



# ENVIRONMENTAL IMPACTS OF NUCLEAR POWER PLANTS

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# AGENDA

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# INTRODUCTION

## Pöyry has extensive expertise in nuclear power EIAs in Finland

- EIA of the new NPP in **Olkiluoto** (OL3) (*EIA completed in 2000*)
- EIA of the NPP in Olkiluoto (OL4) (*EIA completed in 2008*)
- EIA of Fortum new NPP in **Loviisa** (LO3) (*EIA completed in 2008*)
- EIA of Fennovoima new NPP in **Hanhikivi** (*EIA completed in 2009*)
- EIA of **Posiva** spent fuel repository extension (*EIA completed in 2009*)
- EIA of the new NPP in **Lithuania** (*EIA completed in 2009*)
- EIA of VTT **Otaniemi** research nuclear reactor demolition (*EIA completed in 2015*)



Source: Fennovoima

# NUCLEAR POWER IN FINLAND

## In Finland nuclear power consisted 25% of electricity consumption in 2018

- **Teollisuuden Voima Oy (Olkiluoto)**
  - OL 1 & 2, commissioned in 1978 and 1980 -> extension until 2038 (60 years)
  - OL 3, starts operation in 2020
  - OL 4, decision-in-principle accepted in Finland
- **Fortum Power and Heat Oy (Loviisa)**
  - LO 1 & 2, commissioned in 1977 and 1980 -> extension LO1 until 2027; LO 2 until 2030 (50 years)
  - LO 3, decision-in-principle was not accepted in Finland
- **Fennovoima (Hanhikivi)**
  - HAK 1 under construction, estimated start of the operation in 2028

### Nuclear Power Plants in Finland

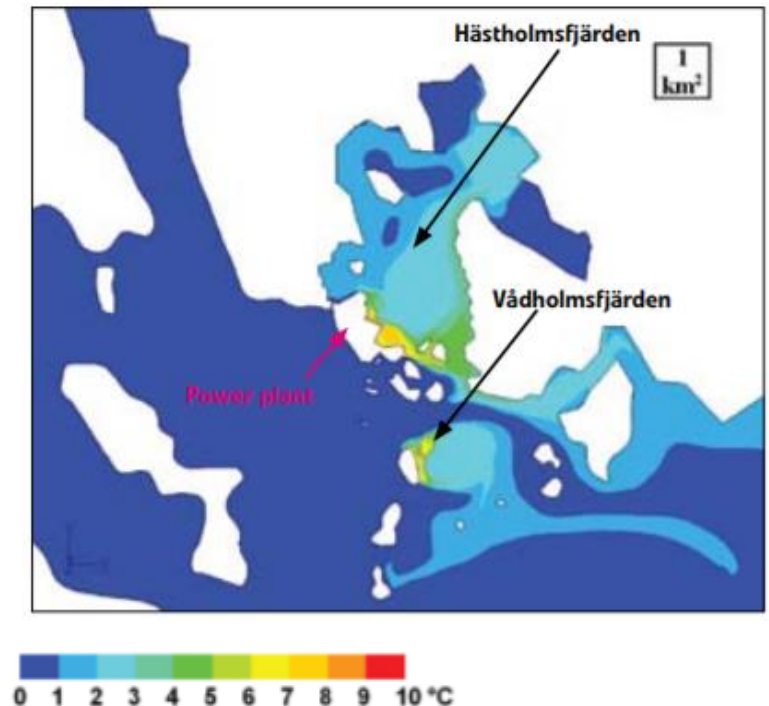


Source: World Nuclear Association

# ENVIRONMENTAL IMPACTS OF NUCLEAR POWER PLANTS LO3 – CASE STUDY

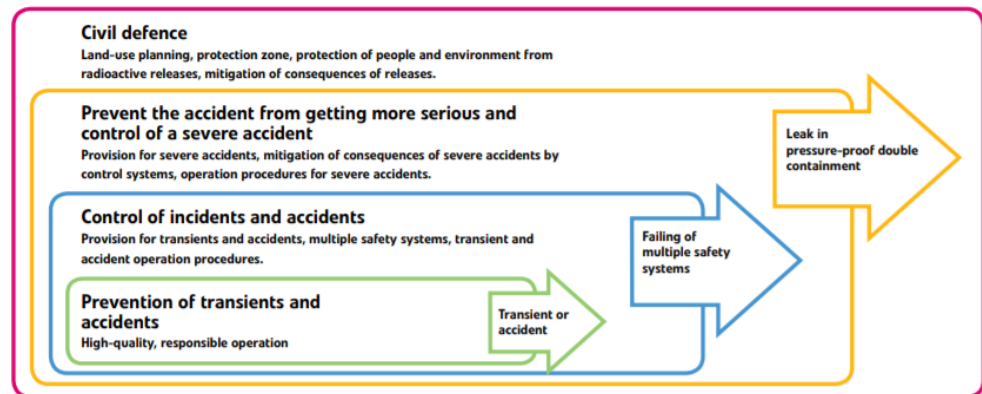
- EIA was carried out in 2007-2008
- EIA consisted impacts of construction and operating of the new power plant unit. The main impact categories under operation were:
  - Air quality and climate
  - Waterways, aquatic life and fishing
  - Soil, bedrock and ground water
  - Flora, fauna, and conservation areas
  - Land use, structures and landscape
  - People and society
- Other main issues addressed were:
  - Impacts from waste and by-products and their handling
  - Environmental impacts from traffic
  - Impacts from accidents
  - Impacts from decommissioning the power plant
  - Impacts from nuclear fuel production and transportation

