

# FENNOVOIMA

## Environmental Impact Assessment Report for a Nuclear Power Plant



October 2008

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Fennovoima's EIA report is available electronically at **fennovoima.fi**

Environmental Impact Assessment Report  
for a Nuclear Power Plant



# Environmental Impact Assessment Report for a Nuclear Power Plant

Fennovoima Ltd.

## Preface

**In the fall of 2007, Fennovoima Oy** (Fennovoima) launched an environmental impact assessment procedure (EIA) for a nuclear power plant project regarding the construction of a nuclear power plant in four alternative localities. In June 2008, the EIA procedure was continued in three alternative localities (Pyhäjoki, Ruotsinpyhtää and Simo).

On January 30, 2008, Fennovoima submitted the environmental impact assessment (EIA) program to the Ministry of Employment and the Economy, which acts as the coordinating authority for the project. The program was placed on display for public inspection from February 5 to April 7, 2008. During the EIA program stage, The Ministry of Employment and the Economy and Fennovoima organized open public meetings in each alternative locality. The Ministry of Employment and the Economy issued a statement on the EIA program on May 7, 2008 (Appendix 1).

Following the Ministry of Employment and the Economy's request for statements, 69 communities submitted a statement concerning the EIA program to the coordinating authority. A total of 153 opinions on the EIA program were submitted. Of these, 35 were from Finnish communities and organizations, four from foreign communities and organizations, and 113 from private individuals from various countries.

The environmental impact assessment report has been drawn up on the basis of the EIA program and the related statements and opinions. Furthermore, a monitoring group consisting of representatives of different com-

munities was established in each alternative locality to gain valuable additional information for the preparation of the EIA report. Fennovoima's project has increased knowledge on nuclear power in the new localities and resulted in active local dialog and public involvement.

This EIA report is one of the most extensive, if not the most extensive, environmental impact assessment reports prepared in Finland during the validity of the EIA Act. It is a comprehensive description of the current state of the environment in the alternative location sites, the project's environmental impacts, their significance and the prevention and mitigation of possible adverse effects.

Fennovoima will attach the EIA report to its application for a decision-in-principle, which it will submit to the Finnish Government by the beginning of 2009. The realization of a nuclear power plant project in any locality requires a statement of recommendation concerning the construction of the nuclear power plant to be issued by the municipality in question.

The EIA report was prepared by Pöyry Energy Oy on the assignment of Fennovoima. A large number of experts from Pöyry Energy Oy took part in the assessment of environmental impacts and the preparation of the EIA report. The experts most centrally involved in the assessment procedure were:

- Mr. Mika Pohjonen, M.Sc. (Agric.) (project manager)
- Ms. Sirpa Torkkeli, M.Sc. (Eng.) (environmental expert)
- Suomen YVA Oy: Mr. Hannu Lauri, M.Sc. (Eng.)

- and Mr. Jorma Koponen, M.Sc. (Eng.) (cooling water modeling)
- Ms. Laura Kyykkä, M.A. and Ms. Tuija Hilli, M.Sc. (Agric.) (water system experts)
  - Mr. Eero Taskila, M.A. (fishing industry)
  - Ms. Minna Jokinen, M.Sc. (Eng.) (environmental expert, traffic, transportation and construction)
  - Ms. Terhi Fitch, M.Sc. (Agric.) (environmental expert, monitoring)
  - Ms. Riitta Ståhl, M.Sc. (Eng.) (energy industry expert)
  - Mr. Arto Ruotsalainen, M.A., Mr. Sakari Grönlund, M.A. and Ms. Saija Miettinen, M.Sc. (Eng.) (social impact assessment)
  - Mr. Juha Pitsinki, M.Sc. (Eng.), M.Sc. (Econ.) and Mr. Anders Lindholm, M.Sc. (Eng.) (assessment of regional economic impacts)
  - Mr. Mike Lewis, B.Sc. (nuclear power technology)
  - Mr. Markku Tuomenoja, M.Sc. (Eng.) (project manager, technical design)
  - Mr. Pasi Rajala, M.Sc. (Eng.) (land use and planning)
  - Mr. Carlo Di Napoli, M.Sc. (Eng.) (modeling and assessment of noise impacts)
  - Mr. Lauri Erävuori, M.A., Ms. Sari Ylitulkkila, M.A., Mr. Tommi Lievonen, M.A., Ms. Soile Turkulainen, M.A. and Mr. Juha Parviainen, M.A., Ms. Anni Korteniemi, M.A., Ms. Tiina Sauvola, undergraduate student, Biology, Ms. Kukka Pohjanmies, undergraduate student, Biology (assessment of impacts on nature)
  - Ms. Mariikka Manninen, Landscape Architect and Mr. Jarkko Männistö, Architect (visualization and assessment of impacts on the landscape)
  - Ms. Mirja Kosonen, M.A. (assessment of health impacts)
  - Ms. Karoliina Joensuu, undergraduate student, Engineering and Arts (environmental expert)
  - Finnish Institute of Marine Research: Ms. Milla Johansson, M.A., Mr. Kimmo Kahma, Ph.D. and Ms. Hanna Boman, M.A. (extreme phenomena on the sea level)
  - Finnish Meteorological Institute: Mr. Seppo Saku, M.A. and Mr. Ari Venäläinen, Ph.D. (extreme weather phenomena)
  - Platom Oy: Mr. Kalevi Puukko, Mr. Tero Lytsy, B.Eng. and Mr. Jani Laine, M.Sc. (Eng.) (operating waste)
- The Ministry of Employment and the Economy will request a number of statements concerning this EIA report and organize public meetings in Pyhäjoki, Ruotsinpyhtää and Simo in cooperation with Fennovoima. In addition, an international hearing procedure pursuant to the Espoo Convention will be applied to the project. Furthermore, all those wishing to present their opinion on the report will have an opportunity to do so. Fennovoima will gratefully receive all opinions concerning the report and use them to ensure that all environmental impacts will be sufficiently taken into consideration as the project progresses.
- We wish you a good read!



Fennovoima is studying the construction of a nuclear power plant in three alternative locations: Pyhäjoki, Ruotsinpyhtää and Simo. Rocky seashore in Finland in 2008.

Fennovoima's parent company is Voimaosakeyhtiö SF, which has a 66% shareholding, and is owned by 48 local energy companies operating in Finland as well as 15 industrial and retail companies. The minority shareholder is E.ON Nordic AB with a shareholding of 34%. Fennovoima is to produce electricity for the needs of its owners at cost price.



## Summary

### **The project and its justification**

In January 2008, Fennovoima Oy (hereinafter Fennovoima) launched an environmental impact assessment procedure (EIA) regarding the construction of a new nuclear power plant in Finland. Fennovoima is studying the construction of a power plant consisting of one or two reactors with an electrical output of 1,500–2,500 MW to one of the following municipalities: Pyhäjoki, Ruotsinpyhtää or Simo.

Fennovoima's parent company is Voimaosakeyhtiö SF which has a 66% shareholding, and is owned by 48 local energy companies operating in Finland as well as 15 industrial and retail companies. The minority shareholder is E.ON Nordic AB with a shareholding of 34%.

Fennovoima is to produce electricity for the needs of its owners at cost price.

Energy production must be increased in order to secure the operational requirements for and expand the operations of Finnish industry and commerce. In 2007, about 90 TWh of electricity was used in Finland (*Finnish Energy Industries 2008a*) and the demand for electricity is estimated to continue growing.

Fennovoima's shareholders account for nearly 30% of all electricity consumed in Finland. One of the main purposes of the project is to increase competition in the electricity market. Furthermore, the project's impact on the regional economy will be significant. The new nuclear power plant will increase carbon dioxide emission

free energy production, reduce Finland's dependence on imported electricity and replace coal- and oil-operated power plants.

### Implementation options to be assessed

The alternative location sites for the nuclear power plant are:

- The Hanhikivi headland in the municipality of Pyhäjoki. The distance to the center of the municipality of Pyhäjoki is less than 7 kilometers. The northeast part of the Hanhikivi headland is located in the town of Raahe. The distance to the center of Raahe is about 20 kilometers.
- The Kampuslandet island and the Gäddbergsö headland in the municipality of Ruotsinpyhtää. The distance to the center of the municipality of Ruotsinpyhtää is approximately 30 kilometers.
- The Karsikkoniemi headland in the municipality of Simo. The distance to the center of the municipality of Simo is approximately 20 kilometers.

During the EIA program stage, the alternative sites inspected also included Norrskogen in Kristiinankaupunki. Fennovoima Oy completed the investigations for these alternative in June 2008.

The impacts of the alternative cooling water intake and discharge locations will be assessed for each site.

The main alternative for the project to be analyzed in the environmental impact assessment is a nuclear power plant with electric power of 1,500–2,500 MW. The power plant can also be constructed in a manner suitable for combined district heating production. The nuclear power plant will consist of one or two light-water reactors (pressurized-water or boiling water reactors) and a disposal site for low- and medium-level waste produced by the reactors.

The project includes the disposal of spent nuclear fuel created by the nuclear power plant operations in Finland according to the requirements of the Nuclear Energy Act.

### Project options

Fennovoima was specifically established to prepare, design and implement a nuclear power plant project to cover its owners' needs for electricity, and its plans do not include other alternative power plant projects. According to the estimates of Fennovoima's owners, other means cannot be used to achieve the required electrical power, delivery reliability and price.

The report describes the energy saving actions of Fennovoima's shareholders. They have engaged in systematic improvements in the efficiency of the use of electricity voluntarily and have achieved considerable savings. However, these means have not and will not be able to achieve such reductions in energy use that the nuclear power plant project would be unnecessary. By



Alternative site locations for the nuclear power plant.

implementing all of the energy saving actions that have been decided or are under consideration, energy savings only equaling the annual production of a power plant of about 24 MW could be achieved.

The zero-option under inspection is that Fennovoima's nuclear power plant project will not be implemented. In the zero-option, the shareholders' increasing demand for electricity would be covered by increasing imports of electricity and/or through other operators' power plant projects.

### Project schedule and the design stage

Preplanning for the nuclear power plant has been carried out in the alternative locations during 2008.

