Long-term management of spent fuel in Finland - policy and regulatory issues

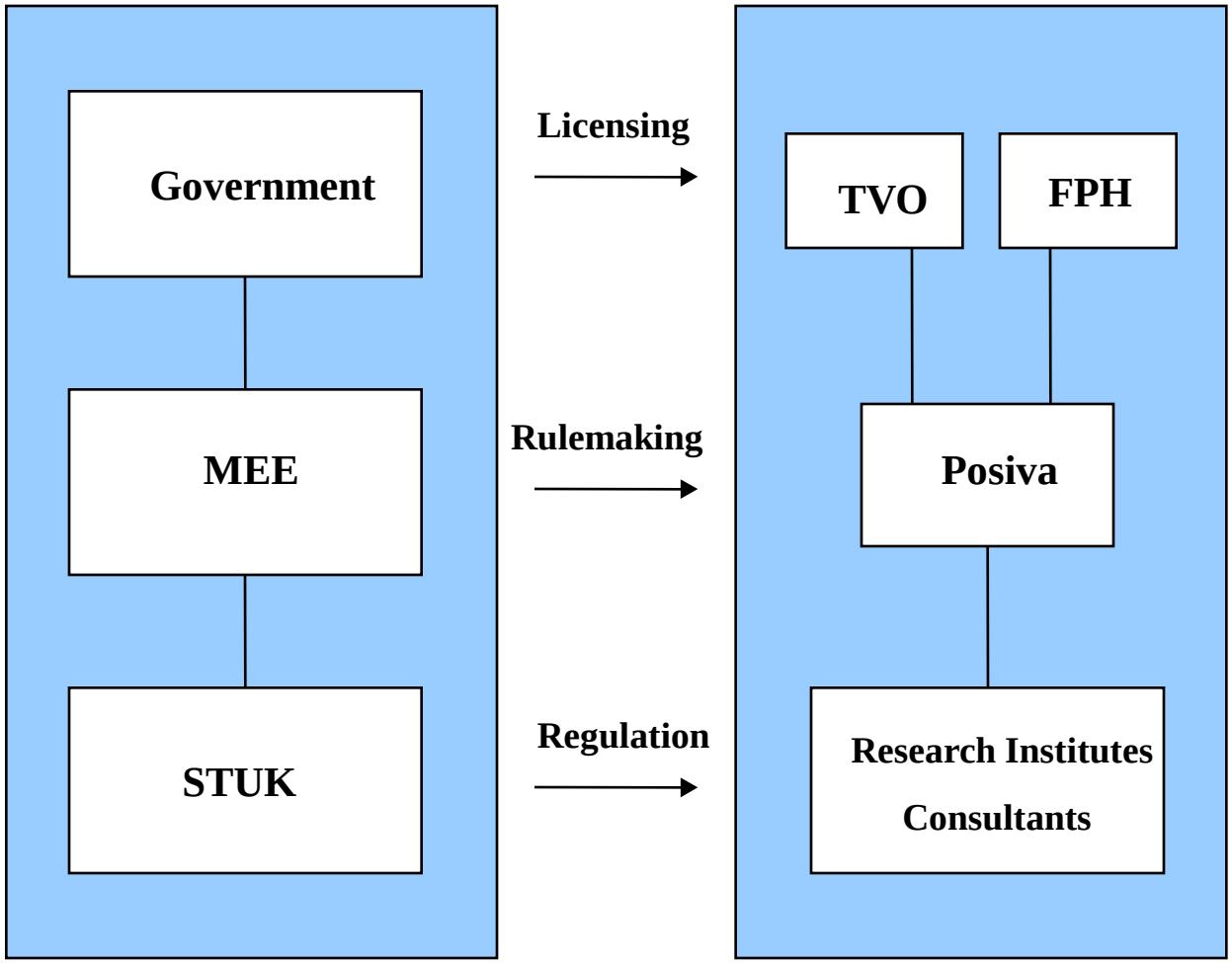
Esko Ruokola
STUK, Radiation and Nuclear Safety Authority

