Loviisa Nuclear Power Plant

Environmental Impact Assessment Programme

August 2020

fortum

Forewords

Climate change and transitioning to a low-carbon energy system make reliable and emission-free electricity production even more important than before. A steady supply of electricity is also important. In line with our vision, we want to promote development towards a cleaner world in the future as well.

At Fortum, we believe that this new world will also need nuclear power for a long time. As a carbon dioxide emission-free, reliable source of energy that is not dependent on the weather, nuclear power contributes to meeting today's need for energy and mitigating climate change – together with renewable energy.

Loviisa nuclear power plant has been producing clean electricity for over 40 years, and we have a long track record as a responsible producer of nuclear power. The impacts of and the added value provided by our operations can be seen locally, regionally and globally. Loviisa power plant's environmental work is managed through an ISO 14001 certified environmental management system. We continuously work to reduce the impacts of our operations on the environment by applying the best practices and technologies.

Fortum has initiated an Environmental Impact Assessment Procedure (EIA procedure) at Loviisa nuclear power plant. The procedure will assess the environmental impacts of the potential lifetime extension of the power plant or, alternatively, the decommissioning of the power plant, as well as the environmental impacts of the final disposal facility for low- and intermediate-level waste.

The EIA Programme you are reading includes Fortum's plan on the assessment of environmental impacts as well as on the organisation of communication and participation. An environmental impact assessment will be performed based on the EIA Programme and the opinions and statements submitted about the programme. The results of the assessment will be presented in the environmental impact assessment report.

The coordinating authority in the project's EIA procedure is the Finnish Ministry of Economic Affairs and Employment, and the coordinating authority in the international hearing is the Ministry of the Environment.

Tiina Tuomela
Executive Vice President, Generation

Contact Details

Project owner:	**Fortum Power and Heat Oy**
Postal address	P.O. Box 100, FI 00048 FORTUM, Finland
Telephone	+358 10 4511
Contact persons	Ari Pekka Kirkinen, Liisa Kopisto
Email	firstname.lastname@fortum.com
Coordinating authority:	**The Ministry of Economic Affairs and Employment**
Postal address	P.O. Box 32, FI 00023 Government, Finland
Telephone	+358 295 048274, +358 295 060125
Contact persons	Jaakko Louvanto, Linda Kumpula
Email	firstname.lastname@tem.fi
International hearing:	**Ministry of the Environment**
Postal address	P.O. Box 35, FI 00023 Government, Finland
Telephone	+358 295 250 246
Contact person	Seija Rantakallio
Email	firstname.lastname@ym.fi
EIA consultant:	**Ramboll Finland Oy**
Postal address	PL 25 FI 02601 Espoo, Finland
Telephone	+358 20 755 611
Contact person	Antti Lepola
Email	firstname.lastname@ramboll.fi

fortum

Ympäristöministeriö
Miljöministeriet
Ministry of the Environment

RAMBOLL

Base maps: National Land Survey of Finland 2019
Translations: AAC Global Oy
Layout and design: Creative Peak

The original language of the environmental impact assessment is Finnish. Versions in other languages are translations of the original document which is the document Fortum is committed to.

Contents

Summary

Project owner and the project background

The project owner in the environmental impact assessment procedure (the EIA procedure) is Fortum Power and Heat Oy, a wholly owned subsidiary of Fortum Corporation. The Fortum Group is the second largest producer of electricity and the largest electricity supplier in the Nordic countries.

Loviisa nuclear power plant, owned and operated by Fortum Power and Heat Oy, consists of two power plant units, Loviisa 1 and Loviisa 2, as well as other associated buildings and storage facilities required for the management of nuclear fuel and nuclear waste. Loviisa 1 began its commercial operation in 1977 and Loviisa 2 in 1980. The power plant has been generating electricity reliably for over 40 years. The electricity generated by Loviisa power plant is used as an uninterrupted, year-round source of energy. Annually, Loviisa power plant produces a total of approximately 8 terawatt hours (TWh) for the national grid. It accounts for approximately 10% of the electricity consumption in Finland. Nuclear energy plays a significant role in Fortum's low-emission electricity production. For its part, Loviisa nuclear power plant supports the climate targets of Finland and the EU, as well as a secure electricity supply.

The current operating licence issued by the Finnish government to Loviisa 1 is valid until the end of 2027, and the operating licence issued to Loviisa 2 is valid until the end of 2030. Fortum is in the process of assessing the extension of the commercial operation of Loviisa nuclear power plant by a maximum of approximately 20 years beyond the current operating licence period. At a later date, Fortum will decide concerning the extension of the operation or decommissioning of the nuclear power plant.

Loviisa power plant is one of the best nuclear power plants in the world in terms of safety and usability. Fortum has invested in the ageing management of Loviisa power plant and has carried out improvement measures throughout the operation of the power plant. Systematic maintenance and modernisations of the power plant ensure that the equipment stays abreast of the changing requirements. In 2014–2018, Loviisa power plant implemented the most extensive modernisation programme in the plant's history, in which Fortum invested approximately EUR 500 million. Thanks to the investments made and the skilled personnel, Loviisa power plant has excellent prerequisites with regard to the technical and safety-related requirements to continue operation after the current licence period.

Project description and the options to review in the EIA procedure

Loviisa nuclear power plant is located approximately 12 km from the centre of the town of Loviisa, on the island of Hästholmen. Loviisa nuclear power plant is an electricity-generating condensing power plant, and both its plant units are pressurised water reactor plants. Electricity generation in a nuclear power plant is based on the utilisation of thermal energy generated by a controlled fission chain reaction. Loviisa power plant is used for the generation of base load electricity. The nominal thermal power of each plant unit of Loviisa power plant is 1,500 MW and the net electric power is 507 MW. The total efficiency of the plant units is approximately 34%. The annual production of Loviisa power plant is approximately 8 TWh. The availability and load factors of Loviisa power plant have been excellent throughout the power plant's operating history.

The low- and intermediate-level waste generated during the operation of Loviisa power plant is processed on the power plant premises and deposited in the final disposal facility for low- and intermediate-level waste (the L/ILW repository), located 110 metres underground on the island of Hästholmen. In due course, the spent nuclear fuel from Loviisa power plant is taken to the spent nuclear fuel encapsulation plant and final disposal facility operated by Posiva Oy at Olkiluoto in Eurajoki, Finland.

Fortum is in the process of assessing the extension of the commercial operation of Loviisa nuclear power plant by a maximum of approximately 20 years beyond the current operating licence period. Fortum will, at a later date, make the decision concerning potential extension of the operation of the nuclear power plant and the application for new operating licences. The other option is to proceed to the decommissioning phase when the power plant's current operating licences expires. In both cases, the project requires a licensing procedure in accordance with the Nuclear Energy Act and an environmental impact assessment procedure.

The options reviewed in this EIA procedure are shown in *Table 1*.

Table 1. Options to be reviewed in the EIA procedure.

Option	Description
Option 1, VE1	Extending the operation of Loviisa power plant by a maximum of approximately 20 years after the current operating licence period, followed by decommissioning. • The option also includes the measures to extend the service life of the power plant, decommissioning of the power plant after the licensing period ends, the operation and ultimate dismantling of plant parts to be made independent and the waste management measures related to these phases. • In addition, the option includes the possibility of receiving, processing, placing in interim storage and depositing for final disposal small amounts of radioactive waste generated elsewhere in Finland.
Option 0, VE0	Decommissioning of Loviisa nuclear power plant after the current licensing period (in 2027/2030). • The option also includes the operation and ultimate dismantling of plant parts to be made independent and the waste management measures related to these phases.
Option 0+, VE0+	Decommissioning of Loviisa nuclear power plant after the current licensing period (in 2027/2030). • The option also includes the operation and ultimate dismantling of plant parts to be made independent and the waste management measures related to these phases. • In addition, the option includes the possibility of receiving, processing, placing in interim storage and depositing for final disposal small amounts of radioactive waste generated elsewhere in Finland.

Extending the operation (Option VE1)

Fortum is in the process of assessing the extension of the commercial operation of Loviisa nuclear power plant by a maximum of approximately 20 years beyond the current operating licence period. During the extension, the operation of the power plant would be similar to what it is currently. Extending the operation of the power plant involves certain changes that may be implemented. These may include:

- replacing some of the old buildings related to the support functions of the power plant;
- water engineering related to the intake of cooling water, and the depositing of the resulting dredging and excavation masses in a new embankment structure;
- changes to the power plant's service water and waste water connections;
- expansion of the interim storage for spent nuclear fuel or alternatively increasing the capacity of the current interim storage.

The assessment also takes into consideration the possibility of receiving, processing, placing in interim storage and depositing for final disposal at Loviisa power plant small quantities of radioactive waste generated elsewhere in Finland.

The Option VE1 also takes into consideration the preparation for decommissioning during the extended operation of the power plant. This includes the expansion of the L/ILW repository and the operation thereof until circa 2090, as well as the preparatory work for and the operation of plant parts to be made independent. In addition, the decommissioning of the power plant after the commercial operation is being explored.

Decommissioning (Options VE0 and VE0+)

If the operation of Loviisa power plant is discontinued after the current licensing period in 2027 and 2030, the preparation for the decommissioning of the power plant (Options VE0 and VE0+) should be initiated in the coming years.

The stages included in the decommissioning of Loviisa power plant include:

- the expansion of the L/ILW repository for decommis sioning waste;
- making the spent fuel interim storage, liquid waste storage as well as the solidification plant, and the L/ILW re pository independent;
- terminating the operation of the power plant units and licensing of the dismantling work;
- detailed planning of and preparations for the disman tling;
- dismantling of the radioactive components of the pow er plant units and any other dismantling work;
- handling and final disposal in the L/ILW repository of radioactive waste as well as reuse of conventional disman tling waste;
- transporting the spent fuel to the encapsulation plant and final disposal facility;
- dismantling of the plant parts to be made independent;
- closure of the final disposal halls / L/ILW repository;
- release from liability and post-closure control by the authorities.

Furthermore, the assessment of Option VE0+ also takes into consideration the possibility of receiving, processing, placing in interim storage and depositing for final disposal small quantities of radioactive waste generated elsewhere in Finland at Loviisa power plant.

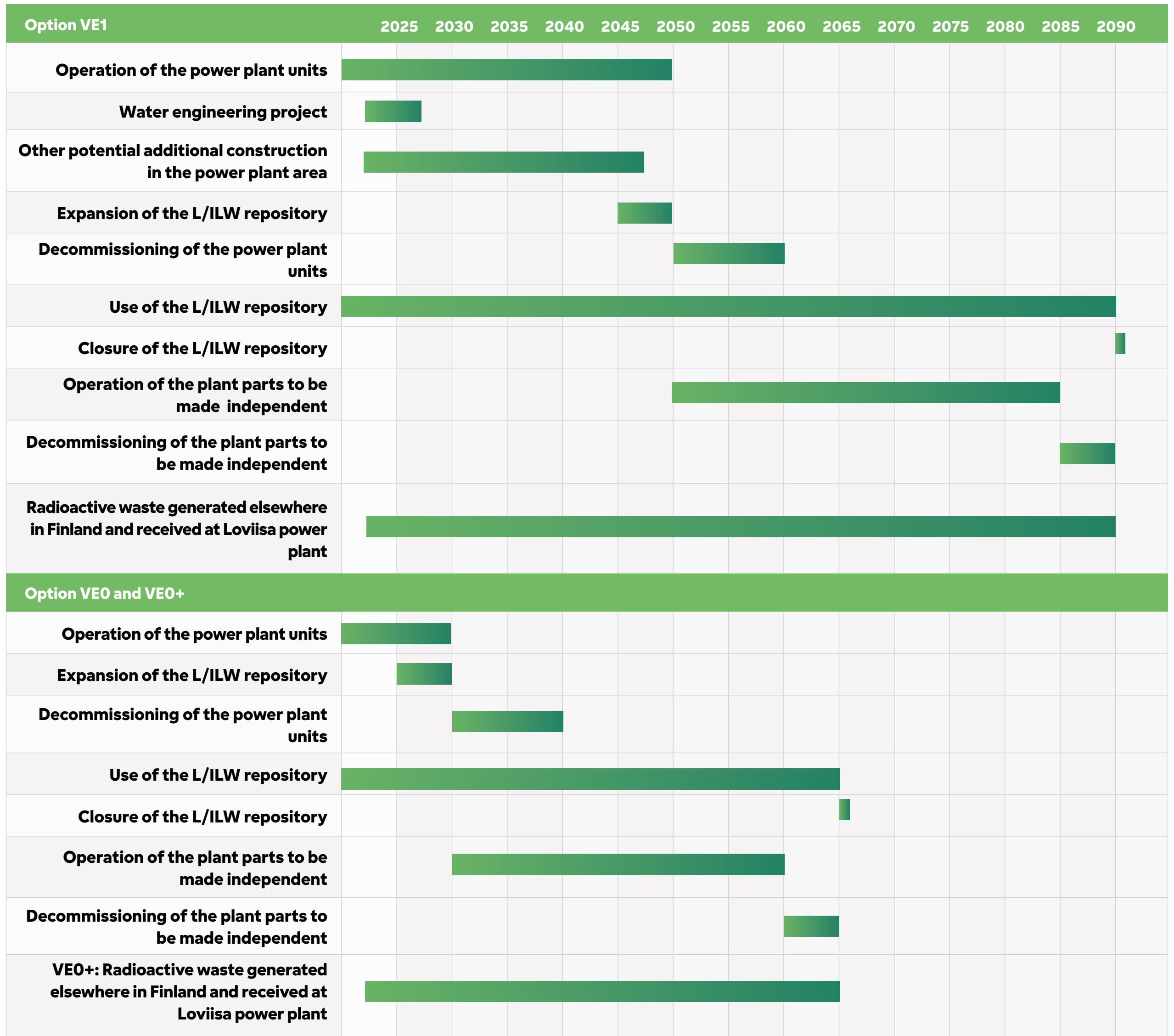


Figure 1. Tentative schedules of the project options, to be specified as the plans progress.

Project schedule

Tentative schedules of the project options to be covered in the EIA procedure are provided in *Figure* 1.

Assessment of the environmental impact of the project

The purpose of the EIA procedure is to assess the project's environmental impacts and foster attention to them in the project's planning phase. In addition, the procedure aims to improve access to information and the opportunities to participate in the planning of the project.

The EIA procedure is based on the Act on the Environmental Impact Assessment Procedure (252/2017) and the Government Decree on the Environmental Impact Assessment Procedure (277/2017). The procedure has two phases. In the first phase, an Environmental Impact Assessment Programme (the EIA Programme) is drawn up. It describes a plan concerning how the environmental impacts caused by the project are assessed. The second phase includes the assessment of the environmental impacts, and the results are presented in the environmental impact assessment report (the EIA Report). The EIA procedure is carried out before licence or permit procedures, and its purpose is to influence the planning of the project and decision-making. In this EIA procedure, the coordinating authority is the Ministry of Economic Affairs and Employment.

Parallel to the EIA procedure conducted in Finland, an international hearing in accordance with the Espoo Convention should be organised in projects that may have impacts extending beyond the borders of Finland. The Ministry of the Environment is responsible for the international hearing involving Finland.

Environmental impact assessment methods

Table 2 shows a summary of the assessment methods by impact and the proposed observed areas. The observed areas concerning environmental impacts have been defined to cover the maximum reach of the impacts. In reality, the environmental impacts are likely to occur in an area smaller than the observed area. The EIA report presents the results of the environmental impact assessment and their affected areas.

Table 2. Summary of the environmental impacts to be reviewed, assessment methods and the preliminary observed area of the impacts.

Component	Methods of assessment	Observed area
Land use, land use planning and the built environment	An expert assessment of how the project relates to the current and planned land use and land use planning. In addition, built environment sites and the distance thereto are assessed.	Approximately up to 5 km from the project area.
Landscape and cultural environment	An expert assessment of the project's relation to the landscape of the vicinity (holiday housing, in particular) and the landscape overall. Cultural environment sites are identified.	Approximately 5 km from the project area.
Traffic	A calculated assessment of the changes generated by the project in traffic volumes and an expert assessment of the impact of transport on traffic safety. The assessment also applies a separate survey conducted concerning the risks and implementation methods related to the transports of spent nuclear fuel.	The traffic routes leading to the project area in Loviisa up to main road 7. In addition, the immediate vicinity of the transport routes for spent nuclear fuel.
Noise and vibration	An expert assessment of the noise emissions and vibration caused by the different phases of the project and transport, as well as their dispersion in the environment.	The project area and its vicinity within an approximately 3-km radius and the nearby areas along the transport routes.
Air quality	An expert assessment of the typical emissions into the air generated by the project.	The typical emissions into the air caused by construction, dismantling and transport activities, and the extension of the operation within an approximate radius of 1–2 kilometres.
Soil, bedrock and groundwater	An expert assessment based on the planned construction and final disposal measures.	The project area.
Surface waters	A modelling of the cooling water and an expert assessment based on it concerning the impact on the sea area. An expert assessment of the impacts of water structures, service water intake, and the management and discharge of wastewater. In addition, a survey is conducted on the pollutants and sub-bottom profiling of sediments.	Approximately 5 km from the project area.
Fish and fishing	An expert assessment to be conducted based on ichthyofauna studies and the impact assessment of surface waters.	Approximately 10 km from the project area.
Flora, fauna and conservation areas	An expert assessment of the impact on the natural environment and conservation areas. In addition, an avifauna survey is conducted in connection with the EIA procedure.	Approximately 10 km from the project area, with a special focus on the sea area.
People's living conditions, comfort and health	An expert assessment (including the regional economy, noise, emissions, traffic and landscape) to be conducted based on the calculated and qualitative assessments carried out in the sections concerning other impacts. In addition, a resident survey and small group interviews are conducted.	The power plant's vicinity and transport routes. The resident survey is conducted within a 20-kilometre radius.
Regional economy	A survey of the regional economy, based on an analysis of the current situation and resource flow modelling.	Finland.

Component	Methods of assessment	Observed area
Emissions of and radiation from radioactive substances	An expert assessment of the release of radioactive emissions generated by the project into the air and sea. Radiation in the vicinity of Loviisa power plant is monitored in accordance with the monitoring programme in effect, and the assessment is based on data obtained from the monitoring. The radiation doses caused by emissions are assessed by means of calculations.	Radiation monitoring of the environment within an approximate radius of 10 km, radiation dose calculation within 100 km.
Use of natural resources	An expert assessment of, for example, the use of blasted rock, and a description of the impact of the nuclear fuel production chain.	The production chain of nuclear fuel at a general level. Other use (e.g. mineral aggregate) locally or regionally.
Waste and by-products	An expert assessment of the waste streams in different phases and the processing, utilisation options and final disposal thereof. Reports prepared earlier (including Posiva 2008) are used to describe the impact of the transport and final disposal of spent nuclear fuel .	Spent nuclear fuel from Loviisa power plant to Eurajoki, including the transport routes. Others locally or regionally.
Long-term safety of the L/ ILW repository	Includes the key results of the safety case and an expert assessment of the impact on long-term safety of the extension of the power plant's service life and the radioactive waste originating from elsewhere in Finland than Loviisa power plant.	The vicinity of the power plant.
Energy markets and security of supply	An expert assessment of the development of and changes in the energy market in the project options.	Finland.
Climate change	Calculated assessment of carbon dioxide emissions (CO_{2e}) and their impact on Finland's total emissions.	At the national level in Finland.
Emergencies and accidents	A modelling of a fictional severe reactor accident which releases 100 TBq of nuclide Cs-137 into the atmosphere. As a result, the modelling provides the fallout and radiation doses caused by the emission. An expert assessment of the impacts.	1,000 km.
Combined impacts	An expert assessment of the combined impacts with regard to the other actors in the region and the associated projects.	The vicinity of the project area and the municipalities involved in the associated projects.
Transboundary impacts	An assessment to be prepared based on separate surveys and modelling of the impact of the project potentially extending beyond the borders of Finland.	1,000 km.

Participation and interaction

The EIA procedure is interactive and enables different parties to discuss and express their opinion on the project and its impacts. One of the key objectives of the EIA procedure is to promote communication about the project and improve the opportunities to participate in its planning. Participation allows for the different stakeholders to express their views.

The environmental impact assessment procedure can be participated in by everyone whose conditions and interests, such as accommodation, work, transport, leisure activities or other living conditions, may be affected by the project to be implemented. In accordance with the EIA legislation, citizens can submit their opinions of the EIA programme and report to the coordinating authority during the period these are available for viewing.

Two public events are organised during the EIA procedure: the first in the programme phase; the second in the report phase. The purpose of the events, open for all, is to provide information produced during the project and the EIA procedure. The events enable citizens to have an opportunity to express their views on the project and the impacts to be assessed and to receive more information. The dates and locations of the public events are communicated through the coordinating authority's announcement concerning the EIA programme and report.

A resident survey is conducted in the EIA report phase to study the attitudes of the area's residents. The resident survey material also serves as data for the impact assessment. In addition, small group events are held in the EIA report phase to disseminate information on the project and hear various stakeholders. The stakeholders may include the area's residents, landowners, fishermen and entrepreneurs. The composition of the groups and the interview themes are tailored in accordance with the need for information and the stakeholder group.

The EIA programme and report will be published on the Ministry of Economic Affairs and Employment website. The documents are available for viewing in accordance with the announcement made by the coordinating authority. The EIA programme and report are also available on Fortum's website. The website also contains up-to-date information on the project, the environmental impact assessment procedure and licensing. In addition, Fortum provides information on the progress of the project, and news conferences and public events, for example.

1. Project owner and the project background

1.1 PROJECT OWNER

The project owner in the EIA procedure is Fortum Power and Heat Oy, a wholly owned subsidiary of Fortum Corporation. The Government of Finland holds 50.8% of the share capital of Fortum Corporation. In the spring of 2020, Fortum acquired a majority interest in Uniper SE, based in Germany. The acquisition made Fortum one of the largest energy companies in Europe and an increasingly important operator in Russia as well. Uniper was consolidated with the Fortum Group as of April 2020, but for the time being, it continues to operate as a separate listed company.

Fortum Corporation and its subsidiaries employ a total of nearly 20,000 people, about 2,000 of whom work in Finland. In the Nordic countries, Fortum is the second-largest producer of electricity and the largest electricity seller. Fortum is among the largest producers of thermal energy in the world. Fortum also offers district cooling, energy efficiency services, recycling and waste solutions, as well as the Nordic countries' largest network of charging stations for electric cars. Fortum's subsidiary Uniper also engages in large-scale global energy trading and owns natural gas storage terminals and other gas infrastructure.

Nuclear energy plays a significant role in Fortum's electricity production that is free of carbon dioxide emissions. Together with Uniper, Fortum is the second largest nuclear power company in Europe. In 2019, the combined electricity production of Fortum and Uniper was approximately 180 TWh, of which 19% was based on nuclear power in Finland and Sweden. Fortum Group's large-scale nuclear power, hydro power and wind power operations make it the third largest producer of emission-free electricity in Europe, and 66% of its production in Europe was free of carbon dioxide emissions in 2019. Including its electricity production in Russia, based primarily on natural gas, 38% of Fortum Group's entire electricity production was carbon dioxide emission-free.

Loviisa nuclear power plant, owned and operated by Fortum Power and Heat Oy, consists of two power plant units, Loviisa 1 and Loviisa 2. The electricity generated by the Loviisa power plant is used as an uninterrupted, year-round source of energy. Annually, Loviisa power plant produces a total of approximately 8 terawatt hours (TWh) of electricity to the national grid. It accounts for approximately 10% of the electricity consumption in Finland. For its part, Loviisa nuclear power plant supports the climate targets of Finland and the EU, as well as a secure electricity supply.

Fortum also holds a 26% share in the current nuclear power plant (Olkiluoto 1 and 2) of Teollisuuden Voima Oyj, and a 25% share in the nuclear power plant unit (Olkiluoto 3) under construction. In addition, the company is a shareholder in Swedish nuclear power plants (Fortum's share in Oskarshamn is 43%, and in Forsmark 22%). Fortum also participates in the nuclear power plant project of Fennovoima Oy, with a share of 6.6%. With Teollisuuden Voima Oyj, Fortum owns Posiva Oy, which is tasked with conducting studies on the final disposal of spent nuclear fuel of its owners, the construction and operation of a final disposal facility, as well as the closure of the facility. Fortum owns a 40% share in Posiva Oy.

1.2 PROJECT BACKGROUND

Fortum's Loviisa nuclear power plant was built in 1971–1980. Loviisa nuclear power plant consists of two power plant units, Loviisa 1 and Loviisa 2, as well as the associated buildings and storage facilities required for the management of nuclear fuel and nuclear waste. Loviisa 1 began its commercial operation in 1977 and Loviisa 2 in 1980. Loviisa power plant has been generating electricity reliably for more than 40 years. The current operating licence issued by the Finnish government to Loviisa 1 is valid until the end of 2027, and the operating licence issued to Loviisa 2 is valid until the end of 2030.

Fortum is in the process of assessing the extension of the commercial operation of Loviisa nuclear power plant by a maximum of approximately 20 years beyond the current operating licence period. Fortum will, at a later date, make the decision concerning potential extension of the operation of the nuclear power plant and the application for new operating licences. The other option is to proceed to the decommissioning phase when the power plant's current operating licences expires.

Fortum has invested in the ageing management of Loviisa power plant and carried out improvement measures throughout the operation of the power plant. The power plant units were customised to meet western safety requirements as early as during the planning phase. Over the years, Loviisa power plant has implemented several projects that improve nuclear safety. In recent years, extensive reforms have been carried out on the automation of the power plant, and ageing systems and equipment have been modernised. In 2014–2018, Loviisa power plant implemented the most extensive modernisation programme in the plant's history, in which Fortum invested approximately EUR 500 million. Thanks to the investments made and the skilled personnel, Loviisa power plant has excellent prerequisites with regard to the technical and safety-related requirements to continue operation after the current licence period.

In addition, the quantity of such radioactive waste generated in the operation of Loviisa power plant that requires final disposal has been considerably reduced, and the efficiency of the use of nuclear fuel has been improved. The radioactive waste from the power plant is processed and deposited in the final disposal facility for low- and intermediate-level waste (the L/ILW repository), located in the power plant area. The project for the final disposal of the spent nuclear fuel generated by the power plant has also progressed to the construction phase of Posiva Oy's encapsulation plant and final disposal facility. Solutions therefore exist for the processing and final disposal of all nuclear fuel generated by Loviisa power plant.

This environmental impact assessment procedure (the EIA procedure) covers the extension of Loviisa nuclear power plant's operations or its decommissioning. In both cases, the project requires a licensing procedure in accordance with the Nuclear Energy Act and an environmental impact assessment procedure (Nuclear Energy Act, section 3, article 1; points 7 b and d of the list of projects). The EIA report to be prepared after this EIA programme and the coordinating authority's reasoned conclusion to be issued on it are appended to any permit applications. In this EIA procedure, the coordinating authority is the Ministry of Economic Affairs and Employment.

2. Options to be reviewed in the environmental impact assessment

The implementation options reviewed for the project include extending the power plant's operation by a maximum of approximately 20 years (VE1) and two different zero options (VE0 and VE0+). In the zero options, the operation of the power plant would not be extended, but the power plant units are decommissioned after the current operation licence period. A brief description of the options being reviewed is provided in *Table 2-1* and *Figure 2-1.*

2.1 OPTION 1, VE1

The project Option 1 covers the extension of the commercial operation of the Loviisa nuclear power plant by a maximum of approximately 20 years. During the extension, the operation of the power plant would be similar to what it is currently, and increasing the thermal power of the plant is not being planned, for example.

If the operation of the power plant is extended, new buildings and structures are potentially constructed and modernisations carried out in the power plant area. The project also includes functions related to the handling of radioactive waste in the power plant area and the expansion of the L/ILW repository. Potential changes to be carried out in the power plant area and its vicinity include:

- replacing some old buildings with new ones by building a new reception warehouse, wastewater treatment plant, welding hall and a waste storage hall, for example;
- water engineering tasks on the cooling water intake structure and the nearby sea area, with the aim of decreasing the temperature of the cooling water taken to the power plant, and the potential depositing of the dredging and excavation masses in an embankment structure on the southwest side of Hästholmen;
- changes to the power plant's service water and wastewater connections, which are specified in the EIA report;
- the expansion of the interim storage for spent nuclear fuel or increasing the capacity of the current interim storage (for example, placing more nuclear fuel in the pools of the existing interim storage).

Option 1 also takes into consideration the preparation for decommissioning during the extension of the operation of the power plant and the actual decommissioning of the power plant after commercial use, in which case the operation of the L/ILW repository would continue, at a maximum, until approximately 2090. Chapter 2.2 describes the functions included in the decommissioning.

One aspect of the extension of the operation and decommissioning being considered, in accordance with the recommendation of the National Nuclear Waste Management Cooperation Group set up by the Ministry of Economic Affairs and Employment (Ministry of Economic Affairs and Employment, 2019), is the possibility of receiving, processing, placing in interim storage and depositing for final disposal in Loviisa power plant area small quantities of radioactive waste generated elsewhere in Finland. Such waste could, for example, be generated in research institutions, industry, hospitals or universities. Since the Loviisa power plant already has the functions and facilities suitable for the handling and final disposal of radioactive waste in place, it would be natural and aligned with the view of the National Nuclear Waste Management Cooperation Group that they would be available as part of the overall solution in society.

2.2 OPTION 0, VE0

Option VE0 reviews the operations of the power plant until the expiration of the current operating licences in 2027 and 2030 and the decommissioning to take place thereafter. Option VE0 is realised if Fortum does not apply for new operating licences for the power plant. In that scenario, a decommissioning licence should be applied for the power plant units and an operating licence should be applied for the plant parts to be made independent.

Decommissioning includes the dismantling of the radioactive systems and equipment of Loviisa power plant and the final disposal of decommissioning waste in the L/ILW repository's current halls and new halls to be built as required. In addition, decommissioning includes making certain functions and waste management related plant parts independent so that the said independent units can function without the power plant units for as long as spent nuclear fuel is kept in interim storage in the power plant area. In Option VE0, the operation of the L/ILW repository would continue until the 2060s.

During the operation of the power plant, preparations are made for decommissioning, including the following:

- operation and expansion of the L/ILW repository to ensure the radioactive decommissioning waste generated in the decommissioning of the power plant can be deposited in the L/ILW repository for final disposal;
- preparations required by and the use of buildings and structures to be made independent (including the interim storage for spent nuclear fuel, liquid waste storage and solidification plant, the L/ILW repository).

The decommissioning phase includes the following:

- power plant dismantling with the main focus on the dismantling of radioactive plant parts and systems;
- handling of radioactive decommissioning waste and its final disposal in the L/ILW repository;
- handling and reuse of conventional dismantling waste;
- operation and dismantling of plant parts to be made independent;
- closure of the L/ILW repository.

During the decommissioning phase, the transport of spent nuclear fuel and its final disposal at Posiva Oy's encapsulation plant and final disposal facility are also carried out. The impacts of these operations are described in greater detail in accordance with the previous environmental impact assessment reports conducted by Posiva, including Posiva's EIA report of 2008.

2.3 OPTION 0+, VE0+

Option VE0+ is the same as Option VE0, except that it also takes into account the handling, interim storage and final disposal of potential radioactive waste generated elsewhere in Finland and received by Loviisa power plant *(see Chapter 2.1)*.

Table 2 1. Options to be reviewed in the EIA procedure.

Option	Description
Option 1, VE1	Extending the operation of Loviisa power plant by a maximum of approximately 20 years after the current operating licence period, followed by decommissioning. • The option also includes the measures to extend the service life of the power plant, decommissioning of the power plant after the licensing period ends, the operation and ultimate dismantling of plant parts to be made independent and the waste management measures related to these phases. • In addition, the option includes the possibility of receiving, processing, placing in interim storage and depositing for final disposal small amounts of radioactive waste generated elsewhere in Finland.
Option 0, VE0	Decommissioning of the Loviisa nuclear power plant after the current licensing period (in 2027/2030). • The option also includes the operation and ultimate dismantling of plant parts to be made independent and the waste management measures related to these phases.
Option 0+, VE0+	Decommissioning of the Loviisa nuclear power plant after the current licensing period (in 2027/2030). • The option also includes the operation and ultimate dismantling of plant parts to be made independent and the waste management measures related to these phases. • In addition, the option includes the possibility of receiving, processing, placing in interim storage and depositing for final disposal small amounts of radioactive waste generated elsewhere in Finland.

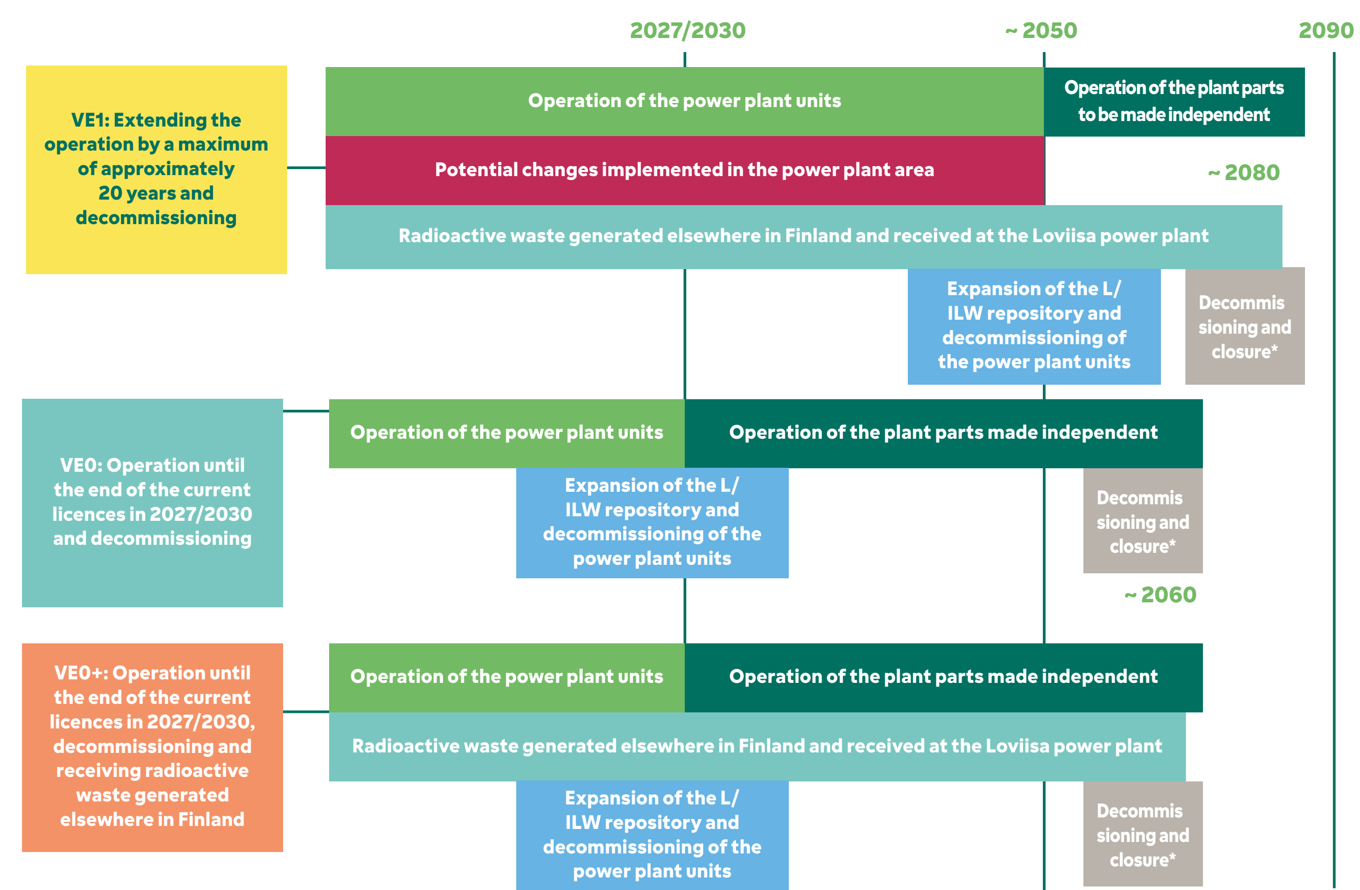


Figure 2-1. Options to be reviewed in the Environmental Impact Assessment procedure and their tentative schedule.

* Decommissioning of the plant parts to be made independent and closure of the L/ILW repository

3. Project description

3.1 LOCATION AND SPACE REQUIREMENT

Fortum's Loviisa power plant is located approximately 12 kilometres from the centre of the town of Loviisa, on the island of Hästholmen in the village of Lappom. The location and current functions of Loviisa power plant are shown in *Figures 3-1* and *3-2*. The buildings and structures required for the power plant's support functions, such as security and temporary accommodation for workers employed for the annual outage, are located on the mainland.

The functions related to the extension of the operation and decommissioning of the power plant covered in the EIA procedure are located in the existing power plant area and its vicinity. As possible, the dredging and excavation mass generated by potential water engineering is deposited in a new embankment structure on the southwest side of Hästholmen (*Figure 3-2*). The power plant's cooling water intake and discharge locations remain unchanged. The location of any new buildings and structures is specified in the EIA report phase.

3.2 CURRENT OPERATION

This chapter provides a general description of Loviisa nuclear power plant and its current operation. Extension of the operation of the power plant is covered in Chapter 3.3, and decommissioning in Chapter 3.4.

