FENNOVOIMA

Application for a Supplement to Government Decision-In-Principle M 4/2010 vp pursuant to Section 11 of the Nuclear Energy Act (990/1987), granted on May 6, 2010

March 2014

This publication is an unofficial translation based on Fennovoima's application.
The original application was submitted to the Ministry of Employment and the Economy in March 2014.

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Summary

On January 14, 2009, Fennovoima Ltd (hereinafter referred to as "Fennovoima" or "the company") applied for a Government decision-in-principle regarding the construction of a new nuclear power plant in Finland. On May 6, 2010, the Finnish Government issued Fennovoima a decision-in-principle, which the Parliament ratified on July 1, 2010.

Fennovoima is now applying for a supplement to the valid decision-in-principle to the extent that changes have taken place in the project. Fennovoima requests that the Government would make a decision to supplement the valid decision-in-principle granted in 2010 to the effect that the supplemented decision-in-principle confirms that Fennovoima's nuclear power plant project remains in line with the overall good of society a in accordance with section 11 of the Nuclear Energy Act.

Fennovoima's nuclear power plant project meets the needs of Finnish society, industry and households. Industry, trade and service businesses in Finland need electricity at a reasonable and stable price to secure their competitiveness and their potential for investment and employment.

Fennovoima will improve the functioning of the electricity market by increasing supply and by introducing new actors into the electricity production sector. This increased competition will benefit all Finnish end users of electricity. The nuclear power plant investment will have a significant impact on the municipality where the plant will be located, and on its economic area. A nuclear power plant at a completely new site will generate long-term industrial activity and help consolidate the business structure and economy of the municipality of Pyhäjoki in Northern Ostrobothnia and the surrounding region. Fennovoima's project will advance the balanced development of Finland without government budget funds.

Finland's energy supply is based on a decentralized and diverse energy production system. One particular strength of the Fennovoima project is that it will decentralize Finland's nuclear power production geographically, in terms of both ownership and organizations.

Fennovoima's project supports the achievement of the objectives of both the national and EU climate and energy strategies.

The new nuclear power plant can be built safely and in compliance with Finnish regulations. The company has the necessary expertise and resources to build the power plant as planned and the appropriate plans for nuclear fuel management and nuclear waste management.

Fennovoima's nuclear power plant project has strong social and business grounds. To secure their international competitiveness and domestic investment and employment potential, Fennovoima's Finnish shareholders need to secure electricity supply at a reasonable and stable price.

Fennovoima's project is in line with the overall good of society as referred to in the Nuclear Energy Act.

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Application

On January 14, 2009, Fennovoima applied for a Government decision-in-principle regarding the construction of a new nuclear power plant in Finland. On May 6, 2010, the Finnish Government issued Fennovoima a decision-in-principle, which the Parliament ratified on July 1, 2010.

As changes have taken place in Fennovoima's project since the decision-in-principle was granted, Fennovoima is now applying for a supplement to the valid decision-in-principle to the extent that changes that have occured. Fennovoima applies from the Government a decision to supplement the valid decision-in-principle granted in 2010 to the effect that the supplemented decision-in-principle confirms that Fennovoima's nuclear power project remains in line with the overall good of society in accordance with section 11 of the Nuclear Energy Act.

Applicant

Fennovoima Ltd is a Finnish limited liability company whose business identity code is 2125678-5. The company is domiciled in Helsinki, Finland. The extract from the trade register, articles of association and shareholder register of the company are appended to this application as Appendix 1A. Fennovoima operates at cost price principle. The company's shareholders will be entitled to the electricity generated by the nuclear power plant and will cover the production costs in proportion to their holdings in the company.

Voimaosakeyhtiö SF owns the entire share capital of Fennovoima. Voimaosakeyhtiö SF, in turn, is owned by Finnish trade and industry companies and local energy utilities.

Changes will take place in Fennovoima's ownership. Rusatom Overseas CJSC, with whom Fennovoima signed a plant supply contract in December 2013, will become a minority shareholder in the company through its Finnish subsidiary. Voimaosakeyhtiö SF will remain the majority shareholder.

Companies that are entitled to cost-price electricity produced by Fennovoima based on their direct or indirect ownership of shares are referred to as "Fennovoima's shareholders" in this application.

For a more detailed description of Fennovoima's ownership structure, see Appendix 1B.

Project

On the basis of the decision-in-principle granted in 2010, Fennovoima is permitted to construct one nuclear power plant unit with a maximum thermal output of 4,900 MW and a final repository for low and intermediate level reactor waste. The decision also includes the other nuclear facilities required for the operation of the new nuclear power plant which are located within the same plant area. These facilities are used for the storage of fresh nuclear fuel, interim storage of spent nuclear fuel, and the handling and storage of low and intermediate level operating waste.

According to the current plans, Fennovoima's nuclear power plant will consist of a nuclear power plant unit equipped with an AES-2006 pressurized water reactor with a maximum thermal power of 3,220 MW and an approximate electrical output of 1,200 MW, and other nuclear facilities required for the operation of the nuclear power plant unit in accordance with the 2010 decision-in-principle.

The project schedule has been further specified to the effect that electricity production is planned to begin in 2024.

Site

The 2010 decision-in-principle states that the nuclear power plant can be built on the Pyhäjoki or Simo site.

In October 2011, Fennovoima selected the Hanhikivi headland in Pyhäjoki, Northern Ostrobothnia, as the future site of the nuclear power plant. The currently valid land use plans for the plant site allocate the areas required for the nuclear power plant.

Purpose and planned lifetime of the nuclear facilities

The nuclear power plant will be used to produce energy. The planned life cycle of the nuclear power plant unit is 60 years.

The repository for the final disposal of low and intermediate level reactor waste will be used for the final disposal of the low and intermediate level reactor waste generated in the operations and decommissioning of the nuclear power plant.

The purpose and planned life cycle of the nuclear facilities comply with Fennovoima's original decision-in-principle application.

Grounds for the project

The grounds on which the 2010 decision-in-principle was granted are still valid.

Fulfilling electricity needs and securing competitiveness

The justification for the 2010 decision-in-principle states that keeping the price of electricity at a reasonable level is one of the goals set by the Finnish Government for the functioning of the deregulated electricity market in Finland. The purpose of Fennovoima is to produce cost-price electricity for the needs of Finnish trade and industry. The Fennovoima shareholders have low self-sufficiency in electricity procurement in Finland and are today largely dependent on market-priced electricity. For market-price electricity the price fluctuations are considerable and the price is difficult to predict. To secure their international competitiveness and domestic investment and employment potential, Fennovoima's Finnish shareholders need to secure the availability of electricity at a reasonable and stable price. Fennovoima was established to respond to this demand.

Increasing competition in the electricity market

Fennovoima's nuclear power plant will improve the functioning of the electricity market by increasing supply and by introducing new actors into the electricity production sector. Nordic competition authorities have assessed that, as a result of the increased demand for electricity and low level of investment in new production capacity, electricity supply is becoming increasingly scarce, and new production capacity is needed. A diverse electricity production system is a prerequisite for a competitive market and essential in order to ensure security of supply.

According to the Finnish Competition Authority, no further obstacles should be set in the way of new investments, and new companies entering the market should be guaranteed equal opportunities to participate in projects such as the construction of new nuclear power capacity.

The energy utilities included in Fennovoima's shareholder base deliver a significant portion of the electricity consumed in Finnish households. The competitiveness of small and medium-sized local energy utilities will be particularly enhanced by their own nuclear power production. Consumers benefit when many local energy utilities price their retail electricity based on actual production costs instead of the market price. The increased competition will benefit all Finnish end users of electricity.

Balanced development of Finland

In terms of its size, duration and requirements, nuclear power plant construction project is a unique investment project. During the busiest period of construction, between 3,000 and 4,000 people will be working at the site. The investment will have considerable permanent economic impact on the region of Northern Ostrobothnia. The nuclear power plant project will generate long-term industrial activity in the municipality of Pyhäjoki, and will help consolidate the business structure and economy of the surrounding region. Hundreds of permanent jobs are created in the new nuclear energy company for decades to come.

The construction of a nuclear power plant at a new site and in a new municipality will require ancillary investment which will contribute to the positive economic impact of the construction phase at both national and, in particular, regional level. Fennovoima's project will benefit the balanced development of Finland without government budget funds.

Ensuring security of supply

Electricity is of key importance to national security of supply. Finland's current dependence on imports and centralization of production operations are risks for security of supply. Construction of new nuclear power capacity will improve Finland's security of supply by reducing dependence on imported electricity and on power production methods that cause emissions of greenhouse gases.

Finland's energy supply is based on a decentralized and diverse production system. The strategic importance of nuclear power production has been emphasized in emissions trading and the targets set for the limitation of greenhouse gas emissions in Europe. Because nuclear power is produced in very large-scale power plant units, sufficient decentralization of nuclear power production becomes an integral aspect of national risk management. One particular strength of the Fennovoima project is that it will decentralize Finland's nuclear power production geographically, in terms of ownership and in terms of organizations.

Supporting climate and energy objectives

By increasing the production of electricity at a reasonable and stable price in Finland, Fennovoima's nuclear power plant project will reinforce the national energy supply in accordance with the objectives of the National Climate and Energy Strategy. The nuclear power operations of Fennovoima will be aimed at meeting the electricity needs of Finnish companies, households and agriculture, and at increasing energy self-sufficiency and carbon-free electricity production capacity.

According to the 2013 update of the National Climate and Energy Strategy, achievement of self-sufficiency in the 2020s will require the commissioning of the nuclear power plant units which have received a decision-in-principle, and a higher capacity of small-scale or otherwise decentralized electricity generation.

The shared climate policy objectives of the EU guide the climate and energy policies of its member states. In January 2014, the European Commission published its proposal for the EU climate and energy objectives to be met by 2030. The proposal aims to reduce greenhouse gas emissions, improve energy security and enhance investor certainty, as well as to support growth, competitiveness and job creation. Fennovoima's project will be a step toward achieving these EU climate and energy objectives.

A more detailed description of the general significance and necessity of the project is given in Appendix 2A to this application.

Implementation of the project

Timetable and manner of implementation

The preparation and contracting phases of the Fennovoima project have been completed. The contracting phase was completed upon signature of the plant supply contract in December 2013 between Fennovoima and Rusatom Overseas CJSC for the supply of an AES-2006 pressurized water reactor to Pyhäjoki. Rusatom Overseas CJSC is a part of the Russian Rosatom Group. The project has now proceeded to the development phase with the objective of carrying out the preparations required for the start of the plant construction.

Based on assessments and negotiations with plant suppliers, Fennovoima chose to implement a turnkey project, where the supply contract is concluded with a single main contractor. From the risk management point of view, the turnkey option offers a natural way of utilizing the nuclear expertise of the Rosatom Group. Rosatom's stake in Fennovoima and its significant role in procuring of external financing during the construction phase also support the plant supplier's commitment to the project and to the agreed time schedule.

Fennovoima will pay particular attention to project and quality management. These are of central importance for ensuring the safety and implementation of the project according to plan. Fennovoima will monitor the design work and the quality of the implementation at all stages of the project.

The AES-2006 plant alternative was not assessed in connection with Fennovoima's original application for a decision-in-principle. Therefore a feasibility assessment of the plant design was carried out in fall 2013 and submitted to the Radiation and Nuclear Safety Authority (STUK) for review. According to Fennovoima's assessment, the plant can be designed and constructed to meet Finnish safety requirements. In the plant supply contract, Fennovoima has defined the requirements set for the principal safety and operating solutions relating to the plant design. Fennovoima will oversee that the requirements are met.

The licensing and permitting processes required in the nuclear energy, building, and environmental legislation, together with management of the design and construction of the nuclear power plant are of major importance for the progress of the project. In accordance with the 2010 decision-in-principle, Fennovoima will apply for a construction license as referred to in the Nuclear Energy Act no later than in June 2015. Fennovoima aims to start electricity production in 2024.

For a more detailed description of the implementation and the time schedule of the project, see Appendix 1C.

Safety

As the future licensee and owner of the nuclear power plant, Fennovoima will be responsible for safety at all stages of the project. Safety takes precedence in all decision-making in the company. Quality management requirements correspond with the safety significance of functions, and the project plan and project management are based on best practices and experience.

An uncompromising safety culture forms the foundation for the design, construction and operation of the power plant. Plant safety shall be ensured through the defense-in-depth principle, that is by means of successive independent structural and functional protection systems. The plant will be designed and operated in a manner that fulfills all Finnish requirements for nuclear and radiation safety, irrespective of the plant design requirements of country of origin. Therefore, the selection of a new plant supplier will not affect the safety principles based on which the 2010 decision-in-principle was granted. The project will be implemented in compliance with nuclear energy legislation and regulatory requirements so that the nuclear power plant will be safe and will cause no danger to people, property or the environment.

The safety principles which are followed in the nuclear power plant are described in Appendix 4A to this application, and the technology of the AES-2006 is described in Appendix 4B.

Suitability of site and the environmental impact of the project

In 2011, Fennovoima selected the Hanhikivi headland in Pyhäjoki as its nuclear power plant site. Based on assessments and research carried out by Fennovoima, the Hanhikivi headland meets the safety and environmental requirements set for a nuclear power plant site, and is a suitable location for a nuclear power plant. STUK assessed the suitability of the Hanhikivi site in 2009 as part of its preliminary safety assessment and stated that no issues that would prevent the construction of a new nuclear power plant in compliance with the safety requirements or implementing the safety or emergency prepapredness arrangements were observed at the new site.

In 2013 and 2014, Fennovoima has complemented its earlier environmental impact assessment by carrying out an environmental impact assessment to investigate the environmental impact that a nuclear power plant with an approximate electrical output of 1,200 MW would have on the Hanhikivi headland during the construction and operating phases. According to the EIA report, the project will have no adverse environmental impacts that are unacceptable or could not be mitigated to an acceptable level. The new environmental impact assessment is enclosed to this application as Appendix 3A.

Land use in the Hanhikivi headland is prescribed by the Hanhikivi regional land use plan for nuclear power and the Raahe and Pyhäjoki local master plans and local detailed plans for the nuclear power plant area. The land use planning required for the nuclear power plant project has proceeded as planned, and is now in force at all three levels of land use planning.

The nuclear power plant is planned to be constructed in the central and northern parts of the Hanhikivi headland. Fennovoima has most of these land areas in its possession either through ownership, lease or preliminary agreements. The leases include a binding preliminary agreement on the option right to purchase the leased property.

Fennovoima will continue obtaining more areas on the Hanhikivi headland in its possession with the objective of owning all of the areas reserved for the nuclear power plant and its supporting functions in the land use plans. Acquisition of the areas will primarily take place based on voluntary agreements, and secondarily on a redemption permit, which can be granted by the Government.

A description of land possession, settlements, other activities and land use planning, suitability for the purpose and limitations concerning land use in the Hanhikivi headland is included in Appendix 3B to this application.

Available expertise

Since the 2010 decision-in-principle, Fennovoima has engaged in systematic increasing of its organization and development of its management system. A change took place in Fennovoima's ownership structure in October 2012, when E.ON announced its withdrawal from all Finnish operations, including Fennovoima's project and its 34 percent stake in Fennovoima. Fennovoima has replaced the expertise offered by E.ON by recruiting new personnel in its own organization and by using external consultants to complement the resources. The number of personnel within the company has doubled during the contracting phase which began in 2010.

Increasing of the company's personnel has accelerated since the plant supply contract was signed to ensure adequate staff numbers and level of expertise to meet the safety requirements and the objectives set for all phases of the project. In 2014, Fennovoima aims to recruit one hundred new experts in various fields. Introduction training will ensure that the personnel know the requirements of the nuclear industry and adopt the appropriate safety culture.

The commitment of the Rosatom Group to Fennovoima's project as a minority shareholder will provide Fennovoima also with an opportunity to utilize its nuclear power expertise and resources throughout the project.

Fennovoima's management system's target is to ensure that nuclear and radiation safety take precedence in all operations. In its 2009 preliminary safety assessment, STUK stated that Fennovoima possesses the necessary prerequisites for creating a construction and operating phase management system that will be aimed at managing safety and quality and adopting the appropriate safety culture.

At the beginning of 2014, Fennovoima had a personnel of approximately 80 employees. During the project development phase, that number will increase to approximately 300 people. In the construction and operating phases, the organization will comprise a maximum of nearly 550 people. The expertise required of the project organization principally consists of project management and quality management, together with knowledge of power plant construction and industrial construction as well as nuclear safety expertise.

The expertise available to Fennovoima is described in Appendix 1C to this application.

Financial resources

The financial foundation of the Fennovoima project is a diverse shareholder base which requires electricity for its long term operations in Finland. Fennovoima operates on the cost price principle. Shareholders are entitled to electricity generated in the nuclear power plant at cost price in proportion to their ownership in the company. Under this principle, Fennovoima's shareholders are responsible for the costs incurred by the company in nuclear energy production in accordance with the articles of association and the shareholders' agreement.

Fennovoima's shareholders hold an important position within Finnish industry and commerce. The shareholder base includes representatives of the metal and energy industries and retail business. In particular, shareholders within trade and industry are major employers. The local energy utilities within the shareholder base are typically owned by municipalities, towns and cities.

Fennovoima's plant supplier, Rusatom Overseas CJSC, which will, through its Finnish subsidiary, become a shareholder in Fennovoima, belongs to Rosatom Group. Rosatom Group is specialized in nuclear technology and is owned by the Russian state. The Rosatom Group will have a significant role in procuring external financing for the construction phase.

The substantial electricity needs of Fennovoima's Finnish shareholders and the involvement of the Rosatom Group as a plant supplier and minority shareholder of Fennovoima, as well as its major role in procuring external financing, ensure that the project can be financed at every phase in a way that is satisfactory to all parties.

A description of financial resources of Fennovoima, economic viability of the project and an overall financing plan are included in Appendix 1B to this application.

Nuclear fuel management

In December 2013, Fennovoima signed an integrated nuclear fuel delivery contract with JSC TVEL, which is a part of the Rosatom Group. The contract covers fuel fabrication and uranium for approximately the first ten years of operation. Upon expiration of the contract, Fennovoima has the opportunity to invite other fuel suppliers to bid and, at its discretion, diversify the delivery to several suppliers, as described in the original application for a decision-in-principle.

Fennovoima has chosen to use nuclear fuel made of reprocessed uranium during the first operating years. The nuclear fuel to be used in Fennovoima's nuclear power plant is similar to the fuel used in existing light water reactors, and it is designed and fabricated by using proven technologies. Natural uranium will remain as a secondary fuel option. There are sufficient known global uranium resources to satisfy the current needs of the nuclear power plants with light water reactors for at least 100 years. In addition, estimated additional uranium resources are significant. The supply of uranium on the global market will not restrict the operations of the nuclear power plant during its life cycle.

Fennovoima will ensure that nuclear material safeguards to prevent nuclear proliferation is implemented in accordance with Finnish legislation and international conventions. Fennovoima will also oversee the design, production, transportation and storage of the nuclear fuel to ensure its quality and safety.

For the plans for organizing the nuclear fuel management of the nuclear power plant, see Appendix 5A to this application.

Nuclear waste management

Fennovoima has the plans required in the Nuclear Energy Act and available methods for providing for nuclear waste management at the nuclear power plant. According to current estimates, the nuclear power plant will generate 1,200–1,800 uranium tonnes of spent fuel during its 60 years of operating life. The total volume of low and intermediate level waste will be approximately 5,000 m^3, and the volume of decommissioning waste 10,000–15,000 m^3. Management of low and intermediate level operating waste will be carried out using similar methods to those being used at existing Finnish power plants. The decision-in-principle granted in 2010 also includes the low and intermediate waste repository to be built on the Hanhikivi headland. Final disposal of the low and intermediate level operating waste generated at Fennovoima's nuclear power plant is estimated to begin in the late 2030s.

According to the 2010 decision-in-principle, Fennovoima shall submit specified plans for its nuclear waste management in connection with the construction license application. Furthermore, Fennovoima shall develop its plan for the final disposal of spent nuclear fuel so that by the end of June 2016, it will either have an agreement on nuclear waste cooperation with the other parties currently under nuclear waste management obligation, or an environmental impact assessment program concerning its own final disposal facility for spent nuclear fuel. Final disposal of the spent nuclear fuel generated at Fennovoima's nuclear power plant is currently estimated to begin in the 2070s at the earliest.

In March 2012, the Ministry of Employment and the Economy appointed a working group to steer joint studies by Finnish nuclear power companies on the available alternatives for the final disposal of the spent nuclear fuel. The final report of the working group was published in January 2013. The working group recommended that the most expedient and cost-effective way to proceed would be to utilize the expertise and experience accumulated in the final disposal project of the nuclear waste management company Posiva Oy, and to aim for an optimal solution in the provision for future final disposal operations. The working group also stated that safe final disposal should be carried out with an optimized schedule and in a cost-effective manner.

Fennovoima is currently preparing an overall plan on the final disposal of spent nuclear fuel. The plan examines the preliminary schedule for the disposal of the spent nuclear fuel generated in Fennovoima's nuclear power plant and interfaces with current operators' final disposal project. Fennovoima's primary objective is to develop and carry out the final disposal of spent nuclear fuel together with other Finnish operators under nuclear waste management obligation. One of the main goals of the overall plan is to determine an optimal final disposal solution which would benefit cooperation between Fennovoima and the other parties under nuclear waste management obligation.

An outline of the plans and the available methods for nuclear waste management are presented in Appendix 5B to this application. A description of the significance of the project from the standpoint of the operation and nuclear waste management of other nuclear facilities in Finland is included in Appendix 2B.

On the grounds presented in this application and its appendices, Fennovoima considers that the project continues to be in line with the overall good of society as referred to in section 11 of the Nuclear Energy Act.

Helsinki, March 4, 2014

Yours faithfully,

FENNOVOIMA LTD

Pekka Ottavainen
Chairman of the Board

Juha Nurmi
CEO

Information about Fennovoima

Appendix 1A

Fennovoima Ltd trade register extract, articles of association and shareholder register

This appendix includes the applicant's trade register extract in accordance with section 24, subsection 1 (1) of the Nuclear Energy Decree (755/2013), and a copy of the articles of association and shareholder register in accordance with subsection 1 (2).

Appendix 1A of the application submitted to the government by Fennovoima includes the following documents as required by the aforementioned Decree:

1. Fennovoima Ltd trade register extract, issued February 10, 2014
2. A copy of Fennovoima articles of association, issued February 10, 2014
3. A list of Fennovoima Ltd's shareholders, issued March 4, 2014.

This publication created from the application does not contain the Fennovoima Ltd trade register extract or the articles of association.

Shareholder register

Shareholder	Amount of shares	Personal ID / Business ID	Address
Voimaosakeyhtiö SF	1 600	2069398-3	Salmisaarenaukio 1, FI-00180 Helsinki, FINLAND

Helsinki March 4th 2014

Juha Nurmi
CEO

Information about Fennovoima

Appendix 1B

Description on the financial resources of Fennovoima and on the economic viability of the nuclear power plant, and the financing plan for the project

Summary

Fennovoima Ltd is an energy company founded in 2007. The purpose of the company is to build new nuclear power capacity in Finland and to produce reasonably priced electricity for its shareholders. All of the company's resources are aimed at the preparation, planning, and implementation of the nuclear power plant project.

Fennovoima operates on at cost price principle. Shareholders will be entitled to take delivery of electricity generated at the nuclear power plant at cost price in proportion to their holdings. Under this principle, Fennovoima's shareholders are responsible for all of the costs incurred by the company in nuclear energy production according to the articles of association and shareholders' agreement.

Voimaosakeyhtiö SF owns Fennovoima in its entirety. Voimaosakeyhtiö SF, in turn, is owned by a large number of local energy companies as well as companies in trade and industry that are consumers of electricity in Finland. A significant change is taking place in the shareholder base of Fennovoima, as the Finnish subsidiary of Rusatom Overseas CJSC will become a minority shareholder of Fennovoima. Further changes may take place within Voimaosakeyhtiö SF when the current shareholders make their final investment decisions and potential new shareholders join the company. It has been agreed in Fennovoima's shareholders' agreement that Voimaosakeyhtiö SF will remain the majority shareholder of Fennovoima even after any future ownership arrangements.

Fennovoima's shareholders hold an important position within Finnish industry and commerce. The shareholder base includes representatives of the metal, food, and energy industries and retail business, among other sectors. The trade and industry shareholders in particular are substantial employers. The shareholders that are local energy companies are typically owned by municipalities and cities.

The nuclear power plant project has been launched because there are compelling business reasons for it. Compared to other emission-free electricity production methods, the production costs of nuclear power are competitive, stable and predictable. The delivery reliability and stable production costs of the nuclear power plant, coupled with the shareholders' constant need for electricity, strengthen the viability of the project. The project is important for the shareholders' strategic decentralization of electricity procurement, and will strengthen the shareholders' operating conditions in Finland.

An overall financing plan has been drafted for the project. Capital expenditure for each phase, risk factors and prevailing conditions will be taken into account in financial planning. Besides the design, construction and operation of the nuclear power plant, the financing plan covers nuclear waste management, decommissioning of the plant and provisions required under the Nuclear Liability Act.

Fennovoima has the financial resources to implement the project safely. The project is planned to be financed by shareholders' equity investments and by external loans. Rusatom Overseas CJSC and Voimaosakeyhtiö SF have agreed on the shareholders' equity investment obligations and the obligation to arrange for loan capital. Rosatom Group will have a significant role in the arrangement of loan capital for the construction phase. The substantial electricity needs of Fennovoima's Finnish shareholders and the involvement of the Rosatom Group as a plant supplier and minority shareholder of Fennovoima, as well as its role in arranging loan capital financing, ensure that the project can be financed at every phase in a way that is satisfactory to all parties.

Introduction

This appendix includes an overall description of Fennovoima's financial resources and the economic viability of the nuclear facility project in accordance with section 24, subsection 1 (5) of the Nuclear Energy Decree (755/2013) and the overall financing plan in accordance with subsection 1 (6). The current document complements the information presented in the original decision-in-principle application, and describes the changes that have taken place in the project.

A nuclear power plant project is an extremely substantial investment in terms of economic impact and duration. When assessing a nuclear power plant project, it must be ensured that the applicant has the financial resources for implementing the planned project in accordance with safety requirements. A significant portion of the nuclear power plant project's total costs will arise during construction, before the operation of the nuclear power plant begins.

Impact of changes that have taken place in the project

Changes have taken place in Fennovoima's ownership base since 2009. New shareholders have joined the company, and some of the earlier shareholders have decided to leave the project. The biggest change occurred in October 2012, when E.ON, Fennovoima's owner by 34 percent share, announced its withdrawal from all its Finnish operations, including Fennovoima's project. Voimaosakeyhtiö SF purchased E.ON's share of the company, after which Fennovoima has been in the sole ownership of Finnish shareholders. Another significant change will take place in the shareholder base of Fennovoima, as the Finnish subsidiary of Rusatom Overseas CJSC will become a minority shareholder. Further changes may occur within Voimaosakeyhtiö SF when the current shareholders make their final investment decisions and potential new shareholders join the company. It has been agreed in Fennovoima's shareholders' agreement that Voimaosakeyhtiö SF will remain the majority shareholder of Fennovoima even after any future ownership changes.

Fennovoima and its shareholders consider the lower plant capacity currently being planned to correspond better to the needs of the owners. Fennovoima and its shareholders possess, together with the Rosatom Group, the financial resources to implement the project safely.

The cost structure of the electricity produced at a nuclear power plant remains essentially the same as was presented in the original decision-in-principle application. According to Fennovoima's estimate, the production cost of the electricity to be produced in the project is still competitive when compared to the production costs of other emission-free power plant investments. Considerations regarding the economic viability of the project must take into account the shareholders' long-term need for electricity in Finland, which has not essentially changed.

The project is still planned to be financed by shareholders' equity investments and by external loans. The pricing solution and turnkey delivery model of the plant supply contract improve the feasibility of the funding of the project. Rosatom Group will have a significant role in arranging the loan capital for the construction phase.

Financial resources of Fennovoima

Fennovoima Ltd is an energy company founded in 2007. The purpose of the company is to build new nuclear power capacity in Finland and to produce reasonably priced electricity for its shareholders. All of the company's resources are aimed at the preparation and planning of the nuclear power plant project. Fennovoima engages in no other business operations.

Mankala principle

As a company, Fennovoima does not seek to make a profit; it will sell the nuclear electricity to its shareholders at cost price. After the completion of the nuclear power plant has been built, the shareholders will be entitled to receive electricity produced in the power plant in proportion to their share. In Finland, this business model is generally called the "Mankala principle". Under the Mankala principle, Fennovoima's shareholders are responsible for all of the costs incurred by the company in nuclear energy production according to the articles of association and shareholders' agreement.

The extensive and diverse ownership base combined with the Mankala principle provide for strong and stable financial resources that will not be solely dependent on the development of the price of the electricity in the Finnish and Nordic markets. The financial position and resources of Fennovoima's shareholders are of central importance when assessing the adequacy of company's financial resources.

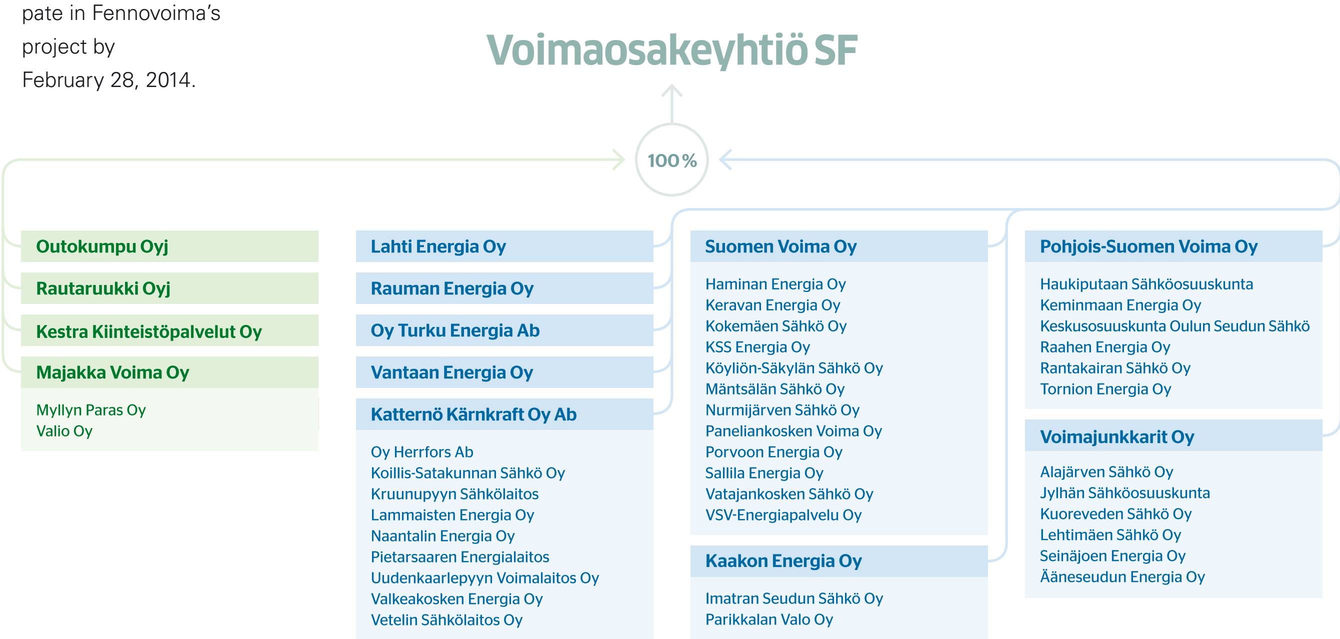
Ownership structure of Fennovoima

In February 2014, Fennovoima has one share series and one shareholder. Fennovoima's entire share capital is owned by Voimaosakeyhtiö SF, which is, in turn, owned by local energy companies and companies in trade and industry that are consumers of electricity in Finland.

Changes will take place in Fennovoima's ownership. A Finnish subsidiary of Rusatom Overseas CJSC, which is a part of the Rosatom Group, will become a minority shareholder of Fennovoima. Voimaosakeyhtiö SF is also investigating the inclusion of potential new shareholders in the project. The Finnish company Voimaosakeyhtiö SF will remain the majority shareholder of Fennovoima.

Voimaosakeyhtiö SF has been established to manage the majority of Fennovoima's share capital. Voimaosakeyhtiö SF's share of Fennovoima is divided between its shareholders, all of which are entitled to the electricity at cost-price and are responsible for the cost of nuclear power production in accordance with the Mankala principle. The companies presented in Figure 1B-1 have made a final decision to participate in the Fennovoima project by February 28, 2014.

Figure 1B-1. Companies which have made a final decision to participate in Fennovoima's project by February 28, 2014.



Fennovoima's shareholders and their financial status

Fennovoima's shareholders hold an important position within Finnish industry and commerce. The trade and industry shareholders are substantial employers. The history and future plans of the shareholders in Finland demonstrate strong commitment to the prosperity and development of Finnish society.

Fennovoima's shareholders vary greatly in terms of ownership structure, company form and size. The shareholder base comprises of customer-owned businesses, municipally owned companies and municipal federations, cooperatives, family businesses and listed companies, all treated as equal shareholders. Local energy companies that are Fennovoima's shareholders are typically publicly owned, i.e. owned in effect by municipalities and cities. The Finnish government is a significant minority shareholder in the listed companies that belong to Fennovoima's shareholders.

The energy companies that are Fennovoima's shareholders have a significant number of electricity customers around Finland. The home communities and operating areas of local energy companies, within which they have a statutory responsibility for the reliability of electricity supply to small-scale customers, cover a large portion of Finland. The production facilities, offices and workplaces of the shareholders representing trade and industry are also located all around the country.

The Rosatom Group will support the implementation of the project through its extensive and high-quality nuclear power expertise and significant financial resources in the dual role of plant supplier and minority shareholder. Rosatom Group is one of the world's biggest producers of nuclear power. It is also considered an ownership of strategic importance for the Russian state. All the nuclear energy operations of the Group are organized under the company Atomenergoprom. Atomenergoprom's credit ratings with the major international credit rating agencies are BBB and Baa2. Financial key figures of Atomenergoprom are listed in Table 1B-1.

Together with the Rosatom Group, the Finnish shareholders of Fennovoima are able to offer a strong and stable financial basis for the project. Fennovoima has the financial resources to implement the project safely.

Net sales	EUR 9.8 billion
Balance sheet total	EUR 46.9 billion
Equity ratio	68 %
Investments	EUR 5.5 billion

Table 1B-1. Atomenergoprom's financial key figures for 2012.

Economic viability of the project

Costs of nuclear energy and other electricity production methods

Nuclear power is one of the most capital-intensive forms of electricity production. Hydroelectric power and wind power are also highly capital intensive. It is characteristic of the production costs of nuclear energy that nuclear fuel accounts for a relatively small part of the costs, while the capital expenditure is relatively high. The cost structure of nuclear power makes it particularly well suited for the production of base load electricity.

The production costs of nuclear energy can be divided into three categories: capital expenditure, nuclear fuel procurement costs, and power plant operating and maintenance costs. Capital expenditure costs consist of depreciation on fixed assets and costs of borrowed capital and equity. The procurement costs of nuclear fuel consist of mining and processing the raw uranium, uranium conversion and enrichment and the cost of fabricating the nuclear fuel elements. The power plant operating and maintenance costs consist of, for example, the costs of operating personnel and annual outages. The costs of nuclear waste management and decommissioning of the plants are also included in the operating and maintenance costs.

The costs of emissions trading will not encumber nuclear power production. The carbon emissions of a nuclear power plant during its life cycle are very small in relation to the amount of energy produced. Measures taken to limit emissions of greenhouse gases and the emissions trading system introduced in the EU have enhanced the cost-effectiveness of nuclear energy compared to electricity production methods that generate carbon dioxide emissions. The price level of emission rights has a highly significant impact on the relative profitability of nuclear energy.

The parties have agreed on the financial obligations and objectives of the project in the plant supply contract, nuclear fuel supply contract and shareholders' agreement. The details of these contracts are not public, but based on the agreements and the cost estimates, Fennovoima's current shareholders have assessed the project as being economically viable and competitive compared to other alternatives.

Importance of predictability and price stability

The price of electricity has fluctuated strongly over the last ten years. There is great uncertainty about future price trends. The wholesale electricity market offers comparatively good potential for hedging against price fluctuations with a perspective of a few years. On the other hand, it is practically impossible to secure a stable and competitive price over the long term, especially for small and medium-sized users of electricity.

Uncertainty about electricity price trends makes investment decisions more difficult for industrial users of electricity. Profitability estimates on new investment projects with long payback periods are susceptible to variations in assumptions about electricity price trends.

Fennovoima shareholders are undertaking long-term domestic investments that will increase their use of electricity. The time scale of these investments is considerably longer than the hedging possibilities offered by the electricity market. From the point of view of Fennovoima shareholders, the only technically and economically sustainable solution for securing the long-term availability of stable-priced electricity is investing in emission-free electricity production that they themselves will own.

The Fennovoima project is a long-term investment. The service life of the planned nuclear power plant is 60 years, during which it will produce electricity at a stable and predictable cost level. The stable production costs of nuclear energy, the substantial electricity needs of Fennovoima shareholders and the significance of efficient electricity procurement as a means of increasing their competitiveness are factors in favor of the economic viability of the project.

Strategic decentralization of electricity procurement

Cost trends in all forms of electricity production involve uncertainty factors. By decentralizing electricity procurement to different forms of electricity production, overall risks related to the procurement can be kept at a reasonable level and the operating conditions for the business can be secured in various future developments.

Because of tightening emission restrictions, it may be assumed that future investments in electricity production in the EU will primarily focus on emission-free forms of production. The majority of Fennovoima's shareholders endeavor to actively control the risks related to electricity procurement and to invest in carbon-free modes of production. The shareholders are engaging independently as well as jointly in various extensive projects. Fennovoima's shareholders' are, among others, involved in joint projects related to the construction of wind farms, which are currently at the planning and preparation phases.

Decentralization of electricity procurement is important for Fennovoima shareholders. In current circumstances, it is economically justified for them to invest in several emission-free forms of electricity production. Because the majority of Fennovoima's shareholders own very little nuclear energy production capacity relative to their electricity needs or none at all, Fennovoima's project is very important for them from the perspective of strategic decentralization of electricity procurement, and as such will strengthen their operating conditions.

Financing plan outline for the project

The financial foundation of the Fennovoima project is a diverse shareholder base that consists of a large number of companies which require electricity for their long-term operation in Finland. Because a nuclear power plant requires substantial capital expenditure and its construction and commissioning phase lasts for several years, the parties who finance it must be committed to the implementation of the project and have the necessary financial resources to make this commitment.

Commitment to the Mankala principle and thereby to meeting all the costs resulting from nuclear energy production over the entire life cycle of the nuclear power plant demonstrates the determination of Fennovoima's shareholders. The planned lifetime of the Fennovoima nuclear power plant, used as a basis for financing plan and financial estimates for the project, is 60 years.

Under the implementation plan and overall timetable drawn up by Fennovoima, electricity production at the nuclear power plant will begin in 2024. Capital expenditure will be at its highest when the power plant is completed and electricity production begins.

Besides design and construction of the nuclear power plant, Fennovoima's financing plan outline covers nuclear waste management, decommissioning of the plant and provision for nuclear damage as required under the Nuclear Liability Act.

Project cost estimate

In December 2013, Fennovoima signed a turnkey plant supply contract with Rusatom Overseas CJSC. The contract price has not been announced in public. Fennovoima has prepared thorough surveys to estimate the costs related to its own scope of responsibilities in the project implementation. Based on these surveys and the plant supply contract, the current total cost estimate of the project, in 2014 monetary value, falls within the cost estimate presented in Fennovoima's original decision-in-principle application in 2009. The cost estimate includes, among others, the following items:

- construction costs
- costs of machines and equipment
- costs of ancillary projects carried out by Fennovoima
- interest costs during construction.

Financing sources of the project

Fennovoima's nuclear power project will be implemented in phases. Capital expenditure for each phase, risk factors and prevailing conditions will be taken into account in financial planning.

The project is planned to be financed by shareholders' equity investments and by external loans. Rusatom Overseas CJSC and Voimaosakeyhtiö SF have agreed on the shareholders' equity investment obligations and the obligation to arrange loan capital.

The Rosatom Group will have a significant role in arranging the loan capital for the construction phase.

The substantial electricity needs of Fennovoima's Finnish shareholders and the involvement of the Rosatom Group as a plant supplier and minority shareholder of Fennovoima, as well as its significant role in arranging loan capital financing, ensure that the project can be financed at every phase in a way that is satisfactory to all parties.

Financing of nuclear waste management and decommissioning

In accordance with the Nuclear Energy Act, a licensee has a nuclear waste management obligation and is responsible for all costs incurred in the appropriate management of nuclear waste generated in the operations of the nuclear power plant, even after the power plant is no longer in operation. The licensee is also responsible for the appropriate decommissioning of the nuclear power plant.

In Finland, the funds required to pay for nuclear waste management and decommissioning are collected on an annual basis from the licensee while the nuclear power plant is in operation. The funds needed for the nuclear waste management of all nuclear power plants operating in Finland are collected in compliance with a uniform procedure and deposited in the national Nuclear Waste Management Fund. This ensures that the money required to pay for nuclear waste management is secure and available in all circumstances.

Fennovoima's annual costs of nuclear waste management and decommissioning will be included in the cost price shareholders will pay for the electricity they use. Fennovoima shareholders will finance the costs of nuclear waste management and decommissioning in full.

Insurance required under the Nuclear Liability Act

As a future operator of a nuclear installation subject to the Nuclear Liability Act (484/1972), Fennovoima will be liable for nuclear damage caused by nuclear incidents at its nuclear facility. The liability for nuclear damage is a so called strict liability, which means that Fennovoima will be liable for the damage regardless of whether the damage has been caused by any negligent act or omission of Fennovoima.

A reform of nuclear liability legislation has been ongoing for a long time. An act amending the Nuclear Liability Act was passed already in 2005 to implement changes required by the international nuclear liability conventions and their supplementary protocols, but the act has not yet been enforced. The 2005 act amending the Nuclear Liability Act (493/2005) is to be enforced by a government decree as soon as the preconditions for ratification by Finland exist. As there was no certainty of when this would happen, unlimited liability of the operator of a nuclear facility in Finland was enforced by enacting a temporary act (581/2011). The act has been in force since January 1, 2012 and will remain in force until Nuclear Liability Act 493/2005 is enforced by a government decree.

According to the valid nuclear liability legislation, Fennovoima, as an operator of a nuclear facility, will have unlimited liability for all nuclear damage arising in Finland and caused by a single nuclear incident. Fennovoima's maximum liability for nuclear damage arising outside Finland and caused by a single nuclear incident will be (excluding interest and any legal expenses) 600 million Special Drawing Rights of the International Monetary Fund (corresponding to approximately EUR 700 million).

Fennovoima is required to obtain nuclear liability insurance approved by the Financial Supervisory Authority to cover its liability under the Nuclear Liability Act or corresponding legislation of another contracting state. The temporary legislation increased the amount of required liability insurance from 175 million Special Drawing Rights of the International Monetary Fund (approximately EUR 205 million) to 600 million Special Drawing Rights (approximately EUR 700 million).

Fennovoima will take out nuclear liability insurance as required in the Nuclear Liability Act or deposit corresponding collateral before the start-up of the planned nuclear power plant.

