Loviisa nuclear power plant

# Summary of the environmental impact assessment programme for the international hearing

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August 2020

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Base maps: National Land Survey of Finland 2019

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.

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# 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 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 secure electricity supply.

### 1.2 Project background

Fortum's Loviisa nuclear power plant was built in 1971–1980. The 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. Another option is to proceed to the decommissioning phase when the power plant's current operating licences expires.

Fortum has been investing 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 already 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. Due 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 radioactive waste generated during the operation of the power plant that requires final disposal has been considerably reduced, and the efficiency of the use of nuclear fuel has been improved. With the exception of spent nuclear fuel, 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 waste 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 in accordance with the EIA Act (EIA 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 project, the coordinating authority is the Ministry of Economic Affairs and Employment.

# 2. PROJECT DESCRIPTION AND THE OPTIONS TO REVIEW

### 2.1 Location of Loviisa nuclear power plant

Fortum's Loviisa nuclear power plant is located on the island of Hästholmen, approximately 12 km from the centre of the town of Loviisa. The distance from the power plant to Helsinki is approximately 100 km (Figures 1 and 2). The power plant and the functions integrally related to it, such as the L/ILW repository and other waste management buildings, cooling water intake and discharge structures, as well as office and storage buildings, are located on the island of Hästholmen. The structures located on the mainland include an accommodation area.

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.


Figure 1. Location of Loviisa in Finland.