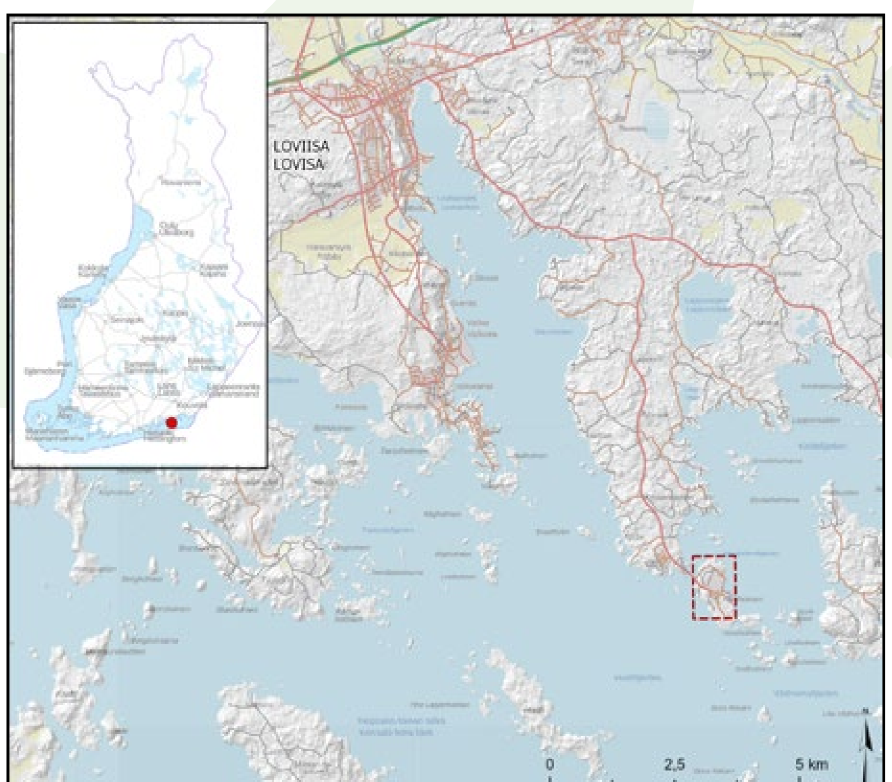
3.2.1 Power plant

3.2.1.1 Operating principle

Loviisa nuclear power plant is an electricity-generating condensing power plant. Instead of conventional fuel (for example, coal, natural gas or peat), Loviisa nuclear power plant uses uranium dioxide (UO_2) made from enriched uranium. Using uranium as fuel is primarily based on the splitting of the nucleus of the atom of the uranium isotope ^{235}U, or fission. In the fission reaction, a heavy atomic nucleus splits into two or more lighter atomic nuclei when hit by a free neutron. The reaction also releases some neutrons and energy. Electricity production in a nuclear power plant is based on the utilisation of the thermal energy generated by a controlled chain reaction.

The reactors of Loviisa power plant are light water reactors in which regular water is used for cooling and as a moderator in the reactor core. The power plant units are pressurised-water plants; in other words, the pressure of the water used as the coolant and moderator of the reactor is kept sufficiently high to prevent it from boiling. The power plant units of Loviisa nuclear power plant are based on the VVER-440 pressurised water plant design.

A pressurised water plant contains separate primary, secondary and seawater systems. The controlled fission reaction that takes place in the reactor core of the primary system generates heat. This heat is cooled by the water circulating in the reactor under high pressure. The heated water is conducted to the steam generators, where it evaporates the lower-pressure water of the secondary system. The generated steam is conducted to the turbines. A generator that shares the same shaft with the turbines generates electricity for the national grid and for the power plant itself. From the turbine, the steam is conducted to a condenser, where it condenses to water. The condensed water is pumped back to the steam generators. The condenser is cooled by a separate seawater system. The seawater used for cooling warms up and is led back to the sea. Radioactive water from the primary system does not mix with the cooling water at any point. *Figure 3-3* shows the operating principle of a pressurised water plant.



Power plant

Figure 3-1. Location of Loviisa nuclear power plant.

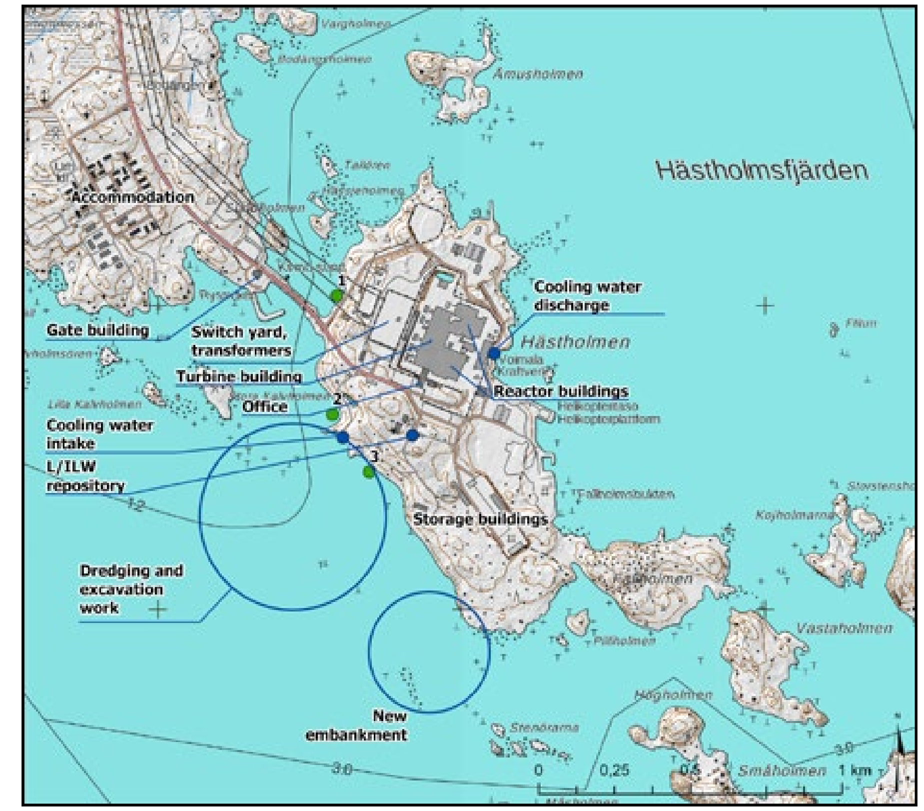


Figure 3-2. The current functions in Loviisa power plant area and the tentative location areas of the planned water engineering measures. The green spots depict the discharge area of the raw water treatment plant (1), the discharge area of the power plant's wastewater treatment plant (2) and the leak water discharge pipe of the L/ILW repository (3).

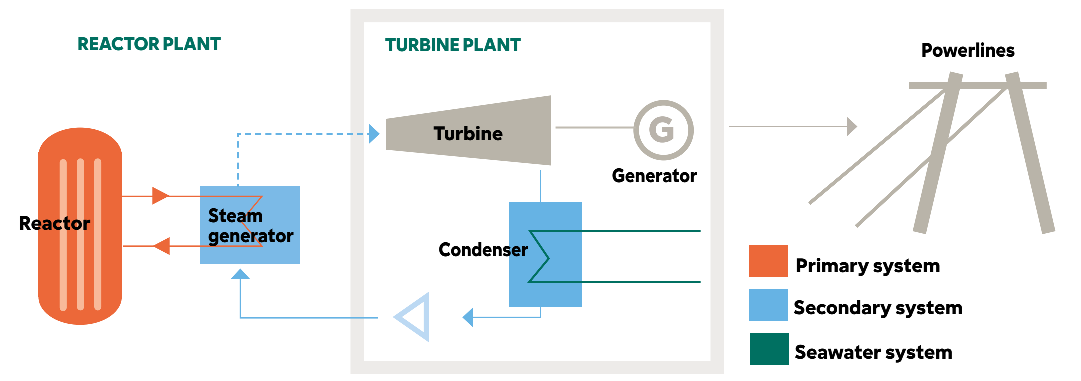


Figure 3-3. Operating principle of a pressurised water plant.

3.2.1.2 Production

Loviisa power plant is used for the production of base load electricity; in other words, the power plant units are usually operated steadily at full power to meet the continuous minimum requirement for electrical power. The original nominal electrical power of the power plant units was 440 MW. In 1997, the modernisation project carried out at Loviisa power plant included power uprating, which increased the nominal thermal power of the reactors from 1,375 MW to 1,500 MW. This increased the nominal electrical power of the plant units to 488 MW. The efficiency of the power plant units has been improved several times, and the net electric power of each unit is currently 507 MW. The total efficiency of the power plant units is approximately 34%. Since the power uprating of 1997, the production of Loviisa power plant has been approximately 8 TWh per year. This accounts for approximately one-tenth of the annual electricity consumption in Finland. The planned annual operating time of the power plant is approximately 8,000 hours. The availability and load factors of Loviisa power plant have been excellent. The operation of Loviisa power plant has been certified to the ISO 14001 Environmental Management and OHSAS-18001 Occupational Health and Safe-ty Assessment Series standards.

The power plant units are kept running continuously at as high and steady a power as possible. The operating period is usually interrupted by the annual outage carried out once per year between July and October. The annual outage includes modifications and maintenance, inspections and refuelling. The outage is carried out on one plant unit at a time and it lasts for 2–8 weeks. During the outage of one unit, the other plant unit is kept in operation. However, there have been occasions when both units were shut down simultaneously for their annual outage. Both power plant units undergo more extensive maintenance every four years. The most extensive annual outages, which are also the longest, take place every eight years.

3.2.1.3 Procurement and use of nuclear fuel

The fuel Loviisa power plant uses is fissionable nuclear fuel made from uranium ore through various chemical and mechanical phases. In the reactor, the nuclear fuel is in the form of small pellets with a diameter of approximately one centimetre. The pellets are encased in hermetically sealed fuel rods approximately 2.5 metres in length. The fuel rods are arranged in fuel bundles, with 126 fuel rods in each. Currently, the number of fuel bundles in the reactor is 313. The amount of nuclear fuel in Loviisa power plant's reactors is a total of approximately 89 tonnes of uranium dioxide (UO_2).

Currently, Fortum procures the nuclear fuel for Loviisa power plant from the Russian TVEL Fuel Company (TVEL). The fuel is transported to Loviisa power plant by road. The power plant's annual fuel requirement is a total of approximately 24 tonnes of uranium dioxide. The fresh fuel stored in dry storage at Loviisa power plant meets the need for between one and two years.

3.2.1.4 Use of chemicals

Most of the chemicals used at Loviisa power plant are various kinds of acid and alkali needed in the manufacture of process water and used to control the acidity and chemical reactions of the power plant's water systems. In addition, chemicals are used for cleaning and to prevent corrosion in the equipment and pipelines, processing the exhaust gases of the primary system and producing ice for the ice condensers in the reactor building. The acids and alkalis most used are sodium hydroxide, sulphuric acid and nitric acid. Ammonia water is used for increasing the pH of the power plant's secondary system and for adjusting the pH of the primary coolant. In the primary system, ammonia water is also used to create reducing conditions. Among other things, hydrazine is used as an oxygen removal chemical for process water to prevent corrosion. Boric acid is used for reactor power (reactivity) control. Power plant processes also use flammable liquids and gases. For example, hydrogen gas is used for cooling the electric generators' rotors, and light fuel oil is used in the emergency power diesel machines.

The industrial handling and storage of chemicals at Loviisa power plant is extensive. Loviisa power plant is an institution subject to a safety assessment as defined in the decree on the industrial handling and storage of hazardous chemicals (855/2012). An institution subject to a safety assessment is obligated to prepare a safety assessment and submit it to the Finnish Safety and Chemicals Agency (Tukes). The obligation is based on the quantities and properties of the chemicals. The obligation to prepare the assessment at Loviisa power plant is due to the use of hydrazine, which is classified as a toxic chemical hazardous to the environment.

3.2.1.5 Water requirement and supply

Seawater is used for various cooling requirements at Loviisa power plant. The primary use is the condensation of steam in the turbines. The cooling water for the power plant is taken from Hudöfjärden on the west side of the island of Hästholmen, using an onshore intake system, and the warmed cooling water is discharged back into the sea at Hästholmsfjärden, on the east side of the island. The cooling water intake is located at an approximate depth of 8.5–11 metres. The cooling water is conducted to the power plant units in a shared rock tunnel that ultimately bifurcates into two plant unitspecific tunnels. The cooling water temperature is increased by approximately 10°C in the turbine condensers. The warmed cooling water is conducted to the cooling water discharge, where the flow spreads over an approximately 90-metre submerged weir, located near the surface of the water (at a level of -0.5 m). The submerged weir spreads the water to the surface layer of the sea, accelerating the release of the excess thermal energy into the atmosphere.

The volume of cooling water used by Loviisa power plant is an average of 44 m^3/s. The maximum flow of cooling water takes place at the end of the summer, when the temperature of the surface water is naturally at its highest. At that time, the cooling water flow may be approximately 55 m^3/s. Fish, algae and other screenings carried with the cooling water to the power plant are removed from the water by means of coarse and fine screens and travelling basket filters. The screenings consist mostly of organic waste, which is taken to an external waste management company for appropriate processing.

In addition to cooling water, the power plant also needs raw water. The raw water for Loviisa power plant is taken from the Lappomträsket lake, located approximately five kilometres north of the power plant. The raw water pumped from the Lappomträsket lake is used in the raw water treatment plant to produce the service water needed in the power plant. Raw water is used as the process, fire, cleaning and rinsing water, as well as the power plant's domestic water. The fully desalinated process water is manufactured using an ion exchange technique in the water desalination plant. The plant area also has a wastewater treatment plant to treat the sanitary wastewater generated in the power plant area.

3.2.1.6 Waste management

The operation of a nuclear power plant generates both radioactive nuclear waste and conventional (non-radioactive) waste. The basis of nuclear waste management is to permanently isolate waste from the environment. According to the Nuclear Energy Act (990/1987), nuclear waste must be handled, stored and permanently disposed of in Finland. The Nuclear Energy Decree (161/1988) further defines the nuclear waste to be permanently disposed of in the Finnish ground or bedrock. More specific requirements are set for the final disposal of nuclear waste in the Radiation and Nuclear Safety Authority's (STUK) Regulation on the Safety of Disposal of Nuclear Waste (Y/4/2018) and in STUK's YVL Guides (nuclear safety guides).

The final disposal of nuclear waste in bedrock is based on using multiple release barriers to ensure that no nuclear waste enters the living environment or is within the reach of people. Bedrock itself is one of the release barriers. Other technical release barriers include the waste matrix that binds the radioactive substances, the waste container, the buffer surrounding the waste container, the backfilling of the final disposal halls and the closing structures of the disposal facility.

The final disposal of nuclear waste is planned and implemented in a way that does not require continuous supervision of the final disposal location to ensure long-term safety. According to international and Finnish surveys, the necessary nuclear waste management measures can be implemented in a controlled and safe manner.

Waste generated during the operation of a nuclear power plant include:

- spent nuclear fuel;
- low- and intermediate-level operational waste (for example, maintenance waste and waste originating from the water treatment processes);
- conventional and hazardous waste.

In addition, the decommissioning of the nuclear power plant generates decommissioning waste and other dismantling waste *(see Chapter 3.4)*.

Conventional waste is treated in the same manner as equivalent waste elsewhere in the industry, in accordance with valid acts, decrees and regulations.

The most central buildings and functions related to nuclear waste management at Loviisa power plant are the L/ILW repository (for the final disposal facility for low- and intermediate-level waste, see Chapter 3.2.2), the interim storage for spent nuclear fuel, the liquid waste storage and solidification plant, as well as the facilities for handling dry waste.

Spent nuclear fuel

Nuclear fuel becomes highly radioactive in the reactor during operation. In Finland, spent fuel is not processed further, but it is highly radioactive nuclear waste that requires final disposal.

At Loviisa power plant, spent nuclear fuel removed from the reactor is typically stored underwater in the spent fuel pool of the reactor building for 1–3 years, which allows its reactivity and heat production to decrease considerably. The spent fuel is then transferred to the power plant's interim storage for spent nuclear fuel, where it is stored in pools of water. Water acts as a radiation shield and cools the spent fuel. During the storage, the activity and heat production of the spent fuel continue to drop.

In due course, the spent fuel is transported in special containers from the interim storage to the Posiva encapsulation plant to be built in Olkiluoto in Eurajoki. Transport from Loviisa to Olkiluoto takes place either by road or sea. The transport of spent nuclear fuel is strictly regulated by national and international regulations and agreements. In Finland, the transports of spent nuclear fuel require a permit from STUK.

At the Posiva encapsulation plant, the spent fuel is packed

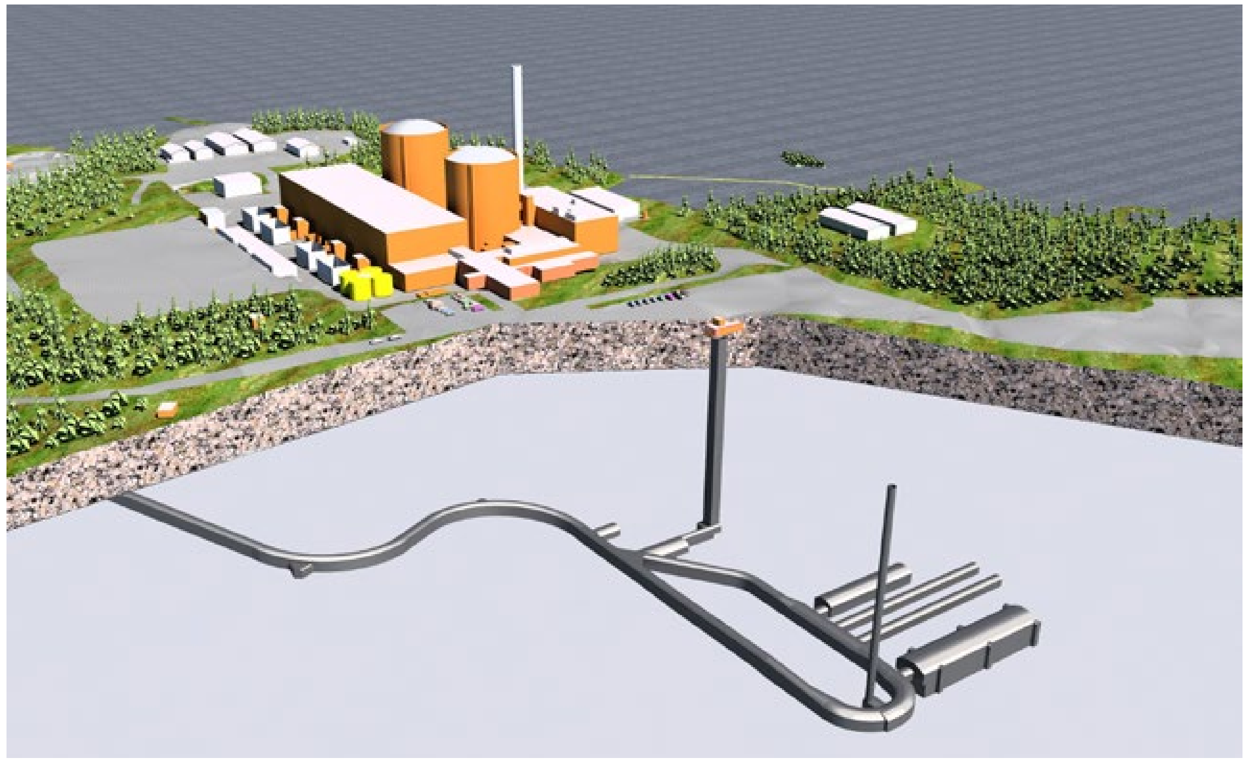


Figure 3-4. The final disposal facility for low- and intermediate-level waste in Loviisa.
Layout: Timo Kirkkomäki, Fortum.

and sealed in final disposal capsules. It is then moved by a lift or via a vehicle access tunnel to the final disposal facility for spent nuclear fuel, located at a depth of approximately 420 metres underground. The transport of spent nuclear fuel from Loviisa to Olkiluoto and its final disposal is covered in greater detail in Posiva's 2008 EIA procedure (Posiva Oy 2008).

According to the current plans, the final disposal of spent nuclear fuel from Loviisa power plant would begin in Posiva's encapsulation plant and final disposal facility in the 2040s.

Operational waste: Liquid waste

Liquid radioactive waste is generated from the process and sewage systems during the operation of the power plant. Liquid waste includes the ionexchange resins used to clean the process systems, the evaporator concentrate of sewage waters, and various types of sludge and precipitate generated by the cleaning of containers, among other things. As a rule, liquid waste is intermediate-level waste. Liquid waste is stored in the liquid waste storage before further processing.

At the solidification plant, liquid radioactive waste is mixed with cement, blast furnace slag and additives into a firm solidification product in the final disposal container made from reinforcement steel. The end product of this process is a solid waste container, in which the radioactive substances are bound in a concrete waste matrix, which also serves as a technical release barrier for the radioactive substances in the final disposal conditions. It is easier and more safe to handle, store, transport and deposit solid waste containers for final disposal than liquid non-solidified waste.

The solidified liquid waste is deposited for final disposal in the solidified waste hall in the L/ILW repository. The final disposal of solidified waste began in December 2019.

Operational waste: Maintenance waste

Most of the waste generated in the radiation controlled area of the power plant is low-level waste. This waste consists primarily of maintenance waste (e.g. insulation material, old work clothing, machine parts and plastic). For final disposal, maintenance waste is sorted and packed in steel barrels, and its activity is analysed using a gamma spectrometer. Based on the activity content, the maintenance waste is either deposited for final disposal in the final disposal halls built for it in the L/ILW repository or cleared from regulatory control when its activity is below the activity limits set by STUK. Waste that is to be cleared from regulatory control is handled as conventional waste and sent for processing outside the power plant. Only about a quarter of the maintenance waste generated in the radiation-controlled area ends up in final disposal, and the remainder can be cleared from regulatory control.

Operational waste: Other waste

In addition to the liquid waste and maintenance waste described above, small quantities of other radioactive waste are generated in the radiation controlled area, including various filters and intermediate-level dry waste. This waste is handled and put into final disposal using various methods according to the type of waste.

Small quantities of waste containing uranium have also been generated during the operation of the power plant (such as certain measuring instruments used in reactor control), which have not been deposited in the L/ILW repository for final disposal thus far. When a licence is applied for the final disposal facility, a permit for the final disposal of this waste in the L/ILW repository can also be applied for.

Conventional waste

A nuclear power plant, like other industrial plants, generates conventional waste (for example, paper, plastic and food waste, as well as scrap metal) and hazardous waste (such as fluorescent tubes and waste oils), which is not radioactive. Most of the conventional waste is reused as materials or energy, and only a small portion of the waste generated annually ends up in landfill. The annual waste quantities vary, depending on the scope of work carried out in the annual outage. Waste is managed as required by the power plant's environmental permit.

3.2.2 L/ILW repository

The low- and intermediate-level waste generated during the operation of the power plant is deposited for final disposal in the final disposal facility excavated for the purpose in the depth of 110 metres on the island of Hästholmen (the L/ILW repository, *Figure 3-4)*. The L/ILW repository was built on Hästholmen in the 1990s and expanded between 2010 and 2012.

The L/ILW repository currently has halls for maintenance waste and solidified liquid waste. The facility is located on the island so that no part of it is under the sea, the existing power plant units or sites reserved for units. The final disposal facility for low- and intermediate-level waste is a separate nuclear facility referred to in the Nuclear Energy Act and Decree, but it is used in connection with Loviisa power plant and is integrated with the power plant's functions. After the operation of the power plant discontinues, the final disposal facility is separated as an independent unit in the same manner as certain other waste management functions, so that it can be used during the power plant's decommissioning.

The final disposal facility for low- and intermediate level waste was granted an operating licence in 1998, and the final disposal of dry maintenance waste packed in steel barrels began in the same year. At the end of 2019, the facility contained approximately 10,000 barrels, or about 2,000 m³ of maintenance waste. The final disposal of solidified waste began at the end of 2019. The operating licence of the final disposal facility is valid until the end of 2055.

Long-term safety cases in accordance with STUK's requirements have been prepared for the final disposal facility for low- and intermediate-level waste at all stages of the facility's lifecycle, most recently in 2018. The cases are used to demonstrate that the long-term safety impacts are at an acceptable level after the final disposal facility is closed. Plans are in place to expand the current halls of the final disposal facility by excavating a final disposal hall for the decommissioning waste of Loviisa power plant. This expansion allows for the depositing for final disposal of all radioactive waste generated by the decommissioning of the power plant in due course, with the exception of spent fuel. The long-term safety case also covers the final disposal of decommissioning waste.

3.2.3 Emissions from the current operations

The operation of a nuclear power plant, regardless of the power plant type, generates emissions into the environment on which legislation imposes various emissions limits. The emissions of a nuclear power plant are divided into conventional and radioactive emissions. The emissions and other environmental considerations of the current operations are provided in *Table 3-1* of Chapter 3.3.6.

3.2.3.1 Radioactive emissions

Radioactive substances are generated in a nuclear power plant during operation. Small quantities of radioactive substances are released into the air and sea in a controlled manner in compliance with the criteria set in legislation, and the licences and regulations concerning the operations. The quantity of the radioactive substances to be released into the environment are limited effectively by delaying and filtering.

Radioactive emissions into the sea and air have been a fraction of the limits set for Loviisa power plant. The impact of the emissions on the people in the vicinity and the surrounding environment is minimal (see Chapter 3.2.4.1). The power plant's emissions of radioactive substances into the air and sea are constantly monitored.

Emissions into the air

The power plant's radioactive emissions into the air during operation largely consist of noble gases, aerosols, halogens and gaseous activation products. Most of the radionuclides released into the environment are short-lived and are only detected in the immediate vicinity of the power plant during environmental radiation monitoring.

In the processing of radioactive gases generated in the power plant, the gases are collected, filtered and delayed to reduce radioactivity. Gases containing small amounts of radioactive substances are released into the air through the vent stack in a controlled manner.

The radioactive emissions into the air from Loviisa power plant in 2008–2018 and the emission limits are presented in Chapter 3.3.6 *(Table 3-1)*. Emission limits have been set for emissions of noble gases and iodine. At their highest, the emissions of radioactive noble gases into the air from the power plant in 2008–2018 were approximately 0.06% of the emission limit (in 2009), and iodine emissions were approximately 0.02% of the emission limit (in 2010). The power plant's radioactive emissions into the air have therefore been significantly below the emission limits set for them.

Discharges into water systems

The power plant's radioactive discharges into the sea consist primarily of process water discharges, sewage water from the radiation controlled area, wastewater from washing the protective clothing used in the radiation controlled area, and the discharges of the purified evaporation concentrate. Before being discharged into the sea, the waters are treated and delayed to reduce radioactivity. The activity is measured, and discharging is only allowed when the activity is below the limits set by the authorities. In addition, the effluents from the floor drains of the waste areas of the final disposal facility for low- and intermediate-level waste are also included in emissions monitoring. The water that contains small quantities of radioactivity to be released into the sea in a controlled manner from the power plant is mixed with the cooling water flow in the cooling water discharge channel and diluted considerably.

The radioactive discharge into the sea from Loviisa power plant in 2008–2018 and the emission limits are presented in Chapter 3.3.6 (*Table 3-1*). At their highest, the power plant's emissions of tritium (H-3) into the sea in 2008–2018 were approximately 14% of the emission limit, and the emissions of other fission and activation products were approximately 0.2% of the emission limit. Thus, the power plant's radioactive emissions into the sea have been significantly below the emission limits set for them. For example, radioactive emissions into the sea have been reduced by separating caesium (Cs) from the evaporation concentrate in the radiation-controlled area

3.2.3.2 Conventional emissions

Emissions into the air

The power supply of Loviisa power plant in exceptional situations is secured by means of emergency diesel generators. Periodic testing of the emergency power sources generate some nitrogen oxide, carbon dioxide, sulphur dioxide and particle emissions. The oil-operated backup heating boiler of the power plant also generates minor emissions of a similar nature.

Traffic at the power plant also generates emissions into the air. The power plant's traffic during operation primarily includes commuting and maintenance traffic, as well as transports of fresh nuclear fuel, various pieces of equipment, chemicals, fuel oil, gases and waste management. The chemicals and fuel oil related to the power plant operations are transported to the power plant by road, in the same manner as other goods transports. In the power plant area, transports follow a guided transport route.

Discharges into water systems

Seawater used as cooling water in the power plant's turbine condensers warms by 8–12 °C, with an average of approximately 10 °C. With the exception of the rise in temperature, the quality of the cooling water does not change when the water flows through the power plant. The volume of seawater used as the cooling water by the power plant is an average of 44 m^3/s. The average heat load into the sea is approximately 57,000 terajoules (TJ) per year, and the average heat load for a 24-hour period is approximately 156 TJ per day of operating. In recent years, the heat load has remained fairly unchanged.

Conventional discharges into the water systems are primarily nutrient loads generated by the process wastewater and sanitary wastewater from the power plant area. Sanitary wastewater is processed in the wastewater treatment plant located in the power plant area. The average annual volume of processed sanitary wastewater conducted to the treatment plant was approximately 24,000 m^3 in 2000–2018. The purified sanitary wastewater is conducted to Hudöfjärden through a discharge channel.

In addition to sanitary wastewater, the sources of various types of process wastewater at the power plant include the production of service water in the raw water treatment plant; the regeneration water of the desalination plant and condensate purification facilities; turbine hall's seepage water; water from the steam generators' blowdown water treatment plant; the automatic flushing of the travelling basket filters of the seawater pump stations; as well as rainwater and water in the ground. Process waters generated in the radiation controlled area are described *in Chapter 3.2.3.1*.

After appropriate treatment, process wastewaters generated in the power plant are finally conducted with the cooling water to the sea in Hästholmsfjärden. In 2000–2018, the average volume of process wastewaters was approximately 160,000 m^3 per year.

The average total nitrogen load of the sanitary wastewater has been approximately 840 kg per year, and the total phosphorus load approximately 9 kg per year. The average total nitrogen load of the process waters has been approximately 800 kg per year, and the total phosphorus load 9 kg per year. Approximately every four years, a controlled discharge of the evaporation concentrate, from which caesium has been separated, is carried out. It temporarily increases the nutrition concentrations. The total nitrogen load generated by the power plant in the 2000s has been approximately 1,650 kg per year, and the total phosphorus load approximately 18 kg per year. The total phosphorus load has decreased in the 2010s. Nutrition discharges into the sea from Loviisa power plant in 2000–2018 are shown in Chapter 3.3.6 (*Table 3-1*).

In 2000–2018, the biological oxygen demand (BOD_7 value) of sanitary wastewater was an average of 177 kg per year, the chemical oxygen demand (COD value) was an average of 410 kg per year, and the solids load was an average of 506 kg per year.

3.2.4 Nuclear and radiation safety

According to the Nuclear Energy Act, the use of nuclear energy must be safe, and it shall not cause harm to people or damage to the environment or property. In Finland, the requirements concerning nuclear and radiation safety of nuclear power plants are based on the provisions of the Nuclear Energy Act and Decree, which are specified in regulations issued by STUK.

This chapter covers the most important areas of radiation and nuclear safety at Loviisa power plant, based on STUK's Regulation on the Safety of a Nuclear Power Plant (Y/1/2018), the Regulation on the Emergency Arrangements of a Nuclear Power Plant (Y/2/2018) and the Regulation on the Security in the Use of Nuclear Energy (Y/3/2016).

3.2.4.1 Radiation and monitoring

In a nuclear power plant, radioactive substances are primarily generated as fission products when the atomic nuclei of the fuel split, through neutron activation in the reactor or its vicinity, and as the products of the radioactive decay chains of the aforementioned substances.

The most important radiation sources during the operation of Loviisa power plant are the nuclear fuel and activation products in the primary system water, due to which the vicinities of the pri-mary system are inaccessible.

The systems that contain radioactive substances are located inside the radiation controlled area. Special safety guidelines must be adhered to in order to protect oneself against radiation. Continuous radiation dose monitoring has been arranged

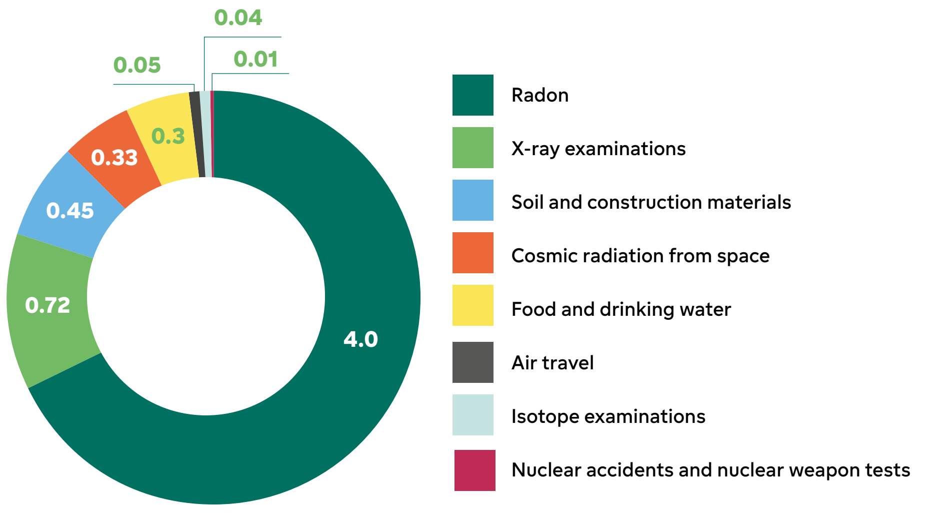


Figure 3-5. The average radiation dose of people in Finland is 5.9 millisieverts per year (Radiation and Nuclear Safety Authority STUK, 2020).

for personnel working within the radiation controlled area, and radiation measurements are carried out on the persons and items exiting the area. During the normal operation of Loviisa power plant, the personnel's radiation doses are significantly below the dose limits and are primarily caused by inspection work carried out in the primary coolant pump area. Most of the radiation doses are accumulated in the steam generator space during outages and in work carried out on the reactor's lid unit.

The radioactive emissions of Loviisa power plant are monitored by means of the power plant's emission measurements. The release of emissions into the environment is monitored in accordance with the environmental radiation control programme approved by STUK. The environmental radiation control is based on continuous dose rate measurements, air and fallout samples, seawater samples and samples taken from the food chain. The emissions of Loviisa power plant are reported to STUK quarterly. The independent control carried out by STUK supplements the control carried out by the power plant. Structural radiation protection, radiation protection of the personnel, and emission and radiation control are carried out under STUK's supervision.

The limits for radiation doses accumulated to the population, caused by the operation of a nuclear power plant, have been defined in the Nuclear Energy Decree (161/1988, Section 22 b). The limit for the annual dose caused to an individual by the normal operation of a nuclear power plant is 0.1 mSv (millisieverts), which is less than 2 % of the average annual dose of 5.9 mSv caused by radiation to a person in Finland (Radiation and Nuclear Safety Authority STUK 2020, *Figure 3–6*). In recent years, the radiation dose caused to an individual in the vicinity of Loviisa power plant has been approximately 0.2% (about 0.00023 mSv) of the dose limit set in the Nuclear Energy Decree and less than one tenthousandth of the normal annual radiation dose a person in Finland receives from other sources on average.

3.2.4.2 Nuclear safety

The safety of nuclear power plants and the requirements set for safety have been and will be continuously developed, based on experience and the results of safety surveys. The safety level of Loviisa power plant is determined by the plant's technical operation principles and solutions, and the expertise and safety-focused attitude of the organisation operating the power plant. According to the defence in depth principle, safety is ensured by means of a series of consecutive levels that are mutually redundant.

The technical nuclear safety of the plant units at Loviisa power plant is ensured by means of safety functions the purpose of which is to prevent the occurrence of incidents and accidents, prevent them from escalating or mitigate the consequences of accident situations. The safety functions have been defined in order to ensure the integrity of the barriers to the dispersion of radioactive substances. The functions are supported by means of support measures that are launched automatically or by an operator.

The most important safety functions of a nuclear power plant are:

- reactivity control, which aims to stop the chain reaction generated by the reactor;
- decay heat removal, which aims to cool the fuel and by doing so to ensure the integrity of the fuel and the primary system;
- Prevention of the dispersion of radioactivity, which aims to isolate the containment and ensure its integrity and, by doing that, to control the radioactive emissions during accidents.

Nuclear power plants have both conventional operating systems and safety systems that are used to implement the aforementioned safety functions during normal operation and during incidents and accidents. The safety systems ensure the cooling of the fuel in the reactor also when the normal operating systems are unavailable. The most important safety systems are the boron feed of the primary system, emergency make-up water system and emergency cooling system , the containment spray system, emergency feed water systems and the diesel generators and automation that support their operation.

A nuclear power plant should be prepared for a severe reactor accident. A severe reactor accident refers to an accident in which the fuel in the reactor is considerably damaged. Although such an accident is highly unlikely, Loviisa power plant is equipped with systems intended to manage a severe reactor accident. These

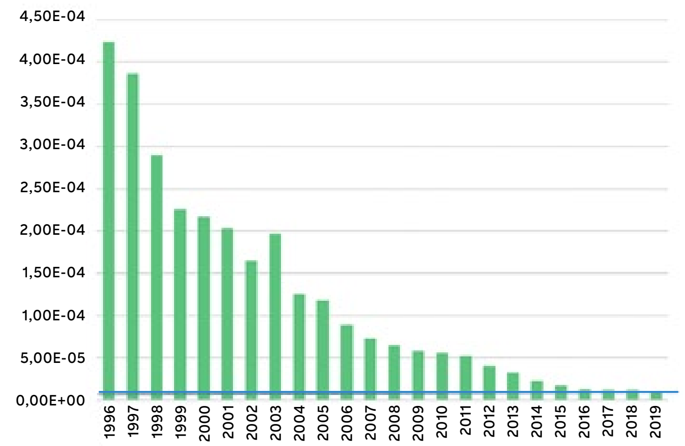


Figure 3-6. The frequency of considerable reactor core damage and nuclear fuel damage of spent fuel in the fuel pools in the Loviisa 1 power plant unit, assessed by means of PRA. The blue line indicates the requirement level (10^{-5}/year) proposed for new nuclear power plants in the STUK Guide YVL A.7.

systems are used to ensure that no radioactive substances are released from the power plant to the extent that they would cause serious harm to the environment.

Several projects to improve nuclear safety have been implemented at Loviisa power plant throughout its operation. The power plant is considerably safer than it was when it was originally commissioned, although it already complied with the requirements at the time. The safety improvements have been based, in accordance with a good safety culture, on the aim of achieving a safety level that is as high as possible, as well as the revised requirements issued by STUK. For example, several changes to improve safety have been implemented since the Fukushima accident. The changes included building an alternative heat sink independent of the sea, i.e. air-cooled cooling towers, and preparations for a high seawater level, improvements related to the availability of fuel for diesel machines, implementation of an alternative decay heat removal of the fuel pool, as well as the increase of the battery capacity. In addition, extensive reforms have been carried out on the automation, and ageing systems and equipment have been modernised.

In accordance with STUK's regulation Y/1/2018, the nuclear facility's safety and the technical solutions of its safety systems shall be assessed and substantiated analytically and, if necessary, experimentally. The probabilistic risk assessment (PRA) of the nuclear power plant is an analytical method referred to in the requirement. PRA is used as decision support in the risk management related to the safety of the nuclear power plant, for example, when assessing the opportunities to perform measures that improve safety and the need for such measures. At Loviisa nuclear power plant, the results of the probabilistic risk assessment have been applied in, for example, the definition of the aforementioned safety-improving modifications.

