



LAND OF THE CURIOUS



 FUTURE ENERGY SOLUTIONS SEMINAR, LAPPEENRANTA

SMR TECHNOLOGIES

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SMR POWER RANGES AND USE CASES

“SMR” is a broad notion; generally, < 1000 MWth; feasible for many applications

Use →	Electricity	Co-generation / Desalination	Naval	District heat / Desalination	Direct Hydrogen (non-LWR)
Thermal power (MW)	1500..10	1000..100	200..100	100..10	~500
Max temp (°C)	300	300	300	120	900
Units / installation	1..12	1..12	1..2	2..5	1..few
Nature of application	Traditional	Heat & desalination new	Movement	New	New, material production
TRL	8	8	9	6	5

BASIC TECHNOLOGY FEATURES

- Mostly UO_2 fuelled Light Water Reactors (LWRs), as the currently operating reactors
 - **Fuel** consumed and **wastes** generated essentially similar to current commercial reactors
 - existing supply chains and services can be used
 - **Quantities** are roughly **proportional** to reactor **thermal powers**
- **Safety** features emphasise inherent processes and “passive” systems
 - Little to no emergency power supply needed
 - Industrial-scale (small) emergency preparedness zones feasible
- “Modular” design and construction, leverages **economy of scale in large numbers** of similar components and modules
- Designed primarily for **electricity** production; **heat** and **desalination** as by-products