Theme of the presentation

Finland is one of the forefront countries in developing geological disposal for high-level waste. This presentation discusses the long-term management of spent fuel in Finland, particularly:

- *what is the current policy and rationale for that*
- *how the program has progressed, how it has been regulated*
- *where are we now, what are the remaining challenges*

Main bodies in nuclear waste arena



Evolution of the spent fuel management policy

1970's

- **Spent fuel was regarded as an asset and reprocessing was the only option**
  - *Contract on return of spent fuel from the Loviisa NPP to Soviet Union*
  - *Reprocessing of the Olkiluoto NPP spent fuel was negotiated but never contracted*

1980's - mid 1990's

- **Government Decision of 1983**
  - *Primary objective: irrecoverable transfer abroad, central repositories preferred*
  - *Secondary objective: preparedness for final disposal in Finland*

Mid-1990's – the present

- **Amendment of Nuclear Energy Act of 1994**
  - *Permanent disposal in Finland, no export or import of spent fuel*
  - *Disposal option is less expensive and complex than reprocessing-recycling*
  - *Inadequate reliance on foreign or international waste management solutions*

The future

- **New fuel cycle approaches can be utilized if available**
  - *Start of disposal in 2020 but permanent closure of repository not until next century*
  - *Retrieval of waste canisters from the repository is technically feasible*

Government's policy decision of 1983 gave a framework for the nuclear waste management program

Spent fuel disposal target schedule

- *Site screening and selection of several suitable sites by the end of 1985*
- *Preliminary site investigations and selection of the most suitable sites by the end of 1992*
- *Detailed site investigation and site selection by the end of 2000*
- *Preparedness for construction of the encapsulation and disposal facility by the end of 2010 (2012 by Ministry's later decision)*
- *Preparedness for operation of the facilities around 2020*

Progress in spent fuel disposal program

Period	Implementation	Regulatory activity
1983 - 1999	• Technical planning • Site investigations • R&D	• Government's Policy Decision • STUK's safety reviews in 1987, 1994 and 1997
1997 - 2001	• EIA program and report • Decision in Principle application	• Safety regulations • EIA review/judgement • STUK's preliminary safety appraisal • Government's Decision in Principle
2000 - 2012	• Confirming site investigations including the URCF • Research and technical development • Construction license application	• Oversight of site investigations • Review of the status of and plans for RTD at three years interval
2013 - 2020	• Construction of the facilities • Operating license application	• Review of the CL application • Oversight of construction
2021 -	•Operation of the facilities	• Review of the OL application • Oversight of operation

Deliberation of SF long-term management options

- **Options for long-term management of spent nuclear fuel were discussed at some length during the EIA ja DiP processes**
- **The overall conclusion was that deep geological disposal involves less uncertain issues than other options, like long-term storage**
  - ***Safety:*** *the multiple barrier concept should ensure that safety is not jeopardized even by unforeseen deficiencies not addressed in the safety case*
  - ***Security:*** *deep disposal is quite invulnerable to human actions*
  - ***Safeguards:*** *diversion from a deep repository is difficult, adequate control measures are feasible*
  - ***Costs:*** *disposal costs are reasonable, around 10 % of the production costs of nuclear electricity*
  - ***Ethics:*** *early disposal minimizes the burden on future generations*
- **It was also noted that geological disposal is imperative also for wastes arising from advanced fuel cycles; by new technologies the quantities of long-lived waste may be reduced but not completely avoided**

Decision-making processes

Decision-in-Principle

- *Proponents application, appended by the EIA report, May 1999*
- *STUK's preliminary safety appraisal, January 2000 ("no evidence on major safety deficiencies")*
- *Host municipality's consent, January 2000 ("non-veto" by votes 20-7)*
- *Government's decision, December 2000 ("in line with overall good of the society")*
- *Parliament's ratification, May 2001 (endorsement by votes 159-3)*

