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EXTENDING THE SERVICE LIFE OF THE OLKILUOTO 1 AND OLKILUOTO 2 PLANT UNITS AND UPRATING THEIR THERMAL POWER

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Contact information

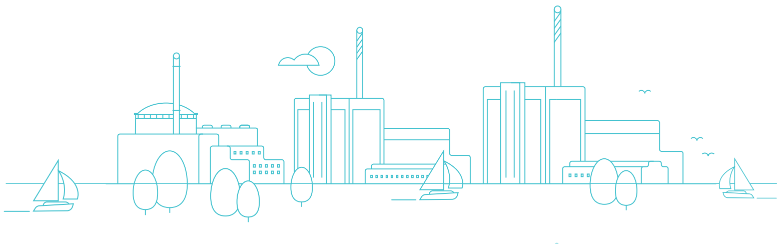
Project owner:	Teollisuuden Voima Oyj
Postal address	Olkiluoto, FI-27160 EURAJOKI
Phone	+358 2 83 811
Contact persons	Eero Lehtonen and Merja Levy
Email	firstname.lastname@tvo.fi
Coordinating authority:	Ministry of Economic Affairs and Employment
Postal address	P. O. Box 32, FI-00023 VALTIONEUVOSTO
Phone	+358 295 047 089
Contact person	Hanna-Mari Kyllönen
Email	firstname.lastname@gov.fi
International hearing:	Finnish Environment Institute
Postal address	Latokartanonkaari 11, FI-00790 HELSINKI
Phone	+358 295 251 325
Contact person	Laura Aitala-Martesuo
Email	firstname.lastname@syke.fi
EIA consultant:	Ramboll Finland Oy
Postal address	P. O. Box 25, FI-02601 ESPOO
Phone	+358 20 755 611
Contact person	Antti Lepola
Email	firstname.lastname@ramboll.fi

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

Content


TVO

1. Project owner and project background



1.1. Project owner

The project owner for the EIA procedure is Teollisuuden Voima Oyj (TVO). TVO produces clean energy domestically, all year round and regardless of the weather at Olkiluoto in Eurajoki using three nuclear power plant units: Olkiluoto 1 (OL1), Olkiluoto 2 (OL2) and Olkiluoto 3 (OL3). The annual production from the OL1 and OL2 plant units is on average 14.4 TWh per year, amounting to approx. 17% of all electricity consumed in Finland. After the start of regular electricity production at the OL3 plant unit in April 2023, TVO now produces approximately 30% of all electricity in Finland.

TVO has been generating electricity for its owners safely and reliably for more than 40 years. TVO's shareholders are Finnish industrial and energy companies which, in turn, are partly owned by 131 Finnish municipalities. TVO operates under the cost price principle (Mankala principle) in the manner described in its Articles of Association.

1.2. The project and its background

The power plant units OL1 and OL2 located in the Olkiluoto power plant area are identical boiling water reactors. They were commissioned in 1978 (OL1) and 1980 (OL2). As part of service life management for the Olkiluoto nuclear power plant, TVO is analysing the possibility of extending the service life of the OL1 and OL2 plant units and uprating their thermal power.

The original planned service life of the OL1 and OL2 plant units was 40 years, until 2018. Their service life was already extended earlier to 60 years, which will be met in 2038. The project involves analysing the possible extension of the service life until 2048 or, alternatively, until 2058.

At the time of commissioning, the thermal power of the plant units' reactors was 2,000 megawatts (MW), from where it has been uprated to the current 2,500 MW in two stages: in 1984 (to 2,160 MW) and between 1994 and 1998 (to 2,500 MW). Correspondingly, the nominal (net) electrical power of the plant units has gone up from the original 660 MW to 710 MW in 1984 and to 840 MW in 1998. As a result of the turbine plant modernisations carried out in 2005–2006 and 2010–2012 and the increase in efficiency, the current nominal value for electrical power is 890 MW.

In the power uprating, the starting point is an increase of the reactor's thermal power by 10% to 2,750 MW, which corresponds to increasing the plant units' nominal electrical power output from the current 890 MW to 970 MW. The total additional electricity generated by the OL1 and OL2 plant units each year would be approximately 1,200,000 MWh. In connection with the power uprating, the operation of the plant units would be extended until 2048 or 2058. The extensive and demanding maintenance and improvement work already performed at the plant units in earlier years allow for the power uprating to be implemented and combined with the periodic safety assessment that will be performed at the latest in 2028.

2. Description of the project and the alternatives being considered

2.1. Location of the Olkiluoto nuclear power plant area

The Olkiluoto nuclear power plant area owned by TVO is located in the municipality of Eurajoki, on Olkiluoto Island (Figure 1 and Figure 2). Generally speaking, the Olkiluoto power plant area refers to the area which houses TVO's plant units OL1, OL2 and OL3 and Posiva Oy's encapsulation plant and disposal facility for spent nuclear fuel.

Within the power plant area, the OL1 and OL2 plant units are located at the plant site that is delimited in the western part of Olkiluoto Island (Figure 2). The plant site contains the OL1, OL2 and OL3 plant units as well as facilities, equipment and functions related to the plant units; these include the interim storage for spent fuel (KPA storage) and the interim storage facilities for very low, low and intermediate-level operating waste (HMAJ, MAJ and KAJ storages).

The proposed project alternatives do not require new space reservations in the power plant area; any modifications will be implemented within the existing, constructed plant site.

Figure 1. Location of Eurajoki in Finland.