In accordance with STUK's Guide YVL A.7, the design of a nuclear power plant unit shall be such that the mean value of the frequency of reactor core damage is less than 10^{-5}/year. Figure 3-6 shows the frequency of considerable reactor core damage and the nuclear fuel damage of spent fuel in the fuel pools in Loviisa nuclear power plant, assessed by means of the probabilistic risk assessment for 1996–2019. Over the course of the past 20 years, the frequency has decreased considerably, in other words, the safety level of the nuclear power plant has improved as a result of the safety-improving modifications and measures close to the level required of new nuclear power facilities *(Figure 3-6)*.

3.2.4.3 Emergency preparedness

Emergency preparedness arrangements are arrangements carried out in preparation for accidents or situations in which the safety of the nuclear power plant has been compromised. To mitigate the consequences of an accident, the power plant and authorities maintain emergency preparedness, aimed at civil defence actions in a radiation hazard situation. Nuclear energy legislation sets requirements for civil defence, rescue and emergency preparedness operations. In addition, the Radiation and Nuclear Safety Authority has issued detailed requirements in the YVL Guides and in STUK Regulations (Y/2/2018) on the emergency preparedness operations. When planning emergency preparation operations, the separate emergency preparedness instructions (VAL Guides) for radiation protection actions in a radiation hazard situation, among other things, are also considered.

The emergency preparedness organisation of Loviisa power plant consists of persons trained for the tasks at the power plant and at Fortum's headquarters in Espoo. Job descriptions and duties have been defined in the emergency preparedness plan in advance. The emergency preparedness organisation has at its disposal the appropriate premises, communications connections and equipment to conduct radiation measurements in the power plant area and in the precautionary action zone (extending to a distance of some 5 kilometres from the plant), among other things. In addition, Loviisa power plant has its own rescue station. The emergency preparedness plan is maintained and developed continuously, and the operations are practised in annual emergency preparedness drills and in cooperation exercises organised every three years, in cooperation between the power plant and several authorities (including STUK, the police, rescue services, the emergency response centre, hospitals and the Finnish Meteorological Institute).

3.2.4.4 Security arrangements

Security arrangements refer to advance preparations for a threat of illegal activity directed against the nuclear power plant or its operations. Nuclear energy legislation sets requirements for the security arrangements of a nuclear power plant. In addition, STUK has set detailed requirements concerning the security arrangements in the YVL Guidelines and in STUK regulations (Y/3/2016).

The security organisation of Loviisa power plant, which comprises persons trained for the tasks, has at its disposal the appropriate premises, communications connections and equipment. The job descriptions and duties of the persons in the security organisation have been defined in advance in the plans and guidelines concerning security arrangements. The plans and guidelines concerning the security arrangements have been prepared in cooperation with the relevant police authorities and aligned with the rescue, emergency and abnormal situation plans prepared by the authorities.

Security arrangements and their related plans and guidelines are maintained and continuously developed, and the operations are regularly practised with the authorities, both in separate drills and as part of the emergency exercises.

3.3 EXTENDING THE OPERATION

Fortum is in the process of assessing the extension of the commercial operation of Loviisa nuclear power plant by a maximum of approximately 20 years beyond the current operating licence period. This chapter describes the prerequisites of the extension of the power plant's operation, and the modifications that may be implemented.

3.3.1 Nuclear and radiation safety

During the extension of the operation, the same basic principles are adhered to as those described in *Chapter 3.2.4*, while considering the requirements set by the changing legislation.

In accordance with the good safety culture, safety improvements are also carried out at Loviisa power plant during the potential lifetime extension. The work is guided by the operation experience gained at Loviisa power plant and other nuclear power plants, changes to STUK's YVL Guides and technological advances. According to Fortum's estimate, the changes made to the requirements in recent years result in some new procedures in addition to those already implemented. For example, the improvement of the seismic conditions of Loviisa power plant is currently being planned.

3.3.2 Ageing management and maintenance of the power plant

Loviisa power plant is one of the best nuclear power plants in the world in terms of safety and availability. The key indicators used to measure safety and reliability have been good throughout Loviisa power plant's operating history. The annual load factors have exceeded 90 per cent.

A well-managed and professional ageing management and maintenance are prerequisites to ensure the safe and economical operation of a nuclear power plant. This objective can be met by continuously improving safety, availability, performance and cost-effectiveness.

The systems, structures and equipment of Loviisa power plant are exposed to various stresses during operation. Examples include normal wear and tear resulting from the operation of the equipment or the fatigue of the structural materials, which may compromise the equipment's integrity and performance. Regulatory requirements concerning systems, structures and equipment, and other requirements, may change during the operation of the power plant, and the technology used may advance, meaning the systems, structures and equipment no longer meet the prevailing requirement level. These factors – in other words, the ageing of systems, structures and equipment – are prepared for in the planning phase by means of reasoned design solutions, and during operation, by monitoring and maintaining the operability of the systems, structures and equipment until they are decommissioned. Among other things, this refers to equipment test runs, quality control inspections and traditional maintenance measures, such as lubrication oil and grease changes. This helps ensure that the systems, equipment and structures function as planned. Equipment is replaced when required as a result of ageing. This requires individual equipment transports to the power plant and commissioning tests of new equipment.

The ageing management programme and procedures cover the entire Loviisa power plant. The systems, equipment and structures of the power plant have been divided into three categories in ageing management. Ageing management is conducted in accordance with the procedures and scope defined for each category. System managers have been designated for ageing management.

The maintenance organisation and the maintenance functions of Loviisa power plant are responsible for ensuring that a system, equipment or structure that is in operation or operable meets the requirements set for the operating condition under normal operation and in incidents and accidents.

3.3.3 Additional construction in the area

3.3.3.1 Water engineering

Over approximately twenty years, it has been necessary to reduce the power of Loviisa power plant due to the high intake temperature of the cooling water during some summers. The power limitations have helped keep the temperature of the cooling water conducted to the sea within the environmental permit's conditions. The seawater temperature is expected to rise in the future due to the warming of the climate, which contributes to the likelihood and duration of power limitations.

Reducing the temperature of the intake cooling water considerably increases the electric output of the power plant, because reducing the temperature improves the efficiency of the turbines. By decreasing the temperature of the intake cooling water, it is possible to reduce the temperature of the discharged cooling water, although this does not affect the heat load being conducted to the sea.

Fortum is therefore investigating the possibility of carrying out water engineering work in the sea area near Loviisa power plant. The essential elements of the water engineering work would include the dredging and excavation of the seabed in front of the intake opening located on the Hudöfjärden side, as well as the dumping of the masses generated by the water engineering work *(Figure 3-2)*. Dredging and excavating the shallower seabed areas in front of the cooling water intake opening would enable cooler seawater from deeper down to access the cooling water intake, which would impact the temperature of the intake cooling water. The potential water engineering includes the construction of an embankment extending approximately 200 metres into the sea from the shore, using the material to be dumped, in the southwest side of Hästholmen island (Fortum Power and Heat Oy 2009). The embankment or a wharf acting as a breakwater would reduce the recirculation of the cooling water from the discharge side to the intake side, which would have a favourable impact on the temperature of the intake cooling water. The embankment would also make it possible to build a wharf should one be needed. The water engineering plans are specified in the EIA report.

3.3.3.2 Buildings

The potential new additional buildings to be constructed in the power plant area during the extension of the operation include a cafeteria building in the vicinity of the office building, an inspection or reception warehouse, wastewater treatment plant and a welding hall. In addition, additional construction related to the interim storage of spent nuclear fuel may be carried out *(see Chapter 3.3.5.1)*.

Table 3-1. The environmental aspects of extending the operation of the power plant.

Environmental aspect	Current operation of the power plant	Extending the operation
Thermal power to be conducted to the water systems	1) 57,000 TJ/year	No major changes.
Need for cooling water	2) 44 m^3/s	No major changes.
Volume of service water	3) 200 000 m^3/year	No major changes.
Radioactive emissions into the water systems	4) Tritium (H-3): 13–21 TBq/year The emission limit is 150 TBq/year	No major changes.
	4) Other fission and activation products: 0.0001–0.002 TBq/year The emission limit is 0.9 TBq/year	No major changes.
Other emissions into the water systems	5) Sanitary wastewater: 24,000 m^3/year 5) Total nitrogen (N): 840 kg/year 5) Total phosphorus (P): 9.3 kg/year	No major changes, but potential water engineering mainly causes temporary clouding of the water in the sea area.
	5) Process wastewaters: 160,000 m^3/year 5) Total nitrogen (N): 800 kg/year 5) Total phosphorus (P): 8.9 kg/year	
Radioactive emissions into the air	4) Tritium (H-3): 0.1–0.4 TBq/year	No major changes.
	4) Carbon-14 (C-14): 0.3–0.5 TBq/year	No major changes.
	4) Iodines (I-131eq.): 0.0000002–0.00005 TBq/year The emission limit is 0.22 TBq/year.	No major changes.
	4) Noble gases (Kr-87eq.): 4.7–8 TBq/year The emission limit is 14,000 TBq/year	No major changes.
	4) Aerosols: 0.00003–0.0008 TBq/year	No major changes.
Other emissions into the air	Emergency power generators: some nitrogen oxide, carbon dioxide, sulphur dioxide and particle emissions.	No major changes.
Waste		
Spent nuclear fuel	24 t/year (UO_2)	No major changes to the annual accumulation, but the quantity of the fuel placed in the intermediate storage in the power plant area increases as the operating time is extended.
Low-level waste	The current accumulation rate is 20–30 m^3/year.	No major changes to the annual accumulation, but the quantities increase as the operating time is extended. An extension of circa 20 years generates approximately 600 m3 of low-level waste and approximately 2,400 m3 of intermediate-level waste when the waste is packed.
Intermediate-level waste	The current accumulation rate is 15–30 m^3/year, and when solidified and packed, 60–120 m^3/year.	
Conventional waste	400–1,000 t/year, of which a maximum of 15% is deposited in landfill, and the rest is reused.	No major changes.
Noise	The most significant sources of noise generated by the power plant are transformers, ventilation equipment and traffic. Testing of safety valves during annual maintenance.	No major changes, but temporary noise may be caused by potential modification and construction work.
Traffic	6) The average daily traffic on Atomitie is approximately 700 vehicles, approximately 40 of which are heavy vehicles.	No major changes, but potential construction work may occasionally increase traffic volumes.

1) On average after the power uprating of 1997
2) Annual average
3) Average from 2003–2018
4) In 2008–2018
5) Average from 2000–2018
6) In 2018

Figure 3-7. An illustration of the final disposal facility of Loviisa power plant for low- and intermediate-level waste. In addition to the existing halls, the illustration depicts the planned final disposal halls for decommissioning waste (dismantling waste halls 1 and 2, a large component hall and reactor vessel silos).

3.3.4 Water and wastewater connections

As part of the review concerning the extension of the power plant's operation, tentative plans have been made to investigate alternative methods to obtain service water for the power plant and to conduct the sanitary wastewater generated in the power plant to a wastewater treatment plant outside the power plant area. The matter is specified in the EIA report.

3.3.5 Waste management

Extending the operation of the power plant does not materially affect the accumulation of the conventional and radioactive waste generated annually. If the operation of the power plant is extended, the waste management methods remain primarily the same as those currently used. The capacity of the final disposal facility for low- and intermediate-level waste is also sufficient for the final disposal of the low- and intermediate-level waste generated during the extension. The most significant change related to waste management, caused by the extension of the operation, targets the interim storage of spent nuclear fuel.

3.3.5.1 Interim storage of spent nuclear fuel

The extension of service life does not change the quantity of the spent nuclear fuel generated annually, but the quantity of spent nuclear fuel to be placed in interim storage in the power plant area increases during the additional years of operation. The interim storage capacity of spent nuclear fuel needs to be increased. This can be achieved, for example, by a denser storing of spent nuclear fuel in the pools of the current interim storage or by building additional pools that expand the current pool capacity. The method for increasing interim storage capacity is selected later, and the selection is affected, for example, by the start date of fuel transports to Posiva and the power plant's service life.

The heat production of spent nuclear fuel reduces during interim storage. Therefore, the cooling need of the interim storage does not increase considerably, despite the fact that the total quantity of the fuel to be placed in interim storage increases. The cooling capacity of the interim storage can be increased by increasing the flow of the cooling water to the heat exchangers or by increasing the size of the heat exchangers.

3.3.6 Summary of the environmental aspects of extending the operation

Table 3-1 shows a summary of the environmental aspects of the extension of the operation of the power plant.

3.4 DECOMMISSIONING

This chapter describes the decommissioning and dismantling of Loviisa power plant. If the operation of Loviisa power plant is not extended, the power plant is decommissioned after the current licensing period. If the operation of the power plant is extended, decommissioning takes place after the new licensing period.

3.4.1 General description of decommissioning

Decommissioning a nuclear power plant is a regulatory activity subject to the provisions of the Nuclear Energy Act and Decree, Radiation and Nuclear Safety Authority Regulations and the Guidelines based on them. In Fortum's plans, decommissioning refers to the dismantling of the radioactive systems, structures and components, and the final disposal of dismantling waste. Preparations are made for the L/ILW repository expansion for decommissioning waste and the licensing of decommissioning in good time before the actual decommissioning work begins. Among other things, decommissioning requires the application of a decommissioning licence in accordance with the Nuclear Energy Act.

After the production phase of Loviisa power plant, the power plant units are decommissioned. Decommissioning begins with a dismantling preparation phase that lasts for a few years. The cur-rent decommissioning strategy is immediate dismantling and final disposal. A decommissioning plan is prepared during the operation and submitted to the authorities every six years in accordance with the Nuclear Energy Act. The decommissioning plan for Loviisa power plant was last updated in 2018. The decommissioning plan includes all phases related to decommissioning and the current plans concerning the phases. The plans are updated and specified gradually in accordance with the experience gained from the operation of the power plant, the comments received from and requirements set by the authorities, and the monitoring of international projects. The final decommissioning plan is submitted to the authorities for approval in good time before applying for the decommissioning licence. This EIA Programme describes decommissioning in a general way.

The stages included in the decommissioning of Loviisa power plant include:

1. expansion of the L/ILW repository for decommissioning waste;
2. making the spent fuel interim storage, liquid waste storage as well as the solidification plant, and the L/ILW repository independent;
3. termination of the operation of the power plant units and licensing of the dismantling work;
4. detailed planning of and preparations for the dismantling;
5. dismantling of the radioactive components of the power plant units and any other dismantling work;
6. handling and disposal of radioactive waste in the L/ILW repository, as well as reuse of conventional dismantling waste;
7. transportation of the spent fuel to the encapsulation plant and final disposal facility;
8. dismantling of the plant parts to be made independent;
9. closure of the final disposal halls / L/ILW repository;
10. release from liability and post-closure control by the authorities.

During decommissioning, the personnel in the power plant area consists of Fortum's own staff and external contractors. The estimated number of personnel is approximately 400 people. The workload required to decommission Loviisa power plant is estimated to be approximately 3,000 person-years in total, of which the power plant's own personnel accounts for approximately 1,700 person-years, and contractors approximately 1,300 person-years.

3.4.1.1 Expansion of the L/ILW repository for decommissioning waste

The decommissioning waste generated in decommissioning is deposited in the bedrock of the power plant area. To a large extent, this L/ILW repository has already been constructed for the low- and intermediate-level waste generated during operation. The final disposal halls for the decommissioning waste have been designed to form an integrated and functional whole with the current hall for the waste generated during operation. The final disposal hall is located underground at a depth of approximately 110 metres below sea level *(Figure 3-7)*.

During the operation of the power plant, the L/ILW repository is expanded by excavating approximately 57,000 m³ for decommissioning waste. The blasted rock is transported by lorry from the repository to the surface and dumped in the nearby area, from where it can be used as the repository filling material at closure.

3.4.1.2 Making the spent fuel interim storage, liquid waste storage, as well as the solidification and the L/ILW repository independent

Before final disposal, spent fuel is allowed to cool in the power plant's interim storage for spent fuel. It must therefore be possible to use the buildings and functions related to the power plant's waste management independently during the decommissioning of the power plant units and the interim storage of spent fuel. Therefore, the interim storage for spent fuel, the liquid waste storage and solidification plant and the L/ILW repository are made independent to ensure their electricity supply, controls, cooling, ventilation and other corresponding functions are separated from the systems of the power plant units before the operation of these is terminated. It is possible that making the interim storage for spent fuel independent requires that a new seawater pump station be built for the removal of the fuel's decay heat.

3.4.1.3 Terminating the operation of the power plant units and licensing of the dismantling work

When decommissioning begins, the power plant units are shut down, and electricity production ceases. During the last years of operation, the required permits are applied for the dismantling work included in decommissioning and the final disposal of dismantling waste. The required licences are covered in *Chapter 10.1.*

3.4.1.4 Detailed planning of and preparations for the dismantling work

Before electricity production ceases, detailed plans are prepared concerning the implementation of the dismantling work. At the same time, the dismantling contracts to be ordered from external contractors specialising in dismantling are prepared.

The termination of operation is followed by a preparation phase of approximately two years before the actual dismantling begins. The preparation phase includes for example the following measures:

- the spent nuclear fuel is transferred from the reactor building's pools to the interim storage for spent fuel, where it is stored according to Posiva's final disposal schedule;
- draining of process systems is carried out;
- radioactive waste is handled;
- the required transport openings are built for large components (such as the reactor pressure vessel);
- decommissioning waste processing halls are built;
- preliminary dismantling is performed.

3.4.1.5 Dismantling of the radioactive components of the power plant units and any other dismantling work

After the preparations, dismantling of radioactive structures and systems begins, with the exception of functions related to the interim storage of spent fuel, liquid waste storage and solidification plant.

Dismantling of radioactive components can be carried out using methods and equipment currently in use. Dismantling begins with the handling of the reactor pressure vessel and the vessel's internal parts, and continues with the dismantling of the primary system and other contaminated systems. The decommissioning of Loviisa power plant aims to deposit large components, such as the reactor pressure vessels and steam generators, intact for final disposal.

The dismantling of the radioactive components and the treatment of waste (described in Chapter 3.4.1.6) take place in parallel. Conventional dismantling measures are described in *Chapter 3.4.3.*

3.4.1.6 Handling and final disposal of radioactive waste in the L/ILW repository and the reuse of conventional dismantling waste

Material dismantled in decommissioning that exceeds the limit values for releasing radioactive material from regulatory control is transported to the final disposal hall for decommissioning waste in the L/ILW repository. Dismantled materials that remain below the limit values can be handled in the same manner as conventional waste.

Reactor pressure vessels and their activated internals are protected against the spread of contamination and transported, radiation-protected, in a special vehicle to the final disposal hall to be built for them in the L/ILW repository. Other activated materials are dismantled and packaged in various types of concrete and wooden boxes, and likewise transported to the designated final disposal hall in the L/ILW repository.

Contaminated dismantling waste primarily consists of process systems which are in contact with radioactive water in the operation phase. The concrete structures of a nuclear power plant may become contaminated as a result of leaks in the process systems or pool lining. Contamination may also be caused by the dismantling measures carried out in the decommissioning phase.

During decommissioning, waste is placed in interim storage on the power plant premises for measurement and packaging, after which it is transported to the final disposal hall. The estimated total volume of decommissioning waste to be deposited in final disposal is approximately 25,000 m3. The maintenance waste generated during the decommissioning phase is placed in barrels that are measured and transported to the final disposal hall. In addition, other dismantling material from the power plant can be used as a filling material in the L/ILW repository. The volume of this material is estimated to be a maximum of 50,000 m3.

Process water to be placed in interim storage in the liquid waste storage to be made independent is treated and purified and then conducted to the sea. Radioactive solutions generated in decommissioning are treated and solidified, and placed in the L/ILW repository for final disposal.

The use of the interim storage for spent fuel that is made independent generates small amounts of radioactive maintenance waste, which is placed in barrels, measured and transported to the final disposal halls. In the interim storage for spent fuel, water from the pools is purified. This generates waste, which is solidified at the solidification plant and transported to the final disposal hall for solidified waste for final disposal.

Activity measurements are performed on non-radioactive buildings, and the buildings are released from regulatory control, after which they can be repurposed. Alternatively, non radioactive buildings may also be demolished, and the demolition waste is recycled or otherwise reused as much as possible.

At the decommissioning phase at the latest, small quantities of waste containing uranium, which have not yet been deposited in the L/ILW repository for final disposal, need to be deposited for final disposal (such as certain measuring instruments used in reactor control). When a licence is applied for the final disposal facility, a permit for the final disposal of this waste in the L/ILW repository can also be applied for.

3.4.1.7 Transporting spent fuel to the encapsulation and final disposal facility

Spent nuclear fuel is placed in the transport containers designed for the purpose in the power plant area and transported to Posiva's encapsulation and final disposal facility located in Olkiluoto in Eurajoki. At the facility, the spent fuel is placed in final disposal capsules in the encapsulation facility and deposited for final disposal in the final disposal facility for spent fuel, located deep in the bedrock.

Once Posiva has received the spent nuclear fuel from Loviisa power plant, Posiva is responsible for the final disposal measures of the fuel.

3.4.1.8 Dismantling of the plant parts to be made independent

Once all spent fuel has been transported to Posiva, the interim storage for spent fuel is drained of water, cleaned and dismantled. Liquid waste is solidified in the solidification plant, after which the liquid waste storage and the solidification plant are emptied, cleaned and dismantled. The radioactive waste generated by all plant parts to be made independent are deposited in the L/ILW repository for final disposal.

3.4.1.9 Closure of the final disposal halls and the L/ILW repository

Finally, the final disposal halls are closed by filling the halls containing release barriers with crushed rock or demolished concrete, and closing the waste hall openings, shafts and the perimeters of the fragmented rock zones in the bedrock with reinforced concrete. The final disp
osal repository is ultimately closed by filling the vehicle access tunnels with blasted rock and casting a giant reinforced concrete plug in the repository entrance. The area is subject to post-closure control by the authorities

3.4.1.10 Release from liability and post-closure control by the authorities

The final disposal of nuclear waste has been completed when STUK has deemed that the nuclear waste has been disposed of in a manner approved by STUK. Correspondingly, a nuclear facility is considered to have been decommissioned when STUK has deemed that the quantity of radioactive substances in the buildings and soil of the facility area meets the legal requirements. After this, an authority (the Ministry of Economic Affairs and Employment) prescribes Fortum's management obligation to have ended, and the ownership of and responsibilities for the nuclear waste are transferred to the State.

Table 3-2. Environmental aspects of the expansion of the L/ILW repository.

Environmental aspect	Current volume and operating licence of the L/ILW repository	Expansion of the L/ILW repository for decom missioning waste and the extension of the power plant s operation
Waste amounts requiring a licence		
Low-level waste (maintenance waste halls)	6,400 m³ (waste amounts in accordance with licence conditions)	A maximum of 50,000 m³
Intermediate-level waste (solidified waste hall)	11,000 m³ (waste amounts in accordance with the licence conditions)	
Decommissioning waste		
Other dismantling waste		A maximum of 50,000 m³
Radioactive waste generated elsewhere in Finland and received at Loviisa power plant		A maximum of 2,000 m³
Hall size		
In bedrock	116,350 m³	approx. 174,000 m³ (when expanding the L/ILW repository, approximately 57,000 m³ of additional space is excavated for decommissioning waste; it is estimated that no additional space is needed for maintenance waste)
Noise	The use of ventilation equipment generates noise.	There are no major changes regarding ventilation. Temporary noise is generated by the construction work.
Vibration	No major vibration is generated.	Temporary vibration is generated by the construction work.
Traffic	Transfer of waste and maintenance work in the repository causes traffic.	Construction work temporarily increases traffic volumes, primarily in the power plant area.
Ground and bedrock	No impacts on the ground and bedrock.	An additional space of approx. 57,000 m³ is excavated for decommissioning waste when the L/ILW repository is expanded. Blasted rock is dumped in the vicinity for the potential filling of the repository later.
Groundwater	Groundwater leaks into the L/ILW repository and is pumped into the sea. This has a minor impact on the consistency of the groundwater near the repository.	When expanding the L/ILW repository, blasting and the explosives used have a temporary impact on the quality (clouding and inorganic nitrogen compounds) and level of the groundwater. The seepage waters of the L/ILW repository are pumped into the sea.
Radioactive discharges into water systems	1) L/ILW repository's seepage waters 40,000 m³/year. Seepage water originating from the bedrock is accumulated in the L/ILW repository and conducted to the sea.	The seepage water of the L/ILW repository is pumped into the sea. When expanding the repository, the volume of seepage water to be conducted to the sea increases at least temporarily.
Emissions into the air	No emissions into the air.	Construction work causes temporary dust and other emissions into the air. Blasting work generates nitrogen emissions in particular into the air.

1) An average from 2000–2018

3.4.2 Safety and radiation protection

At the initial stage of decommissioning, spent nuclear fuel is transferred from the power plant units to an interim storage for spent fuel that has been made independent, which will eliminate the related risks from the power plant units. Decommissioning inside the radiation controlled area is considered radiation work in which the same principles concerning safety and radiation protection apply as during the power plant's operation. According to the Nuclear Energy Decree, the limit of the annual radiation dose received by an individual from the decommissioning according to the plan of a nuclear power plant or other nuclear facility equipped with a nuclear reactor is 0.01 mSv.

Table 3-3. Environmental aspects of decommissioning and plant parts to be made independent.

Environmental aspect	Decommissioning	Operation of the plant parts to be made inde pendent
Thermal power to be conducted to water systems (interim storage for spent fuel)	Spent nuclear fuel requires cooling during the interim storage. The thermal power to be conducted to water systems is comparable to the heat produced by spent fuel, which reduces as radioactivity decreases but is, in any case, insignificant compared to the thermal power conducted to the sea during the operation of the power plant.	
Need for cooling water (interim storage for spent fuel)	The need for cooling water at the interim storage for spent fuel is minimal compared to the use of water in the power plant; approximately a thousandth of the power plant's current need for cooling water.	
Volume of service water	During the power plant's dismantling phases, water is used in various work stages to bind dust or absorb heat, for example. However, the need for service water is considerably smaller than during the power plant's operation.	The volume of service water in the plant parts to be made independent is insignificant.
Radioactive emissions into water systems	Releasing treated process wastewater into the sea generates minor radioactive emissions.	The operation of the plant parts to be made independent generates considerably less radioactive emissions into the water systems than the power plant's operation does.
Other emissions into water systems	The handling of the evaporation concentrate (pH adjustment) generates nitrogen emissions into the sea.	No major emissions into the sea are generated by the operation of the plant parts to be made independent.
Radioactive emissions into the air	The demolition of structures generates dust. The demolished radioactive structures are protected, and the air is filtered to ensure no radioactive emissions are generated into the air.	The operation of the plant parts to be made independent generates considerably less radioactive emissions into the air than the power plant's operation does.
Other emissions into the air	The demolition of buildings generates dust. No other emissions into the air are generated. Transporting dismantling waste increases traffic in the power plant area and its vicinity, which increases exhaust emissions.	The operation of the plant parts to be made independent generates considerably less emissions into the air than the power plant's operation does.
Waste		
Decommissioning waste	The volume of radioactive dismantling waste to be deposited for final disposal is approximately 25,000 m³.	The dismantling waste from the plant parts to be made independent is included in the volume of decommissioning waste.
Other dismantling waste	Ways are sought to repurpose buildings free of radioactivity. Alternatively, non-radioactive buildings may also be demolished, and the demolition waste is recycled or otherwise reused as much as possible. It may also be most practical to deposit for final disposal part of the material eligible for the release of regulatory control by using it to fill areas of the repository that would otherwise remain empty. The volume of this filling material has been estimated to be a maximum of 50,000 m³.	The dismantling waste from the plant parts to be made independent is included in the volume of decommissioning waste.
Noise	The demolition of structures and dismantling of systems generates noise.	The use of ventilation equipment generates noise.
Traffic	Transporting demolition waste increases traffic in the power plant area and its vicinity.	Traffic will be minimal.
Vibration	Temporary vibration is generated by the demolition.	No vibration is generated by the plant parts to be made independent.

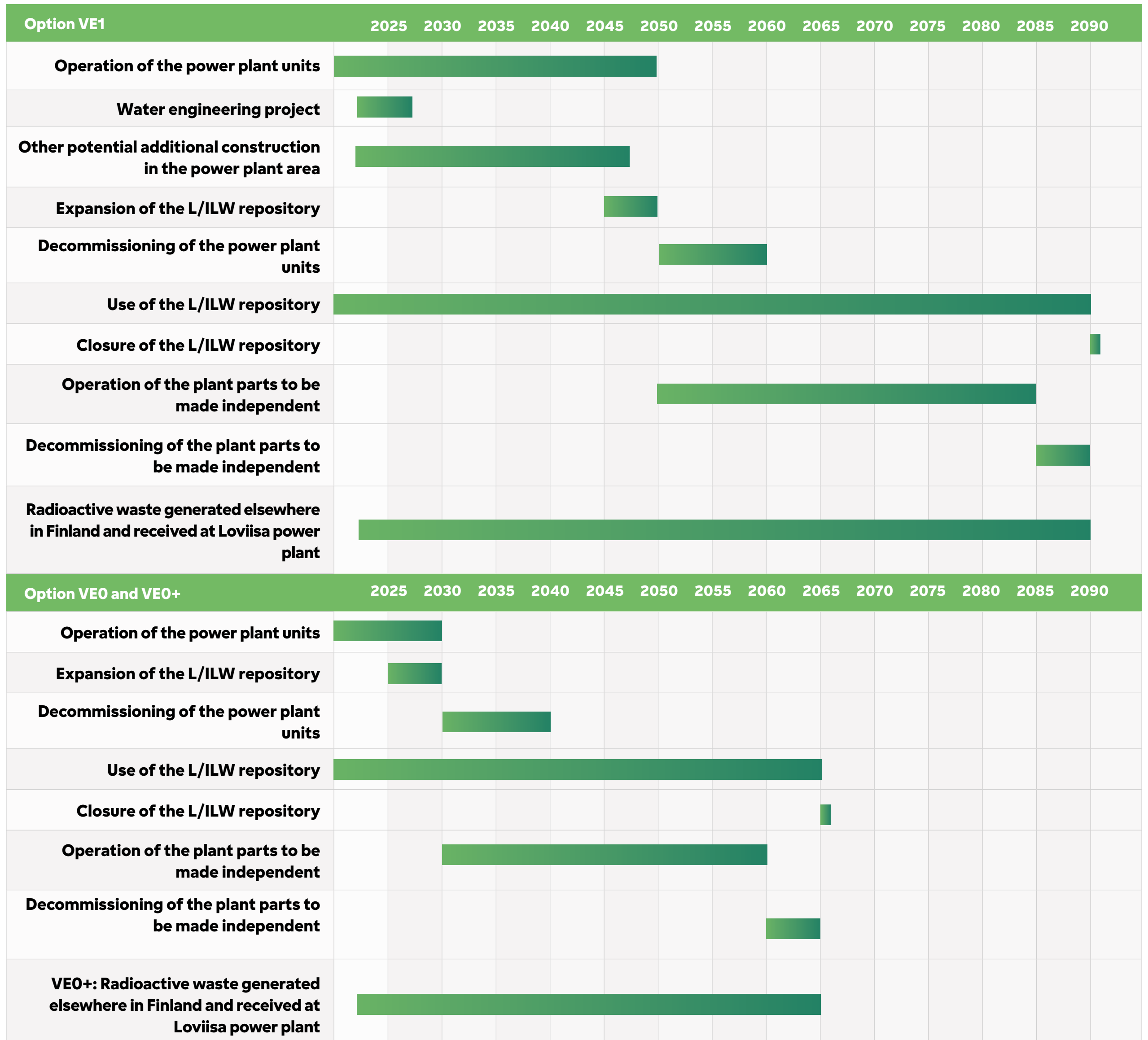


Figure 3-8. Tentative schedules of the project options, to be specified as the plans progress.

The decommissioning waste is deposited for final disposal in the existing and future L/ILW repository halls excavated in the bedrock. The safety of the final disposal of waste over the long term, or the long-term safety of final disposal, is assessed in a separate safety case, which aims to describe the long-term trends of the final disposal system and use them to assess, among other things, the release of radioactive substances from the final disposal halls and the radiation exposure of the population living in the vicinity of the final disposal facility. The nuclear safety legislation includes regulations concerning the level of these radiation impacts. According to the Nuclear Safety Decree, among others, the annual dose received by people who are the most exposed to radiation must remain below 0.1 mSv, and the extensive radiation impact must be insignificantly low. After the closure, the final disposal facility does not require regulatory control.

Long-term safety is based on depositing decommissioning waste in halls excavated to a depth of more than 100 metres using containers that ensure that the release of radioactive substances from the waste is extremely slow. The waste is placed inside release barriers primarily made from reinforced concrete which, with the stable state of the waste, considerably limits the release of radioactive substances for several hundreds and even thousands of years, which reduces the radioactivity of the waste to a fraction of the original.

In addition to the technical release barriers, the bedrock surrounding the final disposal facility further limits the release of radioactive materials to the ground level. Even over the long term, a minimal portion of the radioactive substances contained in the waste can enter the ground level, and their radiation impacts may at most be equivalent to those caused by radioactive substances originating from the ground. These phenomena are covered in the safety case by describing and modelling the long-term trend of waste and the technical release barriers, including the release of radioactive isotopes from the waste, their interaction with the release barriers, migration with the flow of groundwater and through diffusion, among others, and further in the food chains of the environment above the ground.

3.4.3 Conventional dismantling measures

Conventional dismantling measures that generate conventional non-radioactive dismantling waste are also taken during decommissioning. The following chapters describe these dismantling measures at a general level.

3.4.3.1 Planning of dismantling work

Dismantling plans are prepared before starting the dismantling work. The objective of the planning of dismantling work is to carry out the dismantling as efficiently and economically as possible, and in compliance with occupational safety and environmental requirements. Planning should pay particular attention to locating load-bearing structures, the dismantling sequence, supporting the structures during work and fall protection. The transfer and transport of dismantling waste and the recycling of waste material also require advance planning.

3.4.3.2 Asbestos and other harmful substances

Potentially harmful substances in construction materials should be considered in the demolition of buildings. The buildings were constructed in an era when using asbestos and other harmful substances in construction was common. The demolition must be carried out in compliance with the valid legislation (Act on Certain Requirements Concerning Asbestos Removal Work 684/2015), and the relevant guidelines and regulations. Before the demolition of the buildings, construction materials potentially containing asbestos and other harmful substances must be identified. The asbestos and harmful substance inspection is carried out as required in the Act and regulations.

The reuse of materials containing asbestos is prohibited. The dismantling of materials containing asbestos must be carried out before other demolition work begins. In addition to asbestos, the construction materials may contain PAH and PCB compounds, heavy metals and oils, for example. The valid Waste Act and the guidelines issued by local waste treatment authorities should be complied with when handling waste containing asbestos and other harmful substances.

3.4.3.3 Suitability for recovery and landfill disposal

The inspections to be carried out before the demolition of the buildings determine the suitability of the demolition material (concrete and brick waste) for reuse, recycling and recovery, making it possible to separate recoverable materials from other materials. If the demolition material is not suitable for recovery, its suitability for landfill disposal is determined.

Before demolition, a demolition survey is conducted at the site to determine the type and quantity of the materials the demolition of the building produces. Suitable further use of the materials is defined in connection with the demolition survey. Any possibilities of reusing the moveable property in the building in question are also investigated.

Conventional demolition waste, such as metal, plastic, glass, plasterboard and wood waste, as well as waste electrical and electronic equipment (WEEE) are directed, when possible, to a waste management provider licensed to accept such waste for materials recycling. If the materials are not suitable for recycling, they are reused for energy. If the materials are unsuitable for reuse for energy, they are directed for disposal or final disposal in a site that has an environmental permit for processing such waste.

By average weight per square metre, the main waste fraction generated in the area is concrete waste, the type of which is subject to preliminary surveys in connection with the demolition survey. The suitability of the waste material for recovery and landfill disposal is examined in greater detail during demolition in accordance with the valid legislation. If on the basis of its environmental acceptability concrete waste can be used in earth construction, it is crushed into a form suitable for earth construction, and appropriate reuse sites are located for the material. The primary option is to use the crushed concrete at the demolition site in connection with the potential replacement of material, or when filling or closing the L/ILW repository. Other reuse options include road, street and field structures. If the environmental acceptability of concrete waste is insufficient to use the waste in earth construction, the waste is directed to an appropriate landfill for final disposal.

3.4.4 Summary of the environmental aspects of decommissioning

Table 3-2 shows a summary of the environmental aspects of the expansion of the L/ILW repository, and *Table 3-3* includes the environmental aspects of the decommissioning of the power plant and the plant parts to be made independent.

3.5 RADIOACTIVE WASTE GENERATED ELSEWHERE IN FINLAND AND RECEIVED AT THE LOVIISA POWER PLANT

Fortum reviews the possibility of receiving small quantities of radioactive waste generated elsewhere in Finland and its processing, placing in interim storage and depositing for final disposal at Loviisa power plant . Waste generated elsewhere may originate from industry, universities, research institutions and hospitals. It may also include dismantling and operating waste from the research reactor of the VTT Technical Research Centre of Finland (FiR 1) and the research laboratory at Otakaari 3 (OK3). The estimated maximum volume of waste originating from elsewhere in Finland and disposed of at Loviisa power plant is 2,000 m³. The total volume of the active waste to be deposited for final disposal generated at Loviisa power plant is a maximum of 50,000 m³, so the volume of waste originating from elsewhere in Finland and received at Loviisa power plant is small by comparison.

The National Nuclear Waste Management Cooperation Group set up by the Ministry of Economic Affairs and Employment in June 2017 has considered it important that all existing and future radioactive waste in Finland, regardless of its origin, producer or production method is managed appropriately (Ministry of Economic Affairs and Employment, 2019). Since Loviisa power plant already has in place the functions and facilities suitable for the processing and final disposal of radioactive waste, it is natural and aligned with the view of the National Nuclear Waste Management Cooperation Group that they would be available as part of the overall solution in society.

The management of waste originating from elsewhere in Finland and received at Loviisa power plant is carried out in accordance with the same principles as the waste generated at Loviisa power plant. The principle of the management of waste is to separate it from the environment. The final disposal of waste is planned and implemented in a way that does not require continuous supervision of the final disposal location to ensure long-term safety. When required, the handling of waste applies to the power plant's packing and solidification processes.