Fennovoima's objective is to start construction work at the selected plant site in 2012 and start energy production at the new nuclear power plant by 2020.

### Environmental impact assessment procedure

The Directive on Environmental Impact Assessment (EIA, 85/337/EEC) issued by the Council of the European Community (EC) has been enforced in Finland through the EIA Act (468/1994) and Decree (713/2006). Projects to be assessed through the environmental impact assessment procedure are prescribed by the EIA Decree. According to the project list of the EIA Decree, nuclear power plants are projects to which the assessment procedure is to be applied.

Fennovoima submitted the EIA program concerning its nuclear power plant project on January 30, 2008 to the Ministry of Employment and the Economy, which acts as the coordinating authority. The Ministry of Employment and the Economy requested statements on the EIA program from different authorities and other stakeholders, and citizens had the opportunity to present their opinions. The EIA program was placed on public display from February 5 to April 7, 2008. The Ministry of Employment and the Economy issued its statement on the EIA program on May 7, 2008.

The environmental impact assessment report (EIA report) has been drawn up on the basis of the EIA program and related opinions and statements. The EIA report was filed with the coordinating authority in October 2008. Citizens and various stakeholders have the possibility to present their opinions on the EIA report during the time determined by the Ministry of Employment and the Economy. The EIA procedure will end when the Ministry of Employment and the Economy issues its statement on the EIA report.

One of the goals of the EIA procedure is to support the project design process by producing information concerning the project's environmental impacts at as early a stage as possible. Participation of citizens, which is an essential part of the EIA procedure, aims to ensure that various stakeholders' views of the project's impacts are also taken into account at a sufficiently early stage. During the EIA procedure, Fennovoima has launched technical preplanning for the project in all of the alternative sites and land use planning in two municipalities. Preplanning has been performed in close cooperation with environmental experts who carry out the assessment work. The EIA report and the stakeholder interaction that materialized during the EIA procedure, as well as the collected data, act as an important support for the more detailed further design and land use planning for the project.

### **Statements on the assessment program and other participation**

The requested organizations submitted a total of 69 statements on the assessment program to the coordinating authority. The submitted statements mainly considered the program to be appropriate and comprehensive. A total of 153 opinions on the EIA program were submitted, of which 35 were from Finnish organizations and associations, four from foreign organizations and associations and 113 from private individuals from various countries.

The statements and opinions discuss the project-related factors very widely. The cooling water impact assessment has been requested to include the impact of warm water that increases eutrophication and impacts on migrating fish. In addition, the impact of the nuclear

power plant and the surrounding safety zone on nearby residents and their everyday lives has raised plenty of interest. The statements and opinions have also dealt with the impact of radioactive emissions, the possibilities of reducing the emissions and the project's impact on the regional economy and the value of nearby properties. Various opinions suggested that the environmental impact assessment should be supplemented by taking into consideration the entire lifecycle of the project, including the environmental impacts of the processing of uranium, decommissioning the plant units, nuclear waste management and transportation. The opinions also discussed the social significance of the project and the need for assessing alternative energy production methods. The aim has been to take into account the questions, comments and views presented in the statements and opinions as comprehensively as possible in the drafting of the EIA report and associated surveys.

A monitoring group consisting of project-related stakeholders has been established in each of the municipalities being considered. The groups have met three times during the EIA procedure. During the public display of the EIA program, Fennovoima and the Ministry of Employment and the Economy organized open public events in all of the municipalities. Furthermore, other events concerning nuclear power and Fennovoima's project have been organized in the municipalities. Fennovoima has also established offices in all of these municipalities where information about nuclear power and Fennovoima's project has been available for everyone interested in the project. Information about the project has also been provided in Fennovoima News which was distributed in the region of each of the municipalities as a supplement to local newspapers. In addition, Fennovoima publishes the Sisu magazine distributed to stakeholders.

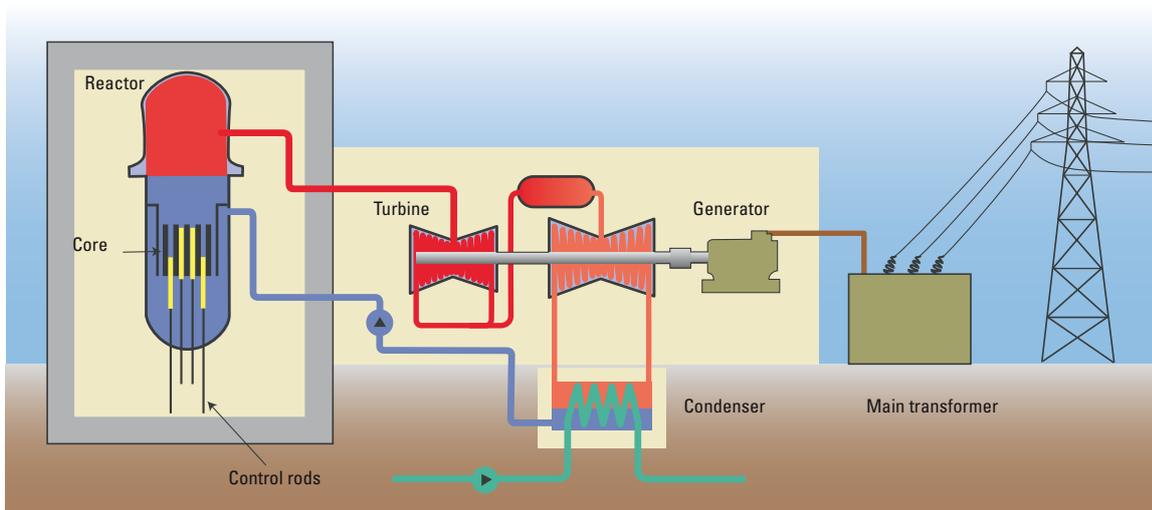
### **Project description**

#### **Technical description**

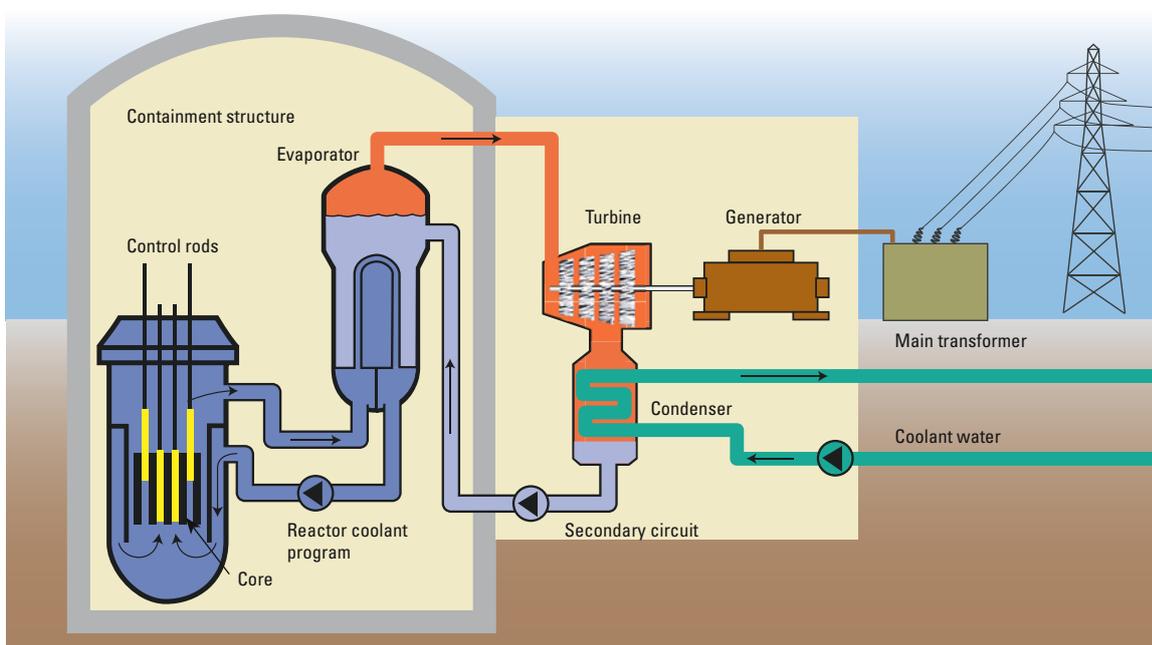
The alternative plant types inspected in the project are the boiling water reactor and the pressurized-water reactor. Both of the reactor types are light water reactors that use regular water to maintain the chain reaction, to cool the reactor and to transfer heat from the reactor core to the power plant process. It is possible to add an intermediate circuit at the low pressure end of both plant types to obtain sufficiently high temperature thermal energy from the process for district heating use.

The heat created in the fission of uranium atom cores used as fuel in the nuclear reactor heats the water in order to produce high-pressure steam. The steam rotates the turbine, which, in turn, drives the electric generator.

A boiling water reactor operates at a pressure of approximately 70 bar. Fuel heats up water in the reactor, and the steam coming from the reactor is led to rotate



The operating principle of a boiling water reactor.



The operating principle of a pressurized water reactor.

Description	Option 1 (one large unit)	Option 2 (two smaller units)
Electrical power	1,500–1,800 MW	2,000–2,500 MW
Thermal power	about 4,500–4,900 MW	about 5,600–6,800 MW
Efficiency	about 37 %	about 37 %
Fuel	Uranium oxide UO <sub>2</sub>	Uranium oxide UO <sub>2</sub>
Thermal power released in cooling to the water system	about 3,000–3,100 MW	about 3,600–4,300 MW
Annual energy production	about 12–14 TWh	about 16–18 TWh
Cooling water requirement	55–65 m <sup>3</sup> /s	80–90 m <sup>3</sup> /s

the turbine. The steam returning from the turbines is led to a condenser, where it releases its remaining heat into water pumped from the water system and condenses into water. The cooling water and the steam returning from the turbine and condensing into water are not brought into direct contact with each other. The boiling water reactor has a more simple steam generation process than the pressurized water reactor. On the other hand, the steam is slightly radioactive when the plant is running and no one can stay close to the turbine during operations.