Information about Fennovoima

Appendix 1C

Description on the planned implementation and organization of the project and expertise available to Fennovoima

Summary

Fennovoima has the goal of beginning the electricity production at the nuclear power plant in 2024. The schedules of licensing and permitting processes required by the nuclear energy, building, and environmental legislation together with the management of the design and construction of the nuclear power plant are essential for the progress of the project. Fennovoima has the sufficient expertise needed for the construction of the nuclear power plant in compliance with the safety requirements and other objectives.

In December 2013, Fennovoima signed a plant supply contract with Rusatom Overseas CJSC. The contract covers the turnkey delivery of an AES-2006 VVER type nuclear power plant. Fennovoima will monitor the design work and the quality of the implementation at all stages of the project. During project implementation, the expertise important to the safety and operation of the plant will be transferred to Fennovoima.

During the development phase of the project, Fennovoima's project organization will grow from 80 employees to more than 340 employees. In the construction and operating phases, the project organization will comprise nearly 550 people. The expertise needed in the project organization consists in large part of normal project management and quality management, together with power plant construction and industrial construction. Sufficient expertise in these areas is available on the employment market.

The project organization responsible for implementing the project will be converted into the operating organization of the nuclear power plant during the commissioning phase. The safety of the nuclear power plant will be ensured by transferring the design, construction and operating expertise to the operating organization. The operating organization will comprise approximately 400 employees.

Fennovoima has already recruited professionals from the nuclear energy field with extensive experience in the preparation, design and construction of nuclear power plants. After signing the plant supply contract, the organization will be rapidly strengthened in accordance with the plans. Introduction training will ensure that the personnel know the requirements of the nuclear power industry and adopt the appropriate safety culture.

The Finnish subsidiary of Rusatom Overseas CJSC, which is a part of the Rosatom Group, will become a minority shareholder of Fennovoima. Companies of the Rosatom Group act as owners and responsible operators of Russian nuclear power plants, and their expertise covers all the phases in the life cycle of a nuclear power plant. Fennovoima has the opportunity to utilize the extensive experience of the Rosatom Group concerning the design, construction, operation and decommissioning of VVER nuclear power plants.

Introduction

This appendix includes an overall description of the expertise available to the applicant as required by section 24, subsection 1 (3) of the Nuclear Energy Decree (755/2013). The current document complements the information presented in the original decision-in-principle application, and describes the changes that have taken place in the project.

Under section 7f of the Nuclear Energy Act (990/1987), Fennovoima is responsible for the nuclear power plant specified in the application being built in compliance with safety standards and for the safe use of the nuclear power plant. Ensuring safety requires that Fennovoima has the appropriate and sufficient expertise available during each phase of the project.

The government decree on general provisions regarding the safety of a nuclear power plant (717/2013) specifies in chapter 7 the requirements concerning the organization and the personnel of a nuclear power plant. The principal requirements concern an advanced safety culture, safety and quality management, lines of management and responsibilities, and the necessary expertise. The requirements apply to the design, construction, operation and decommissioning of nuclear power plants.

Impact of changes that have taken place in the project

Fennovoima's project has made significant progress since the 2010 decision-in-principle. The preparation and contracting phases of the project have been completed, the latter with the signing of the plant supply contract in December 2013. The contract signed with Rusatom Overseas CJSC, a part of the Russian Rosatom Group, concerns a turnkey delivery of an AES-2006 nuclear power plant. Next, the project will move to the development phase with the objective of being granted a construction license.

With the signing of the plant supply contract, the schedule of the project has been specified in more detail. The objective is to start electricity production at the plant in 2024. The new schedule has no significant impact on the duration of the development, licensing and construction phases.

Changes have taken place in Fennovoima's ownership structure. The most significant change occurred in October 2012, when E.ON, Fennovoima's owner by 34 percent share, announced its withdrawal from all Finnish operations, including Fennovoima's project. Fennovoima has replaced the E.ON expertise by increasing its own organization and by using external specialists to complement the resources. Fennovoima's number of personnel doubled during the contracting phase.

Rusatom Overseas CJSC will become a minority shareholder of Fennovoima through its Finnish subsidiary. This allows Fennovoima to utilize the expertise and resources of the Rosatom Group at all stages of the project.

Implementation of the project

Safety culture

Fennovoima has engaged in systematic development of its safety culture. Fennovoima's safety principles ensure that safety is always given priority. Fennovoima aims to make sure that the entire personnel thoroughly understands the significance of the safety culture and adopt responsibility of nuclear safety, both as individual employees and as a working community. In the developing and maintaining of safety, Fennovoima aims to take initiative, work in an open and transparent manner, and involve the community. According to Fennovoima's safety culture, Fennovoima will require that the all the participants of the project also commit to the same safety and quality requirements.

Requirements concerning the development and monitoring of safety culture within the project are included into the plant supply contract. Fennovoima will also define practical safety culture development and evaluation procedures together with the plant supplier in the joint safety culture program concerning the entire project.

Management system

Fennovoima's management system will bring together all the different parts of the organization into a balanced ensemble which ensures that Fennovoima meets all goals set for it. The management system aims to ensure that nuclear and radiation safety take precedence in all operations. All operations correspond with their safety significance so that special attention is given to the factors with a higher impact on safety.

The company is in the process of developing an integrated, process-oriented management system that defines the responsibilities and lines of management and supports a clear decision-making structure. The management system will include a quality system compliant with the ISO 9001 standard, an environmental system compliant with the ISO 14001 standard, and an occupational safety system compliant with the OHSAS 18001 standard.

Requirement management is an important part of Fennovoima's management system and for this purpose the company has adopted the necessary tools and processes.

Model of project implementation

Regardless of the model of project implementation, the responsibility for ensuring the safety of the plant remains with the licensee as referred to in the Nuclear Energy Act, in this case Fennovoima. The fulfillment of this obligation requires significant expertise of the company.

Based on assessments and negotiations with plant suppliers, Fennovoima chose to implement a turnkey project, where the supply contract is concluded with a single main contractor. From the risk management point of view, the turnkey option offers a natural way of utilizing the nuclear energy expertise of the Rosatom Group. In addition, the involvement of the Rosatom Group as a financier and shareholder support the plant supplier's commitment to the project and the agreed schedule. Fennovoima will monitor the design work and the quality of the execution at all stages of the project.

Some of the conventional construction work will be on Fennovoima's responsibility. Such work includes the new connecting road and some of the auxiliary and support buildings to be built at the plant site, such as office buildings.

Schedule and phases of the project

With the signing of the plant supply contract, the schedule of the project has been specified in more detail. The design and construction of a nuclear power plant unit will take approximately ten years. Fennovoima has the goal of beginning electricity production at the nuclear power plant in 2024. The Fennovoima project is subdivided into phases as shown in Table 1C-1. The schedule of the project until the commissioning of the plant is shown in Figure 1C-1.

Preparation and contracting phases

Between 2007 and 2013, Fennovoima carried out the preparation and contracting phases of the project. Table 1C-1 presents the principal content of these phases. The preparation phase ended and the project moved to the contracting phase when the Government issued decision-in-principle in May 2010, and the Parliament ratified the decision in July.

In October 2011, Fennovoima selected the Hanhikivi headland, located in the Northern Ostrobothnian municipality of Pyhäjoki, as its nuclear power plant site. The regional and local land use plans that allow the construction of the Hanhikivi nuclear power plant entered into force in 2013. For a more detailed account of the plant site and land use planning, see Appendix 3B to this application.

The main objective of the contracting phase was achieved in December 2013, when Fennovoima signed the plant supply contract with Rusatom Overseas CJSC, a part of the Rosatom Group, concerning the supply of an AES-2006 nuclear power plant.

Development phase

The development phase that commenced with the signing of the plant supply contract includes the basic design of the plant during which the plant safety principles are defined. The basic design also includes the designing of the systems that have an impact on plant safety.

During the development phase, Fennovoima will continue to develop its organization and procedures by adopting a technical configuration management system, among other things. Together with the requirement and interface management systems, it will ensure uninterrupted communication of technical information during the project implementation as well as the future operating activities. The design reviews carried out by Fennovoima are an essential part of the handling and review process of the plans prepared during basic design.

During the development phase, the plant site will be prepared and its infrastructure built to allow the construction work to commence immediately when the construction

Table 1C-1. Phases of the project.

Phase		**Content**
Preparation		Investigating site options Environmental impact assessment Feasibility studies for plant options Planning preparation Pre-planning Application for decision-in-principle
	Decision-in-pronciple (government and parliament)	
Contracting		Choice of site Procurement of plant Planning
	Plant supply contract	
Development		Basic design Building permit procedure Application for construction license Preparation of plant site
	Construction license (government)	
Construction		Detailed design Construction Application for operating license Continued improvement of safety
	Operating licence (government)	
Use		Normal use Continued improvement of safety Periodic safety review Renewal of operating licence
	Periodic safety review (STUK) Operatng licence (government)	
Decommissioning		End of use Licensing processes related to decommissioning Dismantling the plant

license is granted. During the preparation of the plant site, surveys and measurements used in the design and licensing of the plant will be carried out.

As stated in the 2010 decision-in-principle, Fennovoima will apply for a construction license no later than in June 2015.

Construction phase

In the construction phase, the design, contractor and supplier organizations will be responsible for the performance and organization of the work. Fennovoima will ensure that the quality of design and execution fulfill the requirements by utilizing efficient safety significance based quality and project management.

During the detailed design of the nuclear power plant, the plant supplier and the component suppliers will prepare the design documentation required for the execution of the work.

Fennovoima, the responsible supplier and the authorities will review the plans concerning the manufacturing and installation of the nuclear power plant's structures and components before the work begins. Any deviations from the manufacturing and installation plans will be reported, and the processing of deviations will be agreed on with Fennovoima and, when necessary, the authorities. During the construction work, suppliers will carry out work quality assurance through various on-site inspections and tests. This will ensure that the work is carried out according to the plans and is in compliance with the requirements.

The commissioning of the nuclear power plant will begin with equipment testing and test runs, continue with powering up of systems and conclude with a trial run of the entire plant for each phase. Fennovoima will confirm the functional and other

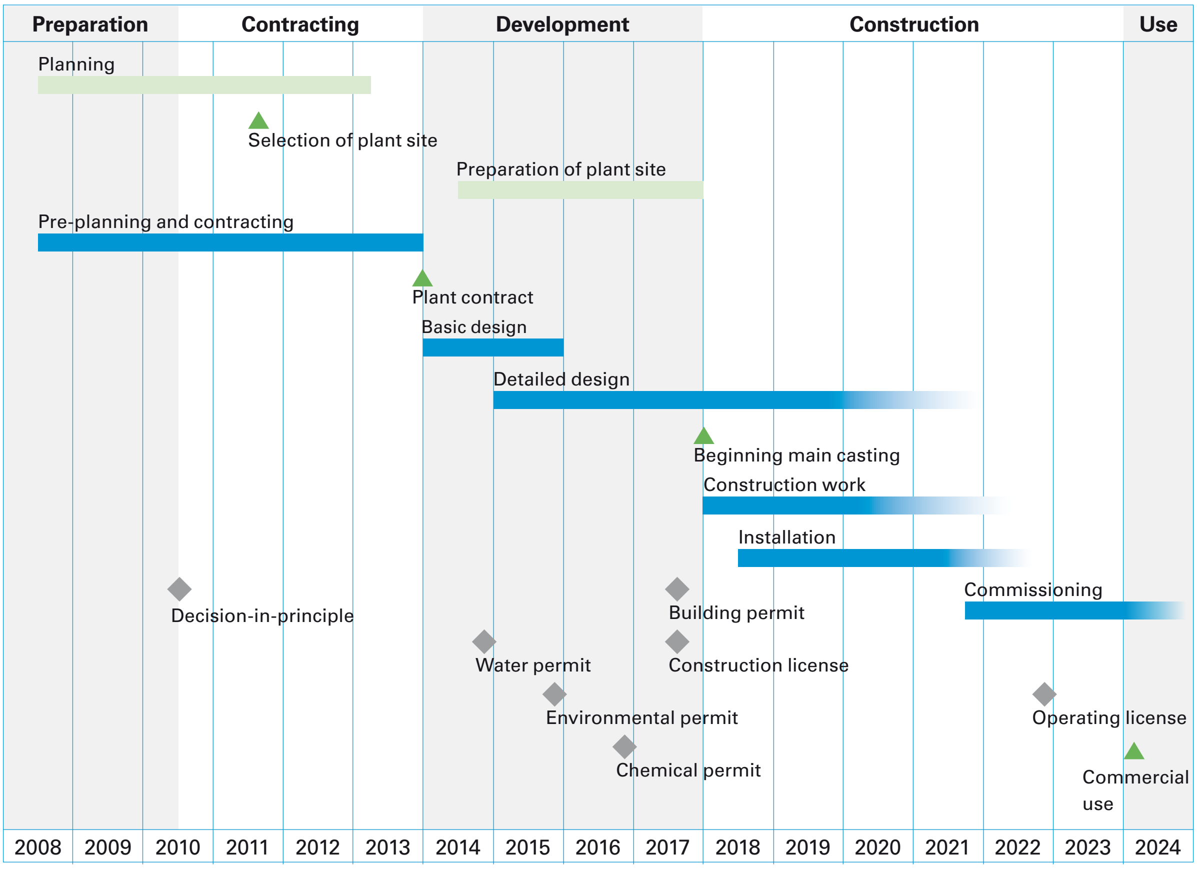


Figure 1C-1. Project schedule.

requirements set for the equipment and systems using analyses and tests specified in the commissioning and testing programs drawn up by the suppliers and inspected by Fennovoima.

Operating a nuclear power plant and loading the nuclear fuel into the reactor requires an operating license as referred to in section 20 of the Nuclear Energy Act. Fennovoima will apply for the operating license on the basis of detailed planning and implementation of the nuclear power plant.

Commissioning and testing are important phases in the training of the operating personnel. Fennovoima will begin the training of the operating personnel during the construction and commissioning phases in accordance with the detailed recruitment and training plans to be prepared together with the plant supplier.

Operating phase

During the operating phase, Fennovoima, as the licensee and operator of the plant, is responsible for ensuring that everything related to the use of the nuclear power plant is safe and fulfills the requirements set for the operating phase. When Fennovoima converts the project organization responsible for the project implementation into the operating organization, it will receive all the necessary information concerning the design, construction and commissioning of the plant. Also the expertise required for the safe and efficient operation of the plant will also be ensured. This way Fennovoima will make sure that the experience and information accumulated during the implementation of the project will carry through to the operation of the plant.

The AES-2006 nuclear power plant to be built in Pyhäjoki is an evolution of the Russian VVER plant type. VVER plants have been developed and operated for more than 40 years in several countries, which means that Fennovoima will be able to utilize the accumulated operating experience.

The operating license periods of existing Finnish nuclear power plants have varied from a few years to the approximately 20 years of the currently valid operating licenses. The overall safety of the plant units is evaluated at intervals of no more than ten years in conjunction with the renewal of the operating license or in the periodic safety review.

For a more detailed description of the construction, commissioning and operating phases, see the original decision-in-principle application.

Fennovoima organization and expertise

Project organization development

Since the granting of the decision-in-principle in 2010, Fennovoima has developed its organization and doubled the number of its personnel. The company has recruited nuclear power professionals with extensive experience in the preparation, design and construction of a nuclear power plant.

Changes have taken place in Fennovoima's ownership structure. The most significant change occurred in October 2012, when E.ON, Fennovoima's owner by 34 percent share, announced its withdrawal from all Finnish operations, including Fennovoima's project. Fennovoima has replaced the expertise of E.ON by increasing its own organization and by using external specialists to complement the resources.

Fennovoima will rapidly increase its project organization, particularly during the development phase, to achieve the objectives set for the development phase and to prepare for the construction phase. During the construction phase, the future operating personnel will be trained and the operating organization established. The employment market has sufficient expertise to meet Fennovoima's needs. Induction training will ensure that the personnel know the requirements of the nuclear industry and adopt the appropriate safety culture.

Fennovoima will also use external consultants to complement its internal competencies and expertise.

Rusatom Overseas CJSC will become a minority shareholder of Fennovoima through its Finnish subsidiary. The ownership arrangement allows Fennovoima to utilize the expertise and resources of the Rosatom Group at all stages of the project.

Organization at the various phases of the project

Development phase

The key functions in the development phase are project planning, preparation of the construction license application, applications for other licenses and permits and preparatory work at the plant site. Fennovoima's development phase organization will cover all the functions required for the safe implementation of the project.

At the beginning of 2014, Fennovoima has approximately 80 employees but as a result of extensive recruitment, the number will increase to approximately 200 by the end of 2014, and further to 300 by the end of 2015. For an estimate of the function-specific number of personnel during the development phase, see Table 1C-2.

Table 1C-2. Fennovoima's estimated number of personnel during the development and construction phases.

Function	Development phase	Construction phase
Administration, accounting and communications	52	66
Project management	31	40
Safety	28	30
Quality management	15	40
Environment and occupational safety	6	6
Power plant technology	84–154	168–338
Construction	24	36
Total	**204–344**	**391–550**

Construction phase

In the construction and commissioning phases, the project organization will be increased by adding new functions as the emphasis of the project gradually moves from planning to execution. At the end of the development phase, the focus in the project organization will be on supervision of the construction work, quality management, authority processes, planning and inspection of the manufacturing and installation of components and systems, and preparation of the operation license application and management of other license and permit processes.

During the construction phase, the required number of personnel will be approximately 550 employees. For an estimate of the function-specific number of personnel during the construction phase, see Table 1C-2. The personnel requirement has been revised to correspond to the selected turnkey plant delivery model.

Operating and decommissioning phases

As the licensee, Fennovoima will be responsible for the safe operation of the nuclear power plant. The organization of Fennovoima during the operation phase will consist of approximately 400 employees. Direct subordinates to the responsible manager of the plant will be the plant management staff and the key functional units such as the operating, maintenance and safety units and the technical support unit.

Fennovoima aims to utilize the operating personnel in the formation of the decommissioning organization.

Utilization of Rosatom's expertise

The Rosatom Group, participating in Fennovoima's project in the dual role of the plant supplier and shareholder, is a nuclear energy field corporation of international significance. For Fennovoima's Finnish shareholders Rosatom will be a partner whose nuclear power expertise can be used to complement Fennovoima's internal expertise at all phases of the project.

Expertise and resources

The nuclear power plants developed by Rosatom Group are best known in Finland from the two VVER-440 type plant units at Loviisa Nuclear Power Plant. Rosatom Group has continuously developed its plant units to meet the latest safety requirements. All in all, the Group comprises more than 250 companies and institutes. The Rosatom Group has more than 260,000 employees, and its turnover was EUR 11.1 billion in 2011.

Rosatom is currently in the process of building considerable new nuclear power capacity in Russia. New nuclear power plant units are being built at the Novovoronezh, Leningrad, Rostov and Beloyarsk nuclear power plant sites. The most advanced stage in the construction work of the new AES-2006 nuclear power plants, which corresponds to the Fennovoima's plant, has been achieved in the Leningrad II nuclear power plant, located in the town of Sosnovy Bor in Russia. The first plant unit of Leningrad II is expected to be completed in 2015. Rosatom Group also has ongoing international construction projects in China, India, Belarus and Iran, among other countries. All in all, Rosatom has 15 VVER plant units under construction, with several new projects being planned outside Russia. For a country-specific listing of new and existing VVER plants, see Table 1C-3.

Country	In operation	Plant supply contract / under construction
Armenia	1	1
Bangladesh		2
Belarus		2
Bulgaria	2	
China	2	2
Czech Republic	6	
Finland	2	1
Hungary	4	2
India	1	4
Iran	1	
Russia	17	8
Slovakia	4	
Turkey		4
Ukraine	15	2
Vietnam		2
Total	**55**	**30**

Table 1C-3. The projects and the existing plants built by the Rosatom Group.

Inside the Rosatom Group the commercial nuclear power production is organized under the subsidiary Atomenergoprom. Atomenergoprom is responsible for the operation of Russian nuclear power plants, and also offers services for the entire life cycle of nuclear power plants, from the mining of the uranium to the production of electricity. Figure 1C-2 presents the Atomenergoprom subsidiaries essential for Fennovoima's project.

Atomenergoprom has aimed at focusing its operations, such as design and construction, to separate companies. The design of the AES-2006/V491 plant type to be delivered to Fennovoima will be carried out by SPbAEP (St. Petersburg Atomenergoproject), which is a part of VNIPIET (All-Russia Science Research and Design Institute of Power Engineering Technology). The primary circuit and principal safety systems will be designed by OKB Gidropress, which has designed the primary circuits for VVER projects of the Rosatom Group.

Fennovoima has signed a fuel agreement with Atomenergoprom subsidiary JSC TVEL, which is responsible for the manufacturing and sales of nuclear fuel. JSC TVEL is an experienced fuel supplier that also supplies fuel for the Loviisa Nuclear Power Plant, among others. In addition to the fabrication of fuel elements, JSC TVEL also has uranium enrichment capacity. In total, JSC TVEL has approximately a 17 percent share of the global nuclear fuel manufacturing industry, and a 45 percent share of the uranium enrichment capacity.

Rosatom Group also includes several institutes that engage in research and development of nuclear technology. The most significant of these institutes is the Kurchatov Institute, which develops models and analyses of nuclear reactors.

Fennovoima has the possibility to utilize the expertise and resources of the Rosatom Group at all stages of the project. Fennovoima can, for example, complement the training of the operating personnel at the nuclear power plants of the Rosatom Group.

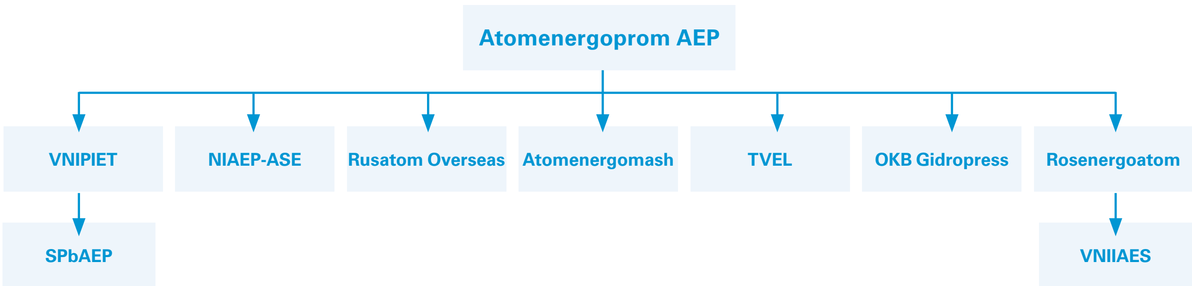


Figure 1C-2. Subsidiaries of Atomenergoprom.

Other expertise available to Fennovoima

Fennovoima will utilize external expertise in its project. Decisions on strengthening the project and operating organization expertise and utilizing external expertise will be made case by case to ensure that Fennovoima will, in all circumstances, possess sufficient internal expertise in key areas of the project, as well as the potential and ability to steer and monitor the other parties involved in the project. The procedures applied to the evaluation, selection and steering of external expertise will depend on the significance of the particular area of expertise for the safety, quality, environmental impact, schedule and costs of the project.

So far, Fennovoima has utilized the expertise of the following organizations, for example, for the surveys and tasks required for the preparation and contracting phases:

- Alleco Ltd: surveys of aquatic vegetation and bottom fauna
- Allen & Overy LLP: contract related legal counseling
- Atkins Oy: project planning
- Brenk Systemplanung GmbH: accident simulations
- Empresarios Agrupados Internacional, S.A.: consultation with regard to the invitation to tender
- Genpro Solutions Ltd: scheduling and cost planning
- Department of Seismology of the University of Helsinki: earthquake research
- Finnish Meteorological Institute: meteorological information
- Fish and Water Research Ltd: surveys of fish stocks and the fishing industry
- Karna Research and Consulting: research into ice-related phenomena
- Luode Consulting Oy: continuously operating seawater quality and flow measurements
- Finnish Institute of Marine Research: surveys of seawater levels
- Nab Labs Ltd: physical and chemical properties of seawater
- Platom Oy: planning of nuclear waste management
- Pöyry PLC: assessment of environmental impacts, preliminary planning and land use planning of plant locations, noise simulations
- Sito Oy: preparation of water permit applications, nature surveys
- Measurement services of STUK: surveys for environmental radiation
- Nature Data Finland Ltd: nature surveys
- Suomen YVA Oyj: cooling water simulations
- WSP Finland Ltd: surveys of explosion loads

General significance of the nuclear power plant project

Appendix 2A

Description of the general significance and necessity of the project

Summary

Finland needs new electricity generation capacity in order to ensure adequate self-sufficiency and competitiveness in energy supply. When building new capacity, priority is to be given to power plants that do not produce greenhouse gas emissions. Fennovoima's nuclear power plant project meets the needs of society, businesses and households.

Fennovoima's shareholders require high volumes of electricity for their operations in Finland. Electricity is needed by industry, trade, services, farms and households. Fennovoima's shareholders have a very low electricity self-sufficiency ratio in Finland and are largely dependent on market-priced electricity. Stable electricity prices are important for the competitiveness and investment potential of Fennovoima's shareholders in Finland. A new nuclear power plant owned by the shareholders will improve their electricity self-sufficiency. Shareholders are also investing in several renewable energy projects.

Fennovoima's nuclear power plant will improve the functioning of the electricity market by increasing the electricity supply and by introducing new actors into the electricity production sector. The increased competition will benefit all Finnish end users of electricity. The energy utilities included in Fennovoima's shareholder base deliver a considerable portion of the electricity consumed in Finnish households. The competitiveness of small and medium-sized local energy utilities will be particularly enhanced by them having their own nuclear power production. Consumers benefit when local energy companies are able to price their retail electricity based on actual production costs instead of the market price.

The nuclear power plant project will generate long-term industrial activity in the locality of the new power plant, and will help consolidate the economy of the surrounding region. A new nuclear energy company will provide hundreds of permanent jobs for decades to come. The region where the power plant is located will be well placed to diversify its range of services. Fennovoima's project will advance the balanced development of Finland without drawing on central government budget funds. The project is an example of cooperation which allows shareholders to pursue long-term development of their operations and to focus on their respective local strengths.

New nuclear power capacity will improve Finland's security of supply by reducing dependence on imported electricity and on fuels that cause emissions of greenhouse gases. Fennovoima's project will also enable the decentralization of nuclear energy production in Finland, both geographically and in terms of ownership and organization.

Fennovoima believes that by increasing the production of electricity at a stable price, the project will reinforce the national energy supply in accordance with the objectives of the National Energy and Climate Strategy.

Introduction

This appendix includes an overall description of the nuclear power plant project's general significance and in particular its necessity for the country's energy supply in accordance with section 24, subsection 1 (4) of the Finnish Nuclear Energy Decree (755/2013). The current document complements the information presented in the original decision-in-principle application, and describes the changes that have taken place in the project.

The following points relevant for political decision-making have been taken into account in the discussion of the social significance and necessity of Fennovoima's project: business policy and the competitiveness of businesses operating in Finland; competition policy; regional policy and employment; security of supply and the delivery of electricity; and climate and energy policy. Each of these areas is discussed in its own chapter in the report. The significance of Fennovoima's project with regard to the operation and nuclear waste management of the country's other nuclear power plants is described in Appendix 2B to this application.

Impact of changes that have taken place in the project

In October 2011, Pyhäjoki was selected as the location of Fennovoima's nuclear power plant. The positive impact of the project on regional economy will thus be focused on this region. The construction and operation of a nuclear power plant has a major impact on the business activities, services and employment market in the site municipality and in the surrounding economic zone. When a nuclear power plant is built in a new municipality and site, many aspects of the infrastructure in the plant area and in its environment need to be developed.

The plant alternative selected by Fennovoima, the AES-2006, has a lower electrical output than what was specified in the original decision-in-principle application. The lower capacity of the plant will have no essential impact on the positive economic impact of Fennovoima's project in Pyhäjoki. The project will be important for the regional economy and improve employment in the area.

Fennovoima's nuclear power plant will improve the functioning of the electricity market by increasing the electricity supply and by introducing new actors into the electricity production sector. A diverse electricity production system is a prerequisite for a competitive market and essential in order to ensure security of supply. With Fennovoima, the Finnish electricity market also gains a completely new actor in the Finnish subsidiary of Rusatom Overseas CJSC, which will be a Fennovoima shareholder.

The changes that have taken place in Fennovoima's nuclear power project do not affect the necessity of the project or reduce its social significance. Fennovoima's Finnish owners' competitive ability will improve with more predictable energy costs and the stable prices of own electricity production. This will assist the owners in doing business and making investments in Finland. Fennovoima's nuclear power project will improve the shareholders' electricity self-sufficiency.

Fulfilling electricity needs and securing competitiveness

Electricity needs among Fennovoima shareholders

Fennovoima's shareholders require high volumes of electricity for their operations in Finland. Electricity is needed by industry, trade, services, farms and households. The various sectors of industry are widely represented among Fennovoima's shareholders.

Currently, Fennovoima's shareholders are dependent on the electricity market. In order to secure their international competitiveness, their prerequisites for domestic investment and their very existence, Fennovoima's shareholders must have guaranteed access to electricity at a reasonable price. The only technically and economically feasible solution is to increase their own electricity production.

The energy utilities included in Fennovoima's shareholder base deliver a considerable portion of the electricity consumed by Finnish households. The greater part of these customers are small-scale electricity consumers and consequently covered by the obligation to deliver provided for in the Electricity Market Act. According to the obligation to deliver, an electricity retailer must deliver electricity at reasonable prices to consumers and other small-scale users of electricity in its area. In practice, a local energy utility acts as the representative of its consumers in procuring electricity from the electricity market and redistributing it to its consumers. As a consequence of the terms of delivery applied to the retail sale of electricity, local energy companies bear some of the price and volume risk involved in the procurement of electricity for small-scale consumers. For the smallest of these companies in particular, these risks may be financially significant and are heightened in an environment where the market price of electricity is subject to major fluctuations.

Energy conservation

The Government's National Energy and Climate Strategy of 2008 set the strategic goals of stemming the growth of final energy consumption and turning the trend of demand downwards. In order to achieve this goal, energy use must be made more efficient in housing, construction and traffic in particular.

The expected development of electricity needs in Finland is determined by factors such as changes to the economic structure, global structural changes in the forestry sector, and significant investment in energy efficiency improvements. Future trends in electricity needs in industry vary by sector, and different industrial sectors have differing capacities and aims for investing in production expansion in Finland. Measures aimed at reducing greenhouse gas emissions and improving energy efficiency will also change the current distribution of electricity consumption. For example, the use of electricity in transport must be increased in order to attain the climate goals set.

The majority of Fennovoima's shareholders are investing in energy conservation, but without new nuclear power capacity of their own, achieving a satisfactory level of electricity self-sufficiency is not a realistic scenario for most of them.

Increased use of renewable energy

At the moment, the electricity production of Fennovoima shareholders' in Finland mainly involves types of generation that cause greenhouse gas emissions. The amount of electricity produced by Fennovoima shareholders and the use of fossil fuels vary on an annual basis due, for example, to weather conditions. During rainy years, more hydroelectric power is generated, while more fossil fuel is required during cold and dry years.

Alongside the nuclear power project, Fennovoima's shareholders have implemented or are working on several projects to increase renewable energy production in Finland. These investments are intended to increase the shareholders' own electricity generation and improve self-sufficiency in electricity procurement, as well as to reduce greenhouse gas emissions by promoting the use of renewable energy sources instead of fossil fuels.

Small and medium-sized energy utilities have a long history of decentralized power generation and of using renewable energy sources. In order to achieve the climate targets set in the National Energy and Climate Strategy, it is vital that local energy utilities maintain their ability to develop their operations.

The significance of shareholders' own nuclear power production

Fennovoima's shareholders have low electricity self-sufficiency in Finland. To cover their electricity needs, they procure electricity from the energy market. Even after the new nuclear power plant will be operational, a large part of the shareholders' electricity needs will be covered by the electricity market.

Fennovoima's shareholders have a real need and interest to invest in their own carbon-free electricity production in Finland. The electricity needs stem from the shareholders' existing operations, i.e. industry, services, agriculture and housing, not on estimates of an increase in operations or in the customer base. The electricity needs of the shareholders represent a considerable percentage of Finland's total electricity consumption and are largely of a stable and permanent nature.

Electricity self-sufficiency based on reasonably and stably priced nuclear power is vital for the competitiveness and investment potential of Fennovoima's shareholders in Finland. Together with bioenergy, wind energy and hydroelectric power investments, Fennovoima's nuclear power plant will reduce the dependence of its shareholders on market electricity, whose prices fluctuate considerably and unpredictably. A new, own nuclear power plant will improve the electricity self-sufficiency of Fennovoima's shareholders.

Increasing competition in the electricity market

Several published expert assessments and reports by the Nordic competition authorities state that there are problems in the electricity market. These problems are partly due to the special characteristics of the electricity market and are related to the electricity wholesale market and electricity production in particular. Centralized ownership of electricity production capacity is considered a major cause of these problems. In Finland, the major part of carbon-free hydroelectric power and nuclear power generation is controlled by a handful of companies.

Studies and polls show that citizens are also displeased with the results so far achieved through the deregulation of the electricity market and with how the market presently works.

General confidence in the electricity market

Attitudes among Finns with regard to energy have been systematically surveyed for the past 30 years. An annual research series has been monitoring opinions among Finns on energy policy issues. The latest survey, conducted in 2013, particularly focused on attitudes towards the different forms of energy production. In summer 2013, another survey investigated opinions among Finns on the relationship between energy, Finland's competitive ability and climate change, and on whether there is a need for additional electricity production capacity. Based on the survey, three in four Finns are in favor of increasing production capacity, and half of them believe that Finland should be completely self-sufficient in terms of electricity production.

Confidence in the electricity market has been recently surveyed in 2011 and 2013. Based on the results, Finns have a fairly critical view of the electricity market. The criticism was based on problems found in the performance of the market.

From the consumers' point of view, the price of electricity is a key indicator of how well the market functions. In the 2011 survey, only one in five Finns believed that competition had lowered the price of the electricity consumed in their own household. Three in five were of the opinion that competition had not succeeded in lowering the prices. Based on the June 2013 survey, three in five respondents considered the price of electricity to be high in Finland. Results of previous surveys have shown that consumers believe the electricity producers' desire to increase their profits to be the number one reason behind price increases. Nearly nine in ten consumers see this as a very important or fairly important reason of price increases. Other structural problems in the market perceived by respondents include lack of competition and the low number of operators.

Functioning of the electricity market and price trends

Electricity market development

The Electricity Market Act entered into force in 1995, deregulating the electricity market in Finland. It was hoped that the new act would increase competition and thereby improve resource allocation, translating into lower costs for consumers. For the time being, the electricity retail market is national, which means that a Finnish household may only procure electricity from an energy utility operating in Finland, not from one in Sweden or Norway.

The wholesale electricity market mainly involves major producers and retail sellers of electricity, and a group of large industrial users. Wholesale prices are determined and largely also implemented in the Nord Pool electricity exchange. In theory, the price for each hour is determined by the production most expensive in its variable costs that is needed to meet the demand for that hour. Transmission capacity between the Nordic countries is available to the energy market in calculating electricity transmissions between regions to optimize the price hour by hour. The concept of the Nordic electricity market is based on this arrangement.

The EU is making gradual progress towards achieving an internal European electricity market. Free movement of energy across national borders has been advanced by three internal energy market packages, the latest of which was issued in 2009. In Finland, the new Electricity Market Act that conformed with the third energy market package entered into force in September 2013. National markets have been combined into regional markets with the final aim of combining these as well. However, the wholesale prices of electricity are still largely regional due to limitations related to transfer connections. Furthermore, the renewable energy support mechanisms are still national, which weakens the integration of the markets and unified European development of new production capacities, for example.

The Nordic Countries have been among the most active developers of a regional electricity wholesale market. In fall 2013, the Nordic energy market was partially combined with the wholesale market that covers all of Western Europe. This means that the price of electricity and transfers between countries and regions are defined at the same time for Western Europe as a whole. Bilateral transfer of electricity between Finland and Russia became technically possible in 2013, and commercial terms and conditions are being developed between the Finnish and Russian national grid operators. Earlier, commercial transfer of electricity was only possible from Russia to Finland.

Electricity market reports by the competition authorities

In the early 2000s, Nordic competition authorities conducted several surveys on the performance of the electricity market. The surveys revealed that, as a result of the increased demand for electricity and low level of investment in new production capacity, electricity supply is becoming increasingly scarce, and new production capacity will be necessary in the near future. A diverse electricity production system is a prerequisite for a competitive market and essential in order to ensure security of supply. According to the competition authorities, investments by new operators are the most effective means of increasing competition.

The Finnish Competition Authority estimates that it is very difficult to enter the electricity production industry. To operate successfully in electricity production requires significant proprietary production capacity. In addition, centralization of operations hinders competition particularly in the wholesale market, i.e. in electricity production. The Competition Authority concluded that to ensure competition in the future, it is essential that the market is not centralized any further. According to the Competition Authority, new companies that seek market entry should be given equal opportunities in comparison with the existing operators to take part in, for example, the construction of additional nuclear power capacity.

Independent expert assessments and improvement of the performance of markets

In early 2000s, the state and performance of the electricity market in Finland was assessed by independent experts commissioned by the Ministry of Trade and Industry (now the Ministry of Employment and the Economy). According to the assessment, one of the electricity market's biggest problems is that electricity production is focused around a small number of companies, which gives them a lot of influence in the energy market.

The electricity market cannot perform as desired if the principal feature of the market is scarcity of production capacity. According to the assessment, electricity producers do not invest because scarcity of supply ensures them the best prices and profits. The assessment report also stated that companies that own hydropower capacity, which can be adjusted in terms of power output, have significantly more influence over the electricity price than other companies whose production capacity cannot be as easily adjusted.

In 2013, a working group appointed by the Ministry of Employment and the Economy investigated the changes required to legislation to enable more efficient supervision of the electricity and natural gas wholesale markets and to improve the performance of the markets. The purpose is to promote the efficiency of the electricity and natural gas markets and healthy competition by constructing a system of sanctions for manipulation and abuse of the electricity and natural gas wholesale markets. The changes suggested by the working group would implement the legislative changes required by the regulation of the European Parliament and the Council (REMIT).

Actual price trends

From the point of view of the electricity consumer, the emissions trade that was introduced in 2005 has substantially exacerbated price trends. The market price of electricity is mostly determined based on the price of condensing energy produced using fossil fuels. This price includes the price of the emissions allowances. High emissions allowance prices rapidly increased the wholesale price of electricity, which resulted in increased retail prices. This hit the service sector, small and medium-sized industry and households in particular, as these users typically have limited potential to reduce their electricity consumption and, in the short term, have no potential at all for replacing electricity with other sources of energy.

The prices of emissions allowances, however, decreased considerably after 2008 as a result of the European recession, and reached a record low in 2013. There is a continuous surplus of emissions allowances on the market, and the prices are not expected to rise again in the near future. In addition, the price of coal in particular has dropped as a result of decreased demand, which also reflects on the market price of electricity. On the other hand, the retail price of electricity, which is important for consumers, has not decreased at the same pace. Figure 2A-1 is a representation of the development of the market price and retail price of electricity from 1998 to 2013.

Centralization of electricity production in Finland

Additional construction of both nuclear power and significant hydroelectric power requires consideration and approval by the Finnish Government. New production capacity cannot be built based on demand. Instead, an increase in supply always requires political decision-making. The same term applies to all Nordic countries.

In the near future, the importance of national needs and solutions will also become significant with regard to other electricity production investments. National targets for the use of renewable energy have been introduced in the EU, and Member States have

Figure 2A-1.
The development of the market and retail prices of electricity from 1998 to 2013.

introduced various subsidy schemes to attain their respective renewable energy targets. In Finland, renewable energy is being supported by a feed-in tariff paid to wind, biogas, wood chip and wood fuel power plants that meet the defined preconditions. Renewable energy subsidies encourage investment, and wind power production capacity in particular has increased in countries with high subsidies. Increased subsidized production, however, weakens the preconditions for investing in other forms of production, and the volume of new non-subsidized production capacity has been very low.

Although there are many electricity-producing companies in Finland, ownership of the strategically and economically superior production methods, i.e. hydroelectric and nuclear power, is centralized. There is far less centralization in CHP production and other condensing power production. It has been estimated that when the fifth nuclear power plant unit (Olkiluoto 3) is completed, the five largest nuclear power owners will possess a combined share of 85 percent of Finland's entire nuclear power production capacity, and approximately 70 percent of its hydropower production capacity.

The impact of the project on the performance of the electricity market

With regard to general interest, it is important to solve the problems that exist in the electricity market. Construction of new emission-free energy production capacity to improve the country's self-sufficiency and to replace old capacity is one of the objectives of the 2011 Government Program.

Fennovoima's nuclear power plant will increase the electricity supply and improve the performance of the wholesale market by introducing several new actors into the electricity and nuclear power production sectors in Finland and in the Nordic countries. The ownership base of nuclear power will become broader and more diverse as the number of companies owning nuclear power production capacity in Finland will increase by several new actors. At the same time, the relative market shares of Finland's largest electricity producers will decrease. With Fennovoima's project, the Finnish electricity market will also gain a new actor in the Finnish subsidiary of Rusatom Overseas CJSC.

Fennovoima's electricity production capacity will be distributed to a large number of shareholders, and with the exception of the subsidiary of Rusatom Overseas CJSC, the project's impact on the market shares of individual companies will be negligible when examined on the Nordic scale. The project will also have a significant positive impact on the electricity retail market in Finland. The competitiveness of small and medium-sized local energy companies will be particularly enhanced by their own nuclear power production, safeguarding their operating potential. For local energy companies, supplying their customers with reasonably priced energy is their principal objective. It is essential for consumers that some local energy utilities will be competing for customers and pricing their retail sales on the basis of their own actual production costs, not on the basis of the market price of electricity.

Balanced development of Finland

In terms of its size, duration and requirements, the Fennovoima nuclear power plant construction project is a unique investment. During the construction phase, the project will employ thousands of people in Finland, and the economic impact on both the immediate locality and the surrounding region as a whole will be considerable. When assessing the implementation potential of a nuclear power plant at a separate new site, the long-term operation of the plant and its significance in terms of its stabilizing impact on the economic structure of the region must be taken into account. Establishing a new nuclear energy company will provide hundreds of permanent jobs for decades to come. The long-term nature of nuclear power production provides reliable opportunities for the expansion and diversification of the local and regional service industry.

In terms of employment effect and additional regional tax revenue, the Fennovoima project offers a unique contribution to the Finnish economy. The construction of a nuclear power plant at a new site and in a new municipality will require ancillary investment which will contribute to the positive economic impact of the construction phase at both national and, in particular, regional levels.

Execution of Fennovoima's nuclear power plant project in Pyhäjoki supports the realization of governmental regional policy objectives. The project will enhance the international competitiveness of the businesses in the region, and reduce the developmental disparity between this region and other parts of the country.

Fennovoima's project will advance the balanced development of the country without drawing on central government budget funds. The project is an example of cooperation by an extensive group of businesses to reinforce their potential for long-term operational development and their reliance on local strengths.

Preparation for the project has long been going on in the entrepreneur associations, chambers of commerce, municipalities and towns of the Pyhäjoki region and Northern Finland. For example, the Raahe District Development Center launched a Hanhikivi project in fall 2012 with the objective of preparing the public sector for the nuclear power plant construction project in its immediate impact area. The main objective of these preparations is to maximize the positive regional impact of the project, increase the attractiveness of the region and to improve the operational preconditions for major projects in the area.

Economic conditions in the Pyhäjoki region

In 2013, the municipality of Pyhäjoki had a permanent population of approximately 3,300 people. The total population of the Raahe economic zone, which covers seven municipalities, was 59,000. The municipality of Vihanti merged with Raahe at the beginning of 2013. In the early 1980s, the population in the area was about 53,600, after which it grew steadily until the early 1990s. The population then started to decline in all the municipalities. In recent years, the decline has been less strong.