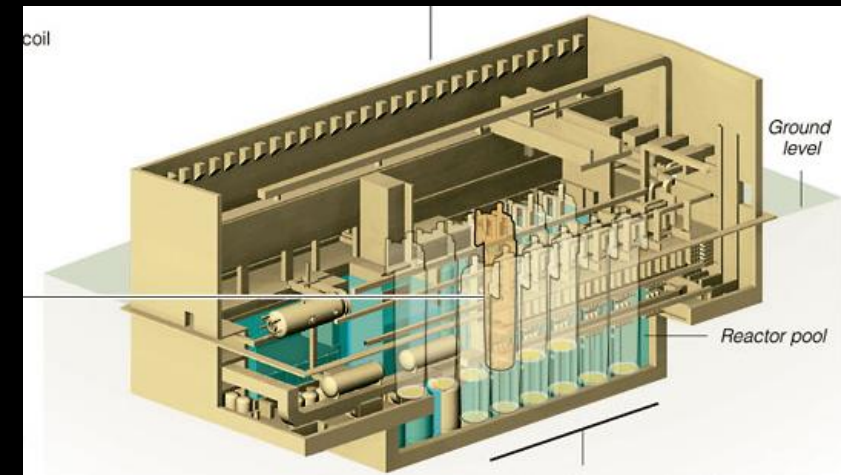
COMMERCIAL SMRS – GENERIC POWER PLANTS

GE Hitachi BWRX-300
870 MWth / 300 MWe



Cost target 2250 \$/kWe

NuScale VOYGR: 4..12 modules / plant
200 MWth / 77 MWe per module



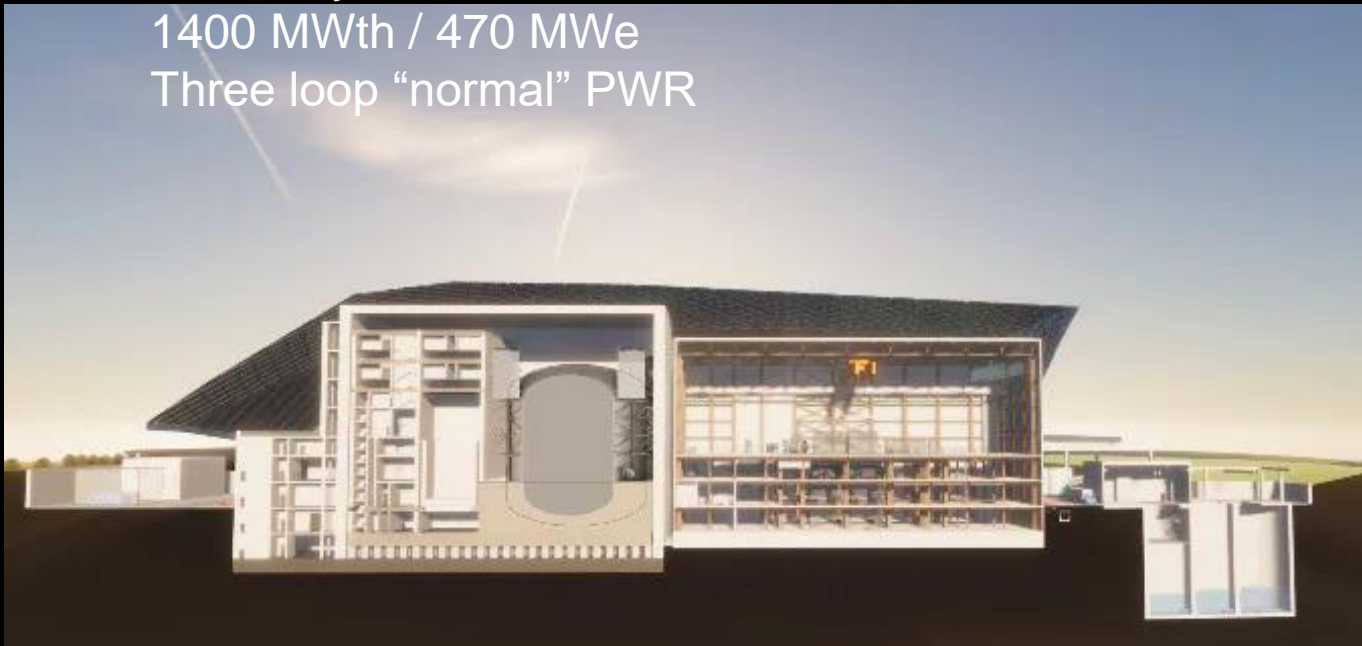
Cost estimate 4200 \$/kWe

COMMERCIAL SMRS – GENERIC POWER PLANTS

Rolls Royce SMR

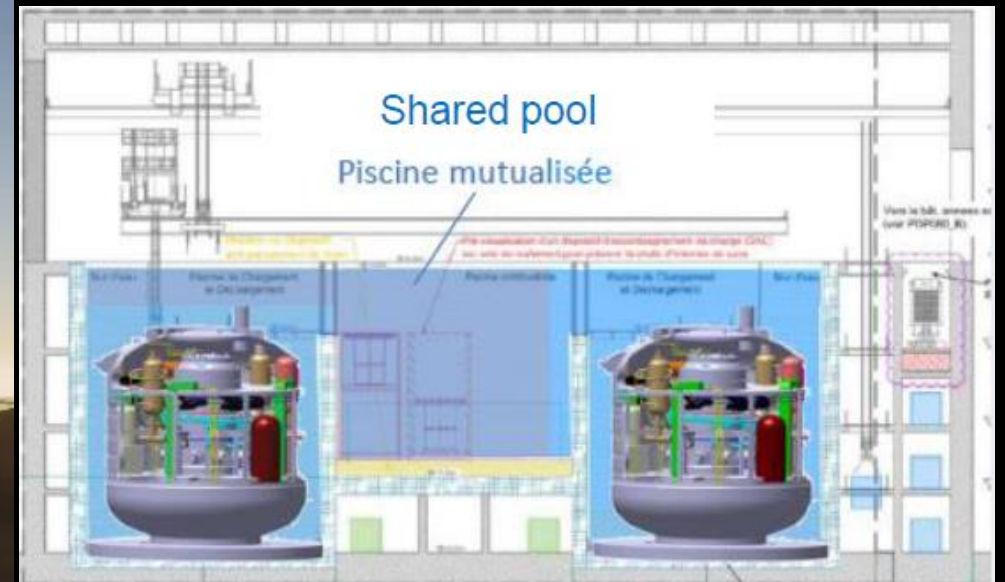
1400 MWth / 470 MWe

Three loop “normal” PWR

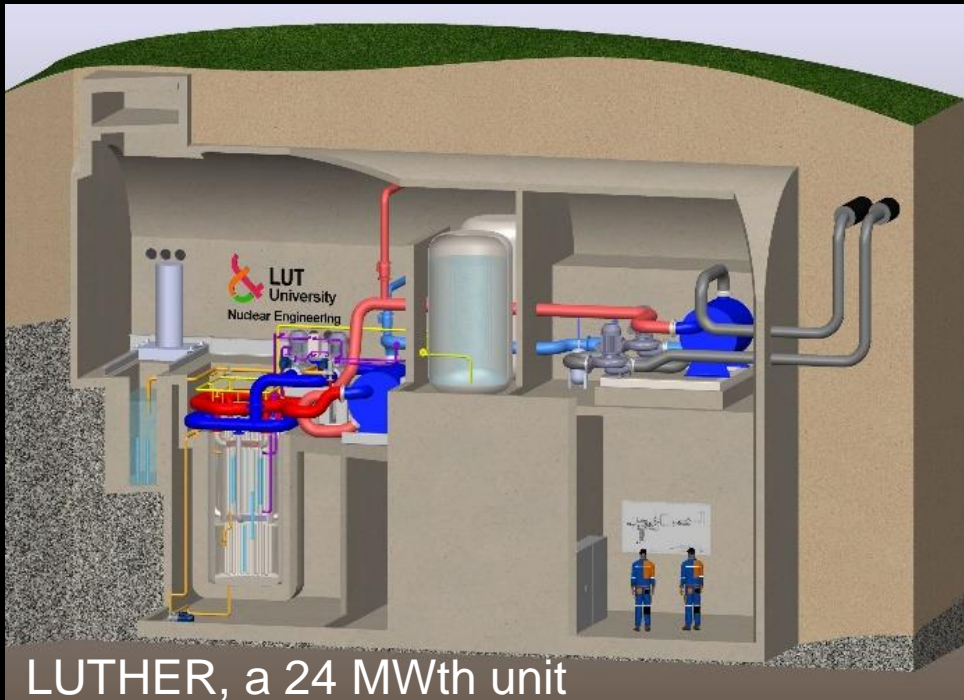


Nuward™: 2 Integral PWR modules / plant

500 MWth / 170 MWe per module