In a pressurized water reactor, fuel heats the water, but the high pressure (150–160 bar) prevents the formation of steam. The high-pressure water coming from the reactor is led to steam generators where the water in a separate secondary circuit is vaporized, and this steam is led to rotate the turbine and electrical generator. Because of the heat exchanger, the steam in the reactor system and turbine plant is kept separate. As a result, water in the secondary circuit is not radioactive.

The nuclear power plant is a base load plant, which will be used continuously at constant power, except for a few weeks' maintenance outages at 12–24-month intervals. The plant's planned operational lifetime will be at least 60 years. The Fennovoima nuclear power plant will be primarily designed as a condensing power plant. The preliminary technical parameters of the planned nuclear power plant are shown in the table be-

side. Preliminary technical specifications of the planned nuclear power plant

Of all the light reactor types available on the market, Fennovoima has selected the following three reactor options suitable for Finland for closer inspection:

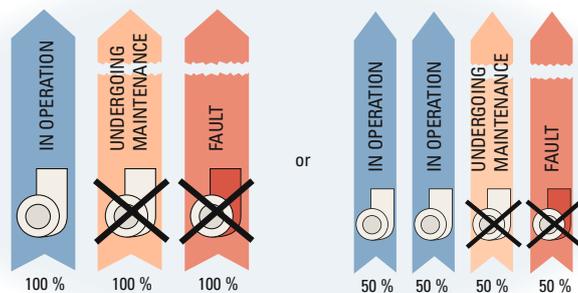
- EPR by Areva NP, a pressurized water reactor of about 1,700 MWe,
- ABWR by Toshiba, a boiling water reactor of about 1,600 MWe, and
- SWR 1000 by Areva NP, a boiling water reactor of about 1,250 MWe.

### Nuclear safety

According to the Finnish Nuclear Energy Act (990/1987), nuclear power plants must be safe and they must not cause any danger to people, the environment or property. The regulations of the Nuclear Energy Act are specified in the Nuclear Energy Decree (161/1988). The general principles of the safety requirements for nuclear power plants applicable in Finland are prescribed in the Finnish Government decisions 395-397/1991 and 478/1999. Detailed regulations concerning the safety of nuclear energy, safety arrangements, preparations and the supervision of nuclear materials are issued in the nuclear power plant guides by the Radiation and Nuclear Safety Authority (STUK, YVL Guide, see [www.stuk.fi](http://www.stuk.fi)). Legislation concerning nuclear energy is currently being revised.

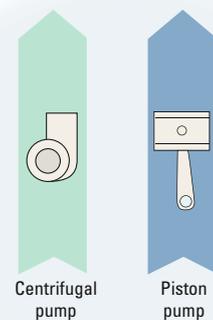
### Redundancy principle

N+2

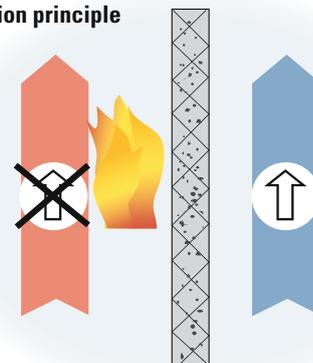


### Diversity principle

E.g.



### Separation principle



Design principles of safety systems.

Safety is the central principle when designing a new nuclear power plant to be constructed. The safety of nuclear power plants is based on following the defense in depth principle. Several simultaneous and independent protection levels will be applied to the design and use of the power plant. These include:

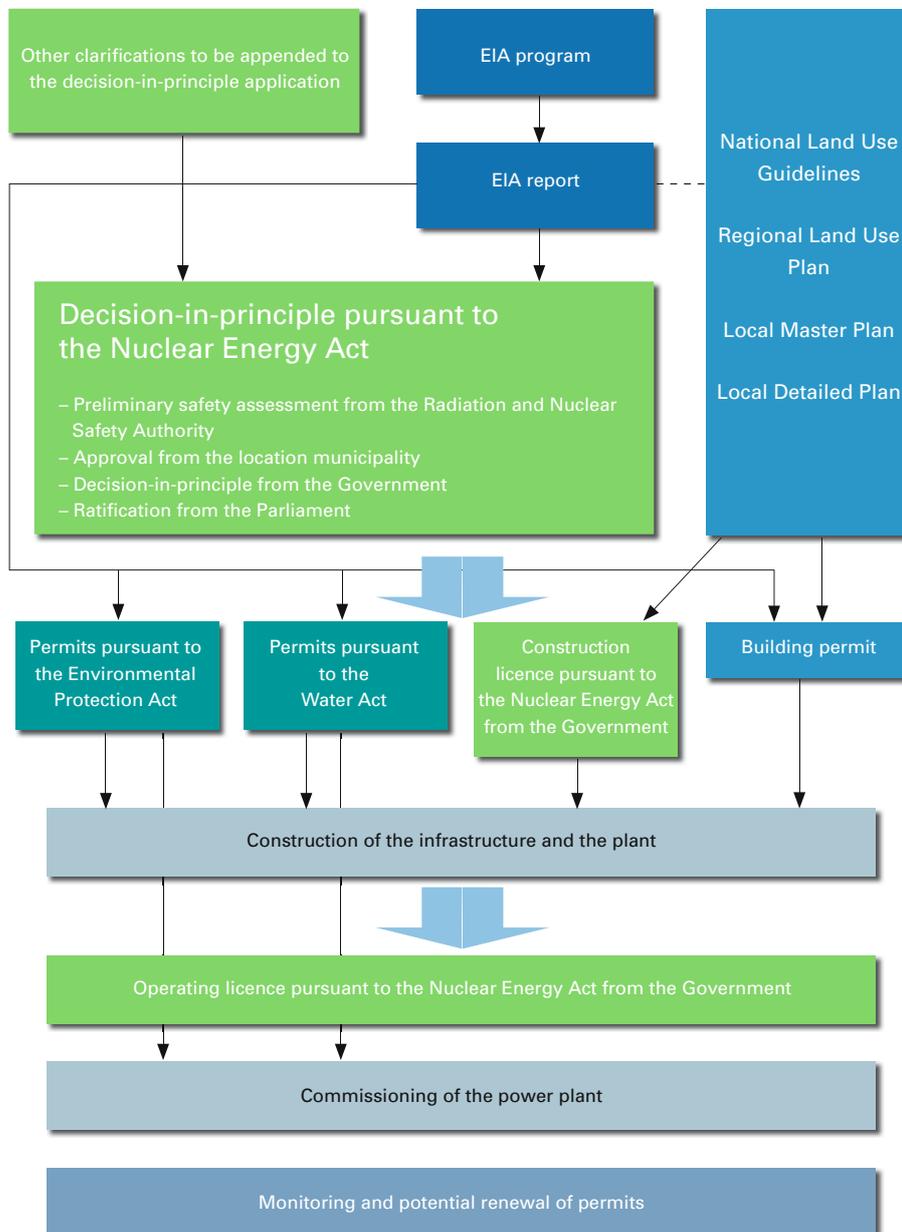
- the prevention and observation of operational malfunctions and faults
- the observation and management of accidents
- the reduction of the consequences of the release of radioactive substances.

Nuclear power plants are designed so that the failure of operations at one protection level does not result in any danger to people, the environment or property. In order to guarantee reliability, each of the levels is to be built on several supplementary technical systems, as well as limitations and regulations related to the use of the power plant.

Tested technology will be applied to the design of the nuclear power plant and all processes are designed to be naturally stable. The capacity of the power plant's safety systems is designed to be manifold in relation to the need so that the systems can be divided into several parallel subsystems.

Safety planning ensures that radioactive substances contained in the plant, fuel in particular, can be prevented from spreading as reliably as possible in all situations. Radioactive fuel is prevented from spreading into the environment using several technical spreading barriers within each other. Each of these barriers must be sufficient to independently prevent the spreading of radioactive substances into the environment.

The nuclear power plant will be constructed so that it is protected against outside threats, such as extreme weather conditions, different flying objects, explosions,



License procedure in the construction and operation of a nuclear power plant.

burning and poisonous gases and intentional damage.

The nuclear power plant will follow a high safety culture and developed quality assurance measures. The objective is to protect the plant from failures and employees from radiation. Supervision of the use and safety of nuclear energy is the responsibility of STUK and the safety of the nuclear power plant will be monitored through different authority inspections.

When applying for a decision-in-principle, STUK will prepare a preliminary safety assessment for Fennovoima's application, assessing how these reactor options inspected by Fennovoima meet Finland's nuclear safety requirements. The detailed implementation of the safety solutions for the plant option selected will be described in great detail when Fennovoima applies for a construction permit for the nuclear power plant. The structures implemented in construction and the results obtained from test operations will be assessed as a whole when Fennovoima applies for the operating permit for the nuclear power plant.

### **Licenses required by the project**

According to the Nuclear Energy Act (990/1987), the construction of a nuclear power plant with a noticeable general significance requires a decision-in-principle issued by the Finnish Government and ratified by Parliament concerning the fact that the construction of the nuclear power plant will be in accordance with the total benefit of the society. The decision-in-principle requires a recommending statement concerning the location of the nuclear power plant to be issued by the planned location municipality of the nuclear power plant. A binding decision on the project investment cannot be made until Parliament has ratified the decision-in-principle. The construction permit will be granted by the Finnish Government if the requirements for granting the construction permit for a nuclear power plant prescribed in the Nuclear Energy Act are met. The operating permit will also be granted by the Finnish Government if the requirements listed in the Nuclear Energy Act are met and the Ministry of Employment and the Economy has stated that the preparations for nuclear waste management costs have been organized as required by law. In addition, the project will, at different stages, require licenses pertaining to the Environmental Protection Act, the Water Act and the Land Use and Building Act.

### **The project's environmental impact**

For the environmental impact assessment, a report of the current status of the environment and the affecting factors have been conducted in each of the alternative sites and municipalities on the basis of available information and reports made for the EIA procedure.

The available environmental information and impact

assessment always include assumptions and generalizations. Similarly, the available design information is preliminary at this stage. This causes inaccuracies in inspection work. Furthermore, any uncertainties related to the assessment methods have been assessed. However, any uncertainties related to all of the said factors are known fairly well and they have been taken into account when assessing the impacts. As a result, the significance and magnitude of environmental impacts has been identified reliably and the conclusions do not include any significant uncertainties.

