VTT TECHNICAL RESEARCH CENTRE OF FINLAND
www.vtt.fi

Transition from Thermal to Fast Reactors in Finland

Pauli Juutilainen, Research scientist, pauli.juutilainen@vtt.fi

Abstract The COSI6 V6.0.2 fuel cycle simulation code developed by CEA-Cadarache was employed to calculate a few rough scenarios on how to introduce fast reactors in Finland. The purpose of the study was to determine if the fast reactors could decrease the inventory of the long-lived transuranic nuclides. The fast reactors' capability of extending the energy resources was not a primary object in this study, so the FR fleet in the scenarios was assumed to be rather small – only sufficient to show the nuclide inventory trajectories.

Current and expected nuclear generating capacity in Finland

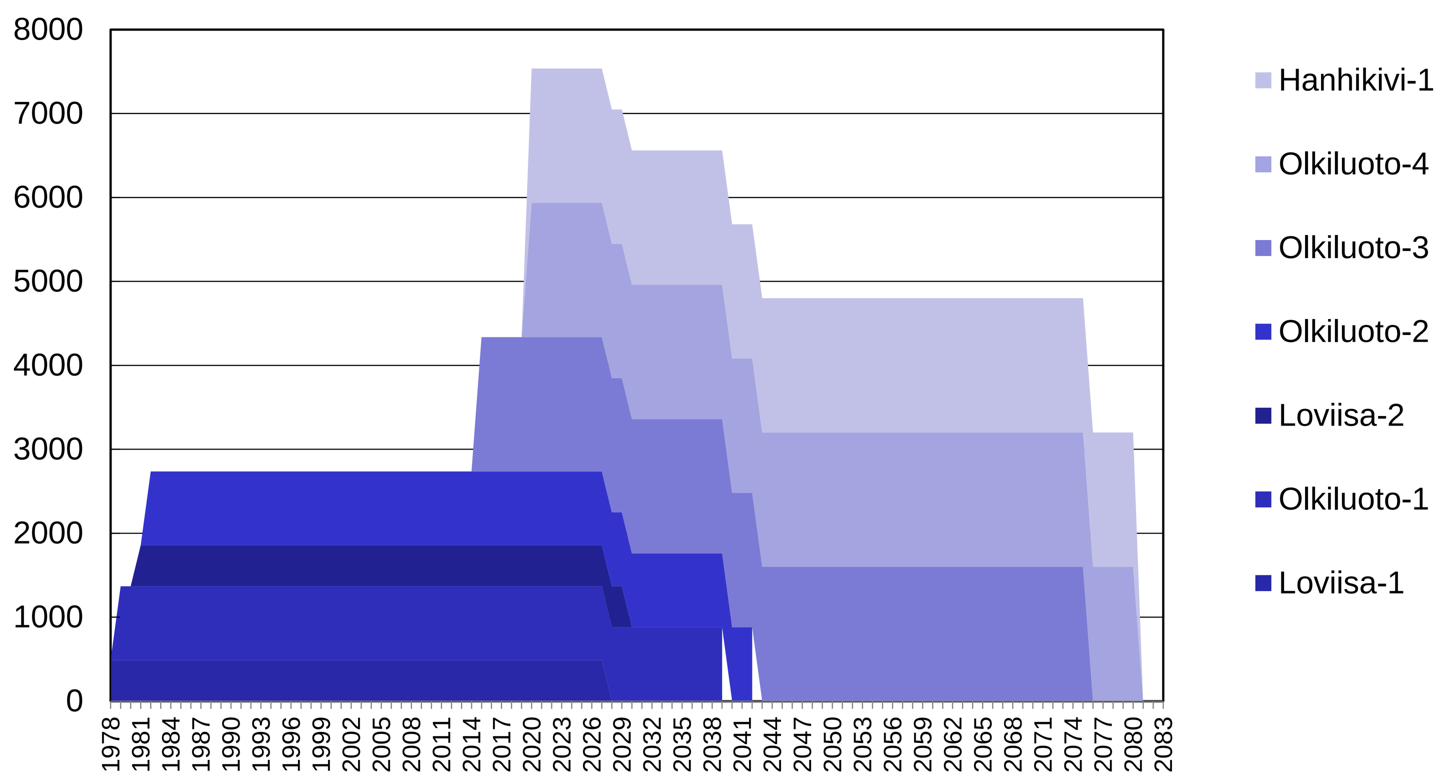


Figure 1: The current estimate of the nuclear generating capacity (MWe) in Finland for the following decades. Olkiluoto-3 (EPR) is under construction, Olkiluoto-4 and Hanhikivi-1 under