is specifically the steady production factor that holds particular added value as an increasing amount of electricity produced with weather-dependent renewable production forms come online in the future.

Nuclear power is an important production form also in terms of the security of supply of energy and delivery reliability. Nuclear power secures delivery reliability especially during peak consumption periods, such as extremely cold spells. In addition to plant reliability and efficiency, another advantage of nuclear power is a

functioning fuel market.

There is an abundant supply of nuclear fuel available in the global markets, which in part emphasises nuclear power's reliability in terms of the security of supply of energy.

Nuclear power has played an important role in Finland's industrialisation and growth in prosperity. Nuclear power is a growing industry sector in Finland; in addition to Finland's four nuclear reactors in operation, there is one new nuclear power unit under construction and one in the planning stage. Moreover, nuclear waste management has been handled in an exemplary manner in Finland. All these factors create strong framework conditions for the nuclear power industry in Finland.

Upon completion, OL3, Teollisuuden Voima's new unit under construction in Olkiluoto, will be the world's biggest nuclear reactor (1,600 MW). According to the plant supplier's timetable, the unit will be commissioned in late 2018. Additionally, preparations are under way for a smaller 1,200-MW nuclear power plant in Finland, in Hanhikivi, Pyhäjoki. Fennovoima, which has ordered the plant, aims to have the Hanhikivi power plant connected to the grid in 2024.

## Nuclear power is a growing industry sector in Finland

## An economic powerhouse

The Loviisa nuclear power plant plays a central role not only in terms of the energy system, but also as a local employer and economic engine.

The construction phase during the 1970s was a time of strong development for Loviisa when about 3,000 people worked on Hästholmen Island. Today some 500 Fortum employees and nearly 100 permanent employees of other companies work at the plant.

Throughout its history, the power plant has had a big impact regionally. The plant has been a significant employer in the

Porvoo–Loviisa–Kotka region.

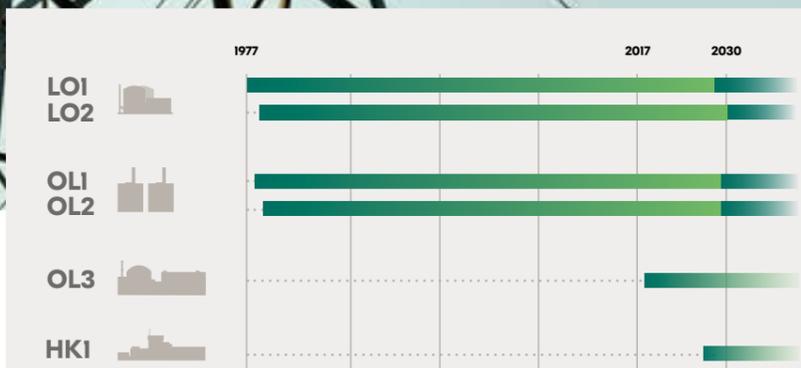
Continuous investments have also had an indirect impact and have strengthened the competence capital of the companies operating in the region. Additionally, the annual outages that take place every summer bring 700–1,000 contractor employees to Loviisa for weeks, which also stimulates the local life.

Fortum is also a significant contributor in terms of local and real-estate taxes and thus has a strong impact on the region's prosperity. Through our sponsorship programme, we support carefully selected,

broad ranging targets that bring tangible joy to as many Finns as possible. The Loviisa power plant's sponsorship targets are related to physical activities for children and youth, culture, and urban amenities in particular.

Fortum has enjoyed operating in Loviisa. The city has been an excellent and constructive collaboration partner throughout the plant's history.

Satu Katajala  
Vice President, Nuclear Production,  
General Manager, Loviisa Power Plant



Fortum owns and operates two reactors in Loviisa (Loviisa 1 and Loviisa 2). Teollisuuden Voima has two reactors at Olkiluoto (OLI, OL2) and a third reactor is under construction (OL3). Teollisuuden Voima filed an application in spring 2017 for an operating license extension for OLI and OL2 units until 2038. Currently, it is estimated, that the Fennovoima Hanhikivi facility will be connected to the national grid in 2024. Loviisa's current operating licenses are valid until the years 2027 and 2030, and Fortum is currently assessing the conditions to extend the units operating licences until 2030's - 2040's.