The project's environmental impacts have been inspected by comparing the changes caused by the project and the different options to the current situation and assessing the significance of the changes.

For the impacts related to the nuclear power plant's construction stage, the following stages and functions have been inspected separately:

- Construction work for the power plant
- Construction of the navigation channel and harbor quay
- Building cooling water structures
- Construction of road connections
- Construction of power lines
- Transportation and commuter traffic.

The following have been inspected with regard to impacts during operations:

- Impacts of cooling water and wastewater
- Waste management
- Transportation and commuter traffic
- Irregular and accident situations
- Combined effects with other known projects
- Impacts crossing the boundaries of Finland

Furthermore, the following have been described with regard to environmental impacts:

- Acquisition chain for nuclear fuel
- Final disposal of spent nuclear fuel
- Decommissioning of the power plant

The assessed impacts include:

- Impact on land use and regional structure
- Impact on water systems and the fishing industry
- Impact of radioactive and other emissions
- Impact on flora, fauna and protected sites
- Impact on the soil, bedrock and groundwater
- Impact on the landscape and cultural environment
- Noise impacts
- Impact on living conditions, comfort and health
- Impact on the regional economy
- Impact on traffic and safety

### **Land use and the built environment**

The area of the power plant site which covers the cen-

tral power plant functions will be about 10 hectares. The plant site will be specified in each municipality as design and planning proceed. The plant activities in the preliminary plans, excluding cooling water intake and discharge structures, harbor quay, and accommodation and parking areas, are expected to require an area of about 100 hectares at each alternative location. Ground area will also be required for new road connections to be built. The power line leading to the plant will restrict land use on a strip 80–120 meters wide depending on the column type.

The construction of the nuclear power plant will restrict land use in the plant's safety zone, but enable new constructions in settlements and villages and along roads. STUK will define the safety zone for the plant later, but, in the inspection work, it has been assumed to extend to a distance of about five kilometers from the plant.

### Pyhäjoki

The holiday homes located on the west coast of the Hanhikivi headland and some of the holiday homes located on the southwest coast of the headland will be removed through the construction of the nuclear power plant and the southwest coast cannot be used for recreational purposes. The new road connection will not cause any significant changes in land use. The Hanhikivi historical monument will remain accessible. The significance of Raahe as a strong industrial region will become stronger, which may improve the conditions for the development of land use.

### Ruotsinpyhtää

Most of the current holiday home areas in the Ruotsinpyhtää location may be preserved. The use of the areas for recreation or outdoor activities will be restricted. On the Kampuslandet island, the new road route will not be in conflict with current land use. In the Gäddbergsö headland, the new road connection will mainly follow the layout of the existing road. A large part of the nuclear power plant's safety zone is already included inside the safety zone of the Hästholmen plant, so there will be no significant changes in land use restrictions. The construction of the nuclear power plant will strengthen the position of the Loviisa region as a center for energy production, which may improve the conditions for the development of land use.

### Simo

The holiday homes located on the south coast of Karsikkoemi will be removed through the construction of the nuclear power plant. The current Karsikkontie road can be used as a road connection. New road connections may be necessary for current land use and any rescue routes but they will not affect land use. The

construction of the nuclear power plant will restrict the building of new residential areas indicated in the middle of Karsikkoemi. The significance of the Kemi-Tornio region as a strong industrial region will become stronger, which may improve the conditions for the development of land use.

### Construction of the nuclear power plant

In the case of one unit, the construction of the nuclear power plant will take about six years and about eight years in the case of two units. During the first construction phase of approximately two years, the necessary roads, as well as excavation and civil engineering work, for the power plant and other buildings will be completed. The actual plant construction work and the partly parallel installation work will take about 3–5 years, and commissioning of the plant will take about 1–2 years.

Impacts related to the construction site functions include dust, noise, landscape impacts, impacts on flora and fauna, and impacts on the soil, bedrock and groundwater. The construction site functions create local dust, and its impact on air quality will mostly be restricted to the construction site. The construction stage will also create impacts on people's living conditions and comfort. The impacts on the regional economy will mainly be positive as economic operations increase in the region.

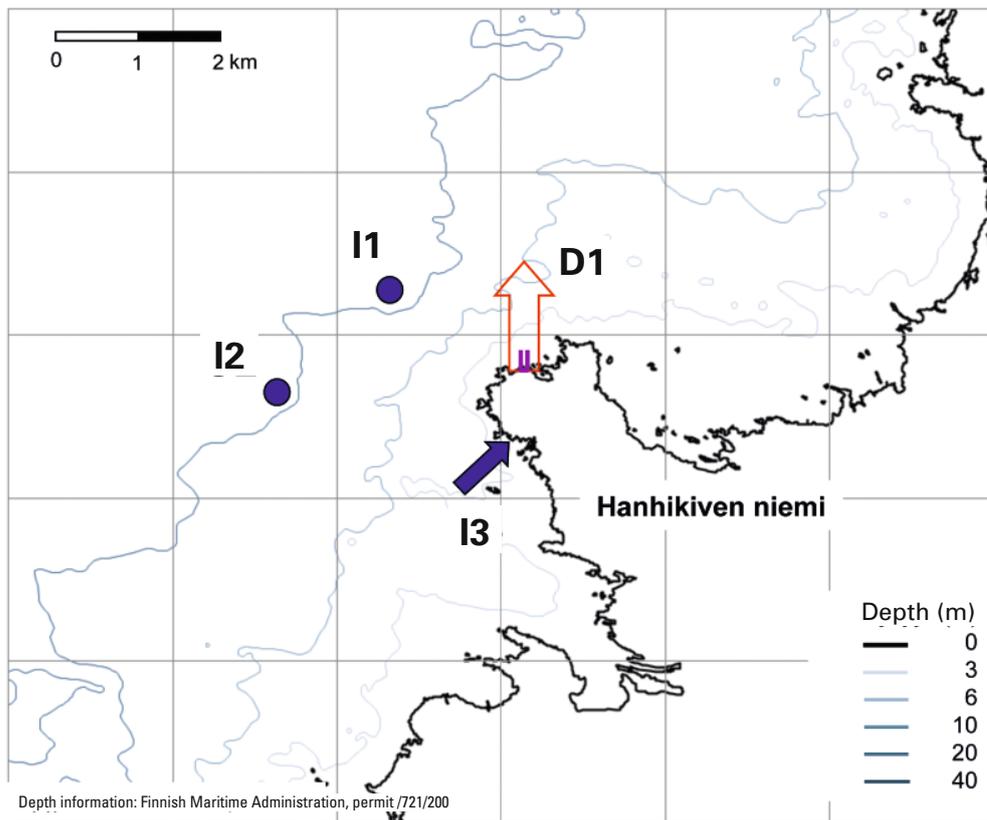
### Radioactive emissions

Fennovoima's nuclear power plant will be designed so that its radioactive emissions fall below the set limit values. The plant's radioactive emissions will be so low that they will not have any adverse impact on people or the environment.

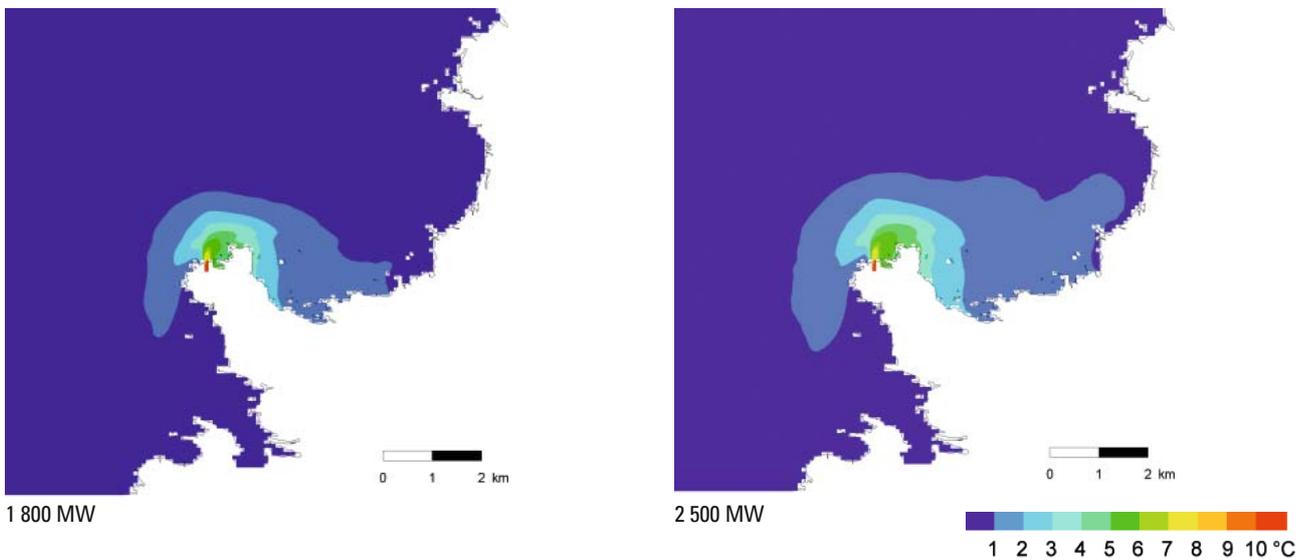
### Other emissions

Traffic during construction will increase emissions significantly in all of the alternatives. However, traffic will only be especially frequent during the fourth or fifth year of construction. In other construction years, traffic volumes and emissions will be considerably lower. Construction-related traffic emissions are not estimated to have any significant impacts on air quality in the areas surrounding the alternative location sites.

In all of the options, traffic to the plant runs mostly along highways or motorways. The traffic volumes on these roads are fairly high, and traffic during the nuclear power plant's operating stage will not cause a significant change in the volumes and, as a result, in traffic emissions and air quality. The nuclear power plant's traffic emissions can be assessed to have an impact on air quality mostly along smaller, less operated roads leading to the nuclear power plant. The current air quality is assessed to be good in all of the location sites. The nuclear power plant's traffic emissions will not reduce the air



Cooling water intake and discharge sites in Hanhikivi headland, Pyhäjoki. The blue circles refer to bottom intakes, the blue arrow refers to shore intake and the red arrow means the discharge site.