consideration with political permission granted in 2010. The reactor types of the latter two have not been selected, but they are going to be about EPR-sized, if not EPR itself.

Nuclear power in Finland today and in the near future

The scenarios were built on the assumption of the near future LWR capacity in Finland depicted in Figure 1: no fast reactors expected to enter production before the retirement of the new major units – currently under construction (Ol-3) or consideration (Ol-4, Ha-1) – around 2080.

Some of the LWR parameters applied in simulations:

- UOX fuel only, MOX not used
- Load factor ~90 %, burn-up 43 GWd/t, 55 GWd/t for EPR
- The newest units (Ol-4, Ha-1) assumed to be EPR

Fast reactor scenarios

The recommended French SFR-V2B model was applied: e.g. power 1450 MWe, equivalent Pu-239 content 11 %, fuel burn-up 100 GWd/t, total heavy metal mass 74 t, core management 5 x 410 efficient full power days.

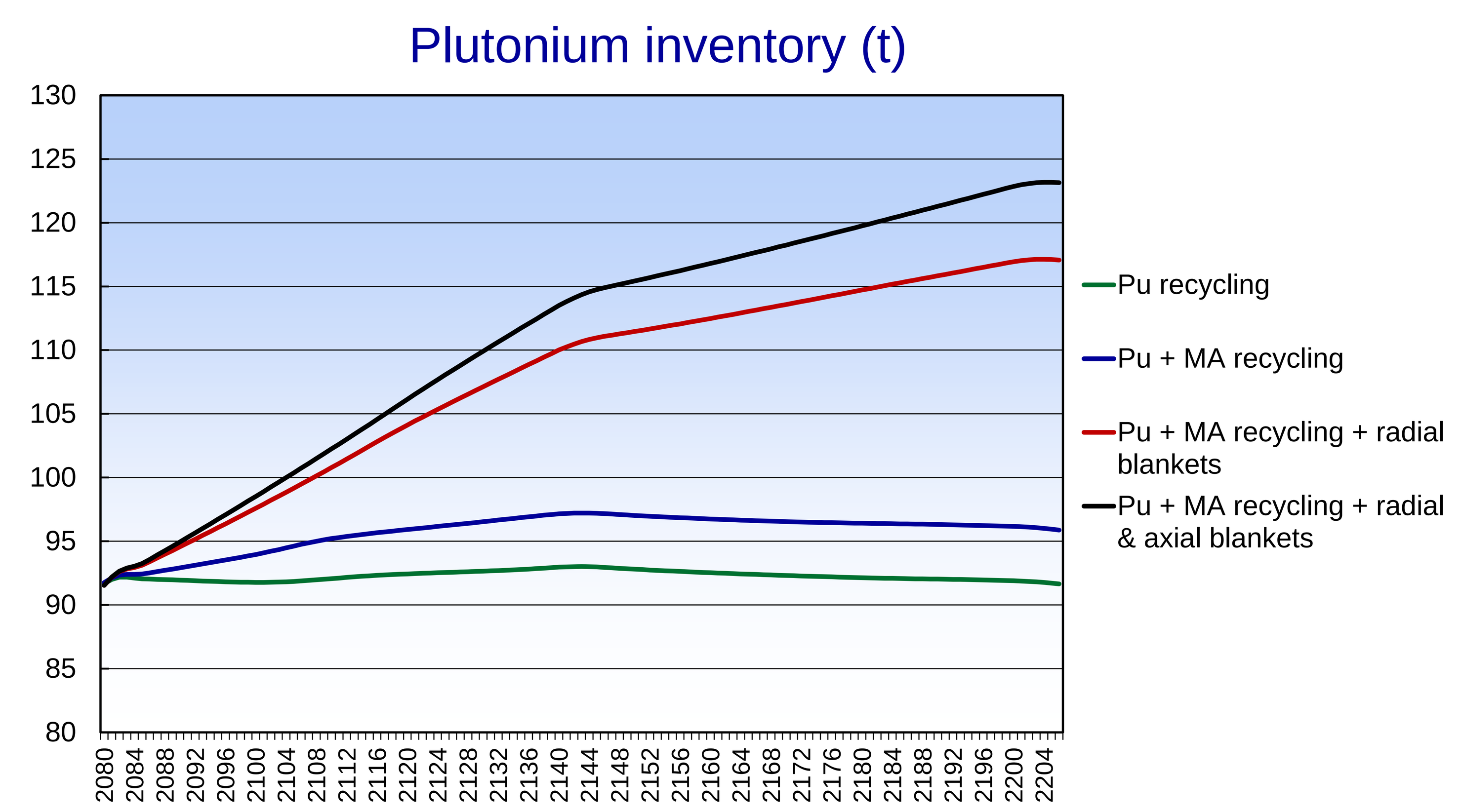
The main scenario paths:

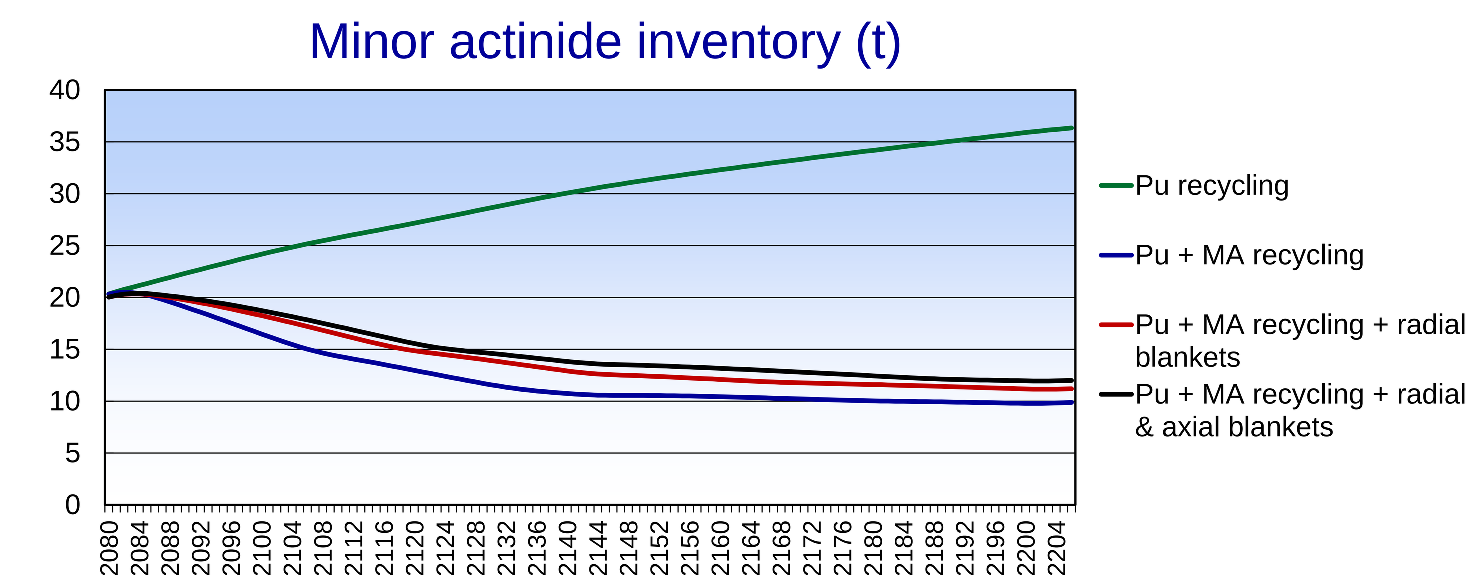
1) Homogeneous plutonium recycling: U and Pu extracted from LWR and FR spent fuel, minor actinides sent to waste stock (COSI6 default scheme)
   - Variations: Pu-239 content, COSI6 fuel type (RNR_GEN4 vs. RNR_GEN4B)
2) Homogeneous plutonium and minor actinide recycling: like the previous model, but also minor actinides were extracted from the spent fuel
3) Homogeneous TRU recycling, fertile blankets added
   - With radial blanket only, and with both radial and axial blankets