The spent fuel from the research reactor of the VTT Technical Research Centre of Finland (FiR 1) may be placed in interim storage at Loviisa power plant. The storage capsule of the spent fuel that enters Loviisa power plant area is inspected, and a suitable location is designated for it. The interim storage continues until the final disposal site is ready to receive the spent fuel. It is also possible that the unused fuel from the research reactor is placed in interim storage at Loviisa power plant. The unused fuel from the research reactor consists of 24 fuel rods with a total uranium mass of approximately 6 kg (VTT 2017).

The primary solution for managing the research reactor's fuel is to return it to the USA. Alternatively, the research reactor's fuel might be deposited for final disposal at Posiva's final disposal facility, but this would require separate licensing. Decommissioning of VTT's research reactor FiR1 is covered in greater detail in a separate EIA procedure (VTT 2014).

It may be technically possible to receive radioactive waste originating from elsewhere in Finland at Loviisa power plant during the current operating period or the extension of the power plant's operation. The activity may continue during the operation and dismantling of the plant parts made independent as long as the functions needed for the management and final disposal of waste are available.

3.6 PROJECT PHASES AND SCHEDULE

The tentative schedule estimates of the project options to be reviewed in the EIA procedure are provided in *Figure 3-8*. In the case of the extension of the power plant operation (Option VE1), commercial operation would be extended by a maximum of approximately 20 years, making the total service life of the power plant units about 70 years. In this scenario, the expansion of the L/ILW repository related to the preparation for the decommissioning of the power plant takes place approximately in the 2040s. In addition, preparatory measures will be taken concerning the plant parts to be made independent of the power plant (the interim storage for spent nuclear fuel, liquid waste storage and solidification plant). The power plant is decommissioned between 2050 and 2060. The operation of the plant parts to be made independent would continue until the 2080s, which is when they will be dismantled and their radioactive dismantling waste will be deposited in the L/ILW repository for final disposal. The use of the L/ILW repository would continue until approximately 2090.

If the operation of Loviisa power plant ends after 50 years – when the current operating licence periods end in 2027 and 2030 (Options VE0 and VE0+)– preparation for the decommissioning of the power plant should be initiated in the coming years. In this option, the expansion of the L/ILW repository for decommissioning waste is scheduled to start in the mid-2020s. The preparations and required plant changes for the operation of the plant parts to be made independent will also be implemented at that time.

The service life of the plant parts to be made independent depends, among other things, on when the final disposal of the spent nuclear fuel from Loviisa power plant begins at Posiva Oy's (hereinafter "Posiva") encapsulation and final disposal facility in Olkiluoto in Eurajoki. According to the current estimate, the final disposal of spent nuclear fuel in Loviisa power plant would begin in the 2040s within the current operating licence period, so the operation of plant parts to be made independent would continue until the 2060s. After that, the plant parts to be made independent will be dismantled and their radioactive dismantling waste will be deposited in the L/ILW repository for final disposal. The L/ILW repository can be closed only after all decommissioning waste has been deposited in the repository for final disposal.

Radioactive waste originating from elsewhere in Finland can be received at Loviisa power plant during the operation and dismantling of the plant parts to be made independent for as long as the functions needed for the handling and final disposal of waste are available.

3.7 LINKS TO OTHER PROJECTS, PLANS AND PROGRAMMES

The project is not directly linked to other ongoing or planned projects in Loviisa power plant area. However, the project may in the future interface with the further use of the transmission lines and the potential use of thermal energy, but this EIA procedure does not include them. The decision on the further use of the transmission lines in the case of the decommissioning of the power plant is made by Fingrid Oyj, the owner of the transmission lines. However, the energy production alternatives at the power plant, such as the utilisation of thermal energy generated in the processes, may become topical in the future.

The project is related to Posiva's project concerning the final disposal facility for spent nuclear fuel, because in accordance with the agreement, Posiva is responsible for the final disposal of the spent nuclear fuel from Loviisa power plant in the Finnish bedrock at Olkiluoto.

Within the framework of the EIA procedure, the possibility of receiving, processing, placing in interim storage and depositing for final disposal at the Loviisa power plant small quantities of radioactive waste generated elsewhere in Finland is also reviewed. Such waste may include waste from industry, universities, research institutions and hospitals, in which case these projects ongoing elsewhere interface with Fortum's Loviisa power plant. The project is therefore linked to the decommissioning of VTT's FiR1 research reactor, in which one of the options is to place spent and unused nuclear fuel in interim storage at Loviisa power plant before the fuel is transported to its final disposal location elsewhere, and to deposit the dismantling and operating waste from the research reactor for final disposal in the L/ILW repository of Loviisa power plant (VTT 2014).

The project may interface with various plans and programmes concerning the use of natural resources and environmental protection, which may be various national target programmes and international commitments. These are identified and listed in the EIA report.

4. Environmental impact assessment procedure

4.1 STARTING POINTS

The purpose of the EIA procedure is to promote the assessment and consideration of environmental impacts as early as the planning stage, as well as to increase access to information and opportunities to participate in the planning of the project. The EIA procedure is carried out before licence or permit procedures, and its purpose is to influence the planning of the project and decision-making. The authority may not grant permission to implement the project until it has received the assessment report and the coordinating authority's reasoned conclusion, as well as the documents concerning the international hearing related to transboundary impacts.

Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (the EIA Directive) has been entered into force in Finland by means of the Act on the Environmental Impact Assessment Procedure (the EIA Act, 252/2017) and the Government Decree on the Environmental Impact Assessment Procedure (the EIA Decree, 277/2017). The first EIA Directive is from 1985 (85/337/EEC), and it has been amended on several occasions, as have the EIA Act and EIA Decree.

Appendix 1 of the EIA Act lists the projects subject to the EIA procedure. Pursuant to point 7b of the list of projects, an assessment procedure in accordance with the EIA Act applies to nuclear power plants and other nuclear reactors, including the dismantling or decommissioning of these facilities or reactors. In addition, according to point 7d, the EIA procedure is applied to facilities which have been designed for the handling of spent nuclear fuel or high-level waste, among other things, for the final disposal of nuclear waste or other radioactive waste, or for long-term storage of spent nuclear fuel, other nuclear waste or other radioactive waste elsewhere than its production location.

4.2 PARTIES

The parties to the EIA procedure are shown in *Table 4-1*. The experts who participate in the preparation of the EIA Programme are provided in *Appendix 2*.

4.3 STAGES AND CONTENTS

The EIA procedure has two stages. The EIA procedure is initiated when the project owner submits the assessment programme (EIA Programme) to the coordinating authority. The EIA Programme defines how the EIA procedure is organised. In accordance with the EIA Decree, the assessment programme should, to a sufficient extent, include the following:

- a description of the project, its purpose, planning stage and location;
- reasonable options for the project, one of which is not to implement the project;
- information about the plans, licences and decisions required by the implementation of the project;
- a description of the present state of the environment in the affected area, the planned or completed studies, the methods to apply and assumptions;
- a plan on the organisation of the EIA procedure and participation;
- the schedule.

Parties	
Project owner	Fortum Power and Heat Oy (the operator responsible for the preparation and implementation of the project)
Coordinating authority	The Ministry of Economic Affairs and Employment (responsible for ensuring that the project's environmental impact assessment procedure is organised in accordance with the EIA legislation)
EIA consultant	Ramboll Finland Oy (in charge of the preparation of the EIA programme in accordance with the EIA legislation)
Other parties	• The Ministry of the Environment (arranges the international hearing) and the participant countries in the international hearing • Town of Loviisa and local stakeholders • Other authorities and experts that the coordinating authority consults for statement • EIA procedure audit group • Other parties whose conditions or interests the project may impact, including the public • Media

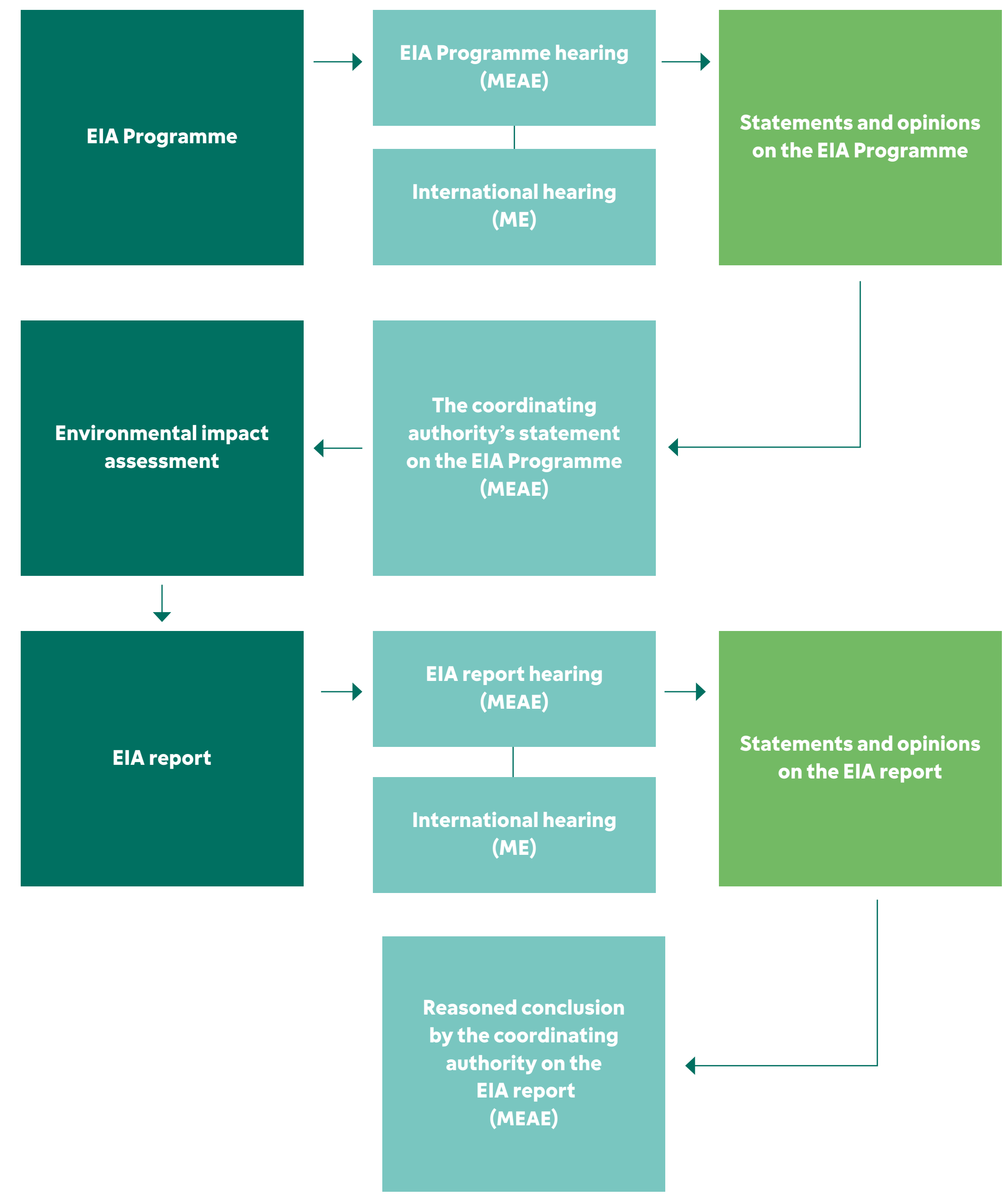


Figure 4-1. The stages of the EIA procedure. MEAE = Ministry for Economic Affairs and Employment, ME = Ministry of the Environment.

The coordinating authority informs the other authorities and the municipalities in the project's impact area of the public viewing of the EIA Programme. The duration of the public viewing is 30–60 days. After this, the coordinating authority gathers the statements and opinions received concerning the EIA Programme and prepares their own statement on the EIA Programme. This completes the first stage of the EIA procedure. An international hearing is conducted simultaneously (Chapter 4.4).

The actual environmental impact assessment is carried out in the second stage of the EIA procedure, based on the EIA Programme and the statement issued on it by the coordinating authority. The results of the assessment are collected in an EIA report, which is submitted to the coordinating authority. The coordinating authority makes the assessment report available for public viewing (for a duration of 30–60 days) in a similar manner as the EIA Programme. An international hearing is conducted in the EIA report stage as well. Based on the EIA report and the statements issued on it, the coordinating authority prepares a reasoned conclusion on the project's most significant environmental impacts, which should be considered in the subsequent licensing processes. The assessment report and the reasoned conclusion by the coordinating authority are appended to the licensing application documents.

Figure 4-1 shows a summary of the EIA procedure stages in Finland and its interconnection with the international hearing.

4.4 INTERNATIONAL HEARING

The principles of international cooperation in the environmental impact assessment have been defined in the UN's Convention on Environmental Impact Assessment in a Transboundary Context (SopS 67/1997, the Espoo Convention). The Espoo Convention

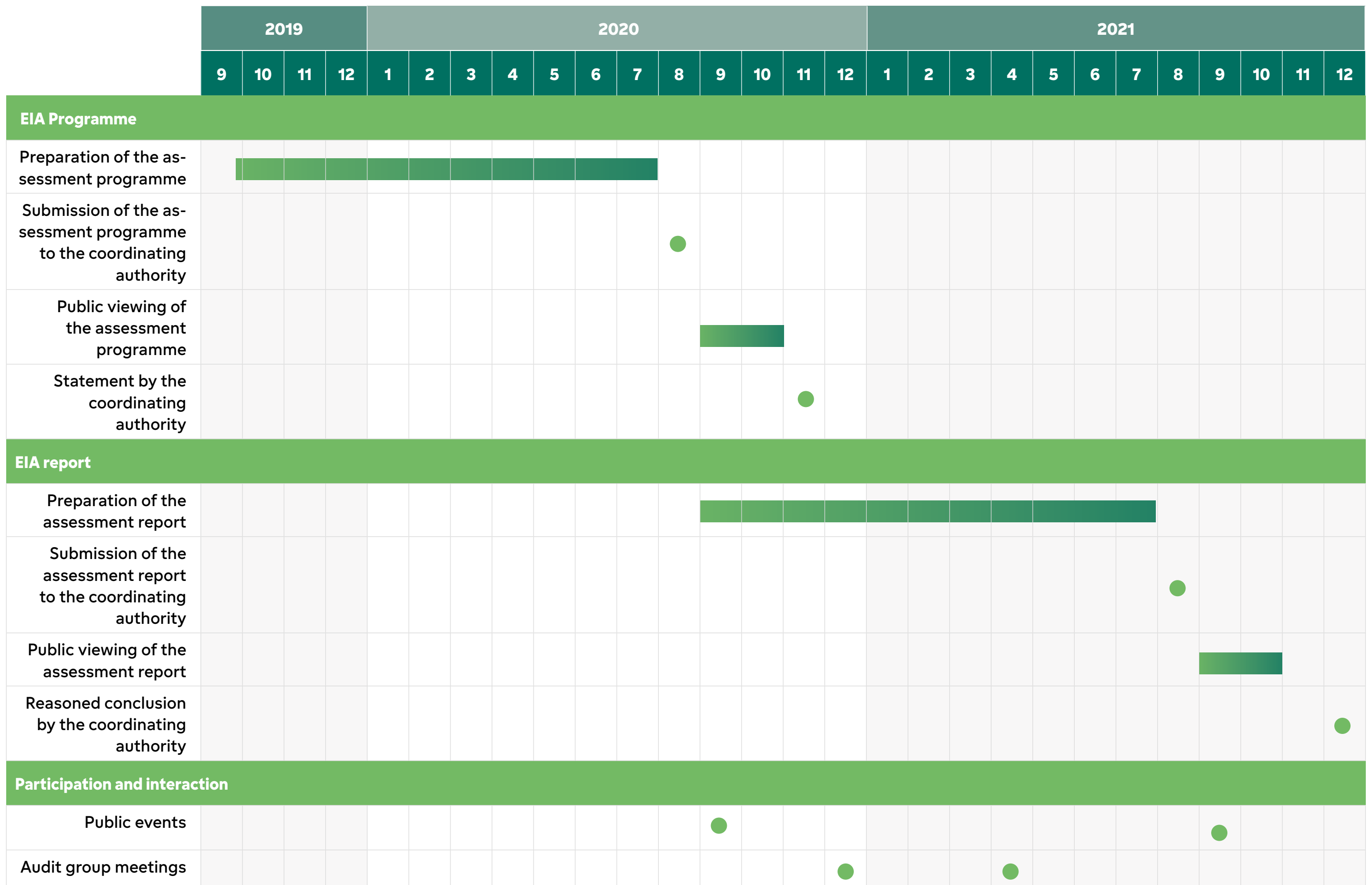


Figure 4-2. Tentative schedule of the EIA procedure. The schedule of the other interaction methods is specified in the EIA report stage.

lays down the general obligations to organise a hearing of the authorities and citizens of the member states in all projects that are likely to have significant adverse transboundary environmental impacts. The EIA Directive also includes provisions on communication in the project, and further requires that a member state must be able to participate in the assessment procedure of another state on its demand. In addition to the EIA Directive, the rights of the public to participate and their right of appeal are also regulated internationally by the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (SopS 121—122/2004, the Aarhus Convention). Among other things, the objectives of the Aarhus Convention include enabling the public to participate in environmental decision-making. The Aarhus Convention has been enforced in the EU by means of several directives, including the EIA Directive.

The obligations concerning the hearing included in the Espoo Convention, the EIA Directive and the Aarhus Convention have been enforced in Finland through the EIA Act and the EIA Decree, for example. The coordinating authority in the international hearing of the EIA procedure in Finland is the Ministry of the Environment. The Ministry of the Environment notifies the environmental authorities of the neighbouring countries about the commencement of the EIA procedure and enquires about their willingness to participate in the EIA procedure. A summary document of the EIA Programme, translated in the language of the target country, and the EIA Programme translated into Swedish or English are appended to the notification. The Finnish Ministry of the Environment submits the feedback received to Finland's coordinating authority (the Ministry for Economic Affairs and Employment) for consideration in the coordinating authority's statement concerning the EIA Programme.

A corresponding international hearing procedure is also arranged in the EIA report stage, to be implemented later, for those targeted parties who have announced their participation in Finland's EIA procedure.

4.5 SCHEDULE OF THE EIA PROCEDURE

The key stages and tentative schedule of the EIA procedure are illustrated in *Figure 4-2.*

4.6 PARTICIPATION AND INTERACTION

The EIA procedure is interactive and enables different parties to discuss and express their opinion on the project and its impacts. One of the key objectives of the EIA procedure is to promote communication about the project and improve the opportunities to participate in the planning of the project. Participation allows for the different stakeholders to express their views.

The environmental impact assessment procedure can be participated in by everyone whose conditions and interests, such as accommodation, work, transport, leisure activities or other living conditions, may be affected by the project to be implemented. In accordance with the EIA legislation, citizens can submit their opinions to the coordinating authority of the EIA programme and report during the period these are available for viewing.

The EIA procedure's interaction plan covers the project's communication, acquisition of information from the different parties, dialogue events open to all, and cooperation between different stakeholders *(Figure 4-3).*

4.6.1 Pre-negotiation

Before the EIA Programme is submitted or during the assessment procedure, a pre-negotiation may be organised between the project owner, coordinating authority and other key authorities. The objective of the pre-negotiation is to promote the overall management of the assessment, planning and licensing procedures required in the project, information exchange between the project owner and the authorities, as well as to improve the quality and usability of surveys and documents, and streamline the procedures. In this project, pre-negotiations were organised between the coordinating authority, the Ministry of the Environment, in charge of the international hearing, and the project owner.

4.6.2 Public events in the EIA procedure

Two public events are organised during the EIA procedure: the first in the programme stage and the second in the report stage. The purpose of the events, open for all, is to provide information produced during the project and the EIA procedure. The events enable citizens to have an opportunity to express their views on the project and the impacts to be assessed and to receive more information. The dates and locations of the public events are communicated through the coordinating authority's announcement concerning the EIA programme and report.

4.6.3 Audit group

An audit group is set up for the assessment procedure with the purpose of promoting the flow and exchange of information between the project owner, the authorities and the key stakeholders in the area. Parties that are invited to the audit group include representatives of the town of Loviisa, adjacent municipalities and local stakeholders as well as various experts and authorities. In addition, the representatives of the project owner and the EIA consultant also participate in the audit group work. The audit group convenes twice during the assessment procedure.

4.6.4 Resident survey

A resident survey is conducted in the EIA report phase to study the attitudes of the area's residents. The resident survey material also serves as data for the impact assessment.

4.6.5 Small group events

Small group events are held in the EIA report stage to disseminate information on the project and to hear various stakeholders. The stakeholders may include the area's residents, landowners, fishermen and entrepreneurs. The composition of the groups and the interview themes are tailored in accordance with the need for information and the stakeholder group.

4.6.6 Information and communication

The EIA programme and report will be published on the Ministry of Economic Affairs and Employment website. The documents are available for viewing in accordance with the announcement made by the coordinating authority.

The EIA programme and report is also available on Fortum's website. The website also contains up-to-date information on the project, the environmental impact assessment procedure, and licensing. In addition, Fortum provides information on the progress of the project and on the news conferences and public events to be held, for example.

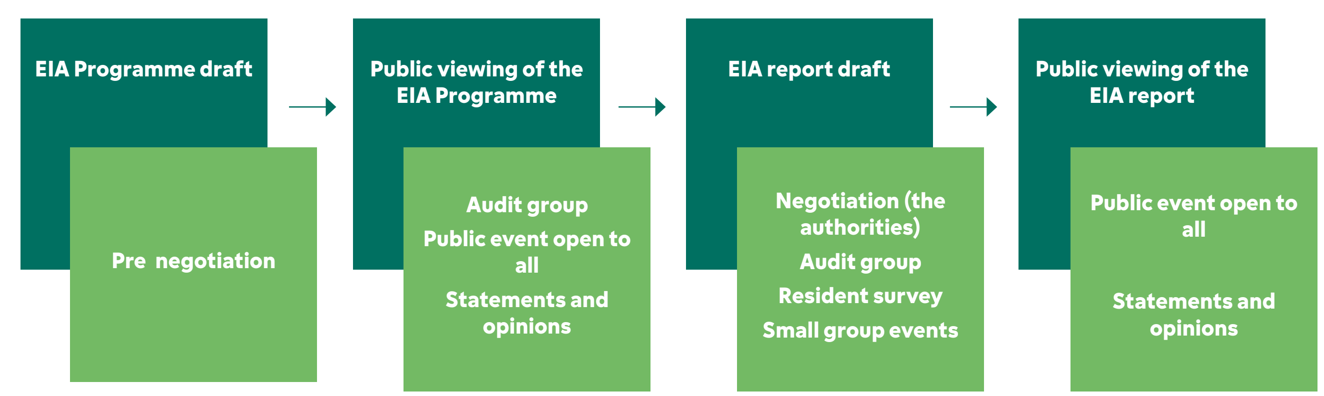


Figure 4-3. Participation and interaction during the assessment procedure.

5. Present state of the environment

5.1 OVERVIEW OF THE PRESENT STATE OF THE ENVIRONMENT

Environmental surveys and reviews have been carried out in the vicinity of Loviisa power plant area since the 1960s. Plenty of information is therefore available on the power plant area and the sea environment in its vicinity in particular. In this EIA Programme, the description of the present status of the environment is provided in a concise form with a focus on the main points. The description of the present status is specified in the EIA report.

5.2 LAND USE, LAND USE PLANNING AND THE BUILT ENVIRONMENT

5.2.1 Community structure and population

Loviisa power plant is located on the island of Hästholmen, in the village of Lappom in Loviisa. The island is approximately 12 km from the centre of Loviisa and about 7 km southeast of the village of Valko. The island may be reached by a 200-metre causeway and bridge over the Kirmosund inlet. Hästholmen island is located outside of the built-up area and in an area not categorised in the areal division of the community structure. The mainland side and the island southeast of Hästholmen are sparsely populated rural areas (*Figure 5-1*).

Fortum owns the island of Hästholmen and the southern edge of the peninsula north of the island, a total land area of approximately 170 hectares, and about 240 hectares of water areas in the vicinity of the power plant. The power plant area borders both publicly (the government, town of Loviisa) and privately owned land. The areas owned by private citizens are primarily used for recreation, while the government's areas are conservation sites.

The power plant structures and buildings are located in the northern and eastern parts of the island of Hästholmen. Approximately a half of Hästholmen island area is being used for the power plant operations. There are structures related to the intake and discharge of cooling water and power transmission on the island's waterfront areas. The buildings and structures needed for the power plant's support operations (including security and the temporary accommodation for annual outage employees) are located on the mainland. There is no other industry in the vicinity of the power plant.

There is a precautionary action zone extending to a distance of five kilometres from the nuclear power plant, where land use restrictions are in force (STUK Y/2/2018). For example, the precautionary action zone may not contain facilities inhabited or visited by a considerable number of people, such as schools, hospitals, care facilities, shops, or significant places of employment or accommodation that are not related to the nuclear power plant (YVL Guide A.2).

The closest residential buildings shown on the map *(Figure 5-1)* are located at a distance of approximately 800 metres northwest of the power plant. These buildings are residential buildings that belong to the power plant's accommodation area and are not permanently inhabited. The distance to the other residential buildings closest to the power plant area is 900 metres. The secondary residences closest to the power plant area shown on the map *(Figure 5-1)* on the south shore of Hästholmen and the eastern and southern sides of the support operations area on the mainland are owned by Fortum. The other closest secondary homes are located on the islands to the south and southeast of Hästholmen (Vastaholmen, Småholmen, Måsholmen, Högholmen, Mysholmen, Björkholmen and Kojholmarna) and on the mainland 1.3–2.2 km from the power plant.

On the map *(Figure 5-1)*, a built-up area (red areas) refers to a densely populated area of a minimum of 200 residents, in which the number, floor area and concentration of the buildings, in addition to the number of inhabitants, have been considered. The areas that have at least one inhabited building within a radius of one kilometre but that are not included in the built-up areas, villages and small villages, belong to the sparsely populated rural area. The project environment does not include villages in accordance with the community structure monitoring data (Finnish Environment Institute, 2019; *Figure 5-1*).

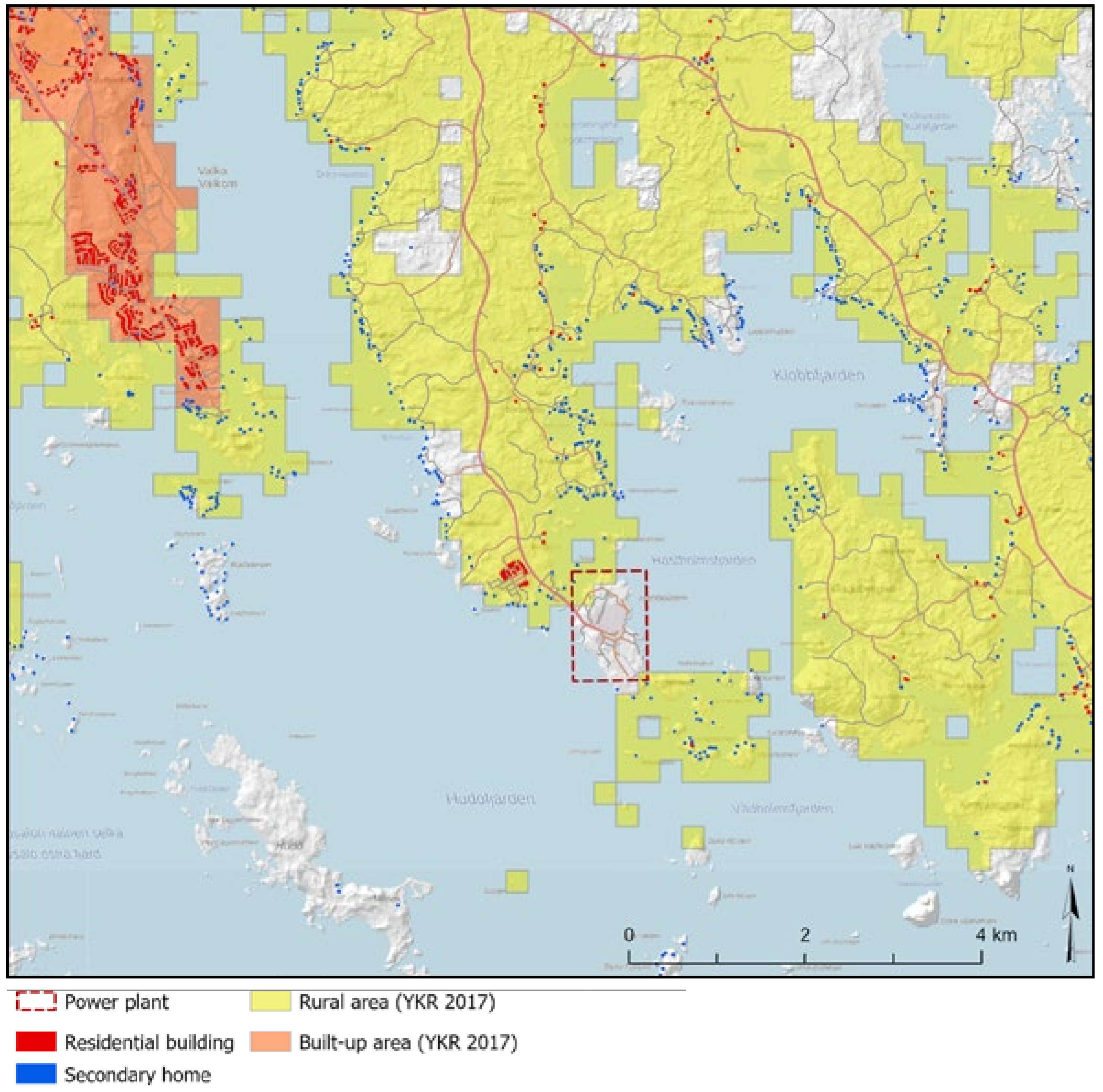


Figure 5-1. Community structure in accordance with the community structure monitoring data in 2017 and resi-dential and holiday buildings. (Source: The Finnish Environment Institute, 2019)

5.2.2 Regional land use plans

The area and its surroundings have a valid Comprehensive Regional Land Use Plan for Eastern Uusimaa (confirmed on 15 December 2010), Phased Regional Land Use Plan for Uusimaa 2 (confirmed on 30 October 2014, the Supreme Administrative Court's final decision in 2016) and Phased Regional Land Use Plan for Uusimaa 4 (approved on 24 July 2017) *(Figure 5-2)* (Helsinki-Uusimaa Regional Council, 2019a). On 21 August 2017, the Board of the Regional Council decided that the Phased Regional Land Use Plan 4 would become effective before it was legally valid.

The Regional Land Use Plan for Eastern Uusimaa includes the symbols indicating nuclear power. The island of Hästholmen has been designated as an energy management zone in which nuclear power plants are allowed (EN/y). The support areas on the mainland northwest of the island and the Björkholmen and Rövarhället islands have been designated as an energy management zone or site (EN). A boating harbour has also been designated on the mainland side. (Helsinki-Uusimaa Regional Council, 2010)

The nuclear power plant's precautionary action zone has been designated around the project area (en/y). According to the planning regulation, "when planning and implementing operations in the precautionary action zone, the provisions of the Radiation and Nuclear Safety Authority's Guide (YVL 1.10) should be followed. Before initiating procedures, the Radiation and Nuclear Safety Authority (STUK) in particular must be provided with an opportunity to issue a statement." (Helsinki-Uusimaa Regional Council, 2010). The YVL Guide 1.10 has been replaced by YVL Guide A.2.

In the Phased Regional Land Use Plan for Uusimaa 2, a 400 kV transmission line and a connecting road have been designated to the north of the power plant, and the Svartholma fortress located approximately two kilometres northwest of Hästholmen has been designated as an important area for the preservation of a cultural environment (nationally significant, RKY 2009) (Helsinki-Uusimaa Regional Council, 2016b).

The islands east of Hästholmen and the western and southern parts of Gäddbergsön have been designated as nationally significant built cultural environments in the Phased Regional Land Use Plan for Uusimaa 4 (Helsinki-Uusimaa Regional Council, 2017).

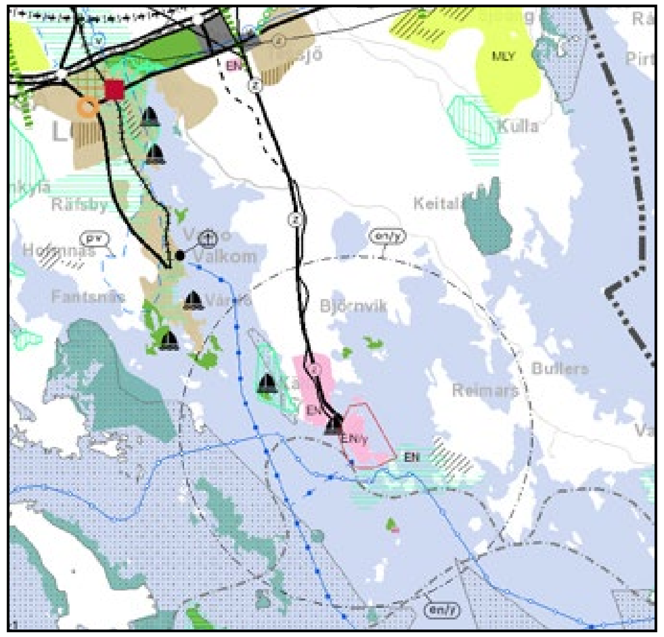


Figure 5-2. An extract of the combination of the valid regional land use plans for Uusimaa.

The Helsinki-Uusimaa Land Use Plan 2050 is being prepared in Uusimaa (Helsinki-Uusimaa Re-gional Council, 2019b). This plan incorporates all key themes of land use, and the preparation of the plan was carried out in 2016–2020. When implemented, the land use plan supersedes all effective and legally valid regional land use plans. An exception to this is the wind power solution presented in the Phased Regional Land Use Plan for Uusimaa 4, which designates four areas suitable for the production of wind power in Eastern Uusimaa. In addition, a separate regional land use plan is being prepared for the Östersundom area. The Helsinki-Uusimaa Land Use Plan 2050 has progressed to the proposal stage. The materials of the land use plan proposal were available for public viewing on 8 October–8 November 2019. Based on the feedback, the land use plan will be finalised for the Assembly of the Regional Council in the spring of 2020. *Figure 5-3* shows an extract of the land use plan map of the Helsinki-Uusimaa Land Use Plan 2050 proposal for the project area.

The Helsinki-Uusimaa Land Use Plan 2050 provides a schematic version of the plan for nuclear power plants and their precautionary action zones included in the valid regional land use plans. The reservation for a designated area for nuclear power plants will be converted into a reservation for a designated site, and the land use plan regulation will be brought up to date. Instead of the area reservation symbols of the valid Regional Land Use Plan for Uusimaa, the plan proposal for the Helsinki-Uusimaa Land Use Plan 2050 uses a site reservation symbol to indicate an energy management zone on Hästholmen island where nuclear plants are allowed (EN/y). The scope of the precautionary action zone of the nuclear power plant is indicated in the same manner as in the Regional Land Use Plan for Eastern Uusimaa, but the symbol used is 'svy'. The 400 kV transmission line and the connecting road are indicated in the same manner as in the valid Phased Regional Land Use Plan 2. Similarly, a regionally valuable landscape is indicated in accordance with the valid Phased Regional Land Use Plan 4.

The land use plan proposal also indicates the need for a district heat transfer connection ('kl', a red dashed arrow) with a development principle symbol. The development principle symbol is used to indicate a transfer connection need related to the utilisation of the waste heat from Kilpilahti oil refinery and Loviisa nuclear power plant, as well as the technical maintenance utility tunnel to the Helsinki metropolitan area.

5.2.3 Master plan

Loviisa's component master plan for shores is in effect in the area (approved on 10 December 2008) *(Figure 5-4)* (Town of Loviisa, 2019a). The island of Hästholmen is indicated as an energy management zone (EN-1). A component area symbol (v) indicates an area where the construction of nuclear power plants is allowed. The areas on the mainland for the support functions of the nuclear power plant are indicated in the land use plan as an area for the service and support functions of energy management (EN-3), where it is possible to build research facilities serving the construction of nuclear power plants, energy management and energy production, as well as storage, production and office buildings.

On the eastern side of the Loviisa component master plan for shore areas is the Gäddbergsö-Vahterpää component master plan, and on the northern side, the Kulla-Lappom component master plan for shore areas, as well as the change to the Kulla-Lappom component master plan affecting a minor area.

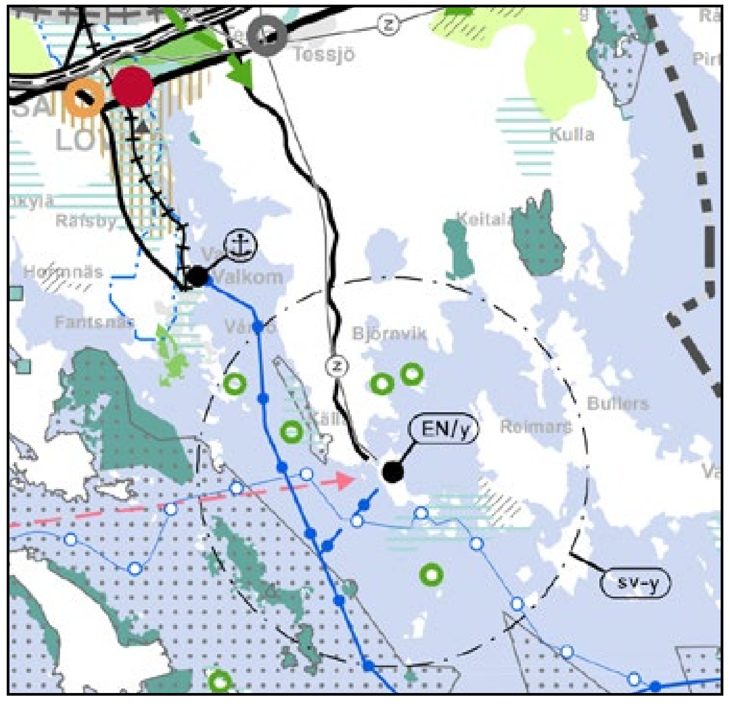


Figure 5-3. An extract of the land use plan map of the plan proposal for the Helsinki-Uusimaa Land Use Plan 2050.

5.2.4 Local detailed plan

The revision and expansion of the local detailed plan of the Hästholmen nuclear power plant area are in effect in the Hästholmen area and the tip of the headland (approved on 21 January 2009, section 26, legally valid on 3 March 2009) *(Figure 5-5)* (Town of Loviisa, 2019a).