Temperature increase in the surface layer as a June average value (bottom intake I2 – discharge D1).

quality so significantly that it would have adverse impacts on people or the environment.

The emission volumes of reserve power and heat production will be very small and will not have an impact on the air quality of the alternative sites.

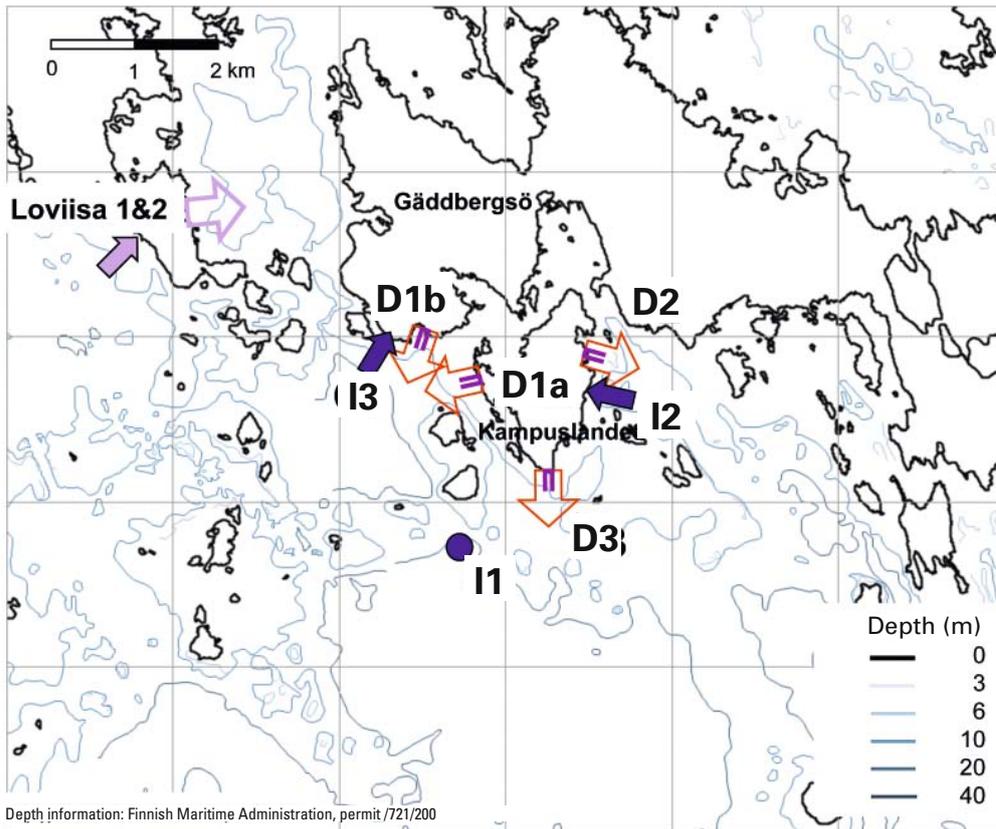
#### Water system and the fishing industry

The conduction of the cooling water used at the power plant to the sea will increase the water temperature close to the discharge site. The extent of the warming

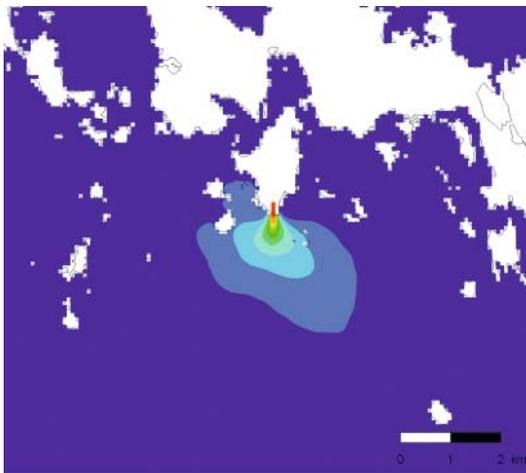
sea area will be defined by the size of the power plant and, to some extent, by the chosen intake and discharge options. The power plant's impact on the sea temperature and the differences between the different intake and discharge options were assessed using a three-dimensional flow model for each municipality.

#### Pyhäjoki

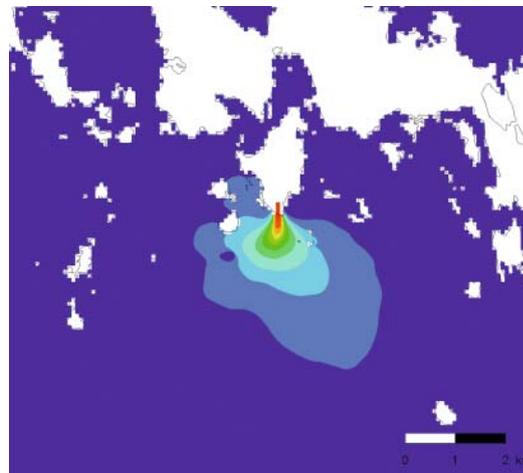
Three different intake sites and one discharge option were studied in Pyhäjoki. Two of the intake alternatives



Cooling water intake and discharge sites in Ruotsinpyhtää. The blue arrows show shore intakes, the blue circle intake from the bottom (tunnel) and the red arrows show the discharge sites. The purple arrow indicates the existing Loviisa plant's intake and discharge location.



1800 MW



2 500 MW



Temperature increase in the surface layer as a June average value (bottom intake I1 – discharge D3).

are for bottom intake (I1 and I2) and one for shore intake (I3).

A temperature increase of more than five degrees centigrade will be limited to the area surrounding the cooling water discharge site. The temperature increase can mainly be observed in the surface layer (at a depth of 0–1 m).

In winter, the thermal load of cooling water keeps the discharge site unfrozen and causes ice to thin out mainly

to the north and east of Hanhikivi. The unfrozen area or thin ice area (thickness less than 10 cm) is about 8 km<sup>2</sup> for the 1,800 MW power plant option and about 12 km<sup>2</sup> for the 2,500 MW power plant option.

Proliferation of aquatic vegetation and phytoplankton will increase in the impact area of cooling waters. In Pyhäjoki, the sea area is open and there are only few nutrients available, because of which the impacts are assessed to be minor. According to the assessments, cool-

ing water discharge will not cause anoxia in deep waters or significantly increased flowering of blue-green algae. The project will not have an impact on water quality.

Possible adverse impacts on fishing include the build-up of slime in nets and, in the summertime, hindering whitefish fishing especially on the fishing ground north of Hanhikivi. In winter, the unfrozen area of water will hinder ice fishing but, on the other hand, it will extend the open water fishing season and attract whitefish and trout to the area.

The impacts of cooling water will mainly be restricted to a distance of a few kilometers from the discharge site and they will not have a wider impact on the condition of the Bothnian Bay.

### Ruotsinpyhtää

Three different intake and discharge sites were studied in Ruotsinpyhtää. One of the intake alternatives is for bottom intake (I1) and two are for shore intake (I2 and I3). The modeling also took into account the effect of cooling water from the existing nuclear power plant in Loviisa.

A temperature increase of more than five degrees centigrade will be limited to the area surrounding the cooling water discharge site. The temperature increase can mainly be observed in the surface layer (at a depth of 0–1 m).

The smallest warming area will be caused by the dis-

charge site (D3) directed to the open sea area south of Kampuslandet, whereas the largest area will be caused by the discharge site (D2) directed to the shallow area east of Kampuslandet.

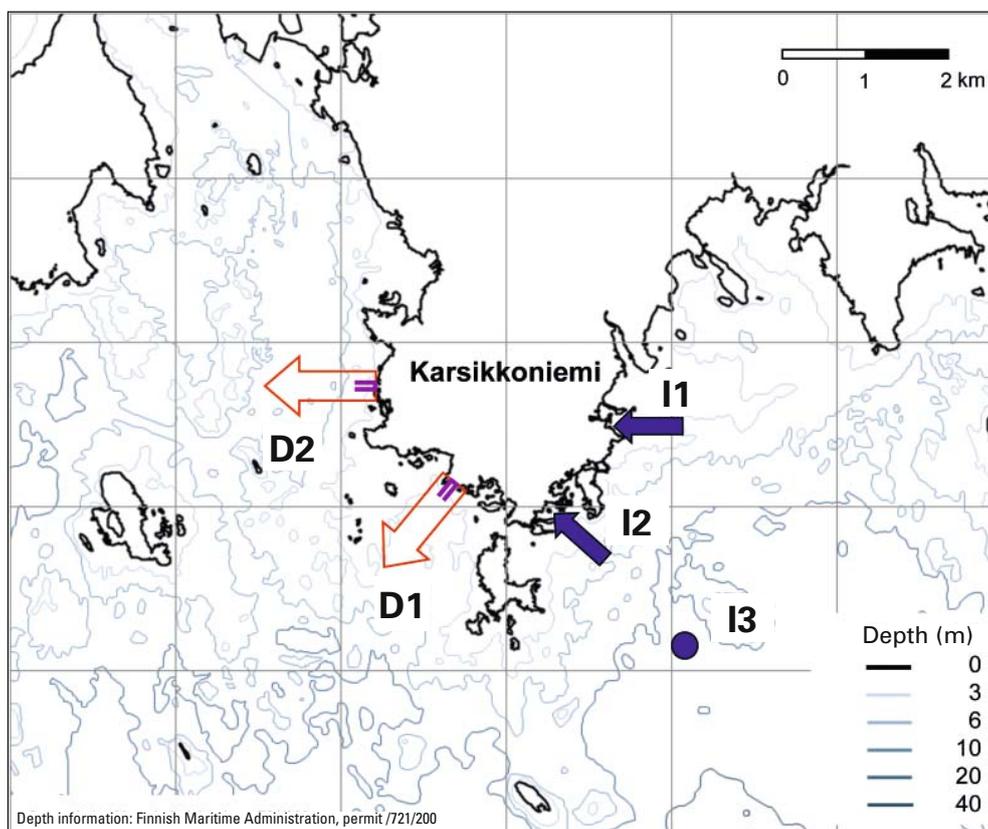
The smallest areas to warm up will be reached by using the bottom intake option (O1) and shore intake west of Kampuslandet (O2). Shore intake west of Kampuslandet (O3) will result in the largest area to warm up.