The economic structure of the Raahe economic zone has been characterized by strong dependence on the Rautaruukki steelworks, which shows in the number of industrial jobs in the area. Rautaruukki also employs people through it subcontracting chain. The number of Rautaruukki's employees has, however, been reduced in the 2000s. The rapid decrease in the number of industrial jobs can be seen in illustrations of the economic structure of the region. Approximately 6,000 industrial jobs disappeared in the Raahe economic zone between 2007 and 2011. The number of jobs has increased in the mining sector and in health and social services.

The state of municipal economies in the Raahe economic zone is, for the most part, poor. Some of the municipalities have a positive annual margin, but they all remain below the Finnish average. Tax revenue is slightly above the national average in Raahe, but clearly below this level in the other municipalities. The municipalities within the Raahe economic zone, including Pyhäjoki, belong to the government-defined Support Area II development area.

Significance of the new nuclear power plant site

The construction and operation of Fennovoima's nuclear power plant will have a major impact on the business activities, services and employment market in the plant site municipality and in the surrounding economic zone. Construction of the plant at a completely new site requires varied infrastructure development both at the future plant site and in its immediate surroundings. Examples of infrastructure investments include new road connections to the plant site and a new harbor for sea transportation of heavy power plant components. The costs of these ancillary projects typical of developing a new site will particularly benefit the municipality where the construction is being undertaken and the economic zone surrounding it.

Implementation at a new site means that Fennovoima's nuclear power plant will require more operating personnel and external services compared to an additional nuclear power plant unit constructed on the same site with existing nuclear power plants. In addition to the plant's operating personnel, Fennovoima will also offer significant employment through the company's other functions, such as maintenance, technical services and administration. Most of these jobs will be expert positions requiring above-average education and training.

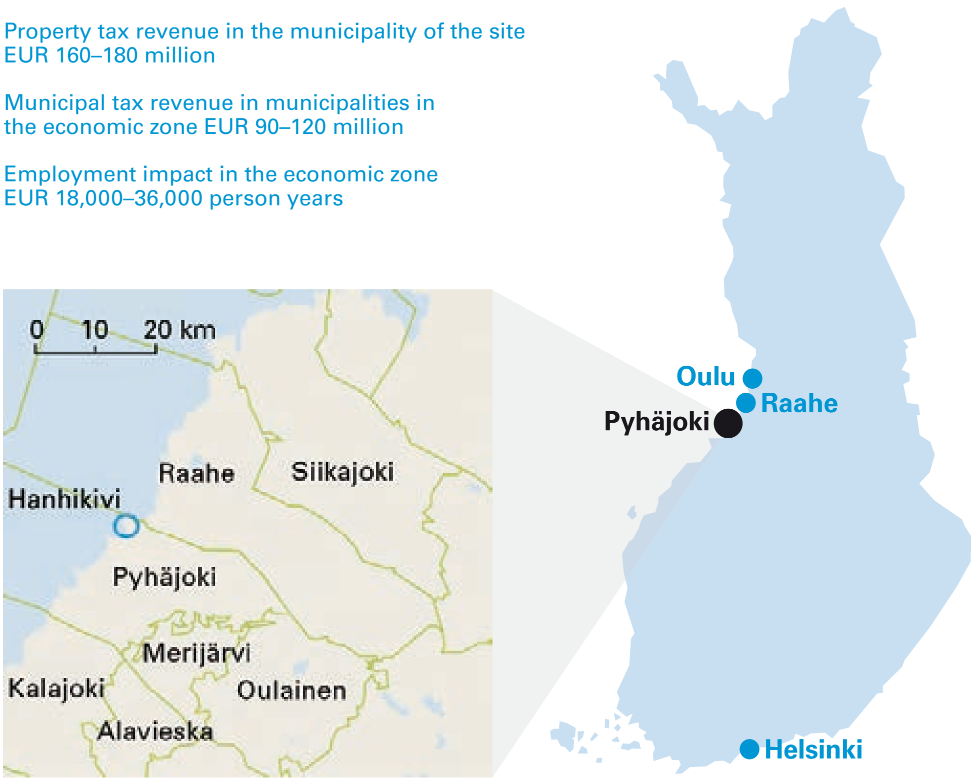
The regional economic impact of Fennovoima's investment is described in a separate report in which the employment and tax effects are assessed, as shown in Figure 2A-2. In addition to the actual nuclear power plant investment, the report takes into consideration the employment effects of ancillary projects.

Figure 2A-2. Assessment of employment and tax revenue impact of Fennovoima's nuclear power plant.

Property tax revenue in the municipality of the site EUR 160–180 million

Municipal tax revenue in municipalities in the economic zone EUR 90–120 million

Employment impact in the economic zone EUR 18,000–36,000 person years



Employment effects within Finland

The employment effects within Finland during the construction of the Fennovoima nuclear power plant project include the procurement and installation of machines and equipment, construction engineering and other construction-related services. Indirect employment effects include, for example, subcontracting, construction materials and equipment, and transportation services.

The total employment effect within Finland of the construction phase of Fennovoima's power plant is estimated at 24,000–36,000 person years. This equates to an average of 2,400–3,600 persons employed within Finland each year throughout the entire ten-year plant construction phase.

During operation, Fennovoima's nuclear power plant is estimated to directly employ 400–500 persons in Finland, of which about 100 will be in external services. These outsourced but essential services include cleaning, security, rescue services, catering and transportation services. There will also be a substantial need for temporary workforce during the annual maintenance outages, about 500 people.

Fennovoima's project supports the production investments of Fennovoima's shareholders in Finland by securing an important resource: the availability of reasonably priced electricity. The knock-on effects of the new shareholder investments thus generated will be extremely substantial, considering the broadness and diversity of the shareholder base.

According to an estimate by FinNuclear Association, Fennovoima's nuclear power project will offer significant business potential for Finnish companies. The Rosatom Group has estimated that approximately 80 percent of the total value of the procurement will be outsourced. The outsourced deliveries will belong to lower safety classes and include extensive opportunities for Finnish companies, provided that they prepare in time and acquire the validation required of nuclear energy suppliers, and are able to deliver either large projects that are the preferred delivery method, or special expertise (FinNuclear Association 2013). Fennovoima wishes to involve Finnish industry in the project, and supports this objective through measures such as training and distributing information.

Impact on the municipal economy and economic and employment structure of Pyhäjoki

The tax revenue of the municipality of Pyhäjoki will increase significantly due to real estate, municipal and corporate taxation. All of the economic zone will benefit from the increase in municipal and corporate tax revenue, but the revenue from the real estate tax will remain mainly in the plant site municipality. Real estate tax revenue in particular will be of major significance to the municipality, even when tax revenue equalization is taken into consideration. The annual real estate tax revenue will bring a strong annual margin compared to other municipalities and the ability for the municipality to plan its own economy and future.

The municipality will be able to invest its increased tax revenue in boosting the quality and extent of its services. The improved service level will, in turn, attract new inhabitants to the municipality. The municipality can also use its higher tax base to reduce its municipal tax rate, which would naturally benefit its inhabitants.

As a counterbalance to the higher tax revenue, the region must invest, for example, in service production and new infrastructure. New real estate developments require municipal engineering investments. As the number of inhabitants increases, additional services must be produced and facilities such as day care centers, schools and leisure services built.

The long-term effects on the municipal economy during the construction and operation of a nuclear power plant at a new site are shown in Figure 2A-3.

The construction phase will generate new demand within the construction and metal industries and for the provision of a range of services. The position of these industries within the economic structure of the region will be strengthened, and the role of service production enhanced. The construction site will generate immediate demand, for example, for cleaning, catering, security and transport services and indirect demand for trade, hotel and restaurant

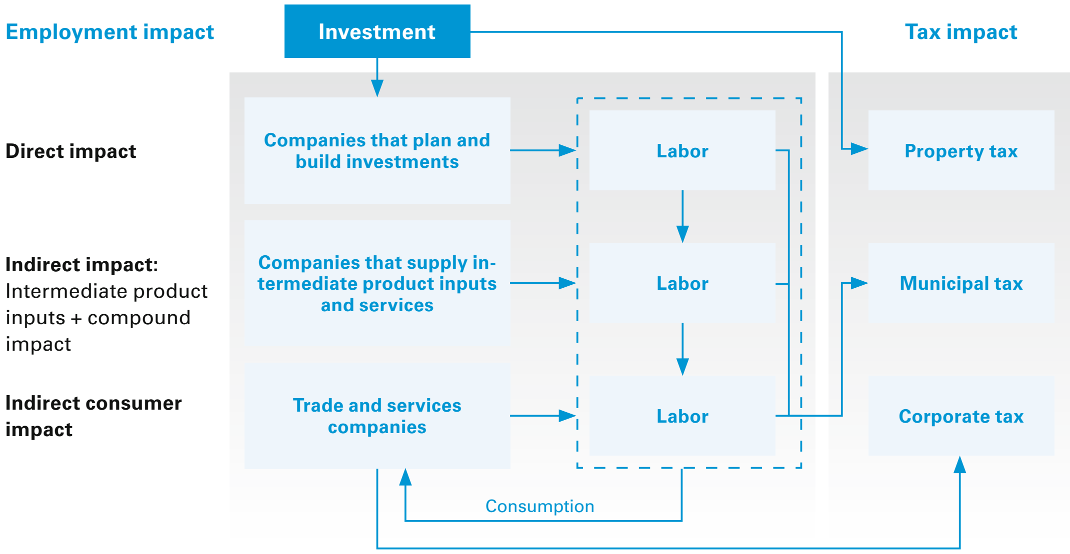


Figure 2A-3. Estimated economic and employment effects of Fennovoima's project in the municipalities of the surrounding area over the entire lifetime of the nuclear power plant.

services. Demand for social and public services and for leisure services will also increase during the construction phase. During the operating phase, migration to the area of permanent employees and their families will increase the demand for services. The increased population and purchasing power will boost the economy within the economic zone.

Real estate and housing in the Raahe economic zone

In the construction phase, there will be a demand for short-term temporary housing near the construction site and a demand for accommodation further away in regional population centers. A maximum of 3,000–4,000 people will work at the nuclear power plant construction site. These numbers are so large that the required accommodation will necessarily include nearby accommodation, barracks adjacent to population centers, rented accommodation in the area and accommodation further away in larger population centers.

The majority of the rented accommodation will be required in Raahe. In 2012, the Raahe economic zone had approximately 5,200 rental apartments. Of these, 200 were located in Pyhäjoki and nearly 3,000 in Raahe (Statistics Finland 2013). It is possible that some of the employees would live in Oulu, for example, with transportation to the construction site arranged.

An increased demand in the rental market may be reflected in increases in the local rental rates. The construction phase, on the other hand, may have a depreciating effect on the prices of the nearby holiday homes. It may also take longer for real estate to sell.

Improving security of supply

In general, security of supply means the capacity to maintain the basic activities that are indispensable for safeguarding the population's living conditions, for sustaining the functioning of critical infrastructure, and the material preconditions for maintaining national defense in case of serious disturbances and emergency situations.

The purpose of security of supply measures is to analyze the threats and risks that endanger the economy and to put means and measures in place to safeguard vulnerable sectors and activities. The objective is to safeguard society's basic economic functions even during disturbances and under emergency conditions.

From the perspective of security of supply, electricity is highly important for employment and the economy and for society as a whole. Finland's current dependence on imports and centralization of production are risk factors that must be taken into account when assessing future investments in electricity production.

Electricity infrastructure as a vital function of society

The structural development of the economy and increased mutual interdependence have resulted in enhanced sensitivity to external disturbances. The spectrum of threats against modern societies is extensive, covering all scenarios from functional disorders of banking and financial systems to widespread pandemics.

On December 16, 2010, the Government adopted a resolution confirming the Strategy for Security in Society. According to the strategy, the production of electricity and heating, the capacity of the electric grid, resilience of functions as well as the functioning of technical systems will be safeguarded. The strategy also states that electric power supply relies on a functioning electricity market, an adequate electric grid, dispersed production facilities and multiple sources of energy as well as the proper balance between peak demand and capacity.

The National Emergency Supply Agency (NESA), the Finnish authority that supports, guides and coordinates the development of security of supply, has set the following goals for Finland's energy supply:

- undisrupted availability of energy
- competitive price
- environmental friendliness.

Current state of the security of electricity supply

Finland is dependent on imported energy, which provides a significant portion of total energy consumption. Finland is also currently dependent on imported electricity, being among the most heavily import-dependent countries in Europe.

Finland's electricity production capacity has fallen short of peak load demand in recent years. In addition to peak loads, a large proportion of the continuous electricity supply is imported.

In December 2013, the Government confirmed the principles of security of supply, including the statement that the security of energy supply relies on a functional energy market, long-term and clear investment-oriented energy policy, and efforts to improve energy efficiency. To improve the security of supply, Finland's energy self-sufficiency ratio and, in particular, the electricity production capacity will be increased through the sustainable utilization of all energy sources and forms of production.

Strengthening security of supply through nuclear power

Undisturbed supply

Nuclear power plants typically have a very high capacity factor. Nuclear power plants are designed for the production of base load power, which means that with the exception of annual maintenance outages, the plants are kept in continuous year-round operation. The power plant availability survey conducted by the Energy Market Authority in 2013 showed that the lowest forced outage factors among Finnish electricity production facilities are to be found at hydroelectric and nuclear power plants, about one and two percent, respectively. The forced outage factors of CHP production and wind power are significantly higher, at about five percent.

The national security of supply of fuels is ensured by emergency stockpiling. Of all the fuels used for generating electricity, nuclear fuel and the interim products in its production process are the easiest to stockpile. The price, volume and weight per energy unit of nuclear fuel are considerably lower than for any other fuel. According to the instructions issued by the authorities regarding the emergency stockpiling of nuclear fuel, nuclear power plants in Finland must at all times have enough fuel in storage to produce electricity for at least seven months. Typically, nuclear power plants stock more fuel than required.

Competitive price

Nuclear power is one of the most competitively priced low-carbon energy sources available within the EU. The costs of nuclear power are also relatively stable.

Environmental friendliness

Nuclear power produces no greenhouse gas emissions, which Finland has committed to reducing. Therefore nuclear power carries no financial encumbrances due to climate policy or carbon dioxide emissions that would complicate investment decisions because of the uncertainty involved. Nuclear power also results in no emissions of sulfur dioxide, nitrous oxides or particles harmful to people or the environment.

Impact of the project on security of supply

New nuclear power capacity will improve Finland's security of supply by reducing dependence on imported electricity and on fuels that cause emissions of greenhouse gases.

Finland's energy supply is based on a decentralized and diverse production system. The strategic importance of nuclear power production has been emphasized by emissions trading and the targets set for the limitation of greenhouse gas emissions in Europe. Nuclear power's share of electricity production is also increasing in Finland. Because nuclear power is produced in large-scale power plant units, sufficient decentralization of these units becomes an integral aspect of national risk management. One particular strength of Fennovoima's project is that it will decentralize Finland's nuclear power production geographically as well as in terms of ownership and organization.

Maintaining the appreciation of the nuclear power industry will ensure a reliable operating and safety culture and the further development of the entire field. By offering new alternatives to both present and future nuclear power experts, Fennovoima will increase the general awareness and attractiveness of the nuclear power industry within Finland.

Competitive electricity prices are crucial to Finland's security of supply. The primary objective of the Fennovoima project is to ensure the supply of stably and moderately priced electricity to a substantial number of local energy utilities and industrial and trade companies. The project will directly improve the operating potential of businesses in these sectors which are important to society. Therefore, the positive impact of the project on security of supply is not limited to energy supply; it will also support Finland's current security of supply system, based on the cooperation of the public sector and the business sector, in other important areas such as food supply and critical basic industry.

Implementing the National Energy and Climate Strategy

This section discusses the impact of Fennovoima's project on the implementation of the National Energy and Climate Strategy adopted by the Government. In summary, we may note that through increasing the production of reasonably and stably priced electricity in Finland, Fennovoima's project will support the national energy supply in accordance with the objectives set in the strategy. The nuclear power operations of Fennovoima will be specifically aimed at meeting the electricity needs of Finnish companies, households and agriculture, and at increasing energy self-sufficiency and low-carbon production capacity. The project further supports the Government's other climate and energy policies. The 2013 National Energy and Climate Strategy places key importance on new nuclear power capacity as a means of increasing emission-free generation of energy.

Objectives of the EU climate and energy policy

The shared climate policy objectives of the EU guide the future climate and energy policies of the Member States. Finland is no exception. The key objectives are included in draft legislation and the EU energy and climate strategy adopted by the European Council and the European Parliament in December 2008. In October 2009, the European Council published the emission reduction goals up to 2050. In 2011, the European Commission issued a low-carbon roadmap with milestones to 2050 and routes to achieving emission reductions. In 2013, the European Commission also published the Green Book on the energy and climate policy framework to 2030.

On January 22, 2014, the European Commission published its proposal for the EU climate and energy objectives to be met by 2030. The proposal aims to reduce greenhouse gas emissions, improve energy security and enhance investor certainty, as well as supporting growth, competitiveness and job creation via a cost-effective approach based on state-of-the-art technology. The proposal includes a greenhouse gas emission goal of 40 percent and an EU-level renewable energy objective of 27 percent.

In accordance with long-term EU policy, emissions must be reduced by 80–95 percent before 2050 in order to be able to limit the temperature increase to 2°C over the long term. Global greenhouse gas emissions will be reduced by 50 percent by 2050.

Objectives of the Finnish climate and energy policy

Prime Minister Jyrki Katainen appointed a ministerial working group to update the long term climate and energy strategy (Government Report 2/2013), and a new version was duly submitted to the Parliament in March 2013. Key objectives of the strategy update included ensuring that the national targets for 2020 are achieved and making preparations for meeting the long-term energy and climate objectives set by the EU. The Finnish climate policy emphasizes the fulfilling of the energy and climate obligations through increased cost-efficiency and energy self-sufficiency, and through securing the availability of an adequate supply of reasonably priced electricity.

The Government aims at a reduction of 80–95 percent in greenhouse gas emissions by 2050. This objective is in line with the EU policy. The long-term objective is a carbon-free society, which can be achieved by following the roadmap for 2050 to be drawn up on the basis of the strategies. The roadmap will focus on increasing energy efficiency and the efficient use of renewable energy sources. The work to establish the roadmap began in 2013.

The 2013 strategy assessed the impact of the previously decided measures and made predictions of additional measures until 2020. The Government has stated that, without new climate and energy policy measures, Finland will not achieve the national objectives agreed on within the EU. Increasing emission-free energy production capacity is among the new key measures. Replacement of coal-fired capacity with emission-free wind and nuclear power (9 TWh) will require considerable investment in the systems that produce or use energy. The most substantial of these include for example the nuclear power plants for which decisions-in-principle have been granted, biorefineries, a synthetic natural gas production plant, and new wind power capacity.

Securing self-sufficiency in electricity procurement

Finland's acquisition of electricity must be based on the availability of sufficient and reasonably priced electricity with good delivery reliability while supporting other climate and energy policy goals. The National Energy and Climate Strategy observes that production capacity in Finland must be diverse and decentralized, and it must be able to cover peak consumption. Production capacity that does not cause greenhouse gas emissions will receive priority. According to the 2013 strategy, securing self-sufficiency is proceeding according to plan.

The annual production output of Fennovoima's nuclear power plant will be approximately 9 TWh of carbon-free electricity. New, cost-competitive nuclear power capacity will significantly increase the supply of electricity in Finland and on the Nordic market. The increased supply will push the market price of electricity down, and this will benefit all users of electricity in Finland.

Increasing the nuclear power capacity will also improve Finland's self-sufficiency and reduce dependence on imported fuels causing greenhouse gas emissions: coal, natural gas and oil. Fennovoima's nuclear power plant will be placed at a new site, which decentralizes production geographically, promotes development of the national grid, and improves the security of supply of electricity.

Fennovoima's project extensively supports Finland's preparation for further construction of nuclear power. The project will diversify the structure of the sector in Finland and further improve international nuclear energy expertise. Finland is and remains a small market area, and although the level of expertise available here is high, Fennovoima's project will bring to Finland in-depth operating experience and expertise that has not hitherto been available from other sources.

Achievement of energy efficiency objectives

The Government strategy sets the objective of gradually reversing the increasing trend of total end use of energy and achieving a level of 310 TWh in 2020. According to the 2013 strategy, the objective concerning electricity will be achieved mainly as a result of slow economic growth and structural changes in the economy. As to the consumption of other forms of energy, Finland may not be able to reach the objective. The vision is that by 2050, end use would be no more than about 200 TWh. In order to achieve this goal, energy use must be made more efficient in housing, construction and traffic in particular.

Electricity produced with nuclear power, competitive in price, can support significant enhancement of energy efficiency, for instance in housing and transport. Electricity is an extremely refined form of energy, and because it is easily adjustable, it is also highly efficient.

Electricity market predictions indicate potential overcapacity in the Nordic electricity market around 2020. Electricity production capacity is predicted to decrease after 2025. At that time, the electricity output of district heating plants will decrease due to the saving of heating energy, and several Finnish and Swedish nuclear power plants will reach the end of their service lives and will be decommissioned. Fennovoima's project will respond to the predicted decrease in electricity production capacity after 2025. Even though large numbers of wind power plants are being constructed in the Nordic countries, the continuity problems of wind power justify the construction of base load capacity.

Replacement of fossil fuels in transportation is one example of energy efficiency attainable through the use of electricity. Complete or partial replacement of combustion engines with electric motors will substantially reduce the overall end use of energy. The savings achieved would be in the order of 60 percent per transport fuel energy unit. The overall savings potential is significant when we consider that transportation amounts to approximately 50 TWh per year, which is 16 percent of the total end use of energy in Finland.

Achievement of emission mitigation objectives

The emissions trading system defines an absolute cap on total greenhouse emissions. The system thus ensures that the emissions trading sector will meet the greenhouse gas emission reduction objectives set by the EU. EU defines national emission goals for the sectors not included in the emissions trading system. In Finland, these accounted for approximately 45 percent of all greenhouse gas emissions in 2011, about 32 million tonnes of CO_2 equivalent. The greatest source of emissions by far outside the emission trading sector is transportation, which alone accounts for almost 40 percent of these emissions. The next greatest sources of such emissions are agriculture and oil heating.

The National Energy and Climate Strategy includes the objective that emissions outside emissions trading must be reduced by 16 percent by 2020, i.e. to about 30 million tonnes of CO_2 equivalent per year. According to the strategy update, the objectives set for emissions outside emissions trading may be met based on the national measures that have already been decided, but the decisions that will be made in the EU concerning the discontinuation of the possibility to offset emissions from deforestation will have an impact on this.

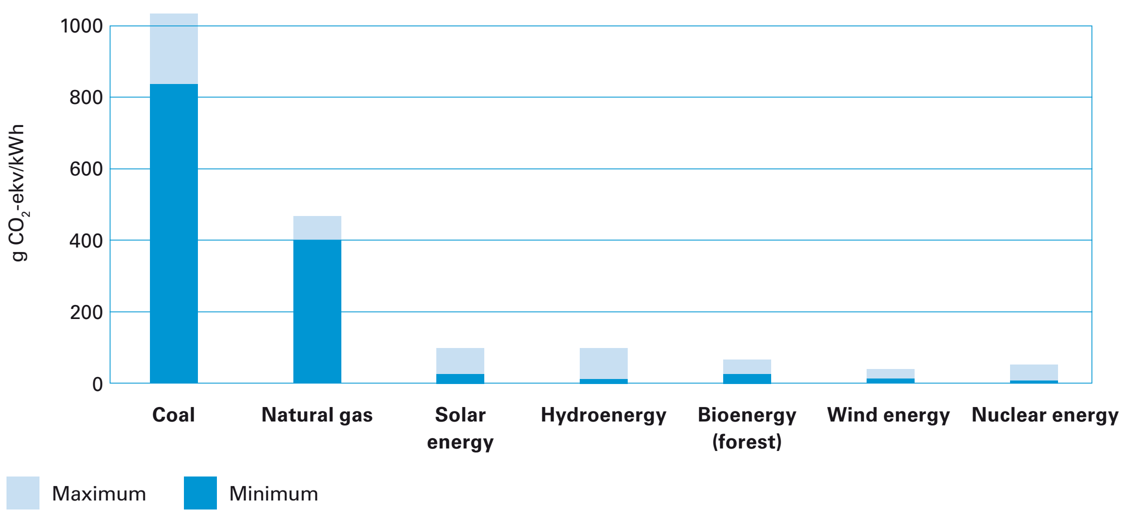
Finland will prepare to further accelerate the reduction of emissions after 2020 so as to achieve a level of 10 million tonnes of CO_2 equivalent in 2050. The goals defined in the National Energy and Climate Strategy can only be achieved over the long term if principal changes are made. In the first stage, measures are targeted above all at transportation and heating. In both of these areas, replacement of current energy sources with electricity is an essential part of the solution. Replacement of fossil transportation fuels with nuclear electricity is a particularly efficient measure in Finland, as it will reduce the carbon dioxide emissions that weigh on the national emissions quota, and decrease the end use of energy, which will help achieve the 38 percent objective set for renewable energy. Furthermore, the increased use of electricity in transportation will help achieve the separate 10 percent objective set for biofuels, as electricity as an efficient form of energy will reduce the total energy consumption of transportation. According to the objective set by the EU, 10 percent of road traffic fuels should consist of renewable energy by 2020. Finland has decided to adopt the higher objective of 20 percent.

It is highly recommendable to replace oil heating with geothermal or air source heat pumps. Increasing the use of electric heat pumps will generate significant reductions in emissions outside emissions trading, and part of the energy thus produced counts towards the percentage of renewable energy.

No national emission reduction requirements or goals have been set in the National Energy and Climate Strategy for energy production or other industrial sectors falling under emissions trading. Compared with many other countries, Finland has a low level of emissions from energy-intensive industries and energy production. However, more than half of all the greenhouse gas emissions in Finland are a result of energy production.

Further construction of nuclear power can help replace separate production of electricity using fossil fuels in Finland and further reduce emissions from energy production. The added nuclear energy capacity will be of the greatest importance to Finland between 2020 and 2050, at which point the majority of the greenhouse gas emissions cuts are meant to be made. With nuclear energy, Finland can secure adequate self-sufficiency in electricity in a manner that is as sustainable as possible for the climate and for Finland's economy (Figure 2A-4).

Figure 2A-4. Comparison of greenhouse gas emissions from various types of electricity production, based on a life cycle model *(Electricity and heating life cycle studies in decision-making, World Energy Council, Energiafoorumi).*



General significance of the nuclear power plant project

Appendix 2B

Description of the significance of the project from the standpoint of the operation and nuclear waste management of other nuclear facilities in Finland

Summary

The founding of Fennovoima and the project launched by the company mark the entry of a new operator into the field. The operating potential of the nuclear energy sector will improve with a larger number of operators and ongoing projects. With the Fennovoima project, more expertise will be acquired and cooperation to improve safety be expanded.

Throughout the project Fennovoima has systematically developed and increased its organization and areas of expertise. In the early stages of the project, the organization's expertise was complemented by the nuclear power expertise of the minority shareholder E.ON Group. Later, the necessary expertise has been acquired by outsourced services purchased in Finland and from abroad. A generational change is currently in progress in the Finnish nuclear energy sector, which means that a large number of new experts will be needed in the near future.

National and international cooperation in the area of safety is common in the nuclear power sector. Sectoral cooperation as well as self-control and self-supervision are in the interests of all operators in the field. Nuclear power plant operators conduct extensive peer reviews of one another, exchange operating experiences and engage in safety research together. The Fennovoima project will diversify this cooperation.

Nuclear waste management at the Fennovoima nuclear power plant will be undertaken using the same methods as at the nuclear power plants already in operation in Finland. In the management of low and intermediate level operating waste, the company has access to methods similar to those used at nuclear power plants already in operation in Finland. Fennovoima's project will enhance the further development of these methods and the related expertise in Finland.

In 1983, the government adopted a decision-in-principle regarding the final disposal of spent nuclear fuel at a single site. Olkiluoto in Eurajoki was chosen as this site in a decision-in-principle adopted by the government in 2000. Fennovoima's primary plan is to develop and implement the final disposal of spent nuclear fuel together with other Finnish operators under the nuclear waste management obligation.

The project will have a beneficial effect on the operations of the other nuclear power plants in Finland and on the organization of nuclear waste management. Fennovoima considers that cooperation with other Finnish nuclear energy operators will improve the safety of nuclear power plants and nuclear waste management, and diversify scope of activities.

Introduction

This appendix includes an overall description of the significance of the project from the standpoint of the operation and nuclear waste management of other nuclear facilities in Finland in accordance with section 24, subsection 1 (4) of the Finnish Nuclear Energy Decree (755/2013). The current document complements the information presented in the original decision-in-principle application, and describes the changes that have taken place in the project.

A description of the general significance and necessity of Fennovoima's nuclear power plant is included in Appendix 2A to this application.

Impact of changes that have taken place in the project

Since the granting of the original decision-in-principle in 2010, Fennovoima has established its role as an operator in the Finnish nuclear power industry. Fennovoima has actively participated in domestic research in the field and in the development of nuclear safety regulations. Since 2008, Fennovoima has had a local office in Pyhäjoki. The company has engaged in open communication concerning the project and aimed to increase knowledge regarding nuclear power, particularly in the municipality of Pyhäjoki and in the surrounding region.

In December 2013, Fennovoima signed a plant supply contract with Rusatom Overseas CJSC for the supply of an AES-2006 pressurized water reactor to Pyhäjoki. Rusatom Overseas CJSC is a part of the Russian Rosatom Group. A separate agreement was signed with JSC TVEL, which is also part of the Rosatom Group, on the delivery of fuel for approximately the first ten operating years of the facility. JSC TVEL also supplies nuclear fuel to the Loviisa Nuclear Power Plant operated by Fortum. The total volume of fuel acquired by all Finnish nuclear power plants is, however, very small compared to the international nuclear fuel market, which means that Fennovoima's nuclear fuel acquisitions will have no adverse impact on the fuel purchases of other Finnish nuclear power plants.

The AES-2006 plant type chosen by Fennovoima is not among the plant alternatives currently being considered for the Olkiluoto 4 project by Industrial Power Corporation (hereinafter referred to as "TVO"). This means that the impact of Fennovoima's project on any other simultaneous nuclear power plant projects has decreased.

As a whole, the project will have a positive impact on the safe operation and nuclear waste management of other Finnish nuclear power plants. The project creates possibilities for further development of activities in the nuclear industry by increasing the available resources.

Impact of the project on the operations of other nuclear facilities in Finland

New operator

At present, nuclear power generation is concentrated with TVO and Fortum Power and Heat Oy (hereinafter referred to as "Fortum"), a subsidiary fully owned by Fortum Oyj. Fortum owns approximately 25 percent of TVO. These two operators have had a central impact on the development of Finnish nuclear industry from its beginnings in the 1970s.

TVO and Fortum have a total of four nuclear power plant units in operation in two locations, at Olkiluoto in Eurajoki and at Hästholmen in Loviisa. Since 2003, TVO has been constructing a new nuclear power plant unit at Olkiluoto. On the basis of operating licenses currently valid, the operating units at Olkiluoto are expected to remain operational at least until the late 2010s, and those in Loviisa until the late 2020s.

A repository for the final disposal of spent nuclear fuel generated in Finland is planned to be built at Olkiluoto in Eurajoki. The design and construction of the repository is the responsibility of Posiva Oy. Posiva is a company owned by TVO and Fortum whose purpose is to manage the spent nuclear fuel and other high-level waste from operating nuclear power plant units in Finland. At the end of 2012, Posiva submitted to the Finnish Government an application for a construction license concerning the nuclear waste facility.

The foundation of Fennovoima in 2007 marked the entry of a new operator into the sector. Fennovoima has already established its role as an operator in the Finnish nuclear industry through active participation in the events and activities in the field. Fennovoima wishes to advance the social acceptability of the nuclear energy sector by engaging in active communication concerning its nuclear power plant project and nuclear power as a safe energy production method.

Ever since it was founded, Fennovoima has worked to increase knowledge regarding nuclear power, particularly in the region of its future power plant site in Pyhäjoki. The business and public sectors of the Raahe region and all of Northern Ostrobothnia are preparing for this large-scale project. Fennovoima is closely involved in various preparations and communication efforts.

Based on opinion polls, more than two thirds of the inhabitants of Pyhäjoki and the neighboring municipalities have either a positive or a neutral attitude towards the project.

Ensuring expertise

According to a 2012 report by the Ministry of Employment and the Economy, Finland will need 2,400 new nuclear power employees by 2025. The estimate takes into account the ongoing projects and the generational change that will take place in the industry. The growth will be largest in conventional fields such as construction, automation and control room technology, mechanical, electrical and process engineering, and quality management. To get these experts to move to the nuclear field, it is important that training on nuclear safety and other special features of the nuclear industry is provided as secondary subjects in undergraduate studies and complementary education for graduated experts.

Since the granting of the original decision-in-principle in 2010, Fennovoima has established a project organization that will be further developed as described in Appendix 1C to this application. New personnel will be recruited from Finland and from abroad. Fennovoima requires experience of the nuclear industry from all experts who will hold positions with importance for nuclear or radiation safety. Most of the project organization will, however, be recruited from outside the nuclear industry. Introduction training will ensure that the personnel know the requirements of the nuclear industry and adopt the appropriate safety culture. Part of Fennovoima's project organization will be included in the operating organization after commissioning of the plant.

In the preparation phase and part of the procurement phase, Fennovoima was able to draw on the expertise of the international company E.ON, which was a minority shareholder. After the changes that took place in Fennovoima's shareholder base, the support provided by E.ON has been replaced by strengthening Fennovoima's own organization in terms of the number, skills and experience of employees. In the future, Fennovoima will be able to utilize the extensive expertise of the Rosatom Group, a Russian nuclear sector operator.

In addition to internal expertise, Fennovoima will utilize external services to a significant degree. The Hanhikivi 1 project will offer plenty of work opportunities for Finnish engineering and project management offices, and experienced nuclear specialists will also be obtained from abroad. Increased international cooperation will promote the development of Finnish nuclear industry and add to the number of experienced specialists in Finland.

Cooperation to further improve safety

Active cooperation in the field of safety both nationally and internationally with the principal of continuous improvement is common in the nuclear power sector. Cooperation within the sector, self-control and self-monitoring are in the interest of all operators, because major incidents are detrimental to everyone in the sector. Examples of cooperation in the sector are extensive peer reviews, exchange of operating experience, and joint nuclear safety research.

With the Fennovoima project, the Finnish nuclear power sector has received an entirely new operator which will add to the human resources and financing necessary for the development of the field. Fennovoima has actively participated in efforts such as commenting on the revised nuclear safety regulations prepared by the Finnish Radiation and Nuclear Safety Authority (STUK). Fennovoima also provides funding for the national nuclear safety research programme and appoints experts to the steering of the programme.

Overall, the project will have a positive impact on the safe operation of the other nuclear power plants in Finland. The project creates potential for further development of operations in the nuclear industry by increasing the available resources.

Other impacts

Fennovoima's project involves the procurement of the required nuclear fuel, as described in Appendix 5A to this application. Each power plant operator obtains the required fuel from the international market independently from each other. Fennovoima has signed an agreement with JSC TVEL, a part of the Rosatom Group, for the purchase of fuel for the first ten operating years. JSC TVEL also supplies nuclear fuel to the Loviisa nuclear power plant operated by Fortum. Even combined, the procurement of nuclear fuel by the nuclear power plants in Finland constitutets only a small percentage of the worldwide market in nuclear fuel, which means that Fennovoima's nuclear fuel procurement will have no adverse impact on the nuclear fuel procurement of the other nuclear power plants in Finland.

Fennovoima's nuclear power plant will be a base load plant, meaning that under normal operation it will continuously generate electricity at full capacity. Appendix 2A demonstrates that there is a future need in Finland's electricity generation system for significant amount of base load power, and the Fennovoima project will thus not have an impact on the ways of operating other Finnish nuclear power plants.

Fingrid Oy, the company responsible for the Finnish national grid, has investigated the connection of Fennovoima's nuclear power plant to the national grid. The nuclear power plant will be connected to the national grid through a secure connection ensuring that it will fulfill all operating requirements even in the case of disruption in the transmission network. Connecting the nuclear power plant to the national grid will not compromise the operations of the other Finnish nuclear power plants.

Impact of the project on other nuclear power plant projects in Finland

Fennovoima was founded for the explicit purpose of implementing the project, and the company has no other ongoing or planned nuclear energy projects. As Fennovoima has no other functions, it can focus fully on the implementation of the project.

The other Finnish nuclear power project currently in progress is the Olkiluoto 4 project of TVO, which received a decision-in-principle from the Finnish Government in 2010. Since 2003, TVO has also been building the Olkiluoto 3 nuclear power plant unit. Simultaneous nuclear power plant projects will have no impact on Fennovoima's potential to carry out the project as planned. Nuclear power plant suppliers are major international corporations, and Finnish projects only cover a small portion of global plant supply capacity. The AES-2006 from the Rosatom Group is not included in the plant alternatives that TVO is considering for Olkiluoto 4.

The nuclear power plant projects currently being planned may have a mutual impact on each other in the field of licensing and regulatory processes required by the Nuclear Energy Act and other legislation, if the licensing takes place during the same period of time.

Significance of the project for Finland's nuclear waste management

Management of low and intermediate level nuclear waste

It is considered in Finland that it is safe and feasible to manage all the low and intermediate level nuclear waste on the site at each nuclear power plant. TVO and Fortum each have a repository for plant waste at Olkiluoto and Loviisa power plant sites. The low and intermediate level operating waste generated at Fennovoima's nuclear power plant will be managed and disposed of at the plant site in the Hanhikivi headland, Pyhäjoki, as described in Appendix 5B to this application.

The management of Fennovoima's operating waste will have no adverse impact on the management of operating waste generated at other Finnish nuclear power plants. For the most part, Fennovoima's plans and the available operating waste management methods are mainly same as those of other Finnish nuclear power plants, so the Fennovoima project will contribute to the further development of these methods and the related expertise in Finland.

For the management of very low level operating waste, Fennovoima is considering construction of a repository in soil as one of the potential disposal systems. This final disposal method has not been used in Finland, but it is used in several countries with nuclear power plants. Fennovoima's alternative solution for the disposal of very low level waste and the expertise to be developed for the implementation of this solution support the development of similar systems at other existing and planned nuclear power plants in Finland.

Spent nuclear fuel management

Management of the spent nuclear fuel is an important part of the obligations set in the license to operate a nuclear facility. The waste management obligation as referred to in the Nuclear Energy Act (990/1987) means that the licensee shall be responsible for all nuclear waste management measures and their appropriate preparations, as well as for their costs, concerning the waste generated as a result of the licensee's operations.

Nuclear waste management comprises all the measures necessary to recover, store and handle nuclear waste and dispose of it permanently (final disposal).

Spent nuclear fuel storage

Spent nuclear fuel removed from the reactor will be first kept in the reactor building of the nuclear power plant for some years. After removal from the reactor building, the spent nuclear fuel from Fennovoima's nuclear power plant will be stored in the spent nuclear fuel storage facility located in the Hanhikivi plant area.

With regard to on-site processing and storage of spent nuclear fuel, Fennovoima's nuclear power plant will have a positive impact on Finnish nuclear waste management. The project will strengthen Finnish nuclear waste handling and storage expertise.

Final disposal of spent nuclear fuel

According to current plans, the final disposal of spent nuclear fuel generated at Fennovoima's nuclear power plant will be carried out using the same methods that are used at existing Finnish nuclear power plants.

In 1983, the government adopted a decision setting out the long-term objectives for the final disposal of spent nuclear fuel. Major objectives included the selection of the final disposal location in 2000, application for a construction license in 2010 and launch of disposal operations in 2020. In accordance with this schedule, originally prepared 30 years ago and modified in 2003, Posiva submitted a construction license application concerning the construction of a final disposal facility and encapsulation facility to the Government in 2012. The construction license application concerns the final disposal of the spent nuclear fuel generated at Fortum's and TVO's nuclear power plants (Loviisa 1 and 2, Olkiluoto 1, 2, 3 and 4). The maximum volume of the disposed fuel is 9,000 tonnes of uranium.

The Government set a condition in the decision-in-principle granted in 2010 that Fennovoima must submit specified plans for its nuclear waste management in connection with the construction license application. Fennovoima must also develop its plan for the final disposal of spent nuclear fuel to the effect that by the end of June 2016, it will either have an agreement of nuclear waste management cooperation with the parties currently under the nuclear waste management obligation, or an environmental impact assessment program as referred to in the Act on Environmental Impact Assessment (468/1994) concerning its own final disposal facility for spent nuclear fuel.

Fennovoima's primary objective is to develop and carry out the final disposal of spent nuclear fuel together with other Finnish operators under the nuclear waste management obligation. In March 2012, the Ministry of Employment and the Economy appointed a working group to control the joint studies of Finnish nuclear power companies on the available alternatives for the final disposal of the spent nuclear fuel. The final report of the working group was completed in March 2013. The report states that it will be expedient and cost-efficient for operators to utilize the expertise generated in the field and to aim for an optimal solution in the provision for future final disposal operations.

Fennovoima is currently preparing an overall plan that examines, among other things, the preliminary schedule for the disposal of the spent nuclear fuel generated in Fennovoima's nuclear power plant and interests in common with the current operators regarding their final disposal project. Final disposal of spent fuel from Fennovoima's nuclear power plant will begin in the 2070s at the earliest.

Fennovoima's project will have a positive impact on the nuclear waste management of other Finnish nuclear power plants. Fennovoima considers that cooperation with other Finnish nuclear energy operators will improve the safety of nuclear power plants and nuclear waste management, and diversify opportunities of activities. For a more detailed description of the significance of Fennovoima's project for spent nuclear fuel management in Finland, see the original decision-in-principle application.

Management of nuclear power plant decommissioning waste

When the operations of the nuclear power plant end, it will be decommissioned. The management of radioactive decommissioning waste will be organized essentially like the management of low and intermediate level operational waste. For a description of the management of radioactive decommissioning waste, see Appendix 5B.

The existing Finnish nuclear power plant units will be decommissioned before the decommissioning of Fennovoima's nuclear power plant begins. The expertise accumulated in this work will be utilized in the planning and execution of the decommissioning of Fennovoima's nuclear power plant. The decommissioning of the nuclear power plant will have no adverse impact on the waste management of the existing Finnish nuclear power plants.

Nuclear power plant site

Appendix 3A

Assessment report pursuant to the Act on
Environmental Impact Assessment Procedure (468/1994)

Introduction

This appendix includes an assessment report pursuant to the Act on Environmental Impact Assessment Procedure (468/1994) in accordance with section 24, subsection 2 (6) of the Nuclear Energy Decree (755/2013) and a description of the design criteria adopted by the applicant to avoid environmental accidents and to restrict the burden on the environment.

In 2008, Fennovoima carried out an environmental impact assessment (EIA) procedure to assess the impacts of the construction and operation of a nuclear power plant of approximately 1,500–2,500 MW consisting of one or two reactors at three alternative locations: Pyhäjoki, Ruotsinpyhtää, and Simo. According to the environmental impact assessment, the Hanhikivi headland in Pyhäjoki is suited as a nuclear power plant site, and no adverse environmental impacts that are unacceptable or could not be mitigated to an acceptable level were found.

In 2013 and 2014, Fennovoima supplemented its earlier environmental impact assessment by carrying out an environmental impact assessment pursuant to the Act on Environmental Impact Assessment Procedure to investigate the environmental impacts of the construction and operation of a nuclear power plant with an approximate electric power of 1,200 MW at Hanhikivi headland.