Most of Hästholmen is designated as an energy management zone (EN) where it is possible to construct nuclear power plants and buildings, and structures supporting their operation. Special areas intended for the support functions of the nuclear power plant (EN-1, EN-2) have also been designated on Hästholmen and on the mainland, as well as in the area between them. In these special areas, building must be adjusted to the landscape due to landscape values. Underground construction is allowed in all the aforementioned areas. A harbour area (LS-4), where a lane and a wharf can be built, is designated in the southwestern part of Hästholmen with an area reservation symbol. Nearby water areas have been designated as water areas where dredging is possible, and where buildings and structures necessary for energy management (W/en-1), can be built. The accommodation area is designated as a quartering area for residential buildings serving energy management (AS/en).

5.3 LANDSCAPE AND CULTURAL ENVIRONMENT

5.3.1 Overview of the landscape

In the landscape province division, the project area belongs to the landscape province of the southern coastland and the coast-

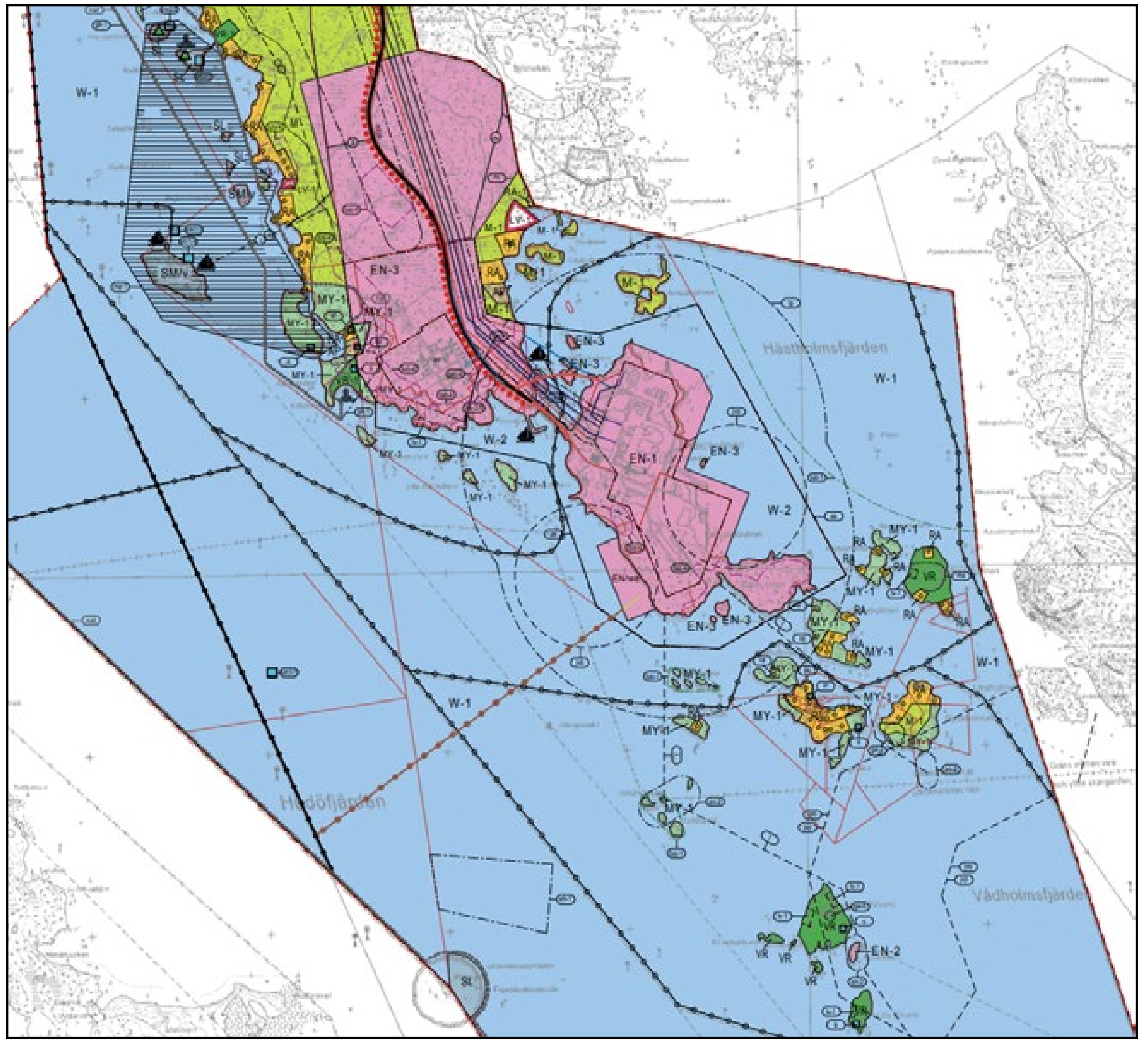


Figure 5-4. An extract of Loviisa's component master plan for shores.

Figure 5-5. An extract of the revision and expansion of the local detailed plan of the Hästholmen nuclear power plant area.

al area of the Gulf of Finland. In the Eastern Uusimaa landscape structure where the landscape regions have been further divided into landscape types, the project area is located in the landscape zone of coastal archipelago and mainland coast (Helsinki-Uusimaa Regional Council, 2007). With regard to the landscape, the zone is very detailed and varied, largely due to the formation of bays, coves and inlets between chains of islands and the folds of the ragged shoreline *(Figure 5-6)* (National Land Survey of Finland 2019).

The profile of Hästholmen and the islands south of it is flat. The highest point of Hästholmen is approximately 16 metres above sea level. The area surrounding the power plant consists of a fairly natural coast and archipelago landscape, with numerous red granite boulders and cobbly areas as a special characteristic. Some of the holiday housing on the coast is located very close to the waterfront, which is why buildings are discernible in the landscape from far away. The eastern shore of Hästholmen has undergone drastic changes as a result of the land filling carried out in the construction of the power plant. There is no protective green zone on the island's eastern shore and part of the northern shore, which is why there is an unobstructed view of the power plant and its associated structures to Hästholmsfjärden on the eastern side of the island. The unbuilt south and west shores of Hästholmen are, for the most part, in their natural state. Although the power plant buildings and stacks are visible to a large part of the Hudöfjärden sea area west and southwest of the island, the forest zone on the southern and western shores softens the landscape considerably. In open areas, the power plant area's lights are visible from afar during the dark.

5.3.2 Valuable landscape and cultural environments and sites

The islands to the east and south of Hästholmen, the western and southern parts of Gäddbergsö and the water areas between them belong to the regionally significant built cultural environment of Vådholmsfjärden *(Figure 5-7)*. According to royal sea charts, there was a haven in Vådholmsfjärden in the 1790s. Structures related to fishing, the haven and log driving have been discovered in the area. In addition, the area features the Kasaberget fire direction tower, dating back to World War II. The area values are based on the haven, log driving and fortresses dating back to World War II (Helsinki-Uusimaa Regional Council, 2016a).

The nationally significant built cultural environment (RKY 2009) of the Svartholma fortress is located at the mouth of the Loviisanlahti bay northeast of Hästholmen (Finnish Heritage Agency, 2019). The Svartholma fortress and the Loviisa land fortress are the eastern bulwark of the Suomenlinna main fortress located off Helsinki, which was built after Sweden's territory losses in the 1740s (Helsinki-Uusimaa Regional Council, 2016a).

There are no permanent archaeological sites in Hästholmen or its surroundings. The Svartholma fortress (site ID 1000001910) is an extensive archaeological site. (Finnish Heritage Agency, 2019)

A cultural heritage survey was conducted in the area of Loviisa's component master plan for shore areas in 2008. According to the survey, there are no cultural heritage sites on Hästholmen island. The nearest cultural heritage site is located on the Stora Kalvholmen island west of Hästholmen. This site is not designated in the component master plan for shore areas. There are also cultural heritage sites on the mainland in the surroundings of the regionally significant built cultural environment of Svartholma and on the islands south of Hästholmen, which are part of the regionally significant cultural environment. The nearest known underwater relics found in the Finnish Heritage Agency's Ancient Relics Register are located at a distance of two kilometres on the western side of the power plant. The wreck of the frigate Fortuna, which sank in 1822, is closest to the power plant. It is located on Hudofjärden to the east of the current shipping lane (Finnish Heritage Agency, 2018).

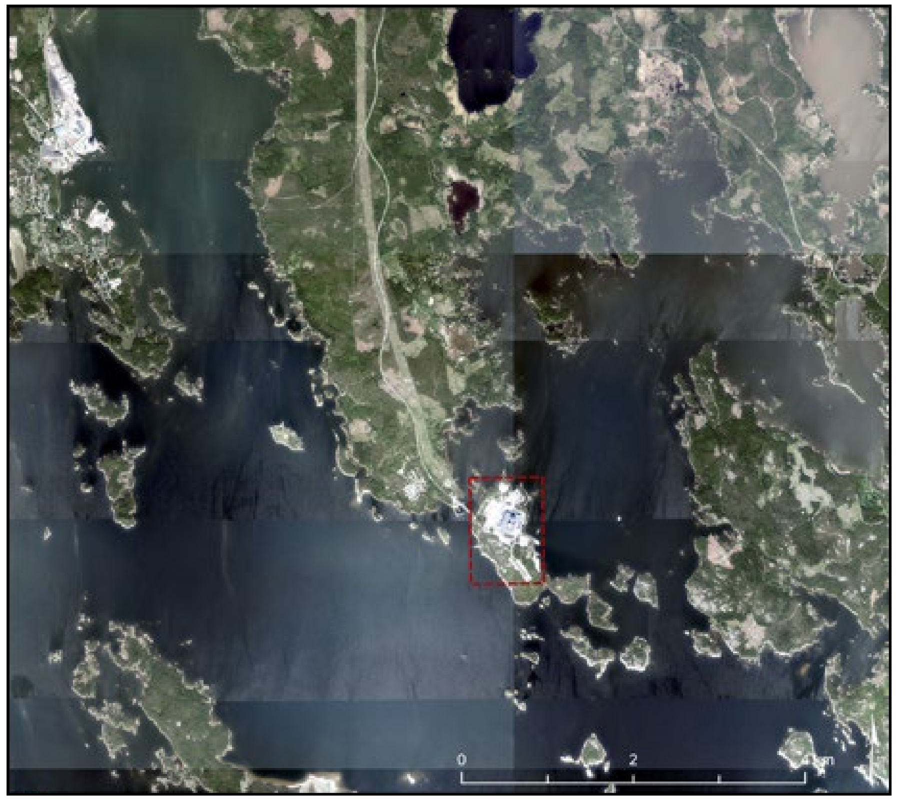


Figure 5-6. Aerial image of the surroundings of Loviisa power plant in 2018.

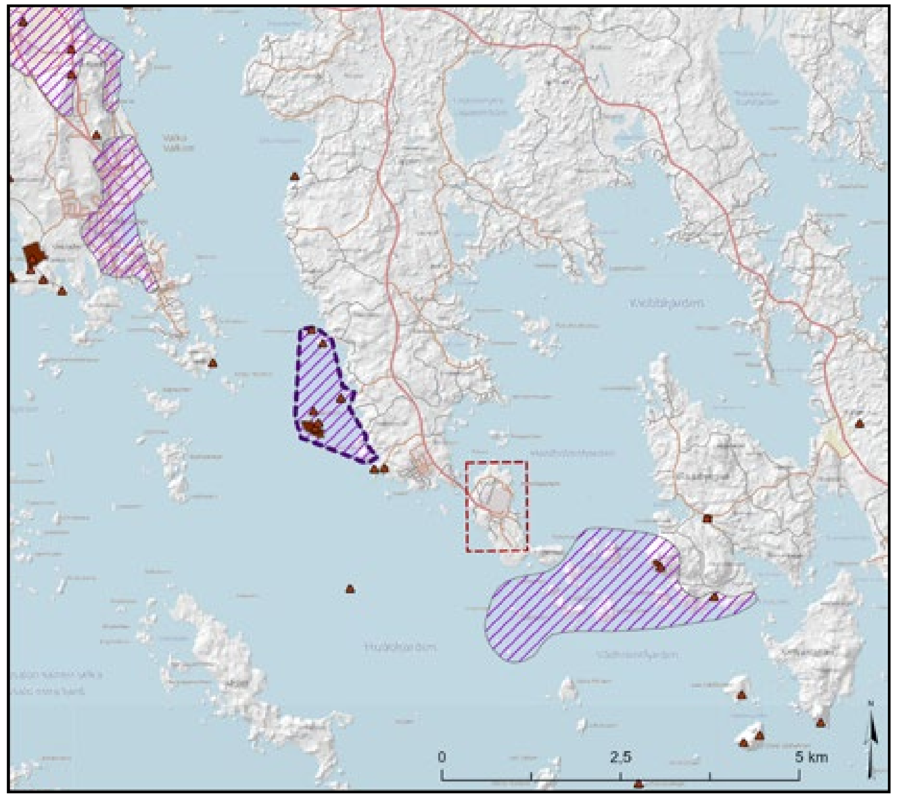
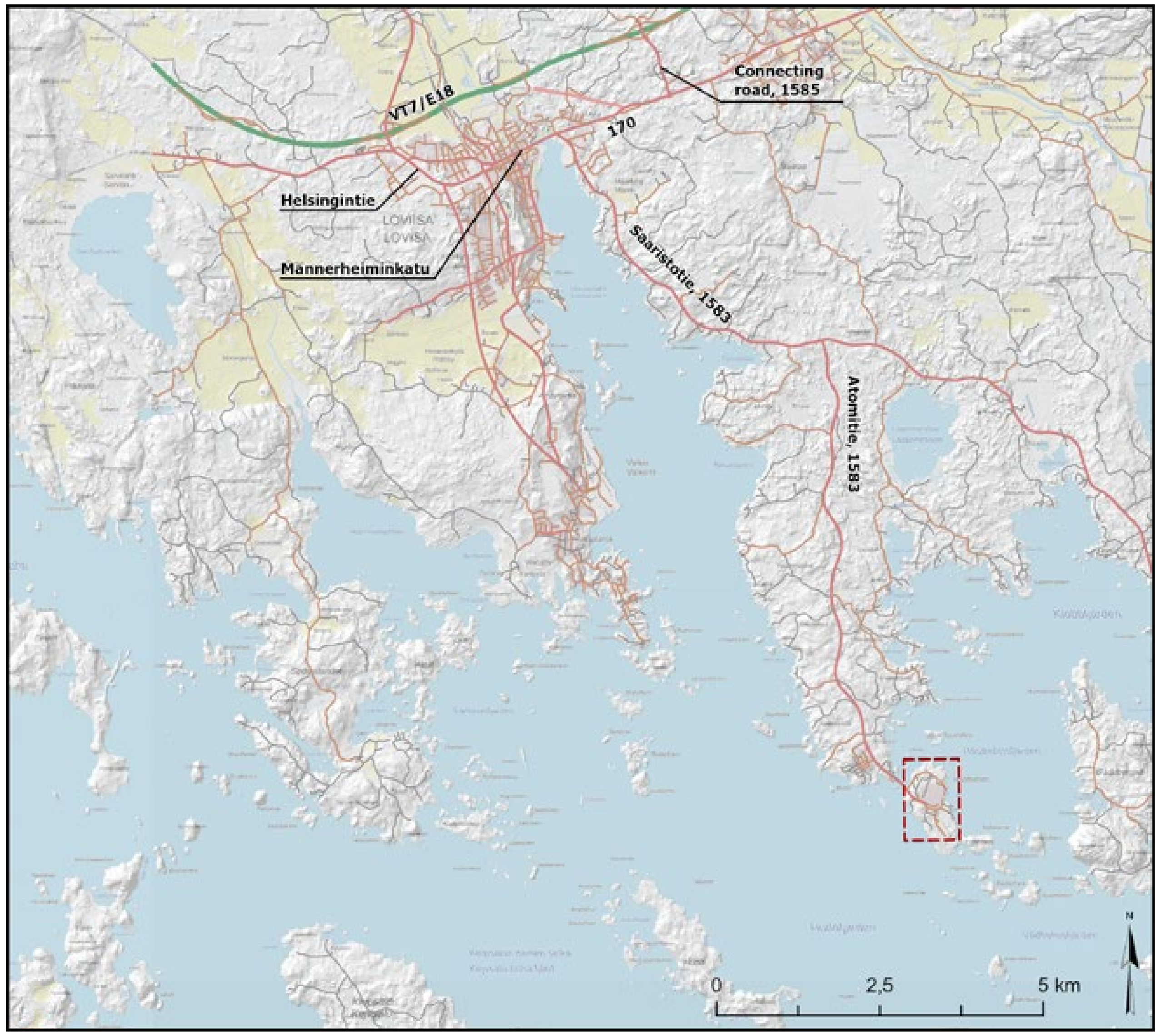


Figure 5-7. Landscape areas and cultural environments, as well as fixed archaeological sites located in the surroundings of the power plant. (Source: Finnish Heritage Agency, 2019; Helsinki-Uusimaa Regional Council, 2019c)



Power plant

(Source: National Land Survey of Finland, 2019)

Figure 5-8. Roads leading from Highway 7 to the power plant on Hästholmen.

5.4 TRAFFIC

Highway 7 from Helsinki to Vaalimaa, part of the main Finnish E18 east-west route, runs via the town of Loviisa. There are highway junctions on the east and west side of Loviisa. The traffic connection from Highway 7 to Hästholmen runs on Saaristotie and Atomitie (1583). Traffic from the western junction to the power plant runs through the centre of Loviisa. The distance from Highway 7 to Hästholmen island is approximately 15 km (*Figure 5-8).*

According to the 2018 traffic volume statistics of the Finnish Transport Infrastructure Agency (Finnish Transport Infrastructure Agency, 2019), the average daily traffic volume to the intersection of Saaristotie and Atomitie to the south of Määrlahti is approximately 1,800 vehicles, including approximately 80 heavy-duty vehicles. The average daily traffic on Atomitie is approximately 700 vehicles, including approximately 40 heavy-duty vehicles. Traffic volumes are at their highest during the power plant's annual outage.

The nearest railway line runs from the Valko harbour to Lahti. There is only freight traffic on this section of the railway.

The Loviisa harbour is located in Valko, Loviisa. There are three waterways near the power plant. The waterway to the Valko harbour runs along the southwestern side of Hästholmen, at a distance of at least a couple of kilometres from the shore. Within ten kilometres of the power plant there is also the Gulf of Finland coastal waterway, which begins from the ports of Hamina and Kotka, and continues as the Helsinki-Orrengrund waterway. The third more extensively used waterway to the ports of Hamina and Kotka is located slightly further out to sea.

To ensure the safety of the power plant and its surroundings, air traffic is prohibited in the Hästholmen area (Government Decree 930/2014). The no-fly zone covers the power plant surroundings within a four-kilometre radius and at an altitude of up to 2,000 metres. Hästholmen has an official heliport for use by the authorities. (Fortum Power and Heat Oy, 2019b)

5.5 NOISE

Noise in the surroundings of the project area is currently affected by Loviisa power plant, traffic noise and sounds of nature. Under certain weather conditions, sounds of nature, such as wind, birds and the waves on the coast, generate a lot of background noise.

One-time environmental noise measurements have been conducted in the surroundings of the power plant and on nearby islands, most recently in 2013 and 2017 (Ramboll Finland Oy, 2013 and 2017). In 2013, noise was measured at seven measuring locations in the surroundings of the power plant. The 2017 measurements were conducted in the same locations as in 2013. In addition, measurements were conducted in one location to the north of the power plant and in one reference location by the road leading to Hästholmen.

There has been some variation in the noise levels measured in different years. In the locations where the noise from the power plant was audible, the measured noise levels were within the limits of the environmental permit. For the most part, the noise was lower than the daytime limit value of 45 dB set in the environmental permit.

5.6 VIBRATION

In the current situation, the only source of vibration in the project area is the road traffic entering and exiting the power plant area. The operation of the power plant units causes no vibration that can be detected by human senses outside the power plant area.

The traffic during the operation of the power plant consists mainly of commuting, maintenance traffic and freight transports. In the current situation, vibration caused by traffic in the environment has not been measured, but it is estimated to be minimal, based on the traffic and soil data.

5.7 AIR QUALITY

Hästholmen's weather is maritime because of the Gulf of Finland. At Loviisa power plant, the wind direction is mostly from southwest. The least wind comes from the southeast (Fortum Power and Heat Oy, 2008). Wind speeds on the coast are higher than inland. Loviisa power plant has a weather observation system that measures the rainfall and air temperature among other things. The average rainfall in 1995–2018 (measurement data available for 19 years) at Loviisa power plant was approximately 635 mm per year. The average annual temperature at Loviisa power plant was +5.9 °C in 1995–2018 (measurement data available for 22 years).

No regular air quality measurements are carried out in the Loviisa area, but the most significant sources of emissions generating impurities are reported. The average air quality in Loviisa is good, since there are no major industrial facilities in the area releasing emissions into the air, and the emission densities of even the busiest roads are relatively low. (Uusimaa Centre for Economic Development, Transport and the Environment, 2019)

In Loviisa, road traffic accounts for the majority of the nitrogen oxide and carbon monoxide emissions, which concentrate on the areas near Highway 7 and the town centre. Household wood burning causes the majority of the particle and volatile organic compound (VOC) emissions, whereas most of the sulphur dioxide emissions are caused by energy production. In addition to the local emissions, the area's air quality is also affected by the long-range transport of emissions. Based on the air quality measurements carried out in the Helsinki metropolitan area and elsewhere in Uusimaa, it has been estimated that the concentrations of nitrogen oxide, breathable particles and microparticles have been below the limit values. (Uusimaa Centre for Economic Development, Transport and the Environment, 2019). As a health protection measure, limit values have been set for certain air impurities in the outdoor air to indicate the highest allowed value of air impurities (Government Decree 79/2017).

Traffic emissions in Loviisa power plant area mainly come from commuting and maintenance traffic. In addition to road traffic, marine traffic may affect the air quality. There are three waterways near Loviisa power plant, and the vessels using them may have an occasional impact on air quality. In the power plant area, the generation of emergency power also releases small amounts of emissions into the air occasionally, but their impact on the local air quality is minimal.

Loviisa power plant's radioactive emissions into the air are covered in Chapter 3.2.3.1, and the present state of the environment with regard to radiation in Chapter 5.14.

5.8 GROUND AND BEDROCK

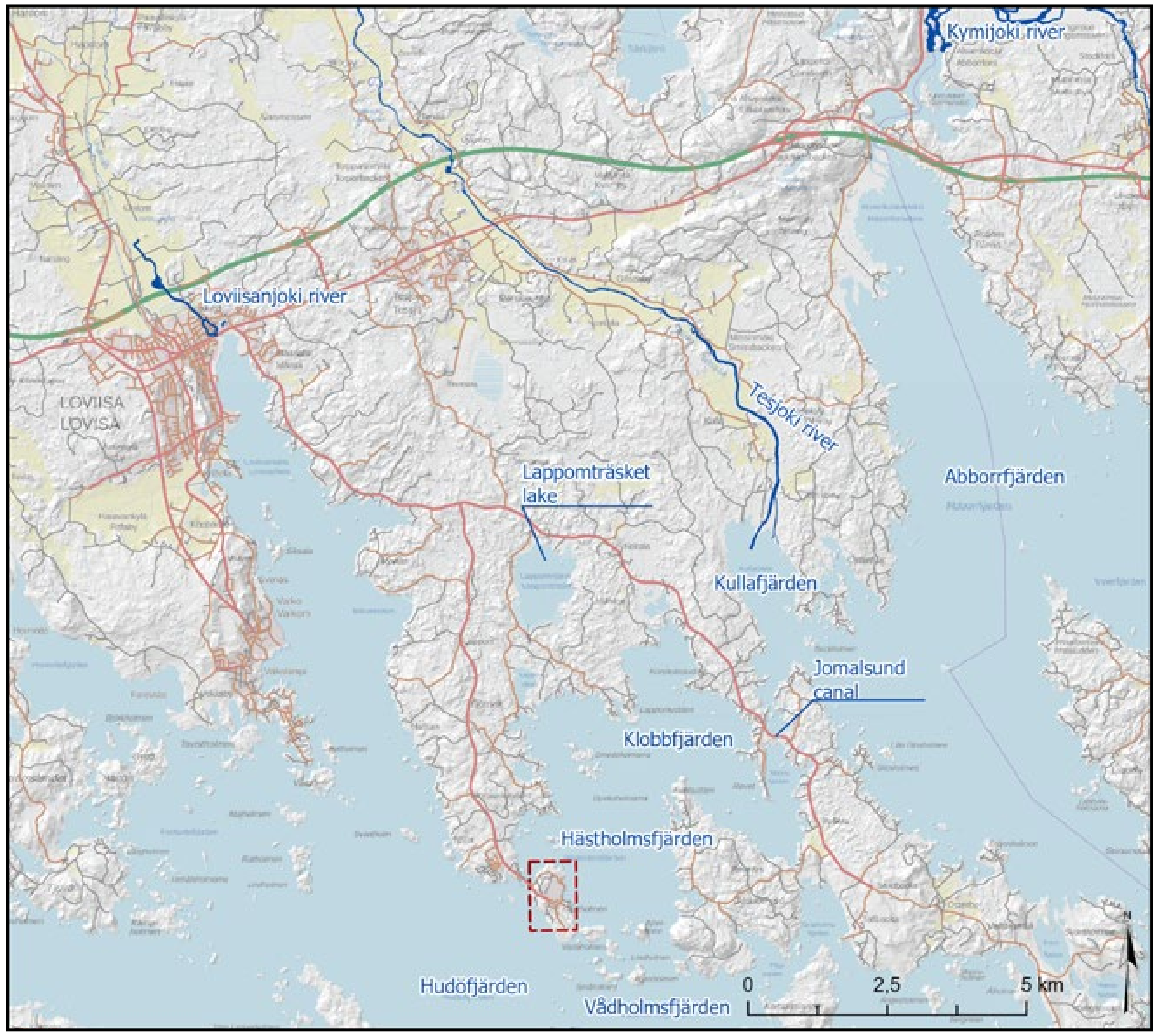
The island of Hästholmen is located in the coastal zone of Loviisa, and the area profile is generally flat and low. The area is characterised by numerous islands, bays extending deeply into the main-land and long peninsulas with a distinct tendency to lead from northwest to southeast. The bays reflect the selvage zones in the bedrock, the shape of which has been accentuated by the wear caused by the ice sheet during the ice age.

The highest parts of Hästholmen are 16 metres above sea level. The seabed around the island is generally at a depth of 5–10 metres, but basins of 15 metres can also be found locally. The island's bedrock is to a large extent exposed or only covered by a thin layer of soil. It has been found that to the south and the east of the island, the bedrock sinks locally as deep as 60–70 metres under the strata (Anttila 1988). With the exception of these depressions, the bedrock can be typically found within 20 metres below sea level in the water areas near Hästholmen.

The soil in the Hästholmen area primarily consists of stony and rocky moraine. The thickness of the moraine layer on the island is usually a few metres at most. Construction in the power plant area has required extensive earth moving activities, which is why the original surface of the ground is covered by various land masses in many areas. The layers of soil on the seabed consist mainly of moraine or rough soil types, gravel and sand, with clay and silt sand layered on top in places. The thickest layers of soil can be found in a basin on the eastern side of Hästholmen, where the total thickness of strata is approximately 60 metres.

The bedrock in Hästholmen is rapakivi granite, typical of the Loviisa area, which can be found in several variants. The most common variant on Hästholmen is pyterlite. The main minerals are potassium feldspar, plagioclase, quartz, biotite and hornblende. Fluorite is a typical accessory mineral. It is mostly unweathered and massive, and its strength properties are good. The typical disintegration of rapakivi into small rocks has been found mainly deeper in the zones containing fragmented rock (Anttila, 1988).

Hästholmen's patches of bare rock are dominated by two nearly vertical main cleavage directions, northeast to southwest and northwest to southeast. The third main cleavage direction veers slightly to the east/northeast. Therefore, the cleavage type is overall nearly cubic. In addition, rock studies have indicated zones containing fragmented rock with a higher density of cleavages than elsewhere in the rock. The final disposal facility (L/ILW re-



Power plant (source: National Land Survey of Finland, 2019)

Figure 5-9. Adjacent sea areas surrounding Loviisa power plant, nearby rivers and the Lappomträsket

pository) excavated at a depth of approximately 110 metres in the bedrock of the island has been designed to ensure these zones of fragmented rock do not intersect with the final disposal facility.

The weathering of rock, especially when associated with fragmentation, always weakens the strength properties of rock mass to some extent. However, the secondary minerals formed as a result of weathering increase the capacity of the rock to retain substances carried with groundwater, such as radio nuclides.

5.9 GROUNDWATER

In the Hästholmen area, groundwater is primarily found in the layers of loose soil that cover the rock in deeper rock depressions in which the strata are thicker. Gaps in the bedrock contain groundwater. Seepage waters originating from the bedrock are carried to the L/ILW repository, the quality of these waters is monitored, and they are managed by means of pumping. The level of groundwater in the Hästholmen area is usually only a few metres below the surface of the ground, and the sea and groundwater levels meet in the littoral zone. The groundwater in the surface level of the groundwater layer is fresh, becoming saline further down. In the central parts of the island, the interface of fresh and saline groundwater is more than 100 metres underground (Snellman and Helenius 1992; Hatanpää 1997).

There are no categorised groundwater areas in the vicinity of Hästholmen. The nearest groundwater area is the Valko groundwater area approximately seven kilometres to the northeast on the mainland. It has been designated as a groundwater area important for water supply (class 1). There are no private domestic water wells in the vicinity of Hästholmen.

5.10 SURFACE WATERS

5.10.1 Overview of the sea area

The island of Hästholmen is located on the boundary of the coastal and outer archipelago in the Gulf of Finland. *Figure 5-9* shows the sea areas surrounding the island of Hästholmen, the rivers running to the sea off Loviisa and the Lappomträsket lake, which is the source of raw water for the power plant. East of Hästholmen, the bay areas of Hästholmsfjärden and Klobbfjärden form the Klobbfjärden body of water, which is representative of the surface water type of coastal archipelago in the Gulf of Finland. West of Hästholmen lies Hudöfjärden, which is located primarily in the Keipsalo body of water that belongs to the surface water type of coastal archipelago in the Gulf of Finland. The Loviisa-Porvoo body of water, representative of the surface water type of the outer archipelago in the Gulf of Finland, is located south of Hästholmen. Orrengrundsfjärden is a fairly open sea area, and the open sea begins at Orrengrund, approximately 12 kilometres south of Hästholmen.

The sea area off Loviisa is characterised by consecutive pools separated by inlets and shallow underwater thresholds. Water exchange at the bottom of these pools is minimal compared to the outer sea.

5.10.2 Topography and depth conditions

Hästholmsfjärden, to the east of Hästholmen, is a semi-closed, fairly shallow bay area that is connected to the outer sea area only via narrow and shallow inlets *(Figure 5-9)*. The size of the area is approximately 9 km² with a volume of 68.5 million m³, and the maximum depth is approximately 18 metres. The average depth is 7.6 metres. Several underwater thresholds limit water exchange between Hästholmsfjärden and the outer sea area (Launiainen, 1979). The shallower Klobbfjärden is located northeast of Hästholmsfjärden. Water exchange between these two pools is limited by a shallow interrupted only by a narrow water area that is approximately 10 metres deep. The bay areas of Hästholmsfjärden and Klobbfjärden are connected to the Tesjoki river and the Ahvenankoskenhaara delta of the Kymijoki river, Kullafjärden and Abborrfjärden, located northeast of the areas, via the narrow Jomalsund canal *(Figure 5-9)*.

The volume of Hudöfjärden (*Figure 5-9*), located west of Hästholmen island, is higher than that of Hästholmsfjärden and its deepest spot is 24 metres. The sea area is more open than Hästholmsfjärden, although to the south, there are thresholds that limit water exchange in the hypolimnion layer. The 9.5-metre waterway of the Valko harbour in Loviisa, dredged in the 1980s, has probably improved water exchange in the area to some extent. Water exchanges occur more efficiently further out to sea than in the coastal archipelago.

The sea level is measured at Loviisa power plant, and the variation of the daily averages is between -30 cm and 30 cm (the N60 measuring system). The closest station for measuring the sea level is in Emäsalo in Porvoo, where daily sea level averages varied between -60 cm and 70 cm in 2018 (Kymijoen vesi ja ympäristö ry, 2019).

5.10.3 Currents and stratification conditions

In the Gulf of Finland, the direction of surface currents is primarily anti-clockwise. Off Loviisa, as with the entire northern coast of the Gulf of Finland, the current flows to the west in the direction of the coast. At the local level, the currents are affected, among other things, by the topography of the area and the profile of the seabed, variations in sea level, wind and river runoff.

The weather and wind direction affect the currents in the sea area around Hästholmen. When the wind blows from the southeast, the surface water flows towards Hästholmsfjärden, and the flow of surface water to Vådholmsfjärden is mostly obstructed. When the wind blows from the west, southwest and northwest, surface water is discharged from Hästholmfjärden towards Vådholmsfjärden. A rising sea level weakens the water exchange in Hästholmfjärden, while surface water can flow to Vådholmsfjärden when the sea level is low. (Fortum Power and Heat Oy, 2019b)

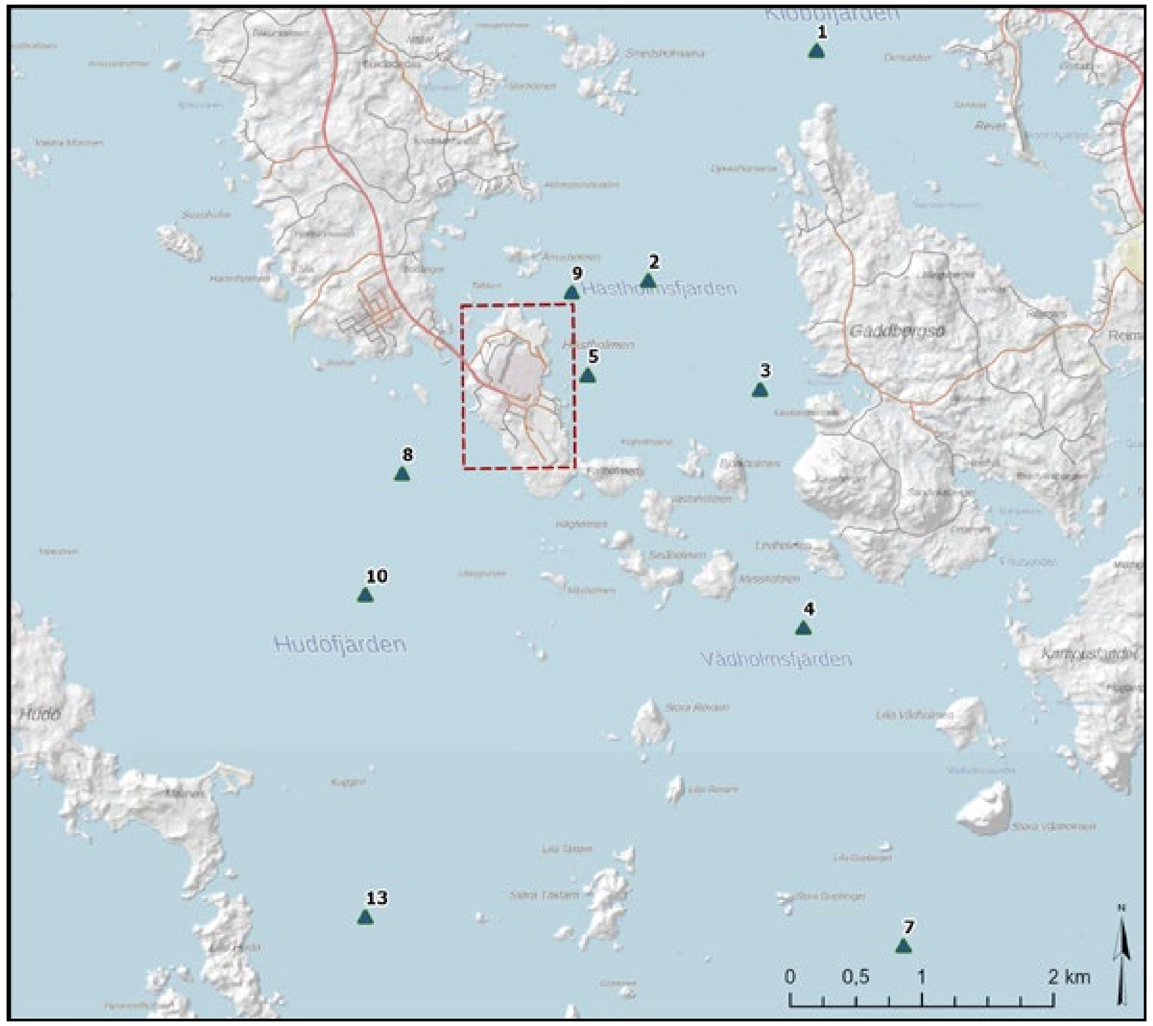
The cooling water circulation of Loviisa power plant also has a small impact on the currents in the nearby sea area. The cooling water circulation moves an average of 44 m³/s of water from Hudöfjärden to Hästholmsfjärden. The impacts mainly target the vicinity of the discharge location and narrow inlets but do not reach Klobbfjärden (Marjamäki, 2012). Part of the cooling water circulates back to the intake location from the southern side of Hästholmen. The embankment built between Hästholmen and the mainland weakens currents in the area.

The seasonal fluctuation of the temperature causes stratification of seawater in the deeper areas of the Gulf of Finland in the outer archipelago and on the open sea in particular. Water stratification also includes an upwelling/downwelling phenomenon that occasionally influences the temperature of surface water in the coastal and outer archipelago. In upwelling, surface water from the coastal area flows offshore and is replaced by the nutrient-rich and cooler water rising from deeper parts of the sea (Raateoja and Setälä, 2016), which results in a sudden cooling of the surface water. Off Loviisa, the wind blowing from the west for sufficiently long periods of time along the coast can cause upwelling. Correspondingly, long-lasting winds from the east may cause downwelling, in which warm surface water flows to the coast of Finland and upwelling of cool water takes place on the coast of Estonia (Raateoja and Setälä, 2016). From time to time, down-welling also raises the temperature of the seawater off Loviisa (Fortum Power and Heat Oy, 2019a).