In winter, the uniform area of thin or nonexistent ice cover will expand. The unfrozen area or thin ice area (thickness less than 10 cm) varies from 3 to 5 km<sup>2</sup> for the 1,800 MW power plant option and from 4.5 to 5.5 km<sup>2</sup> for the 2,500 MW power plant option.

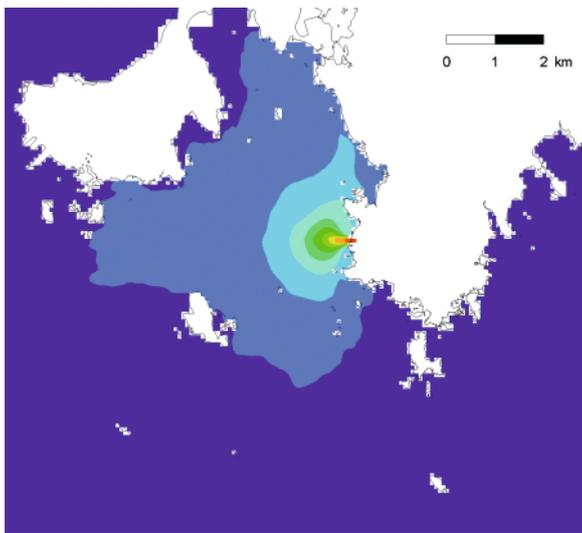
Proliferation of aquatic vegetation and phytoplankton will increase in the impact area of cooling waters. Due to eutrophication, flowering of blue-green algae may increase locally, particularly if the mostly shallow sea area east of Kampuslandet is chosen as the discharge site. The project may have local adverse impacts on the oxygen level near the bottom of basin areas. The impacts will be smaller if the option (D3) directed towards the open sea is chosen as the discharge site.

In bottom intake, nutrient concentration may increase slightly at the discharge site and intensify the impact of thermal load to some extent.

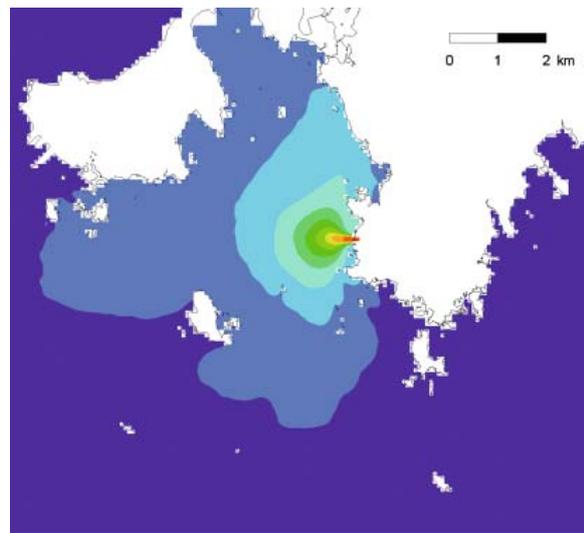
Possible adverse impacts on fishing include the build-up of slime in nets and decreased catching efficiency of



Cooling water intake and discharge sites in Karsikko, Simo. The blue ball refers to bottom intake, the blue arrows refer to shore intake and the red arrows indicate discharge sites.



1 800 MW



2 500 MW



Temperature increase in the surface layer as a June average value (bottom intake I3 – discharge D2).

traps in the affected area of cooling waters. In winter, the unfrozen area of water will hinder ice fishing but, on the other hand, it will extend the open water fishing season and attract whitefish and trout to the area.

The impacts of cooling water will mainly be restricted to a distance of a few kilometers from the discharge site and they will not have a wider impact on the condition of the Gulf of Finland.

### Simo

Three different intake sites and two discharge sites were studied in Simo. Two of the intake alternatives are for shore intake (O1 and O2) and one for bottom intake (O3).

A temperature increase of more than five degrees centigrade will be limited to the area surrounding the cooling water discharge site. The temperature increase can mainly be observed in the surface layer (at a depth of 0–1 m).

The discharge option (D1) directed towards the open sea southwest of Karsikko will cause a smaller warming area than the option west of Karsikko (D2). The bottom intake option (I3) will cause the smallest warming area during summer. There is not much difference between the shore intakes (I1 and I2) with regard to the warming area.

In winter, the uniform area of thin or nonexistent ice cover will expand. The unfrozen area or thin ice area (thickness less than 10 cm) varies from 7 to 9 km<sup>2</sup> for the 1,800 MW power plant option and from 9 to 13 km<sup>2</sup> for the 2,500 MW power plant option.

Proliferation of aquatic vegetation and phytoplankton will increase in the impact area of cooling waters. The discharge site directed to the open sea (D1) is as-

essed to cause minor eutrophication. In discharge to the more sheltered and already nutrient-rich Veitsiluoto Bay, eutrophication will probably increase relatively more. Cooling waters are assessed not to cause anoxia in hypolimnion.

Possible adverse impacts on fishing include the build-up of slime in nets and decreased catching efficiency of traps in the affected area of cooling waters. According to assessments, cooling waters will not have an impact on fish migration. In winter, the unfrozen area of water will hinder ice fishing but, on the other hand, it will extend the open water fishing season and attract whitefish and trout to the area.

The impacts of cooling water will mainly be restricted to a distance of a few kilometers from the discharge site and they will not have a wider impact on the condition of the Bothnian Bay.

### Soil, bedrock and groundwater

The most significant impact on soil, bedrock and groundwater will be caused during the nuclear power plant's construction stage. Construction work will be planned so that there will be as few adverse impacts as possible. During construction, all earth-moving, excavation and dredging masses are to be utilized on the site in different landfills and landscaping work. The foundation waters and rain waters drained from the construction site will contain more solids and any oil and nitrogen compounds than waters normally drained from tarmac-covered yards. The quality and volume of water drained to the sea from the construction site will be monitored. The project will not have any adverse impacts on usable groundwaters.

## Flora, fauna and protection sites

Noise and other operations during the construction stage may disturb fauna close to the power plant site. Construction work will cause some of the living environments to change permanently. The project's design and implementation will take into account the natural values of the regions, if possible. Construction work is to be scheduled so that they will cause as little damage as possible to nesting bird stocks. Protection sites or areas for protected species will be avoided when locating buildings and other infrastructure.

### Pyhäjoki

The Hanhikivi area is rich in bird species. The planned plant site will be located in an area where the avifauna mainly consists of forest species. The Hanhikivi headland is on the route of migrating birds and acts as a staging area for many species. Power lines will increase the risk of migratory bird collisions.

There are a few occurrences of endangered and otherwise noteworthy plant species at the Hanhikivi headland. If the habitats of the species outside the construction areas are retained, the occurrence of the species in the area would probably not deteriorate.

The Hanhikivi headland area would change and nature in the area would become so fragmented that the area's significance as a model of uninterrupted succession development, i.e. slow change in flora and fauna in the uplift area, would clearly deteriorate.

The project area includes the nature conservation area of Ankkurinnokka and several habitat types defined in the Nature Conservation Act. The overgrowing of protected shore meadows may intensify.

The closest Natura area is located about two kilometers away, south of the area. The project is assessed not to have significant adverse impacts on the protection criteria of the Natura 2000 area.

### Ruotsinpyhtää

The observed bird species can mostly be deemed regular species for coastal and inland archipelago areas. The area does not include any habitat entities of major significance to bird species. The project is assessed not to cause any major adverse impacts on the avifauna. Power lines will increase the risk of migratory bird collisions.

Most of the natural characteristics of the area are mainly common for the shore area, and the forests are highly managed. Therefore, the project's impacts on biodiversity would remain relatively low.

There are no nature conservation areas or habitat types in accordance with the Nature Conservation Act in this area. The closest nature conservation areas are approximately three kilometers to the northwest and southwest. According to assessments, the project will not have an impact on the nature conservation areas.

The closest Natura area is approximately 1.5 kilometers south of Kampuslandet at its closest. The project is assessed not to have significant adverse impacts on the protection criteria of the Natura 2000 area.

### Simo

The birdlife at Karsikkoniemi is versatile due to the versatile habitat structure of the area.

The areas which would change the most are located in the inner parts of the Karsikkoniemi headland where there are no significant sites considering the avifauna or other animals, except for the Lake Karsikkojärvi, and in the Laitakari and Korppikarinnokka area which are significant for avifauna. Power lines will increase the risk of migratory bird collisions.

There are plenty of occurrences of endangered and otherwise noteworthy plant species at Karsikkoniemi headland. Construction may destroy some of the occurrences from the area.

There are no nature conservation areas in the assessment area. There are a few habitat types in accordance with the Nature Conservation Act in this area. The overgrowing of protected shore meadows may intensify on the western shore of Karsikkoniemi.

The closest Natura area is located at Ajos headland, approximately 3.5 kilometers from the assessment area. A slight heat impact from the cooling waters may occasionally extend to the area. The project is assessed not to have significant adverse impacts on the protection criteria of the Natura 2000 area.

## Landscape and cultural environment

The nuclear power plant will alter the landscape considerably. The pictures on the next page illustrate the impact of the nuclear power plant on the landscape in the alternative locations, both for the one-unit and two-unit alternatives. In Pyhäjoki, the character of the surroundings of the Hanhikivi antiquity and the position of the Takaranta seashore meadow would change. In Kampuslandet, Ruotsinpyhtää, the nuclear power plant would impact the cultural landscapes of provincial value and the surroundings, scenery and position in the overall setting. In Ruotsinpyhtää, the nuclear power plant would be located in the vicinity of the existing nuclear power plant. In Karsikkoniemi, Simo, the landscape is in a state of change, and the nuclear power plant would be placed as an annex to the Kemi industrial zone. The landscape status of a nationally important fishing village will change.