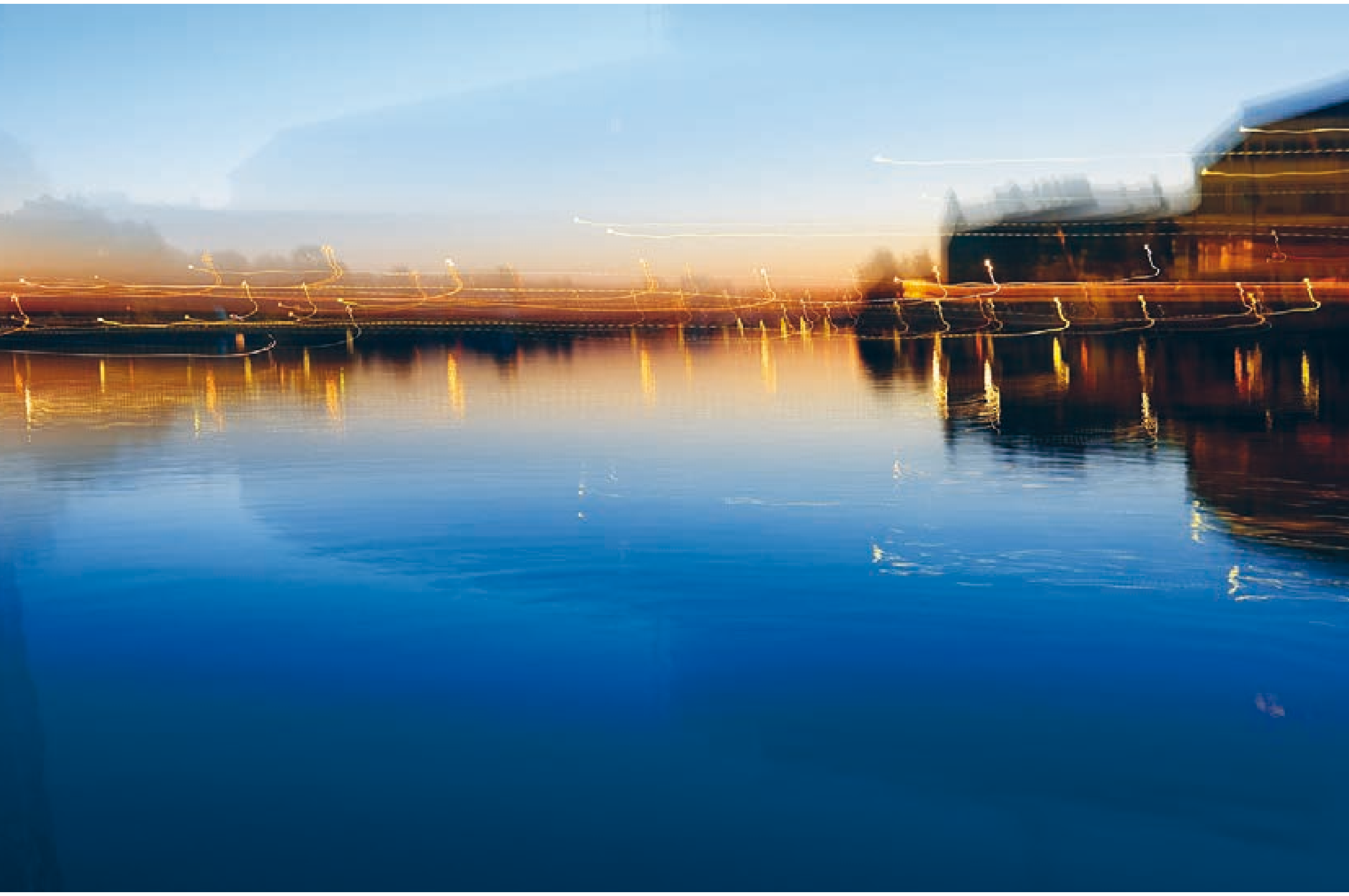
Chapters 3 and 4 of the EIA report describe the design criteria that Fennovoima will adopt to avoid environmental damage and to restrict the burden on the environment. Furthermore, chapter 7 of the report presents the means to prevent and mitigate the adverse impacts within each impact assessment section, and chapter 9 contains a summary of the prevention and mitigation measures of the most significant impacts.

The new Environmental Impact Assessment Report was submitted on February 13, 2014, to the Ministry of Employment and the Economy, which acts as the coordinating authority in the EIA procedure. The hearing procedure began at the end of February and will take 60 days. To conclude the assessment procedure, the coordinating authority will issue a statement concerning the report and its adequacy. The application will be supplemented with the statement of the coordinating authority once the statement has been issued.

This publication contains a summary of the Environmental Impact Assessment Report, including the key content of the report. The summary is presented in the same form as it was published in the Environmental Impact Assessment Report in February 2014.

The entire Environmental Impact Assessment Report for the project is available in electronic form on the Fennovoima website at **www.fennovoima.com**.

Summary



1 Project

Background of the project

Fennovoima Ltd. (hereinafter "Fennovoima") is studying the construction of a nuclear power plant of approximately 1,200 MW at Hanhikivi headland in Pyhäjoki, Finland. As part of the studies, Fennovoima will carry out an environmental impact assessment as laid down in the Act on Environmental Impact Assessment Procedure (468/1994; hereinafter "the EIA Act") to study the environmental impacts of the nuclear power plant's construction and operation.

In 2008, Fennovoima implemented an environmental impact assessment (EIA) to assess the impacts of the construction and operation of a nuclear power plant of approximately 1,500–2,500 megawatts that consists of one or two reactors at three alternative locations: Pyhäjoki, Ruotsinpyhtää, and Simo. An international hearing procedure pursuant to the Espoo Convention was also performed in connection with the EIA procedure.

Fennovoima received a Decision-in-Principle in compliance with section 11 of the Nuclear Energy Act (990/1987) on May 6, 2010. Parliament confirmed the Decision-in-Principle on July 1, 2010. The Hanhikivi headland in Pyhäjoki was selected as the plant site in the autumn of 2011 (Figure 1).

The nuclear power plant of approximately 1,200 MW which is the object of this environmental impact assessment and the supplier of which is a company belonging to the Russian Rosatom Group was not mentioned as one of the plant alternatives in Fennovoima's original application for a Decision-in-Principle. This is why the Ministry of Employment and the Economy required that Fennovoima updates the project's environmental impact assessment with this EIA procedure. The international hearing procedure in compliance with the Espoo Convention is simultaneously implemented.

Figure 1. The project site and the Baltic Sea region countries, including Norway.

Assessed alternatives

The implementation alternative being assessed consists of the environmental impacts from the construction and operation of a nuclear power plant of approximately 1,200 MW. The plant will be constructed on the Hanhikivi headland in Pyhäjoki. The plant will consist of one nuclear power plant unit of the pressurized water reactor type. The zero-option assessed is not implementing Fennovoima's nuclear power plant project.

In addition to the nuclear power plant itself, the project will include interim storage of spent nuclear fuel on site, as well as treatment, storage, and final disposal of low and intermediate level operating waste. The following are also included in the project scope:

- Intake and discharge arrangements for cooling water
- Supply and handling systems for service water
- Treatment systems for wastewater and emissions into the air
- Constructing roads, bridges, and banks
- Constructing a harbor area, wharf, and navigation channel for sea transport.

The report also describes the nuclear fuel supply chain, the final disposal of spent nuclear fuel, and decommissioning of the nuclear power plant. A separate EIA procedure will be applied to the latter two at a later date. A separate EIA procedure will also be applied to the transmission line connection to the national grid.

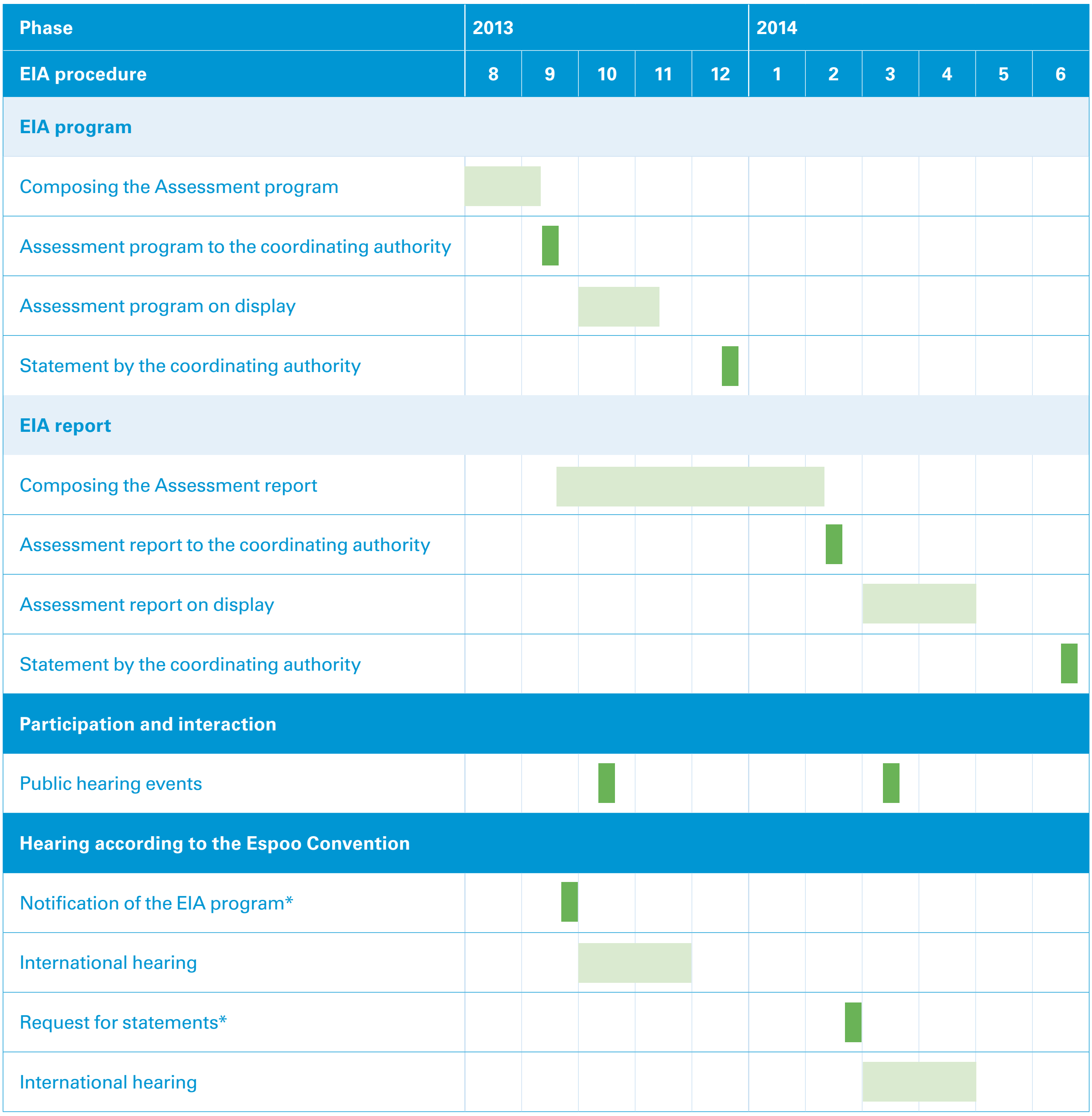
Schedule

Key stages and planned schedule of the EIA procedure are presented in Figure 2.

2 Environmental impact assessment and stakeholder hearing procedure

EIA procedure

The environmental impact assessment procedure is based on the Council Directive on the assessment of the impacts of certain public and private projects on the environment (85/337/EEC) that has been enforced in Finland through the EIA Act (468/1994) and the EIA Decree (713/2006). The objective of the EIA procedure is to improve the environmental impact assessments and to ensure that environmental impacts are consistently taken into account in planning and decision-making. Another objective is to increase the availability of information to citizens and the possibility for them to participate in the planning of projects. The EIA



*by the Ministry of the Environment

Figure 2. Schedule of the EIA procedure.

procedure does not involve any project-related decisions nor does it solve any issues pertaining to permits or licenses.

The EIA procedure consists of the program and the report stages. The environmental impact assessment program (EIA program) is a plan for arranging an environmental impact assessment procedure and the required investigations. The environmental impact assessment report (EIA report) describes the project and its technical solutions, and offers a consistent assessment of the environmental impacts based on the EIA procedure.

The environmental impact assessment in a transboundary context as laid down in the Espoo Convention is also applied to the Fennovoima nuclear power plant project. Parties to the Convention have the right to take part in an environmental impact assessment procedure carried out in Finland if the state in question may be affected by the adverse environmental impacts of the project to be assessed. The Finnish Ministry of the Environment coordinates the international hearing procedure. The Ministry submits all statements and opinions it has received to the coordinating authority to be taken into account in the coordinating authority's statements regarding the EIA program and the EIA report.

The stages of the EIA procedure are presented in Figure 3.

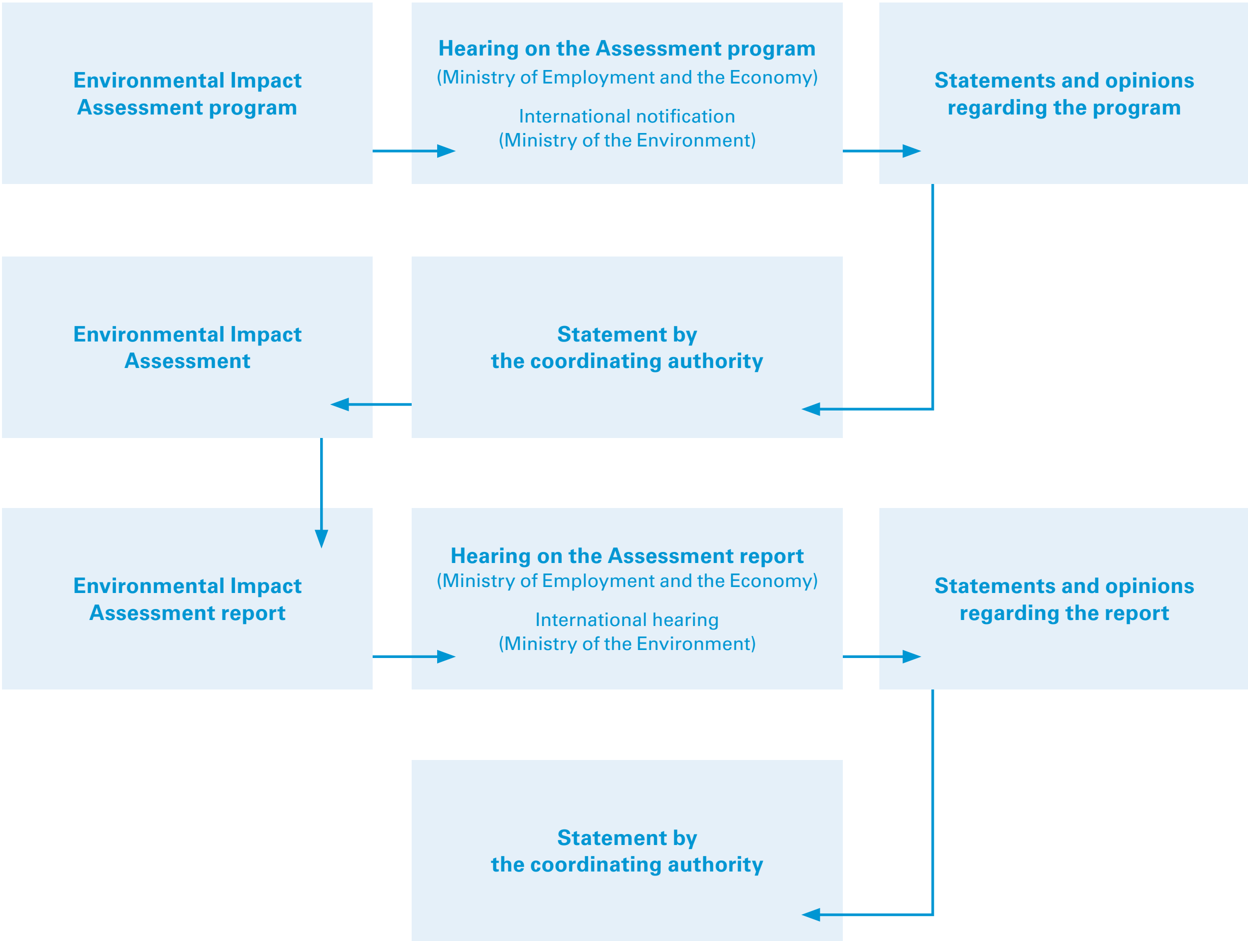


Figure 3. Stages of the EIA procedure.

National and international hearing

On September 17, 2013, Fennovoima submitted the EIA program concerning the nuclear power plant project of approximately 1,200 MW 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 various authorities and other stakeholders, and citizens also had the opportunity to present their opinions. The EIA program was available for reviewing in Finland from September 30 to November 13, 2013 and available for international reviewing from September 30 to November 28, 2013.

A total of fifty-one statements and opinions regarding the EIA program were submitted to the Ministry of Employment and the Economy. Fifty-seven statements and notifications were submitted in the international hearing process. Sweden, Denmark, Norway, Poland, Germany (two federated states), Latvia, Estonia, Russia, and Austria announced that they will participate in the EIA procedure.

The Ministry of Employment and the Economy issued its statement on the EIA program on December 13, 2013.

The opinions of Finnish stakeholders on the project were studied by implementing a resident survey in the area surrounding the planned plant site and by arranging group interviews during the EIA procedure. The opinions received were taken into account in assessing the environmental impacts.

The environmental impact assessment report has been drawn up on the basis of the EIA program and the related opinions and statements. The EIA report was submitted to the coordinating authority in February 2014. Citizens and stakeholders will have the opportunity to voice their opinions on the EIA report by the deadline specified 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.

3 Project description and plant safety

Operating principle of the plant

Nuclear power plants produce electricity in the same manner as condensing power plants using fossil fuels: by heating water into steam and letting the steam rotate a turbogenerator. The main difference between nuclear power plants and conventional condensing power plants is in the heat production method: in nuclear power plants, the heat is produced in a reactor using the energy released by splitting atom nuclei, whereas in condensing power plants, the water is heated by burning suitable fuel, such as coal, in a boiler.

The most widely used reactor type is the light water reactor. The reactors of the nuclear power plants currently in operation in Finland are light water reactors. The alternative types of light water reactors are the boiling water reactor and the pressurized water reactor. The type considered for this project is the pressurized water reactor.

In a pressurized water reactor, fuel heats the water but high pressure prevents the water from boiling. The heated high-pressure water is led from the reactor to steam generators. In the steam generators, the water is distributed into small-diameter heat transfer tubes. The heat transfers through the walls of the tubes into the water circulating in a separate circuit, which is the secondary circuit. The water in the secondary circuit turns into steam, which is then led to the turbine rotating a generator (Figure 4). As the reactor system and the secondary circuit are completely separated from each other, the water circulating in the secondary circuit is not radioactive.

In nuclear power plants, more than one third of the thermal energy generated in the reactor can be converted into electric energy. Rest of the heat produced is removed from the power plant using condensers. In the condensers, low-pressure steam from the steam turbines releases energy and turns back into water. Condensers are cooled using cooling water taken directly from a water system. The cooling water, the temperature of which rises by 10–12 °C in the process, is then returned back to the water system.

Nuclear power plants are best suited as base load plants, which mean that they are used continuously at constant power except for a few weeks' maintenance outages at 12–24-month intervals. Plants are designed for an operational lifetime of at least 60 years.

Description of the plant type

The Rosatom AES-2006 pressurized water reactor that is being studied in this project is a modern, third-generation nuclear power plant. The AES-2006 plants are based on VVER technology, which has been developed and used for more than 40 years and consequently offers the benefit of long-term operational experience. The version of the plant under consideration for Fennovoima's project is the latest development step in the VVER plant series. VVER plants have a history of safe operation spanning over 30 years in the Loviisa nuclear power plant.

Table 1 shows the preliminary technical data of the planned new nuclear power plant.

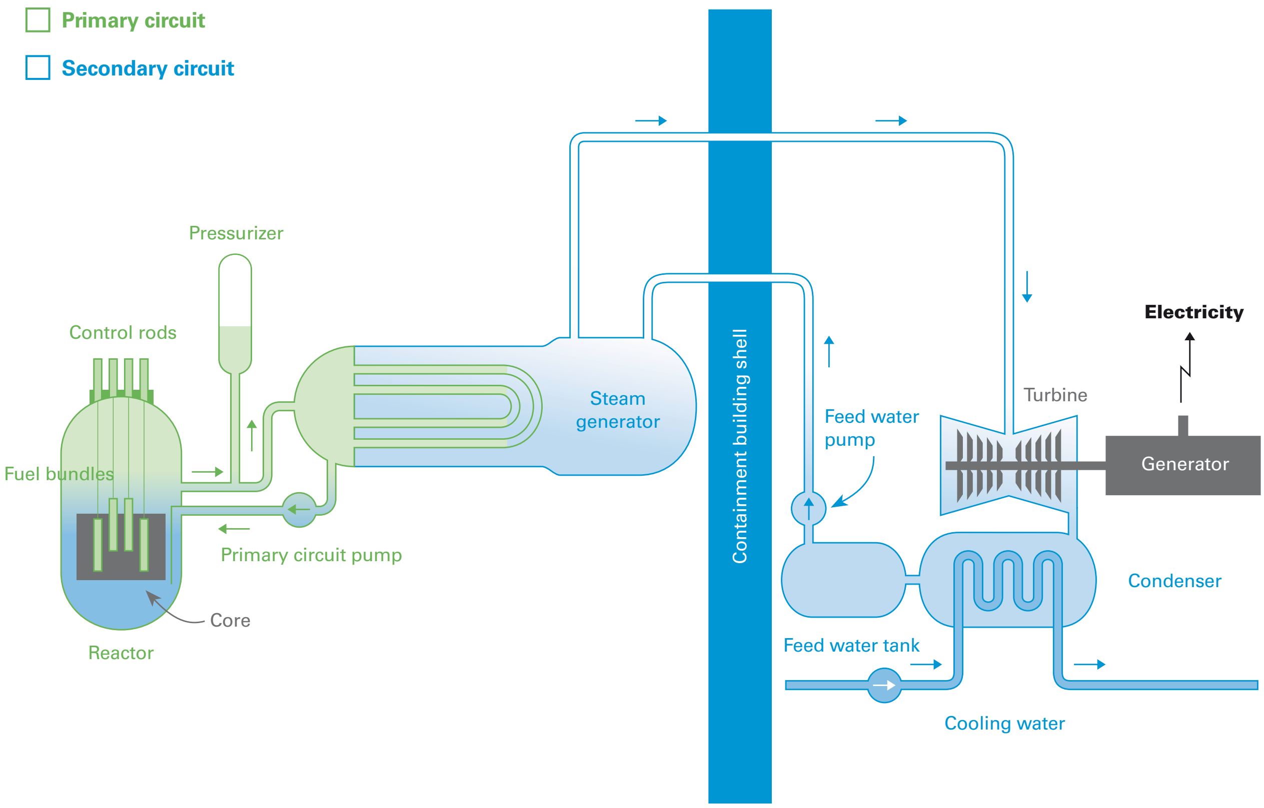


Figure 4. Operating principle of a pressurized water reactor.

Table 1. Preliminary technical specifications of the planned new nuclear power plant.

Description	Value and unit
Reactor	Pressurized water reactor
Electric power	Approximately 1,200 MW (1,100–1,300 MW)
Thermal power	Approximately 3,200 MW
Efficiency	Approximately 37 %
Fuel	Uranium dioxide UO_2
Fuel consumption	20–30 t/a
Thermal power released in cooling to the water system	Approximately 2,000 MW
Annual energy production	Approximately 9 TWh
Cooling water consumption	Approximately 40–45 m^3/s

The safety of the plant is based on both active and passive systems. Active systems are systems that require a separate power supply (such as electric power) to operate. Among the important safety features of the AES-2006 are additional passive safety systems, driven by natural circulation and gravity. Being independent from the supply of electric power, they will remain in operation even in the unlikely event of total loss of power supply and unavailability of the emergency power generators. The possibility of a severe reactor accident, meaning a partial meltdown of the reactor core, will be considered in the design of the plant. To cope with a severe accident, the containment building will be equipped with a core catcher. The plant type features a double-shell containment building. The outer containment shell is a thicker structure made of reinforced concrete that is capable of withstanding external collision loads, including a passenger airplane crash.

Nuclear safety

The safety requirements related to the use of nuclear energy are based on the Finnish Nuclear Energy Act (990/1987) which states that nuclear power plants must be safe and shall not cause any danger to people, the environment, or property.

The regulations of the Nuclear Energy Act are further specified in the Nuclear Energy Decree (161/1988). The general principles of the safety requirements set for nuclear power plants are laid down in Government Decrees (734/2008, 736/2008, 716/2013, and 717/2013). Their scope of application covers the different areas of the safety of nuclear energy use. Detailed regulations on the safety of nuclear energy use, safety and emergency preparedness arrangements, and nuclear material safeguards are given in the regulatory guides on nuclear safety (YVL Guides) issued by the Radiation and Nuclear Safety Authority (STUK). Various national and international regulations and standards also control the use of nuclear energy.

The safety of nuclear power plants is based on the defense-in-depth principle. Several independent and supplementary protection levels will be applied to the design and operation of the Fennovoima nuclear power plant. These include the following:

- Prevention of operational transients and failures through high-quality design and construction, as well as appropriate maintenance procedures and operation.
- Observation of operational transients and failures and returning the situation to normal using protection, control, and safety systems.
- Management of design basis accidents using existing and planned safety features.
- Observation and management of severe accidents using the accident management system.
- Mitigation of the consequences of releasing radioactive substances through emergency and rescue operations.

The nuclear power plant will be equipped with safety systems that will prevent or at least limit the progress and impact of failures and accidents. The safety systems will be divided into several parallel subsystems, the combined capacity of which will be designed to exceed the requirement several times over (the redundancy principle). The overall system consisting of multiple redundant subsystems will be able to perform its safety functions even in the case of the failure of any single piece of equipment and the simultaneous unavailability of any piece of equipment contributing to the safety function due to maintenance or any other reason. This redundancy ensures the operational reliability of the safety systems. Reliability can be further improved by utilizing several pieces of equipment of different types to perform the same function. This eliminates the chance of type-specific defects preventing the performance of the safety function (the diversity principle). The redundant subsystems will be separated from each other so that a fire or a similar incident cannot prevent the performance of the safety function. One alternative for implementing the separation is to place the subsystems in separate rooms (the separation principle).

The nuclear power plant will be designed to withstand the loads resulting from various external hazards. These include extreme weather conditions, sea and ice-related phenomena, earthquakes, various missiles, explosions, flammable and toxic gases, as well as intentional damage. Other factors that will be taken into account in the design include the eventual impacts of climate change, such as the increasing frequency of extreme weather phenomena, increase in the temperature of seawater, and rises in the average sea level.

Construction of the nuclear power plant

The construction of a nuclear power plant is an extensive project. The first phase of construction, which will take approximately three years, will feature the construction of the infrastructure required for the plant and performance of civil engineering work.

The earthworks will include bedrock blasting and rock excavation work performed for the purpose of constructing the cooling water tunnels and the power plant excavation, as well as the filling, raising, and leveling of the plant area and the supporting areas. Hydraulic engineering works, including soil and rock excavation work performed for the purpose of building the navigation channel, the harbor area, and the cooling water intake and discharge structures, will be carried out simultaneously with the earthworks.

The harbor basin, the navigation channel, the auxiliary cooling water inlet channel, and the cooling water intake structures will be located in the western and northwestern parts of the Hanhikivi headland. The cooling water discharge structures will be located on the northern shoreline. According to the plan, the cooling water will be taken from the harbor basin located on the western shore of the Hanhikivi headland using an onshore intake system and discharged at the northern part of the headland.

The actual power plant construction work will begin after the completion of the infrastructure and the civil engineering works. The construction of the power plant will take 5–6 years, including installation work carried out at the plant. The commissioning of the plant will take 1–2 years. The objective is to put the plant into operation by 2024.

Radioactive emissions and their control

Radioactive emissions into the air

According to the Government Decree (717/2013), the radiation dose to individual inhabitants of the surrounding area caused by the normal operation of a nuclear power plant may not exceed 0.1 millisieverts per year. This limit value is the basis for determining the limits for emissions of radioactive substances during normal operation. Emission limits will be established for iodine and inert gas emissions. The emission limits are separately specified for each nuclear power plant. In addition to iodine and inert gas emissions, the nuclear power plant will release tritium, carbon-14, and aerosols into the air. Even at the theoretical maximum level, the annual emissions of these substances will remain so low that setting separate emission limits for them is not necessary in Finland. However, these emissions will still be measured.

The Fennovoima nuclear power plant will be designed so that the emissions of radioactive substances remain below all set emission limits. Furthermore, Fennovoima will determine its own emission targets for the nuclear power plant. These targets will be stricter than the set emission limits.

The radioactive gases generated in the nuclear power plant will be processed using the best available technology. Gaseous radioactive substances will be directed into a cleaning system, where the gases will be dried, delayed, and filtered using charcoal filters, for example. Gaseous emissions can also be filtered using efficient high-efficiency particulate air (HEPA) filters. The cleaned gases will be released into the atmosphere via the vent stack. Radioactive emissions into the air will be monitored and measured in the several stages of the gas treatment systems, and finally at the vent stack.

Radioactive emissions into the sea

As in the case of emissions into the air, power plant-specific emission limits will be set for radioactive emissions into the sea. Furthermore, Fennovoima will determine its own emission targets, which will be stricter than the set emission limits. In Finland, tritium emissions have been approximately 10 % and other emissions clearly less than 1 % of the set emission limits. The amount of tritium from a nuclear power plant in seawater decreases to an insignificant level at a very short distance from the plant.

Radioactive liquids from the controlled area will be led to the liquid waste treatment plant where they will be cleaned so that their activity level falls well below the set emission limits before they are released into the water system. The water, which will contain only a low level of radioactivity, will be released into the sea after the treatment process. The level of radioactivity in the water released into the sea will be determined using a representative sample and by conducting measurements at the outlet line before the water is released into the cooling water discharge tunnel. The goal is to minimize the volume of emissions into the sea by, for example, recycling the process and pool water and by minimizing the generation of wastewater.

Waste management

In addition to conventional waste, radioactive waste is generated during the operation of a nuclear power plant. This waste is divided into two main categories:

- Very low, low and intermediate level waste, i.e. operating waste (such as low level waste generated during maintenance or repairs and components, and equipment removed from inside the reactor pressure vessel that have been activated by neutron radiation, which are intermediate level waste)
- High level waste, i.e. spent nuclear fuel.

The basic principle for the management of radioactive waste generated in the nuclear power plant will be permanent isolation of the waste from the environment. The party under the nuclear waste management obligation (in practice, the owner of the nuclear power plant) will be responsible for the implementation of nuclear waste management and liable for covering the related expenses. According to the Nuclear Energy Act, nuclear waste must be treated, stored, and permanently disposed of within Finland.

Operating waste

Whenever possible, solid radioactive waste will be sorted at the site where the waste is generated. For storage or final disposal, maintenance waste will be packed in vessels, typically 200-liter drums. Before waste is packed in the storage or disposal vessels, its volume will be decreased using various methods, such as compression or mechanical or thermal cutting. Wet and liquid radioactive waste, ion exchange resins, sludge materials, and concentrates will be processed by drying. Wet waste will be solidified in cement order to facilitate safe handling and final disposal. The properties of the waste will be characterized for further treatment and final disposal of the waste.

For the final disposal of low and intermediate level waste, Fennovoima will build an operating waste repository in the bedrock of the plant site, at a depth of approximately 100 meters. The operating waste repository for low and intermediate level waste may be either a rock silo or a tunnel. Of these, the latter solution is more probable. In the case of a tunnel-type repository, the waste would be transported in via a vehicle access tunnel. Very low level waste may also be placed in a surface repository on ground level. Should Fennovoima decide not to build a surface repository, the very low level waste will be disposed of in the operating waste repository in the same way as low and intermediate level operating waste.

Spent nuclear fuel

Following removal from the reactor, the spent nuclear fuel will be transferred to the reactor hall water pools, where they are allowed to cool down for 3–10 years. From the reactor hall, the spent fuel will be transferred to interim storage, where it will remain for a minimum of 40 years prior to final disposal. During the interim storage period, the activity and heat generation of the spent fuel will continue to decrease significantly. After the interim storage, the spent fuel will be transported to a final disposal site built for this particular purpose.

Water pools or dry storage will be used for interim storage of the spent nuclear fuel. The water pools will be located in a building made of steel-reinforced concrete, for instance. The water will act as a radiation shield and cool the spent fuel. In dry storage, the spent fuel is packed in special containers designed for the purpose.

The spent fuel will be disposed of in the Finnish bedrock. The final disposal will be implemented using the KBS-3 concept developed in Sweden and Finland. In the final disposal solution following this concept, the spent fuel will be encapsulated in copper canisters, surrounded with bentonite clay, and deposited in deposit holes drilled deep in the bedrock. As the disposal of spent fuel will not begin until the 2070s at the earliest, technological developments in the field can also be taken into account in the planning of Fennovoima's final disposal solutions.

At present, Fennovoima is preparing an overall plan on the final disposal of spent nuclear fuel. One of the main goals of the overall plan is to determine an optimal final disposal solution which will be able to, for its part, promote cooperation between Fennovoima and the other Finnish parties under the nuclear waste management obligation.

A condition included in the Fennovoima Decision-in-Principle states that Fennovoima must have an agreement on nuclear waste management cooperation with the parties currently under the nuclear waste management obligation or start its own EIA procedure for the final disposal project by summer 2016. The final disposal of Fennovoima's spent fuel will require the completion of an EIA and a Decision-in-Principle procedure, as well as a construction license and an operating license, regardless of the location of the final disposal facility.

Water supply

Water consumption and water supply

Fresh water (service water) will be needed at the power plant for potable water and for preparing the plant's process waters. The power plant will consume service water approximately 600 m^3/day. The plan is to obtain the service water from the local municipal water utility.

Cooling water

The cooling water consumption will vary depending on the amount of energy produced. A plant of approximately 1,200 MW will require approximately 40–45 m^3/sec of seawater to cool the condensers. According to the plan, the cooling water will be taken from the harbor basin located on the western shore of the Hanhikivi headland using an onshore intake system and discharged at the northern part of the headland. Major impurities and objects will be removed from the cooling water before it is led into the condensers. After the cooling water has passed through the condenser, it will be discharged back into the sea through the cooling water discharge channel. The temperature of the water will rise by 10–12 °C in the process.

Wastewater

The power plant will generate wastewater both as a result of using potable water and through the operation of the plant. Sanitary wastewater will include water from sanitary facilities and shower rooms, for example. The plan is to transfer the sanitary wastewater to the municipal wastewater treatment plant. Wastewater generated during the operation of the plant will include various types of washing water, wastewater resulting from the production of the circulating water, and wastewater from operation. These will be properly treated and either taken to the municipal wastewater treatment plant or discharged into the sea.

4 Present state of the environment

Location and land use planning

The project site is located in Northern Ostrobothnia on the western coast of Finland on the Hanhikivi headland in the municipalities of Pyhäjoki and Raahe (Figure 5). The Hanhikivi regional land use plan for nuclear power, partial master plans for the nuclear power plant site in the areas of Pyhäjoki and Raahe, and local detailed plans for the nuclear power plant site in Pyhäjoki and Raahe have been ratified for the Hanhikivi headland area.

The immediate surroundings of the Hanhikivi headland site are sparsely populated and no industrial activity is

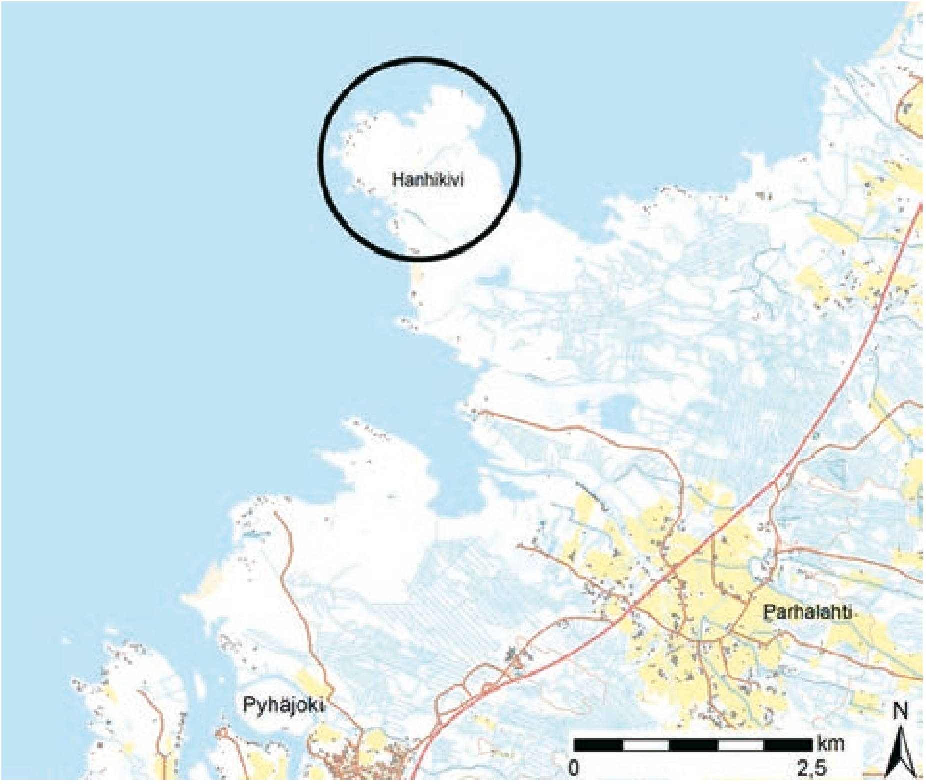


Figure 5. Location of the power plant site in the area of the Hanhikivi headland.

practiced in the immediate surroundings of the headland. The center of Pyhäjoki is located a little over five kilometers south of the headland. The center of Raahe is located approximately 20 km from the headland. The village of Parhalahti located a little over five kilometers from the nuclear power plant will be included in the plant's five-kilometer protective zone. Approximately 440 permanent residents live within the protective zone. There are 11,600 permanent inhabitants within a twenty-kilometer radius of the site. There are approximately twenty holiday homes on the Hanhikivi headland and a couple of hundred holiday homes with the twenty-kilometer zone.

Main road 8 (E8) is approximately six kilometers from the nuclear power plant site. The closest railway station and port are in Raahe. The closest airport is in Oulu, approximately 100 km from Pyhäjoki.

Natural conditions

The Hanhikivi headland area is low-lying land-uplifting coast, the typical features of which include seaside meadows and paludifing shallow bays. The most prevalent habitat type on the Hanhikivi headland is the forests of land uplift coast. The area is a significant natural forest succession site, but there are no mature forests in the area.

The Parhalahti-Syölätinlahti and Heinikarinlampi Natura 2000 area is located approximately two kilometers to the south of the project site. The Natura 2000 area is also an avifauna area of national significance, and it is included in the Finnish Waterfowl Habitats Conservation Program.

There are a Finnish Important Bird Area (FINIBA), several nature conservation areas, and other important objects in the immediate surroundings of the Hanhikivi headland. Five endangered or otherwise protected vascular plant species and the moor frog, a species included in the species listed in Annex IV (a) to the Habitats Directive, have been found in the area.

The most significant bird flocking areas are Takaranta to the east of the project area and Parhalahti. A large number of bird species have been found in the areas due to the varied habitats. Most of the areas important in terms of avifauna are located in the coastal area of the Hanhikivi headland that includes water areas, coastline, and representative forest compartments. The proportion of deciduous forests in the area is large. This is why specific species have been observed in the area in large quantities.

The loose soil in the Hanhikivi headland is mainly moraine. The bedrock is mainly metaconglomerate. The Hanhikivi headland area has been classified as a valuable area in terms of nature and landscape, and it is also a valuable bedrock area. There is a boundary mark originating from historical times, Hanhikivi, on the headland.

The nearest classified groundwater area is located approximately ten kilometers from the Hanhikivi headland.

Water systems

The coastline around the Hanhikivi headland is very open, and water changes efficiently in the area. The depth of the water around the Hanhikivi headland increases very slowly, initially at a rate of one meter per 100 m distance. The water quality at the Hanhikivi headland depends on the general state of the Bay of Bothnia and water coming from the Pyhäjoki river running along the coast. Pyhäjoki river empties approximately six kilometers from the plant site on the south side of the Hanhikivi headland. The quality of the seawater in front of the headland corresponds to the water quality typically found along the coast of the Bay of Bothnia. According to the ecological classification of the Finnish environmental administration, the water quality of the sea in front of the Hanhikivi headland is moderate or good, and excellent farther away from the shore (more than two kilometers away). The state of the coastal waters is affected by eutrophication caused by nutrients carried by rivers, as well as the population centers and industries found in the coastal regions. There are several small gloe lakes and one flada on the Hanhikivi headland.

The shores of the Hanhikivi headland are gently sloping and open to the waves. The most sheltered and diverse areas are the shallow bays on the eastern side of the headland. There are not many species of aquatic vegetation. Charophyte meadows, which have been found all along the coastline, are one of the most representative underwater habitat types.

The sea in front of the Hanhikivi headland is significant both in terms of the fish stock and in terms of fishery. The fish species typically found in the area are those typically found in the whole of the Bay of Bothnia. Species of economic significance include the sea-spawning whitefish (*Coregonus l. widegreni*), common whitefish, perch, herring, vendace, sea trout, salmon, and pike. Spawning river lampreys can also be caught in the rivers emptying into the area. Furthermore, endangered graylings have been found in the area. The surroundings of the Hanhikivi headland are an important spawning area for whitefish, herring, and vendace. There are some whitefish and salmon migration routes close to the project area, but they also migrate further out to sea.

5 Assessed environmental impacts

Premise of the assessment

In compliance with the EIA Act, the assessment has covered the environmental impacts of the approximately 1,200 MW nuclear power plant on:

- Human health, living conditions, and wellbeing
- Soil, water systems, air, climate, vegetation, organisms and biodiversity
- Infrastructure, buildings, landscape, cityscape, and cultural heritage
- Utilization of natural resources
- Mutual interdependencies of these factors.

The assessment particularly focused the impacts that deviate from the impacts assessed in the EIA of 2008 or those not covered by the 2008 EIA. Environmental impacts considered significant or felt significant by the stakeholders have also been taken into account.

The impact assessment has utilized the studies and surveys executed for the EIA of 2008, as well as environmental studies and impact assessments of the project completed after said EIA. The studies and surveys prepared earlier have been updated when necessary to correspond to the current situation and the 1,200 MW nuclear power plant currently being assessed. The following additional studies and surveys were implemented for the environmental impact assessment described in this EIA report:

- Resident survey and small group interviews
- Modeling of the spread of radioactive releases in the case of a severe accident
- Noise emission modeling
- Cooling water modeling.

Furthermore, calculations included in the 2008 EIA, such as traffic volume calculations, calculations of the impacts on regional economy, and emissions from the zero-option, were updated.

Land use and the built environment

The land use plans for the nuclear power plant site are legally in force and indicate the areas required by the nuclear power plant. The land use plans enable construction of the planned nuclear power plant on the Hanhikivi headland, and implementation of the project will not require any changes to the current land use plans.

