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Lappeenranta University of Technology

Panel discussion topics

Future on Gen4 reactor studies

The need of test and demonstration reactors

The Future of Nuclear Power

Nordic – Gen4 Seminar

Lappeenranta, September 4, 2014

Prof. Juhani Hyvärinen

The Need for Power

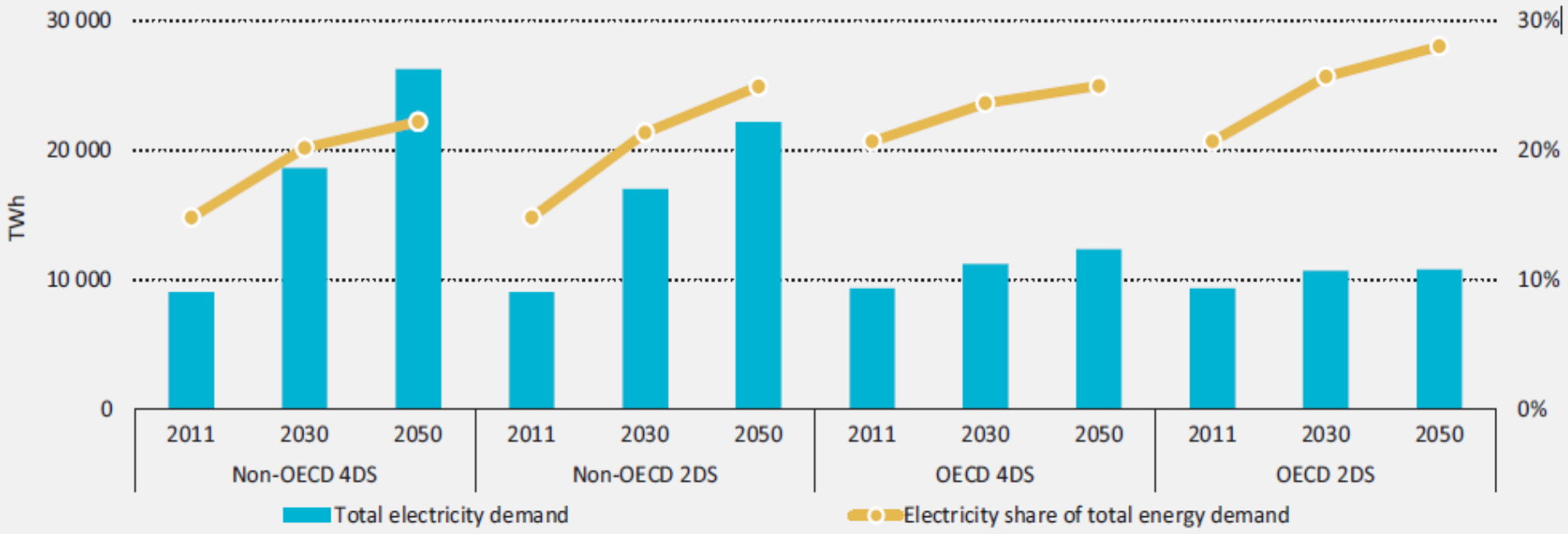
Highlights of the OECD/IEA Energy Technology Perspectives 2014:

- *Globally, growth in **electricity demand** is outpacing all other final energy carriers; this creates potential for radically transforming both energy supply and end use.*
- *The transition to electrification is not neutral: in fact, decarbonisation requires a massive reversal of recent trends that have shown continued reliance on unabated fossil fuels for generation.*

Global constraints:

- Global warming due to greenhouse gases, mainly CO2 → need to decarbonise
- Increase in world population, Increasing standard of living → increasing energy consumption (but decoupling possible to some degree)
- Ideological environment
- Reluctance to introduce nuclear in new areas (heating, transport)