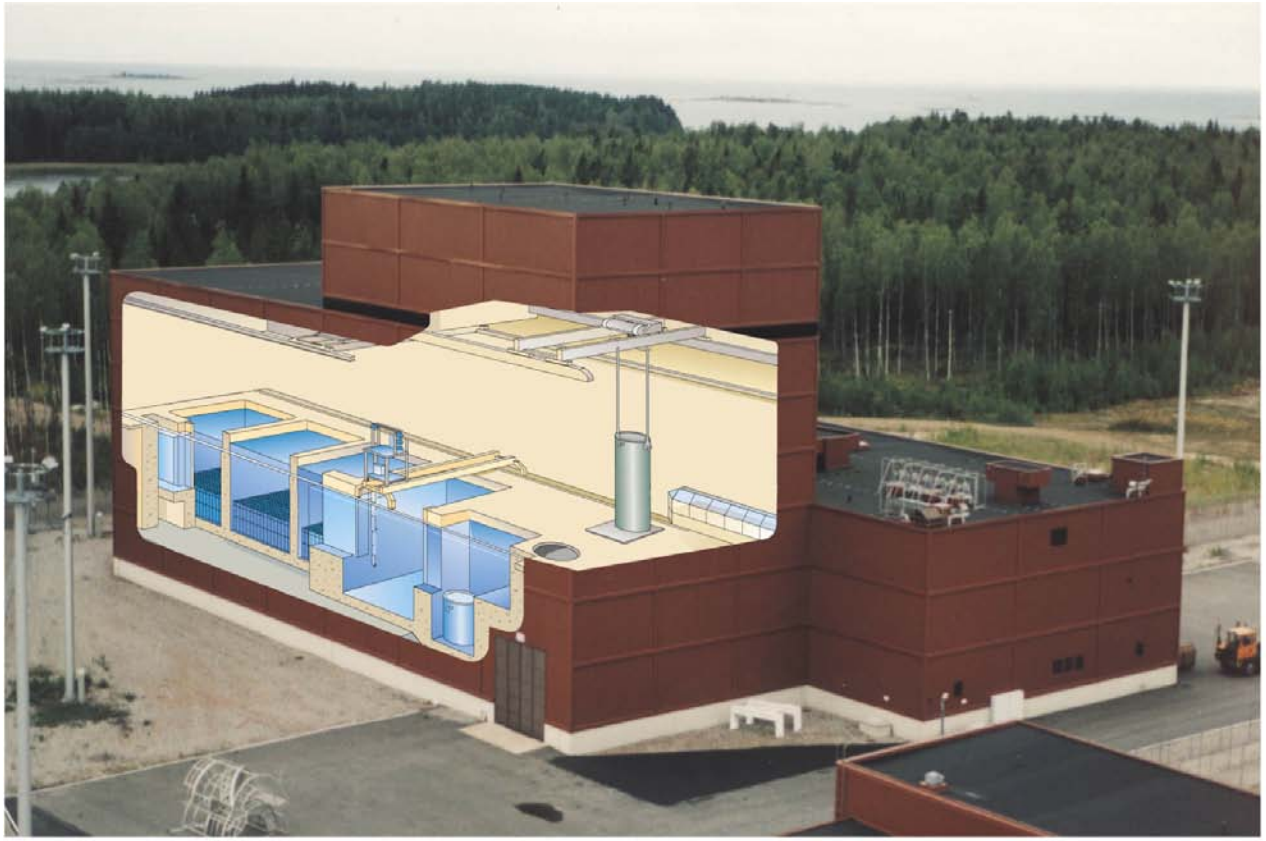
Construction licence process

- *Proponents application by 2012*
- *STUK's safety judgement*
- *Government's decision*