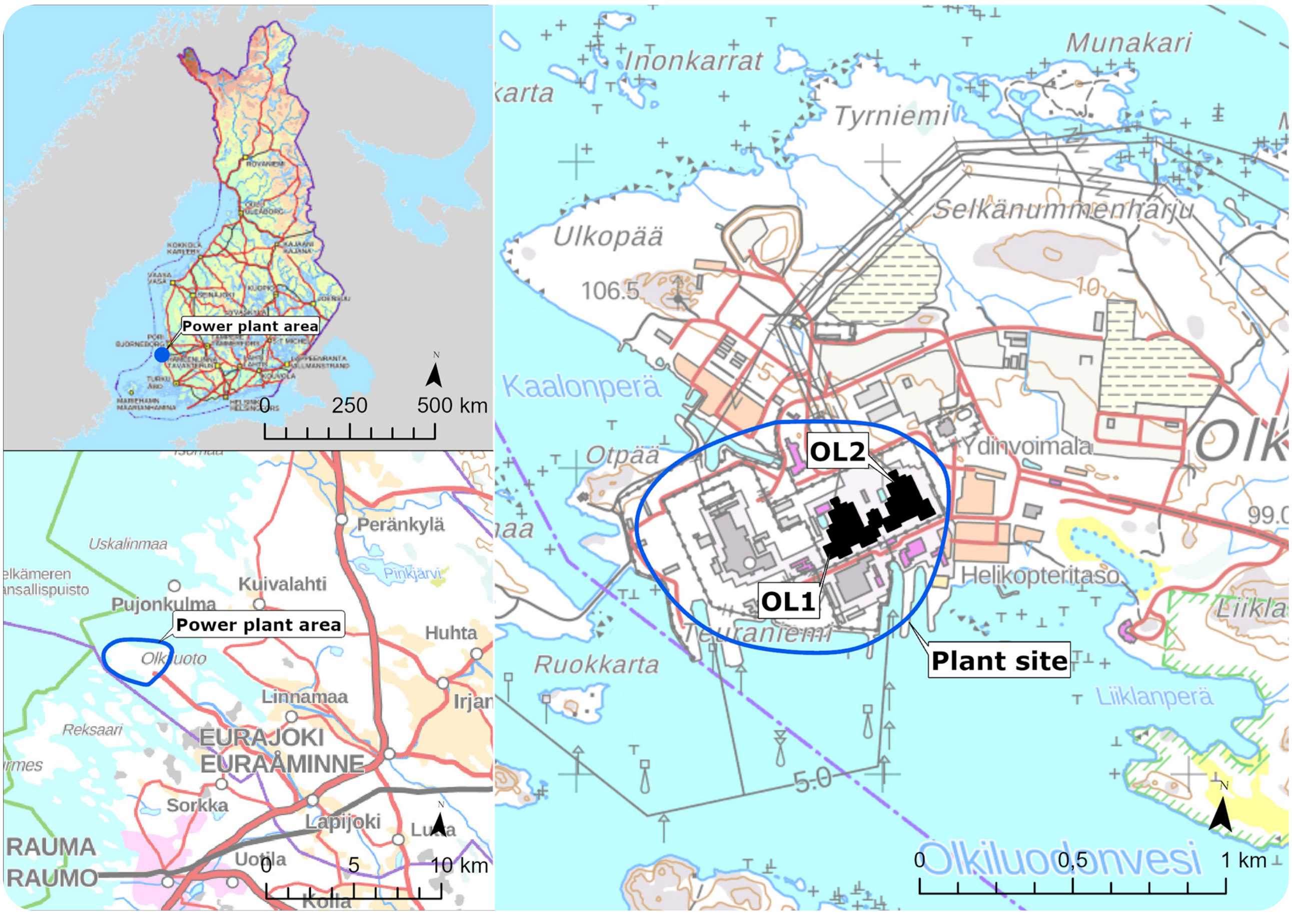


Figure 2. *The location of the Olkiluoto power plant area and the location of the OL1 and OL2 plant units within the site area.*

2.2. Current operation

The OL1 and OL2 plant units have been generating electricity for the good of Finnish society for more than 40 years already. During their years of operation, the plant units have been modernised in many ways and their safety has also been improved. The current net electrical output of the OL1 and OL2 plant units is 890 MW and their annual electricity production is approximately 14.4 terawatt hours (TWh) in total, corresponding to approximately 17% of the electricity consumption in Finland. Since the early 1990s, the capacity factors for OL1 and OL2 have been between 93-97%. High capacity factors indicate that the plant units operate reliably.

Electricity production at a nuclear power plant is based on the utilisation of thermal energy generated by means of a controlled fission chain reaction. The nuclear power plant units OL1 and OL2 are of a boiling water reactor type (BWR). In the pressure vessel of a boiling water reactor plant, water is circulated through the fuel assemblies in the reactor core, causing the water to heat up and vaporise. The steam generated in the reactor is routed, via the steam separator and steam dryer located in the pressure vessel, along the steam lines into the high pressure turbine, from there to the reheaters and finally to the low pressure turbines. The turbines are connected by means of an axle to a generator that generates electricity for the national grid. The steam coming from the low pressure turbines is condensed into water inside the condenser, using a sea water cooling circuit. The generated condensate is pumped using condensate pumps, through the clean-up system and the condensate preheaters, to the feedwater pumps, which pump it as feedwater back into the reactor via the preheaters. The warmed sea water is routed back into the sea.

Cooling water for the Olkiluoto power plant is taken from the southern side of Olkiluoto Island, on the shore of Olkiluodonvesi to the south of the OL1 and OL2 plant units. The volume of cooling water consumed by the OL1 and OL2 plant units is approximately 38 m^3/s per unit, with the OL3 plant unit consuming approximately 57 m^3/s. Therefore, the total consumption is approximately 133 m^3/s. At present, the process heats the cooling water by approximately 10°C, and the water is routed back into the sea along the discharge tunnels and outlet channel. The cooling water ends up on the Iso-Kaalonperä bay located at the western end of the island. The largest environmental impacts from the current operation of the Olkiluoto power plant are the result of the cooling water's thermal load on the sea. The impacts of cooling water are local, mainly focusing on the area near the cooling water discharge location.

The very low, low and intermediate-level waste generated during the operation of the power plant is processed at the power plant and initially stored in the waste storage facilities of the plant units or, according to their radioactivity, transferred to the interim storage for very low-level waste (HMAJ storage), low-level waste (MAJ storage) or intermediate-level waste (KAJ storage). Low and intermediate-level waste is placed in final disposal in the operating waste repository (VLJ repository), which is located in the power plant area. Very low-level waste will be placed in the near-surface final disposal facility for very low-level waste that is currently being planned. Spent nuclear fuel from Olkiluoto power plant is placed in interim storage within the power plant area, inside the water pools of the spent fuel interim storage facility. In time, the spent nuclear fuel will be placed in final disposal at Posiva Oy's encapsulation plant and disposal facility at Olkiluoto in Eurajoki.

2.3. The alternatives examined in the EIA procedure and the schedule for the project

In this EIA procedure, the implementation alternatives being examined for the project are continuing the operation of the OL1 and OL2 plant units at the current power level until 2048 (VE1a) or 2058 (VE1b) and continuing the operation at an uprated power level until 2048 (VE2a) or 2058 (VE2b). In the zero alternative, the operation of the plant units will continue until the expiration of the current operating licence in 2038 (VE0). The alternatives being considered are presented in the enclosed figure (Figure 3).

The current operating licence for the OL1 and OL2 plant units under the Nuclear Energy Act (990/1987) is in force until 2038. A new operating licence must be applied for in all project alternatives. In the case of alternatives VE2a and VE2b, this will be done by the end of 2028 and, in alternatives VE1a and VE1b, at the latest before 2038 when the current operating licence expires. According to the terms of the valid operating licence, TVO must draw up a periodic safety assessment for the OL1 and OL2 plant units and submit it to the Radiation and Nuclear Safety Authority (STUK) for approval by the end of 2028.

According to the preliminary schedule for the power uprating project, the plant modifications and operating tests required for the power uprating may be implemented in the 2020s. They could also be implemented in the 2030s. No decision has been made on the implementation or its schedule. The earliest possible implementation time for the power uprating would be in 2028, assuming that all necessary permits for the implementation have been granted.

If the operation of the OL1 and OL2 plant units is not continued (VE0), the decommissioning of the plant units will take place following the current operating licence period. If the operation of the plant units is continued, decommissioning will take place after the new operating licence period. The decommissioning of nuclear power plants is subject to licence and regulated according to the Nuclear Energy Act and Decree and the Radiation and Nuclear Safety Authority's regulations and guides. According to the current EIA Act (252/2017), the dismantling or decommissioning of a nuclear power plant requires an EIA procedure. A separate environmental impact assessment will be drawn up for the decommissioning of the OL1 and OL2 plant units, according to the legislation in force, once decommissioning becomes relevant.