**33.7 %**  
Share of nuclear in Finland's power generation

The use of nuclear power and public acceptance go hand in hand. According to Finnish Energy's 2016 survey of public attitudes towards energy, the share of nuclear power supporters has grown in Finland. Correspondingly, the share of those opposed to nuclear power has decreased. This trend in recent years can be partly attributed to the increased awareness about the role nuclear power plays in mitigating climate change.

## ENERGY MARKET DEVELOPMENT MUST BE MARKET-DRIVEN

Finland is part of the Nordic electricity market. The highly deregulated Nordic electricity market has significantly benefited the Finnish national economy and Finnish consumers. Our Nordic energy system operates regionally very efficiently, with the different energy forms supplementing one another.

Nuclear power isn't publicly subsidised. Nevertheless, nuclear power must compete with heavily subsidised renewable electricity production.

Decisions related to the Loviisa power plant – and more broadly to the competitiveness of the entire Finnish nuclear power industry – are extremely important for the sector, whether they are related to taxation, legislation, or the interpretation of nuclear safety requirements. For electricity producers, the rather difficult market situation creates its own challenges also for the nuclear power industry.

Emissions trading, in which a price is set for carbon dioxide emissions, is the single most important steering mechanism towards a low-carbon climate and energy policy. Emissions trading is also an important instrument because it is market-driven and covers the entire EU.

We at Fortum support an ambitious energy and climate policy, and we are of the opinion that the emissions trading system should be strengthened. Overlapping energy targets and political steering mechanisms must be avoided. This will give also our nuclear power industry the prerequisites for success.

Esa Hyvärinen  
Senior Vice President, Public Affairs  
Fortum

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# Mitigating climate change – the biggest challenge of our time

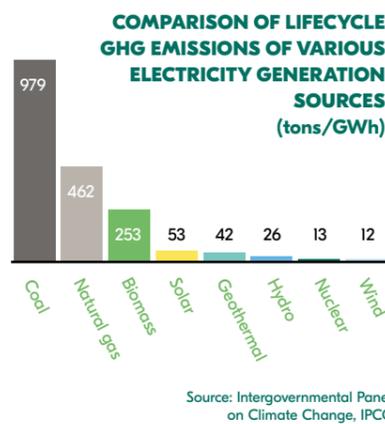
From a global perspective, nuclear power plays an important role alongside renewable energy in the battle against climate change.

The Paris climate agreement and the European Union’s ambitious climate targets set new requirements also for Finland’s energy policy. So emissions reduction plays a key role in Finnish climate and energy strategy. Nuclear power helps in the achievement of these targets.

The role that carbon dioxide-free nuclear power plays as a producer of clean energy is significant in mitigating climate change. The greenhouse gases over the lifecycle of nuclear power are on the same level with wind, hydro and solar power. For example: if the electricity produced over the entire operating life of the Loviisa power plant were produced by coal condensing power plants, about 230 million tonnes of carbon dioxide would have been released into the atmosphere.

Nuclear power and renewable energy are not mutually exclusive. On the contrary, transitioning to a low-carbon energy future will advance the efficient use of all emissions-free energy sources.

Fortum is investing a lot also in renewable energy. In line with Fortum’s strategic policies, nuclear power is an important step on the path towards a solar economy that is based on the efficient use of renewable energy sources. Nuclear power



plays crucial role in the goal to replace the use of coal with emissions-free energy production.

## Nuclear power is on a growth curve

Society is electrifying at a rapid pace; thus the significance of electricity production – and, consequently, nuclear power – is growing globally. A relevant example of society’s electrification is transportation, which has been largely reliant on fossil fuels. The mainstreaming of electric transportation will also result in a reduction

in emissions.