Operating licence process

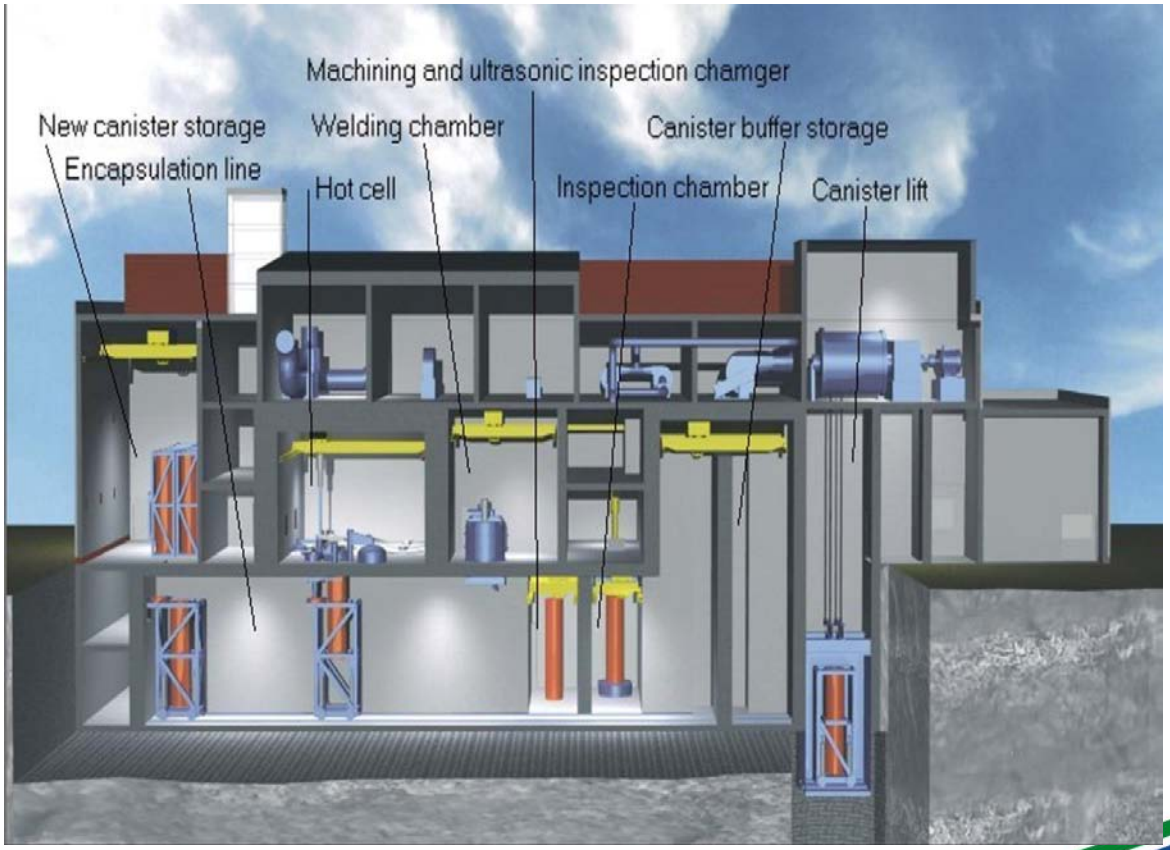
- *Proponents application around 2020*
- *STUK's safety judgement*
- *Government's decision*

Prior to disposal, the decay heat of spent fuel is decreased by interim storage for 30 - 50 years in on-site pool facilities