In the Gulf of Finland, salinity decreases towards the east, and in the coastal archipelago, the differences between the hypolimnion and the surface layer in terms of salinity are typically fairly small. Thus, the most significant factor causing the stratification of seawater is temperature.

5.10.4 Quality of seawater

The quality of seawater is impacted by the area's point pollution sources and diffuse pollution originating from a larger area and several sources. Point pollution in Loviisa power plant's nearby sea area is caused by the power plant itself and the Vårdö wastewater treatment plant, as well as the pisciculture facilities of Ab Loviisan Smoltti Oy and Semilax Oy. Most of the nutrient load, however, is generated by the diffuse load carried by the river wa-



Power plant ▲ Monitoring point (Source: National Land Survey of Finland, 2019; Kymijoen vesi ja ympäristö, 2018)

Figure 5-10. Monitoring locations for the required monitoring of the quality of seawater in the sea area near the Loviisa power plant.

ters to the area. The nutrient load caused by river waters is considerably affected by the rainfall at any given time, since during pluvial years, leaching of nutrients may be two- or threefold compared to years with minimal rainfall (Karonen et al., 2015). Occasionally, the internal phosphorus load caused by the poor oxygen regime of the seabed is considerable in Hästholmsfjärden and Hudöfjärden (Leino, 2012).

The water quality of the sea area adjacent to Loviisa power plant has been monitored for decades. The power plant's required monitoring includes the monitoring of water quality at various depths. The seawater quality monitoring locations are shown in *Figure 5-10*.

The average salinity of surface water over the long term has remained fairly stable and typical of brackish water in the sea area near Hästholmen, in a range of 3.5–5‰. The differences in salinity between the surface water and the hypolimnion near the bottom have typically been fairly small. The oxygen regimen of the surface water has been good, and the average oxygen saturation has ranged between 90 and 120% during the growing season. Oxygen supersaturation resulting from accelerated production of phytoplankton, a typical phenomenon in eutropic waters, has been observed in the surface water in the summertime. The oxygen regime of the hypolimnion has often been poorer than that of the surface water, due to the stratification of the water, among other things. In recent years, lack of oxygen has been detected in the hypolimnion, primarily in the basins of Hästholmsfjärden (Kymijoen vesi ja ympäristö ry, 2018).

Based on the average nutrient content in the growing season, the surface water of the sea area near Hästholmen is slightly eutrophic or eutrophic. The average total phosphorus content of the surface water during the growing season varied between 20–35 µg/l in 2000–2017 (Kymijoen vesi ja ympäristö ry, 2018). The total nitrogen content of the surface water was approximately 300–425 µg/l, on average, in 2000–2017. The nutrient content in the hypolimnion near the bottom has typically been higher than in the surface water. The poor oxygen regimen of the hypolimnion of the bay, resulting in nutrients dissolving into the water from the sediment, has repeatedly caused total phosphorus and nitrogen contents that are higher in the Hästholmsfjärden basin area than in other locations.

Loviisa power plant's radioactive emissions into the sea are covered in Chapter 3.2.3.1, and the present state of the environment with regard to radiation in Chapter 5.14.

5.10.5 Thermal load into the sea

The seawater warmed in the cooling of Loviisa power plant is conducted to Hästholmsfjärden on the eastern side of the island of Hästholmen. The thermal load from the cooling water of Loviisa power plant is the most significant environmental impact targeting the nearby sea area, which is why long-term monitoring of the temperature of the seawater has been carried out since the 1960s. Based on the results of observations and perpetual measurements, the thermal load impacts the temperature and inherent thermal stratification of the surface water in the area, especially near the discharge location on Hästholmsfjärden. Occasionally, the rising temperatures of the surface water can be observed in a larger area, depending on the wind conditions. In the sea area, the thermal load is distributed evenly in the surface layer of the water, with minimal blending with lower water layers. The thermal load reinforces Hästholmsfjärden's vertical thermal stratification (Fortum Power and Heat Oy, 2019b).

During the open water season, the layer formed by warm cooling water spreads in the sea area as a surface water layer that is a few metres thick and does not easily mix with the denser hypolimnion. During the open water season, the currents caused by the wind and the level of seawater significantly affect the dispersion of the warmed water and the size of the impact area.

The impact of the thermal load on the nearby sea area can be best observed in the winter, when the ice cover effectively prevents the heat from dissipating into the atmosphere (Ilus, 2009). In the winter, the impact area of the thermal load is larger than during the open water season. In accordance with its density, the more saline and warmer cooling water discharged on Hästholmsfjärden settles between the cold freshwater carried by the rivers and the cold, more saline seawater, forming an intermediate layer of warm water near the surface. The warmer intermediate layer with a thickness of a few metres can usually be observed only on Hästholmsfjärden, Vådholmsfjärden and Hudöfjärden. Further out, the temperature of the intermediate layer decreases gradually as the surrounding cold water mixes with it (Marjamäki, 2012).

5.10.6 Ice conditions

The thermal load caused by the power plant and the changes in the currents affect the ice situation of the nearby sea area. The ice situation of the area is also monitored as part of the plant's required monitoring. A permanent ice cover is formed in the area in question later than normal, and the ice breaks up earlier, compared to areas that are not exposed to the thermal load. The formation of a permanent ice cover and the duration of the ice cover period are significantly impacted by the severity of winters. Warning boards and the local newspaper are used to warn people of a weakened ice situation.

In the early winter, the impact of the power plant's cooling waters on the ice cover is manifested as a large area of melt water, which can also be seen in satellite pictures. Thus, the ice cover is normally quite thin in the sea off the plant and in the inlets leading out of Hästholmsfjärden. Late in the winter, ice melts quickly in the inlets as the currents make warm water well up and come into contact with the ice. In the northern parts of Hästholmsfjärden and on Klobbfjärden, the ice is usually solid (Ilus, 2009).

The average ice situation and the size of the unfrozen area vary depending on the severity of the winter. During severe and extremely severe winters, the unfrozen area may be very small, and the coolant water flows under the ice in the immediate vicinity of the discharge location. During mild winters, the unfrozen area is at its largest. (Ilus, 2009).

5.10.7 Sediments

The layers of soil on the seabed near Loviisa power plant consist mainly of moraine or rough soil types, gravel and sand, with clay and silt sand layered on top in places. These soil layers are at their thickest in the bedrock basin east of Hästholmen, where the total thickness of the layers is approximately 60 metres.

Sediment samples were taken from the area in front of the cooling water intake for a test on harmful substances towards the end of 2019. Samples were collected from 11 locations. The results are reviewed in greater detail in the EIA report stage when the report on the harmful substance test is available.

5.10.8 Biology and ecological status of the sea area

5.10.8.1 Phytoplankton and base production

The phytoplankton species and their biomass in the sea areas near the power plant are typical of the coastal waters of the Gulf of Finland. In May, the dominant species are dinoflagellates and diatoms. The share of blue-green algae is at its highest in the population in June–July and again in October. The dominant species in the phytoplankton populations in the autumn are large coldwater diatoms.

There has been a declining trend in the chlorophyll a content in the surface water during the growing season in the 2000s: In other words, the quantity of algae has declined. There is a lot of variation between years, as the quantity of algae is influenced by a number of factors, such as the temperature of summers and the nutrient supply (Kymijoen vesi ja ympäristö ry, 2018).

The amount of base production in Loviisa sea area has been studied by means of measurements of the phytoplankton base production since 1967. During this monitoring, the amount of base production has increased both at the discharge and intake location of the cooling water. The increase is connected with the general increase in the nutrient content in and the overall eutrophication development of the Gulf of Finland. Based on long-term monitoring, the trend in the base production seems to have taken a declining turn.

5.10.8.2 Aquatic vegetation

Aquatic vegetation has been monitored in the sea areas near Loviisa power plant since 1971. The seabed on the shores of Hästholmen island is mostly rocky and usually very steep underwater, which is why the aquatic vegetation zones are generally narrow (Ilus, 2019). In 2017, a total of 12 aquatic plant species belonging to vascular plants and macroalgae was found in the areas being monitored. The species were customary to the area, such as hornwort, spiked watermilfoil, spiny naiad, perfoliate pondweed, fennel pondweed, *Fucus radicans* brown alga, *Cladophora glomerata* macroalga, *Ectocarpus siliculosus* brown alga, bladder rack, and sea lettuce (Monivesi Oy, 2018).

The quantity of aquatic plants on the discharge side has been higher than on the intake side due to the warming effect of the power plant's cooling water on the surface water, but the overall eutrophication development experienced in the Gulf of Finland has also been observed on the intake side. The strongest increase in the coastal vegetation and eutrophication of the shore areas can be seen at a distance of approximately one kilometre from the cooling water intake. Aquatic plants sensitive to water pollution have decreased in the areas of both Hudöfjärden and especially Hästholmsfjärden.

5.10.8.3 Benthic fauna

The benthic fauna populations in the sea area surrounding Loviisa power plant were first studied in 1966, when the quantity of species was deemed fairly low. The quantity of species is limited by the salinity of the brackish water, which is too low for many marine species and too high for freshwater species. More regular monitoring of benthic fauna began in 1973. There have been considerable changes in the condition of the floor of the area and in benthic fauna in the last 40 years or so. In deeper areas especially, the condition in the floor has weakened drastically since the 1980s, which can be explained by the overall weakening of the oxygen regimen in the Gulf of Finland (Ilus, 2019).

Based on the extensive benthic fauna monitoring carried out in 2017 (Kymijoen vesi ja ympäristö ry 2018; Monivesi Oy, 2018), in most areas on the soft floor, the oxygen regimen was poor, or the floor had no oxygen at all, which weakened the living conditions of the benthic fauna. At the monitoring stations closer to the coast, the benthic fauna of the mud floors was poor in terms of the variety of species and consisted of a few dominant species. At the sampling station near the power plant's cooling water discharge location, the benthic fauna population was more abundant than at the other stations, and the species were more diverse, which was probably due to the better water exchange and the coarser materials of the seabed. The thermal impact of the cooling water may also be a factor in the quantities.

Based on the benthic fauna study in the littoral zone, the most important group at all sampling stations was crustaceans (among others, the amphipoda in genus *Gammarus*). At the sampling station closest to the shore, important groups in the benthic fauna, including mussels and insects, included chironomid larvae, apart from crustaceans. The most abundant species of insects was the *Caenis horaria* mayfly, and among mussels, the small *Macoma baltica* clams. Further offshore, the share of insects declined and the share of gastropods and oligochaetes increased correspondingly.

Non-natives species, or species introduced by people to the area being monitored, have also spread to the sea area near Loviisa. In 2017, a total of nine non-native species were detected in the benthic fauna studies conducted in the joint monitoring of the sea area off Loviisa. Most of the non-native species were found in the littoral zone. Non-native species found in the area include barnacles *(Balanus improvisus)*, brackish hydroid *(Cordylophora caspia)* and false mussel *(Mytilopsis leucophaeta)*. The false mussel is a species that benefits from the thermal impact and as such, it was only observed in monitored areas that were located in the impact areas of the cooling water. The aforementioned three species also create a biofouling phenomenon which entails biological contamination of various surfaces under aquatic conditions. Among organisms involved in fouling, false mussels cause the most problems in the cooling water systems of Loviisa power plant, which is why the power plant has been monitoring and studying the false mussel since 2005. (Kymijoen vesi ja ympäristö ry, 2018).

5.10.8.4 Ecological status

Surface waters are classified on the basis of the ecological status of water systems, which is an overall assessment of the biological factors, as well as the physico-chemical and hydromorphological factors of water. The ecological status of the Klobbfjärden body of water located in the sea area of Loviisa power plant was assessed as bad in the second planning period (Open access, the Hertta database, 25 November 2019). The categorisation is based on an extensive biological data (phytoplankton and benthic fauna) used in assessing the biological category as bad. The data concerning the physico-chemical status also indicated a bad status. Above all, the status is weakened by the weak oxygen regimen of the water mass and the oxygen depletion of the floor. The ecological status of the body of water in other nearby sea areas, such as the eastern Gulf of Finland, has been assessed as poor.

5.10.9 Other water systems

The Lappomträsket lake, which is the source of the power plant's raw water, is located north of the power plant area *(Figure 5-9)*. The water level of the lake was lowered decades ago to dry out additional arable land, but later in the 1970s, it was raised again due to the water supply needs of Imatran Voima, currently Fortum (Ramboll Finland Oy, 2012a). The Lappomträsket lake is a clear shallow humic lake with an area of approximately 109 hectares. Of the lake's area, 82% is at most one metre deep. The water quality of the Lappomträsket lake is good, which is partly due to the oxidation of water performed by Fortum. Thus, the ecological status of the lake has been assessed as good (Water Map Service, 2018).

5.11 FISH AND FISHING

The ichthyofauna and fishing in the sea area off Loviisa power plant has been monitored since 1971. Among other things, the following information on the ichthyofauna of the area is based on the observations obtained from fishing surveys and fish bookkeeping, as well as reviews of the biomass carried to the power plant.

The ichthyofauna in the sea area surrounding Hästholmen consists of both marine fish and freshwater fish species adapted to the brackish water. Marine species important for fishing can be found in the area, such as Baltic herring and Baltic sprat, salmon, sea trout, as well as Coregonus lavaretus and Baltic whitefish, eel and flounder. Among these, migratory species include salmon, sea trout, Baltic whitefish, Baltic herring and eel. Key freshwater species important in terms of fishing include pikeperch, pike, common perch and burbot. Other abundant fish species include cyprinids: roach, silver bream, bream and ide.

The breeding areas of the ichthyofauna of the Gulf of Finland have been studied in connection with the Finnish Inventory Programme for the Underwater Marine Environment (VELMU). Based on data from field studies, maps have been prepared in the online service of the environmental administration (VELMU Map Service, 2019) on the breeding areas of various fish species based on incidence probability modelling. According to the model, favourable breeding areas exist in the vicinity of Hästholmen for common perch and pike, among other species. Based on the incidence probability modelling, pikeperch breeds primarily in the far end of the Loviisanlahti bay and on the northern and south-eastern shores of Klobbfjärden. The most favourable breeding areas for Baltic herring include the shallow vegetation areas of the middle and outer archipelagos as a whole. Modelling results for the breeding area of whitefish that spawns in the sea are not presented for the sea area off Loviisa in the VELMU map service.

The surveys of the current status of the nuclear power plant project being planned by Fennovoima Oy in Ruotsinpyhtää included surveys of the fry production areas of the ichthyofauna in the Gäddbergsö and Kampuslandet areas in 2009 (Pöyry, 2009). The survey area is located on the south-eastern side of Hästholmen island, at a distance of up to approximately one kilometre. Based on the surveys, there are significant breeding areas for Baltic herring and Gobiidae in the south-eastern sea area near Hästholmen. The surveyed area also included shores with sand and gravel floor that whitefish spawning in the sea use as spawning areas.

Fishing in the area is monitored as part of the required monitoring by requesting commercial fishermen to report their catches, and fishing is monitored with annual bookkeeping. Three commercial fishermen who practise fishing in the area submitted their bookkeeping on fishing for 2018. Their primary fishing method was net fishing, focusing on the spring and autumn. In bottom-set gillnet fishing, pikeperch accounted for the majority of the catch (57%), although pike (30%) was also caught. The results are in line with earlier monitoring results (ÅF-Consult Oy, 2019).

According to a survey conducted among recreational and subsistence fishermen, the calculated total catch of recreational fishermen was an estimated 14.9 tonnes and approximately 20.7 kg per household in 2017. The catch consisted primarily of pike, Baltic herring, perch, bream and pikeperch. Recreational fishing in the area concentrates on the summer months (ÅF-Consult Oy, 2018).

Most of the biomass carried to the power plant with the cooling water intake has been fish, primarily Baltic herring or smelt. The fish are removed from the water with coarse and fine screens and travelling basket filters. The screenings, which consist primarily of fish, aquatic plants and algae, are taken to an external waste management company for appropriate processing and utilisation as material in the same manner as other organic waste generated in the power plant. Thus, the intake of cooling water can also be considered to have a cleaning impact on the sea, as phosphorus is removed from the sea with the screenings.

5.12 FLORA, FAUNA AND CONSERVATION AREAS

5.12.1 Overview of the biotopes and vegetation

From the botanic geography perspective, the Loviisa region is located in the anemone belt, and its Lounaismaa part in the southboreal zone. This part of the southboreal zone has the most favourable climate and a rich vegetation. The rich grass-herb vegetation and groves differentiate the area from the rest of southern Finland. The demanding woodland plants of the area include the hepatica, yellow anemone and wood anemone, lungwort, pilewort, white satin flower, fumitories, wall lettuce, alternate-leaved golden saxifrage and torgrass. Ash, European hazel and European white elm have also spread to the area.

Hästholmen island is approximately 75 hectares in area, about half of which is the built-up environment intended for the power plant's operations. Hästholmen is connected to the smaller Tallholmen island by a narrow isthmus. In addition, the small islands of Hässjeholmen and Tallören are almost connected to Hästholmen by isthmuses, very shallow water areas and cobble deposits. The dominant tree on the islands of Hästholmen and Tallholmen is pine. The islands also feature some patches of bare rock with few or no trees, and plenty of rocky soil. The narrow isthmus between Hästholmen and Tallholmen features typical alder grove stands. The shores of the islands are primarily rocky, and larger reed stands or other flood meadows are rare. Only the shallow between Hässjeholmen and Hästholmen and the isthmus of Tallholmen feature small reed stands.

5.12.2 Fauna in land areas

In the area of the town of Loviisa, the fauna consists primarily of typical species that have adapted to living in managed forests, such as fox, brown hare and cervids. The only large predator more generally seen in the Loviisa region is the lynx (Natural Resources Institute Finland), 2019a).

No precise data on the fauna in land areas is available for the power plant area. The elk population is fairly strong near the power plant area and in the surroundings of the road leading to the area south of the centre of Loviisa. No prior information exists on the incidence of the species listed in Appendix IV(a) of the Habitats Directive (including the flying squirrel, bats and otters). Two otters were spotted at the power plant's cooling water intake location in connection with the avifauna monitoring, launched in December 2019, that is conducted for the EIA procedure. There is no prior researched information on the incidence of the species in the area, but the sea area that remains unfrozen throughout the winter may induce the species to spend winters and breed in the area.

The incidence of flying squirrels and bats was studied when land use planning was carried out in the component master plan area of the northern part of Loviisa and Tesjoki in 2005. The only breeding area for the whiskered bat and brown long-eared bat observed in the land use plan area is approximately 10 km from Hästholmen. There are no habitats preferred by the flying squirrel on Hästholmen island or the cape next to it, and there are no known breeding or resting areas for the flying squirrel in the vicinity of the power plant (Fortum Power and Heat Oy, 2008).

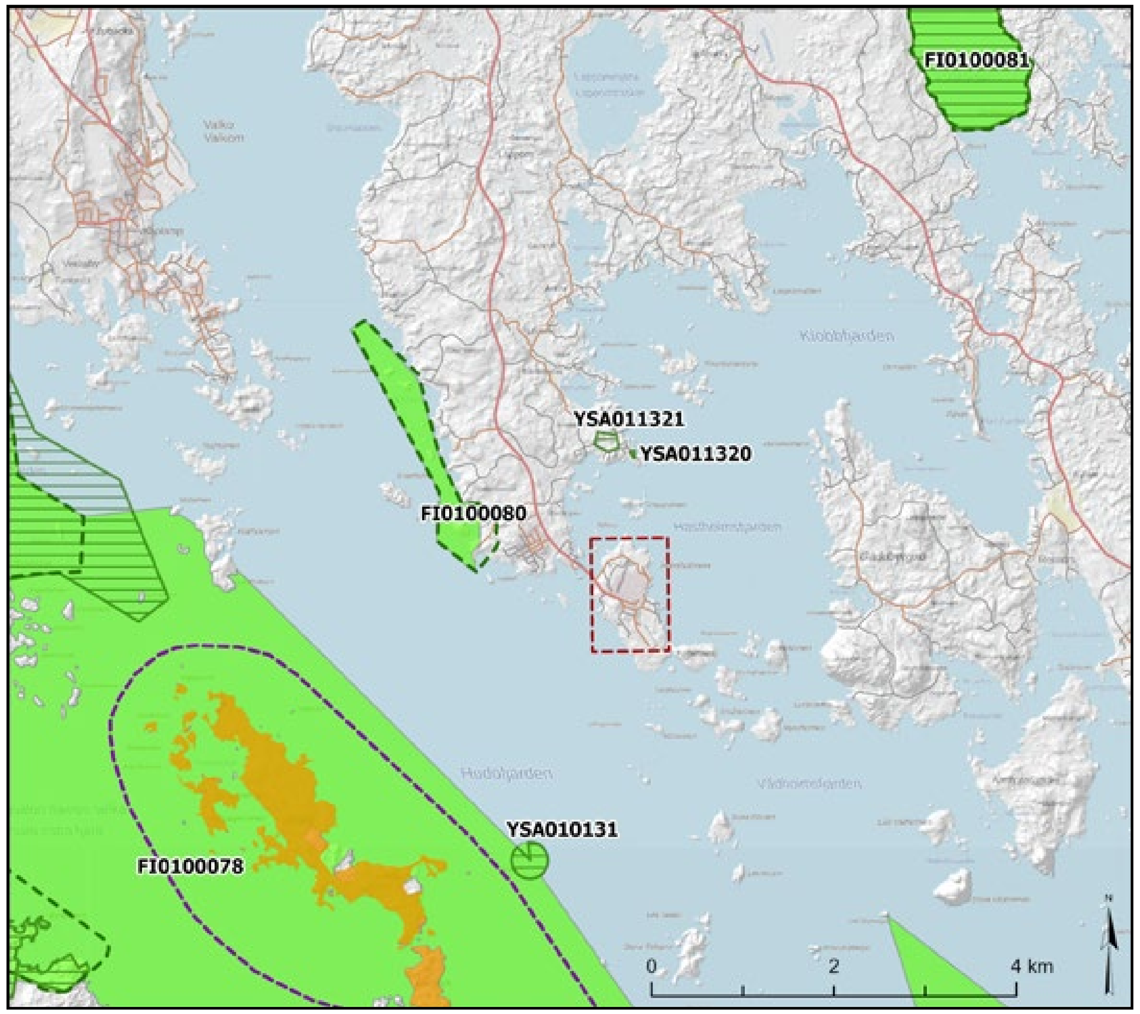
However, it is likely that bat species may be found in the vicinity of Hästholmen, in particular during migration periods. During the spring and autumn migrations, migrating/migratory bats can in practice be found everywhere in the coastal region.

5.12.3 Marine mammals

According to surveys conducted among fishermen, seals have been observed in Loviisanlahti bay. Both grey seals and Baltic ringed seals can be found in the Gulf of Finland area. The grey seal is considerably more common than the ringed seal in the eastern Gulf of Finland. Based on the calculations carried out in 2019 by the Natural Resources Institute Finland, the grey seal population of the Gulf of Finland was 685 seals (Natural Resources Institute Finland, 2019b). The population (in Finland and Russia combined) of the Baltic ringed seal in the Gulf of Finland is estimated at less than 200 seals (Ministry of Agriculture and Forestry 2018). This means that the seals observed in the Loviisa region are most likely grey seals.

5.12.4 Avifauna

In terms of the land bird species, the Loviisa region is representative of the typical forest areas in the southern coastal region. In



(Source: National Land Survey of Finland, 2019)

Figure 5-11. Nature conservation areas, sites covered by conservation programmes, Natura 2000 sites and a nationally important bird area (FINIBA) in the vicinity of the power plant.

Loviisa, the land bird species are abundant but rare species are few. By contrast, waterfowl species abound.

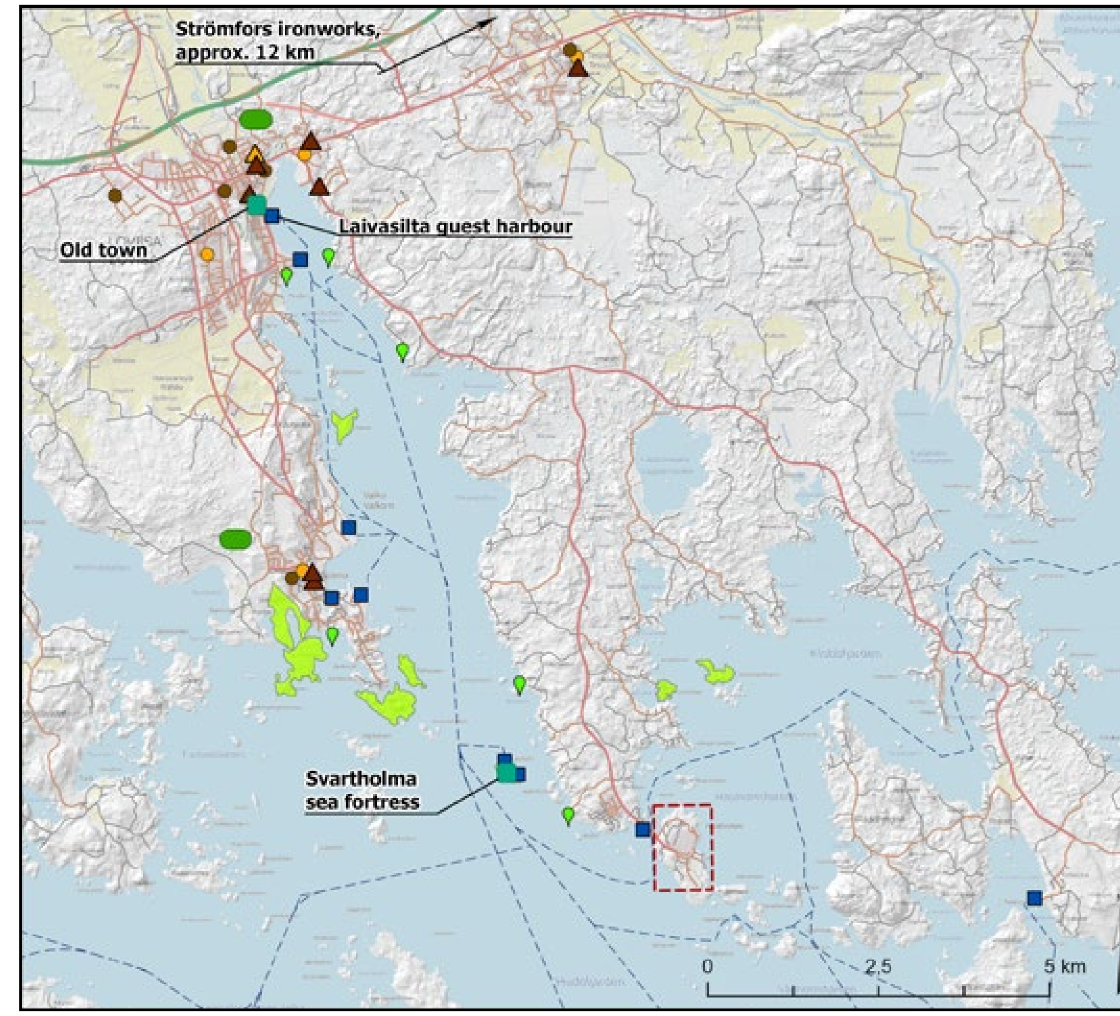
There are no internationally important (IBA), nationally important (FINIBA) or regionally important bird areas (MAALI) in the power plant area or its immediate vicinity. The nearest bird area categorised as important is the sub-area included in the FINIBA area of the archipelago in the eastern Gulf of Finland, more than two kilometres to the southwest *(Figure 5-11)*.

Hästholmsfjärden, located east of the power plant area, is a locally important bird area for overwintering waterfowl in particular. The impact area of the cooling water remains unfrozen throughout the winter, enabling waterfowl to overwinter in the area. Species observed to stay in the area through the winter include at least the common coot, smew and mute swan. The thermal impact and overwintering in the area may make it possible for some waterfowl species to find food, resulting in them nesting earlier in the vicinity of the power plant area.

Avifauna monitoring related to the EIA procedure was launched in December 2019. The results are reviewed in greater detail in the EIA report stage when the report on the avifauna survey is available.

5.12.5 Nature conservation

The Natura 2000 network site closest to the power plant area is the Källaudden–Virstholmen area (ID FI0100080), located at least approximately 1.3 km to the southwest *(Figure 5-11)*. The area is protected as a site referred to in the Habitats Directive (a SAC area). The next closest Natura 2000 network site is the marine reserve (FI0100078) in Pernajanlahti bay and the Pernaja archipelago located at least approximately 2.3 km to the southwest. It is considerably vast and protected as a site compliant with both the Wild Bird and Habitats Directives (a SAC and SPA area). The Natura area in the marine reserve of Pernajanlahti bay and the Pernaja archipelago also includes the small islet of Kuggen, which is protected as an avifauna conservation area (YSA010131). The Kullafjärden waterfowl habitat (FI0100081) is approximately 7 km to the northeast of the power plant.



(Source: Town of Loviisa, 2019b; Helsinki-Uusimaa Regional Council, 2019a)

Figure 5-12. The sensitive sites closest to the project area, and tourism and recreational sites.

The established nature conservation areas closest to the power plant at a distance of 0.8–1 km to the north are the privately owned nature conservation areas of the Karhulahti shore (YSA011320) and Bastuängen common forest (YSA011321) *(Figure 5-11)*. The nature conservation area of Karhulahti shore is approximately 0.2 hectares, and the area of the Bastuängen common forest is approximately 4 hectares.

5.13 PEOPLE AND COMMUNITIES

5.13.1 Population

Loviisa lies on the coast of the Gulf of Finland, approximately 90 km east of Helsinki. In 2018, Loviisa had approximately 15,000 inhabitants. Loviisa and its neighbouring municipalities of Pernaja, Liljendal and Ruotsinpyhtää merged into the town of Loviisa in 2010. Loviisa's neighbouring municipalities include Kouvola, Lapinjärvi, Myrskylä, Porvoo and Pyhtää. Loviisa forms the Loviisa sub-regional area with Lapinjärvi.

The share of Swedish-speaking inhabitants of the population in Loviisa (40.6%) and in Lapinjärvi (30.7%) is considerably higher than in Pyhtää (7.4%). In the Loviisa sub-regional area, the share of people over 65 years of age is higher, and the share of people under 15 is lower than in Uusimaa and the average for Finland as a whole. The share of people of studying and working age in the population is slightly lower than in Uusimaa and the average for Finland as a whole. The demographic trend in the Loviisa region has been declining for a long time. In 2018, net emigration was 78 people in Loviisa, 22 in Lapinjärvi and 38 in Pyhtää (Statistics Finland, 2019a). According to the population forecast, the population in the Loviisa area will remain fairly unchanged until 2040 (Helsinki-Uusimaa Regional Council, 2019d).

There are no permanent residents up to a distance of one kilometre from the power plant. There are about 40 year-round residents up to a distance of five kilometres from the power plant. For the most part, the population is concentrated in the areas of Björnvik and Lappom north of the power plant. Approximately 12,400 people live within a distance of 20 kilometres of the power plant. The largest population concentration in the vicinity is the centre of the town of Loviisa, 12 km from the power plant. Tesjoki and the municipal centres of Ruotsinpyhtää and Pyhtää are built-up areas of less than 1,000 inhabitants each. Smaller population centres include Kuggom, the Pernaja municipal centre, the village of Isnäs in Pernaja and the village of Purola in Pyhtää. There are plenty of recreational settlements in the vicinity of Hästholmen. There are approximately 400 secondary homes within five kilometres of the power plant and approximately 900 secondary homes within ten kilometres.

5.13.2 Sensitive sites and recreational use

There are no schools or day care centres within a five-kilometre radius of the power plant. The nearest school and day care centre are in the village of Valko, approximately seven kilometres from the power plant. The day care centres, schools and other educational institutions, as well as the healthcare services closest to Loviisa power plant are shown in *Figure 5-12*.

The tourist attraction closest to the power plant area, the Svartholma fortress, and other destinations farther away, namely the old town of Loviisa, Strömfors ironworks and Loviisa's 'Laivasilta' marina, are shown in *Figure 5-12*. Loviisa's other marinas and docks include Bockhamn, Lillfjärden, Kabböle, Rönnäs and Backstensstrand. The Loviisa area is home to a number of enterprises offering fishing, accommodation, nature and activity services. Tourism has been on the increase in the area in recent years, but it is not among the key travel destinations in Finland.

Loviisa also offers several recreational destinations in its water areas, as well as hiking trails, nature trails and outdoor recreation areas. The recreation areas included in the regional land use plan in the vicinity of the power plant are shown in *Figure 5-12*. Recreational use of the water areas and beaches near the power plant was studied in a survey carried out in 2012 (Ramboll Finland Oy, 2012b). According to the survey, most of the recreational use happens in the summer when the area's water systems and shores are actively used for holidays, outdoor activities on the beach, swimming and saunas. Boating, observing nature and fishing are also popular activities (Town of Loviisa, 2019c).

5.13.3 Business, industry and services

Key figures of the business structure in Loviisa are shown in *Table 5-1*. According to the key figures of Statistics Finland, there were approximately 4,900 jobs in Loviisa in 2017 (Statistics Finland, 2019a). An increasing share of the labour force in Loviisa works in the service industry, although this share is significantly smaller than the average in Uusimaa and Finland as a whole. One of the most important employers in the processing industry in Loviisa is Fortum's Loviisa power plant, which generates electricity (approximately 500 jobs). The number of business establishments in Loviisa in 2017 was 1,410 (Statistics Finland, 2019b). The share of the processing industry is higher in Loviisa than the average in Finland. Loviisa's enterprise structure focuses on small and medium-sized enterprises. In 2016, there were 99 industrial establishments in Loviisa, the turnover of which was EUR 121 million (Kokkonen, 2018). Loviisa's income tax rate in 2020 is 20.25% (Association of Finnish Municipalities, 2020).

Table 5-1. Key figures for the town of Loviisa 2017.
(Source: Statistics Finland, 2019a)

	Per cent %
Primary production	5.8
Processing	32
Services	59.9
Unemployment rate	11.2
Employment rate	71.2
Commuting	41.6

5.14 RADIATION

The status of radioactive substances in the surroundings of Loviisa power plant has been monitored for a long time. The baseline studies began as early as 1966, before the construction of the power plant began. Radiation control of the environment is based on sampling, the identification of radionuclides in the samples and the determination of their levels. Control focuses on the routes through which people are exposed to radioactivity and the indicator organisms that enrich radioactive substances in the land and sea environment.

The radioactive substances observed in the surroundings of Loviisa power plant may be due to radioactivity present in nature, or they may originate from Loviisa power plant or elsewhere. Sources of radioactive substances carried to the area from elsewhere include nuclear weapon tests and the Chernobyl nuclear power plant accident, among others.

Radioactive nuclides present in nature include Be-7, K-40, H-3 and C-14, among others. The concentrations of radioactive substances present in nature are usually higher than the concentrations of nuclides originating from the operation of the power plant, nuclear accidents or nuclear weapon tests. Cs-137 and Sr-90 present in samples taken from the environment primarily result from the fallout from the Chernobyl accident and nuclear weapon tests. The impacts of the 1986 Chernobyl nuclear power plant accident have been detected in the fallout samples taken from the land environment and samples taken from the sinking matter in the water environment. The radioactivity caused by Cs-137 in the sinking matter currently remains higher than the levels before the Chernobyl accident.

Nuclides originating from Loviisa power plant are seldom detected in the air, fallout and land environment, and the detected concentrations are minimal. They are usually detected from the air or fallout samples. Nuclides originating from Loviisa power plant's emissions have not been detected in plants used for human consumption, milk and meat. The impact of the power plant has mainly been visible in mud samples and the samples from the water environment, in which a small num-ber of nuclides originating from the power plant has been detected regularly. The radioactivity levels detected in samples from the water environment have been low, and mainly found in the sinking matter and indicator organisms that absorb radioactivity but are not part of human nutri-tion. Radioactive substances originating from the power plant have not been detected in fish. The results of the measurements of external radiation have not shown abnormal results caused by Loviisa power plant.

6. Assessed impacts and assessment methods

6.1 PREMISE OF THE ASSESSMENT

6.1.1 Reports and other materials used in the assessment

Among other things, the description of the present state of the environment in the EIA Programme has used the following materials that also form the basis for the assessment of impacts:

- Geographic dataset from the National Land Survey of Finland
- Databases of the environmental administration and the Finnish Environment Institute
- Land use planning data from regional councils and the town of Loviisa, and separate surveys included in land use plans
- Finnish Heritage Agency's register portal of the cultural environment
- Data from the BirdLife Finland association on important bird areas (FINIBA and IBA), as well as other reports on bird areas deemed to be regionally important
- Research data and databases of the Geological Survey of Finland
- Traffic volume data by the Finnish Transport Infrastructure Agency
- Municipality-specific data and key figures published by Statistics Finland
- Any other data published by municipalities and the authorities
- Various map applications and aerial photographs
- Data from the previous EIA procedures related to nuclear power and nuclear waste management carried out in Finland
- Observations, studies and reports related to Loviisa power plant that concern, among other things, cooling waters and wastewaters, nutrient load and currents of the sea area, professional fishing, population, business and industry, and traffic in the area, flora and fauna, as well as radiation monitoring in the environment.

The materials are verified, and the data is updated if required for the EIA report. The following separate surveys have been planned as part of the assessment to support the existing data:

- Survey of harmful substances in sediments
- Sub-bottom profiling of the seabed
- Cooling water modelling
- Avifauna survey
- Ichthyofauna surveys (test net fishing and fry research) in the power plant's sea area
- Assessment of the impacts on the regional economy
- Resident survey and small group interviews
- Accident modelling and dose calculation

6.1.2 Assessed impacts and significance of impacts

The impacts of the planned projects are assessed in the environmental impact assessment procedure in a manner and accuracy required by the EIA Act and Decree. According to the EIA Act, the EIA procedure assesses the direct and indirect impacts of the operations related to the project which target:

- the population, as well as the health, living conditions and comfort of people;
- soil, ground, water, air, climate, vegetation, as well as organisms and biodiversity, especially the protected species and habitats;
- community structure, tangible property, landscape, townscape and cultural heritage;
- use of natural resources; and
- the mutual interaction between the aforementioned factors.

In accordance with section 4 of the EIA Decree, the assessment report should include an estimate and description of the likely significant environmental impacts of the project and its reasonable options, as well as a comparison of the options' environmental impacts. The environmental impact assessment compares the environmental impacts for when the project is implemented, and when it is not implemented, and the differences between these scenarios. The comparison is performed based on the information that is available and specified during the assessment.