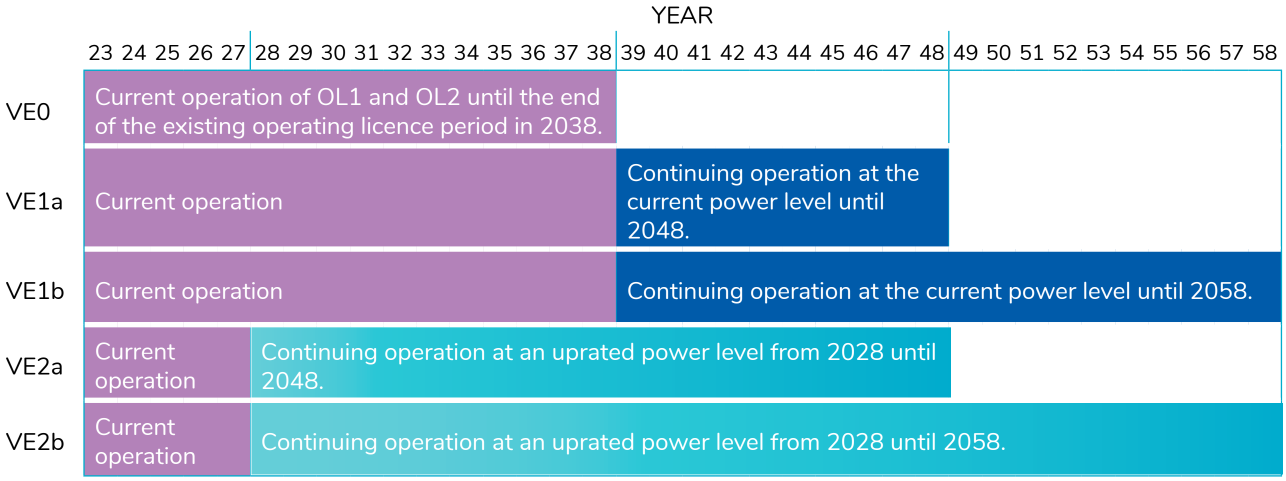


Figure 3. The alternatives examined in the EIA procedure and their preliminary planned schedules.

2.4. Changes to current operation

The enclosed table (Table 1) presents key figures for OL1 and OL2 during the current operation (VE0) and compares them to extending the service life at the current power level (VE1) and extending the service life at an uprated power level (VE2).

Table 1. Key figures in the various alternatives.

Explanation	VE0 Continuing current operation of OL1 and OL2 until 2038	VE1 Extension of operation until 2048/2058	VE2 Power uprating and extension of operation until 2048/2058
Plant type	Boiling water reactor		
Electrical power output	890 MW		970 MW
Thermal power output	2,500 MW		2,750 MW
Efficiency	35.6%		35.3%
Reactor operating pressure	70 bar		
Annual electricity production	approx. 7 TWh/plant unit		approx. 7.6 TWh/plant unit
Thermal power routed into the water system	98,000 TJ/a		109,000 TJ/a
Volume of cooling water	38 m^3/s per plant unit		
Cooling water temperature	Temperature increase of approx. 10 °C		Temperature increase of approx. 11 °C
Volume of service water	Approx. 272,000 m^3 of raw water for Olkiluoto, of which approximately one half is used as household water and half as process water, fire-fighting water and other uses.		
Fuel	Uranium dioxide UO_2		
Number of fuel assemblies	500 pcs		

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Explanation	VE0 Continuing current operation of OL1 and OL2 until 2038	VE1 Extension of operation until 2048/2058	VE2 Power uprating and extension of operation until 2048/2058
Fuel consumption	approx. 18 t/a		
Spent nuclear fuel (per year)	approx. 19 t/a		
Spent nuclear fuel (over the plant's entire service life)	approx. 2,483 t (by 2038)	approx. 2,861 t (by 2048) approx. 3,240 t (by 2058)	
Very low, low and intermedi-atelevel waste (per year)	approximately 50 m^3	No significant changes to annual accumulation.	
Very low, low and interme-diatelevel waste (over the plant's entire service life)	approx. 8,250 m^3 (by 2038)	approx. 8,750 m^3 (by 2048) approx. 9,250 m^3 (by 2058)	
Other waste [1)]	Recyclable waste 2,610 t/a Landfill waste 0 t/a Hazardous waste 219 t/a		
Releases of radioactive sub-stances into the air [2)]	Noble gases (Kr-87 equiv.): 0–9.7 TBq/a. Release limit: 9,420 TBq/a. Iodine (I-131): 0.00000008–0.002 TBq/a. Release limit: 0.1 TBq/a. Aerosols: 0.000007–0.2 TBq/a Carbon-14 (C-14): 0.6–1.2 TBq/a Tritium (H-3): 0.2–2.7 TBq/a		
Other releases into the air [3)]	CO_{2e} 914 t/a NO_x 1.2 t/a SO_2 0.0 t/a Particles 0.1 t/a		CO_{2e} 927 t/a NO_x 1.2 t/a SO_2 0.0 t/a Particles 0.1 t/a
Releases of radioactive sub-stances into water [2)]	Fission and activation products: 0.00008–0.0006 TBq/a. Release limit: 0.3 TBq Tritium (H-3): 1.3–2.5 TBq/a. Release limit: 18.3 TBq		
Other releases into water [4)]	Household waste water, total 86,550 m^3/a Phosphorus 5 kg/a Nitrogen 4,222 kg/a BOD_{7ATU} 412 kg/a		
	Process waste water, total 25,000 m^3/a Phosphorus 5 kg/a Nitrogen 100 kg/a		
Noise [5)]	Nearest holiday housing (Leppäkarta) 39.4–42.1 dB Main gate 48.6–56.3 dB		
Traffic	Approximately 1,000 vehicles/day. More during annual outages.		

1) Average for OL1, OL2 and OL3 over three years.
2) Range of variation for OL1 and OL2 in 2007–2022. The highest values in the actual release ranges have been related to rare exceptions.
3) Average for OL1 and OL2 over three years.
4) Household waste water: Average for OL1, OL2 and OL3 over three years. Process waste water: Average for OL1 and OL2 over three years.
5) Range of variation for 2020–2022.

3. Nuclear safety and radiation safety

According to the Finnish Nuclear Energy Act, the operation of a nuclear power plant must be safe and it shall not cause danger to people, the environment or property. The nuclear safety and radiation safety requirements set in Finland for a nuclear power plant are based on the provisions of the Nuclear Energy Act and Decree, which are then supplemented by means of regulations issued by the Radiation and Nuclear Safety Authority (STUK).

3.1. Nuclear Safety

The safety and safety requirements of the Olkiluoto nuclear power plant have been developed, and are being continuously developed, based on results from safety studies and operating experience, for example.