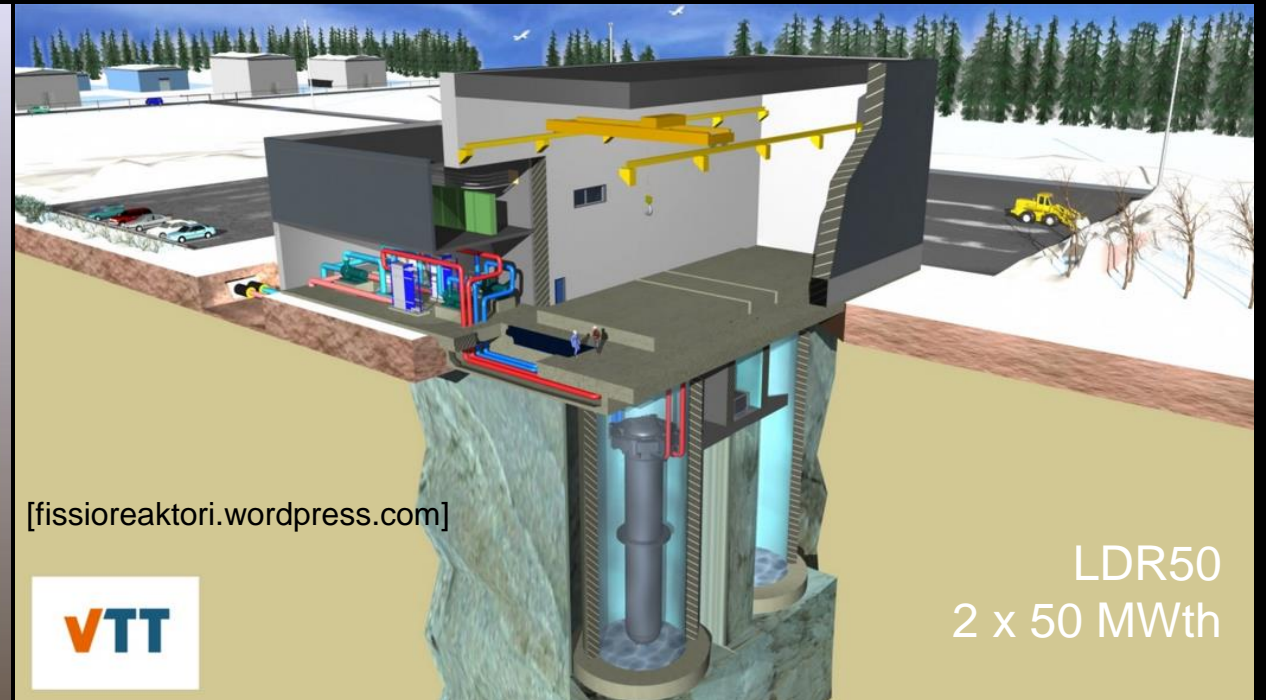


FINNISH DISTRICT HEATING REACTOR CONCEPTS



LUTER, a 24 MWth unit

LUT HEating Reactor



[fissioreaktori.wordpress.com]



LDR50
2 x 50 MWth



ABOUT ALTERNATE REACTOR TECHNOLOGIES

- All imaginable variants of fission reactors have been already tried and proven in 1950-1980 timeframe
- Currently of renewed interest:
 - Gas-cooled graphite moderated designs → high-temperature applications, up to 900 °C
 - Molten salt systems → temperatures around 600 °C, thermal breeding → thorium utilisation feasible
 - Lead-cooled systems → temperatures up to 600 °C, fast breeding of plutonium
- Non-LWR designs tend to feature new fuel chemistries and relatively high U-235 enrichment, up to 20 %, the civilian maximum



CONCLUSIONS

- »» Many feasible reactor technologies are there
- »» Reasonable commercial promises are there
- »» No questions of principle, but many questions in practice
- »» New nuclear plant and site licensing is feasible in Finland, today
- »» Regulation of technical detail will be a challenge, but also an opportunity to revamp oversight practices for effectiveness and efficiency