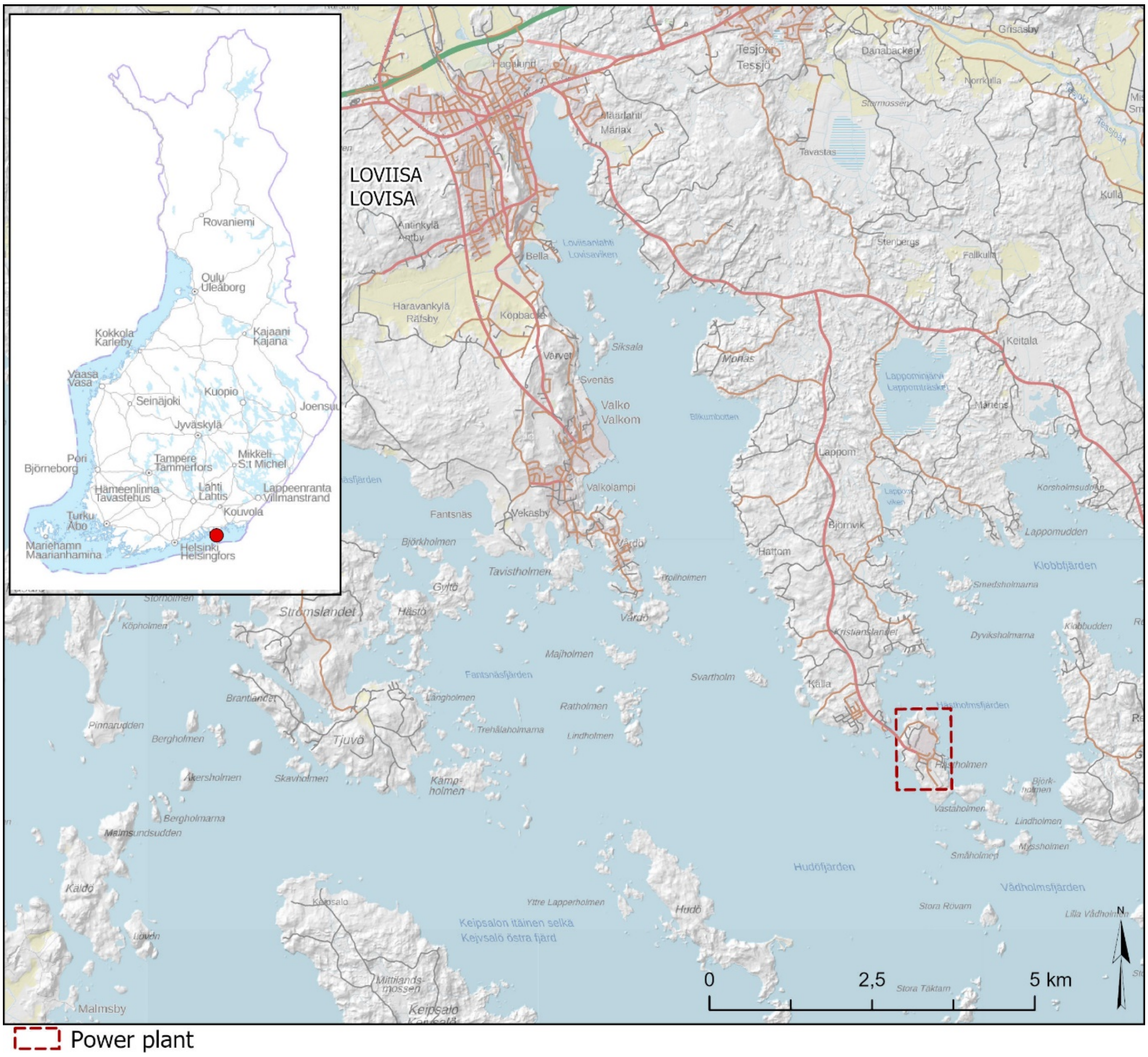


Figure 2. Location of Loviisa nuclear power plant.

## 2.2 Current operation of the power plant

Loviisa nuclear power plant is an electricity-generating condensing power plant. Loviisa power plant units Loviisa 1 and Loviisa 2 are pressurised water 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 production of base load electricity; in other words, the power plant is usually operated steadily at full power to meet the continuous minimum requirement for electrical power. The nominal thermal power of each power plant unit of Loviisa power plant is 1,500 MW, and the net electric power is 507 MW. The total efficiency of the power plant units is approximately 34 %. The annual production of Loviisa power plant is approximately 8 TWh. This accounts for approximately one-tenth of the annual consumption of electricity in Finland. The availability and load factors of Loviisa power plant have been excellent.

The low- and intermediate-level waste generated during the operation of the power plant is processed in the power plant and deposited in the final disposal facility (the L/ILW repository), located 110 metres underground in the power plant area. The spent nuclear fuel of Loviisa power plant is deposited for interim storage in pools of water in the interim storage for spent nuclear fuel in the power plant area. In due course, the spent nuclear fuel will be deposited for final disposal in Posiva Oy's encapsulation plant and final disposal facility at Olkiluoto in Eurajoki.

The cooling water for Loviisa power plant is taken from the west side of the island of Hästholmen, using an onshore intake system, and the water, warmed by approximately 10 °C, is discharged back into the sea on the east side of the island. The volume of sea water used by the power plant for cooling is an average of 44 $m^3/s$. The most significant environmental impact of the current operation of Loviisa power plant is the thermal load from the cooling water on the sea. The condition of the nearby sea area has been monitored since late 1960s. The impacts of the cooling water are local and mainly target the vicinity of the cooling water discharge site.

### 2.3 Options to be reviewed in the EIA procedure

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 would be decommissioned after the current operation licence period. A brief description of the options being reviewed is provided 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.<br>• The option also includes the measures to extend the service life of the power plant, decommissioning of the power plant after the licence period ends, the operation and ultimate dismantling of plant parts to be made independent, and the waste management measures related to these phases.<br>• 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).<br>• 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).<br>• 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.<br>• 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. |

#### 2.3.1 Option 1, VE1

The project Option 1 covers the extension of the commercial operation of 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 modifications to be carried out in the power plant area and its vicinity include:

- replacing some old buildings with new ones by, for example, building a new reception warehouse, waste water treatment plant, welding hall and a waste storage hall;
- 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;
- modifications to the power plant's service water and waste water 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 storages).

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 2.3.2 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 established by the Ministry of Economic Affairs and Employment, is the possibility to receive, process, place in interim storage and deposit 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 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.

### 2.3.2 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 plant parts related to waste management independent to ensure that the said independent plant parts can function without the power plant units for as long as spent nuclear fuel is stored 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.

### 2.3.3 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 at Loviisa power plant (see Chapter 2.3.1).

## 2.4 Project schedule

Tentative schedules for the project options to be covered in the EIA procedure are provided in Figure 3.