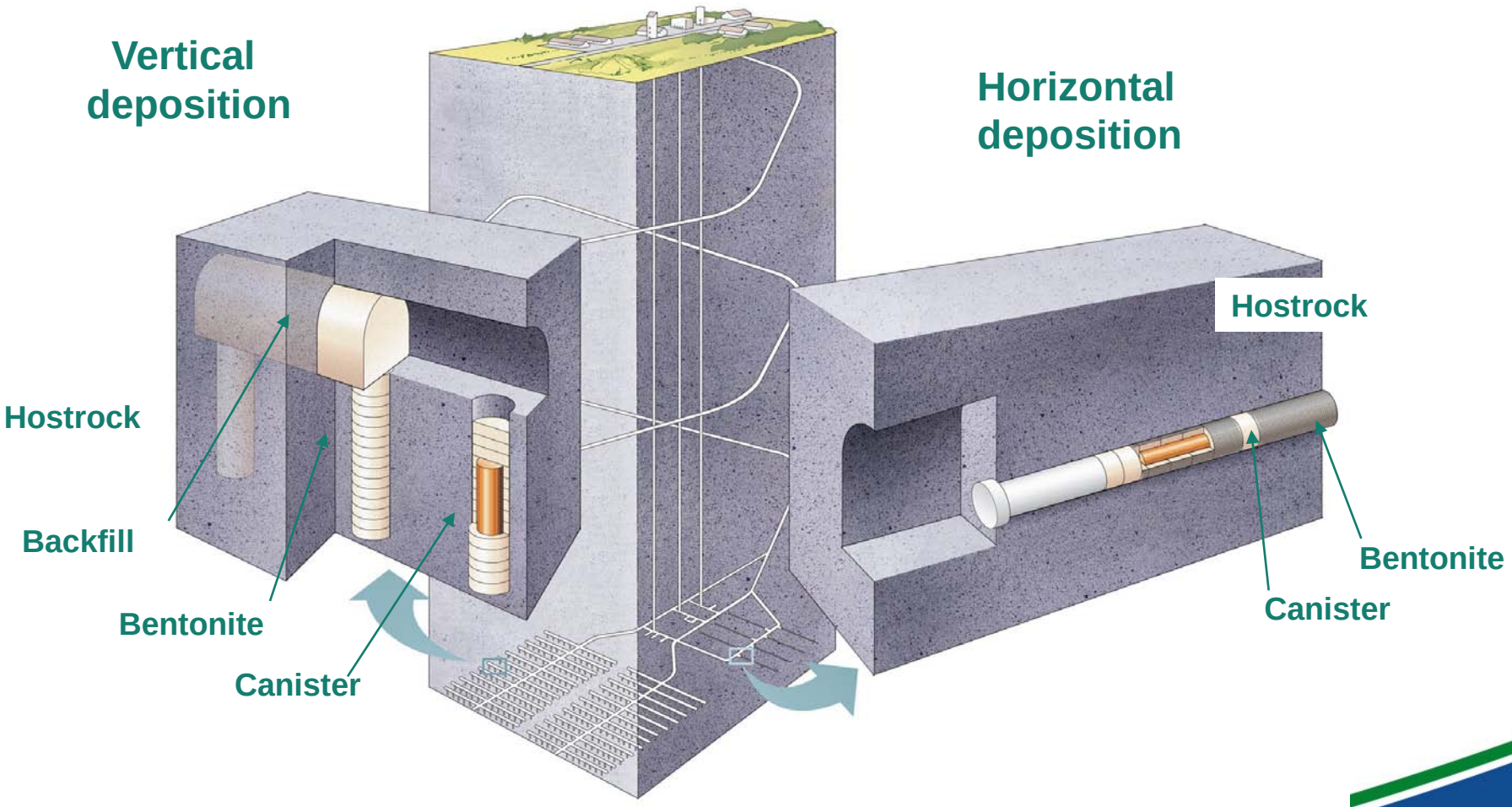


Spent fuel elements are inserted into iron-copper disposal canisters in an encapsulation facility