The main buildings and operations of the power plant will be located in the middle and northern parts of the Hanhikivi headland, in an area marked as an energy management block area in the local detailed plan for the nuclear power plant by the municipality of Pyhäjoki. The total block area is 134.6 hectares. The local detailed plans of the municipalities of Pyhäjoki and Raahe for the nuclear power plant site also include areas allocated for buildings required for nuclear power plant support operations.

The construction of the nuclear power plant will change the land use at the actual plant site and in its surroundings. The holiday residences on the western shore will be removed, and it will no longer be possible to use the western shore for recreational purposes. The new road connection planned for the nuclear power plant will not cause any significant changes in the land use of the area. Figure 6 is a modified aerial image indicating what the nuclear power plant would look like on the Hanhikivi headland.

The construction of the power plant will have an impact on the municipalities' infrastructure. It will restrict land use in the plant's protective zone but enable new construction in settlements and villages as well as along roads. Densely populated areas, hospitals, or institutions in which a large number of people will visit or reside, or significant industrial activities which could be affected by an accident at the nuclear power plant, cannot be placed inside the protective zone. Plans for holiday homes or recreational activities in the area must ensure that the preconditions for appropriate rescue activities will not be placed at risk.

The project will increase the significance of Raahe as a strong industrial region, which may improve the preconditions needed for the development of land use.

Landscape and cultural environment

In addition to the actual construction site, landscape impacts during construction work will be caused by heavy traffic required by the transport of large building parts and its requirements, new road connections and the improvement of current roads. High cranes will be visible in the landscape from far away.

The power plant will be placed in a visible area at the tip of a headland reaching out into the open sea. The headland is currently a location that is in its natural state in the landscape. The surroundings of the plant will be clearly different from the environment in terms of size and character, and the plant will clearly change the landscape. The landscape status of Takaranta, a seashore meadow of regional importance, will change.

The status of the nationally valuable Hanhikivi monument of antiquity as part of the landscape and the character of its immediate surroundings will significantly change. The monument will remain accessible.

Soil, bedrock, and groundwater

Normal operation of the nuclear power plant will not have any significant impacts on the soil or bedrock. The risk of soil contamination will be eliminated by proper technical means, such as drainage arrangements for overflow water and wastewater.

Excavation of the bedrock will reduce the geological value of the Hanhikivi headland. As indicated by the land use plans, representative parts of the bedrock will be left visible.

Groundwater level and pressure may decrease during construction and also during operation due to the drying measures of the structures. The project may influence the quality of groundwater, mainly during construction, due to the use of explosives and injecting of the bedrock. The impact on groundwater will remain fairly local and minor when the proper mitigation and prevention means are used.

Flora, fauna, and conservation areas

Some of the forests and seashores on the Hanhikivi headland will be changed into constructed environment, which means that species in those areas will disappear or change. The construction activities will not involve any nature conservation areas or seashore meadows protected by the Nature Conservation Act; nor will the construction activities have any direct impacts on them. Hanhikivi headland is an area of regional significance due to its representative as natural forest succession series of the land uplift coast. The construction activities will cause partial fragmentation of this habitat type, which has been classified as highly endangered.

Figure 6. A modified aerial image of the nuclear power plant on the Hanhikivi headland.

No endangered plants grow in the areas where construction will take place, nor have any Siberian flying squirrels or bat nesting or resting places been found there. Two exemptions from the protection measures have been granted to Fennovoima, one concerning the removal of a small breeding place of the moor frogs and one concerning the transfer of moor frogs from the area to a breeding place suitable for the species. The noise during construction may temporarily disturb the birds close to the power plant construction site and the road.

The discharging of warm cooling water into the sea during the operation of the plant may indirectly contribute to the paludification of the seashore meadows and make habitats less favorable to the protected Siberian primrose.

Construction or operation of the nuclear power plant is not expected to cause any significant adverse impacts on the protected habitats or species or the integrity of the Parhalahti-Syölätinlahti and Heinikarinlampi Natura 2000 area. The area influenced by noise during construction and operation will be less than one kilometer from the power plant site, which means that the noise will not disturb, even temporarily, the avifauna in the Natura 2000 area. The dredging work will cause some turbidity but not – according to the assessment – in the Natura 2000 area. The turbidity of the seawater off the coast of the Hanhikivi headland also naturally increases during storms or periods of heavy rainfall. The cooling water impacts will not extend to the Natura 2000 area.

Water systems and fishery

Impacts of construction

Dredging during the construction of the navigation channel, the harbor area, the auxiliary cooling water inlet channel, and the cooling water discharge area, as well as the construction of protective piers, will cause temporary turbidity of the seawater. The seabed in the area to be dredged mainly consists of quickly settling rough-grained materials, such as sand and gravel. When such rough-grained materials are dredged, the turbidity will spread to approximately 10–100 meters from the dredging or deposit site, while the dredging of more fine-grained materials may cause turbidity of the water in an area extending up to five kilometers from the site. The dredging is not expected to cause any releases of nutrients or contaminants into the sea. There are Charophyte meadows in the cooling water discharge area. These meadows will be lost. The area that will be changed by the construction is small, however. According to the observations made, Charophyte meadows are fairly common in the sheltered bays which can be found along the north and south coastline of the Hanhikivi headland.

Fishing in the construction areas and in their immediate vicinity will not be possible during the hydraulic construction works. The construction activities in the sea area may also drive away fish from a larger area and temporarily influence the migration routes of fish. Excavation, in particular, will cause powerful underwater noise that may drive away fish from an extensive area. The impact will most likely be significant in an area extending at least one kilometer from each blasting place. The construction activities in the sea will destroy some whitefish (*Coregonus l. widegreni*) and herring spawning areas in the dredging areas. The fishing activities in the area mainly focus on whitefish. Whitefish come to the area to feed on herring spawn. Thus, the project may have adverse impacts on the fishing of whitefish in the project site's immediate vicinity.

Impact of cooling water and wastewater

The impacts on water systems include the impacts caused by warm cooling water, purified process and washing waters, and water intake. The purified process water, washing water, and sanitary wastewater will only cause minor nutrient loads when compared to, for instance, the loads entering the sea area through the local rivers. Since the water will also be mixed with the cooling water and the cooling water will be discharged into the open sea area, the eutrophication caused by the waters will be marginal.

The fact that the cooling water used at the power plant will be discharged into the sea will increase the temperature of the seawater close to the discharge place. The power plant's impact on the temperature of the sea has been studied with the help of a three-dimensional flow model.

The temperature of the seawater will increase by more than 5 °C in an area of approximately 0.7 km^2 in the immediate vicinity of the cooling water discharge place, and the temperature of the seawater will increase by 1 °C in an area of approximately 15 km^2. The thermal impacts will be at the highest in the surface water (0–1 meters below the surface) and decrease at greater depths (Figure 7). According to the modeling results, the temperature increase will cease at a depth of more than four meters.

In the winter, the thermal load from the cooling water will keep the discharge area unfrozen and cause the ice to be thinner, mainly to the north and east of Hanhikivi. The scope of the open water area and the area where the ice is thinner will largely depend on the temperature during the early winter. According to the modeling results, the annual differences in the thickness of the ice will even out further into the winter months, as the ice becomes thicker overall, in such a manner that the open water area will be 2.4–2.5 km^2 by February–March. At this time of the year, the open water area will extend approximately 2-5 kilometers from the discharge place and the area with thinner ice approximately 0.5–2 km further than the open water area.

The project is not expected to have any adverse impacts on the zooplankton population: no significant changes in the zooplankton populations of cooling water discharge areas have been observed in Finnish or foreign studies. The project is expected to increase the total primary production of aquatic vegetation and change the composition of species by increasing the growth of filamentous algae in the warming area, for instance. These impacts are expected to extend to roughly the area where the average temperature increase will be at least one degree Celsius. Since no significant changes to the primary production are expected, the amount of organic matter accumulated on the seabed is expected to remain low, which means that no significant impact on the benthic fauna will occur. The cooling water discharges are not expected to cause anoxia in deep water or significantly increased blooming of cyanobacteria.

Possible adverse impacts on fishing include the build-up of slime in nets and, in the summertime, hindering of whitefish fishing, especially in the fishing grounds north of Hanhikivi. The area that remains unfrozen in the winter 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 in the wintertime. The cooling water and the resulting impacts are not expected to influence the ability to use fish as human food.

Radioactive emissions into the sea

Radioactive emissions into the sea will include tritium and other gamma and beta emissions. The emissions will be so low that they will not have any adverse impacts on people or the environment.

The Fennovoima nuclear power plant will be designed so that the emissions of radioactive substances remain below all set emission limits. Furthermore, Fennovoima will determine its own emission targets for the nuclear power plant. These targets will be stricter than the set emission limits. Radioactive liquids will be led to the liquid waste treatment plant where they will be processed so that their activity level will fall well below the emission limits.

The strict emission limits and supervision of the emissions from the nuclear power plant keep the emissions very low. The impact of radiation on the environment will be extremely minor when compared to the impact of radioactive substances existing normally in nature.

Emissions into the air

Radioactive emissions

The radioactive gases generated during the operation of the nuclear power plant will be processed using the best available technology to minimize the emissions. Gaseous radioactive substances will be collected, filtered, and delayed to decrease the amount of radioactivity. Gases containing small amounts of radioactive substances will be released into the air in a controlled manner through the vent stack and the emissions will be measured to verify that they remain below the set limits. The remaining released radioactive substances will be effectively diluted in the air.

The Fennovoima nuclear power plant will be designed so that the emissions of radioactive substances remain below all set emission limits. Furthermore, Fennovoima will determine its own emission targets for the nuclear power plant. These targets will be stricter than the set emission limits. The strict emission limits and continual monitoring will keep the emissions of the nuclear power plant very low. The radiation impact on the environment will be insignificant when compared to the impact of radioactive substances existing normally in nature.

According to the preliminary data, the radioactive emissions into the air will be higher than those of the currently operating Finnish nuclear power plants. The emissions will, however, still remain well below the emission limits set for the currently operating Finnish nuclear power plants. The radiation exposure caused by the emissions will remain low, since with these emission values the radiation dose will remain clearly below the limit value of 0.1 millisieverts per year laid down in the Government Decree (717/2013). For reference, the average annual radiation dose of a person living in Finland is 3.7 millisieverts.

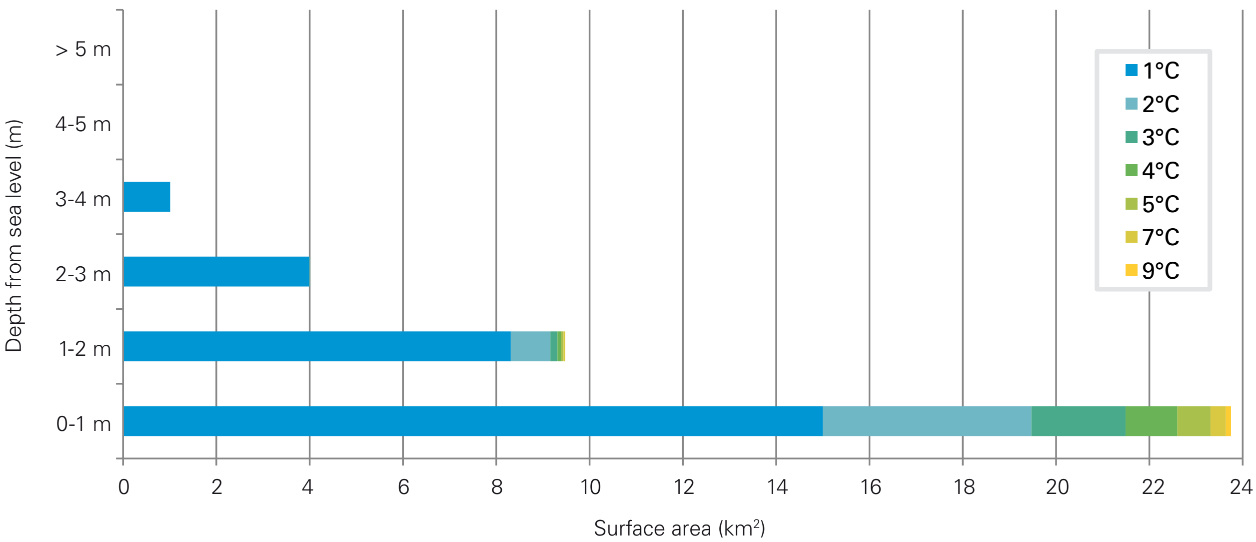


Figure 7. Areas where the temperature increase will exceed 1, 2, 3, 4, 5, 7, and 9 degrees Celsius at the average temperature in June.

Other emissions into the air

Excavation work, construction site traffic, and specific functions, such as rock crushing, will generate dust during the construction of the nuclear power plant. The dust will influence the air quality mainly at the construction site. The traffic emissions will increase significantly during the construction phase, particularly during the period of the heaviest construction activities. Since the air quality in the area is currently good and the period of heavy traffic will be limited in duration, the traffic emissions during construction will not have any significant impacts on the air quality in the area.

During operation of the nuclear power plant, emissions will be generated by the emergency power system and commute traffic. These emissions are not estimated to have any significant impacts on the air quality.

Waste and waste management

The handling and final disposal of the operating waste will not cause any significant environmental impacts when the facilities are properly designed and the waste management actions are properly implemented. Final disposal facilities will be monitored and the radioactive substances contained in the operating waste will become safe for the environment over time.

The handling and interim storage of the spent nuclear fuel will be safe and do not cause any significant environmental impacts due to the careful design and execution of the facilities. During interim storage for decades, the status of spent fuel will be regularly monitored. A separate EIA procedure shall be arranged on the final disposal and transportation of spent nuclear fuel.

The handling of conventional or hazardous waste at the nuclear power plant will not give rise to any environmental impacts. The sorted waste fractions will be processed outside the power plant site in appropriate manner.

Traffic and traffic safety

Traffic volumes will clearly increase during the construction period, particularly during the years when the construction activities are at the heaviest. Traffic volumes on main road 8 to the north of the Hanhikivi headland will increase by approximately 64 %. The increase will be slightly smaller on the south side, approximately 39 %.

The total traffic volume on main road 8 in the immediate vicinity of the intersection leading to the nuclear power plant will increase by approximately 15 %. The volume of heavy traffic will increase by approximately 6 %.

The new road to be built from the main road to the nuclear power plant will be designed to be suitable for power plant traffic. The intersection from the main road will include preselection lanes and the speed limits to ensure the safety and smooth flow of traffic.

Noise

According to noise emission modeling, the noise caused by the project will remain below the guideline values set for residential areas and areas including holiday residences, both during the construction and operation of the plant.

During the noisiest construction phase, i.e. when excavation and rock crushing work is underway, the average daytime noise level at the closest holiday residences will be approximately 40 dB(A). This value still remains clearly below the guideline value for holiday residences of 45 dB(A). The noise level in the closest nature conservation areas (the meadow in the northwestern corner of the Hanhikivi headland and the Siikalahti seashore meadow) may, according to the modeling results, be approximately 50–53 dB(A).

During the heaviest construction phase, the traffic noise of 55 dB(A) and 50 dB(A) from the road leading to the Hanhikivi headland will spread to fairly narrow zones, and there are no residences within the areas affected. The zone where the noise will be approximately 45 dB(A) will extend to a small part of the nature conservation area and an important bird area near the road connection.

The noise carrying from the nuclear power plant during its normal operation to the residential areas and areas including holiday residences will be fairly minor. The average noise level at the closest holiday residences will remain below 30 dB(A). The noise caused by the power plant traffic will also be minor, remaining clearly below the guideline values for residential areas.

People and society

According to the results of the resident survey and group interviews residents and other stakeholders have very different views on the nuclear power plant project and there are local groups both opposing and supporting the project. Opposition is often based on the perceived risks and fears associated with nuclear power plants, and the belief that nuclear power is ethically questionable. The supporters emphasize its positive economic impacts and environmental friendliness.

The municipality of Pyhäjoki will receive major property tax revenue during the construction phase. The revenue will vary in relation to the stage of completion of the nuclear power plant. The annual employment effect of the construction phase in the economic area will be approximately 480–900 man-years. The project will boost business in the economic area, and demand for private and public services will grow.

The property tax revenue to the municipality of Pyhäjoki during the operation phase has been evaluated to be approximately € 4.2 million per year. The annual employment effect in the economic area will be 340–425 man-years. The arrival of new residents, boosted business, and escalated building activity will increase tax revenue. The population base and housing stock will increase.

Normal operation of the nuclear power plant will not cause any radiation impacts on human health. Moving in the power plant site and using the site for recreational purposes will not be allowed, which means that it will no longer be possible to use the area for hunting, etc. Warm cooling water will melt or weaken the ice and, as a result, will restrict recreational activities on ice during the winter, such as fishing or walking. On the other hand, it will extend the open water fishing season.

Impacts of abnormal and accident situations

Nuclear accident

The impacts of a nuclear power plant accident have been assessed based on a severe reactor accident. The spread of any radioactive release caused by a severe accident, the consequent fallout, and the radiation dose received by the general public have been modeled in compliance with the requirements laid down in Government Decree (717/2013) and the YVL Guides of the Radiation and Nuclear Safety Authority. The modeling results are indicative only, and they are based on assumptions in which the radiation doses have been overestimated. More detailed studies of nuclear safety and accident situations, and their consequences required by the nuclear energy regulations will be executed as the project proceeds.

The assumed release in this survey was the severe accident limit value laid down in the Government Decree (717/2013), a cesium-137 release of 100 TBq, which corresponds to an INES 6 accident.

The modeled severe reactor accident would not cause any direct or immediate health impacts on people in the immediate vicinity of the facility. The radiation doses during the first two days after the accident would be a maximum of 23 mSv if no civil protection actions were implemented. The dose is clearly below the limit for showing changes in the blood count, which is 500 mSv. The radiation dose caused by the release during the entire lifetime of a person living five kilometers from the plant would be approximately 150 mSv for a child (over the course of 70 years) and approximately 76 mSv for an adult (over the course of 50 years). Theses doses are lower than the dose received by the average Finn during their entire lifetime from natural sources.

In the case of the modeled severe accident, all the people living less than two kilometers from the plant would have to be evacuated. People living up to three kilometers from the plant would have to take shelter indoors. Children living up to five kilometers from the plant should take an iodine tablet. There would be no need for adults to take an iodine tablet, however.

Short-term restrictions on the use of agricultural and natural products could be necessary. The use of mushrooms as food might have to be restricted in an area extending to around 50 km from the plant in the direction the emissions have spread. The use of freshwater fish as food might have to be restricted in an area extending to around 300 km from the plant. The use of reindeer meat might have to be restricted in an area extending up to 1,000 km from the plant in the direction the emissions have spread.

Other abnormal and accident situations

Other potential abnormal and accident situations mainly include chemical and oil leaks that may contaminate the soil or groundwater. Furthermore, situations posing a radiation danger may occur due to fire or human error, for example. Such situations will be prevented by means of technical measures and by training personnel.

Decommissioning of the power plant

The impacts of decommissioning will remain minor, provided that the radiation protection of the people participating in the decommissioning is properly arranged. Waste generated during the demolition phase will be similar to the waste generated during the plant's operation, and it can be treated in the same way as operating waste. Most of the waste generated during the decommissioning of the nuclear power plant will not be radioactive.

A separate EIA procedure will be executed to assess the environmental impacts of the decommissioning phase of the nuclear power plant.

Nuclear fuel production chain

There will be no impacts from the nuclear fuel production chain in Finland. The impacts will be assessed and regulated in each country producing nuclear fuel according to national regulations.

The environmental impacts of uranium mining operations are connected with the radiation of the uranium ore, the radiation impacts of the radon gas released from the ore, and wastewater. Any environmental impacts caused by the conversion, enrichment, and production of fuel assemblies are related to the handling of dangerous chemicals and, to a lesser extent, the handling of radioactive substances. The environmental impacts of the different stages of the production chain, beginning with mines, will be governed by legislation as well as international standards and audits by independent parties.

Intermediate products transported in the nuclear fuel production chain are, at the most, slightly radioactive. The transport of radioactive substances will be carried out in compliance with national and international regulations on the transport and storage of radioactive substances.

Energy markets

The Fennovoima nuclear power plant will improve the maintenance reliability of electricity supply by reducing Finland's dependence on fossil fuels and imported electricity as well as maintaining the Finnish electricity production capacity. The fact that Fennovoima's nuclear power plant will be built in a new location will also improve the maintenance reliability concerning potential failures in power transmission.

The new nuclear power plant will make Finland more self-sufficient in terms of electricity production.

Zero-option

The assessed zero-option is that Fennovoima's nuclear power plant project will not be implemented. In this case, the impacts of the project described in this environmental impact assessment report will not be realized.

If the new nuclear power plant unit is not constructed in Finland, the same amount of electricity must be produced by other means. The assumption is that, in such a case, 20 % of the nuclear power plant's electricity production capacity of 9.5 TWh would be replaced with separate electricity production in Finland. The remaining 80 % would be produced abroad. The replacement electricity would most likely be produced in coal-fired power plants. The production to replace the Fennovoima nuclear power plant in Finland and abroad would cause a little less than seven million tonnes of carbon dioxide emissions, a little less than six thousand tonnes of both sulfur dioxide and nitrogen oxide emissions, and a little less than a thousand tonnes of particle emissions per year. The impacts of the sulfur dioxide, nitrogen oxide, and particle emissions would be mainly local, while the impact of the carbon dioxide emissions would be global.

Cumulative impacts with other known projects

The nuclear power plant and wind farm projects currently active in the region will create an energy production area of national significance. The area that is currently in its natural state or used for agricultural production will become a large-scale energy production zone.

The project may have a cumulative impact with the planned Parhalahti wind farm project in terms of recreational activities, as both the nuclear power plant and the wind farm project will limit land use opportunities and make hunting in the area more difficult.

Dredging to be implemented in connection with the sea wind farm project and a project of soil extracting from the sea could have a cumulative impact on the fish stock and thus fishing as the result of increased turbidity of the water if the dredging and extracting operations are simultaneously implemented.

The environmental impacts of the construction and operation of the grid connection will be assessed in a separate EIA procedure.

6 Transboundary environmental impacts

The normal operation of the nuclear power plant does not cause any transboundary environmental impacts.

In order to assess the impacts of a nuclear power plant accident, the EIA procedure has included dispersion modeling of a radioactive release caused by a severe reactor accident as well as the consequent fallout and radiation dose to population. The studied release was the cesium-137 release of 100 TBq laid down in the Government Decree (717/2013), which corresponds to a severe reactor accident (INES 6). The impacts of a release five times higher than that were also assessed. The release that is five times higher corresponds to an INES 7 accident.

Impacts of the modeled severe nuclear accident

The modeled severe reactor accident would not cause any immediate health impacts on the population in the surrounding areas under any weather conditions. Civil protection measures would not be necessary outside Finland. The radiation dose caused by the accident would remain outside Finland statistically insignificant.

The Hanhikivi nuclear power plant site is located approximately 150 km from the coast of Sweden. If the wind were to blow to the west and the weather conditions were unfavorable, a child living on the coast of Sweden would receive a lifetime dose of a maximum of 8 mSv, and an adult a lifetime dose of 4 mSv at most. At the Norwegian border approximately 450 km from the power plant site, the release would cause a dose of a maximum of 4 mSv for children and 2 mSv for adults. On the coast of Estonia approximately 550 km from the power plant site, the maximum lifetime dose for children would be 3 mSv and 2 mSv for adults. The dose on the coast of Poland approximately 1,100 km from the power plant site would remain below 1 mSv for adults and below 2 mSv for children. The plant site is approximately 1,850 km from the Austrian border in Central Europe. Even if the weather conditions were unfavorable, the release would cause a lifetime dose of 1 mSv at most for a resident of Austria. In comparison, a resident of Austria may during their lifetime receive a dose of more than 200 mSv from natural background radiation.

A severe accident may increase the radioactivity of reindeer meat or freshwater fish species to a level that requires temporary restrictions on their use as food. The use of freshwater fish may have to be restricted in the coastal areas of northern Sweden. The restrictions on freshwater fish can be limited to specific rivers and lakes in the worst fallout zone. The use of reindeer meat may have to be restricted in Sweden, Norway, and the northwestern part of Russia. However, the radioactivity of reindeer meat can be reduced by preventing reindeer from eating lichen, because cesium accumulates in lichen. This could mean that reindeer would have to be transferred from the worst fallout zone. The reindeer could also be kept in enclosures feeding on clean food until the radioactivity in the fallout zone has decreased to an acceptable level. If these restrictions were followed, the radioactivity in reindeer meat or freshwater fish would not pose any danger to people.

Assessment of the impacts of an INES 7 accident

If the release were the release that is five times higher than the 100 TBq release discussed above (more than 50,000 TBq of iodine-131 equivalents), the accident would be classified as an INES 7 accident. Such a high release is theoretically impossible in terms of noble gases, because the release would mean that five times more noble gases than the reactor contains would be released.

Such a fivefold release would not cause any immediate health impacts. If the wind were to blow to the west and the weather conditions were otherwise unfavorable, the lifetime dose of a child on the coast of Sweden would be approximately 37 mSv and the lifetime dose of an adult approximately 18 mSv. Under similar unfavorable conditions, the radiation dose at the Norwegian border could be a maximum of 14 mSv for children and 7 mSv for adults. The radiation doses in the other countries bordering the Baltic Sea would remain below 12 mSv for children and 6 mSv for adults even if the weather conditions were unfavorable. The lifetime radiation dose in Austria would not exceed 5 mSv for children and 2 mSv for adults.

Such a fivefold release would give rise to restrictions on the use of food products outside of Finland. The use of reindeer meat would have to be restricted in the fells of Sweden, Norway, and northwestern Russia, depending on the direction the release has spread. Also depending on the direction the release has spread, restrictions on the use of freshwater fish could be necessary in Sweden, Norway, northwestern Russia, and the Baltic states. If grazing of cattle were not limited, restrictions on the use of meat could be necessary in the coastal areas in northern Sweden.

7 Comparison of the alternatives

The differences between the impacts caused by the currently assessed plant of approximately 1,200 MW and the impacts caused by the 1,800 MW plant assessed in 2008 are mainly due to updates made in the project's technical design, new data on the present status of the environment, and stricter safety regulations. According to the assessment, the plant size or the specified plant type will not change the environmental impacts in any significant way.

The environmental impacts caused by the 1,200 MW plant are different from the impacts caused by the previously assessed 1,800 MW plant mainly in the following respects:

- The impacts on water systems and fishery will be slightly reduced because, according to the new cooling water modeling results, the cooling water would warm up the seawater in a somewhat smaller area.
- The impacts on flora, fauna, and conservation areas will be slightly reduced due to the lower cooling water load.
- According to the preliminary data for the nuclear power plant type AES-2006, the radioactive emissions into the air will be higher than those from the 1,800 MW plant assessed in the EIA of 2008. The Fennovoima nuclear power plant will be designed so that the emissions of radioactive substances remain below the values given in the preliminary data and reach the level of EIA of 2008 and the emission limits of the currently operating Finnish nuclear power plants at the most.
- The relative increase in traffic volumes is slightly lower than in the previous assessment due to the fact that the current traffic volume has increased and the growth forecasts have been changed. The traffic volumes are still the same for both plant alternatives, however.
- The spread of noise emission during operation of the plant is slightly different from the results of the previous noise modeling due to the changed plant layout. The sources of noise, the magnitude of noise, and the volume of traffic are similar for both plant sizes.
- The volumes of operating waste and spent nuclear fuel will be lower, which means that the impacts will be less.

If the zero-option was chosen, i.e. the project was not implemented, neither the negative nor the positive impacts would be realized. The Hanhikivi headland would remain in its current state. The positive financial impacts (such as improved employment rate and tax revenue) would not occur. Substitutive electricity production would cause environmental impacts, such as emissions into the air.

8 Prevention and mitigation of adverse environmental impacts

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

Fears and perceived threats caused by nuclear power can be mitigated by arranging proper communication so that the local residents will have enough information about how the nuclear power plant works and how its safety is ensured. Active communication with all stakeholders can be used to enhance the communication between the organization responsible for the project and the local residents. Furthermore, public events and information events can be arranged locally.

Adverse impacts on people or the environment during construction will be mitigated and prevented by, for instance, performing especially noisy activities at the suitable locations, constructing noise barriers, and guiding and scheduling traffic. The increased turbidity of the seawater due to construction activities in the sea area can be controlled or limited with the data provided by continuously operating measuring buoys on the prevailing flows. Access to the seashore areas at the plant site and other construction site areas including protected species or habitats will be prevented with fences and proper markings.

Social impacts caused by the construction can be mitigated by decentralizing the accommodation facilities of the employees into the neighboring municipalities and arranging a variety of training for foreign and local employees.

The nuclear power plant will be designed so that the emissions of radioactive substances remain below all set emission limits. The best available technology will be used to minimize emissions when handling radioactive gases and liquids during operation, and the emissions will always be kept as low as reasonably achievable. Radioactive emissions will be continuously monitored by means of measuring and sampling.

Fish can be prevented from being drifted into the cooling water intake system through a variety of technical methods and with the technical design of the cooling water intake systems.

The general disadvantages caused by the local warming of the seawater to fish and fishery can be compensated by implementing a fishery subsidy. The disadvantages caused to professional fishermen can be compensated on a case-by-case basis. Paludification of the seashore meadows can be prevented by grazing or clearing common reeds and bushes.

Potential accidents involving the use of chemicals and the processing of radioactive waste will be prevented with technical measures and by providing training to the employees. The power plant facilities will contain systems for the safe handling and transportation of waste and the monitoring of the amount and type of radioactive substances. The spent nuclear fuel will be handled safely at all stages of the waste management process.

The plant will be designed in such a manner that the probability of a severe accident is minimal. The risk of radioactive releases will be minimized by applying the defense-in-depth safety principle. The risk of accidents and abnormal situations will be minimized by applying strict quality and safety requirements, and by applying the continuous improvement principle. The impacts of a release caused by an accident can be clearly mitigated by means of civil protection measures. Protection measures influencing the food industry and restrictions on the use of food products can clearly reduce the radiation dose due to food ingestion.

9 Project feasibility

The project is feasible in terms of the environmental impacts. No such adverse environmental impacts that could not be accepted or mitigated to an acceptable level were identified during the environmental impact assessment.

Furthermore, the project will have positive environmental impacts, such as the impact on the local economy and the fact that the project will increase the local carbon dioxide -free energy production capacity.

10 Monitoring of environmental impacts

The impacts caused by the nuclear power plant's construction and operation on the environment will be monitored with monitoring programs approved by the authorities. The programs will include the monitoring of emissions and the environment as well as detailed reporting procedures.

Radioactive emissions will be monitored by means of process and emission measurements inside the plant and by monitoring radioactive substances and radiation present in the environment. Radioactive emissions into the water and air will be monitored with reliable radiation monitoring systems. The plant's radiation monitoring program will include measuring external radiation with dosimeters and continuously operating meters as well as analyzing the radioactivity of the outdoor air and representative samples of different stages of food chains. This will ensure that the emissions into the air and water will not exceed the plant-specific emission limits ratified by the Radiation and Nuclear Safety Authority and that the radiation exposure caused by the emissions will remain as low as reasonably achievable.

Conventional emissions will be monitored in compliance with the obligations laid down in the water and environmental permits. The monitoring of emissions will include the following, for instance:

- Monitoring water systems
- Monitoring fishery
- Monitoring emissions into the air
- Monitoring noise emissions
- Monitoring flora and fauna
- Waste management record.

The data obtained during the environmental impact assessment and issues raised in the public display events, statements, group interviews, and resident survey will be utilized in the monitoring of the social impact. The working methods created during the EIA procedure can also be utilized when monitoring the social impacts of the project and when communicating with the stakeholders.

11 Permits and licenses required by the project

The EIA procedure does not involve any project-related decisions nor does it solve any issues pertaining to permits or licenses; instead, the objective is to produce information to serve as a basis for decision-making.

The Finnish Government has granted Fennovoima a Decision-in-Principle in compliance with the Nuclear Energy Act (990/1987). Since the project that is being assessed in this EIA was not mentioned as a plant alternative in the original application for a Decision-in-Principle, the Ministry of Employment and the Economy has required further surveys.

According to the Decision-in-Principle, Fennovoima must apply for the construction license in compliance with the Nuclear Energy Act by June 30, 2015. The construction license will be granted by the Finnish Government, provided that the requirements for granting the construction license for a nuclear power plant prescribed in the Nuclear Energy Act are met.

The operating license will also be granted by the Finnish Government, provided that the requirements of the Nuclear Energy Act are met and the Ministry of Employment and the Economy has stated that the provisions for nuclear waste management costs have been made as required by law.

In addition, the project will, at different phases, require permits in compliance with the Environmental Protection Act, the Water Act, and the Land Use and Building Act.

Nuclear power plant site

Appendix 3B

Hanhikivi in Pyhäjoki

Summary

In 2011, Fennovoima selected the Hanhikivi headland in Pyhäjoki as its plant site. Based on surveys and studies carried out by Fennovoima, the Hanhikivi headland meets the safety and environmental requirements set for a nuclear power plant site, and is a suitable location for a nuclear power plant. The Radiation and Nuclear Safety Authority (STUK) assessed the suitability of the Hanhikivi plant site in 2009 as part of its preliminary safety assessment and found that considering the conditions on the site, there are no factors that would render the site unsuitable for building a nuclear power plant according to safety requirements or in terms of implementing security and emergency preparedness arrangements.

Land use in the Hanhikivi headland is prescribed by the Hanhikivi regional land use plan for nuclear power and the Raahe and Pyhäjoki local master plans and local detailed plans for the nuclear power plant area. The land use planning required for the nuclear power plant project has proceeded as planned, and is now in force at all three levels of land use planning.

The plan is to construct the nuclear power plant in the central and northern parts of the Hanhikivi headland. Fennovoima is in possession of most of these land areas either through ownership, or by having signed pre-contracts for the purchase or leases. The leases include a binding preliminary agreement on the right to purchase the leased property. Fennovoima will continue purchasing more areas on the Hanhikivi headland with the objective of owning all of the areas reserved for the nuclear power plant and its supporting functions in the local detailed land use plans. Acquisition of the areas will primarily take place based on voluntary agreements, and only then based on expropriation license, which can be granted by the Government.

There are no factors related to the design, construction or safety of the nuclear power plant in the Hanhikivi headland or its immediate surroundings that would render the site unsuitable for its purpose. There is no existing industrial infrastructure in the planned plant area to limit Fennovoima's possibilities of constructing a nuclear power plant and all the necessary functions. There are also no such population centers or functions in the immediate surroundings of the Hanhikivi headland that would prevent the planning and execution of effective emergency preparedness and rescue arrangements to limit potential nuclear damage.

An environmental impact assessment report (EIA report) in accordance with the Act on Environmental Impact Assessment Procedure has been drawn up concerning the project. According to the EIA report, the project will have no adverse environmental impacts that are unacceptable or could not be mitigated to an acceptable level.

The Hanhikivi nuclear power plant can be connected to the Finnish national grid.

Introduction

This appendix includes an overall description of the ownership and occupation of the site planned for the nuclear facility in accordance with section 24, subsection 2 (3) of the Nuclear Energy Decree (755/2013), a description of settlement and other activities and town planning arrangements at the planned nuclear facility site and in its immediate vicinity in accordance with subsection 2 (4) and in accordance with subsection 2 (5), a description of the suitability of the planned location for its purpose, taking account of the impact of local conditions on safety, security and emergency response arrangements, and the impacts of the nuclear facility on its immediate surroundings. The current document complements the information presented in the original decision-in-principle application, and describes the changes that have taken place in the project.

In 2013 and 2014, Fennovoima supplemented its earlier environmental impact assessment by carrying out an environmental impact assessment to investigate the environmental impacts of the construction and operation of a nuclear power plant with an approximate electric power of 1,200 MW at Hanhikivi headland. According to the EIA report, the project will have no adverse environmental impacts that are unacceptable or could not be mitigated to an acceptable level. The information gathered within the environmental impact assessment forms part of the source materials for the current report. The information has been complemented with information received in the land use planning process and separate surveys on factors with a potential impact on the safety of the plant site. The new environmental impact assessment is included to this application as Appendix 3A.

During the later phases of the project, the construction and operation of a nuclear power plant requires that the appropriate land use plans as per the Land Use and Building Act (132/1999) exist in addition to the licenses referred to in the nuclear energy legislation. In addition, the construction and operation of a nuclear power plant is subject to an environmental permit procedure as defined in the Environmental Permit Procedures Act (735/1991).

The Government Decree on the Safety of Nuclear Power Plants (717/2013) requires that the safety impact of local conditions, as well as the security and emergency preparedness arrangements, shall be considered when selecting the site of a nuclear power plant. The site shall be such that the impediments and threats posed by the facility to its environment remain extremely minor and heat removal from the plant to the environment can be reliably implemented.

Impact of changes that have taken place in the project

In 2011, Fennovoima selected the Hanhikivi headland in Pyhäjoki as its plant location. Based on surveys and studies carried out by Fennovoima, the Hanhikivi headland meets the safety and environmental requirements set for a nuclear power plant site, and is a suitable location for a nuclear power plant. STUK assessed the suitability of the Hanhikivi plant site in 2009 as part of its preliminary safety assessment and found that considering the conditions on the site, there are no factors that would render the site unsuitable for building a nuclear power plant according to safety requirements or in terms of implementing security and emergency preparedness arrangements.

The information concerning the Hanhikivi plant site presented in the original decision-in-principle application remain, for the most part, current and valid. Since 2009, the land use planning required for the nuclear power plant project has proceeded as planned, and is now in force at all three levels of land use planning. Changes have also taken place in the ownership and occupation of the site area. Minor changes have also occurred in the population of the area but according to Fennovoima's assessment these changes have no impact on operations such as emergency preparedness.

Research and surveys concerning the plant site have continued since the submission of reports in connection with the original decision-in-principle application. The design basis for the Pyhäjoki plant site has been further specified based on various studies. The research and surveys carried out between 2009 and 2013 have been described in more detail in the report submitted to the Radiation and Nuclear Safety Authority (STUK) in fall 2013. In the surveys no factors were found that would prevent the implementation of the project. The characteristics of the Hanhikivi headland render it well suited as a nuclear power plant site.

Hanhikivi in Pyhäjoki as the site of the plant

Selection of the plant location

At the beginning of the project in 2007, Fennovoima had nearly 40 alternatives for a nuclear power plant location. Alternatives were reduced based on surveys, and in 2009, only two remained: Hanhikivi in Pyhäjoki and Karsikko in Simo.

The Hanhikivi headland in Pyhäjoki was selected as the plant site in 2011. Several different factors were taken into account in selecting the site location. Special emphasis was placed on safety, technical feasibility, environmental and nature-related matters, building costs, and the regional community's willingness and capability to accept the project. Dozens of specific issues falling under these general themes were examined. The most important issues in terms of safety were the population and activities in the immediately surrounding area, effective implementation of security and emergency response arrangements, arrangement of the intake and discharge of cooling water in a reliable manner under various conditions, and the soil and bedrock properties. Hanhikivi was selected as the plant site based on an overall assessment. In the end, the selection of the Hanhikivi headland was supported by, among other things, the higher integrity of the bedrock and lower seismic design values, which affect the dimensioning of the nuclear power plant building and the equipment installed inside it.

STUK carried out a preliminary safety assessment of Fennovoima's nuclear power plant project in 2009. As part of this safety assessment, STUK also assessed the suitability of the Hanhikivi headland in Pyhäjoki for a nuclear power plant. According to STUK's statement, no issues that would prevent the construction of a new nuclear power plant in compliance with the safety requirements or implementing the security or emergency preparedness arrangements were observed at the new plant site. In autumn 2013, Fennovoima submitted to STUK a report regarding the plant site which describes the most recent development of the site and any changed information, and lists the studies that are most important regarding the site's safety. The report is connected to the plant alternative's safety assessment, and it states that most of the plant data presented in the original decision-in-principle application remain valid.

Hanhikivi in Pyhäjoki

The Hanhikivi headland is located in Northern Ostrobothnia and is divided between the municipalities of Pyhäjoki and Raahe. Most of the headland is located in the municipality of Pyhäjoki, less than seven kilometers from the municipal center (Figure 3B-1). The northeastern part of the Hanhikivi headland reaches into the area of the town of Raahe, around 20 kilometers from the center of the town.

The municipality of Pyhäjoki is located on the coast of the Gulf of Bothnia between the municipalities of Raahe and Kalajoki, in the southwestern part of Northern Ostrobothnia. Pyhäjoki is part of Oulu region. The approximate population of the Pyhäjoki municipality is 3,350.

The town of Raahe neighbors Pyhäjoki in the north. The approximate population of Raahe is 25,600 (2013). Raahe is the second largest town in Northern Ostrobothnia, behind Oulu, and the third largest town in the Oulu region.

Figure 3B-1. Location of the Hanhikivi in Pyhäjoki.

The Raahe economic zone covers seven municipalities with a combined population of 59,000. In addition to Pyhäjoki and Raahe, the economic zone includes the municipalities of Alavieska, Merijärvi and Siikajoki and the towns of Kalajoki and Oulainen.

The plant area and buildings

The nuclear power plant buildings will be located in the central and northern parts of the Hanhikivi headland, in the energy management area indicated in the Pyhäjoki local detailed plan for the nuclear power plant. The size of the block area is 134.6 hectares, and it forms the plant area with land use restrictions in force as referred to in STUK regulations. All the major operations of the nuclear power plant will be located in this plant area.

In the Pyhäjoki and Raahe local detailed land use plans for the nuclear power plant area, areas are also allocated for buildings required for the nuclear power plant's support operations.

A preliminary layout of the plant area is presented in Figure 3B-2. The area indicated as "1" will contain the reactor island, and the area indicated as "2" to the north of it will contain the turbine island.

Settlements in the immediate vicinity

Permanent settlements

The immediate surroundings of the Hanhikivi plant site are sparsely populated, and no significant changes have taken place in the number of permanent residents in recent years. The five-kilometer radius from the nuclear power plant is calculated to include the village of Parhalahti, located slightly more than five kilometers from the nuclear power plant. Approximately 440 permanent residents live within this five-kilometer radius. Within the twenty-kilometer radius, there are approximately 11,600 permanent residents. The twenty-kilometer radius includes the Pyhäjoki population center and the center of Raahe (Figure 3B-3). (Statistics Finland 2013.)