## Traffic and safety

The increase in traffic at the nuclear power plant's construction stage will be notable in all of the options. However, traffic will only be especially frequent in the fourth or fifth year of construction. As a result, any ad-



Photomontage: The nuclear power plant in Pyhäjoki (and Raahe) (1 unit).

Photomontage: The nuclear power plant in Pyhäjoki (and Raahe) (2 units).



verse traffic impacts will only cover this limited period.

At the operating stage, the nuclear power plant's traffic will only have a minor impact on traffic volumes on the main routes in the alternative sites. The planned improvement projects for routes leading to the alternative sites will improve traffic safety, and according to assessments, nuclear power plant traffic will not reduce the traffic flow and safety.

### Noise

The noisiest stage during the construction of the nuclear power plant will be the first years of construction when functions that cause significant noise include the rock crushing plant and concrete mixing plant. During the operating phase, the most significant noise impact will occur in the immediate vicinity of the turbine hall and the transformer.

### Simo

During the construction phase, the daytime guide value of 45 dB(A) will be exceeded on a few dozen existing holiday properties in the vicinity of the power plant. The night-time guide value of 40 dB(A) will be exceeded on a maximum of 10 existing holiday properties in the vicinity of the power plant and on a few holiday properties close to the road. The holiday homes located on the south coast will probably be removed with the implementation of the project.

### Pyhäjoki

The daytime guide value will be exceeded on about 15 existing holiday properties in the vicinity of the power plant and on 10 holiday properties near the road. The night-time guide value will be exceeded on about 15 to 20 existing holiday properties in the vicinity of the pow-

Photomontage: The nuclear power plant in Kampuslandet, Ruotsinpyhtää (1 unit).



Photomontage: The nuclear power plant in Kampuslandet, Ruotsinpyhtää (2 units).

er plant. Some of the holiday residences on the west and southwest coast will be removed with the implementation of the project.

### Ruotsinpyhtää

During the construction phase in the Kampuslandet location, the daytime guide value will be exceeded on about 20 existing holiday properties in the vicinity of the power plant and on 10 holiday properties near the road. In the Gäddbergsö location, the daytime guide value will be exceeded on less than 20 existing holiday properties in the vicinity of the power plant and on about 30 holiday properties near the road.

During the operating phase in the Kampuslandet location, the night-time guide value will be exceeded on no more than about 10 existing holiday properties in the vicinity of the power plant. In the Gäddbergsö location,

the night-time guide value will be exceeded on a few existing holiday properties in the vicinity of the power plant.

### Impact on people and society

The nuclear power plant project will have significant impacts on the regional economy, employment, the property market in the surroundings of the location site, the population, industrial structure and services. During the construction phase, the project's municipal tax revenue will be EUR 2.8 to 4.5 million in the economic areas, and property tax revenue in the location municipality will be determined by the stage of completion of the nuclear power plant. The employment impact of the construction stage on the economic area will be 500–800 man-years. During the operating stage, property tax revenue in the location municipality

Photomontage: The nuclear power plant in Gäddbergsö, Ruotsinpyhtää (1 unit).



Photomontage: The nuclear power plant in Gäddbergsö, Ruotsinpyhtää (2 units).

will be EUR 3.8 to 5.0 million a year and municipal tax revenue EUR 1.9 to 2.4 million a year in the economic area. In the economic area, employment impact will be 340–425 man-years annually. The arrival of new residents, boosted business and escalated building activity will increase tax revenue. The population and residence bases will grow and, as a result, the demand for private and public services will increase.

A number of people will move close to the nuclear power plant during the construction stage and the demand for services will increase. The accommodation of a large group of employees in a new municipality may also include negative impacts. Increased traffic and noise caused by construction work may have a local impact on comfort.

Normal operation of the nuclear power plant will have no radiation-related, detectable impact on the health, living conditions or recreation of people living

in the vicinity. Access to the power plant area will be prohibited and the area cannot be used for recreational purposes. Warm cooling water will melt or weaken the ice and, as a result, restrict recreational activities on ice during the winter, such as fishing or walking.

The opinions of those living and operating in the surrounding areas of the location sites on the nuclear power plant site were identified through group interviews and resident surveys. The opinions varied greatly and groups for and against the project have been established in the areas. Opposition is often based on risks and fears associated with nuclear power plants, and on the belief that nuclear power is ethically questionable. The supporters emphasize its positive economic impacts and environmental friendliness.

#### **Impact of the use of chemicals**

The use of chemicals and oils at the nuclear power plant



Photomontage: The nuclear power plant in Karsikkoniemi, Simo (1 unit).

Photomontage: The nuclear power plant in Karsikkoniemi, Simo (2 units).



will not cause any adverse environmental impacts under normal conditions. The risks of chemical accidents will be taken into account in the design of the plant. The probability of an accident where a dangerous volume of chemicals or oils can enter the atmosphere, water system or soil is low.

### Impact of waste management

Regular waste created at the nuclear power plant will be sorted, sent for treatment, utilization and final disposal in a manner required by waste legislation and environmental license decisions. Waste handling at the plant will not cause any significant environmental impacts.

Sufficient facilities for the handling and disposal of low- and medium-level power plant waste will be built at the nuclear power plant. The facilities will contain systems for the safe handling and transportation of waste and the monitoring of the amount and type of ra-

dioactive substances. The disposal facilities for low- and medium-level waste can be built in underground facilities and the disposal facilities for very low-level waste can also be built in facilities located in the ground. Once the use of the final disposal facilities is terminated, the connections will be sealed and will not require any supervision afterwards. Any radioactive substances contained in the waste will become safe for the environment over time. Careful planning and implementation will help to eliminate significant environmental impacts caused by the treatment and final disposal of operating waste.

Spent nuclear fuel will be transported to a repository located in Finland by sea or road.

### Impact of decommissioning the power plant

The new nuclear power plant's estimated operating life is at least 60 years. As a result, the decommissioning of

Fennovoima's plant is estimated to begin in 2078 at the earliest.

The most significant environmental impacts of decommissioning will arise from the handling and transport of radioactive decommissioning waste generated during dismantling of the controlled area of the plant. The most radioactive portion of such waste will be treated and disposed of similarly to operating waste. As many of the dismantled contaminated plant parts and equipment as possible will be cleaned so that they can be released from the radiation authority's control and either recycled or disposed of at a general landfill site. The plant's systems will be sealed so that radioactive substances cannot spread into the environment.

The majority of waste generated through the nuclear power plant's dismantling operations is not radioactive and can be treated similarly to regular waste. Environmental impacts in the plant area and nearby roads caused by the dismantling, treatment and transportation of the nuclear power plant's non-radioactive structures and systems include dust, noise and vibration. Furthermore, in road sections with only a little traffic, the emissions of increasing traffic will have an impact on air quality.

Decommissioning can be performed so that the power plant site will be released for other operations or some of the buildings will be left at the site and utilized for other purposes, or energy production or other industrial operations will be continued at the site.

### **Impact of a nuclear accident**

Nuclear power plant incidents and accidents can be categorized using the international INES scale into Categories 0–7 which illustrates the severity of nuclear power plant incidents. Categories 1–3 indicate incidents that reduce safety and Categories 4–7 refer to different types of accidents. An accident is considered to be at least in Category 4 if any civic defense measures must be started outside the plant.

In order to assess impacts caused by a nuclear power plant accident, the spreading of radioactive emissions caused by a serious reactor accident (INES 6) have been modeled as an example case, as well as the resulting fallout and radiation dose for the population. Using the modeling results, the environmental impacts caused by an accident of Category 4 on the INES scale have also been assessed. It is not justified to include an assessment of an accident more serious than INES Category 6 in an environmental impact assessment because the occurrence of such an accident must be practically impossible in order to grant a construction and operating license for a nuclear power plant in Finland.

According to the limit value set by the Government Decision (395/1991), the caesium-137 emission caused by the modeled accident is 100 TBq. The model includes

such a number of nuclides that corresponds to more than 90 percent of the radiation dose caused.

The spreading calculation of radioactive emissions is based on the Gaussian spreading model and its versions suitable for short and long distances. The spreading of a radioactive emission and radiation dose calculation have been modeled at a distance of 1,000 km from the nuclear power plant.

### **Impact of a serious accident**

According to the Government Decision (395/1991), a serious reactor accident, i.e. an accident caused by the melting of the fuel core, shall not cause direct adverse health effects to the population in the vicinity of the nuclear power plant or any long-term restrictions on land use.

The likelihood of a serious nuclear accident is extremely low. In the event of such an accident, the impacts of a radioactive release on the environment will strongly depend on the prevailing weather conditions. The most important weather factor for impacts is rain, which will effectively flush down the radioactive substances included in the emission cloud. If the weather conditions are unfavorable, the impacts of the emission in the areas where rain occurs will be higher but the total impact area will, on the other hand, be smaller than in case of typical weather conditions.

The season also has an impact on the contamination of food products. Following a serious accident (INES 6), it is not likely that the use of agricultural products will be restricted in the long term. Short-term restrictions on the use of agricultural products may apply to areas within a 1,000 km radius of the plant without any protective measures aimed at livestock or food production. In case of unfavourable weather conditions, restrictions on the use of various kinds of natural produce may have to be issued in areas affected by the greatest fallout. For example, long-term restrictions on the consumption of certain mushrooms may be required in areas up to 200–300 kilometres of the accident site.

Under the threat of a serious accident, the population will be evacuated, as a protective measure, from an approximately five kilometer wide safety zone surrounding the facility. In unfavorable weather conditions, protection may be necessary indoors within a maximum of 10 kilometers. The use of iodine tablets may also be necessary according to guidelines issued by the authorities. Serious accidents will have no direct health impacts.

### **Impact of a postulated accident**

In the event of an INES Category 4 accident, no protective measures will be needed in the vicinity of the nuclear power plant. The INES Category 4 includes postulated accidents that are used as design criteria for the design of nuclear power plants' safety systems.

### Impact of the nuclear fuel production chain

A nuclear power plant uses about 30–50 tons of enriched uranium as fuel per year; 300–500 tons of natural uranium will be required to produce this amount of fuel. The impact of the fuel acquisition chain will not be directed at Finland. The arising impacts will be assessed and regulated in each country according to local legislation.