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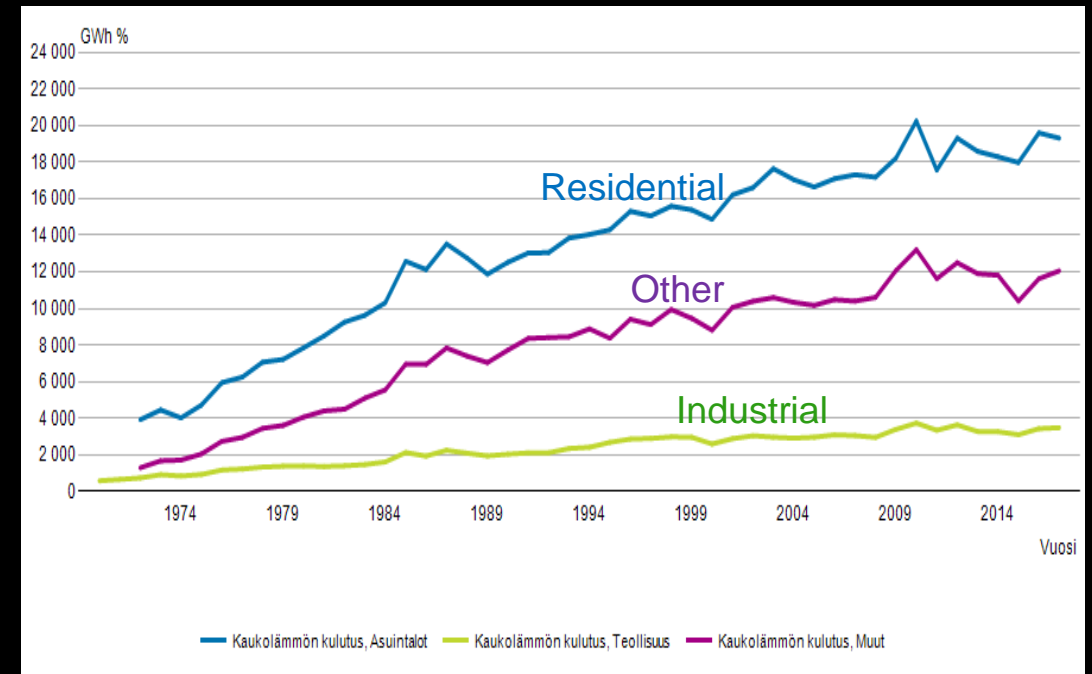
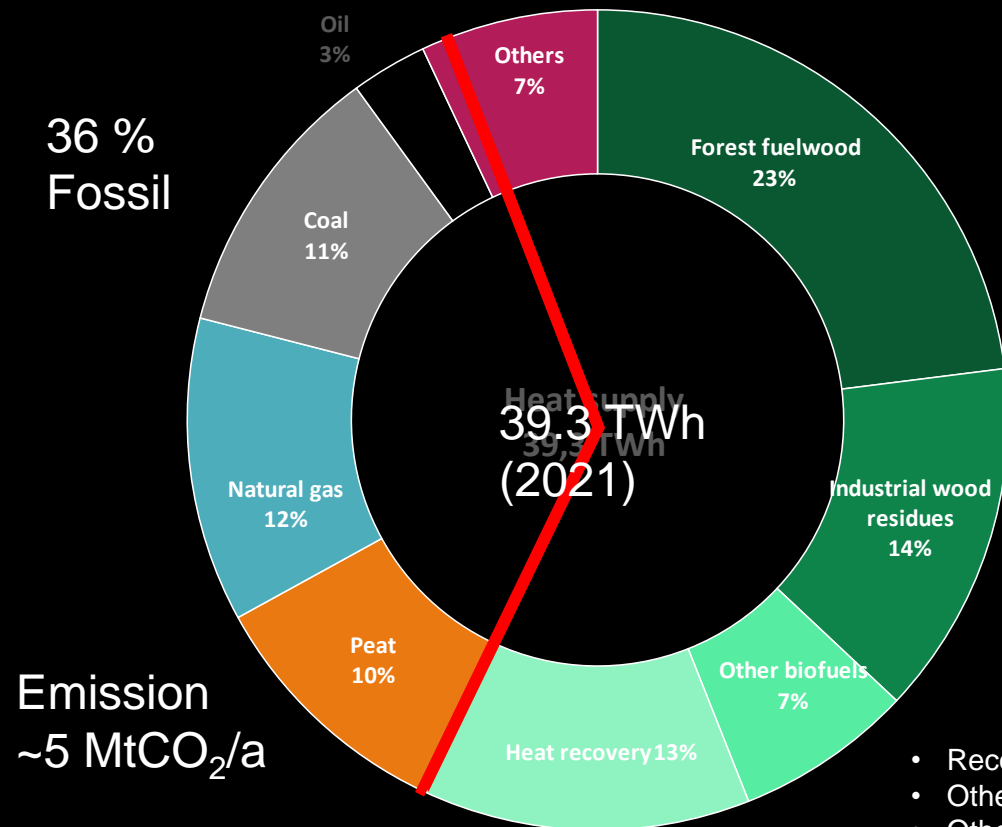
Thank you!

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NUCLEAR DISTRICT HEATING = GHG REDUCTION



[Finnish Energy 2022]

- Recovered (recycled) heat: energy that would otherwise go to waste
- Other biofuels: includes also the bio share of municipal waste
- Other: non-bio share of municipal waste, plastic or hazardous waste, electricity.