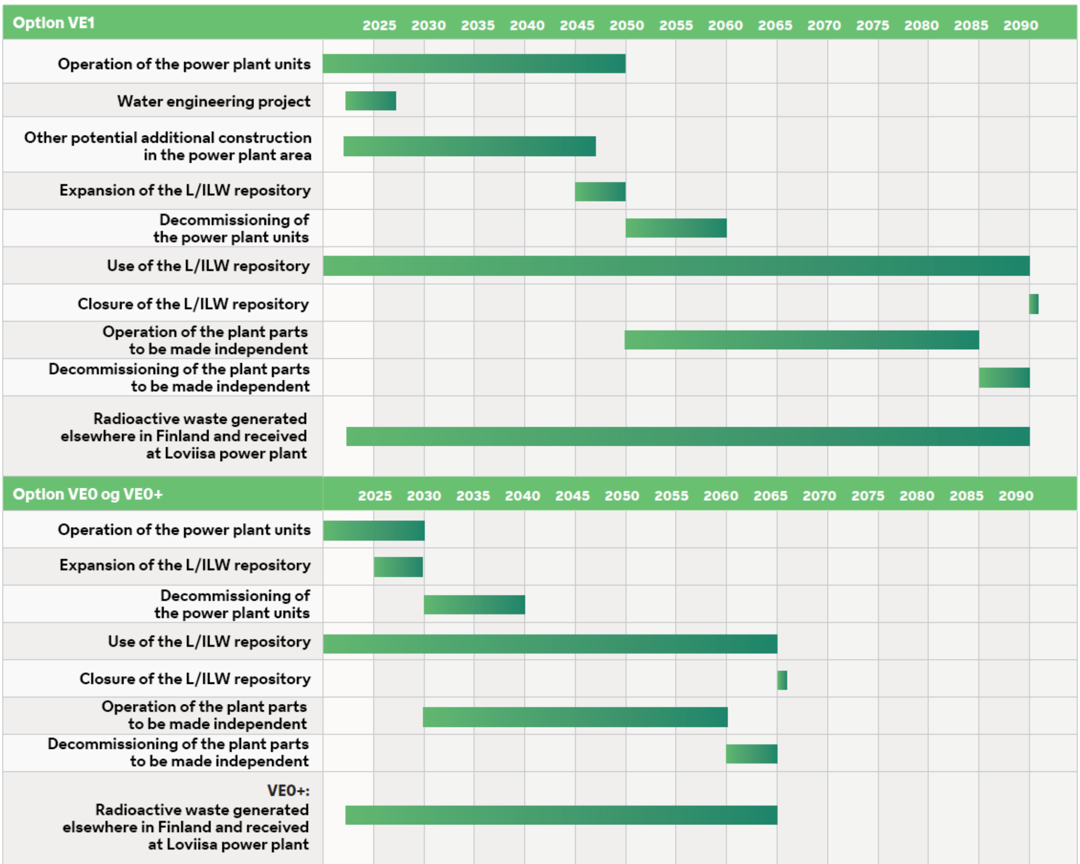


Figure 3. Tentative schedules of the project options, to be specified as the plans progress.

# 3. SAFETY OF THE NUCLEAR POWER PLANT

### 3.1 Nuclear and radiation safety

According to the Nuclear Energy Act, the nuclear power plant must be safe and it must cause no danger to people, the environment or material property. In Finland, the requirements concerning the 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 the Radiation and Nuclear Safety Authority (STUK).

This chapter covers the most important areas of radiation and nuclear safety, and the safety of nuclear waste management at Loviisa power plant, based on STUK's Regulation on the Safety of a Nuclear Power Plant (Y/1/2018), Regulation on the Emergency Arrangements of a Nuclear Power Plant (Y/2/2018), Regulation on the Security in the Use of Nuclear Energy (Y/3/2016) and Regulation on the Safety of Disposal of Nuclear Waste (Y/4/2018).

#### 3.1.1 Radiation and monitoring

At Loviisa nuclear power plant, 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 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. Most of the radiation dose is accumulated during annual outages.

The radioactive emissions of Loviisa power plant are monitored by 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. 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 ten-thousandth of the normal annual radiation dose a person in Finland receives from other sources on average.

#### 3.1.2 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 principles of operation 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 so, to control radioactive emissions during accidents.

The safety systems also ensure the cooling of the fuel in the reactor 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 operations.

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 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. In accordance with a good safety culture, the safety improvements have been based 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 at the power plant, 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 4 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 4).