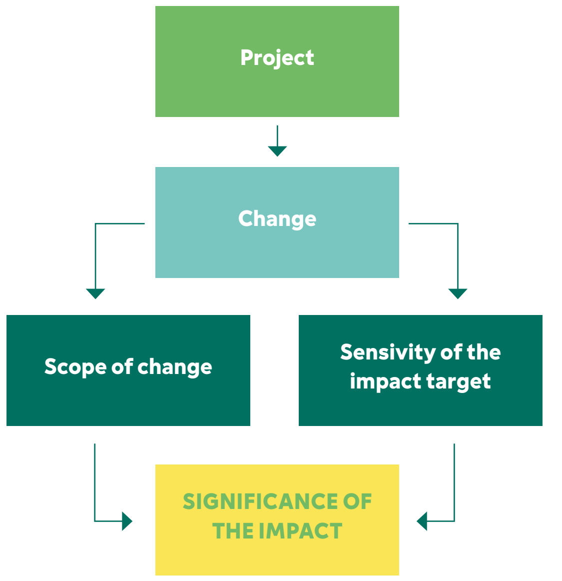


Figure 6-1. Factors affecting the significance of the impact.

The assessment of the significance of the impacts provides an inference chain that is used as the basis of the conclusions on the project's significant impacts in the impact assessment. In assessing the significance of the impact *(Figure 6-1)*, the extent of the change and the capability of the environment to absorb changes, or the susceptibility of the impact target, are considered. The assessment of the target's susceptibility is also associated with the target's value for different stakeholders, such as residents and entrepreneurs. In the assessment procedure, the extent of the change and the susceptibility of the target, as well as the resulting significance of the impact, are divided into four categories: minor; moderate; high; and very high. The impacts for the environment can be either negative or positive.

6.1.3 Most significant environmental impacts identified

The environmental impact assessment in this project focuses on reviewing the most significant impacts identified as the key impacts for the projects with regard to the extension of the power plant operations, preparations for decommissioning and decommissioning. Based on the preliminary planning data, the following have been identified as the most significant environmental impacts thus far:

- If extending the operation, the impacts on the environment are similar to those in the current operation. The most significant impact is caused by the thermal load of the power plant's cooling water on the nearby sea area. Based on the preliminary planning data, the changes would primarily target the impacts on the landscape caused by potential new structures. In addition, potential impacts may be caused to water systems by water engineering work, such as dredging, excavation and the construction of the new embankment structure, among other things. Water engineering work may help decrease the temperature of the cooling water conducted to the sea. Potential construction work may also cause temporary noise, and the traffic volumes on roads leading to Hästholmen may temporarily increase. In addition, in the case of an extended operation, the radiation impacts are similar to what they are currently.
- Tentatively, it has been assessed that the most significant impacts of the preparation for decommissioning are generated by the excavation of the expansion of the L/ILW repository to be constructed and the temporary storage of the blasted rock, and primarily target the soil, bedrock and groundwater. In addition, the construction of the L/ILW repository may cause temporary noise, vibration and dust. The traffic volumes in the area may also momentarily increase. The impact of the construction work required by buildings and structures to be made independent is similar to the current impacts caused by the operation of the power plant. They are primarily related to waste management and radiation protection. Potential changes compared to the current operation may be primarily caused by the organisation of cooling for the interim storage for the spent fuel that is made independent. However, these impacts on water systems would be only a fraction of the impacts of the power plant's current operation.
- The key environmental impacts of decommissioning are caused by the dismantling of radioactive plant parts, as well as the treatment, transport and final disposal of waste. The most significant environmental aspects are primarily generated by the personnel's potential exposure to radiation. In addition, there may be impacts from process waters, which

are treated and subsequently conducted to the sea. Other environmental impacts identified as the most significant at this stage include those on the regional economy caused by decommissioning, as well as on greenhouse gases, soil and bedrock, groundwater, air, water systems and the landscape. Decommissioning may also highlight impacts targeting people, and especially how different people experience them.
- Management of radioactive waste generated elsewhere in Finland and received at Loviisa power plant does not considerably differ from the handling of the power plant's own waste. The most important aspect is to organise the management of this waste sustainably and responsibly in accordance with society's best interests. Fortum does not accept radioactive waste generated elsewhere in Finland that cannot be handled and deposited for final disposal safely taking the available technical solutions into consideration.

The following chapters describe the environmental impact assessment methods by area.

6.2 LAND USE, LAND USE PLANNING AND THE BUILT ENVIRONMENT

The environmental impact assessment studies whether the changes related to the extension of the power plant's operation or its decommissioning affect the current and future land use in the vicinity. The project's direct land use impacts primarily target the project area and its immediate vicinity. The impacts targeting land use therefore focus especially on the impacts on the nearest population.

The valid local detailed plan makes it possible to carry out modification work in the power plant area, construct additional structures and buildings, and decommission the power plant. Needs to make changes to land use plans may emerge after decommissioning if the land use restrictions for the power plant's operation change or cease to exist.

In the EIA report, the situation of the project area and its surroundings with regard to land use plans is verified, and potential needs to change the plans are assessed. In addition, the relationship of the project with national objectives concerning the use of areas is reviewed.

The impacts on the use of tangible property (both fixed and moveable) are assessed by experts if the potential for impacts increases during the assessment. The environmental impact assessment does not include the assessment of impacts on the value of the fixed and moveable property

6.3 LANDSCAPE AND CULTURAL ENVIRONMENT

The Landscape Impact Assessment of the impacts on landscape reviews changes to the landscape caused by work and additional construction related to the extension of the power plant's operation and its overall decommissioning. The level of the landscape's changes and impacts depends on the visibility of the expansions and dismantling work to be assessed, and the characteristics of the landscape. Decommissioning and the associated dismantling of structures affects the overall landscape.

A description is prepared of the area's landscape structure, overall landscape and cultural environment. The materials used in the assessment of impacts targeting the landscape and the built environment include maps, aerial photos, land use plans and other surveys of the area, as well as register information from the authorities (among other things, the Open data geographic datasets of the Finnish Heritage Agency and the environmental administration).

The assessment of the impacts targeting the landscape and the cultural environment focuses on the change in the overall landscape: how visible the changes caused by the project are, how extensive the change in the landscape is, and which parts of the landscape experience the greatest change. Special attention is paid to the changes in the landscape that target holiday housing.

6.4 TRAFFIC

The assessment of traffic impacts focuses on the situation resulting from the extension of the power plant's operation and its decommissioning.

The traffic impacts of the extension of the operation are similar to those in the current situation; in other words, the greatest impacts on the roads leading to the power plant result from the annual outage. The information on the current traffic situation in the reviewed area is collected from the data provided by the Finnish Transport Infrastructure Agency, and the traffic output and changes to the area's traffic network caused by the extension of the operation are examined. The changes in the volume of heavy-duty and passenger traffic are viewed separately.

The traffic impacts of decommissioning are reviewed by estimating the transport volumes and methods related to it and the routes used. In addition, the transport arrangements in the project area are described. Any changes to the traffic volumes with regard to heavy-duty traffic and passenger traffic, and in traffic arrangements are presented. With regard to the spent nuclear fuel, the assessment considers both the road transport and shipping options (Posiva 2008). Based on these, an expert assessment of the impact on the flow and safety of traffic is conducted.

6.5 NOISE

This assessment area covers noise caused by the various stages of the project and transport. The noise impacts of the extension of the operation are similar to those in the current operations. Noise deviating from the current operation is generated by potential construction work and the excavation of the L/ILW repository. Noise related to decommissioning is generated especially by the dismantling activities and handling of dismantling materials.

The assessment of the noise impacts is based on the project planning information and the existing information concerning the current noise level in the area's environment. An expert assessment of noise emitted to the environment is carried out based on the noise emissions generated in the project, and the noise levels caused by the project are compared to the results of the existing surveys for the area, the limit values of the power plant's environmental permit and the guideline values of noise. As the noise measurements in the current status have indicated that the noise in the environment mainly consists of the sounds of nature and noise from the power plant, there is no need to assess any combined impacts with other noise generated in the vicinity. The assessment also considers potential underwater noise caused by water engineering.

6.6 VIBRATION

Concerning vibration, the assessment especially examines the impacts of vibration caused by the excavation of the L/ILW repository and the dismantling activities. The assessment also considers the transport impacts of vibration.

The impacts of vibration are assessed based on the power of the shockwave generated by the vibration source and the dispersion of vibration. The assessment covers buildings and structures in the project area and the immediate vicinity, as well as devices and equipment sensitive to vibration. In addition, any impacts of vibration experienced by people are assessed.

6.7 AIR QUALITY

The conventional emissions caused by the extension of the operation of the power plant will to a large extent be similar to those seen currently. In the EIA report, the emissions caused by the operation of the power plant's diesel and backup power generators are presented based on the operating times and estimated fuel consumption of the current power plant. The impacts are assessed by comparing the emissions with the emission limits.

Potential additional construction and the expansion of the L/ILW repository, as well as dismantling related to decommissioning, cause dust emissions. In addition, emissions are caused by traffic in both the extension and decommissioning of the operation. The assessment of these impacts is based on an expert estimate of dust and exhaust emissions, carried out on the basis of planning and traffic volume data, and the impact of these emissions on air quality. Potential increases in content are viewed by comparing them to the particle content caused by the current operation and the present status of air quality in the Loviisa area.

Radioactive emissions into the air caused by the extension of the operation and decommissioning of Loviisa power plant are presented, and an expert assessment of their impacts is provided by comparing the power plant's estimated emissions with the actual emissions and the emission limits. The radiation doses caused by the emissions are assessed by means of calculations.

The methods to assess greenhouse gas emissions are covered in Chapter 6.19.

6.8 GROUND AND BEDROCK

With the extension of the operation, the impacts on the ground and bedrock are related to the potential construction in the area (including new storage and hall buildings). The impacts of construction are local and mainly target the surface of the ground. The impact assessment covers additional construction at the power plant with a focus on the land areas and planned construction measures required by the related structures and buildings (such as earth works, excavation and filling), among other things.

The most significant impact on the bedrock in the preparation for the decommissioning of the power plant is caused by the expansion of the L/ILW repository at a depth of more than 100 metres and the related excavation. These impacts on the ground and bedrock are assessed on the basis of the dimensions of the underground parts, the operation of the repository and the planned construction measures (including excavation). In addition, the reuse of the blasted rock in the closure of the repository is reviewed.

The baseline data in the assessment includes existing research data and maps of the ground and bedrock of the Hästholmen area.

Any areas with contaminated soil in the project area are identified before construction work if necessary.

6.9 GROUNDWATER

In the option to extend the operation, the impacts on groundwater remain similar to the current impacts. The impacts of rock excavation and blasting carried out during the expansion of the L/ILW repository on the quality of the groundwater may include temporary local clouding, increased nitrogen compound content and residue from explosives. The seepage water accumulated in the repository is pumped into the sea. Currently, the volume of seepage water is less than 60 m³/day. The expansion of the repository is likely to increase the volume of seepage water to some extent. In addition, repository construction may have a local impact on the level of groundwater.

The assessment of the impact on groundwater includes potential changes caused by the modification and expansion of the power plant, and the L/ILW repository and additional construction to the quality, volume and level of groundwater. The baseline data in the assessment includes existing research data on the groundwater conditions of and the quality of groundwater in the Hästholmen area.

6.10 SURFACE WATERS

Long-term monitoring has been carried out on the impacts of the power plant on the quality of surface waters and the biological sea environment, so the state of the nearby sea area and its long-term changes are known well. The most significant environmental impact of the power plant on the nearby sea area is the thermal load. Otherwise, the load caused by the power plant is minimal compared to the other load for the area.

To assess the impact of the extension of the operation, a cooling water modelling is carried out both in the current situation and in the new situation when the potential water engineering has been completed. In addition to reviewing the measured data on temperatures, a calculation model on currents is used to assess the impact of the cooling water on the seawater temperature. The assessment covers the cooling waters of both power plant units. The outcome is the dispersal calculations for the basis of the environmental impact assessment. The model calculations on the dispersal of the cooling waters and the estimates of the impacts on the temperatures of the sea area focus on the discharge side – in other words, on Hästholmsfjärden and Klobbfjärden. The sea area of the intake side, Hudöfjärden and Vådholmsfjärden to the south, are included in the model assessment, since some cooling waters recirculate from the discharge side to the intake side.

If the power plant's operation is extended, the load and impacts on surface waters remain largely similar to the current situation, with the exception of minor changes. To lower the coolant water intake temperature, water engineering is planned in the intake area. The measures include dredging, excavation, potential dumping of masses in the sea and the construction of a new embankment structure. These measures cause temporary clouding of water in the sea area, and an expert assessment is carried out on the impact of clouding based on water engineering plans, considering the dredging volume and the type of sediment, among other things. In addition, alternative methods of managing the power plant's service water and wastewater are investigated. The impacts of this on water systems are assessed based on the nutrient load. The assessment is based on the planning data concerning wastewater connections, as well as on existing surveys and research data on the state of the sea area.

With regard to decommissioning, the impacts on water systems end, for the most part, when the power plant's operation is discontinued. Cooling related to making the interim storage of spent nuclear fuel independent is likely to require a new seawater pumping station, but its related cooling water intake and discharge volumes are a fraction of the current volumes. An expert assessment is conducted on their impact on water systems.

The radioactive discharge to the sea caused by the extension of the operation and decommissioning of Loviisa power plant are presented, and an expert assessment is provided on their impacts by comparing the power plant's estimated discharge with the actual discharges and the discharge limits. The radiation doses caused by the discharge are assessed by means of calculations.

6.11 FISH AND FISHING

The impacts of the extension of the operation on fish and fishing may be caused by the discharged wastewater and the cooling waters warming the surrounding sea area that affect the marine ecosystem. In addition, dredging and excavation in the sea area may also have impacts. The assessment of the impacts targeting fish and fishing in the extension of the power plant's operation is based on the data on the current status of the ichthyofauna and fishing, and the assessment of the impacts on surface waters (Chapter 6.10). In addition, studies on test net fishing and fry research that complement the data on the current status of the ichthyofauna in the area are carried out for the EIA report. An expert assessment is carried out on the indirect impacts of the project activities that affect the quality of water for the fishing industry of the area.

During decommissioning, the impacts on water systems, and on fish and fishing, decrease as changes occur in the cooling water and wastewater. An expert assessment is conducted on them based on the impacts targeting surface waters.

6.12 FLORA, FAUNA AND CONSERVATION AREAS

The other sections of the EIA procedure provide important background information in terms of nature impacts, such as those caused by noise, dust, traffic and the thermal load conducted to water systems (and the discontinuation thereof), among other things. The assessment of the impacts is based on these assessments and models, as well as on complementary surveys in the field.

If the operation is extended, the power plant's impacts on flora and fauna remain similar to the current impacts, except for the direct impacts on habitats caused by potential additional construction, as well as indirect disturbances (e.g. traffic, noise, dust). Local impacts on flora and fauna related to decommissioning are primarily caused by dismantling measures and transport. For the most part, the measures target the built areas. Clearing the area for various access routes and potential storage areas may require cutting trees and levelling topsoil. Detailed planning also includes more specific reports concerning these areas when the need to update potential nature surveys carried out in the field is assessed.

The reports on the current status of the area are complemented by surveys conducted on the avifauna between December 2019 and December 2020. The surveys especially cover the impact of the power plant's warm cooling water on the avifauna that overwinters in the area, species that rest in the area during the spring and autumn migration seasons, and nest in Hästholmsfjärden. The nesting birds are mapped using the archipelago bird counting method, in which the populations of waterfowl and waders are determined by counting the nests on each island and rocky islet.

With regard to the impacts on sites included in the Natura 2000 network, the assessment aims to determine if the options being assessed are likely to cause significant impacts on nature values that are being protected in the Natura areas. The assessment considers other potential activities or projects that cause combined impacts. The preparation of the report applies a means test in the Natura assessment which identifies potential impact mechanisms that target the basis for protection and assesses their potential significance. If the impacts prove significant, or if the possibility of significant impacts cannot be reliably ruled out, the assessment is expanded into a Natura assessment in accordance with section 65 of the Nature Conservation Act, and opinions on the assessment are requested during the public display of the EIA report as required by the Nature Conservation Act.

With regard to sites included in other programmes in nature conservation areas, the assessment determines whether the options under assessment cause significant impacts in terms of the conservation objectives.

6.13 PEOPLE AND COMMUNITIES

6.13.1 People's living conditions, comfort and health

The assessment section covers the assessment of the social impacts targeting individuals, communities or society, which studies potential changes in the well-being of people or its distribution.

The EIA procedure assesses the impact of the extension and decommissioning of the power plant on the comfort and safety of the residential and living environment, traffic and mobility, outdoor activities in and recreational use of the surroundings, communality and local identity, services, business and industry, and demographics, as well as the use of tangible and fixed property in the vicinity. The assessment report also examines the impact of potential accidents.

Social impacts, such as residents' concerns, fears, wishes, and uncertainty about the future, may emerge as early as the planning and assessment stage of the project. Social impacts are tightly linked to other impacts (such as the regional economy, noise, emissions, traffic and landscape), either directly or indirectly. The identification and assessment of the social impacts helps map those population groups and areas that are particularly affected. At the same time, the significance of the impacts and the opportunities to mitigate and prevent adverse impacts is assessed.

The assessment of social impacts is an expert assessment based on all available baseline information. The baseline data includes the following:

- results of other impact assessments;
- feedback received at audit group meetings and small group meetings;
- results of the residential survey;
- opinions and statements submitted about the EIA programme;
- other feedback received during the assessment procedure (e.g. public events);
- population and map statistics, and other statistics;
- media visibility.

The impact on people's living conditions, comfort and health is assessed by means of the "Ihmisiin kohdistuvien vaikutusten arvioiminen" guideline (Kauppinen ja Nelimarkka, 2007) on the assessment of impacts on people prepared by the National Research and Development Centre for Welfare and Health (Stakes). The guideline on the application of the EIA Act in the assessment of health and social impacts, published by the Ministry of Social Affairs and Health (Ministry of Social Affairs and Health 1999), is also utilised in the assessment.

Health impacts are assessed by comparing the results generated in the other impact assessment sections of this EIA procedure with the guideline values or recommendations (e.g. traffic, noise, vibration, air quality, groundwater and surface waters). In addition, theoretical radiation exposure is assessed and compared with the limit values set in the requirements by the authorities and the natural background radiation, among other things. Operations related to both the extension and decommissioning in the power plant area are considered. In addition, the potential health impacts of the transport of spent nuclear fuel are assessed based on the reports concerning the risks and implementation methods of transport and other surveys (among others, Posiva Oy 2008).

The health impacts of potential exceptional situations are assessed on the basis of the risk assessment (Chapter 6.20). The starting point of the activities is to ensure that the quantity of radioactive substances released in potential accidents is sufficiently low to cause no direct health impacts.

6.13.2 Methods of interaction

To collect feedback from residents and other actors, a resident survey is conducted, and meetings of the audit group and small group meetings are held during the EIA procedure, in addition to the opinions and statements obtained on the EIA Programme, and the feedback collected in the public event.

Audit group

An audit group is set up for the assessment procedure with the purpose of promoting the flow and exchange of information between the project owner, the authorities and the key stakeholders in the area. Parties that are invited to the audit group include representatives of the town of Loviisa, adjacent municipalities and local stakeholders as well as various experts and authorities. Representatives of the project owner (Fortum Power and Heat Oy) and the consultant (Ramboll Finland Oy) also participate in the work of the audit group. The audit group convenes twice during the assessment procedure.

Resident survey

A resident survey is conducted at the EIA report stage to study the views of the area's residents on the impacts of the project and their attitude to the project. A summary of the assessment programme, including a description of the project, is attached to the resident survey.

The resident survey targets permanent households and holiday residents, focusing on the immediate surroundings. The survey questionnaire is sent by mail to all permanent households and holiday residents within five kilometres of the power plant area and to a representative sampling of other households in the Loviisa region within a 5–20-kilometre radius. In both areas, one questionnaire is sent to each household. The addresses of the recipients are obtained from the Population Register Centre. However, those who have prohibited direct marketing or the disclosure of their address information will not receive the questionnaire. The survey can also be taken online.

The results of the resident survey are used in the impact assessment, and the experiential information collected in the survey can also be compared to impacts assessed by other means. The survey may raise potential concerns about the project but also offer methods to mitigate its impacts.

Small group events

Small group events are held at the EIA report stage to disseminate information on the project and collect the views of various stakeholders on the project and its impacts. Participants in the events can offer their views on the impacts and functions to be assessed, among other things.

The small group events consist of workshops. They include group work on the present status of the area, the project options to be assessed and their schedule, as well as the potential impacts of the projects on people's living conditions and comfort. The methods applied in the group work include markings made on maps and increased dialogue between various stakeholders. The outcomes of the events and the themes highlighted in the discussions are summarised, and their conclusions are presented in the EIA report.

The composition of the workshops' groups and themes is customised based on the information needs and the target group to elaborate on factors raised in the resident survey, among other things. The stakeholders may include the area's permanent and holiday residents, fishermen, environmental organisations and local entrepreneurs. The composition of the small group events is specified in the EIA report stage once the public event of the EIA Programme and the first meeting of the audit group have been held, and the results of the resident survey are available.

6.13.3 Regional economy

The impact of extending and decommissioning the operation of the power plant is assessed by using the resource flow model developed by the Natural Resources Institute Finland on the assignment of Sitra. The resource flow model helps assess the project's impacts on the regional economy. The information of the resource flow model is updated with the latest statistics available on the state of the regional economy and business and industry before the impact assessment (including jobs and turnover by sector).

The assessment covers the direct impacts of the project options on the regional economy, and the multiplier effects of production and consumption generated by the operation on employment, total yield, value added and tax income. The assessment of the impacts on the regional economy thus consider not only the direct impacts of the project but also the production impacts that are indirectly linked to the operations, as well as changes in consumption caused by the changed compensation of employees and its associated impacts.

At the beginning of the impact assessment, the present situation is evaluated, followed by the impacts of the stages of the project lifecycle on the economy in the scenarios of extending the power plant's operation and decommissioning. Among other things, the resource flow model provides information on both direct links and the connections stemming from the multiplier effects between sectors and enterprises. The results of the model describe the impacts on enterprises, the region, the regional economy and the whole of Finland.

6.14 RADIATION

The methods to assess the radiation impact are described in Chapters 6.7, 6.10, 6.13, 6.16, 6.17, 6.20 and 6.22.

6.15 USE OF NATURAL RESOURCES

The EIA report assesses the impacts generated by the use of natural resources. Factors included in the assessment of the use of natural resources include the reuse of blasted rock generated in the construction of the L/ILW repository and the recycling of conventional dismantling materials generated in the dismantling processes. In addition, a schematic presentation of the production chain of nuclear fuel, including the impacts of the use of uranium, is provided.

6.16 WASTE AND BY-PRODUCTS

The EIA report describes the quantity, type and handling of conventional and hazardous waste, low and intermediate waste, as well as decommissioning waste and other dismantling waste, generated during the extension of the power plant's operation and during decommissioning. The related environmental impacts are assessed on the basis of the properties and handling techniques of waste and by-products, among other things. In addition, potential reuse sites and the final disposal solutions for waste are described. With regard to radioactive waste, the main focus of the environmental impact assessment is on the long-term impacts of such waste after the waste has been deposited in the final disposal facility located in the power plant area (Chapter 6.17).

The handling and interim storage of spent nuclear fuel in the power plant area are described, and their environmental impacts are assessed on the basis of the decommissioning plan of Loviisa power plant, among others. In addition, the transport of spent nuclear fuel from Loviisa power plant to Posiva's encapsulation plant and final disposal facility in Eurajoki, and the main principles of the final disposal concept are described. The environmental impact of transport and final disposal of spent nuclear fuel are assessed in the environmental impact assessment procedure concerning the encapsulation plant and final disposal facility (Posiva Oy, 2008 and 2012). The assessment's main results are included in the EIA report. In addition, a risk and implementation method report concerning transport is used.

The environmental impacts of radioactive waste generated elsewhere in Finland and received at Loviisa power plant are based, among other things, on the results obtained in the EIA procedure concerning the decommissioning of VTT's FiR1 research reactor (VTT 2014) and other surveys on the topic. Their impacts are assessed as part of the impact of waste management at Loviisa power plant.

6.17 LONG-TERM SAFETY OF THE L/ILW REPOSITORY

The long-term safety of the final disposal of the nuclear waste to be deposited on Hästholmen for final disposal are assessed by means of a separate safety case in accordance with decrees, provisions and regulations issued pursuant to the Nuclear Energy Act and Radiation Act. In 2018, Fortum prepared a safety case on the final disposal of radioactive waste generated in the operation and decommissioning of Loviisa power plant.

The safety case is a set of documents that demonstrates how the requirements concerning the long-term safety of final disposal are met. It assesses the development of the different parts of the final disposal system, and their ability to contain and delay the release of radioactive substances and their entry into the surface environment. The main uncertainties related to the functioning of release barriers have been combined in a scenario. A key tool in the assessment of the impact of the uncertainties includes probability-based calculation methods.

The main sections of the safety case are as follows:

- Description of the development of the final disposal system and the design basis
- Performance analysis and preparation of scenarios
- Emission and dose analysis
- Summary.

The safety case's supervisory authority is STUK, which approves the documents if the safety requirements are met. The latest safety case was approved in 2019.

The EIA report presents the key results of this safety case and separately assesses the impact on long-term safety of the extension of the power plant's operation and the radioactive waste received at Loviisa power plant from elsewhere in Finland

6.18 ENERGY MARKETS AND SECURITY OF SUPPLY

Loviisa power plant generates electricity for the Nordic wholesale electricity market and promotes Finland's security of supply by maintaining the national capacity. Extending the operation will not change the situation on the electricity market, but it will strengthen Finland's security of supply through reliable domestic production in potential exceptional situations, especially when the Nordic electricity market does not function for some reason. In decommissioning, the need for electricity would be covered by the market through other means, which would be likely to weaken Finland's security of supply. However, it is not possible to reliably determine an alternative form or location of electricity production. The advantage of Loviisa power plant is that it produces stable base power, whereas nearly all other new production in the Nordic countries varies based on the weather. The impact on the electricity market and Finland's security of supply are assessed taking the schedules of the different options in the project into account.

6.19 CLIMATE CHANGE

The climate change impact is assessed based on the greenhouse gas emissions generated in the project. The emissions are presented as carbon dioxide equivalents (CO_{2e}): the greenhouse gas emissions created in the different stages of the project are made commensurate to describe the global warming potential (GWP).

With regard to the extension of the power plant's operation, the assessment focuses on the direct greenhouse gas emissions of the activities, generated mainly by the CO_{2e} emissions from the use of fuel by the power plant's backup power generators and transport. In addition, the carbon dioxide emissions of various forms of energy production based on published reports on lifecycle studies of various fuels are viewed and compared.

Electricity production is covered by the EU's emissions trading. The emissions of individual power plants therefore do not affect overall emissions in the EU, since emissions trading sets a limit on the total emissions of the participating operators.

With regard to decommissioning, the assessment examines the impact of the termination of the power plant's operation in terms of Finland's national carbon neutrality objective when electricity production with nuclear power, free of carbon dioxide emissions, is replaced by other methods of electricity production.

The risks caused by climate change (e.g. rising sea levels or floods) to the project in the event of exceptional situations and accidents are identified at the EIA report stage, and the preparations for such risks are described.

6.20 EMERGENCIES AND ACCIDENTS

The EIA report includes a description of a fictional severe reactor accident. The assessment is based on the assumption that a quantity of radioactive substances (100 TBq of nuclide Cs-137) corresponding to the limit value of a severe accident in accordance with section 22 b of the Nuclear Energy Decree 161/1988 is released into the environment. The impact of the dispersion of the release in the accident is studied over a distance of 1,000 km from the power plant. The fallout and radiation dose caused by the release and their impact on the environment are described on the basis of modelling outcomes and the existing research data.

In addition, the EIA report presents other identified exceptional situations, related to the extension of the operation and decommissioning of the power plant (including waste management), and reviews their environmental impact based on the requirements set for a nuclear power plant by the authorities and the surveys conducted. The assessment provides a concise description of the emergency preparedness in the event of a nuclear accident. In addition, recognised emergencies and accidents, such as fires or risk situations related to transport are presented, which may cause a radiation hazard. Recognised emergencies and accidents can be prevented and contained by means of technical and administrative methods. These are described at a general level in the EIA report.

The EIA report also identifies other conventional environmental and safety risks related to the project, and potential emergencies and accidents associated with them. Such risks and incidents mainly include chemical and oil spills that may contaminate the soil and groundwater. The existing safety and risk analyses for the power plant are reviewed to identify emergencies and accidents.

6.21 COMBINED IMPACTS

The combined impacts of the project functions with other functions and projects in the vicinity are assessed by impact area in the EIA report. Other operators in the vicinity of the project area are identified and described. In addition, the report describes the impact of the associated projects on the basis of existing published environmental impact assessments. These include Posiva's encapsulation plant and final disposal facility for spent nuclear fuel (Posiva Oy, 2008) and the potential organisation of waste management related to the decommissioning of the FiR 1 research reactor (VTT, 2014).

6.22 TRANSBOUNDARY IMPACTS

According to a preliminary assessment, in the options reviewed in the EIA procedure, the only transboundary impact would be the release of radioactive substances generated in a severe reactor accident related to the extension of the operation of the power plant (VE1). No transboundary impacts have been identified with regard to decommissioning (VE0 and VE0+).

Potential transboundary impacts are assessed in the EIA report based on the dispersion calculations, in which the impact of the dispersion of the emission caused by the accident is studied over a distance of 1,000 km from the power plant. In addition, the assessment views other potential risks related to emergencies, accidents, and transport, and estimates whether the impact could be transboundary.

6.23 SUMMARY OF THE ASSESSMENT METHODS AND A PROPOSAL OF THE SCOPING OF THE IMPACT AREA

The project area refers to the Hästholmen area, which is the location of the current functions of the power plant and the changes planned for them in the project. Environmental impacts are assessed especially in the project area and its vicinity, but the area to be studied may also be broader. The observed areas concerning environmental impacts have been defined to cover the maximum reach of the impacts. In reality, the environmental impacts are likely to occur in an area smaller than the observed area. The EIA report presents the results of the environmental impact assessment and their affected areas.

Table 6-1 shows a summary of the assessment methods by impact and the proposed observed areas.

Table 6-1. Summary of the environmental impacts to be reviewed, assessment methods and the preliminary observed area of the impacts.

Component	Methods of assessment	Observed area
Land use, land use planning and the built environment	An expert assessment of how the project relates to the current and planned land use and land use planning. In addition, built environment sites and the distance thereto are assessed.	Approximately up to 5 km from the project area.
Landscape and cultural environment	An expert assessment of the project's relation to the landscape of the vicinity (holiday housing, in particular) and the landscape overall. Cultural environment sites are identified.	Approximately 5 km from the project area.
Traffic	A calculated assessment of the changes generated by the project in traffic volumes and an expert assessment of the impact of transport on traffic safety. The assessment also applies a separate survey conducted concerning the risks and implementation methods related to the transports of spent nuclear fuel.	The traffic routes leading to the project area up to main road 7 in Loviisa. In addition, the immediate vicinity of the transport routes for spent nuclear fuel.
Noise and vibration	An expert assessment of the noise emissions and vibration caused by the different phases of the project and transport, as well as their dispersion in the environment.	The project area and its vicinity within an approximately 3-km radius and the nearby areas along the transport routes.
Air quality	An expert assessment of the typical emissions into the air generated by the project.	The typical emissions into the air caused by construction, dismantling and transport activities, and the extension of the operation within an approximate radius of 1–2 kilometres.
Soil, bedrock and groundwater	An expert assessment based on the planned construction and final disposal measures.	The project area.
Surface waters	A modelling of the cooling water and an expert assessment based on it concerning the impact on the sea area. An expert assessment of the impacts of water structures, service water intake, and the management and discharge of wastewater. In addition, a survey is conducted on the pollutants and sub-bottom profiling of sediments.	Approximately 5 km from the project area.
Fish and fishing	An expert assessment to be conducted based on ichthyofauna studies and the impact assessment of surface waters.	Approximately 10 km from the project area.
Flora, fauna and conservation areas	An expert assessment of the impacts on the natural environment and conservation areas. In addition, an avifauna survey is conducted in connection with the EIA procedure.	Approximately 10 km from the project area, with a special focus on the sea area.
People's living conditions, comfort and health	An expert assessment (including the regional economy, noise, emissions, traffic and landscape) to be conducted based on the calculated and qualitative assessments carried out in the sections concerning other impacts. In addition, a resident survey and small group interviews are conducted.	The power plant's vicinity and transport routes. The resident survey is conducted within a 20-kilometre radius.
Regional economy	A survey of the regional economy, based on an analysis of the current situation and resource flow modelling.	Finland.
Emissions of and radiation from radioactive substances	An expert assessment of the release of radioactive emissions generated by the project into the air and sea. Radiation in the vicinity of Loviisa power plant is monitored in accordance with the monitoring programme in effect, and the assessment is based on data obtained from the monitoring. The radiation doses caused by releases are assessed by means of calculations.	Radiation monitoring of the environment within an approximate radius of 10 km, radiation dose calculation within 100 km.
Use of natural resources	An expert assessment of, for example, the use of blasted rock, and a description of the impact of the nuclear fuel production chain.	The production chain of nuclear fuel at a general level. Other use (e.g. mineral aggregate) locally or regionally.
Waste and by-products	An expert assessment of the waste streams in different phases and the processing, utilisation options and final disposal thereof. Reports prepared earlier (including Posiva 2008) are used to describe the impact of the transport and final disposal of spent nuclear fuel.	Spent nuclear fuel from Loviisa power plant to Eurajoki, including the transport routes. Others locally or regionally.
Long-term safety of the L/ILW repository	Includes the key results of the safety case and an expert assessment of the impact on long-term safety of the extension of the power plant's service life and the radioactive waste originating from elsewhere in Finland than Loviisa power plant.	The vicinity of the power plant.
Energy markets and security of supply	An expert assessment of the development of and changes in the energy market in the project options.	Finland.
Climate change	Calculated assessment of carbon dioxide emissions (CO_{2e}) and their impact on Finland's total emissions.	At the national level in Finland.
Emergencies and accidents	A modelling of a fictional severe reactor accident which releases 100 TBq of the Cs-137 nuclide into the atmosphere. As a result, the modelling provides the fallout and radiation doses caused by the release. An expert assessment of the impacts.	1,000 km.
Combined impacts	An expert assessment of the combined impacts with regard to the other actors in the region and the associated projects.	The vicinity of the project area and the municipalities involved in the associated projects.
Transboundary impacts	An assessment to be prepared based on separate surveys and modelling of the impact of the project potentially extending beyond the borders of Finland.	1,000 km.

7. Uncertainties

The EIA procedure is part of the project planning stage, and the planning details concerning the project will be specified as the project progresses to subsequent stages through licensing, for example. The baseline information and impact assessment currently applied may therefore include various assumptions and generalisations that may cause uncertainties in the assessment of environmental impacts. The EIA report describes the identified potential uncertainties and assesses their significance with regard to the reliability of the results of impact assessments.

8. Prevention and mitigation of adverse impacts

The possibilities of preventing or mitigating the project's potential adverse impacts through planning and implementation methods are viewed as part of the environmental impact assessment. The identified methods to prevent and mitigate adverse impacts are presented in the EIA report.

9. Impact monitoring

The impact assessment includes the potential need to update the project owner's existing monitoring programmes for environmental impact assessment. Loviisa power plant monitors the impact on the state of the nearby sea area through qualitative and biological water monitoring (benthic fauna, phytoplankton, aquatic vegetation), among other things, and on professional and recreational fishing. In addition, extensive radiation monitoring of the environment is carried out.

10. Required plans, licences and decisions

10.1 LICENCES AND PERMISSIONS PURSUANT TO THE NUCLEAR ENERGY ACT

The power plant units of Loviisa nuclear power plant have operating licences in accordance with the Nuclear Energy Act which are valid until the end of 2027 and 2030 respectively. The operating licence of the final disposal facility for low- and intermediate-level waste is valid until the end of 2055.

To extend the operation of the power plant, new operating licences must be applied for the power plant units. The decommissioning of the power plant units requires that a decommissioning licence be applied. The operating licence and decommissioning licence are issued by the Government.

In the case of both extending the operation and the decommissioning of the power plant, the L/ILW repository is operated longer than the validity of the current operating licence, which is why a new operating licence must be applied for the L/ILW repository. In addition, the current operating licence of the L/ILW repository does not cover all planned purposes of use, and they can be taken into account in the potential licence application.

Other plant parts to be made independent need an operating licence when the commercial operations of the power plant units end, and their operating licence expires when the decommissioning licence becomes effective. The implementation of the project also requires other licences in accordance with the Nuclear Energy Act.

10.1.1 Operating licence

The licence to operate a nuclear facility may be issued provided that the prerequisites listed in section 20 of the Nuclear Energy Act are met. The prerequisites include the following:

- the nuclear facility and its operation meet the safety requirements laid down in the Nuclear Energy Act, and appropriate account has been taken for the safety of workers and the population;
- the methods available to the applicant for arranging nuclear waste management, including disposal of nuclear waste and decommissioning of the facility, are sufficient and appropriate;
- the applicant has sufficient expertise available, and especially the competence of the operating staff and the operating organisation of the nuclear facility are appropriate;
- the applicant is considered to have the financial and other prerequisites to engage in operations safely and in accordance with Finland's international contractual obligations.

Operation of the nuclear facility shall not be started on the basis of the licence granted for it until the Radiation and Nuclear Safety Authority has ascertained that the nuclear facility meets the safety requirements set, that the security and emergency arrangements are sufficient, that the control necessary to prevent the proliferation of nuclear weapons has been arranged appropriately, and that the nuclear facility operator has arranged, in the manner provided, indemnification regarding liability in the event of nuclear damage. In addition, it is required that the Ministry of Economic Affairs and Employment has ascertained that provision for the cost of nuclear waste management has been arranged in accordance with the provisions of the Act.

10.1.2 Decommissioning licence

When the operation of a nuclear facility has been terminated, the holder of the operating licence shall be obligated to undertake measures to decommission the nuclear facility in accordance with the plan and the requirements set for decommissioning referred to in section 7g of the Nuclear Energy Act, and apply for a licence for the decommissioning of the nuclear facility. The licence shall be applied for well in advance so that the authorities have adequate time to assess the application before the termination of the operating licence of the nuclear facility.