The International Energy Agency (IEA) predicts that nuclear power production will grow in the coming decades – despite the fact that a significant portion of the nuclear power plants that are operating today will be decommissioned during the same period.

There are currently close to 60 new nuclear power plants under construction, 20 of them in China alone. There are more nuclear power plants being constructed than ever before. The emphasis of the growth is in Asia where the industrialising countries are largely wrestling with emissions and air pollution caused by the use of coal.

Nuclear power is a means to solving these problems. It also offers opportunities for the export of Finnish advanced nuclear power expertise and technology.

## Nuclear power and renewable energy are not mutually exclusive

## A future in small reactor units?

Large nuclear power projects have faced difficulties in recent years in many Western countries. Meanwhile, projects in China and in other developing countries are advancing along a much smoother path.

One distinguishing factor is related to the advantages of serial production. Western countries build plants one by one, so the challenges related to construction of the first nuclear power plant recur again and again.

Electricity demand is currently growing faster in emerging economies than in Western countries, so a series of multiple units can be built for these markets. Nuclear power builders can utilise the plant documentation and other documents that have already been approved once by the safety authority. In Western countries, the serial construction of small modular reactors

(SMR) could provide this same advantage to those Western countries that might not have the need to build several big plants.

Conceptually, SMR plants aim to solve many of the problems related to big plant units. The plant concepts have a lot of “passive” safety features. Some of them don’t require active pumps and other systems in order to function; rather, they operate on a gravity basis, for instance.

One of the underlying principles of SMR plants is that they are modular and several components can be manufactured in factories and brought to the plant site in an operationally ready state. An important aspect related to this (and one that has a significant impact on profitability) is the harmonisation of licensing. At the unit level, SMR of course loses to big plant concepts, but the forfeiture of this economy of scale could be offset by standardising

## Economy of scale can be offset by the serial production of smaller units.

SMR solutions and by approving them in a harmonised manner in several different markets.

The lack of economy of scale can be offset by the serial production of smaller units. This would improve the profitability of projects and would reduce the risks during construction: production capacity could be increased more flexibly to correspond with electricity demand.

Kristiina Söderholm  
R&D, Nuclear  
Fortum

## Finnish nuclear power expertise is already an export product

Finland is internationally renowned for its nuclear power expertise. People around the world are very interested in the high availability and the numerous best practices related to the operation and maintenance of our nuclear power plants.

Our nuclear waste management solutions are also respected. When talking about the final disposal of spent fuel, the Finnish Posiva is mentioned as a forerunner. Correspondingly, the Fortum-developed NURES technology is known for the purification of Fukushima’s liquid waste, among others.

Finnish nuclear power expertise is in high demand around the world. While new construction of nuclear power is not active in Europe, elsewhere in the world plants are being planned

and constructed all the time. Several nuclear power plants will be decommissioned in the near future, and this work requires a comprehensive understanding of nuclear waste management. Plenty of this expertise can be found in Finland.

Finland has everything needed to further develop our nuclear power expertise as well as technologies that have significant export potential.

Petra Lundström  
Vice President, Nuclear Services  
Fortum

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# This is what it's all about

As an emissions-free production form, nuclear power in tandem with renewable energy plays a central role in climate change mitigation and in transitioning to a low-carbon energy system.

Nuclear power is a central production form in terms of security of energy supply and delivery reliability.

Financial subsidies must be gradually phased out, and the EU's emissions trading scheme must be the only mechanism steering electricity production towards zero emissions.

Nuclear power is an important production form that is not publicly subsidised in Finland.

The competitiveness of nuclear power must be factored into energy policy decision-making. Nuclear power's competitiveness must also be taken into consideration in the legislation and policy-making that indirectly impacts the energy sector, such as tax policies.

Fortum is currently assessing the possibility of pursuing an extension to the operation of the Loviisa nuclear power units (the current operating licenses are valid until 2027 and 2030).

The nuclear power sector is continuously evolving and new technologies offer interesting opportunities for sector development and for the offering of products and services. It is important that the political framework and legislation around the nuclear energy sector enable the advancement of the sector.