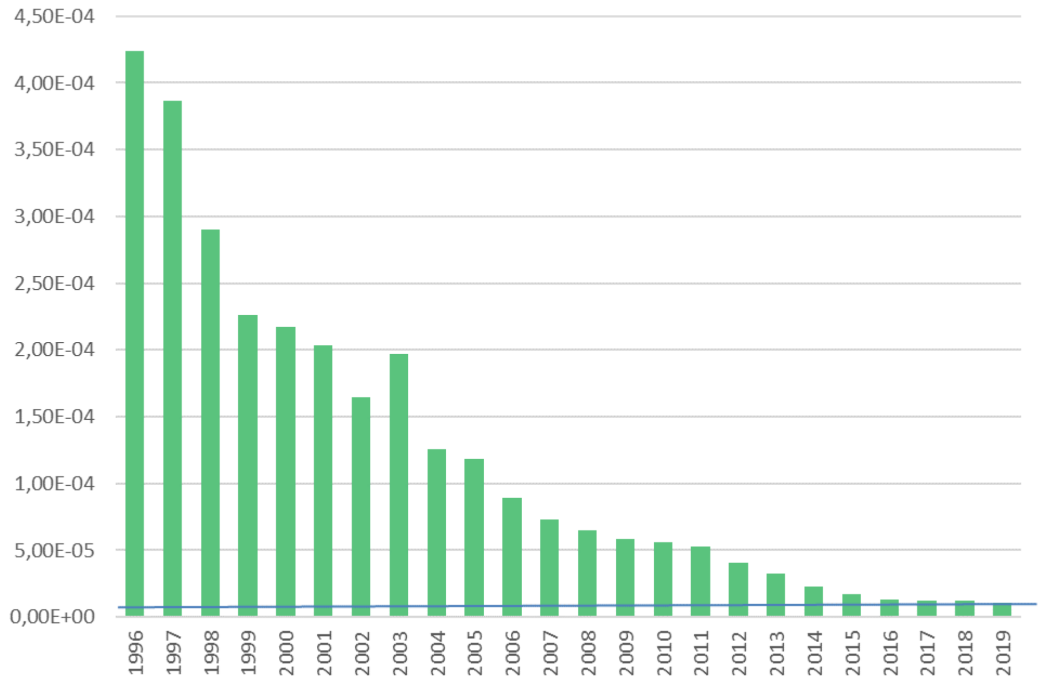


**Figure 4. The frequency of considerable reactor core damage and nuclear fuel damage of spent fuel in the fuel pools in the Loviisa 1 power plant unit, assessed by means of PRA. The blue line indicates the requirement level ($10^{-5}$/year) proposed for new nuclear power plants in the STUK Guide YVL A.7.**

### 3.1.3 Emergency preparedness and security arrangements

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. Correspondingly, security arrangements refer to advance preparations for a threat of illegal activity directed against the nuclear power plant or its operations. 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, and security arrangements. In addition, STUK has issued detailed requirements concerning these in the YVL Guides and in STUK regulations (Y/2/2018 and Y/3/2016). 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 security organisation and emergency organisation of Loviisa power plant, which comprise persons trained for the tasks, have the appropriate premises, communications connections and equipment at their disposal. The job descriptions and duties have been defined in advance in the emergency preparedness plan and the plans concerning the security arrangements. In addition, Loviisa power plant has its own rescue station. Both emergency preparedness and security arrangements and the related plans and guidelines are maintained and continuously developed, and the operations are regularly practised with the authorities.

### 3.1.4 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 STUK's 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 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 technical release barriers, with the stable state of the waste, considerably limit the release of radioactive substances for several hundreds and even several thousands of years, which reduces the radioactivity of the waste to a fraction of the original.

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. According to the Nuclear Energy Decree, the annual dose caused by a closed final repository facility and received by the people most exposed to radiation must remain below 0.1 mSv, and the extensive radiation impact must be insignificantly low.

Most of the waste generated in the radiation controlled area of Loviisa power plant during operation 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. Based on the activity content, the maintenance waste is either deposited for final disposal in the final disposal facility (the L/ILW repository) located 110 metres underground or released from regulatory control, and treated as conventional waste.

Liquid radioactive waste is generated in the process and sewage systems during the operation of the power plant. 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 of reinforcement steel. The solidified liquid waste is deposited for final disposal in the solidified waste hall in the L/ILW repository.

The radioactive dismantling waste generated in the decommissioning after the operation of the power plant is handled in the power plant area and deposited for final disposal in the halls separately built for such waste in the L/ILW repository.