The safe operation of the Olkiluoto nuclear power plant is based on a high level of plant technology, the principle of continuous improvement, nuclear professionalism i.e. competent and responsible personnel, and independent internal and external oversight.

In order to ensure safe operation, TVO is systematically analysing the level of safety. TVO regularly assesses the status of overall safety from the perspectives of production, nuclear safety and radiation safety, corporate safety and security, plant unit service life management and leadership, the organisation and personnel. TVO regularly assesses and develops the operation of the plant units using internationally applied safety indicators. These include, for example, the unavailability of safety systems, the collective radiation dose, unplanned energy unavailability and unplanned automatic scrams/trips.

The basic principle for nuclear and radiation safety is to prevent the release of radioactive material into the environment. In order to prevent any releases, the safety of the plant units is ensured many times over by using diverse structural barriers and safety systems. Nuclear safety and radiation safety are developed by analysing risks and preparing for them.

The nuclear safety of the OL1 and OL2 plant units is ensured by means of safety functions that are intended to prevent the occurrence of incidents and accidents, to stop them from progressing or to mitigate the consequences of accidents. Safety functions have been defined in order to ensure the integrity of the release barriers for radioactive substances. The functions are supported by means of support actions that start automatically or are started by an operator.

The key safety functions of a nuclear power plant are as follows:

- Reactivity management, which aims at stopping the chain reaction inside the reactor.
- Residual heat removal, which aims at cooling the fuel and, thereby, ensuring the integrity of the fuel and primary circuit.
- Preventing the spread of radioactivity, which aims at isolating the containment and ensuring its integrity, thereby managing radioactive releases during an accident.

A nuclear power plant has systems for regular operation as well as safety systems that are used to implement the abovementioned safety functions during normal operation and in case of incidents and accidents. The safety systems are used to ensure the cooling of the nuclear fuel inside the reactor even when normal systems for operation are not available. The most important safety systems are the systems related to shutting down the reactor and residual heat removal.

A nuclear power plant must be prepared for a severe reactor accident. A severe reactor accident refers to an accident where the fuel inside the reactor becomes significantly damaged. Even though such an accident is very unlikely, the OL1 and OL2 plant units are equipped with systems for managing a severe reactor accident. These systems are used to ensure that the power plant will not release radioactive substances in amounts that would cause major hazards to the environment.

During the operating history of the OL1 and OL2 plant units, numerous projects have been implemented to improve nuclear safety; as a result, the plant units are significantly safer now than when they were first started. These safety improvements have been based on continuously seeking the highest possible level of safety in accordance with a high level of safety culture as well as STUK's changed requirements. Following the Fukushima accident, for example, several changes that improve safety have been made, as a result of which the calculated probability of a severe reactor accident has been significantly reduced.

3.2. Radiation and its monitoring

At a nuclear power plant, radioactive substances are mainly formed as fission products as the atom nuclei in the fuel split, inside the reactor and in its vicinity by means of neutron activation, and as the products of radioactive decay chains of the substances mentioned above.

Systems containing radioactive substances are located inside what is known as the radiation controlled area. In the radiation controlled area, specific safety instructions are followed in order to protect against radiation. Continuous radiation monitoring has been arranged for personnel working in the radiation controlled area, and radiation measurements are performed on people and items when leaving the radiation controlled area. During the normal operation of the OL1 and OL2 plant units, radiation doses incurred by the personnel are clearly below the statutory dose limits.

Radioactive releases from the OL1 and OL2 plant units are monitored by means of the power plant's release measurements, and the dispersion of the releases into the environment are tracked in accordance with an environmental radiation monitoring programme approved by STUK. Environmental radiation monitoring is based on continuous dose rate measurements, air and fallout samples, sea water samples and samples taken from the food chain. The releases from the OL1 and OL2 plant units are reported to STUK for each quarter. Independent monitoring performed by STUK supplements the monitoring performed by the power plant. Structural radiation protection, radiation monitoring for the personnel, release monitoring and environmental radiation monitoring are implemented under STUK's supervision.

The Nuclear Energy Decree (161/1988) defines the limit values for radiation doses incurred by the population as a result of the operation of a nuclear power plant. The limit value for the annual dose incurred by an individual from the normal operation of a nuclear power plant is 0.1 mSv (millisievert), which is less than 2% of the average annual dose of 5.9 mSv incurred by Finns due to radiation. In recent years, the actual radiation dose incurred by individuals in the vicinity of the OL1 and OL2 plant units has been approximately 0.2% (approx. 0.0002 mSv) of the dose limit set in the Nuclear Energy Decree, and less than one ten-thousandth of the normal annual radiation dose received by Finns from other sources on average.

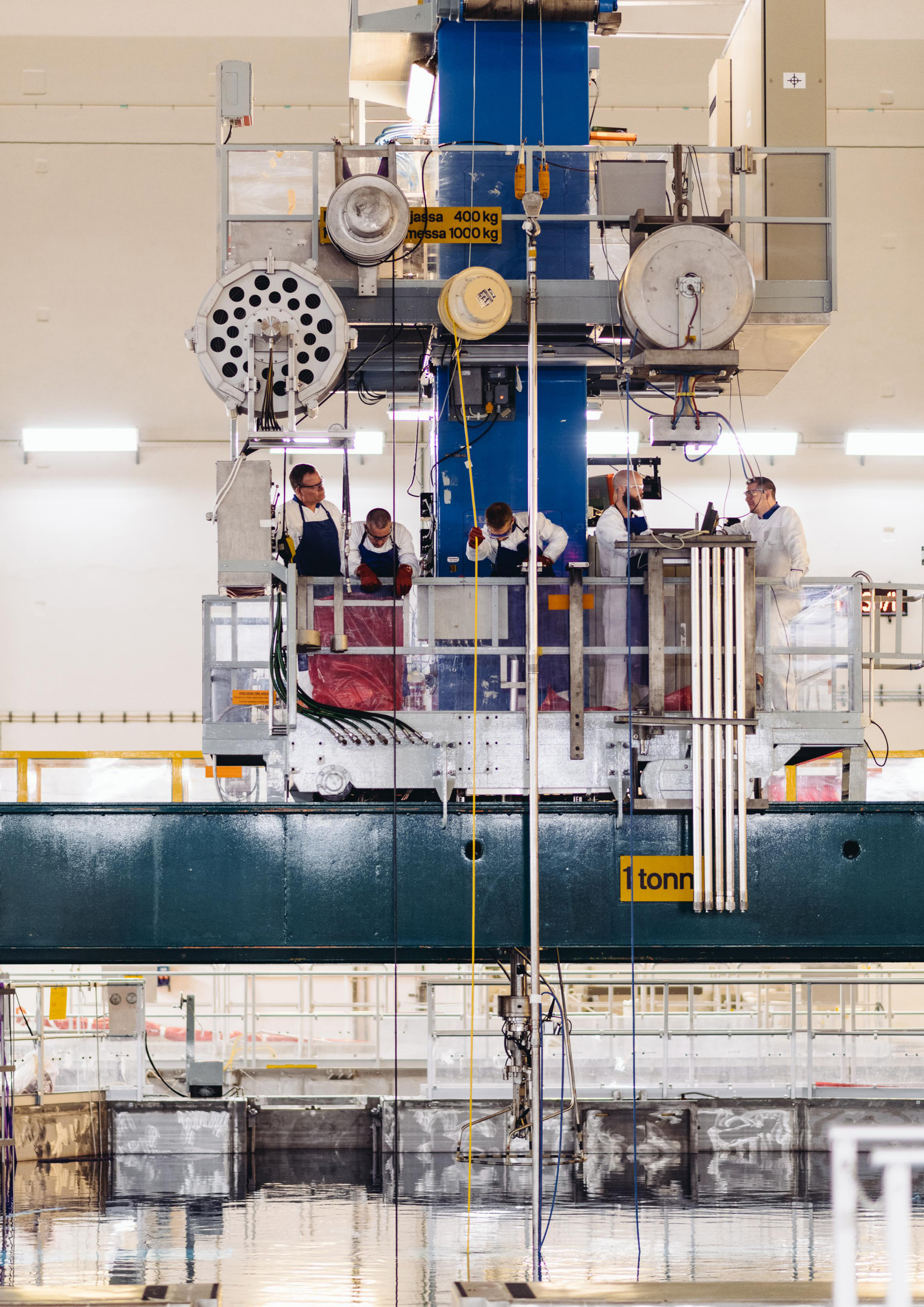
3.3. Ageing management and maintenance at the power plant