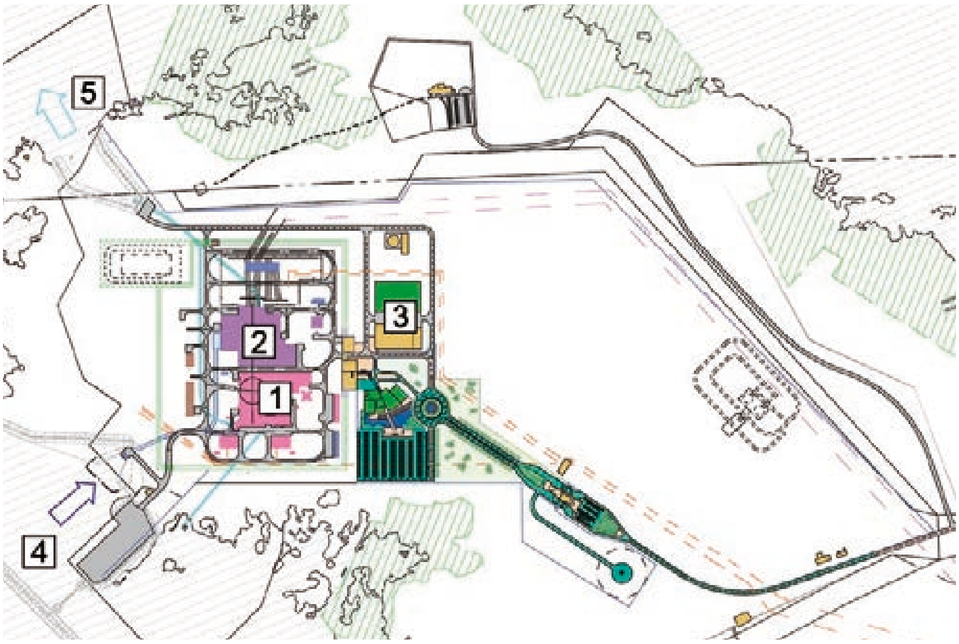


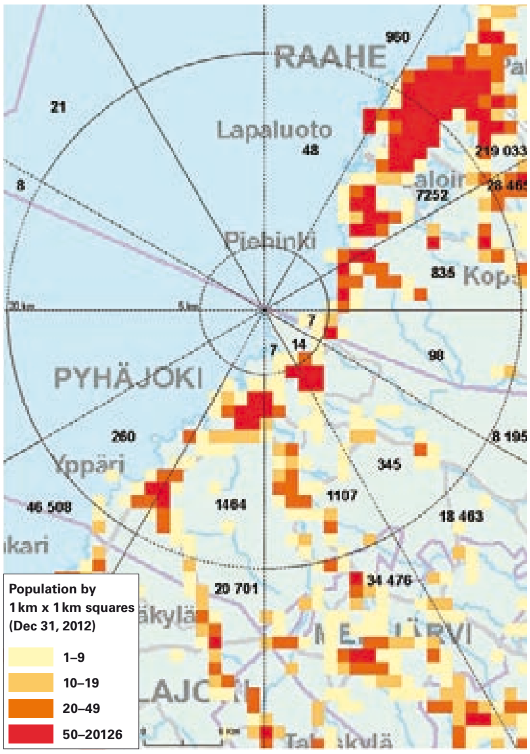
Figure 3B-2. Preliminary layout of the nuclear power plant area.
1) reactor island,
2) turbine island,
3) office and auxiliary buildings,
4) harbor and intake of cooling water (indicated by an arrow),
5) discharge of cooling water.

There are approximately 377,000 people living within a hundred-kilometer radius of the power plant site (Statistics Finland 2013). Of these, a significant number live in the Oulu region. The largest population centers in the area are Oulu, Kokkola, Raahe, Ylivieska, Kiiminki, Haukipudas, Kempele, Nivala, Oulunsalo and Kalajoki.

Leisure dwellings

There are plenty of leisure dwellings in the coastal areas of Pyhäjoki. Leisure dwellings are scarcer in the Hanhikivi area (some 20 holiday homes) than elsewhere in the Pyhäjoki shore areas. The holiday homes on the Hanhikivi headland are located on the

Figure 3B-3. Distribution of population in the immediate vicinity of the nuclear power plant project within the radius of five and twenty kilometers in 2012 (*Statistics Finland 2013*).



western coast, while the eastern coast is in large part a nature conservation area. Within a twenty-kilometer radius, there are a few hundred holiday homes. The nearest public beach is located in the western part of the headland.

Current and projected population

The economic zone of Raahe consists of seven municipalities (definition of districts on January 1, 2013 following the union of the municipality of Vihanti and the town of Raahe). The area has a total of 59,000 inhabitants. The population in the area grew between the beginning of the 1980s and the early 1990s, after which the trend turned downwards in all municipalities in the area (Figure 3B-4). The population of Kalajoki has grown again since 2005.

According to the population projections of Statistics Finland, the population of the municipalities within the Raahe economic zone will remain fairly stable up to 2040 (Table 3B-1). The population of the municipality of Pyhäjoki is estimated to decrease by 261 (8 per cent) between 2012 and 2040. The population of the town of Kalajoki is estimated to increase by approximately 1,000 by 2040.

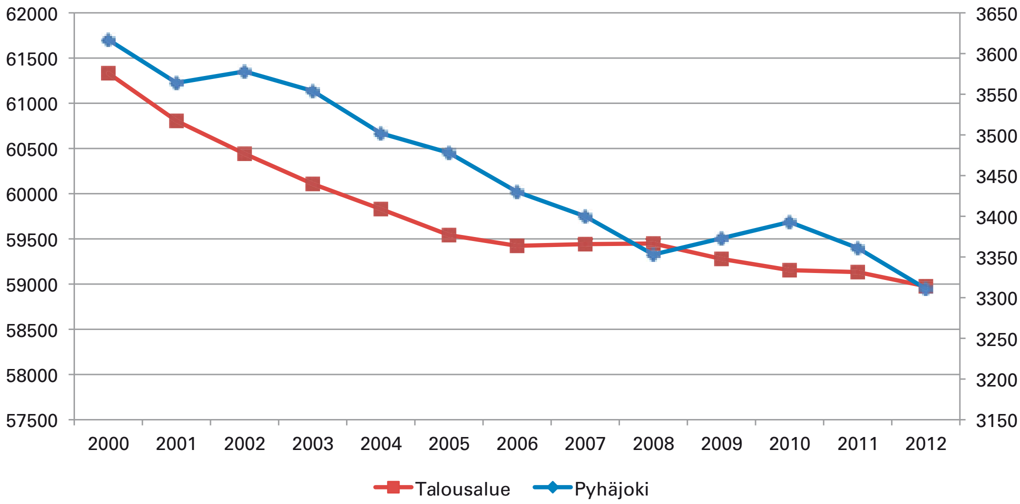


Figure 3B-4. Development of the population in the municipality of Pyhäjoki and the economic zone of Raahe from 2000 to 2013 (*Statistics Finland 2013*).

Table 3B-1. Population projection for the Raahe economic zone from 2015 to 2040 (*Statistics Finland 2013*).

	2012	2015	2020	2030	2040
Pyhäjoki	3 340	3 292	3 253	3 183	3 079
Alavieska	2 737	2 707	2 692	2 680	2 669
Kalajoki	12 667	12 821	13 101	13 507	13 655
Merijärvi	1 192	1 173	1 148	1 122	1 106
Oulainen	7 864	7 735	7 580	7 394	7 224
Raahe	22 618	22 718*	22 832*	22 786*	22 396*
Siikajoki	5 614	5 554	5 500	5 436	5 376
Vihanti	3 020	2 887*	2 746*	2 565*	2 457*
Yhteensä	**59 052**	**58 887**	**58 852**	**58 673**	**57 962**

* The municipality of Vihanti was merged with the town of Raahe on January 1, 2013.

Principal activities in the immediate vicinity

The primary forms of land use in the Hanhikivi headland include forestry and outdoor activities. There are no permanent settlements on the headland. There are some 20 holiday homes on the southwestern and western shores of the headland. A public beach has been defined for the western coast of the headland. Near to the tip of the headland, on the border between Pyhäjoki and Raahe, there is a large erratic boulder called Hanhikivi, which is classified as a historical monument.

The population center of Pyhäjoki is located approximately seven kilometers south of the headland. The village of Parhalahti is located approximately five kilometers from the planned power plant site. The center of Raahe is located approximately 20 kilometers away.

There is no industrial activity in the immediate vicinity of the Hanhikivi headland. There is, for instance, engineering industry in the Pyhäjoki region. In the town of Raahe, some 15 kilometers from the Hanhikivi headland, on the coast of the Gulf of Bothnia, there are Rautaruukki Corporation's steelworks, Oy Polargas Ab's atmospheric gas plant and liquid gas storage facilities. To the south of the municipality of Pyhäjoki, more than 20 kilometers from the Hanhikivi headland, there are Lohtaja site's restricted military areas of the Finnish Defense Forces.

Main road 8 passes the nuclear power plant site to the east of the Hanhikivi headland, at an approximate distance of five kilometers. A local road leads to the Hanhikivi headland along its south-western coast from the village of Parhalahti. The Tankokarinnokka fishing port can be reached via the road, as well as the leisure dwellings located on the southwestern and western coasts of the headland.

Protective zone and emergency planning zone

A protective zone and emergency planning zone as referred to in YVL regulations from STUK will be defined around the nuclear power plant. The radius of the protective zone is five kilometers and that of the emergency planning zone approximately 20 kilometers from the power plant. The purpose of these areas is to ensure that the location of the nuclear power plant is taken into account in land use planning and rescue planning in the area. Restrictions on land use and permitted functions are in force within the protective zone. The number of permanent inhabitants as well as any recreational activities in the protective zone should be kept such that an appropriate rescue plan can be drawn up for the area. An approximate definition of a nuclear power plant protective zone as referred to in the STUK regulations, extending to about five kilometers' distance from the facility, has been indicated in the currently valid Hanhikivi regional land use plan for nuclear power.

The protection measure defined for the protective zone is the rapid evacuation of the entire protective zone. Case-specific protection measures of varying degrees will be used within the emergency planning zone outside of the protective zone; potential measures include taking shelter indoors, taking iodine tablets and evacuation. In a situation with a nuclear threat, measures will be instigated in the part of the emergency planning zone that would be affected by any emission based on the prevailing weather conditions.

Fennovoima will draw up a preliminary emergency preparedness plan for the nuclear power plant in connection with the construction license application. The plan will be based on analyses of the progress over time of potential accident scenarios, radioactive releases and varying weather conditions. STUK will review the emergency preparedness plan, which will then be delivered to the regional rescue department, among other recipients. Regional rescue authorities will be responsible for preparing detailed rescue plans for the protective zone and the emergency planning zone. The authorities will be responsible for the execution of rescue measures.

Ownership and possession of the site

The nuclear power plant is planned to be constructed in the central and northern parts of the Hanhikivi headland. Most of the area is currently in the possession of Fennovoima. A total of 366 hectares of land and water areas belonging to the Hanhikivi headland is in the possession of Fennovoima in January 2014 (Figure 3B-5). Most of the central and northern land areas of the headland are included in this area.

Fennovoima is in possession of these land areas either through ownership, or by having signed pre-contracts for the purchase or leases. The areas have been leased under two-part lease agreements that include a binding preliminary agreement on the right to purchase the leased property.

Fennovoima will continue the acquisition of areas on the Hanhikivi headland with the objective of owning all of the areas reserved for the nuclear power plant and its supporting functions in the land use plans. Acquisition of areas will primarily continue using voluntary agreements. In May 2012, Fennovoima submitted an application to the Government for a redemption permit based on the Act on the Redemption of Immoveable Property and Special Rights (603/1977). The redemption permit applies to land and water areas that are currently part of four farms, totaling around 108 hectares. Around 107 hectares of the area to which the redemption permit applies are land and water areas owned by a single group of holdings for redistribution.

Current situation of town planning and planning arrangements

Land use planning required by the project

Executing the project requires that the land use planning for the site includes a site reservation for the nuclear power plant in the regional land use plan, the local master

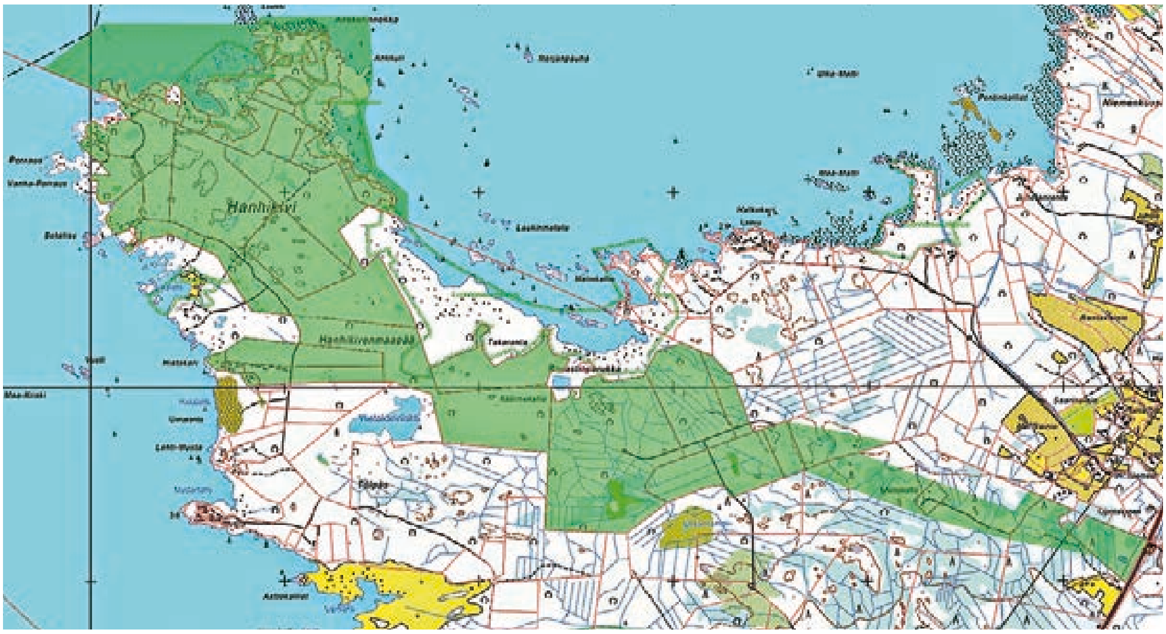


Figure 3B-5. The areas in possession of Fennovoima on the Hanhikivi headland are highlighted in green. (Property ID 878:13: Approximately 99.1 per cent of the property (approximately 1.2 ha) is managed by Fennovoima (portions 0.278443/0.281)).

plan and the local detailed plan. Land use in the Hanhikivi headland is prescribed by the Hanhikivi regional land use plan for nuclear power and the Raahe and Pyhäjoki local master plans and local detailed plans for the nuclear power plant area. The currently valid land use plans for the plant site indicate the areas reserved for the nuclear power plant.

The land use planning required for the execution of the project in the Hanhikivi headland has been completed and is in force at all three levels. The regional land use plan for nuclear power became legally valid in the fall, and the local master and detailed plans in summer 2013. Procedures pursuant to the Land Use and Building Act (132/1999) have been followed to prepare the land use plans of all levels as required by the project. The Council of Oulu Region has been responsible for preparing the regional land use plan. The local master and detailed land use plans have been prepared by the municipality of Pyhäjoki and the town of Raahe. The land use plans allow the construction of a nuclear power plant as specified within the project in the Hanhikivi headland, with no changes required to the currently valid land use plans.

Regional land use plan

Hanhikivi regional land use plan for nuclear power

The Hanhikivi regional land use plan for nuclear power applies in the Hanhikivi headland area. On April 7, 2008, the Board of the Regional Council of the Oulu Region decided to begin preparing a regional land use plan concerning the Hanhikivi headland for the purposes of the nuclear power plant project. The Hanhikivi regional land use plan for nuclear power was approved at a meeting of the Assembly of the Regional Council on February 22, 2010, and ratified in the Ministry of the Environment on August 26, 2010 (decision YM/2/5222/2010). In a decision issued on September 21, 2011, the Supreme Administrative Court rejected two complaints filed for the ratification of the land use plan. Following public notices, the regional land use plan for nuclear power became legally valid.

The Hanhikivi plant area is included in the Hanhikivi regional land use plan for nuclear power in its entirety (Figure 3B-6). The outline of the area defined in the Hanhikivi regional land use plan for nuclear power covers the planned nuclear power plant and the protective zone surrounding the plant at a radius of five kilometers. The plan also covers the power line connections from the current 220 kV main grid power line to the power plant area, as well as the 400 kV main grid to the substation in Nivala and to an optional substation at Lumimetsä in Vihanti. Furthermore, the land use plan area includes a reservation for a navigation channel to a harbor in the power plant area.

Most of the Hanhikivi headland, a total of 300 hectares, is indicated as energy management area (EN-yv) in the regional land use plan for nuclear power. Energy management areas are reserved for facilities, buildings and structures that serve energy production, and based on the more detailed land use plans, one or two nuclear power plant units as well as a repository for low and intermediate level nuclear waste can be constructed in the area as specified in the construction license granted in accordance with the Nuclear Energy Act. Furthermore, activities supporting a nuclear power plant may be placed in the area, such as temporary housing or plants and structures connected to the treatment of water.

The regional land use plan for nuclear power does not allow the final disposal of spent nuclear fuel in the Hanhikivi area, but temporary storage of spent nuclear fuel is allowed until the fuel can be transferred to a final repository. The minimum period of storage is 40 years.

Due to the historical significance of the Hanhikivi border rock, a monument of national importance located on the border of the energy management area, and the historical borderline indicated by the stone (currently the municipal border), the environment of the stone and the borderline must be kept as open as possible.

The regional land use plan for nuclear power also indicates the approximately outline of the protective zone reaching to a distance of five kilometers from the nuclear power plant. The protective zone includes the village of Parhalahti on both sides of main road 8.

The protective zone symbol indicates the protective zone in which land use restrictions are in force as specified in the STUK requirements. No new dense settlement and hospitals or facilities inhabited or visited by a considerable number of people will be allowed within the zone. Furthermore, the zone may not contain any significant productive activities as could be affected by an accident at the nuclear power plant. STUK as well as the rescue authorities must have the opportunity to issue a statement regarding the planning of the area.

Revision of the Northern Ostrobothnia regional land use plan, regional land use plan of the first stage

Revision of the Northern Ostrobothnia regional land use plan began in fall 2010, and the Assembly of the Regional Council approved the regional land use plan of the first stage on December 2, 2013.

The proposed first stage (Figure 3B-7) defines three nature conservation areas on the Hanhikivi headland. The following restriction applies to any land use planning for these areas: the land use of the area and its environment must be planned and implemented so that the purpose for which the area has been protected is not subjected

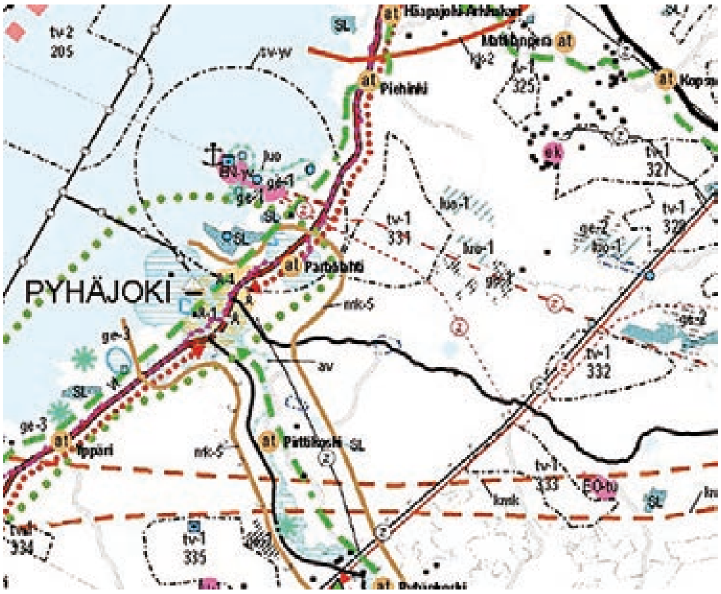


Figure 3B-6. The Hanhikivi headland in the Hanhikivi regional land use plan for nuclear power (2010).

Figure 3B-7. The Hanhikivi headland in the Northern Ostrobothnia regional land use plan of the first stage.

to any risk; instead, the natural diversity and ecological connections between areas must be protected. A statement from the Centre for Economic Development, Transport and the Environment, as specified in section 133 of the Land Use and Building Act, shall be requested on the building permit application.

Rocks important for the landscape (ge-1) are found on the southern and northern shores of the Hanhikivi headland. The ge-1 indication marks the geological formations of national importance in terms of nature and landscape conservation. According to the planning restriction, the land use in the area must be planned so that the landscape is not ruined, elements of significant aesthetic value or special natural formations are not destroyed, and no major or extensive harmful changes are caused to the natural environment.

A preliminary reservation for a 400 kV main power line has been made close to the Pyhäjoki and Raahe municipal border, and to the south of it, a reservation for a 110 kV main power line.

A need for a bicycle and pedestrian connection has been indicated for main road 8.

Local master plans

Component master plans for the Hanhikivi nuclear power plant area in the Pyhäjoki and Raahe municipalities apply to the Hanhikivi area. The local master plan for the Hanhikivi nuclear power plant area was approved by the Pyhäjoki Municipal Council on October 27, 2010, and by the Raahe Municipal Council on November 15, 2010. The land use plans have entered into force in summer 2013 after public notice.

The local master plan (Figure 3B-8) includes reservations for the nuclear power plant (EN-1) and its support and maintenance areas (EN-2). The land use plan also includes an area for work site functions (TP-1). The land use plan indicates that areas are to remain in agricultural and forestry use (M-1) along the Hanhikivi road connection which leads to the power plant area from main road 8. Some of the shore and water zone included in the energy management area and located at a distance of approximately 200 meters from the shoreline is indicated as W-1, a zone that can be used for the purposes of the power plant, such as the construction of docks and other structures and equipment required for the power plant. The construction must be carried out in compliance with the Water Act. The nature conservation areas (SL, SL-1, SL-2) and green protective zones (EV, EV-1) are also indicated in the local master plan.

The land use plan area is included in the nuclear power plant's protective zone in accordance with the general stipulation of the component master plan.

Local detailed plans

Local detailed plans for the Hanhikivi nuclear power plant area in the Pyhäjoki and Raahe municipalities apply to the Hanhikivi area. The local detailed plan for the Hanhikivi nuclear power plant area was approved by the Pyhäjoki Municipal Council on October 27, 2010, and by the Raahe Municipal Council on November 15, 2010. The land use plans entered into force in summer 2013 after a public notice.

The local detailed plan for the Pyhäjoki nuclear power plant area (Figure 3B-9) indicates an energy management area that can be used for building a nuclear power plant. The local detailed plan also indicates other necessary facilities required for the power plant: an area for temporary housing, other support function areas, the necessary traffic areas and a preliminary reservation for a navigation channel. The local detailed plan also indicates the locations of nature conservation areas and a protected historical monument, the Hanhikivi border rock. Passage to these areas is routed through the agricultural and forestry areas.

The entire tip of the Hanhikivi headland is largely reserved as an energy management area under two different indications (EN-1 and EN-2). A nuclear power plant with one or two plant units can be built on the EN-1 area. Temporary storage facilities for

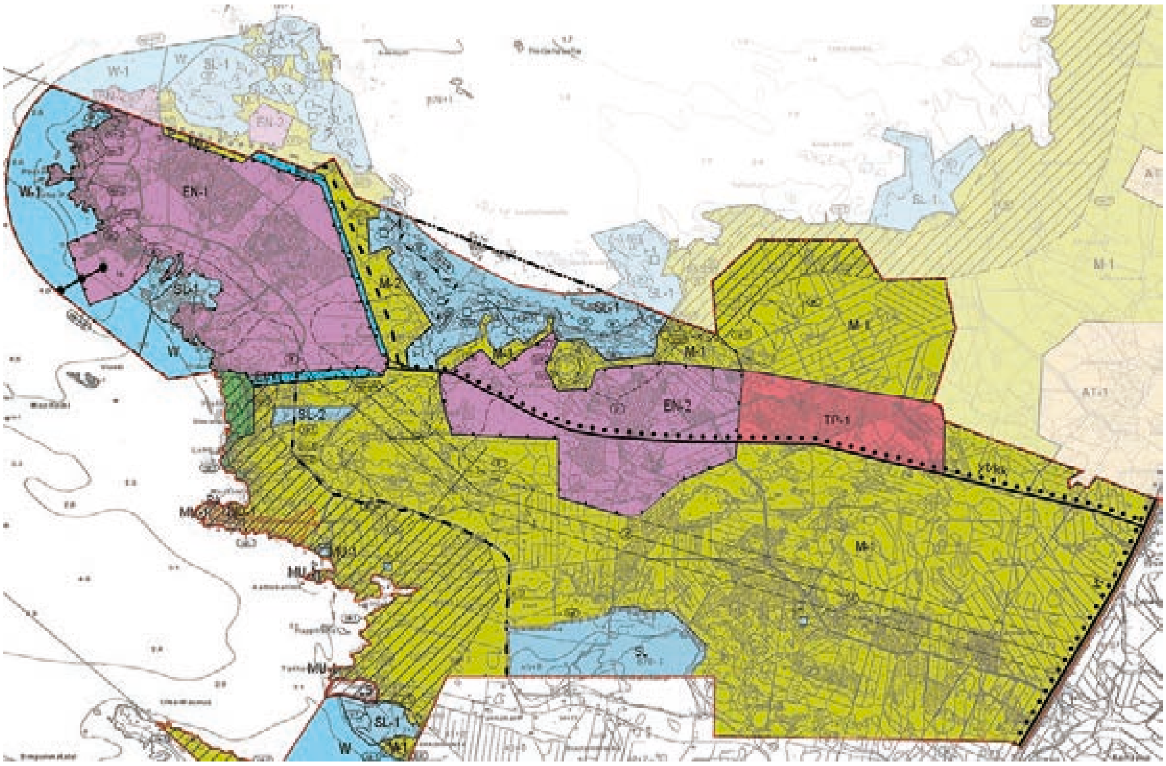


Figure 3B-8. Excerpt from the Pyhäjoki component master plan for the Hanhikivi nuclear power plant area (2010). The Raahe local master plan for the nuclear power plant area is printed with grayed out colors.

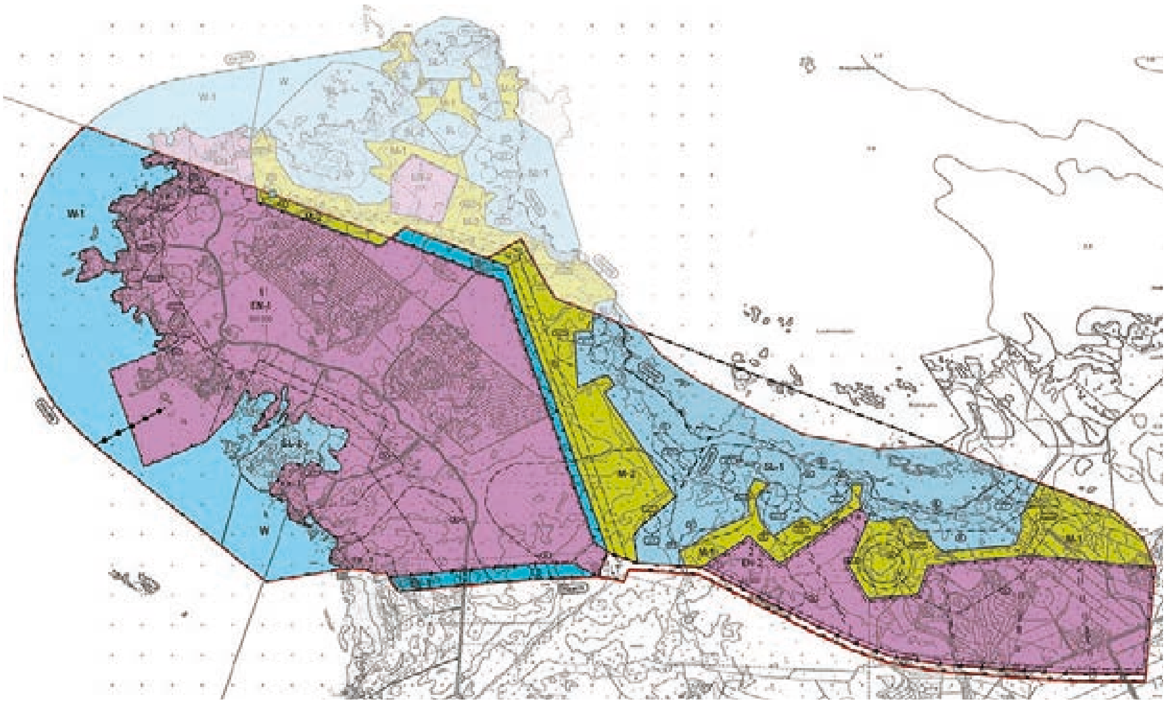


Figure 3B-9. The Pyhäjoki local detailed plan for the Hanhikivi nuclear power plant area (2010).

spent nuclear fuel and final disposal facilities for low and intermediate level nuclear waste can also be built in the area. The final disposal facilities consist of underground repositories (VLJ repositories) and their entrance buildings and structures, as well as encapsulation facilities and related auxiliary buildings. Temporary storage of spent nuclear fuel is also allowed in the area.

The water area that can be used for the purposes of the power plant and in which special areas have been defined for the construction of docks and other structures and equipment within the stipulations of the Water Act has been indicated as W-1. Other water areas have been indicated as W.

The total permitted building volume is 300,000 m^2 for EN-1 and 96,000 m^2 for EN-2.

The Raahe local detailed plan for the power plant area (Figure 3B-10) indicates the areas in which support facilities for the nuclear power plant as well as housing for construction and maintenance personnel can be built (EN-2). The local detailed plan also indicates the locations of nature conservation areas and the protected Hanhikivi border rock. Preliminary passage to these areas is routed through the agricultural and forestry areas. The water area that can be used for the purposes of the power plant and in which special areas have been defined for the construction of docks and other structures and equipment within the stipulations of the Water Act has been indicated as W-1.

The total permitted building volume indicated in the local detailed plan for EN-2 areas is 4,000 m^2.

In addition to the local detailed plans for the nuclear power plant area, the Hanhikivi headland has a separate local detailed plan for the workplace area located along the road connection that leads to the power plant area from main road 8. The workplace area is included in the component master plan for the nuclear power plant area.

The local detailed plan for the workplace area (Figure 3B-11), or the extension of the local detailed plan for the Hanhikivi nuclear power plant area in blocks 2, 4, 5 and 6, was approved by the Pyhäjoki Municipal Council on May 22, 2013. A complaint concerning the decision has been filed with the Oulu Administrative Court.

The local detailed plan for the workplace area indicates blocks of workplace and industrial functions in the immediate vicinity of the Hanhikivi nuclear power area. The plan indicates service building areas (P) and industrial and warehouse areas (T-1 and TY). The necessary traffic areas and green protective zones are also indicated (EV). The permitted building volume of the plan area has been defined using the ratio (e) of building volume to the surface area of the plot or building site.

The preparation of an extension of the local detailed plan for the Hanhikivi nuclear power plant area in block 3 has also begun (Figure 3B-12). The area is on the south side

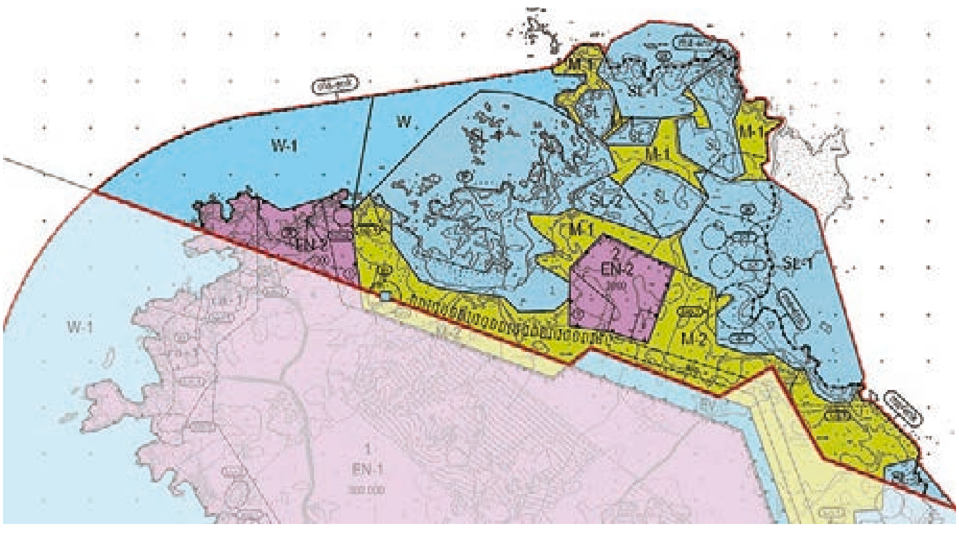


Figure 3B-10. The Raahe local detailed plan for the Hanhikivi nuclear power plant area (2010).

Figure 3B-11. The extension of the local detailed plan for the Hanhikivi nuclear power plant area in blocks 2, 4, 5 and 6 (2013).

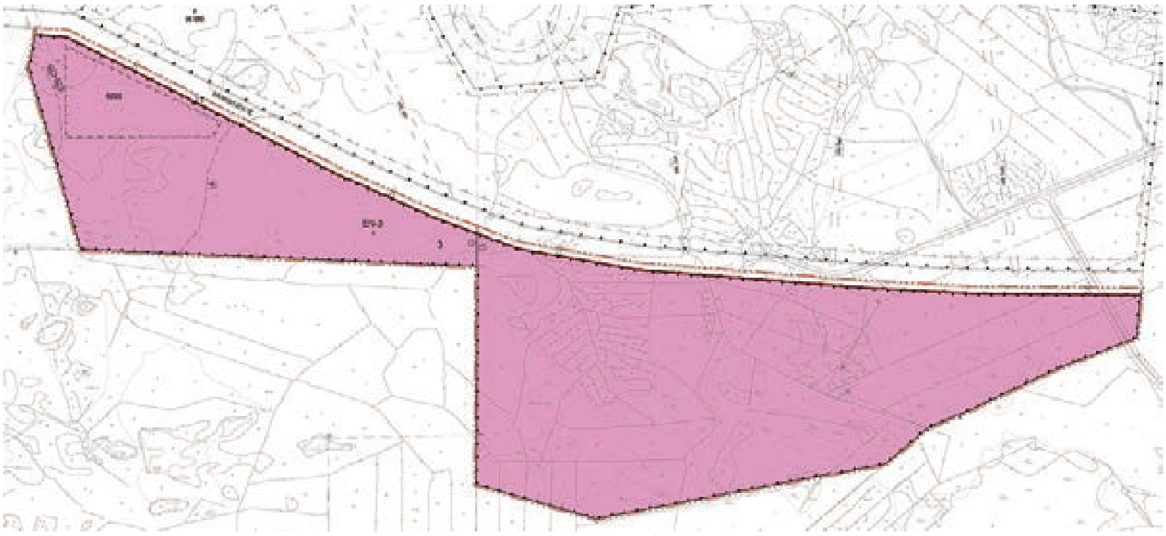


Figure 3B-12. Extension II of the local detailed plan of the Hanhikivi nuclear power plant area in block 3, draft plan (2013).

of the road connection from main road 8. On the north side, the land use plan extension area is limited by the local detailed plan of the Hanhikivi nuclear power plant area.

The purpose of the plan is to place support functions and construction and maintenance functions in the immediate vicinity of the Hanhikivi nuclear power plant area. The land use plan takes into account potential new power lines. The Pyhäjoki Municipal Council made the decision to launch the land use planning project on March 27, 2013. Block 3 belongs to the component master plan for the nuclear power plant. The draft plan was publicly displayed in summer 2013.

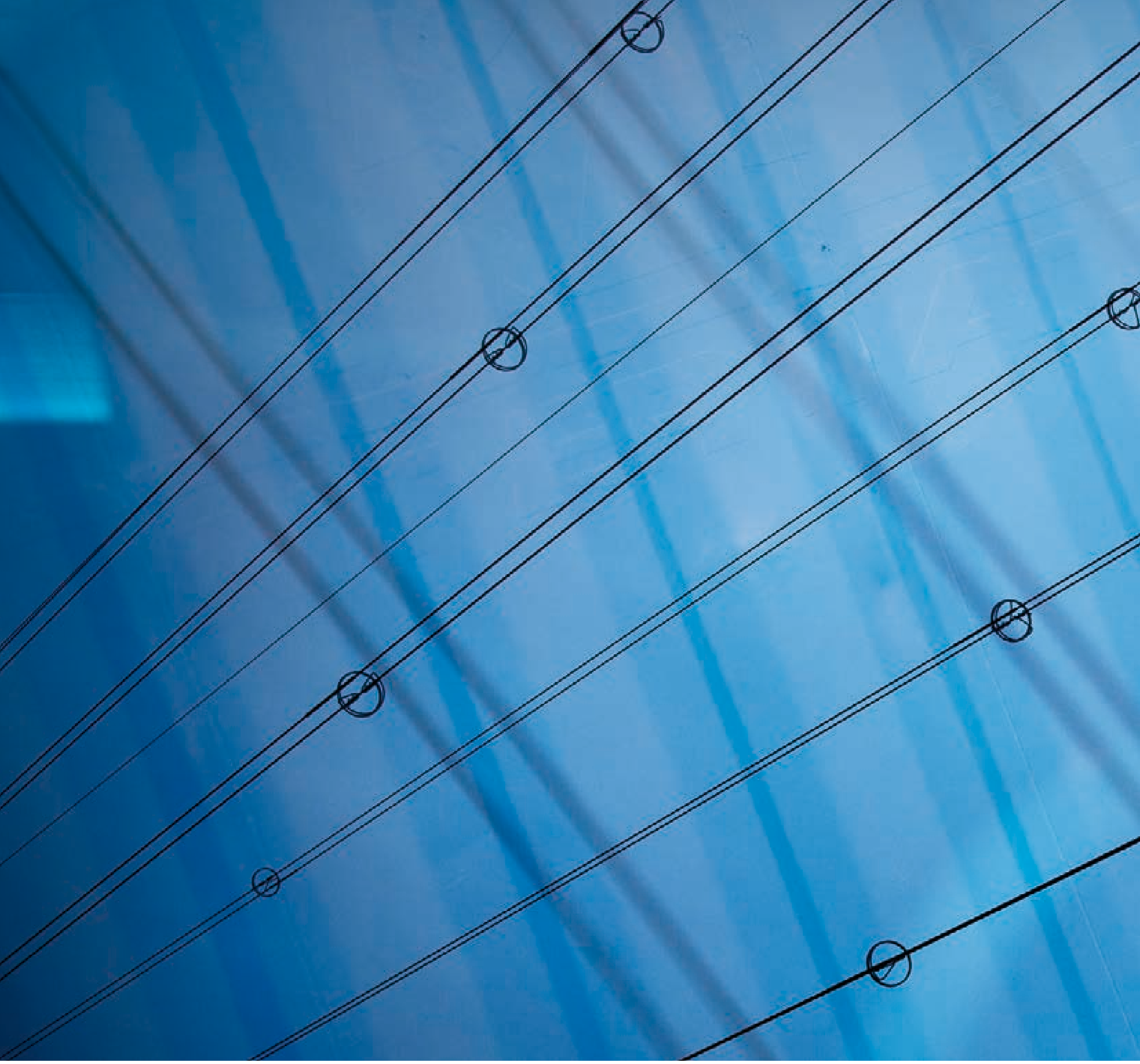
Suitability of the site for the construction and operation of a nuclear power plant

Based on completed surveys, the Hanhikivi headland in Pyhäjoki is well suited for a nuclear power plant site.

There are no factors related to the design, construction or safety of the nuclear power plant in the Hanhikivi headland or its immediate surroundings that would render the site unsuitable for the purpose or that could not be mitigated to an acceptable level. Furthermore, there is no existing industrial infrastructure in the planned site area to limit Fennovoima's possibilities of constructing a nuclear power plant along with all the necessary functions.

Planning the security arrangements measures together with the rescue authorities and Fennovoima's right of possession at the planned site area are favorable factors in protecting the plant against illegal activities. There are no population centers or functions in the immediate surroundings of the Hanhikivi headland that would prevent the planning and execution of effective emergency preparedness and rescue arrangements to limit potential nuclear damage.

An environmental impact assessment report (EIA report) as referred to in the Act on Environmental Impact Assessment Procedure has been drawn up concerning the project. According to the EIA report, the project will have no adverse environmental impacts that are unacceptable or could not be mitigated to an acceptable level.



Safety of the nuclear power plant

Appendix 4A

Description of observed safety principles

Summary

In Fennovoima's project, safety always takes precedence over all other objectives. Compliance with the stipulations of legislation and statutory regulations is the absolute minimum requirement for the construction and operation of Fennovoima's nuclear power plant.

Pursuant to section 6 of the Nuclear Energy Act, the use of nuclear energy must be safe and must not cause injury to people, or damage to the environment or property. Fennovoima's nuclear power plant can be constructed and operated in accordance with this requirement. Management of nuclear waste generated by the plant can also be executed in accordance with the general safety principle. Furthermore, the plant's security and emergency preparedness arrangements can be implemented at the selected plant site in compliance with laws and regulations.

The use of nuclear energy is subject to a license in Finland. Fennovoima will be responsible for the safety of the nuclear power plant and the related nuclear waste management in all phases of the project. The starting point for the safety design of the Fennovoima nuclear power plant is full compliance with the nuclear safety principles and regulations prescribed in the Nuclear Energy Act and in Government Decrees concerning nuclear safety. The minimum level of safety in the project is achieved by observing the general principles of nuclear energy use prescribed in chapter 2 and the safety principles and regulations prescribed in chapter 2a of the Nuclear Energy Act.

The level of safety at the nuclear power plant shall be kept as high as practically achievable. Plant safety shall be ensured through the defense-in-depth principle, that is by means of successive independent structural and functional protections. The plant will be designed and operated so that it fulfills the principles of entitlement, optimization and limitation regarding radiation use prescribed by the Radiation Act. In accordance with the limitation principle, neither the radiation dose of individuals nor the limit values set for the release of radioactive materials will be exceeded during normal plant operation or in the event of an anticipated operational occurrence or accident.

In December 2013, Fennovoima signed a plant supply contract concerning an AES-2006 nuclear power plant. The plant will be designed, constructed and operated in a manner that meets all requirements regarding the use of nuclear energy and radiation safety. The safety of the nuclear power plant design will be subjected to detailed assessment in connection with the application for a construction license referred to in section 18 of the Nuclear Energy Act.

The safety level to be followed in Fennovoima's project at minimum consists of legislation, general safety provisions from the Government, detailed safety regulations issued by STUK, and other stipulations concerning the operations.

Introduction

This appendix includes an overall description of the safety principles to be observed in accordance with section 24, subsection 2 (2) of the Nuclear Energy Decree (755/2013). The current document complements the information presented in the original decision-in-principle application, and describes the changes that have taken place in the project.

Pursuant to section 6 of the Nuclear Energy Act (990/1987), the use of nuclear energy must be safe and must not cause injury to people, or damage to the environment or property. The licensee has the obligation to ensure that nuclear energy is used in a safe manner. From the viewpoint of Nuclear Energy Act, the use of nuclear energy is considered safe when it meets the requirements defined in legislation and regulatory guides.

Nuclear power production is characterized by the radioactive materials used and generated in the electricity production process. Nuclear power plant safety primarily involves designing, construction and operating the plant in such a way that ensures that the effects caused by these radioactive materials are kept at a level that is acceptable and as low as practically achievable.

The general principles of nuclear energy use in Finland are prescribed in the Nuclear Energy Act. Continuous observation of safety principles is a fundamental precondition for the construction and operation of Fennovoima's nuclear power plant. Detailed regulations governing the following of safety principles are given in Government Decrees and in the regulatory guides for nuclear safety: the YVL guides issued by the Finnish Radiation and Nuclear Safety Authority (STUK). The authorities have effective legislation-backed means at their disposal for ensuring the safe use of nuclear energy at all phases of operations and for intervening if any actions are suspected as being in conflict with set requirements.

Amendments have been made to nuclear energy legislation and regulations since the 2010 decision-in-principle for example due to the Fukushima nuclear accident. Some of the Government Decrees have been replaced by new ones, and STUK issued new YVL guides in December 2013.

- The new Government Decrees are:
- Government Decree on the Safety of Nuclear Power Plants (717/2013)
- Government Decree on Emergency Response Arrangements at Nuclear Power Plants (716/2013).

Amendments have also been made into the Nuclear Energy Act (990/1987) and the Nuclear Energy Decree (161/1988).

The most significant changes made in nuclear safety regulations are concerned with matters such as preparation for external hazards of an extreme nature, such as occurred in the Fukushima accident, and the ability to cope with situations that involve a complete loss of all power supply to the plant. Stricter requirements have also been issued for the quality and project management of nuclear power plant projects. The basic safety principles presented in the Nuclear Energy Act have remained unchanged even if the details of regulations have been developed.