In due course, the spent nuclear fuel generated in Loviisa power plant is taken to the encapsulation plant and final disposal facility operated by Posiva Oy at Olkiluoto in Eurajoki, Finland, after which Posiva is responsible for the final disposal measures of the fuel.

### 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 the power plant's operating history.

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. This will help ensure that the systems, equipment and structures comply with their design basis – in other words, that they fulfil the tasks designed for them in the planned situations. 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.

# 4. EIA PROCEDURE

In Finland, the requirement to carry out an EIA procedure is based on the Act on the Environmental Impact Assessment Procedure. In addition, this project applies the Espoo Convention on the Environmental Impact Assessment in a Transboundary Context (the international hearing).

## 4.1 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 lays down the general obligations to organise a hearing for 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 into 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.

### 4.2 EIA procedure in Finland

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 Finnish 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.

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 in Finland before the permit procedure, 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 reasoned conclusion, as well as the documents concerning the international hearing related to transboundary impacts.

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. In Finland, the coordinating authority informs the other authorities and 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.

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 5 shows a summary of the EIA procedure phases in Finland and its interconnection with the international hearing.

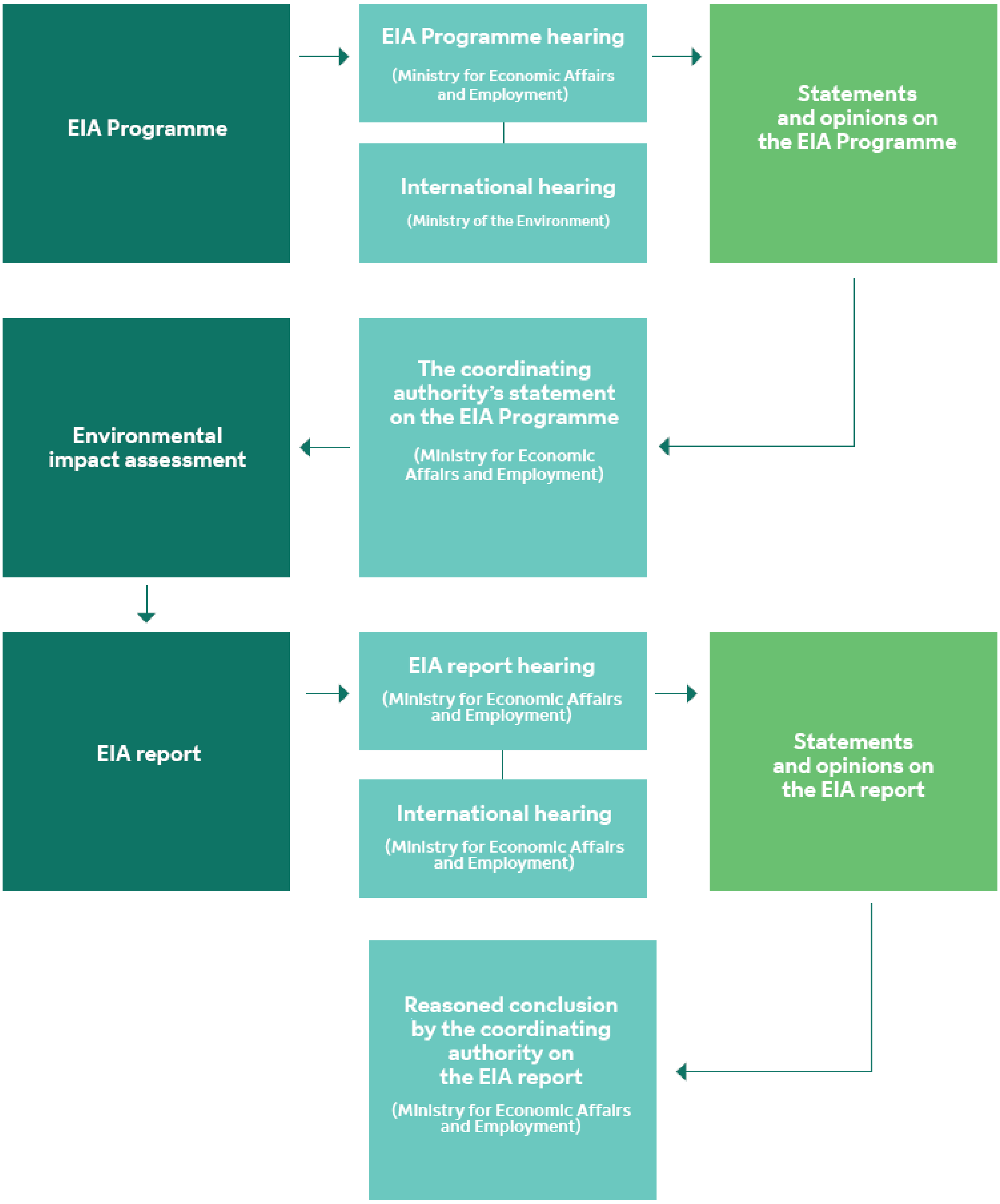


Figure 5. The stages of the EIA procedure.

### 4.3 Schedule of the EIA procedure

The key stages and tentative schedule of the EIA procedure are shown in Figure 6.

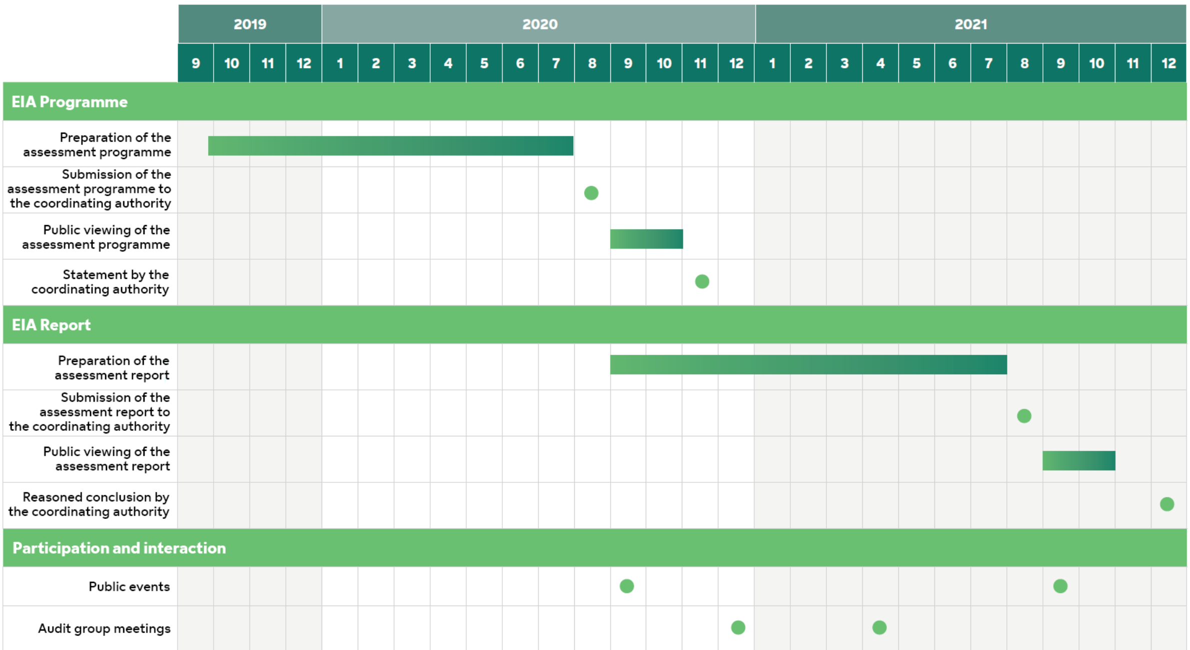


Figure 6. Tentative schedule of the EIA procedure. The schedule of the other interaction methods is specified in the EIA report stage.

## 5. ASSESSMENT OF THE ENVIRONMENTAL IMPACT OF THE PROJECT

### 5.1 Structure of the EIA Programme

The structure of the EIA Programme is as follows:

Summary
1. Project owner and the project background
2. Options to be reviewed in the EIA procedure
3. Project description
4. Environmental Impact Assessment Procedure
5. Present state of the environment
6. Assessed impacts and assessment methods
7. Uncertainties
8. Prevention and mitigation of adverse impacts
9. Impact monitoring
10. Required plans, licences and decisions

### 5.2 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

### 5.3 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 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.

### 5.4 Most significant environmental impacts identified and assessment of transboundary impacts

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. The impacts of extending the operation 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, in the same manner as is currently the case. The impacts of the cooling water are local and mainly target the vicinity of the cooling water discharge site. Based on preliminary planning data, the most significant environmental impacts identified compared to the power plant's current situation are the areas listed in Table 2. The actual assessment of environmental impacts will be conducted in the next phase of the EIA procedure, and its results will be included in the EIA report. The impacts of exceptional situations and accidents are covered after the Table.