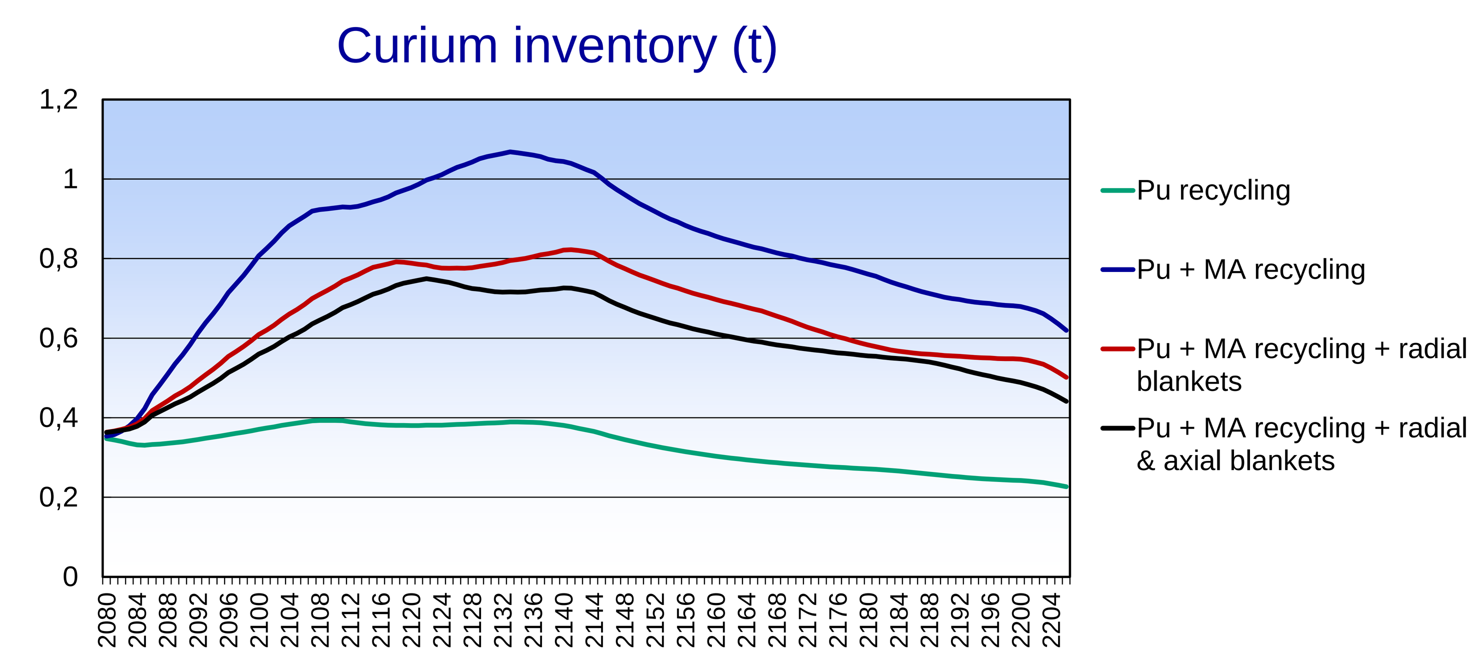
Additionally, FR operation and capacity variations were examined in all scenarios.

Transuranic inventories

In these scenarios two fast reactors were operated after LWR era 2080-2140 and one 2140-2200.







Conclusions

Simple COSI6 models suggest stabilisation or some decrease to transuranic inventories after fast reactor deployment, particularly the created amount of waste per unit energy decreases in most cases.

Some improvements for future calculations:

- Heterogeneous MA recycling models
- Variation in fuel compositions over time
- Various Pu-contents and burn-ups
- Fuel composition validity tests with other computing tools