The OL1 and OL2 plant units have been systematically developed over the decades. TVO systematically modernises the plant units during annual outages and through modernisation projects. State-of-the-art solutions that improve operability, productivity and safety are being commissioned throughout the operations.

The OL1 and OL2 plant units are among the best nuclear power plants in the world in terms of operability and safety. The annual capacity factors for the OL1 and OL2 plant units have been consistently above 90%, on average, and the indicators measuring safety are at a good level. This has been due, in part, to the approach chosen by TVO: continuously improving safety and ensuring operability. The result has been achieved through proactive equipment replacements, comprehensive preventive maintenance and the development of the plant units' processes, which allow for good operability and the gradual improvement of the plant units' efficiency.

The systems, structures and components of a power plant are subject to various types of stress during operation. This results in normal wear as a result of equipment operation or the fatigue of their structural materials, which may result in degraded integrity and operability. The authority requirements and other requirements targeting the systems, structures and components may change over the course of the power plant's operation, and the technology being used may develop in ways where the systems, structures and components no longer meet the current level of requirements. These factors, which are also referred to as the ageing of systems, structures and components, are prepared for during the design stage through justified design solutions and, during operation, by monitoring and maintaining the operability of systems, structures and components until their decommissioning. Among other things, this comprises test operation of the equipment, quality control inspections and maintenance. This allows for ensuring that the systems, structures and components operate as planned. In order to ensure operability, equipment replacements are performed due to ageing.

The OL1 and OL2 plant units are qualified for a service life of 60 years. In practice, this means that the load analyses and operational capabilities of the systems and their components have been demonstrated to be sufficient for a 60-year service life. When the service life of the plant units is extended until 2048, the qualification of the systems must be demonstrated for a service life of 70 years. If the service life of the plant units is extended until 2058, the qualification of the systems must be demonstrated for a service life of 80 years. The plan is to complete this with the help of a separate management programme by 2038, when the service life of 60 years is reached. This may cause a need to replace system components at the plant units. In addition to requalification, the ageing management programme and practices cover the entire power plant unit. Ageing management is the responsibility of appointed system owners who monitor the condition of systems and take the necessary actions if shortcomings are observed in the operation of systems. Preventive maintenance and periodic tests are used to ensure that systems, structures and components meet the operability requirements under normal operating conditions as well as during incidents and accidents.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4. Environmental impact assessment procedure

The aim of the environmental impact assessment procedure (EIA procedure) is to ensure that the significant environmental impacts of the planned project are analysed to a sufficient level of precision. Its aim is to produce information to support the planning and decision-making of the project but also to provide the various parties with increased access to information and opportunities for participation in the project's planning stage.

In Finland, the need for an EIA procedure is based on the Act on Environmental Impact Assessment Procedure. This project also applies the Espoo Convention on the assessment of transboundary impacts (international hearing).

4.1. International hearing

The principles of international cooperation in environmental impact assessment are defined in the Espoo Convention (SopS 67/1997) and the Aarhus Convention (SopS 121–122/2004). These have been enacted within the EU by means of several directives, such as the EIA Directive (2011/92/EU) and national EIA acts and decrees. Finland and Estonia have a mutual EIA agreement that further specifies the Espoo Convention. Furthermore, Finland and Sweden have a transboundary reactor agreement (SopS 19/1977).

If the environmental impacts of a project may cross national borders, an international hearing is arranged for the environmental impact assessment in cooperation with another country. In this case, the Finnish Environment Institute which acts as the coordinating authority for the international hearing, notifies the target countries that an EIA procedure has been started for the project and enquires whether they are willing to participate in the EIA procedure. A summary document for the EIA programme that has been translated into the target country's language and the EIA programme translated into Swedish or English will be enclosed with the notification. The Finnish Environment Institute will relay the received feedback to the coordinating authority for the EIA, the Ministry of Economic Affairs and Employment (MEAE), to be considered in its statement on the EIA programme. In accordance with the EIA Act, the coordinating authority will submit its statement and the translations of its essential parts to the Finnish Environment Institute for further submittal to the European Union member states for information.

A corresponding international hearing will be arranged at the later EIA report stage to the target countries who have expressed that they will participate in the Finnish EIA procedure.

4.2. The EIA procedure in Finland

The European Union's EIA directive (2011/92/EU) has been enacted in Finland via the Act on the Environmental Impact Assessment Procedure (EIA Act, 252/2017) and the Government Decree on the Environmental Impact Assessment Procedure (EIA Decree, 277/2017). The EIA procedure is applied to projects and changes thereto that are likely to have significant environmental impacts. Appendix 1 to the EIA Act lists projects to which the EIA procedure applies. Uprating the thermal power of a reactor is one of the projects to be assessed according to section 7b (nuclear power plants).

The EIA procedure has two stages. The EIA procedure starts when the project owner submits the assessment programme (EIA programme) to the coordinating authority. The EIA programme defines how the EIA procedure is arranged. According to the EIA Decree, the assessment programme shall include, among other things, the following to a necessary extent:

- A description of the project, its purpose, design stage and location;
- Any reasonable alternatives in the project, one of which shall be that the project is not implemented;
- Information on the plans, permits and decisions required for implementing the project;
- A description of the current state of the environment in the likely affected area, any analyses planned or already completed and the methods and assumptions to be used;
- A plan on the arrangement of the EIA procedure and participation;
- A schedule.

The coordinating authority will notify the other authorities and the municipalities in the project's area of impact that the EIA programme is on display for public inspection. The display for public inspection will last from 30 to 60 days. Following this, the coordinating authority will compile the statements and opinions received regarding the EIA programme and draw up its own statement on the EIA programme, which will conclude the first stage of the EIA procedure. Simultaneously, an international hearing will take place.