**Table 2. Most significant environmental impacts tentatively identified that are generated by the modification related to the project, compared to the current situation in the power plant operation, and an assessment of transboundary impacts.**

| | Most significant environmental impacts identified | Preliminary assessment of the transboundary impacts |
|---|---|---|
| **Extending the operation** | Based on the preliminary planning data, the changes would primarily target the impacts on the landscape caused by potential new structures. | Impacts are local. No transboundary impacts. |
| | Potential impacts may be caused to water systems by water engineering work, such as dredging, excavation and the construction of the new embankment structure. Water engineering work may help decrease the temperature of the cooling water conducted to the sea. The impacts of the cooling water are local and mainly target the vicinity of the cooling water discharge site. | Impacts are local. No transboundary impacts. |
| | Construction work may also cause temporary noise, and traffic volumes may temporarily increase. | Impacts are local. No transboundary impacts. |
| **Preparation for decommissioning** | Tentatively, it has been estimated that the most significant impacts on the environment are caused by the excavation related to the expansion of the L/ILW repository and the temporary storage of the blasted rock, and that they primarily target the soil, bedrock and groundwater. | Impacts are local. No transboundary impacts. |
| | The construction of the L/ILW repository may cause temporary noise, vibration and dust. | Impacts are local. No transboundary impacts. |
| | Traffic volumes may temporarily increase during the construction of the L/ILW repository. | Impacts are local. No transboundary impacts. |
| | 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. | Impacts are local. No transboundary impacts. |
| | 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. | Impacts are local. No transboundary impacts. |
| **Decommissioning** | 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. | Impacts are local. No transboundary impacts. |
| | Impacts on the regional economy related to decommissioning have been identified as a significant environmental impact. | The impacts on the regional economy may be reflected on the national level in Finland. No transboundary impacts. |

| | | |
|---|---|---|
| | With regard to the discontinuation of the operation, the project may have impacts on greenhouse gas emissions. | Replacing electricity production with nuclear power, which is free of carbon dioxide emissions, by other methods of production may impact Finland's greenhouse gas emissions. 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. |
| | Decommissioning may also have impacts on the soil and bedrock, groundwater, air, water systems and landscape. | Impacts are local. No transboundary impacts. |
| | Decommissioning may highlight impacts targeting people, and especially how different people experience them. | Impacts are local. The impacts experienced by different people are individual and subjective. |
| **Management of radioactive waste generated elsewhere in Finland and received at the Loviisa power plant** | The activity 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. | Impacts are local. No transboundary impacts. |

According to a preliminary assessment, in the options reviewed in the EIA procedure, the only transboundary impact would be the emission of radioactive substances generated in a severe reactor accident related to the extension of the operation of the power plant (VE1).

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.

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 emission in the accident is studied over a distance of 1,000 km from the power plant. The fallout and radiation dose caused by the emission 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 disturbances 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.

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.

The EIA report describes 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. The environmental impact of transport and final disposal of spent nuclear fuel are assessed in the Posiva's environmental impact assessment procedure concerning the encapsulation plant and final disposal facility. The assessment's main results are included in the EIA report. In addition, a risk and implementation method report concerning transport is used.

### 5.5 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 3 shows a summary of the assessment methods by impact and the proposed observed areas.

**Table 3. 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. |

| Component | Methods of assessment | Observed area |
|---|---|---|
| **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 the 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. |

| Component | Methods of assessment | Observed area |
|---|---|---|
| **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. |

### 5.6 Mitigation of adverse impacts and their monitoring

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.

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.

## 6. PERMITS, PLANS AND DECISIONS REQUIRED BY THE PROJECT IN FINLAND

### 6.1 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 (the L/ILW repository) 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.

## 6.2 Other permits

The valid local detailed plan makes it possible to carry out change work in the power plant area, construct additional structures and buildings, and decommission the power plant. In addition, the project requires permits in accordance with the Land Use and Building Act (132/1999) (e.g. a building permit), as well as, potentially, permits in accordance with the Environmental Protection Act (527/2014) and Water Act (587/2011) (e.g. environmental permit and water permit).