The environmental impacts of uranium mining operations are associated with the radiation of the uranium ore, radiation effect of the radon gas released from the ore, tailings and wastewater. Any environmental impacts from the production steps of conversion, enrichment and fuel rod bundles are related to the handling of dangerous chemicals and, to a lesser extent, the handling of radioactive materials. The environmental impacts of the different stages of the production chain, starting from mines, are increasingly prescribed by international standards and audits carried out by external parties, in addition to legal regulations.

In the fuel production chain, the intermediate products and fuel assemblies transported from the mines to the power plant are slightly radioactive at most. The transportation of radioactive materials will be carried out in compliance with national and international regulations on transport and storage of radioactive materials.

### Impact on the energy market

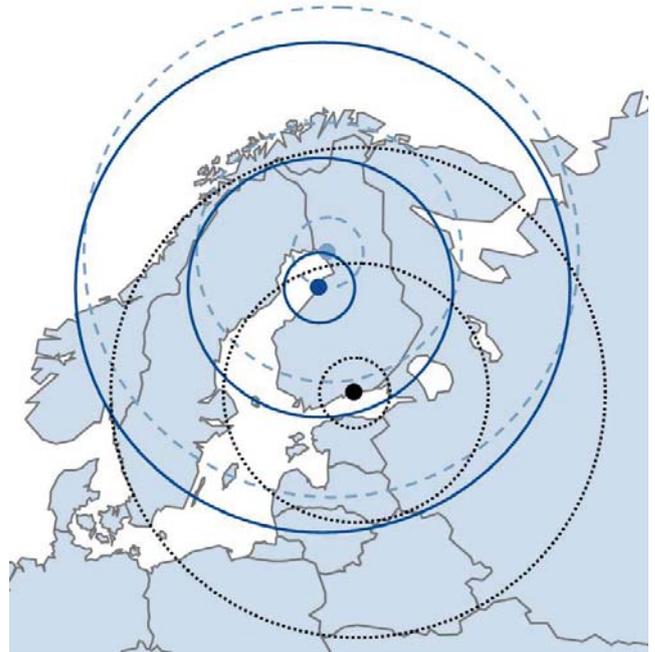
The Nordic electricity market is very dependant on hydroelectricity production which has a significant impact on the price of electricity. Using the new nuclear power plant intended for the production of basic power, the price fluctuation caused by hydroelectricity can be reduced because the role of hydroelectricity in the formation of the price of electricity will be reduced. It has been calculated that the construction of the sixth nuclear power plant unit will reduce the market price of electricity on the stock exchange, as well as the price to be paid by consumers. The new nuclear power plant will improve the maintenance reliability of electricity production by reducing Finland's dependency on fossil fuels and imported power.

### Environmental impacts crossing Finland's borders

The only transboundary impact during normal operation of the nuclear power plant will be the regional economic impact in the region of Haparanda. The impacts of an extremely unlikely serious nuclear power plant accident would likewise extend outside Finland's borders.

### Impact on regional economy

Especially at the Simo location, the direct and indirect employment-related impacts of the project would extend to Haparanda and the surrounding areas in Sweden due



Zones of a 100, 500 and 1,000 kilometer radius surrounding the alternative locations. The plant sites from north to south are Simo, Pyhäjoki and Ruotsinpyhtää.

to the proximity of the national border. Even today, cooperation between Tornio and Haparanda is extensive, and many basic municipal services and leisure activity facilities are shared. The training and recruiting of labor is also at least partly planned jointly. Depending on circumstances such as the actions taken by the municipality itself (such as training and supplying workforce, supplying services, supplying housing), there may be significant benefits for Haparanda.

### Impact of a serious nuclear power plant accident

The impacts of a serious nuclear power plant accident have been illustrated from the area surrounding the plant up to a distance of 1,000 kilometers. The exact layout of the studied area around each alternative plant location is illustrated in the figure above.

With regard to local agricultural products used as food, the fallout in typical weather conditions will be so small that long-term restrictions are not required on their use. Without any protective measures aimed at livestock or food production, short-term usage restrictions of no more than a few weeks may be necessary in areas up to 1,000 kilometers from the power plant site until concentrations of I-131, which is significant to the buildup of radiation doses, have decreased sufficiently. The half-life of I-131 in agricultural products is about 8 days.

In case of an accident during unfavorable weather, it is also probable that restrictions on the use of various kinds of natural produce will have to be issued in areas affected by the greatest fallout. For example, long-term



The Environmental Impact Assessment Program was completed in spring 2008. First buds of spring in Pyhäjoki, 2008.

restrictions on the consumption of certain mushrooms may be required in areas up to 200–300 kilometres from the power plant site.

The modeled serious reactor accident in the example does not cause any immediate health impacts on the surrounding population in any weather conditions. To limit the thyroid radiation dose, children should take iodine tablets when recommended by authorities within a distance of 100 kilometers from the accident site in all weather conditions. This impact could therefore extend to the northeastern corner of Sweden in the case of the Simo location, or the northern coast of Estonia in the case of the Ruotsinpyhtää locations. No other civic defense measures would be necessary in other countries.

In addition to a serious accident, the impacts of a postulated accident (INES 4) have been assessed. Its impacts would not cross Finland's borders.

#### **Impact of the zero-option**

If a new nuclear power plant is not built in Finland, its production will probably be substituted mainly by imported power. The rest of the electricity will be produced in Finland by utilizing the existing or new power production capacity which would mostly consist of separate electricity production and, to a small extent, of combined power and heat production.

If the Fennovoima project is not implemented, the current status of the environments of the inspected location sites will possibly be affected by other projects, functions and plans.

#### **Prevention and reduction of adverse environmental impacts**

An environmental management system will be used to connect the nuclear power plant's environmental issues with all of the power plant's functions, and the level of environmental protection will be improved continuously.

At the construction stage, adverse noise impacts or other disturbances in the immediate vicinity of the plant can be reduced by scheduling as many of the particularly noisy or otherwise disturbing actions to be carried out in the daytime and communicating their schedule and duration. In addition, the location of the functions and temporary noise protection can be used to reduce the adverse noise impact of the construction site significantly.

The biological adverse impacts caused by construction work on water systems close to cooling water structures or routes and the harbor quay and navigation channel can be reduced by scheduling the construction work to take place at the most biologically inactive time.

Social impacts during construction can be reduced by decentralizing the accommodation of the workers to nearby municipalities in addition to the location municipality. The impacts caused by cultural differences can be reduced through training organized for foreign employees.

The impact of power lines on land use, the landscape and natural resources can be reduced by taking the impact into account as well as possible in the design of the power line route and in the column solutions. The

impacts caused by the construction of roads can be reduced through thorough design of the road routes and construction work.

The only means available to significantly reduce the thermal load to the water systems is so-called combined production, i.e. a power plant that would produce electricity and also district heating or industrial steam. Implementing the Fennovoima nuclear power plant project as a combined electricity and heat generation plant is possible from a technical viewpoint, and also possibly feasible from an economical viewpoint if the thermal energy demands is high enough. Fennovoima will study the future district heating demand, production methods and their environmental and climatic impacts at various sites, especially in the Helsinki Metropolitan area.

Local impacts in water systems from the use of cooling water can be alleviated by means of a variety of technical solutions. The location and shape of the affected area of cooling waters can be influenced through the placement of the intake and discharge structures. Fish can be prevented from being driven into the cooling water intake system through different technical measures and through design of the cooling water intake systems.

Impacts during the nuclear power plant's operating stage on nature and animals can be reduced particularly by taking into account the birdlife of the area during operation. The risk of birds colliding with power lines can be reduced by improving the visibility of the power line using bird warning spheres.

The location of the power plant in the landscape can be improved by selecting the correct surface materials and colors, planning building locations carefully and adding plants.

The impacts on the nearby traffic volumes and safety can be reduced through different technical solutions that improve the traffic flow and safety and by organizing bus transport for the personnel to the worksite.

Noise impacts can be reduced by placing buildings that prevent noise and functions that cause noise from spreading and selecting building materials and technologies that dampen noise.

Emissions of radioactive substances can be reduced through appropriate technical measures and they will be monitored continuously through measurements and sampling.

Waste and wastewater generated during the construction and operation of the nuclear power plant will be treated appropriately. The objective is to minimize the volume of waste generated. The majority of the waste generated will be utilized by recycling or by using it in energy production.

The chemical storage will be built according to the requirements set by the Chemicals Act and related regula-

tions. Any leaks will be prepared for through structural means. Any chemical damage will be prevented using safety instructions and by training the personnel.

Fears related to nuclear power plants can be alleviated by providing information about the risks and impacts related to nuclear power in an active, appropriate and clear manner.

The nuclear power plant's design will prepare for the possibility of operational malfunctions and accidents. An up-to-date contingency plan will be prepared for the nuclear power plant and its surroundings, and there will be drills in its use at regular intervals.

A decommissioning plan for the nuclear power plant will be drawn up at the initial stages of plant operation. One of the primary objectives of the plan is to ensure that dismantled radioactive components will not cause any harm to the environment.

### **Feasibility of the project**

As a result of the environmental impact assessment, none of the project's implementation options were identified to have such adverse environmental impacts that they could not be accepted or reduced to an acceptable level. Thus, the project is feasible. However, the impacts of the different options differ from each other with regard to certain impact types and these differences should be taken into account when selecting and developing the project's implementation options.

### **Monitoring program for environmental impacts**

The environmental impacts of the nuclear power plant project must be monitored in accordance with the monitoring programs approved by the authorities. The monitoring programs define the specific details of load and environmental monitoring and reporting to be performed. The release of radioactive materials from the nuclear power plant will be monitored through continuous measurements and sampling. In addition, the radiation measurements in the power plant area and its vicinity will ensure that the radiation dose limits defined in regulations issued by the authorities will not be exceeded. The monitoring of the project's regular emissions includes the following subfields:

- Monitoring cooling water and wastewater
- Monitoring water systems
- Monitoring the fishing industry
- Monitoring the boiler plant
- Waste records
- Noise monitoring.

The project's impact on people's living conditions, comfort and well-being has been assessed and the information obtained will be used to support design and decision-making, and to reduce and prevent any adverse impacts.