In the second stage of the EIA procedure, the actual environmental impact assessment will be performed on the basis of the EIA programme and the coordinating authority's statement regarding it. The results of the assessment are compiled into an EIA report that is submitted to the coordinating authority when complete. The coordinating authority sets the assessment report, similarly to the EIA programme, on display for public inspection (for 30–60 days). An international hearing will also be held during the EIA report stage. Based on the EIA report and the statements provided concerning it, the coordinating authority draws up a reasoned conclusion on the key environmental impacts of the project and places it on display for public inspection. The assessment report and the coordinating authority's reasoned conclusion are enclosed with the permit application documents.

The figure below (Figure 4) presents a summary of the stages of the EIA procedure in Finland and how the international hearing links to it.

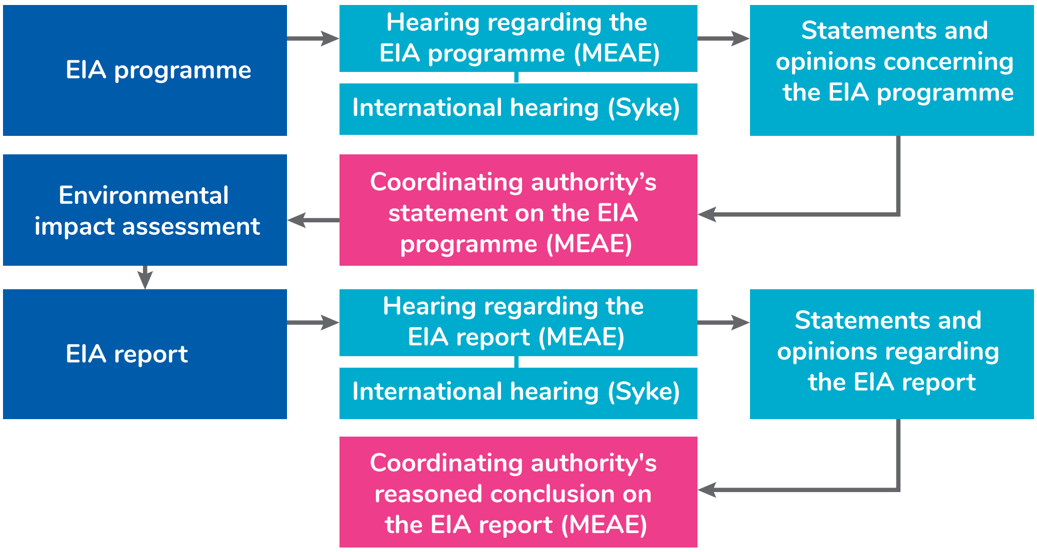


Figure 4. Stages of the EIA procedure. MEAE = Ministry of Economic Affairs and Employment. Syke = Finnish Environment Institute.

4.3. Schedule for the EIA procedure

The key stages and preliminary schedule for the EIA procedure are presented in the figure below (Figure 5). The international hearing is performed while the EIA programme and report are on display for public inspection. In Finland, advance negotiations and authority negotiations as well as public events will be arranged during the national EIA procedure. The coordinating authority's statement and reasoned conclusion and the translations of their essential parts will be submitted to the European Union Member States for information once the translations have been completed.

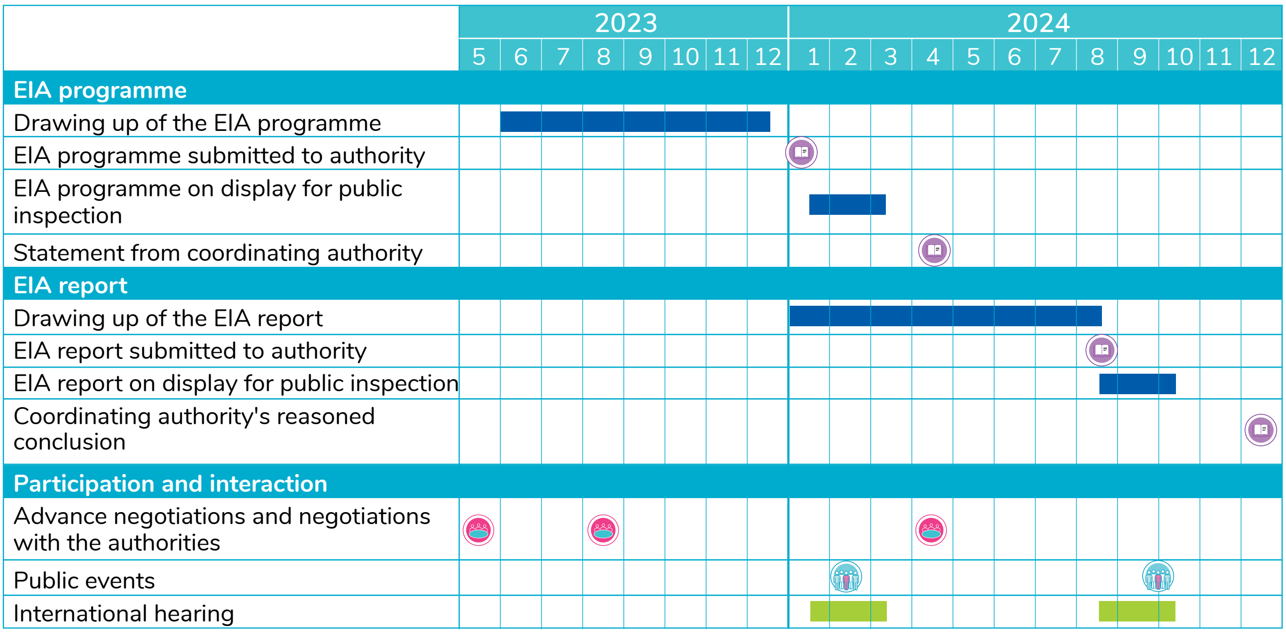


Figure 5. Preliminary schedule for the EIA procedure.


KAAPELI

5. Assessment of the environmental impacts of the project

5.1. Structure of the EIA programme

The structure of the EIA programme is as follows:

Summary
1. The project and the alternatives being considered.
2. Current operation.
3. Project description.
4. Environmental impact assessment procedure.
5. Current state of the environment.
6. The impacts being assessed and the assessment methods.
7. Uncertainty factors.
8. Prevention and mitigation of harmful impacts.
9. Monitoring of impacts.
10. The project's licence and permit process and project's relation to plans and programmes.

5.2. The impacts being assessed and the significance of the impact

The purpose of the environmental impact assessment is to systematically identify and assess the generated impacts and their significance. An impact refers to a change in relation to the current state of the environment brought about by the project, its alternative or a function related to them. In this EIA procedure, the current state refers to the present state of the nearby areas of Olkiluoto nuclear power plant area, where the OL1, OL2 and OL3 plant units are in operation.

The purpose of an environmental impact assessment is to assess, in the manner and accuracy required by the EIA Act and Decree, the environmental impacts caused by the project, which may affect the following:

- 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 as regards 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.

The impacts may be either negative or positive as regards the environment, or there may be no changes when compared to the current situation.