## Temperature impact on summer season



# ENVIRONMENTAL IMPACTS OF NUCLEAR POWER PLANT LO3

- It is estimated that the radiation dose caused by the new power plant to nearby resident is hundredth of the annual 0.1 mSv radiation dose limit set for power plant operations -> no significant effect on human health
- Nuclear safety is ensured at several different levels. An accident can result in radiation releases only if all safety levels fail
- The low and intermediate level of radioactive waste is disposed of repository located more than 100 meters below ground -> expansion of current facility
- Posiva's EIA procedure makes it possible to handle spent nuclear fuel from Fortum and TVO power plant units
- Impacts on local landscape or noise levels are not changed as new unit locates in the power plant area
- No severe impacts on fauna and flora



# ENVIRONMENTAL IMPACTS OF NUCLEAR POWER PLANT LO3

- During operation of the new power plant unit, a small amounts of radioactive substances are released in a controlled manner into the sea
- The releases are formed mainly by the exchange of the process water used in the reactor, laundry area, sewage and the evaporation waste's discharge water
- The power plant radioactive doses to the air and sea are monitored constantly
- In the summer time discharging of cooling water will cause an increase in the temperature of the sea water around the discharge location. The flow of nutrient will also increase in the radius of few kilometers.
  - Not, however, significant impact on water quality, zoo bethos, aquatic vegetation, fish stocks and fishing industry.



# TRANSBOUNDARY ENVIRONMENTAL IMPACTS OF NUCLEAR POWER PLANT LO3

- Espoo convention applies to the Loviisa 3 project
  - Ministry of the environment notified environmental authorities of Baltic sea countries (Estonia, Russia, Denmark, Germany, Sweden, Poland, Latvia and Lithuania) and Norway about the commencement of the process. Latvia and Denmark notified that they will not take part to the EIA procedure.
- Environmental impacts outside Finland - Impacts of a severe accident
  - Accident is very unlikely but if International Nuclear Event Scale (INES 6) level release occurs, there would be radiation doses outside Finland borders
  - Modelling showed that restriction of milk use ( $^{131}\text{I}$ , action level of 500 Bq/kg) could come into force in some deposition areas close to 500 km radius
  - Within 100 km,  $^{137}\text{Cs}$  deposition is 20 kBq/m<sup>2</sup>, and this would not disrupt use of agricultural products
  - A release into the sea will mix to the huge amount of sea water and part of it will sediment in the sea bed





# NUCLEAR POWER PLANT SAFETY PROGRAMME IN FINLAND

- SAFIR 2018: **The Finnish Research Programme on Nuclear Power Plant Safety 2015 - 2018**
- The objective of national nuclear power safety research is to ensure that if new matters related to the safe use of nuclear power plants should arise, the authorities possess sufficient technical expertise and other competence for determining the significance of those matters without delay.
- Several research institutions have been involved (VTT, several universities)
- Some technical issues that were considered:
  - Structural Integrity condition monitoring, thermal and radiation degradation of polymers inside NPP containments -> setting acceptance criterion for O-rings, use of real components in ageing studies, combined effects of radiation and heat and dose rate effect. As a result, several end-of-life criteria was suggested
  - For the project long term operation aspects of structural integrity is to develop methods and tools for structural safety analysis of primary circuit components, reactor pressure vessel and dissimilar metal welds
  - Focusing on early detection of deterioration, monitoring of deterioration, and application of prognostics for the estimation of remaining service life
  - Thermal ageing and environmentally-assisted cracking research for plant life management
  - Proposing an updated ground motion prediction equation for probabilistic seismic- hazard analyses of Finnish nuclear installations.

# KEY ISSUES TO MANAGE ENVIRONMENTAL RISKS OF NUCLEAR POWER PLANTS DUE TO AGING

- The challenges to manage nuclear power safety risks are equivalent to new and aging power plants
  - However, if aging is not well managed, risks will increase
- Life-time and operational hours go hand-in-hand
  - Modernisation projects (already ongoing in current NPPs)
- Issues to be considered due to aging:
  - Safety issues
  - Availability of spare parts
  - Waste management
    - Is the waste disposal facility sufficient?
    - How to dispose of low-level waste (LLW), and has the extension been planned?
- Condition based measurement and maintenance
  - Corrective maintenance vs. predicted maintenance (requirements to be increased)
- Artificial intelligence: knowledge about the condition of the equipment and what kind of failures may occur
- Monitoring of environmental impacts will be increasingly important



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