Fennovoima executes its project in accordance with valid laws and regulations.

Fennovoima's nuclear power plant will consist of one plant unit and a repository for low and intermediate level operating waste generated at the plant. The current document presents the principles and key requirements that shall be observed in order to ensure the safety of Fennovoima's nuclear power plant unit. The technical operating principles of the selected plant type are presented in more detail in Appendix 4B to this application, and the safety factors concerning the plant site in Appendix 3B. The operating waste repository is described in Appendix 5B.

Impact of changes that have taken place in the project

The selection of a new plant alternative instead of the alternatives described in the original application for a decision-in-principle does not affect the safety principles presented in this appendix, as the principles are of a general nature and apply to any plant alternative. The plant will be designed, constructed and operated in a manner that fulfills all Finnish requirements for nuclear and radiation safety, even though the original design of the plant is based on the requirements of another country.

Fennovoima has conducted a feasibility study together with the plant supplier to investigate the key technical and safety aspects of the plant alternative. Based on the feasibility study, Fennovoima is certain that the plant alternative can be made to comply with Finnish regulations with minor modifications. An overall description of the technical operating principles of the plant alternative assessed by Fennovoima is presented in Appendix 4B to this application.

Since the 2010 decision-in-principle, Fennovoima has engaged in systematic increasing of its organization. Fennovoima is responsible for all the licensing, construction and operation of the nuclear power plant, for which the expertise of E.ON was planned to be utilized as presented in the original application for a decision-in-principle. For a description of the expertise available to Fennovoima, see Appendix 1C to this application.

General principles of nuclear energy use

The overall good of society

Based on section 5 of the Nuclear Energy Act, the use of nuclear energy, taking into account its various effects, must be in line with the overall good of society. The decision-in-principle granted in 2010 confirms that Fennovoima's project is in line with the overall good of the society.

Licensing and responsibility for safety

The use of nuclear energy is subject to a license in Finland. The Government grants the license to construct and operate a nuclear power plant. The licensee is unequivocally obliged to assure the safety of the use of nuclear energy during all phases of operations. All use of nuclear energy must be at all times in accordance with the general principles of the Nuclear Energy Act.

General safety principle

Pursuant to section 6 of the Nuclear Energy Act, the use of nuclear energy must be safe and must not cause injury to people, or damage to the environment or property. In Fennovoima's project, safety takes precedence over all other objectives. Compliance with the stipulations of legislation and statutory regulatory regulations is the absolute minimum requirement for the construction and operation of Fennovoima's nuclear power plant.

Nuclear waste management

Section 6a of the Nuclear Energy Act requires that nuclear waste generated in Finland in connection with use of nuclear energy must be properly handled, stored and permanently disposed of in Finland. Final disposal of the low and intermediate level reactor waste generated at Fennovoima's nuclear power plant will be managed on site as detailed in Appendix 5B to this application. The spent nuclear fuel generated during the operation of Fennovoima's nuclear power plant is planned to be disposed of in a final disposal facility to be built in Finnish bedrock. Appendix 5B also includes a description of Fennovoima's plans and available methods for the management and final disposal of spent nuclear fuel.

Security and emergency preparedness arrangements

According to section 7 of the Nuclear Energy Act, sufficient security and emergency preparedness, as well as other arrangements for limiting nuclear damage and for protecting the use of nuclear energy against illegal activities, shall be a prerequisite for the use of nuclear energy. Fennovoima prepares the plans regarding the nuclear power plant's security and emergency arrangements in cooperation with the authorities. The emergency preparedness arrangements of the Fennovoima nuclear power plant will be planned and implemented in cooperation with STUK and the rescue authorities to ensure that any effects of nuclear damage caused by the operations of Fennovoima's nuclear power plant can be effectively contained.

Safety principles

Technical safety principle

Section 7a of the Nuclear Energy Act requires that the safety of nuclear energy use is maintained at as high a level as practically possible. For the further development of safety, measures shall be implemented that can be considered justified considering operating experience and safety research and advances in science and technology. Safety requirements and measures to ensure safety must be determined and targeted relative to the risks of using nuclear energy.

The AES-2006 plant type selected by Fennovoima represents advanced technology. The essential aspects of the plant design are based on proven technology, and the experience gained from the construction and operation of previous generations of nuclear power plants, as well as advances in science and technology, have been taken into account in its development.

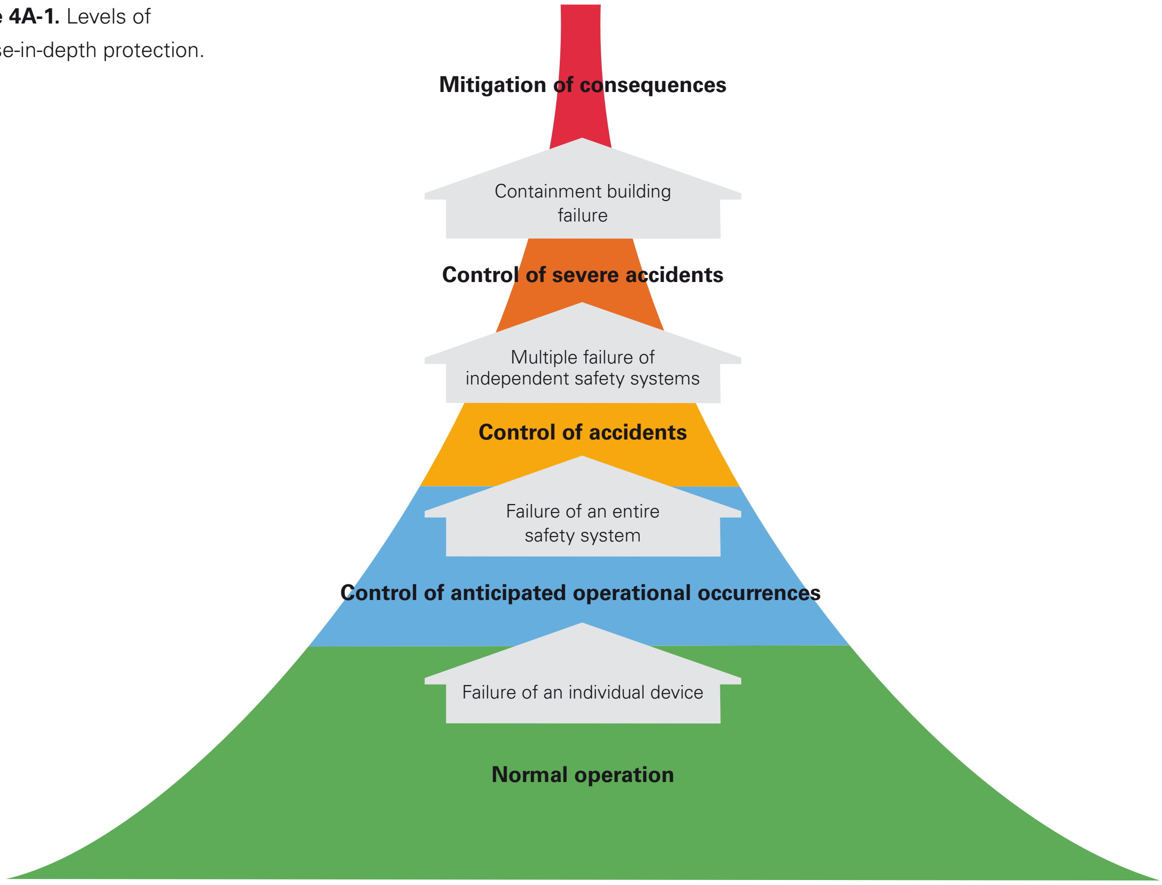
Defense-in-depth principle

Of all safety principles, the defense-in-depth principle referred to in section 7b of the Nuclear Energy Act is the most central. According to the defense-in-depth principle, the safety of a nuclear facility must be secured with successive, independent protections. The principle shall be applied both to structural and functional plant safety.

The uncontrolled release of radioactive materials generated by the nuclear power plant's operations into the environment is prevented by means of structural barriers. Functional implementation of the defense-in-depth principle is based on safety functions defined for the nuclear power plant. The plant's principal safety functions are reactor shutdown, residual heat removal from the reactor, and ensuring the integrity of the containment. The safety functions are successive, so that a failure of a single function shall not be able to cause harm to people or the environment (Figure 4A-1). The principle is applied to the design of technical systems as well as to the planning of the actions and procedures of the organization and the people.

For a detailed description of defense-in-depth principles, see the original application for a decision-in-principle.

Figure 4A-1. Levels of defense-in-depth protection.



Radiation safety principles

Pursuant to section 7c of the Nuclear Energy Act, radioactive material emissions arising from nuclear energy use must be restricted in accordance with the principle prescribed in section 2, subsection 2 of the Radiation Act (592/1991), which states that emission-related radiation exposure must remain as low as practically possible. The maximum values for radiation exposure of individuals arising from the operation of the nuclear facility or from other nuclear energy use are prescribed in the Government Decree on the Safety of Nuclear Power Plants (717/2013).

Fundamental nuclear safety requirements

Provision for anticipated operational occurrences and accidents

Section 7d of the Nuclear Energy Act stipulates that the design of a nuclear power plant shall provide for the possibility of anticipated operational occurrences and accidents. Based on the feasibility study of Fennovoima's selected plant type, it can be implemented to meet the requirements and radiation dose limits listed in Table 4A-1.

Verification and assessment of safety

According to section 7e of the Nuclear Energy Act, compliance with requirements concerning the safety of a nuclear power plant must be reliably demonstrated. As the nuclear power plant project proceeds, an overall assessment of plant safety will be carried out in connection with the application for the construction and operating licenses, and regularly at ten-year intervals during the operation of the plant. STUK will continuously oversee the safety of the construction and operation of the plant.

Construction and operation

Section 7f of the Nuclear Energy Act stipulates that safety shall have highest priority during the construction and operation of a nuclear facility, and specifies that the holder of the construction license or operating license is responsible for plant safety. Fennovoima will be responsible for plant safety at all phases of the project. The safety of people, the environment and property is given precedence over all other objectives.

Decommissioning

According to section 7g of the Nuclear Energy Act, the design of a nuclear facility shall provide for the facility's decommissioning. Fennovoima will prepare a decommissioning plan together with the plant supplier in connection with the construction license application.

Nuclear materials and nuclear waste

Section 7h of the Nuclear Energy Act requires the nuclear power plant to have sufficient facilities, equipment and other arrangements in place to ensure the safe handling, treatment and storage of the nuclear materials needed by the plant and of the nuclear waste generated by its operations. Appropriate facilities will be designed and built at the

Table 4A-1. The maximum individual radiation doses and incident frequencies per incident category.

Incident category Government Decree (717/2013)	**Annual dose commitment limit** Government Decree (717/2013)	**Likelihood of occurence** Guide YVL B.3
Normal operation	0,1 mSv	–
Abnormal operation (anticipated operational occurrence)	0,1 mSv	More than once per 100 years
Category 1 postulated accident	1 mSv	Less than once per 100 years
Reference value	*The Finnish average individual annual dose commitment is approximately 3.7 mSv*	
Categry 2 postulated accident	5 mSv	Less than once per 1,000 years
Extension of postulated accidents	20 mSv	Less than once per 10,000 years*
	Requirements Government Decree (717/2013)	**Design objective** Guide YVL A.7
Severe accident	No extensive civil defence measures required No long-term restrictions on the use of extensive geographical and aquatic areas Atmospheric release of cesium-137 under 100 TBq	Less than once per 100,000 years
Very severe accident	Selection of plant site Mitigation of radiation hazard	Less than once per 2,000,000 years

* Incident frequency is indicative; extension of postulated accidents is not specified in Regulatory Guide YVL.

Fennovoima nuclear power plant for the safe handling and storage of fresh fuel, other nuclear materials and nuclear waste generated at the plant.

Personnel

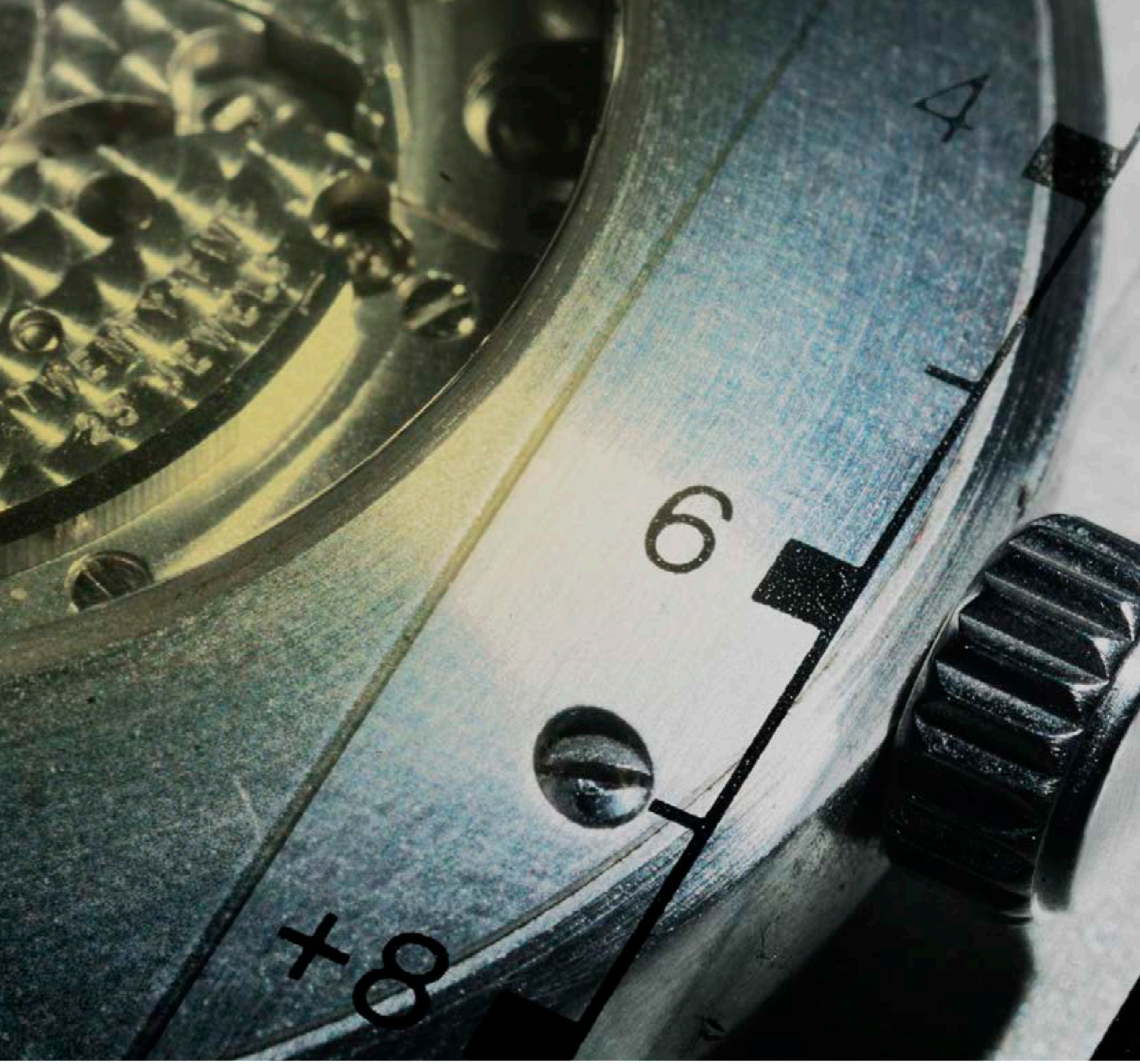
Pursuant to section 7i of the Nuclear Energy Act, the holder of the license granting the right to use nuclear energy must have a sufficient number of qualified personnel suitable for the related tasks. The licensee shall appoint persons responsible for ensuring emergency preparedness arrangements, security arrangements and the control of nuclear materials. Only persons approved by STUK specifically for each position can be appointed as the person responsible or the deputy. The licensee must organize adequate training for maintaining and developing the expertise and skills of the personnel responsible for nuclear safety-related tasks. Fennovoima will carry out recruitment, introduction training and other training operations to ensure that it will have an appropriate organization for each phase of the project, and the adequate expertise to ensure safety. Fennovoima has strongly increased its organization and will continue to develop the expertise of the personnel during the project. For a more detailed description of Fennovoima's organization and the available expertise, see Appendix 1C to this application.

Management system

Section 7j of the Nuclear Energy Act requires that the management system for a nuclear power plant shall pay particular attention to the impact of safety related opinions and the attitudes of the management and personnel towards the maintenance and development of safety, alongside systematic operating methods and their regular assessment and development. Fennovoima emphasizes the importance of a good safety culture as a prerequisite of the implementation of the project. Key points of the maintenance and development of safety culture are defined in Fennovoima's safety policy, which is part of the company's management system.

Responsible manager

Section 7k of the Nuclear Energy Act states that the licensee must appoint a responsible manager and deputy for the construction and operation of the nuclear power plant. Fennovoima will appoint a responsible manager and a deputy in connection with the construction license application at the latest.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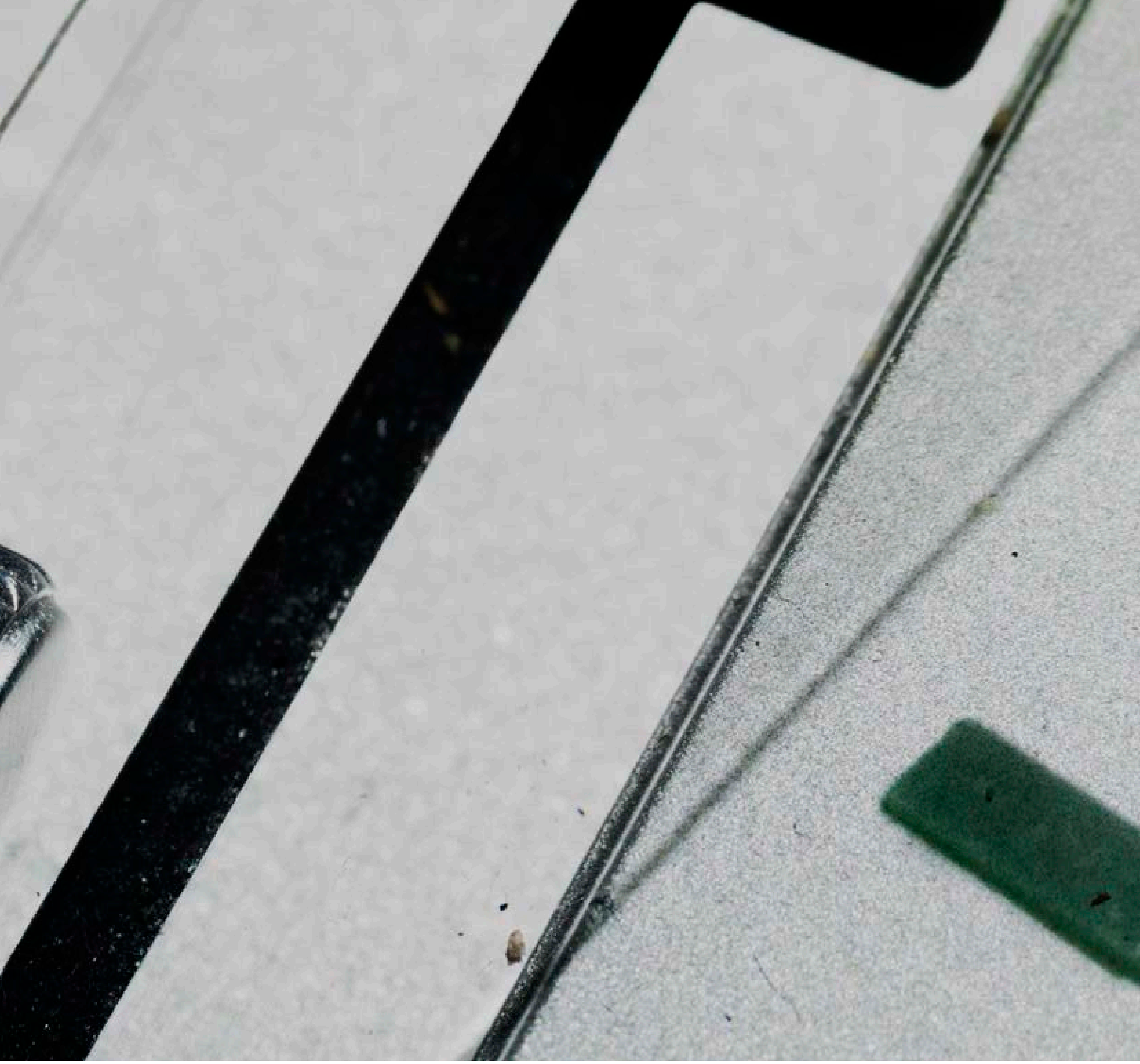


Safety of the nuclear power plant

Appendix 4B

General description of the technical principles of a nuclear power plant

Summary

In December 2013, Fennovoima and Rusatom Overseas CJSC signed a plant supply contract concerning the delivery of an AES-2006 nuclear power plant to Hanhikivi in Pyhäjoki. The AES-2006 developed by the Rosatom Group is a pressurized water reactor with an electrical output of approximately 1,200 MW and the basic technology very similar to that of other pressurized water reactors. The safety solutions of the plant represent the most advanced technology available.

Fennovoima has assessed the operating and safety principles of Rosatom's AES-2006 and found that the plant can be designed and constructed to meet Finnish safety requirements and any other requirements that Fennovoima sets for its nuclear power plant. According to the feasibility study prepared by Fennovoima together with the plant supplier, the AES-2006 can be built in Finland so as to ensure safe operation and to cause no injury to people, or damage to property or the environment.

The three-step licensing procedure defined in nuclear energy legislation ensures that safety receives the appropriate attention at all phases of a nuclear power plant project. The plant will be designed specifically for Fennovoima's nuclear power plant project, and the necessary modifications will be made to fulfill Finnish requirements. In the actual licensing phases, when the construction and operating licenses pursuant to the Nuclear Energy Act are applied for, the design and construction of the power plant will be reviewed in detail.

The waste heat generated during plant operation and discharged into the sea with the cooling water can be utilized. The technical-economic feasibility of the utilization of waste heat will be assessed separately at later stages of the project.

Introduction

This appendix includes an overall description of the technical principles of the planned nuclear facility in accordance with section 24, subsection 2 (1) of the Nuclear Energy Decree (755/2013). The current document complements the information presented in the original decision-in-principle application, and describes the changes that have taken place in the project. The technical principles of the repository for low and intermediate reactor waste to be built in the plant area are described in Appendix 5B to this application.

Pursuant to section 6 of the Nuclear Energy Act (990/1987), the use of nuclear energy must be safe and must not cause injury to people, or damage to the environment or property.

The three-step licensing procedure defined in nuclear energy legislation ensures that safety receives the appropriate attention at all phases of a nuclear power plant project. Fennovoima and the plant supplier have together completed a feasibility study for the AES-2006 pressurized water reactor with regard to this application. The purpose of the feasibility study is to ensure that the plant alternative has no features that could at a later stage of the project completely prevent the construction of the plant in Finland, or require considerable changes to the plant.

In the actual licensing phases, when the construction license pursuant to section 18 and operating license pursuant to section 20 of the Nuclear Energy Act will be applied for, the design and construction of the power plant will be reviewed in detail. This will ensure that the plant will be constructed to meet Finnish regulations.

The current document is a description of the AES-2006 developed by Rosatom, and the general technical principles of its major safety functions. In addition, the document briefly discusses the potential of utilizing the waste heat produced by the nuclear power plant.

Impact of changes that have taken place in the project

In December 2013, Fennovoima signed a plant supply contract with Rusatom Overseas CJSC for the supply of an AES-2006 pressurized water reactor to Pyhäjoki. Rusatom Overseas CJSC is a part of the Russian Rosatom Group. The AES-2006 plant alternative was not assessed in connection with Fennovoima's original application for a decision-in-principle. A feasibility study of its plant design was carried out in fall 2013 and submitted to the Radiation and Nuclear Safety Authority (STUK) for review. The basic technical information of the plant is presented in Table 4B-1. Similarly to the plant alternatives investigated earlier, AES-2006 is a light water reactor, which means that the operating principles of light water reactors described in the original application for a decision-in-principle apply.

The AES-2006 is a modern pressurized water reactor, similar to for example Areva's EPR, which was included in the original plant alternatives. The long history of modern pressurized water reactors has resulted in similar basic technology being used by all plant suppliers, and the major safety functions (power control, reactor cooling and preventing the spread of radioactive substances) are based on similar solutions. With

	Rosatom AES-2006
Manufacturer, Country (of origin)	Rosatom, Russia
Thermal Power (MW)	about 3,220
Electricity Output (MW)	about 1,200
Reactor Type	Pressurized Water Reactor (PWR)
Primary Safety Systems	Active and passive
Reference Plant, Country	Leningrad II-1, Russia

Table 4B-1. Technical information of Rosatom's AES-2006 nuclear power plant.

regard to its key operating principles and safety assurance, the AES-2006 is therefore very similar to the alternatives introduced in the original application for a decision-in-principle. In some respects, the technology of the AES-2006 is more advanced, as its more extensive use of passive cooling systems increases the reliability of its residual heat removal. Figure 4B-1 is a presentation of the basic process of the AES-2006.

Technology and safety of Rosatom AES-2006

History

Rosatom's AES-2006 is a modern, third-generation nuclear power plant, which comes in two different versions: AES-2006/V392M and AES-2006/V491, which is the version to be built as Hanhikivi 1.

Rosatom has developed VVER reactors (Vodo-Vodyanoi Energetichesky Reaktor; "Water-Water Power Reactor") in an evolutionary manner, meaning that technical improvements have been added to existing plant types while maintaining proven solutions. AES-2006 plants are the latest evolution in this development, which means that they are based on proven VVER technology.

VVER plants have been developed and operated for more than 40 years. The VVER-440 was one of the first VVER reactors to be used for commercial energy production, and two plant units of this type have been safely operating in Loviisa for more than 30 years. The next major development was the VVER-1000, which had a higher thermal output and considerably more advanced safety features. All key safety systems are implemented as four independent, parallel redundancies that will be able to perform the necessary safety function even if one of the redundancies was not operational.

The plant type was further developed in the 1990s with the VVER-91 and later the VVER-91/99. Several plants of these types are currently operated around the world. The

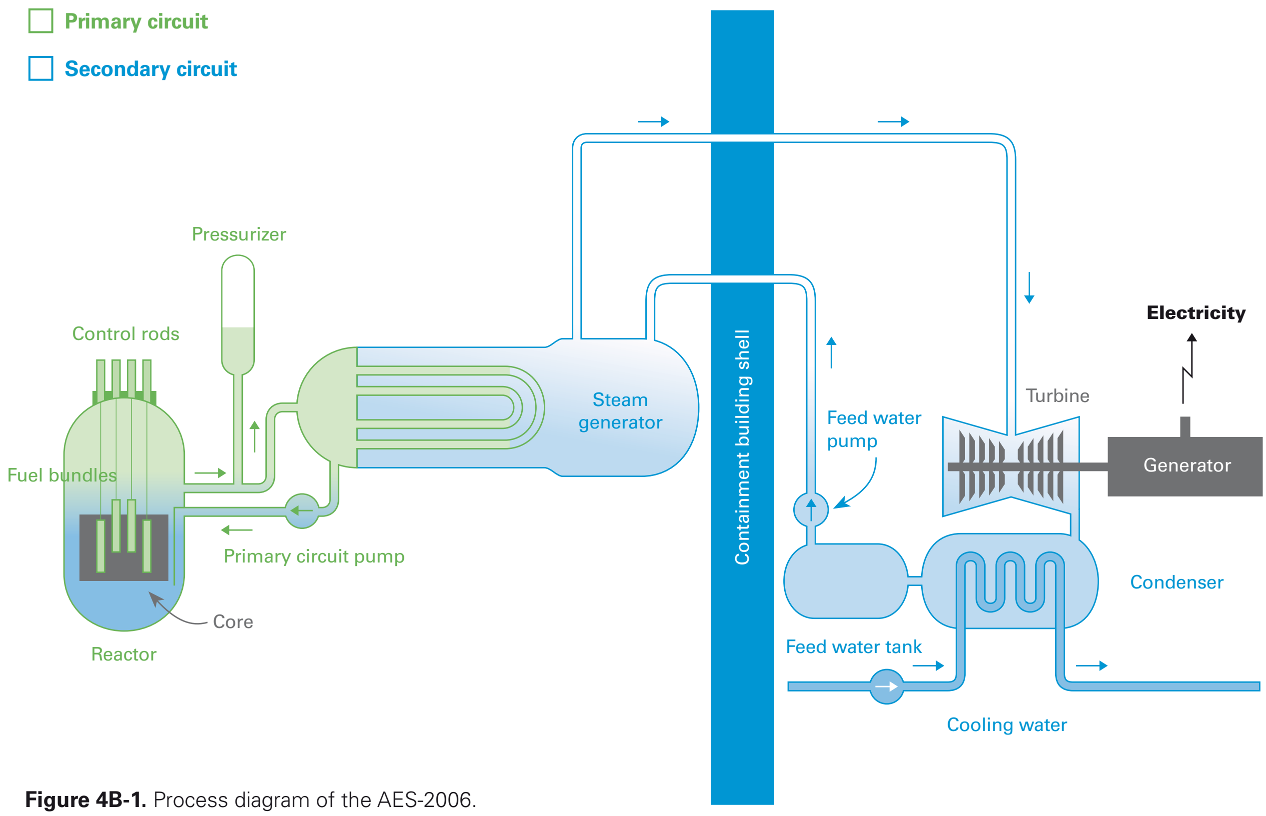


Figure 4B-1. Process diagram of the AES-2006.

AES-2006/V491 is a new evolution of the VVER-91/99. Important safety features of the AES-2006 that were not found in earlier models include passive safety systems driven by natural circulation and gravity. These systems require no electricity or other external driving force to keep them operational.

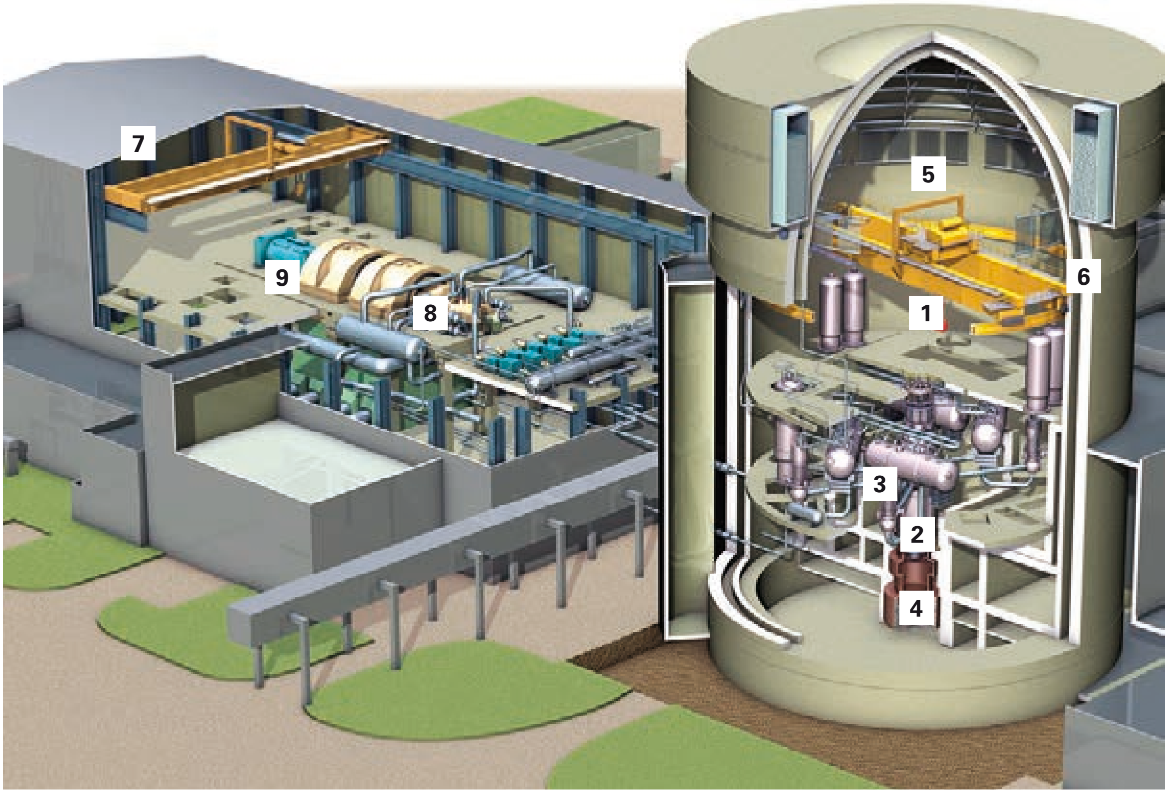
From the start, the safety design of the AES-2006 has aimed to comply with IAEA's safety guidelines and standards, European Utility Requirements (EUR), and the Russian national regulations and requirements.

The Leningrad II-1 (V491) plant unit under construction since 2008 in Sosnovy Bor is used as a reference plant for Hanhikivi 1. In addition to Sosnovy Bor, the same plant type is being constructed in Russia in Kaliningrad (one unit, V491) and Novovoronezh (two units, V392M).

The current document discusses the AES-2006/V491 plant version (hereinafter: "AES-2006").

Basic technology

The AES-2006 has the basic structure of a modern pressurized water reactor. To prevent embrittlement of the reactor pressure vessel due to fast neutrons, the pressure vessel is larger than in earlier VVER plants, leaving more water between the fuel and the wall of the pressure vessel to slow down fast neutrons and thus protect the pressure vessel. There is more than 30 years of operating experience in managing radiation embrittlement in VVER plants, and appropriate monitoring programs are in place. Figure 4B-2 is an approximate representation of the plant.



1 Reactor building
2 Reactor pressure vessel
3 Steam generator
4 Core catcher
5 Passive containment heat removal system
6 Inner and outer containment building
7 Turbine building
8 Steam turbine
9 Generator

Figure 4B-2. Rosatom AES-2006/V491.

The reactor core of the AES-2006 has 163 nuclear fuel elements and 121 control rods. The fuel elements have a hexagonal cross-section, and each of them contains 312 fuel rods. The large number of control rods ensures that the reactor will remain subcritical at low temperatures. The control rods are finger control rods typical of pressurized water reactors. They are used for rapidly shutting down the reactor and for adjusting the power distribution. During power operation, electromagnets hold the control rods in the top section of the core or completely out of the core. To adjust the power distribution, the control rods are also equipped with electronic motor control capable of precision operation.

The reactor core is designed so that the natural feedback of reactor power will restrain power variations. For example, when the core temperature increases, the reactor power decreases, which will keep the reactor stable at all temperatures. In addition, the safety margins related to heat transfer of the nuclear fuel are large in transient conditions.

The reactor's primary circuit has four reactor coolant loops, each with a horizontal steam generator and electric reactor coolant pump. The primary circuit also has a pressurizer for adjusting the primary circuit pressure.

The reactor, primary circuit and the components connected to it are manufactured from carefully selected materials, using the best modern manufacturing techniques. The components of the AES-2006 primary circuit will be designed and manufactured in accordance with the leak-before-break principle. This means that the pipes have no identified failure mechanisms that would cause a full and abrupt break. The rooms will also be equipped with complete leak detection systems that will reveal any minor leaking cracks in the pipes before a full failure.

The AES-2006 has a double containment that protects the reactor. The inner containment is dimensioned to withstand the energy discharged into the containment in accident conditions. The inner containment is a massive, cylindrical, pre-tensioned reinforced concrete structure with a steel lining. The inner containment is protected by an outer containment. The outer containment is the outer wall of the cylindrical reactor building, and it is dimensioned to withstand a collision from a large passenger airplane.

Next to the reactor building, there is a building that contains safety systems. Each subsystem of safety systems is located in its own compartment of the safety system building. Safety system-related devices are also separated by subsystem in the containment so that failure of one system's devices as a result of flooding or fire, for example, will not prevent the operation of other systems.

The safety building also contains the automation and auxiliary systems required for the control of safety systems. The reactor building of the AES-2006 has safety systems that use no external power source. The power supply of the active systems located in the safety building that require an external power source has been backed up by emergency diesel generators. The sea is the primary heat sink of the systems of the safety building. The diesel generators and the seawater pump stations of safety systems have been divided into pairs in separate, isolated buildings. External incidents will thus not be able to damage both buildings at once.

The reactor building, safety building, steam cell and turbine building of the AES-2006 are placed in line so that the turbine axis is directed at the reactor. This ensures that any turbine blade or piece of rotor which breaks off the steam turbine due to a failure cannot hit any safety-critical constructions.

The main safety functions of the AES-2006, such as emergency core cooling systems, are implemented using both active and passive safety systems. Safety systems follow the redundancy principle by being built as four parallel redundancies that will be able to perform the necessary safety function even if one of the redundancies was not operational.

The redundancies are located in separate facilities to comply with the separation principle. The active safety systems of the AES-2006 will be designed to comply with the diversity principle by using a minimum number of common factors that could result in the failure of several redundancies at the same time. Furthermore, passive safety systems are used to back up active safety systems. The implementation of each safety function is described in the following sections.

Reactor shutdown and power control

Control rods are used to shut down the reactor and to manage its power output. Emergency shutdown of the reactor is carried out by cutting power to the electromagnets that hold the control rods up. As a result, the control rods drop into the reactor core. The control rods drop into the reactor core within seconds. The control rods will be dimensioned so that the reactor will shut down and remain subcritical even if a single control rod stays completely out of the reactor due to a failure.

If the movement of the control rods is completely prevented for any reason, the reactor will be automatically shut down by pumping borated water into the primary circuit from dedicated storage tanks. The boron solution pumping system consists of four redundancies of 50 % capacity, which means that the system meets the single failure criterion set out in Government Decree 717/2013. With a total system capacity of 4 × 50 %, the system will be able to carry out the required safety function even if one of the pumps fails while another one is under maintenance.

Reactor cooling and residual heat removal

The cooling and residual heat removal of the AES-2006 can be carried out by active or passive systems. During operational occurrences that are not of a serious nature, cooling may, for example, be carried out via the steam generators by leading steam either into the turbine plant condenser or into the atmosphere through the steam generators' blowdown valves. During operational occurrences, the water mass inventory of the steam generators is maintained by an emergency feedwater system. In cases involving a complete loss of the AC supply, steam generators can be cooled down using a passive steam generator cooling system that requires no external power supply to transfer the heat into water tanks located outside the containment.

If steam generators are not available, the primary circuit can also be cooled using a system that feeds water into the reactor from a high-pressure emergency core cooling system and lets water out from the pressurizer's blowdown valves. During normal conditions and operational occurrences that are not of a serious nature, direct cooling of the primary circuit in low-pressure conditions is possible by using a low-pressure emergency core cooling system with residual heat removal settings. The system consists of four full-capacity redundancies (4 × 100 %), which means that the system exceeds the failure criteria of a single failure of one redundancy combined with one redundancy being under maintenance.

During accidents and operational transients of a more serious nature, particularly in the case of primary circuit leaks, both high-pressure and low-pressure emergency core cooling systems are used to cool the reactor. The emergency core cooling systems also include accumulators pressurized by nitrogen gas. The accumulators are connected to the reactor pressure vessel via non-return valves. The accumulators discharge automatically with no control measures required when the pressure of the primary circuit falls below the gas pressure of the tanks.

The high-pressure and low-pressure emergency core cooling systems both have four redundancies. The pumping capacity of each redundancy (4 × 100 %) is adequate for performing the emergency cooling function, which means that the emergency core cooling systems meet the failure criteria set for a primary safety function. The pressure produced by the high-pressure emergency core cooling system pumps is selected to be lower than the opening pressure of the steam generator safety valves. This prevents the release of primary circuit coolant into the environment in situations that involve a leak from the primary circuit to the secondary side (turbine side) of the steam generators.

High-pressure and low-pressure emergency core cooling systems take water from a cooling water tank located in the lower part of the containment. Boron is added to the emergency cooling water as in all pressurized water reactors. Water that leaks into the containment from the primary circuit flows into the same tank. The sump strainers of emergency core cooling systems are dimensioned to strain any insulation materials and impurities with no major pressure loss.

The high-pressure and low-pressure systems function as mutual back-up systems. If the high-pressure system is not operational, the pressure of the primary circuit is lowered so that the emergency cooling capacity of the low-pressure system is adequate. The pressure of the primary circuit can be lowered either by steam generator blowdown valves, primary circuit blowdown valves, or both. The capacity of the high-pressure system, on the other hand, is adequate to fill the reactor and maintain an adequate cooling level with no separate pressure relief.

Residual heat is transferred into the ultimate heat sink via steam generators. The atmosphere or the sea (via the condenser) can be used as the ultimate heat sink. In addition, residual heat can be removed from the containment using a completely passive containment residual heat removal system. Residual heat can also be transferred into the sea via the low-pressure emergency core cooling system's heat exchangers and the intermediate and seawater circuits. The intermediate and seawater circuits are included in the plant's safety systems. There are four intermediate and seawater circuits, one for each safety system redundancy.

Overpressure protection of the primary circuit is carried out using three safety valves connected to the pressurizer and controlled by spring-loaded control valves. At the reference plant, pressure relief to mitigate severe accidents is designed to use the same safety valves that are used in other accident conditions. In addition, the primary system pressure can be reduced by using the passive residual heat removal system of the steam generators. The solution used at the reference plant may require a new severe accident pressure relief line to be designed before a construction license is applied for.

Ensuring the integrity of the containment

The outer shell of the AES-2006 containment is a reinforced concrete structure that will be dimensioned to withstand an aircraft crash. The inner containment is made of pre-tensioned reinforced concrete with a steel lining to ensure gas-tightness. The pressure of the annular space between the outer and inner containment will be kept slightly below atmospheric pressure to allow monitoring of the containment and to ensure that any leaks occur through filtering systems.

The pipes and channels that pass through the containment wall are equipped with isolation valves on both sides of the wall. In the case of a transient or accident, the valves are closed or they close automatically, unless the valve in question is used to control the situation as a part of a safety system. To secure the isolation function, the inner and outer isolation valves are different from each other. All systems have two isolation valves, with the exception of the emergency core cooling system suction lines, which only have one isolation valve because the flow route must be open during accident conditions.

The AES-2006 has the possibility of direct cooling of the containment using two different systems. The containment can be cooled using a sprinkler system with active pumps. The water sprayed into the containment by the sprinkler system flows via sumps to heat exchangers that will transfer the heat from the containment into the intermediate circuit and further into the sea. The passive containment cooling system requires no electricity and therefore remains operational even in conditions that involve a complete loss of all power supply to the plant. Cooling of the containment will reduce the pressure within the containment during accidents. As a result, the containment will remain gas-tight and the spread of radioactive substances into the environment can be prevented.

Instrumentation and control of the safety systems

Monitoring and control of safety systems will be primarily carried out using programmable instrumentation and control systems. The reactor protection system consists of four redundancies so that at least four times the necessary number of measuring instruments required for starting up the major safety functions exist, ensuring that each redundancy has all the necessary instrumentation. The safety function is launched when two out of four measuring instruments indicate that the start-up criteria are met. This operating method has been chosen for its ability to allow the testing of an individual redundancy even during the operation of the plant; even if one redundancy is being tested and another fails, the safety function is still able to launch, but it will not be triggered unnecessarily.

The AES-2006 has two reactor protection system redundancies which have differing operating principles. To back up programmable systems for cases of common cause failure, the plant has hardwired back-up systems that operate independent of any computers.