The assessment report presents, among other things, an estimate and description of the likely significant environmental impacts of the project and its reasonable alternatives. The environmental impact assessment takes into account impacts during any possible modifications and operation. Furthermore, the project's possible joint impacts with other functions or other planned projects are assessed.

When assessing the significance of an impact, the magnitude of the change caused by the impact and the capability of the environment to receive changes, that is, the sensitivity of the affected aspect are considered. The magnitude of the change caused by the project is defined and assessed on the basis of several variables. When assessing the magnitude of the change, its scope, duration and strength are considered. A direction is also determined for the change, that is, whether the impact is positive or negative. In terms of geographical scope, the impact may be regional or local or cross the Finnish national borders. In terms of duration, the impact may be temporary, short-term, long-term or permanent. Other factors such as the recurrence and timing of the change and its accumulation and restorability are also examined. In some cases, the magnitude of measurable changes can be modelled from the initial data (for example, the spreading of cooling water into the sea area). In order to determine the magnitude of qualitative changes, an expert assessment is prepared; in order to reduce its subjectivity, the initial data which the assessment is based on will be presented as transparently as possible.

The sensitivity of an affected aspect is determined on the basis of the characteristic features and current status of the target or area. The affected aspect's sensitivity to change describes the capability of the asset to receive, withstand or tolerate changes caused by the project. Sensitivity is also affected by whether the aspect is protected by law or if there are any defined guideline values, norms or recommendations for the impact. For impacts affecting humans, the number of people using or experiencing the aspect and their experience are also taken into account.

In the assessment procedure, the magnitude of the change, the sensitivity of the affected aspect and the resulting significance of the impact are assessed using a scale of four steps: minor, moderate, large and very large.

5.3. The most significant environmental impacts identified and assessment of transboundary impacts

The environmental impact assessment for this project focuses on examining the impacts that have been identified as being the most important for the project in the cases of service life extension and power uprating.

Impacts on the environment will mainly be similar to those of the current operation. Based on the initial planning data, the areas listed in the table (Table 2) have been identified as key environmental impacts at this stage when compared to the current status of the power plant. The actual environmental impact assessment work will be carried out during the next stage of the EIA procedure, and its results will be reported in the EIA report.

The possible impacts of incidents and accidents are discussed in the paragraphs below the table.

Table 2. A preliminary list of the identified key environmental impacts due to the changes related to the project, compared with the current state of the power plant's operation and a preliminary assessment of impacts crossing the borders of Finland.

The most significant identified environmental impacts		Preliminary assessment of impacts crossing the borders of Finland
Thermal load from the cooling water	In the scenario where the service life is extended, the impacts on the marine environment would be similar to those of the current operation, but the impacts will continue beyond the current operating licence period, up to 2048 or 2058. In the power uprating scenario, there will be some changes to the OL1 and OL2 power plants' current operation, the most significant of which is the increase in thermal load from the cooling water. Based on preliminary information, the temperature of the cooling water discharged into the sea area would increase by approximately 1°C when compared to the current activities. As a consequence, the impacts on surface water and fish stocks would be increased somewhat, when climate change scenarios are also considered.	The effects will be local. No impacts beyond the borders of Finland.
Volume of spent nuclear fuel and waste volumes	In the scenario where the service life is extended and power is uprated, the waste volumes and volume of spent nuclear fuel generated by the OL1 and OL2 plant units will remain the same at the annual level, but the volumes will grow according to the years of operation. The nuclear power plant has existing methods and plans for handling, storage and final disposal, which will not be materially affected by continuing the operation or uprating the power. Posiva will, if necessary, examine the licensed capacity in the disposal repository for spent nuclear fuel so that the capacity of the disposal facility will match the spent nuclear fuel generated by the nuclear power plants of TVO and Fortum Power and Heat Oy in Finland during their service lives.	The effects will be local. No impacts beyond the borders of Finland.
Regional economy	In the scenario where the service life of the OL1 and OL2 plant units is extended and their power is uprated, the most significant positive impacts will most likely be related to regional economy. The nuclear power plant's impacts on the regional economy are extremely high at the level of the Eurajoki area and also visible at the level of the entire country.	The impacts would likely be seen at the level of all of Finland. No impacts beyond the borders of Finland.
Energy markets	The Finnish energy market is expected to be subject to positive impacts of a major significance. Extending the service life of the OL1 and OL2 plant units and their potential power uprating will improve Finland's self-sufficiency in terms of energy, promote the clean energy transition and support the functionality of Finland's energy system and availability of electricity.	The impacts would likely be seen at the level of all of Finland. No impacts beyond the borders of Finland.
Greenhouse gas emissions and climate change	A preliminary assessment indicates that the project will have significant positive impacts on greenhouse gas emissions and climate change, among other things. Extending the service life of the OL1 and OL2 plant units and uprating their power would support Finland's goal of being carbon neutral by 2035, because the use of nuclear power in the production of electricity generates a very minor amount of greenhouse gas emissions.	The impacts support Finland's goal of becoming carbon neutral, but the positive impacts at the Nordic/EU/global level are minor.

As regards the alternatives examined in the EIA procedure, a preliminary estimate indicates that only the impact of releases of radioactive substances resulting from a severe reactor accident could extend beyond the borders of Finland.

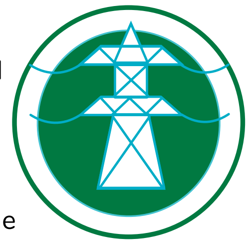
In the EIA report, the possible transboundary impacts will be assessed on the basis of, among other things, a dispersion calculation. Furthermore, other potential risks related to, for example, incidents, accidents and transports are examined and the potential for the impacts extending beyond the borders of Finland is assessed.

In the EIA report, a severe reactor accident is examined as an imaginary accident case. The assessment is based on the assumption that an amount of radioactive substances equivalent to the limit value for a severe accident pursuant to section 22 b of the Nuclear Energy Decree (161/1988) is released into the environment (100 TBq of Cs-137 nuclides). The impacts of such a release's dispersion in the accident will be studied over a distance of 1,000 km from the power plant. The fallout and radiation dose resulting from the release and the impacts on the environment will be described on the basis of the modelling results and existing research data.

The EIA report also describes identified environmental risks and safety risks related to the operation of the power plant and assesses the impacts of potential incidents and accidents based on authority requirements and the power plant's safety and risk analyses, among other things. Any identified incidents and accidents may be prevented and limited by technical and administrative means. These are described at a general level in the EIA report. The risks caused by climate change (such as sea level rise or flooding) are identified in the EIA report stage as regards any possible incidents and accidents related to them, and preparation for them is described.

The environmental impacts of the transport and final disposal of spent nuclear fuel are assessed in the environmental impact assessment for the encapsulation plant and disposal facility performed by Posiva, the main results of which are described in the EIA report. The risk and implementation analysis concerning transports is also utilised.