- A licence for the decommissioning of a nuclear facility may be granted if the prerequisites listed in section 20 a of the Nuclear Energy Act are met. The prerequisites include the following:
- the nuclear facility and its decommissioning meet the requirements related to safety in accordance with the Nuclear Energy Act, and the safety of the employees and the population, as well as environmental protection, have been duly taken into account;
- the methods available to the applicant for the decommissioning of the nuclear facility as well as other nuclear waste management are adequate and appropriate;
- the applicant has the necessary expertise and especially the competence of the nuclear facility personnel and the organisation of the nuclear facility available, and they are appropriate and suitable for
- decommissioning;
- the applicant has the financial and other necessary requirements to carry out the decommissioning safely and in accordance with Finland's international contractual obligations.

The decommissioning of a nuclear facility may not be started before the granting of the related licence unless otherwise provided in the other licences of the licence holder. The decommissioning of a nuclear facility may not be started on the basis of the licence granted for it until the Radiation and Nuclear Safety Authority has ascertained that the nuclear facility meets the safety requirements for decommissioning, that the security and emergency arrangements are sufficient, that the control necessary to prevent the proliferation of nuclear weapons has been arranged appropriately, and that the nuclear facility operator has arranged, in accordance with the related provisions, indemnification regarding liability in the event of nuclear damage. In addition, it is required that the Ministry of Economic Affairs and Employment has ascertained that provision for the cost of nuclear waste management has been arranged in accordance with the provisions of the Act.

10.1.3 Other licences in accordance with the Nuclear Energy Act

In addition to the operating licence and decommissioning licence, the project may include other licences in accordance with the Nuclear Energy Act. Section 21 of the Nuclear Energy Act provides the prerequisites for granting a licence for other use of nuclear energy, such as the possession, manufacturing, production, transfer, handling, use, storage, transport and import of nuclear substances and nuclear waste, as well as final disposal on a smaller scale than extensive final disposal (the operating licence). In accordance with section 16 subsection 2 of the Nuclear Energy Act, STUK grants a licence for the aforementioned operations by application.

- A licence can be granted for other use of nuclear energy when so required by the operation if the prerequisites set in section 21 of the Nuclear Energy Act are met: The prerequisites include the following:
- the use of nuclear energy meets the safety requirements laid down in the Nuclear Energy Act, and appropriate account has been taken of the safety of the workers and the population, and environmental protection;
- the applicant has possession of the site needed for the use of nuclear energy;
- nuclear waste management has been arranged appropriately, and provision for the cost of nuclear waste management has been made in accordance with the provisions of the Nuclear Energy Act;
- the applicant's arrangements for the implementation of control by the Radiation and Nuclear Safety Authority as re-

ferred to in the Nuclear Energy Act are sufficient;
- the applicant has sufficient expertise available, and the operating organisation and competence of the operating staff are appropriate;
- the applicant is considered to have the financial and other prerequisites to engage in operations safely and in accordance with Finland's international contractual obligations;
- the authorisations required under the Council Directive on the supervision and control of shipments of radioactive waste and spent fuel (2006/117/Euratom) have been obtained from foreign states, and the said provisions can also be observed in other respects;
- the use of nuclear energy otherwise meets the principles laid down in Sections 5–7 of the Nuclear Energy Act and does not conflict with the obligations under the Euratom Treaty.

The use of nuclear energy shall not be initiated on the basis of a granted licence until the Radiation and Nuclear Safety Authority has ascertained, when required by the operations, that the use of nuclear energy is in accordance with the safety requirements set, that the security and emergency arrangements are sufficient, that the control necessary to prevent the proliferation of nuclear weapons has been arranged appropriately, and that indemnification regarding liability in the event of nuclear damage in connection with the operations has been arranged in compliance with the relevant provisions.

10.2 LAND USE PLANNING

The valid local detailed plan makes it possible to carry out modification work in the power plant area, construct additional structures and buildings, and decommission the power plant. Needs to change land use plans may become topical after decommissioning if existing limitations to the use of land in the power plant area and its surroundings caused by the power plant's operation are lifted. The local detailed plan is approved by the Loviisa town council.

10.3 PERMITS IN ACCORDANCE WITH THE LAND USE AND BUILDING ACT

In accordance with the Land Use and Building Act (132/1999), the construction of power plant buildings related to the required modification work, the necessary infrastructure and facilities requires a building permit. In Loviisa, the town's building and environmental board is responsible for the duties and decision-making of the building inspection authorities.

In areas covered by a local detailed plan, a building permit is granted under the following conditions:
- the building project is in keeping with the valid local detailed plan;
- construction meets the requirements laid down in the Act and other requirements prescribed in or under the Act;
- the building is appropriate for the location concerned;
- a serviceable access road to the building site exists or can be arranged;
- water supply and wastewater management can be organised satisfactorily and without causing environmental harm; and
- the building will not be located or constructed in a way that causes unwarranted harm to neighbours or hinders appropriate building on a neighbouring property.

Separate action permits may be required for smaller structures, such as containers of temporary warehouses if they are not included in the building permit application.

A separate demolition permit in accordance with the Land Use and Building Act is not needed, but the local building supervision authority shall be notified in writing of the demolition of a building or part thereof 30 days before the demolition work begins (Land Use and Building Act, section 127).

10.4 ENVIRONMENTAL AND WATER PERMIT

The operation of a nuclear power plant requires an environmental permit in accordance with the Environmental Protection Act (527/2014) (annex 1 Activities subject to a permit, *Table 2* Other installations, section 3 Energy production, b) nuclear power plant).

Loviisa power plant has an environmental permit and a water permit granted by the environmental permit agency of Western Finland on 8 April 2009 (decision numbers 23/2009/2 and 24/2009/2). The permit became legally valid by the decision issued by the Supreme Administrative Court on 19 June 2012. The permit applies to the operation of the power plant, cooling water intake, emissions of the power plant and monitoring. The power plant has a service water abstraction permit granted by the Water Rights Court by its decision on 27 December 1976 for the abstraction of raw water from Lappomträsket lake. The said permit applies to the conduction of water from the Lappomträsket lake and the regulation of the water level.

A permit is required for any change in an activity that increases emissions or their impact, or for any other substantial change in an activity requiring an environmental permit. However, no permit is required if the change does not increase the environmental impact or risks, and if the change in the activity does not require the permit to be reviewed. (Environmental Protection Act Section 29) The operator shall inform the environmental protection authority without delay of the termination of the activity. When required, the authority shall grant a new environmental permit, including the permit provisions, for the measures, monitoring requirements and other obligations required to terminate the activity.

Granting the environmental permit requires that the operations, considering the permit provisions to be set and the location of the activity, do not alone or together with other functions:
- cause harm to health;
- cause other
  - harm to the environment and its functions;
  - prevent or materially hinder the use of natural resources;
  - cause a loss of general amenity of the environment or of special cultural values;
  - reduce the suitability of the environment for general recreational use;
  - cause damage or harm to property or impairment of use;
  - constitute a comparable violation of the public or private interest;
- result in the violation of the prohibition of soil or groundwater contamination;
- cause the deterioration of special natural conditions, present a risk to the water supply or affect other potential uses important to the public interest within the area impacted by the activity;
- create the unreasonable burden referred to in the Adjoining Properties Act.

Permit provisions that prevent and limit emissions are set for the operations in the permit by considering the nature of the operations and local environmental conditions.

A separate environmental permit is required if a rock-crushing plant (with a minimum operating time of 50 days per year) is set up in the area for decommissioning and dismantling operations during construction work.

Water intake and discharge structures and water engineering work require a permit in accordance with the Water Act (587/2011). The application should include a project description and a report on the impact of the project in accordance with the Government Decree on the management of water resources (1560/2011).

A permit for a water resources management project will be granted if:
- the project does not significantly violate public or private interests;
- the benefit gained from the project to public or private interests is considerable compared with the losses incurred for public or private interests.

The water resources management project may not jeopardise public health or safety, cause considerable detrimental changes in the natural state of the environment or the aquatic environment and its functions, or cause considerable deterioration in the local living or economic conditions.

The environmental permit authority is either the Southern Finland Regional State Administrative Agency or the environmental protection authority of the town of Loviisa, depending on the operation subject to the permit application. In water permit matters, the permit authority is the Southern Finland Regional State Administrative Agency. The environmental permit application and the permit application in accordance with the Water Act concerning the same operation shall be processed jointly and decided by a single decision unless this is considered unnecessary for a specific reason.

10.5 PERMITS AND DOCUMENTS IN ACCORDANCE WITH THE CHEMICALS ACT

Facilities engaged in extensive industrial handling and storage of chemicals require a permit granted by the Finnish Safety and Chemicals Agency (Tukes). The extent of the industrial handling and storage of chemicals is determined based on the quantity and dangers of the chemicals stored in the facility. The permit sets conditions for the activities, and a commissioning inspection is conducted at the facility after the permit is granted. Fortum's Loviisa power plant has a valid permit for the extensive industrial handling and storage of chemicals, and the power plant is an institution subject to a safety assessment regulated by Tukes.

The Act on the Safe Handling of Dangerous Chemicals and Explosives (390/2005, the "Act on Chemical Safety") excludes radioactive substances and products containing radioactive substances from its area of application. Changes in the handling, storage and quantities of radioactive materials do not therefore as a rule result in changes to the chemicals permit.

However, changes in the operation may, in accordance with the Act on Chemical Safety, invoke an obligation to apply in writing for a permit for a production facility change if the planned change is an expansion comparable to the establishment of a production facility or another essential change. Changes categorised as essential include a significant increase in the quantity of hazardous chemicals, a significant change in the hazardous chemicals being handled or stored, or in their properties or state, a significant change in the manufacturing or handling method, or another change that may significantly affect the accident risk. The notification of the change in the operation submitted to Tukes should include the essential information on the change and a report on the safety impact of the change. The institutions subject to a safety assessment should also update the essential parts of the safety assessment.

The Tukes regulatory authority should be notified of the decommissioning of Loviisa power plant in accordance with the Act on Chemical Safety. The notification concerning the decommissioning of the operation must include a plan for how the structures and areas of the production facility and its parts to be decommissioned are cleaned if required after the operations are discontinued, and the measures that are taken to ensure that hazardous chemicals and explosives do not cause personal injuries or damage to the environment or property.

10.6 OTHER PERMITS AND PLANS

The Government Decree on areas restricted for aviation (VNa 930/2014) has defined the surroundings of the power plant as a no-fly zone. The no-fly zone covers the power plant surroundings within a four-kilometre radius and at an altitude of up to 2,000 metres. On a general level, the Aviation Act (864/2014) requires a permit for air navigation obstacles to set up a facility, building, structure or sign of a certain height. The party responsible for maintaining the air navigation obstacle must notify the Finnish Transport Safety Agency or an instance designated by it of any changes concerning the obstacle (such as the removal of the air navigation obstacle) and its contact information.

Conventional dismantling requires a dismantling plan. In this connection, a contractor who has a work permit for asbestos demolition granted by the permit authority carries out the required survey concerning asbestos and harmful substances. The demolition method, protection and reuse possibilities of waste are determined based on the survey.

Anttila, P. 1988. Engineering geological conditions of the Loviisa power plant area relating to the final disposal of reactor waste. Voimayhtiöiden ydinjätetoimikunta, Report YJT-88-11.

Association of Finnish Municipalities, 2020 Tax rates of municipalities in 2020. https://www.kuntaliitto.fi/sites/default/files/media/file/Liite%203_kuntakohtaiset%20prosentit%20 2020_1.xlsx 12 February 2020

Eastern Uusimaa Regional Council 2007. Landscape types in Eastern Uusimaa.

Finnish Environment Institute 2019. Open data geographical location data service of the environmental administration.

Finnish Heritage Agency 2019. Cultural environment service portal. https://www.kyppi.fi/palveluikkuna/portti/read/asp/default.aspx 28.11.2019.

Finnish Heritage Agency 2018. Cultural environment service portal. [www.kyppi.fi] (15 June 2018)

Finnish Transport Infrastructure Agency 2019. Traffic volumes in 2018. https://julkinen.vayla.fi/webgis-sovellukset/webgis/template.html?config=liikenne 26 November 2019.

Fortum Power and Heat Oy 2008. Expansion of the Loviisa nuclear power plant with a third power plant unit. Environmental impact assessment report.

Fortum Power and Heat Oy 2019a. Loviisa power plant's report on seawater temperatures and their impact on the state of the sea area in the summer of 20 18. Internal report LO1-K873-00107.

Fortum Power and Heat Oy 2019b. Report on environmental impacts 2019. Internal report LO1-K870-00141.

Hatanpää, E. 1997. Groundwater report for the Loviisa area. Posiva Oy, Work report LOVIISA-96-03.

Helsinki-Uusimaa Regional Council, 2010. Regional Land Use Plan for eastern Uusimaa. Land use plan map, symbols and regulations.

Helsinki-Uusimaa Regional Council 2016a. Missä maat on mainiommat. Uudenmaan kulttu-uriympäristöt. Uudenmaan liiton julkaisuja E 176.

Helsinki-Uusimaa Regional Council 2016b. Phased Regional Land Use Plan for Uusimaa 2. Land use plan map, symbols and regulations as well as reports.

Helsinki-Uusimaa Regional Council, 2017. Phased Regional Land Use Plan for Uusimaa 4. Land use plan map, symbols and regulations, as well as reports.

Helsinki-Uusimaa Regional Council 2019a. Map service of the Helsinki-Uusimaa Regional Coun-cil.https://kartta.uudenmaanliitto.fi/maakuntakaavat/index.html?x=380783&y=6684698&zoom=0&lang=fi&layers=0-0 27 November 2019.

Helsinki-Uusimaa Regional Council. 2019b. The Helsinki-Uusimaa Land Use Plan 2050 (pro-posal stage). Land use plan map, symbols and regulations as well as reports.

Helsinki-Uusimaa Regional Council 2019c. Cultural environments in Uusimaa. Open data download service. https://avoinaineisto-uudenmaanliitto.opendata.arcgis.com/datasets/uudenmaan-kulttuuriymp%C3%A4rist%C3%B6t?geometry=25.924%2C60.332%2C26.578%2C60.391 27 November 2019.

Helsinki-Uusimaa Regional Council 2019d. https://www.uudenmaanliitto.fi/tietopalvelut/uusimaa-tietopankki/aineistot/vaesto 23 November 2019.

Ilus, E. 2009. Environmental effects of thermal and radioactive discharges from nuclear power plants in the boreal brackish water conditions of the northern Baltic Sea. STUK.

Karonen, M., Mäntykoski, A., Nylander, E. & Lehto, K. (eds) 2015. Vesien tila hyväksi yh-dessä. Kymijoen-Suomenlahden vesienhoitoalueen vesienhoitosuunnitelma vuosiksi 2016–2021. Centre for Economic Development, Transport and the Environment. Reports 132/2015.

Kauppinen, T. & Nelimarkka, K. 2007. Ihmisiin kohdistuvien vaikutusten arvioiminen. Stake guides 2007:68. 55 pp. https://www.julkari.fi/bitstream/handle/10024/77751/IVA-opas%20 taittoversio.pdf?sequence=1&isAllowed=y

Kokkonen V. 2018. Statistics Finland, Enterprise statistics, Establishments of enterprises by industry and municipality, email 23 November 2018.

Kymijoen vesi ja ympäristö ry 2018. Fortum Power and Heat Oy Loviisa power plant and Oy Loviisan Smoltti Ab. Comprehensive annual report for joint monitoring of the sea area 2017. Kymijoen vesi ja ympäristö ry publication No. 272/2018. ISSN 1458-8064.

Kymijoen vesi ja ymparisto ry 2019. Fortum Power and Heat Oy Loviisa power plant and Oy Loviisan Smoltti Ab. Annual report for joint monitoring of the sea area 2018. Kymijoen vesi ja ympäristö ry publication No. 280/2019. ISSN 1458-8064.

Launiainen, J. 1979. Studies of energy exchange between the air and the sea surface in the coastal area of the Gulf of Finland. Finnish Marine Research, 246, 3–110. ISSN 0357-1076. Fin-nish Institute of Marine Research.

Leino, K. 2012. Nutrient load in the sea area near the Loviisa power plant. 6 November 2012.

Marjamäki, M. 2012. Selvitys Loviisan voimalaitoksen jäähdytys- ja jätevesipäästöistä rantakiinteistöille ja purkualueen vesialueille aiheutuvista vahingoista, 17 December 2012, LO1-C2-00736.

Ministry of Agriculture and Forestry, 2018. Memo concerning the special season hunting of the ringed seal 2018 – 2019, reg. no. 1186/1 March 2018.

Ministry of Economic Affairs and Employment 2019. Kansallisen ydinjätehuollon yhteistyöryhmän loppuraportti. Työ- ja elinkeinoministeriön julkaisuja 2019:39 Ministry of Eco-nomic Affairs and Employment, Helsinki 2019. ISBN PDF: 978-952-327-435-8.

Ministry of Social Affairs and Health 1999. Ympäristövaikutusten arviointi. Ihmisiin kohdistuvat terveydelliset ja sosiaaliset vaikutukset. Oppaita 1999:1. 51 p.

Monivesi Oy 2018. Fortum Power and Heat Oy Loviisa power plant and Oy Loviisan Smoltti Ab. Merialueen yhteistarkkailu: vesikasvillisuuden ja kovan pohjan eliöstön tutkimukset vuonna 2017. 2 March 2018.

National Land Survey of Finland 2019. Open map and geographical location data by the National Land Survey of Finland. https://www.maanmittauslaitos.fi/kartat-ja-paikkatieto

Natural Resources Institute Finland, 2019a. Game monitoring service. http://riistahavainnot.fi/ 19 December 2019.

Natural Resources Institute Finland, 2019b. https://www.luke.fi/uutinen/itameren-hyljekannat-jatkavat-kasvua-–-laskenta-tehtiin-hyvissa-olosuhteissa/ 9 January 2020.

Posiva 2008. Expansion of the repository for spent nuclear fuel. Environmental impact assessment report. Posiva Oy.

Posiva 2012. Construction permit application for the Olkiluoto encapsulation plant and final disposal facility. Appendix 16. Other report deemed necessary by the authorities: Updated report on environmental impacts (Statement by the Ministry of Trade and Industry on Posiva Oy's EIA report 1999). Posiva Oy.

Pöyry 2009. Fish breeding area surveys in Pyhäjoki, Ruotsinpyhtää and Simo. Fennovoima Oy. Nuclear power plant project. 60K30029.25. October 2009.

Raateoja, M. & Setälä, O. (eds.) 2016. The Gulf of Finland Assessment. Reports of the Finnish Environment Institute 27/16. 362 pp.

Ramboll Finland Oy 2012a. Fortum Power and Heat Oy, Mapping and removal of turf rafts in Lappomträsket lake. 24 October 2012. LO1-K879-00024.

Ramboll Finland Oy 2012b. Survey of coastal residents 2012, Loviisa's Hästholmsfjärden and Klobbfjärden. 30 November 2012.

Ramboll Finland Oy 2013. Environmental noise measurements of Loviisa power plant in 2013.

Ramboll Finland Oy 2017. Environmental noise measurements of Loviisa power plant in 2017.

Radiation and Nuclear Safety Authority 2020. Average radiation dose of people in Finland. https://www.stuk.fi/aiheet/mita-sateily-on/ihmisen-radioaktiivisuus/suomalaisen-keskimaarainen-sateilyannos 29 April 2020.

Snellman, M. & Helenius, J. 1992. Loviisan Hästholmenin pohjavesikemia, yhteenveto vuosien 1980–1992 tutkimuksista. Voimayhtiöiden ydinjätetoimikunta, Report YJT-92-27.

Statistics Finland, 2019a. Key figures of municipalities. https://www.stat.fi/tup/alue/kuntienavainluvut.html#?year=2019&active1=SSS 28 November 2019.

Statistics Finland, 2019b. The PX-Web databases of Statistics Finland, establishments of enterprises by municipality and establishments of enterprises by industry and region. http://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__yri__alyr/?tablelist=true 28 November 2019.

Town of Loviisa 2019a. Master plans and local detailed plans of the town of Loviisa.

Town of Loviisa 2019a. Map service of the town of Loviisa: https://kartta.loviisa.fi/ims

Town of Loviisa 2019c. https://www.loviisa.fi/tiedotteet/2018-vilkas-matkailuvuosi-loviisassa 28 November 2019.

Uusimaa Centre for Economic Development, Transport and the Environment 2019. Air quality in Uusimaa in 2018 and development in 2004–2018.

VELMU map service 2019. Data from the VELMU map service. https://paikkatieto.ymparisto.fi/velmu/ 19 December 2019.

VTT 2014. Environmental impact assessment report. Decommissioning of the FiR 1 research reactor. VTT Technical Research Centre of Finland Ltd. October 2014.

VTT 2017. Licence application, decommissioning of the FiR 1 research reactor. 20 June 2017. Reg. no. 356/0652/2017.

Water Map Service 2018. Ecological status of surface waters. http://paikkatieto.ymparisto.fi/vesikarttaviewers/Html5Viewer_2_5_2/Index.html?configBase=http://paikkatieto.ymparisto.fi/Geocortex/Essentials/REST/sites/VesikarttaKansa/viewers/VesikarttaHTML525/virtualdirectory/Resources/Config/Default 4 June 2018.

ÅF-Consult Oy 2018. Loviisa power plant. Monitoring of cooling water and wastewater in 2017.

ÅF-Consult Oy 2019. Loviisa power plant. Monitoring of cooling water and waste water in 2018.

APPENDIX 1.

Glossary and abbreviations

AVI Regional State Administrative Agency

Becquerel (Bq) The measurement unit of radioactivity, refers to a decay of one radioactive atom per second. The concentration of radioactive substances in foodstuffs is expressed in becquerels per unit of mass or volume (Bq/kg or Bq/l). Multiple units of becquerel include kilobecquerel (kBq), which is one thousand becquerels, and megabecquerel (MBq), which is one million becquerels.

Contamination Radioactive impurity. Decontamination = purification of an item from radioactive impurity.

Conventional waste Conventional and hazardous waste that is not radioactive.

Cooling water Cooling water is seawater used to cool the steam from the turbines in a condenser back into water, which is then pumped back to the steam generators. Cooling water does not come into contact or mix with the process waters or primary and secondary system waters of the nuclear power plant.

Coordinating authority The Ministry of Economic Affairs and Employment is the coordinating authority in this EIA procedure.

dB Decibel, or a unit of the sound pressure level, which has a logarithmic scale. An increase of 10 dB increases noise by tenfold.

Decommissioning Dismantling a completely closed nuclear facility so that no special measures are needed in the plant area due to radioactive substances originating from the dismantled nuclear facility. Decommissioning also includes the handling, storage and final disposal of the low- and intermediate-level waste (decommissioning waste) accumulated in the dismantling of the plant. In addition, conventional dismantling waste may be generated in decommissioning.

Decommissioning waste Waste generated in the decommissioning of a power plant or other nuclear facilities after operation that contains radioactivity and is deposited in the L/ILW repository for final disposal. See dismantling waste

Dismantling waste An overall concept for waste generated in connection with the decommissioning and dismantling of nuclear facilities. Dismantling waste includes both decommissioning waste that contains radioactivity and non-radioactive conventional waste.

Dry waste handling facility Areas in Loviisa power plant in which radioactive waste other than liquid radioactive waste is handled and packed.

EIA Environmental impact assessment.

ELY centre Centre for Economic Development, Transport and the Environment.

Final disposal The permanent disposal of radioactive waste in such a manner that the repository site does not need supervision and the radioactivity of the waste is not a hazard to nature.

Final disposal facility A nuclear facility designed for the final disposal of radioactive waste.

Final disposal hall A hall in the final disposal facility in which radioactive waste is stored/deposited for final disposal. In the L/ILW repository of Loviisa power plant, final disposal halls include maintenance waste halls and the solidified waste hall.

FiR 1 A TRIGA Mark II-type research reactor located in Otaniemi, Espoo, in Finland.

Hazardous waste Hazardous waste includes decommissioned substances or items that may cause special danger, or harm to health or the environment. Hazardous waste includes energy-saving lightbulbs and other fluorescent lights.

IBA and FINIBA areas IBA areas are internationally significant bird areas, and FINIBA areas are nationally significant bird areas in Finland. The parties responsible for the project to map the areas are the Finnish Environment Institute and BirdLife Finland.

Interim storage for spent nuclear fuel A water pool storage in Loviisa power plant area in which high-level spent nuclear fuel removed from the reactor is stored. The interim storage consists of two water pool storages, KPA1 and KPA2. The spent nuclear fuel is transported from the interim storage to Posiva for final disposal.

Intermediate-level waste Intermediate-level waste, as well as low-level waste, are the power plant's maintenance waste. In addition, such waste is generated in the decommissioning of the power plant. Handling intermediate-level waste requires effective radiation protection arrangements (the activity is usually 1–10,000 MBq/kg).

International hearing A hearing procedure in accordance with the Espoo Convention on the assessment of the transboundary environmental impact, in which different countries can participate.

L/ILW repository The final disposal facility of Loviisa power plant for low- and intermediate-level waste. The abbreviation L/ILW stands for 'low- and intermediate-level waste'.

Light water reactor Reactor type in which regular water is used for cooling and as a moderator. Most nuclear power plant reactors in the world are light water reactors.

Liquid waste solidification plant A hall at Loviisa power plant where liquid radioactive waste is stored.

Long-term safety The safety of the final disposal of radioactive waste with regard to the radiation exposure of people and the environment after the final disposal facility has been closed. Depending on the activity of the waste, the timespan of the review can be from hundreds to hundreds of thousands of years.

Loviisa nuclear power plant/power plant The nuclear power plant located on the island of Hästholmen in Loviisa, Finland, and the related functions.

Low-level waste Low-level, similar to intermediate-level waste are the power plant's maintenance waste. In addition, such waste is generated in the decommissioning of the power plant. Low-level waste can be handled without radiation protection arrangements, because its radioactivity is usually low (generally no more than 1 MBq/kg).

Maintenance waste Waste accumulated in the maintenance and repair of the nuclear power plant. Maintenance waste consists, among other things, of contaminated protection and insulation materials and defective components. For the most part, maintenance waste is low-level waste.

Maintenance waste hall A hall in the L/ILW repository in which low- or intermediate-level waste is stored. There are three maintenance waste halls in Loviisa power plant's L/ILW repository (HJT1, HJT2 and HJT3).

Moderator A substance used for the moderation of the neutrons generated in the nuclear reaction. The purpose of the moderator is to maintain the reaction. In a light water reactor, regular water (light water) is used as the moderator.

Nuclear facility A nuclear facility refers to plants used to generate nuclear energy, including research reactors, facilities carrying out extensive final disposal of nuclear waste, as well as facilities used for extensive production, use, handling or storage of nuclear material and nuclear waste. For example, at Loviisa nuclear power plant, once the power plant units have been decommissioned, the nuclear facility consists of plant parts to be made independent.

Nuclear fuel Uranium (or plutonium) intended to be used in the reactors of nuclear power plants. Nuclear fuel does not burn in the sense that it would react with oxygen (as happens when coal or wood is burned); instead, heat is produced when the nuclei of uranium are split in chain reactions. The 'combustion products' are isotopes of lighter elements generated in the chain reaction. Most are radioactive.

Nuclear material Specific fissionable materials suitable for generating nuclear energy, such as uranium, thorium and plutonium.

Nuclear power plant A nuclear power plant refers to a nuclear facility, equipped with a nuclear reactor, used to generate electricity or heat, or a plant complex formed by power plant units and other associated nuclear facilities in the same location.
A nuclear power plant comprises one or more nuclear power plant units, each of which has one reactor, and one or two turbines and generators

Nuclear power plant unit/power plant unit/plant unit Loviisa power plant consists of two nuclear power plant units, Loviisa 1 and Loviisa 2.

Nuclear waste A generic name for the radioactive waste generated in the operation of a nuclear facility. Nuclear waste is low- or intermediate-level waste or high-level fuel waste.

Operational waste Low- and intermediate-level waste generated in nuclear facilities, such as nuclear power plants. For example, operational waste is generated in the handling of radioactive liquids and gases, and in maintenance and repair work carried out in the radiation controlled area.

Plant parts to be made independent The nuclear power plant's plant parts to be made independent are the interim storage for spent nuclear fuel, liquid waste storage, solidification plant and the L/ILW repository. Making a plant part independent refers to the separation of certain functions, such as cooling or ventilation, from the systems of the power plant units, to ensure the said plant parts to be made independent can function without the power plant units.

Power plant area The area used by the nuclear power units and other nuclear facilities in the same area or surrounding them, where moving and staying is restricted by the Ministry of the Interior Decree issued based on section 9 article 8 of the Police Act (872/2011) (STUK Y/2/2018). Loviisa nuclear power plant area covers the islands of Hästholmen and Tallholmen and their adjacent sea area, the Kirmosund causeway and the main gate building.

Pressurised water plant A light water reactor type in which water is used as a coolant and a moderator. The pressure of the water is kept so high that the water will not boil despite the high temperature. The water that has passed through the reactor core releases its heat into the secondary system water in separate steam generators, where the secondary system water is vaporised and used to drive a turbine.

Process wastewater Wastewater generated in the power plant process.

Project area The project area refers to the Hästholmen area, which is the location of the current functions of the power plant and the changes planned for them in the project.

Project owner Fortum Power and Heat Oy, or the operator responsible for the implementation of the project to be reviewed in the EIA procedure.

Radioactive substance A substance that decays into other substances and concurrently emits ionising radiation.

Radioactive waste Radioactive waste refers to radioactive substances and equipment, goods or materials contaminated by radioactivity that are not required and that must be rendered safe because of their radioactivity.

Radiation controlled area The radiation controlled area refers to a work area where special safety guidelines must be observed to ensure radiation protection, access to which is controlled. At a minimum, those rooms in the facility where the external dose rate can exceed 3 μSv/h or where a 40-hour weekly stay can cause an internal dose in excess of 1 mSv per year due to the radionuclides originating from a nuclear facility, shall be defined as a controlled area. (YVL Guide C.2)

Release barrier A technical or natural structure or material that provides safety functions – in other words, prevents radioactive substances from being released into the environment.

Release from regulatory control If waste generated in the radiation-controlled area does not exceed the limits set by the authorities, it can be released from regulatory control. Waste released from regulatory control can be handled as conventional waste.

Sanitary wastewater Wastewater that originates from the toilets, kitchens, washrooms of residences, offices, buildings and institutions, as well as equivalent areas and equipment, and from business operations.

Seepage water Groundwater that accumulates in a shaft or tunnel built or excavated in the bedrock. At Loviisa power plant, seepage waters are generated in the L/ILW repository.

Sievert (Sv) The unit of radioactive dose that represents the effect of radiation on the human body. Fractions of it include a millisievert (mSv), which is a thousandth of a sievert, and a microsievert (μSv), which is a millionth of a sievert.

Solidification plant A plant in which liquid radioactive waste is rendered into solid form by mixing it with a suitable medium. At Loviisa power plant's solidification plant, liquid waste is mixed with cement and other components.

Solidified waste hall A hall in the L/ILW repository in which solidified waste is stored. There is one solidified waste hall in the L/ILW repository of Loviisa power plant.

Spent nuclear fuel Nuclear fuel removed from the nuclear reactor after operation. Spent nuclear fuel contains uranium fission products and is highly radioactive.

STUK The Radiation and Nuclear Safety Authority, which is the authority supervising safety in Finland, a research institution and an expert organisation.

TEM The Ministry of Economic Affairs and Employment. The coordinating authority in the environmental impact assessment procedure.

VTT VTT Technical Research Centre of Finland Ltd.

YM The Ministry of the Environment. Serves as the coordinating authority for the international hearing in Finland.

YVL Guides Nuclear safety guides; the Authority Guides published by the Radiation and Nuclear Safety Authority that describe the detailed safety requirements concerning the use of nuclear energy.

EIA Programme experts

Expert	Duties and qualification
Antti Lepola Project director	**Master of Science (forestry planning)** Lepola has 30 years' experience in environmental research and planning. His core competence areas include the environmental impact assessment of projects, water, environmental and chemical permit applications, as well as related surveys. Lepola has long experience of environmental consulting related to energy production and the environmental impact of the industry. Lepola has participated in more than 70 EIA procedures and worked as a project manager in more than 30 EIA procedures.
Anna-Katri Räihä EIA project manager and expert (subconsultant)	**Master of Sciences (environmental economics)** Räihä has more than 10 years' experience in environmental consulting and project management related to the environmental projects of several fields of industry. Her core competence includes environmental impact assessments, international hearings in the EIA, environmental legislation and greenhouse gas calculations. Räihä has worked as a project manager and project coordinator in several extensive EIA procedures and as an expert in environmental issues in numerous EIA procedure impact assessments (including greenhouse gas emissions and their impact on the environment, traffic impact, impact of the use of natural resources). Her EIA competence also includes various areas of communication and stakeholder engagement.
Elina Wikström EIA coordinator	**Master of Sciences (environmental science)** Wikström works as a project manager and coordinator in environmental studies, assessment projects concerning the environmental impact of the infrastructure sector, and accessibility projects. She has more than 10 years' experience of project management. She specialises in the management of the EIA procedure, as well as the environmental impact of transport infrastructure projects, and the transmission and production of energy.
Mikko Happo Health impacts	**Doctor of Sciences (environmental health), docent (toxicology of combustion emissions)** Happo's job description includes expert tasks related to air quality as well as development tasks in air quality and health services. In addition, his duties include expert services related to the environmental and health sector and its reporting concerning air quality, emissions into the air, or other environmental and health impacts.
Anne Kiljunen Air quality	**Master of Sciences (inorganic and analytical chemistry)** Kiljunen works as an environmental expert and has seven years' experience of various environmental expert tasks related to air quality. She has experience of various tasks in the field, the reporting of measurements, preparation of environmental permit applications and environmental impact assessments
Kirsi Koivisto Vibration	**Master of Science in Engineering (foundation engineering and soil mechanics)** Koivisto has worked in the field of vibration inspections and studies for more than 10 years and as a project manager since 2007. She has extensive experience in the methods used in Finland to dampen vibration and in carrying out various vibration inspections. Koivisto's area of specialisation includes planning, studying and development of dampening methods, as well as assessing the impact of vibration.
Timo Laitinen Landscape and land use	**Master of Social Sciences (social and economic geography)** Laitinen has more than six years' experience of EIA procedures and related impact assessments. He has participated in approximately 30 EIA procedures as an appraiser of impacts (landscape and cultural environment, land use and land use planning) and worked as a coordinator in ten EIA procedures.
Otso Lintinen Ichthyofauna and fishing	**Master of Science (fishing industry)** Lintinen works as a project manager in various projects related to water research. He has 11 years' experience of corresponding tasks. His area of specialisation is studies concerning the fishing industry.
Timo Metsänen Avifauna (subconsultant)	**Bachelor of Natural Resources, Environmental Planning, nature planner (special vocational qualification)** Metsänen has more than 20 years' experience of various avifauna surveys. He works as a subconsultant for Ramboll Finland in the project (Tmi Luontoselvitys Metsänen).
Juho Mäkelä Waste management	**Bachelor of Engineering (environmental technology)** Mäkelä has more than five years' experience of tasks related to material efficiency, waste management and earth construction. He works as a planner in projects related to the utilisation of materials. He has also worked as an independent quality controller in earth construction projects that require an environmental permit.
Jussi Mäkinen Nature and avifauna	**Master of Science (environmental ecology)** Mäkinen has 16 years' experience of aligning natural values and the planning of land use in various land use planning and construction projects. Mäkinen specialises in the impact assessments of projects with considerable environmental impacts and the preparation of the required nature and environmental surveys. Mäkinen is one of Finland's leading experts in matters related to the Natura 2000 network (assessments, deviation procedures). His other areas of specialisation include ecological network surveys, ecological compensation, exemption permit applications, as well as various species surveys concerning avifauna especially.

Expert	Duties and qualification
Ville Mäntylä Dismantling operations	**Architectural drafter** Works as a project manager and harmful substance expert in projects related to construction. He has 18 years' experience of corresponding tasks. His areas of specialisation include dismantling consultation projects, as well as asbestos and harmful substance surveys.
Pekka Onnila Groundwater, soil and bedrock	**Master of Science (soil science)** Onnila has extensive experience of the assessment of groundwater risks and impacts related, for example, to EIA projects, land use planning and environmental permits. In addition, Onnila is responsible for groundwater monitoring related to various functions and forms of land use.
Venla Pesonen Social impacts	**Master of Science (environmental science) Bachelor of Engineering (environmental technology)** Pesonen works as an interaction designer in the interaction team of the land use unit. She has several years of diverse experience of the assessment of impacts targeting people, planning and implementation of stakeholder engagement, the facilitation of events, as well as methods of interactive information gathering, analysis and reporting in various projects.
Arttu Ruhanen Noise	**Bachelor of Engineering (environmental technology)** Ruhanen has more than 10 years' experience of the preparation of environmental studies. Every year, he works in several dozens of projects as a planner or project manager studying noise. Ruhanen's special expertise in matters related to noise focuses on the industry, noise studies in the mineral aggregate operations and wind power, as well as various noise measurements.
Sanna Sopanen Surface waters	**Doctor of Science (aquatic ecology)** Sopanen has extensive experience of surveys related to the quality of surface waters and the aquatic environment, spanning 20 years. Her special expertise is related to the interactive relationships in the aquatic ecosystem and the factors affecting them in both inland waters and sea areas. Sopanen has participated in numerous environmental impact assessments (EIA), licensing and land use plan-ning projects, nature surveys, Natura assessments and various water system sur-veys as an expert on the impact on water systems.

The following persons from Fortum Power and Heat Oy have also participated in the preparation of the EIA Programme:

Expert	Duties and qualification
Jarkko Ahokas nuclear safety	**Master of Science in engineering, energy technology**
Tapani Eurajoki nuclear waste, long-term safety	**Master of Science in engineering, nuclear and energy technology**
Mika Harti nuclear safety	**Master of Science in engineering, energy technology**
Matti Kaisanlahti nuclear waste, power plant decommissioning	**Master of Science in engineering, energy technology**
Pasi Kelokaski power plant decommissioning	**Master of Science in radiochemistry**
Liisa Kopisto power plants' environmental aspects	**Master of Science in environmental biology; Master of Science in engineering, environmental technology**
Ossi Koskivirta acquisition of nuclear fuel, spent nuclear fuel	**Master of Science in engineering, nuclear technology**
Satu Ojala aspects of the power plant related to water systems	**Master of Science, limnology**
Tommi Rapponen radiation safety, accidents	**Doctor of Philosophy, physics**