Electricity feed of the safety systems

Normally, safety systems get their power supply directly from the plant generator or from the national grid via a separate transformer. For back-up power, the plant has four emergency diesel generators, dimensioned to be able to maintain all safety systems. Each diesel generator serves all the loads included in its own redundancy, such as pumps, fans, valve actuators, monitoring and control systems.

Hanhikivi 1 will also have diesel generators dedicated for design extension conditions and severe accidents added as part of normal progress of plant design. These components do not exist in the reference plant. These diesel generators will be separate from the emergency diesel generators and improve the electricity self-sufficiency of the plant; power supply to the most critical systems of the plant can be arranged even in particularly difficult accident conditions which involve the loss of external power supply.

Management of a severe reactor accident

Management of a severe reactor accident is carried out at the AES-2006 by four special safety functions: reactor pressure relief, cooling the molten core in the core catcher located at the bottom of the reactor pit; catalytic recombination of hydrogen; and residual heat removal from the containment.

At the reference plant, reactor pressure relief is planned to be carried out using primary circuit safety valves and the emergency gas removal system. The solution as such is not compliant with Finnish safety requirements, which state that the systems designed for the management of severe accidents must be independent of the systems designed for the plant's normal operation and design basis accidents. If pressure relief cannot be carried out using existing systems, for example by increasing their capacities, the necessary pressure relief line will be designed before the construction license application is submitted.

In the AES-2006, cooling of a molten core in case of a severe reactor accident is arranged to take place in the core catcher, which is located below the reactor pressure vessel. Cooling water will flow onto the outer surface of the core catcher from the coolant tank located inside the containment, and from the shaft used for the inspection of reactor internals. A molten core will be cooled directly within the core catcher and indirectly from the outside. The steam generated in the core catcher will be condensed in the passive residual heat removal system of the containment, from which the coolant will flow back into the core catcher via the coolant tank. The core catcher will ensure that a hot molten core will not come into contact with the floor of the containment, and that the core will remain inside the containment. The core catcher of the AES-2006 is the result of long-term research and development.

Hydrogen is released during a severe reactor accident, when the zirconium cladding of the nuclear fuel, as well as other metals, oxidizes due to the influence of steam. The hydrogen flows into the containment and causes a fire and explosion hazard, which is prevented in the AES-2006 by equipping the facility with passive recombiners which turn hydrogen and oxygen into water through a catalytic process. The catalytic oxidization of hydrogen in the recombiners begins spontaneously at a very low hydrogen concentration, before the concentration increases to a level where the hydrogen-air mixture in the containment would be able to ignite. The number of recombiners will be determined so as to rule out any possibility of an explosive hydrogen-air mixture being created.

In severe accident conditions, the primary means of removing residual heat from the containment will be a passive residual heat removal system with a 4 × 33 % capacity.

A severe reactor accident occurring during a plant outage will be managed similarly to an accident that occurs during power operation, with the difference that provision must be made for closing the access openings of the containment and, in particular, the equipment hatch fast enough, if they have been opened for maintenance work.

Provision for external hazards

The dimensioning of the plant will take into account any external hazards such as extreme weather conditions, climate change, earthquakes, chemical transportation accidents that may occur in the vicinity of the plant, and illegal activities, including an intentional airplane crash.

Fennovoima defines, together with Finnish and Swedish authorities and research institutes, a design basis to be used in the design of the plant constructions. This design basis is, with high certainty, much more stringent than any conditions that can be assumed to exist during the lifetime of the plant. The impact of climate change will be assessed based on the predictions of the UN's Intergovermental Panel on Climate Change (IPCC).

The AES-2006 specifically designed for Fennovoima will be dimensioned to withstand external hazards so that it can be operated at the Pyhäjoki site until the end of its lifetime with sufficient safety margins.

Various structural and organizational safety arrangements will be used to protect against illegal activities. Collision of a passenger airplane will be taken into account in the dimensioning of safety-critical structures. At Rosatom's reference plant, preparation for an airplane crash is not at the level required by Finnish regulations, but Fennovoima's plant will be designed to meet Finnish requirements.

Assessment of the prospects for building the AES-2006 in compliance with Finnish regulations

STUK assessed the AES-2006 plant type in 2009 and found its design objectives and basic principles to be, for the most part, in line with Finnish regulations. STUK has also listed four items where the technical solution will need to be developed before a construction license is granted:

- Physical separation of safety systems must be ensured.
- Protection against an airplane crash must be extended to the steam cell and safety system building.
- Separation of the instrumentation and control systems included in different safety classes must be indicated more clearly.
- Primary circuit pressure relief during a severe accident must be implemented independently of other pressure relief systems.

Resolving the four issues listed above in compliance with the current requirements will be included in the engineering work to be carried out before applying for a construction license. In addition, STUK requires in connection with its assessment that analyses and testing are carried out to clarify the basis for some of the plant's technical solutions:

- Experiments to prove the functional capacity of passive residual heat removal systems.
- The analysis requirements of reactor pressure vessel materials and the implementation, inspection and radiation protection principles of the primary circuit pipe branches.
- The impact of postulated unexpected pipe breaks of the primary circuit on the durability of reactor internals.
- The need to add a containment filtered venting system.
- Sump strainers of the emergency core cooling system and experiments to ensure their functionality.
- Technical solutions related to the cooling water supply to the systems that implement the diversity principle for 72-hour residual heat removal.
- AC power supplies that implement the diversity principle.
- Power supply for the severe accident management system.
- Lessons learned from the Forsmark incident.
- Separation principles of the electrical and I&C systems.
- Extent of the hardwired reactor protection system.
- Application of the diversity principle to the measurements of the reactor protection system and the activation of protections.

The additional clarifications listed above are typical additional information concerning technical solutions, which STUK has also requested in connection with the preliminary safety assessment of other plant alternatives considered in Finland.

Between 2009 and 2013, STUK has modified the requirements set for technical solutions as a result of for example the Fukushima nuclear accident. Some of these new requirements have not been taken into account in the 2009 assessment. Fennovoima carried out a feasibility study together with the plant supplier to assess the ability of the AES-2006 to meet the latest Finnish safety regulations. The assessment revealed no such matters that would prevent the design and construction of the AES-2006 in compliance with Finnish regulations. The feasibility study has been submitted to STUK for review.

Electricity generation and other utilization of thermal energy

Production of electricity using condenser technology

The primary purpose of Fennovoima's nuclear power plant is the production of electricity using a condenser power plant process. The power production properties of the low-pressure turbine at the plant correspond to those of condenser power plant turbines, which is a major benefit for the management of power grid disturbances.

Fennovoima and the Finnish national grid operator Fingrid have carried out a preliminary survey and found that Fennovoima's plant alternative can be connected to the national grid in Pyhäjoki. The survey covered power transfer in various operating conditions of the national grid, and network disturbance management in accordance with Fingrid's system requirements.

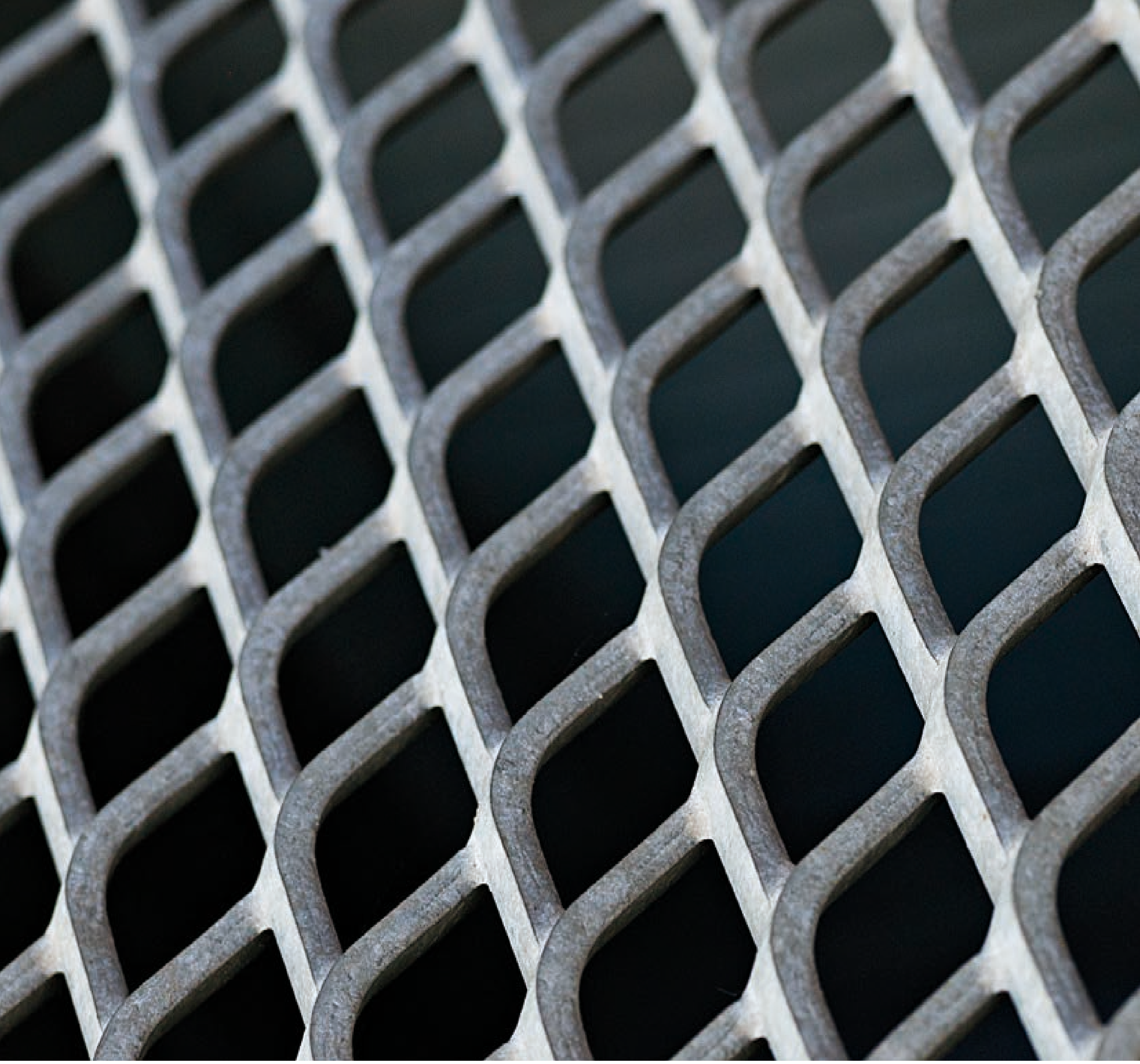
Combined heat and power

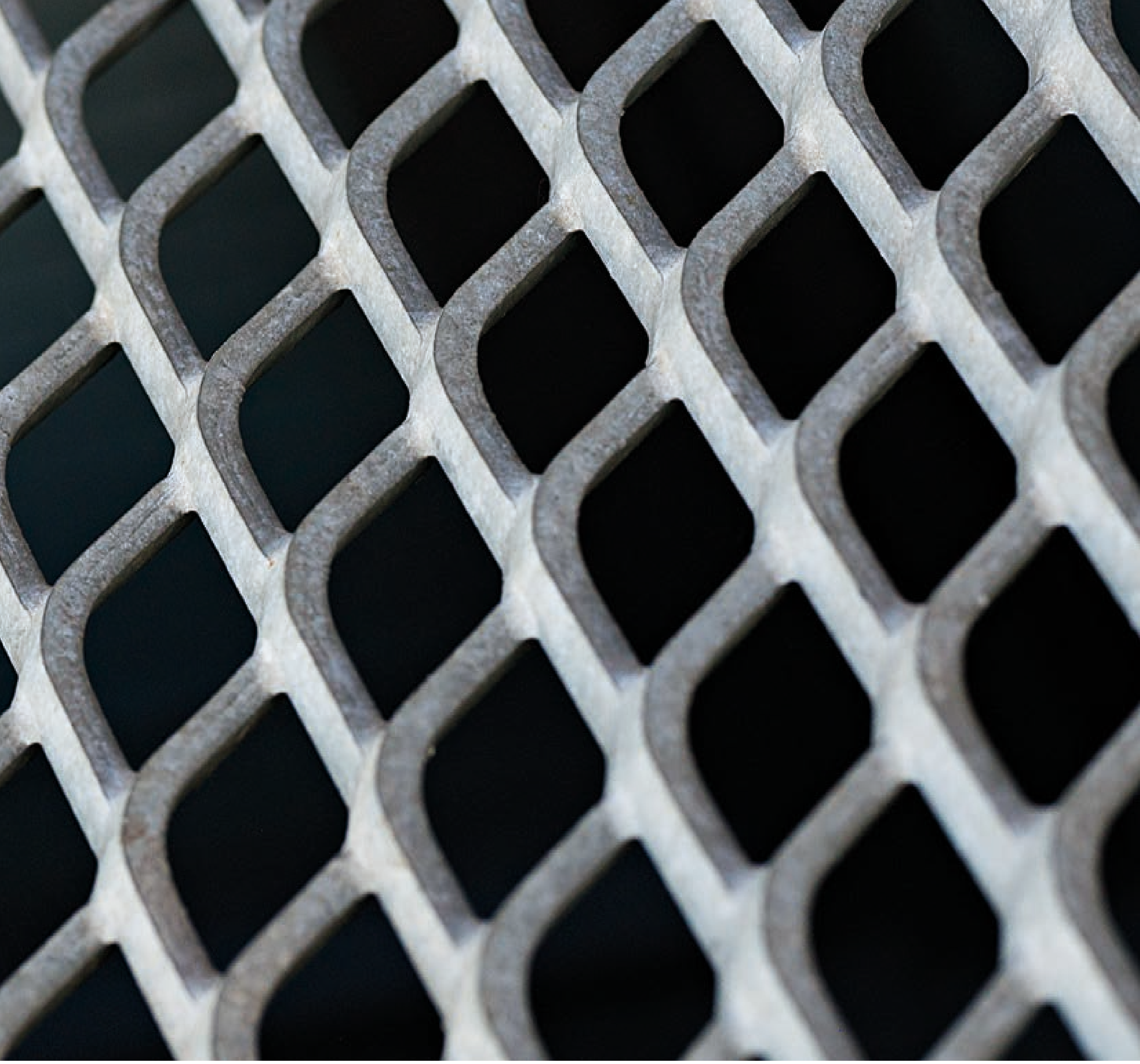
After the 2010 decision-in-principle was issued, Fennovoima investigated the technical and economic prerequisites of district heat production and the consumption of district heat in the Raahe region, but found that the district heat option was not economically viable and abandoned it.

Utilization of waste heat

Utilization of the waste heat generated at the nuclear power plant to keep harbors or other water areas unfrozen in winter is possible with no significant changes to the nuclear power plant or its systems, as the method of use sets no conditions on the temperature of the water that is used. Utilization will, however, require the installation of a pump station in the cooling water discharge channel and insulated transfer pipes to the heating target. Utilization of waste heat will help control the distribution of the heat in various areas of the sea and reduce the impact of the heat on the ice conditions in the vicinity of the plant.

The technical feasibility of waste heat utilization, its economic viability compared to other alternatives, and the environmental impact of, for example, the pipes will be separately investigated when the potential of waste heat utilization is further specified.





Nuclear power plant fuel and waste management

Appendix 5A

General plan for nuclear fuel management

Summary

The nuclear fuel management of Fennovoima's nuclear power plant will be arranged so as to enable appropriate monitoring of the design, production, transportation and storage of the nuclear fuel to ensure quality and safety. Availability of nuclear fuel will be ensured for the entire planned service life of the plant. Safeguards to prevent nuclear proliferation in connection with nuclear fuel management can be conducted in accordance with Finnish legislation and international agreements.

In December 2013, Fennovoima signed a nuclear fuel supply contract with JSC TVEL, which is a part of the Rosatom Group. The contract covers nuclear fuel fabrication and the delivery of uranium for approximately the first ten years of operation. Fennovoima has chosen to use reprocessed uranium fuel during the first operating years.

The nuclear fuel to be used in Fennovoima's nuclear power plant is similar to that used in existing light water reactors, and it is designed and fabricated using proven technologies.

The known global uranium resources and the resources already in use will last for at least 100 years of operation of nuclear power plants based on the current light water reactor technology. Estimated additional resources are also significant. The supply of uranium on the global market will place no restrictions on the operation of the nuclear power plant during its planned service life.

Fennovoima will take into account the environmental impact of the entire nuclear power plant fuel management process. For a more detailed description of the environmental impact of the various phases of nuclear fuel management, as well as an account of the means to limit the environmental stress, see the project's environmental impact assessment report.

Nuclear fuel constitutes only a minor share of the total cost of nuclear electricity production. Changes in the price of uranium thus have no significant impact on the production costs of nuclear power or on the profitability of new nuclear power plant projects.

Introduction

This appendix includes an overall description of the applicant's plan for arranging nuclear fuel management in accordance with section 24, subsection 2 (7) of the Nuclear Energy Decree (755/2013). The current document complements the information presented in the original decision-in-principle application, and describes the changes that have taken place in the project.

The procurement, transportation and storage of the nuclear fuel required for the operation of the nuclear power plant is a key factor with respect to the feasibility of the nuclear power plant construction project.

Nuclear fuel management must be arranged so that the supply of nuclear fuel to the nuclear power plant is ensured throughout the planned service life of the plant, and so that the design, production, transportation and storage of nuclear fuel is duly supervised and controlled to ensure appropriate quality and safety.

Impact of changes that have taken place in the project

In December 2013, Fennovoima signed a plant supply contract with Rusatom Overseas CJSC, which is a part of the Rosatom Group, for the supply of an AES-2006 nuclear power plant with a electrical output of 1,200 MW. The lower capacity than that specified in the original decision-in-principle will reduce the volume of nuclear fuel required.

As a result of the changes that have taken place in Fennovoima's shareholder base, Fennovoima will manage its nuclear fuel procurement independently. In December 2013, Fennovoima signed a nuclear fuel supply contract with JSC TVEL, which is a part of the Rosatom Group. The contract covers fuel fabrication and delivery of uranium for approximately the first ten years of operation. When the contract expires, Fennovoima will have the possibility to ask for bids to nuclear fuel supplyand, if seen profitable for Fennovoima, also diversify the fuel procurement to several suppliers, as was stated in the original decision-in-principle application.

Nuclear fuel procurement

Fennovoima's nuclear fuel procurement plan

Fennovoima signed a nuclear fuel supply contract at the same time as the plant supply contract. The nuclear fuel supply contract was signed with JSC TVEL, which is a part of the Rosatom Group. The fuel contract covers fuel deliveries for approximately the first ten years of operation. The fuel delivery will be an integrated delivery that covers the manufacture of the fuel, delivery of uranium, and related services. Fennovoima will ensure that the necessary safeguards to prevent nuclear proliferation can be implemented in accordance with Finnish legislation and international agreements. Fennovoima will also perform appropriate monitoring of the design, production, transportation and storage of the nuclear fuel to ensure appropriate quality and safety.

Fennovoima has chosen to use reprocessed uranium fuel during the first operating years. Reprocessed uranium is uranium extracted from nuclear fuel earlier removed from a reactor. Reprocessed uranium is also used in several other European countries, such as Germany and Sweden. Its properties do not essentially differ from those of uranium fuel manufactured from natural uranium, and it requires no changes to operations such as fuel transportation. The contract signed provides

Fennovoima with the option of choosing to also use natural uranium instead of reprocessed uranium.

When the contract expires, Fennovoima will have the possibility to ask for bids to nuclear fuel supplyand, if seen profitable for Fennovoima, also diversify the fuel procurement to several suppliers, as was stated in the original decision-in-principle application.In the future the fuel procurement may be also carried out as integrated deliveries or by entering into separate agreements for fuel fabrication, enrichment and conversion services and the procurement of uranium. At the moment, JSC TVEL is the only company that fabricates fuel for the AES-2006 type of plant. Fennovoima intends to actively seek an alternative fuel supplier for its facility in order to reduce its dependence on one fuel supplier.

Security of supply

Nuclear power plants usually stock enough fuel for one year's operation. If required for reasons of security of supply, nuclear fuel can easily be stocked for longer periods of operation. Fennovoima plans to maintain a safety stock of two reload batches for at least the first few years of operation.

Requirement and adequacy of uranium

The annual fuel consumption of a nuclear power plant with an electrical output of 1,200 megawatts is in the range of 20–40 tonnes of enriched uranium. 200–350 tonnes of natural uranium will be required to produce this amount of fuel. Instead of natural uranium, fuel can be manufactured using secondary sources such as reprocessed uranium chosen by Fennovoima.

Reprocessed uranium is produced, for example, in Russia and France and it is available on the global market in minor quantities. It can be assumed that improving processing techniques will increase the volume of fuel being recycled, which will make reprocessed uranium a more common alternative.

The known global uranium resources and the resources already in use will last for at least 100 years of operation of nuclear power plants based on the current light water reactor technology. Estimated additional resources are also significant. The supply of uranium on the global market will place no restrictions on the operations of the nuclear power plant during its proposed lifetime.

For more information on global uranium resources and their adequacy, see Fennovoima's original decision-in-principle application.

Production of nuclear fuel

The production of nuclear fuel for light water reactors includes the following phases:

1. mining of uranium, separation of uranium ore from base rock and ore enrichment
2. conversion of enriched ore into uranium hexafluoride
3. increasing the concentration of U-235 in the uranium hexafluoride by isotopic enrichment
4. conversion of enriched uranium hexafluoride into uranium dioxide
5. fabrication of nuclear fuel pellets and fuel rods
6. assembly of nuclear fuel elements.

When reprocessed uranium is used, mining and ore enrichment are eliminated from the production process. Instead, the uranium used for the fuel is produced by reprocessing spent nuclear fuel at a reprocessing plant. The uranium separated from spent fuel is converted into uranium hexafluoride. After this phase, the fuel production process is similar to that of fuel manufactured using natural uranium.

The basic technology of light water reactor fuel manufacturing was established as early as in the 1970s. There is extensive practical experience of the various technologies used at all stages of the production process.

Reprocessing of nuclear fuel

Spent nuclear fuel still contains considerable amounts of uranium; for example, its U-235 concentration is close to that of natural uranium. At a reprocessing plant, plutonium and fission products are separated from the spent fuel, and the remaining uranium is recycled as fuel. Figure 5A-1 is a representation of the typical composition of reprocessed uranium.

Reprocessing of spent nuclear fuel reduces the volume of nuclear waste to approximately to one fifth, and is estimated to increase the energy output of the original mined uranium by 20–30 percent. Furthermore, the activity of the nuclear waste separated from spent fuel in the reprocessing process will decrease considerably faster after the first hundred years than the activity of spent nuclear fuel.

Spent nuclear fuel reprocessing plants operate in countries with a large number of nuclear power plants, such as France, Japan, the United Kingdom and Russia.

Fuels of various types can be manufactured from spent nuclear fuel, such as reprocessed uranium, which is similar to raw uranium or mixed-oxide fuel. It can be assumed that improving processing techniques will increase the volume of fuel being recycled.

For more information on the production of nuclear fuel, see Fennovoima's original decision-in-principle application.

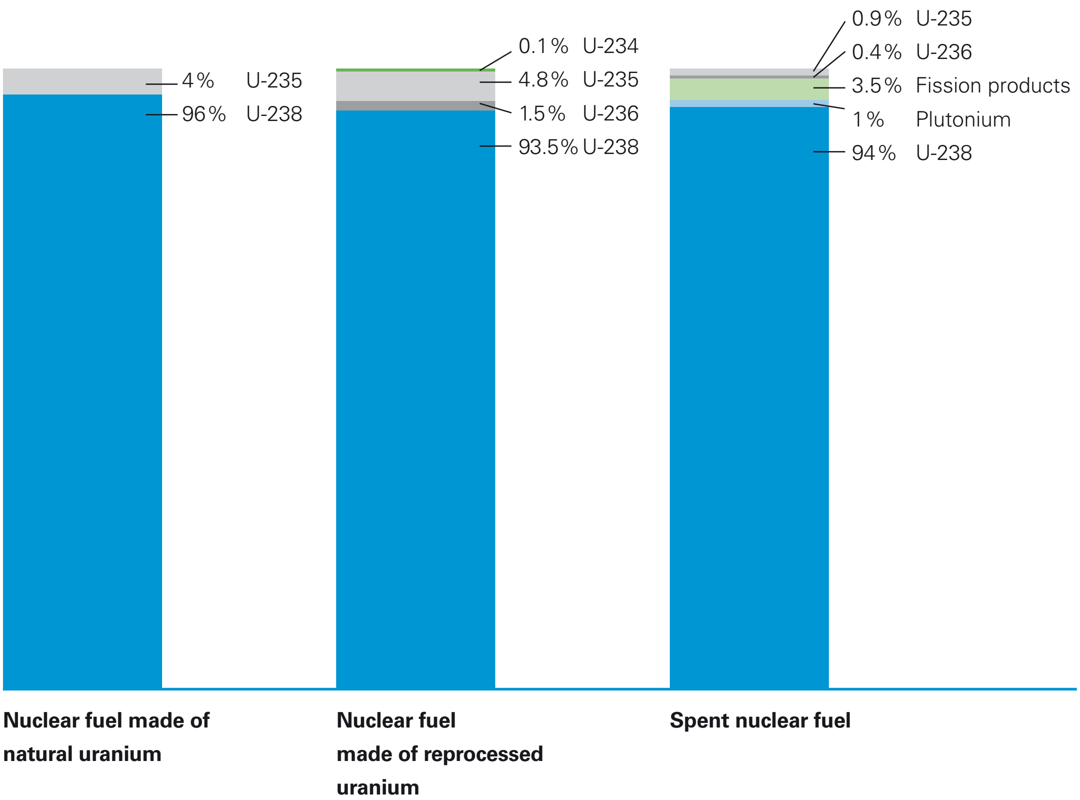


Figure 5A-1. Typical composition of nuclear fuel manufactured from natural uranium or reprocessed uranium, and that of spent nuclear fuel.

Transportation and storage of nuclear fuel

The annual fuel consumption of nuclear fuel in nuclear power plants is low in terms of mass compared to power plants based on other fuels. For example, a coal-fired condensing power plant consumes around 100,000 times higher fuel mass per unit of electrical power generated than a nuclear power plant. Correspondingly, the volumes of transported nuclear fuel are very low.

Transportation is necessary at the various phases of the nuclear fuel production chain and, depending on the geographical distribution of the production chain, the transportation distances can be long. All the intermediate products in the nuclear fuel production chain, from uranium ore to nuclear fuel assemblies, are very weakly radioactive. Nuclear fuel is transported by specialized transportation firms with the required skills, appropriate equipment and permits issued by authorities supervising the operations.

For more information on nuclear fuel transportation, see Fennovoima's original decision-in-principle application.

Minimization of the environmental impact of nuclear fuel management

Fennovoima will take into account the environmental impact of the entire nuclear fuel management process. Fennovoima requires companies operating within the nuclear fuel production chain to implement a certified environmental management system or other verifiable indication that the environmental impact of their operations is monitored and at an acceptable level.

For a more detailed description of the environmental impact of the various phases of nuclear fuel management, as well as an account of the means to restrict the burden on the environment, see the project's environmental impact assessment report included in this application as Appendix 3A.

Nuclear fuel management costs

Nuclear fuel constitutes only a minor share of the total cost of nuclear electricity production. Changes in the price of uranium thus have no significant impact on the production costs of nuclear power or on the profitability of new nuclear power plant projects.

Nuclear power plant fuel and waste management

Appendix 5B

General description of Fennovoima's plans and available methods for nuclear waste management

Summary

Fennovoima has the appropriate methods for organizing the nuclear waste management at the nuclear power plant. Fennovoima's waste management plans are based on methods proven to be safe and appropriate for nuclear waste management in Finland.

Fennovoima estimates that during its 60 years of operation, the Fennovoima nuclear power plant will generate approximately 5,000 m^3 of low and intermediate level operating waste packaged for final disposal, 10,000–15,000 m^3 of decommissioning waste, and spent nuclear fuel equivalent to between 1,200 and 1,800 tonnes of uranium.

Sufficient facilities, equipment and other arrangements will be planned and constructed to ensure the safe handling, treatment and storage of the nuclear materials needed at the plant and the nuclear waste generated during operation. Low and intermediate level reactor waste and the decommissioning waste will be treated, stored and finally disposed of at the plant site on the Hanhikivi headland in Pyhäjoki. The spent nuclear fuel generated during the operation of the plant will also be treated and placed in an interim storage at the plant site.

For the final disposal of the reactor waste, a repository for low and intermediate level waste will be built in the plant area in accordance with the decision-in-principle granted in 2010. The repository will consist of underground final disposal facilities and, possibly, a surface repository for very low level reactor waste, as well as the related buildings and structures. Surveys conducted by Fennovoima at the Hanhikivi plant location have identified no factors that would preclude the construction of a repository for low and intermediate level reactor waste. The operation of the repository for reactor waste is estimated to begin no earlier than in the latter half of the 2030s.

The spent nuclear fuel generated during plant operations is planned to be disposed of in Finnish bedrock using the KBS-3 method developed in Sweden and Finland. The decision-in-principle granted in 2010 sets conditions for developing a plan for the final disposal of spent nuclear fuel. Fennovoima will prepare an overall plan concerning the final disposal of spent nuclear fuel, which describes for example the connections of Fennovoima's operations with the final disposal project of other Finnish nuclear power plant operators. The purpose of the overall plan is to define a final disposal solution that is optimal from the perspective of the society. The final disposal of the spent nuclear fuel from Fennovoima's nuclear power plant is estimated to begin no earlier than in the 2070s.

From the start-up of the nuclear power plant, Fennovoima will comply with the financial provision obligation stated in the Nuclear Energy Act and pay a yearly nuclear waste management fee to the National Nuclear Waste Management Fund. The accrued funds will be used to ensure that the plant's low and intermediate level nuclear waste, spent nuclear fuel and decommissioning waste are managed in a safe and socially acceptable manner.

Introduction

This appendix includes an overall description of the applicant's plans and available methods for implementing nuclear waste management, in accordance with section 24, subsection 2 (8) of the Nuclear Energy Decree (755/2013). The current document complements the information presented in the original decision-in-principle application, and describes the changes that have taken place in the project.

According to section 9 of the Nuclear Energy Act (990/1987), the licensee is under the waste management obligation and responsible for all measures to recover, treat and dispose of the nuclear waste generated during the operation of the plant. Fennovoima's plans and available methods for arranging nuclear waste management are essentially similar to the plans and available methods of existing Finnish nuclear power plants.

Impact of changes that have taken place in the project

The plans for nuclear waste management have not changed in any significant degree from those presented in the original decision-in-principle. The new plant type with a lower thermal output has primarily affected the expected waste volumes. According to current estimates, the nuclear power plant will generate 1,200–1,800 uranium tonnes of spent fuel during its 60 years of operation. The total volume of low and intermediate level waste will be approximately 5,000 m^3, and the volume of decommissioning waste 10,000–15,000 m^3.

Fennovoima will build at the Hanhikivi plant site the necessary facilities for the treatment, storage and final disposal of low and intermediate level reactor waste and an interim storage for spent nuclear fuel in accordance with the decision-in-principle granted in 2010. The interim storage system used for the spent nuclear fuel will be selected by the time the power plant construction license is applied for.

As specified in the original decision-in-principle application, the spent nuclear fuel will be disposed of deep in the Finnish bedrock using the KBS-3 method developed in Sweden and Finland. Fennovoima's primary objective still is to work together with other Finnish operators under the nuclear waste management obligation. To advance this objective, Fennovoima will prepare an overall plan for the management of spent nuclear fuel.

Low and intermediate level nuclear waste management

Reactor waste

Low and intermediate level waste, known as 'reactor waste', is generated at a nuclear power plant. Reactor waste includes the radioactive waste accumulated during the plant's operation, excluding spent nuclear fuel, decommissioning waste or highly activated metal waste. Reactor waste is generated during the normal operation of the plant in tasks such as the handling of radioactive liquids and gases, and maintenance and repair work carried out in the controlled area. The controlled area refers to the area within the nuclear power plant where special safety regulations are enforced with respect to radiation protection and prevention of the spread of radioactive contamination. Access to the area is controlled.

Reactor waste is divided into the categories presented in Table 5B-1 on the basis of radioactivity concentration. In addition to the average activity concentration, reactor waste is sorted and classified as required by further treatment, exemption from control, storage and final disposal operations.

Table 5B-1. Classification of reactor waste based on average radioactivity concentration.

Category	Average activity concentration	Required radiation protection
Extremely low-level waste	under 0.1 MBq/kg	Can be handled without special radiation protection
Low-level waste	under 1 MBq/kg	Can be handled without special radiation protection
Intermediate level waste	under 10 GBq/kg	Handling requires effective radiation protection

Estimate of the reactor waste volume

A 1,200 MW AES-2006 power plant is estimated to produce approximately 5,000 m^3 of low and intermediate level reactor waste during its 60 years of operation. Table 5B-2 presents an estimate of the division of the waste volume into various waste types.

On-site recovery, storage and treatment

According to the Nuclear Energy Act, the nuclear power plant must have sufficient facilities for handling and storing low and intermediate level waste. The reactor waste treatment and storage facilities will be located in the power plant area and in connection with the power plant. The appropriate licenses will be applied for in accordance with the power plant licensing procedures.

For the treatment and storage, reactor waste is divided into dry, wet and liquid waste. For the characterization and treatment methods of the waste, see the original decision-in-principle application.

Table 5B-2. An estimate of the volumes of low and intermediate level waste generated by the AES-2006 annually and over the operating life of 60 years (after treatment and packing).

	Amount of waste	
	[m^3/year]	[m^3/60 years]
Dry waste		
Compressible		
Extremely low-level	-	-
Low-level	12,1	726
Intermediate level	4	240
Incompressible		
Extremely low-level	-	-
Low-level	22,5	1 350
Intermediate level	3,6	216
Total (dry waste)	42,2	2 532
Wet waste		
Ion-exchange waste		
Extremely low-level	-	-
Low-level	16,8	1 008
Intermediate level	18,3	1 098
Miscellaneous wet waste	-	-
Total (wet waste)	35,1	2 106
Total (all)	77,3	4 638

Final disposal on site

A repository for low and intermediate level reactor waste will be built in the nuclear power plant site in accordance with the decision-in-principle granted in 2010. The total activity of the nuclear waste to be disposed of in the repository will exceed 1 TBq (terabecquerel), which makes it an extensive final disposal of nuclear waste as referred to in section 3 of the Nuclear Energy Act and section 6 of the Nuclear Energy Decree. Based on section 4 of the Nuclear Energy Act, the reactor waste repository is a separate nuclear facility.

The reactor waste repository will consist of an underground final disposal facility and the auxiliary facilities, buildings and structures closely related with the operations of the repository. Based on section 22 of the Government Decree on the Safety of Disposal of Nuclear Waste (736/2008), very low level waste can be disposed of in the ground instead of the bedrock. Fennovoima is considering the construction of this kind of surface repository for very low level waste.

According to Fennovoima's estimate, a construction license for the repository in accordance with the Nuclear Energy Act will be applied for no earlier than in 2032. Final disposal of reactor waste is estimated to begin in the latter half of the 2030s at the earliest. If Fennovoima decides to construct a separate repository for very low level waste in the ground, the appropriate planning permission will be applied for from STUK in 2026 at the earliest. The waste generated between the commissioning of the nuclear power plant and the beginning of the final disposal activities will be stored safely in a facility to be built in the power plant area.

The operating principles and structure of the low and intermediate level waste repository and the surface repository for very low level waste have been presented in the original decision-in-principle application.

Spent nuclear fuel management

Estimate of the spent nuclear fuel volume

The maximum thermal output of Fennovoima's AES-2006 nuclear power plant will be 3,220 MW. Fennovoima aims to operate the nuclear power plant at full capacity with the exception of the refueling and maintenance outages carried out at intervals of approximately 12 months, and the power limitation conditions such as periodic testing of safety systems set out in the operational limits and conditions of the plant.

About 20–30 tonnes of spent fuel will be removed from the reactor of the nuclear power plant each year. During the 60 years of operation of the nuclear power plant, a total of some 1,200–1,800 tonnes of spent nuclear fuel will be generated.

On-site treatment and storage

The on-site treatment and storage of the plant's spent nuclear fuel is an integral aspect of a nuclear power plant's operations. The treatment and storage of spent nuclear fuel mainly follows the same nuclear and radiation safety principles and radiation exposure limits that apply to the operation of the nuclear power plant. The collective dose commitment limit per individual arising in any period of one year from normal plant operations, including handling and storage of spent fuel, is 0.1 mSv.

The key safety factors with respect to the treatment and storage of spent nuclear fuel include:

- the integrity of the nuclear fuel assemblies and tightness of nuclear fuel rods is ensured
- the radiation protection arrangements are effective
- sufficient cooling of the nuclear fuel is ensured
- the formation of critical concentrations of nuclear fuel is prevented.

Spent nuclear fuel is typically stored in fuel pools in the reactor building or the nuclear fuel building for three to ten years until the radioactivity and decay heat of the fuel have both fallen sufficiently to facilitate handling. The capacity of the reactor building's fuel pools will be sufficient to accommodate the equivalent amount of spent nuclear fuel produced during approximately ten years of normal plant operations. The spent nuclear fuel is then moved by means of a purpose-designed spent fuel transfer container to an interim storage facility where it will be kept for at least 40 years according to preliminary plans.

The interim storage for spent nuclear fuel will consist of either pool storage or dry storage. The operating principles of both have been described in the original decision-in-principle application. The interim storage model will be selected before the construction license for a nuclear power plant is applied for, and the interim storage will be taken into use in 2033 at the latest.

Transportation to the final disposal site

After the interim storage period, spent nuclear fuel is transported to the final disposal location in a transport cask. The original decision-in-principle application includes a brief description of the transportation of spent nuclear fuel. As transportation alternatives, sea, road and rail transportation or a combination of these, are still viable depending on the location of the final disposal facility.

Final disposal

Section 7h of the Nuclear Energy Act requires that nuclear waste shall be managed so that after disposal of the waste no radiation exposure is caused which would exceed the level considered acceptable at the time the final disposal is carried out. Permanent disposal of nuclear waste shall be planned with due regard to safety and so that no monitoring of the disposal site is required for ensuring long-term safety.

In Finland, direct disposal of the nuclear fuel in the bedrock is regarded by the government's decision-in-principle a solution serving the overall good of society. Disposal in bedrock is internationally regarded as the preferred method of long-lived high-level nuclear waste management due to the extremely stable conditions of bedrock repositories in comparison to aboveground repositories.

The safety regulations regarding the final disposal of nuclear waste in bedrock are prescribed in a Government Decree (736/2008). The decree sets out general requirements for the safety of final disposal-related facilities and the long-term safety of final disposal. The spent nuclear fuel generated at Fennovoima's nuclear power plant is planned to be disposed of deep into the Finnish bedrock using copper canisters in accordance with the KBS-3 final disposal method. In addition to the copper canister, the safety of final disposal using the KBS-3 method is ensured by the multiple barriers formed by the bentonite buffer, tunnel filling material and bedrock. For a technical description of the method and the final disposal measures, see the original decision-in-principle application.

The 2010 decision-in-principle contains the condition with regard to final disposal operations that Fennovoima must submit a further specification of its nuclear waste management plans in connection with the construction license application. In addition to this, Fennovoima must develop its plan for the final disposal of spent nuclear fuel to the effect that by the end of June 2016, it will either have an agreement of nuclear waste management cooperation with the parties currently under the nuclear waste management obligation, or an environmental impact assessment program as referred to in the Act on Environmental Impact Assessment (468/1994) concerning its own final disposal facility for spent nuclear fuel.

In March 2012, the Ministry of Employment and the Economy appointed a working group to steer joint studies by Finnish nuclear power companies on the available alternatives for storing spent nuclear fuel. The final report of the working group was published in January 2013. The working group stated that the most expedient and cost-effective way to proceed would be to utilize the expertise and experience accumulated in the final disposal project of the nuclear waste management company Posiva Oy, and to aim for an optimal solution in the provision for future final disposal operations. The working group also stated that safe final disposal should be carried out with an appropriate schedule and in a cost-effective manner.

Fennovoima is currently preparing an overall plan on the final disposal of spent nuclear fuel. The matters discussed in the plan include the preliminary schedule for the disposal of the spent nuclear fuel generated in Fennovoima's nuclear power plant and interests in common with the current operators regarding their final disposal project. Fennovoima's primary objective is still to develop and carry out the final disposal of spent nuclear fuel together with other Finnish operators under the nuclear waste management obligation. One of the main goals of the overall plan is to determine an optimal final disposal solution which can, for its part, advance cooperation between Fennovoima and the other parties under the nuclear waste management obligation.

Fennovoima will enter into an agreement with the current operators or prepare its own environmental impact assessment program concerning the spent nuclear fuel disposal facility, as required by the decision-in-principle granted in 2010. After this, Fennovoima will have at least 50 years to select a final disposal location, plan a final disposal facility based on the KBS-3 method or another method that meets the long-term safety requirements, submit license applications, and construct the facility before the planned beginning of final disposal operations.

Final disposal of the spent nuclear fuel generated at Fennovoima's nuclear power plant is currently estimated to begin in the 2070s at the earliest.

Alternatives to direct final disposal

According to section 26 of the Nuclear Energy Decree, the Ministry of Employment and the Economy must submit to the Government a special review of the methods of nuclear waste management that are currently applied and planned in the nuclear industry. The original decision-in-principle application describes controlled long-term storage, reprocessing and recycling, and transmutation as alternatives to direct final disposal. These alternatives are not allowed by current legislation.

Management of nuclear power plant decommissioning waste

Decommissioning of the nuclear power plant

Decommissioning waste consists of radioactive waste generated during the decommissioning of a nuclear power plant. When the operation of the nuclear power plant is finished, the radioactive substances mainly originating from the migration of radioactive matter or the activation of the materials will remain in the plant's structures, systems, and equipment.

A nuclear power plant may be demolished immediately after the end of production operations or after a period of controlled storage. For a description of the classification, treatment and final disposal of the decommissioning waste, see the original decision-in-principle application.

Fennovoima will draw up the nuclear power plant decommissioning plan required for the construction license application in cooperation with the plant supplier.

If the plant is decommissioned immediately after the end of production operations, demolition work is estimated to begin in the latter half of the 2080s. According to

Fennovoima's preliminary estimate, Hanhikivi 1 will produce 10,000–15,000 m^3 of decommissioning waste. The decommissioning waste will be disposed of in the repository for low and intermediate level waste to be constructed in the plant area.

Provision for the cost of nuclear waste management

According to the Nuclear Energy Act, the holder of the nuclear power plant's operating license, as the party with the obligation for waste management, is responsible for all costs arising from the appropriate management and preparation of nuclear waste generated as a result of the operation of the plant.

The licensee will meet this obligation to provide for the waste management costs by paying annual contributions into the National Nuclear Waste Management Fund administered by the Ministry of Employment and the Economy so that the total sum covers the extent of the financing obligation. The Fund is not included in the state budget. The licensee's total waste management financing obligation, at any given time, comprises the estimated future cost of managing all the nuclear waste produced by the licensee to that date.

As a licensee, Fennovoima will fulfill its obligations for financial provision for the cost of nuclear waste management and to pay National Nuclear Waste Management Fund contributions and, in so doing, will ensure that the low and intermediate level nuclear waste, spent nuclear fuel and decommissioning waste produced by Fennovoima's nuclear power plant is managed in a safe and socially acceptable manner.

For a description of Fennovoima's provision for the cost of nuclear waste management, see the original decision-in-principle application.