5.4. Summary of the assessment methods and a proposal for limiting the examined area of impact



The plant site refers to the Olkiluoto area where the current functions of the OL1 and OL2 plant units are located and where the project's planned changes to the plant units will take place. Environmental impacts are examined, in particular, in the plant site and its nearby areas, but the area under review will also be extended to a wider area, if necessary. For environmental impacts, the areas under review have been defined to the extent where the impacts could reach, at a maximum. In reality, environmental impacts will likely take place in an area smaller than the area under review. The EIA report presents the environmental impact assessment results and their areas of impact.

The following (Table 3) presents a summary of the assessment methods and the proposed areas under review, broken down by impact.

Table 3. Summary of the environmental impacts examined, methods used in the assessment and the preliminary area under review for the impacts.

Area	Assessment methods	Area under review
Land use, zoning and the constructed environment	An expert assessment of the project's relationship with the current and planned land use and zoning. Additionally, an analysis of the locations in the constructed environment and distances thereto.	Approximately 5 km from the power plant area.
Landscape and cultural environment	An expert assessment of the project's relationship with the landscape in the nearby areas and a broader landscape. Locations in the cultural environment are identified.	Approximately 5 km from the power plant area.
Traffic	A calculated assessment of the changes in traffic volumes caused by the project and an expert assessment of the impacts of transports on traffic safety.	The roads leading to the power plant area and their immediate surroundings (0–2 km).
Noise and vibration	An expert assessment of the noise emissions and vibration from the different stages of the project and transports and their dispersion within the environment.	The site area and its immediate surroundings at a radius of approximately 3 km and the nearby areas along the transport routes.
Air quality	An expert assessment of the conventional emissions into the air (carbon dioxide, nitrogen oxide, sulphur dioxide and particulate emissions) caused by the project and their impact on air quality.	Approximately 1–2 km from the power plant area.
Climate change	Calculated estimate of greenhouse gas emissions and their impacts on Finland's total emissions. The greenhouse gas emissions generated during the fuel life cycle of different forms of energy production are also compared. The risks caused by climate change are identified and preparing for them is described.	CO_{2e} emissions at the regional level and for all of Finland. Risks locally in the power plant area
Soil, bedrock and groundwater	Expert assessment of the possible impacts of the modifications in the project, based on existing research data.	Power plant area.
Surface water	Cooling water modelling and an expert assessment of impacts on the sea area prepared on its basis. An expert assessment of the impacts of cooling water, service water intake and the treatment and discharge of wastewater.	Approximately 10 km from the power plant area.
Fish stocks and fishery	An expert assessment prepared on the basis of studies on fish stocks and a surface water impact assessment.	Approximately 10 km from the power plant area.
Vegetation, animals and conservation areas	An expert assessment of impacts on the natural environment and conservation areas, based on the results from other impact assessments, for example.	Approximately 10 km from the power plant area.
People's living conditions, comfort and health	An expert assessment based on the calculated and qualitative assessments performed in the other impact areas (regional economy, noise, emissions, traffic and landscape, among other things).	Approximately 20 km from the power plant area.
Regional economy	A regional economy analysis based on an analysis of the current situation and resource flow modelling.	At the level for all of Finland.
Releases of radioactive substances and radiation	An expert assessment of the radioactive releases into the air and sea caused by the project. Radiation monitoring in the nearby areas of the power plant is implemented according to the existing monitoring programme, and the assessment is based on monitoring data. Radiation doses from the releases are estimated by means of calculation.	Environmental radiation monitoring approximately 10 km from the site area, radiation dose calculation approximately 100 km from the site area.
Use of natural resources	An expert assessment of nuclear fuel procurement and the impacts of its supply chain at the general level.	The nuclear fuel supply chain at the general level.

Area	Assessment methods	Area under review
Waste and byproducts	An expert assessment of the project's waste flows, their handling, opportunities for utilisation and final disposal. The description of the impacts from the transports and final disposal of spent nuclear fuel utilises the analyses already completed.	Olkiluoto area.
Energy markets	An expert assessment of the development of the energy markets and their changes for the project alternatives.	At the level for all of Finland.
Incidents and accidents	A modelling of an imaginary severe reactor accident where 100 TBq of the Cs-137 nuclide is released into the atmosphere. The results of the modelling establish the fallout and radiation doses caused by the release. An expert assessment of the impacts.	1,000 km from the power plant area.
Joint impacts	An expert assessment of joint impacts concerning the OL3 plant unit and the other actors and related projects in the area.	Areas near Olkiluoto.
Transboundary impacts	An assessment based on separate analyses and modellings regarding whether the impacts of the project may extend across the borders of Finland.	1,000 km from the power plant area.

5.5. Mitigation of detriments and follow-up of impacts

As part of the environmental impact assessment work, possibilities for preventing or mitigating the project's potential harmful impacts through design and implementation, among other things, are examined. The EIA report presents the identified means for preventing and mitigating detriments.

In connection with the environmental impact assessment, the project owner's existing monitoring programmes for environmental impacts are reviewed and the potential need for updating them is assessed. This is described in the EIA report.

6. The permits, plans, notifications and decisions required for the project in Finland

6.1. Decisions and licences according to the Nuclear Energy Act

The OL1 and OL2 plant units have an operating licence pursuant to the Nuclear Energy Act that is in force until the end of 2038. In order to extend the service life of the OL1 and OL2 plant units, a new operating licence must be sought. In the scenario involving power uprating, the aim is to combine the periodic safety assessment and the new operating licence application required by the uprated power and service life extension. The operating licence is issued by the Government.

The operating licence for the disposal repository for low and intermediate-level waste (VLJ repository) is in force until the end of 2051. TVO will seek a new operating licence for the VLJ repository in good time before the expiration of the operating licence in order to enable the operation of the VLJ repository beyond the decommissioning of the power plant units.

The operating licence for the OL1 and OL2 plant units comprises the operation of the interim storage facilities for nuclear waste (MAJ, KAJ, KPA), and if service lives are extended at the OL1 and OL2 plant units, the operation of their interim storage facilities is also extended under the same operating licence. If the operation of the OL1 and OL2 plant units ends in 2038, a dedicated operating licence will be sought for the interim storage facilities or it will be combined with the operating licence for the OL3 plant unit.

Olkiluoto Island also houses Posiva's encapsulation plant and disposal facility for spent nuclear fuel, for which Posiva sought an operating licence in late 2021. The Government will decide on granting the operating licence. The final disposal of spent nuclear fuel is planned to begin in the mid-2020s.

If the operation of the OL1 and OL2 plant units is not continued, the decommissioning of the plant units will take place following the current operating licence period. If the operation of the plant units is continued, decommissioning will take place after the new operating licence period. A separate environmental impact assessment will be drawn up for the decommissioning, according to the legislation in force, once it is relevant.

6.2. Other permits

The valid zoning makes it possible to carry out modification work in the power plant area and construct additional structures and/or buildings. In accordance with the Land Use and Building Act (132/1999), the construction of buildings related to the required modification work and the necessary infrastructure and facilities requires a building permit. 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.

The operation of a nuclear power plant requires an environmental permit in accordance with the Finnish Environmental Protection Act (527/2014). The other permits related to the operation of the power plant are mainly various technical permits that are intended to, among other things, ensure industrial safety and prevent material damage.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