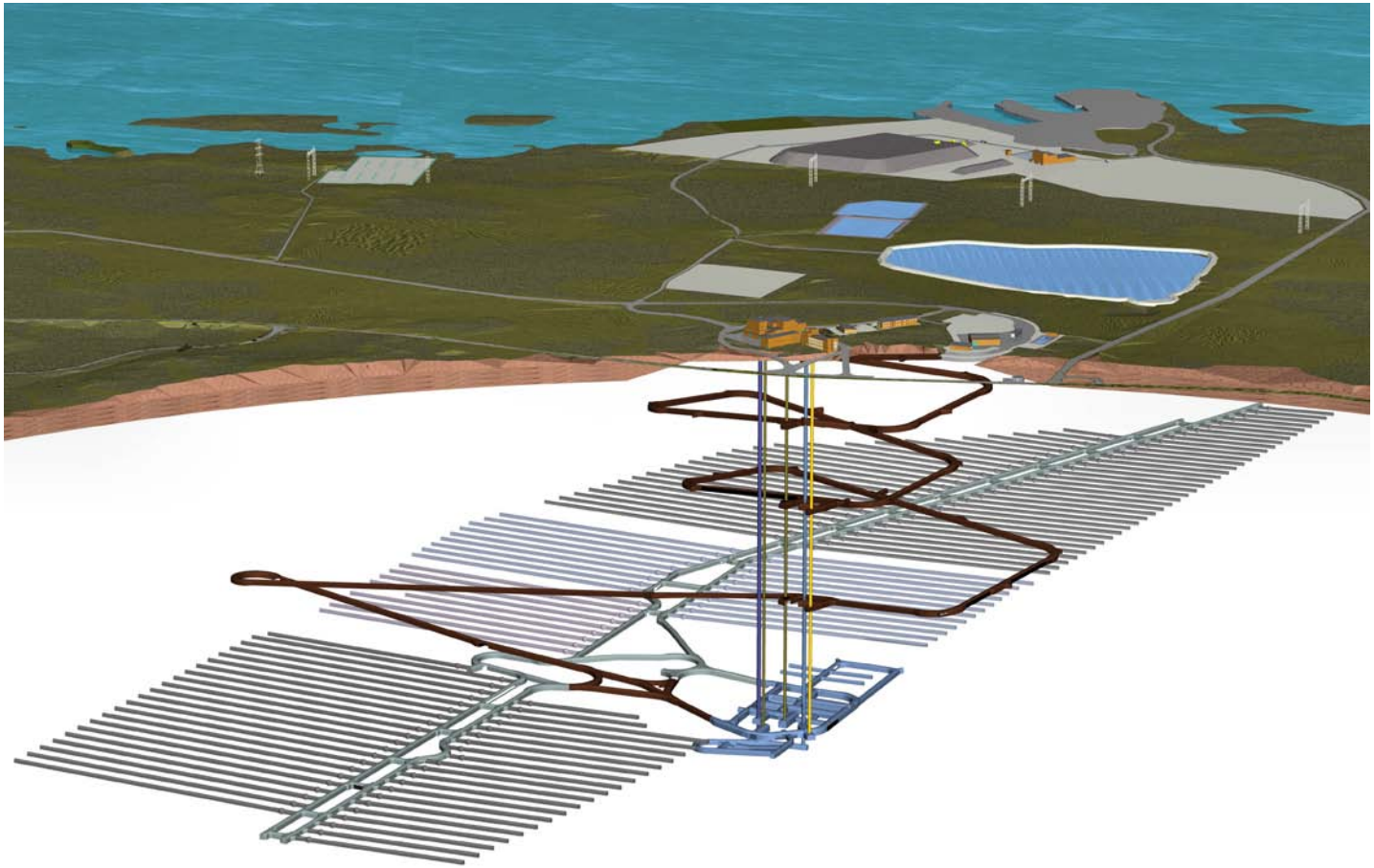
Lo 1&2 Ol 1&2 Ol 3



The waste canisters, surrounded by bentonite buffer, are deposited into bedrock holes at about 0,5 km depth



Confirmation in-situ investigations are being made in the underground rock characterization facility (brown/yellow) prior to the construction of the repository



State of the art

The encapsulation and disposal technology is close to maturity

- *Further development work is needed for industrial scale fabrication of the engineered components (canister, buffer)*
- *Finding optimal positions for canisters in the host rock and minimization of the adverse impacts at the rock - EBS interface requires also technical development*

Operation of the facilities involves no potential for major nuclear accidents

- *The encapsulation and disposal facilities are in many respects based on inherent safety features*

The suitability of Olkiluoto as disposal site has not been seriously challenged

- *The investigations made so far have not revealed any substantial unsuitability features, nor that future changes in the site conditions would seriously jeopardize the safety*

Confidence in long-term safety has strengthened but further evidence is still needed to ensure the proper performance of the disposal system

- *The disposal system, when behaving as planned, ensures high level of containment and isolation of the radioactive substances*
- *Further research and testing is needed to ensure the performance of the engineered components (canister, buffer)*
- *Insight into the nature of extreme climatic conditions (deglaciation, permafrost) and their impact on the disposal system need also be improved*