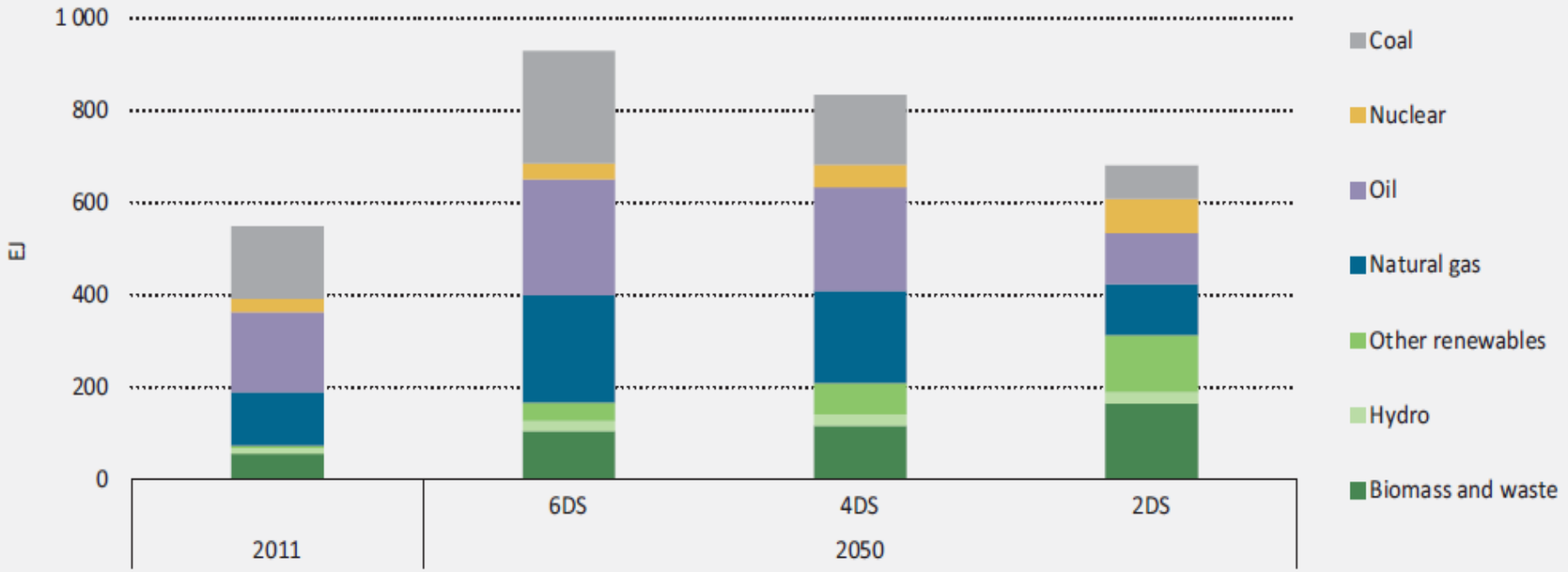
Large increase in electricity demand



Notes: TWh = terawatt hours. Unless otherwise indicated, all tables and figures in this report derive from IEA data and analysis.

2DS = 2 Degree Scenario, global warming < 2 °C; 4DS global warming < 4 °C

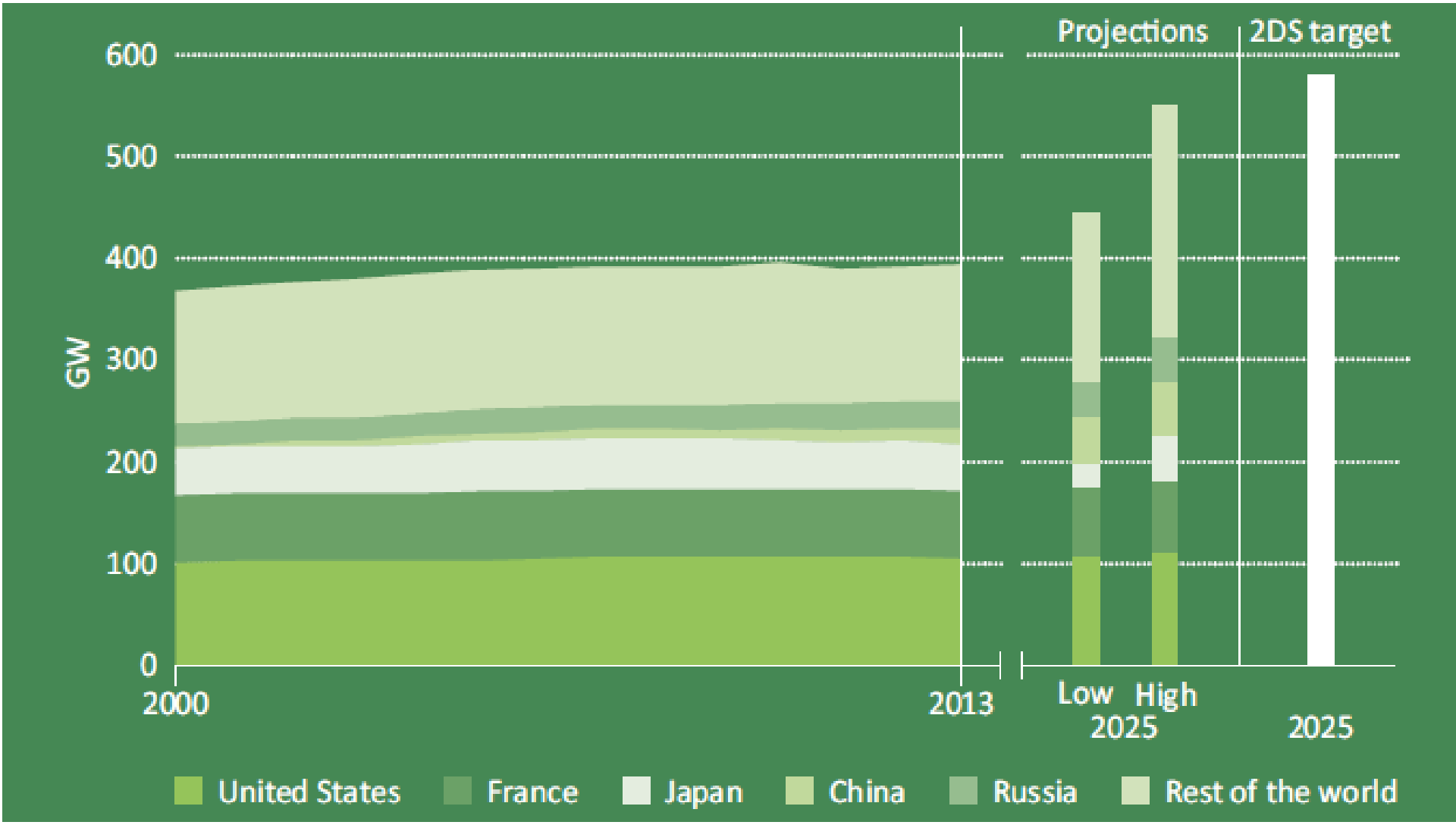
Nuclear is the only a large-scale emissions-free controllable source



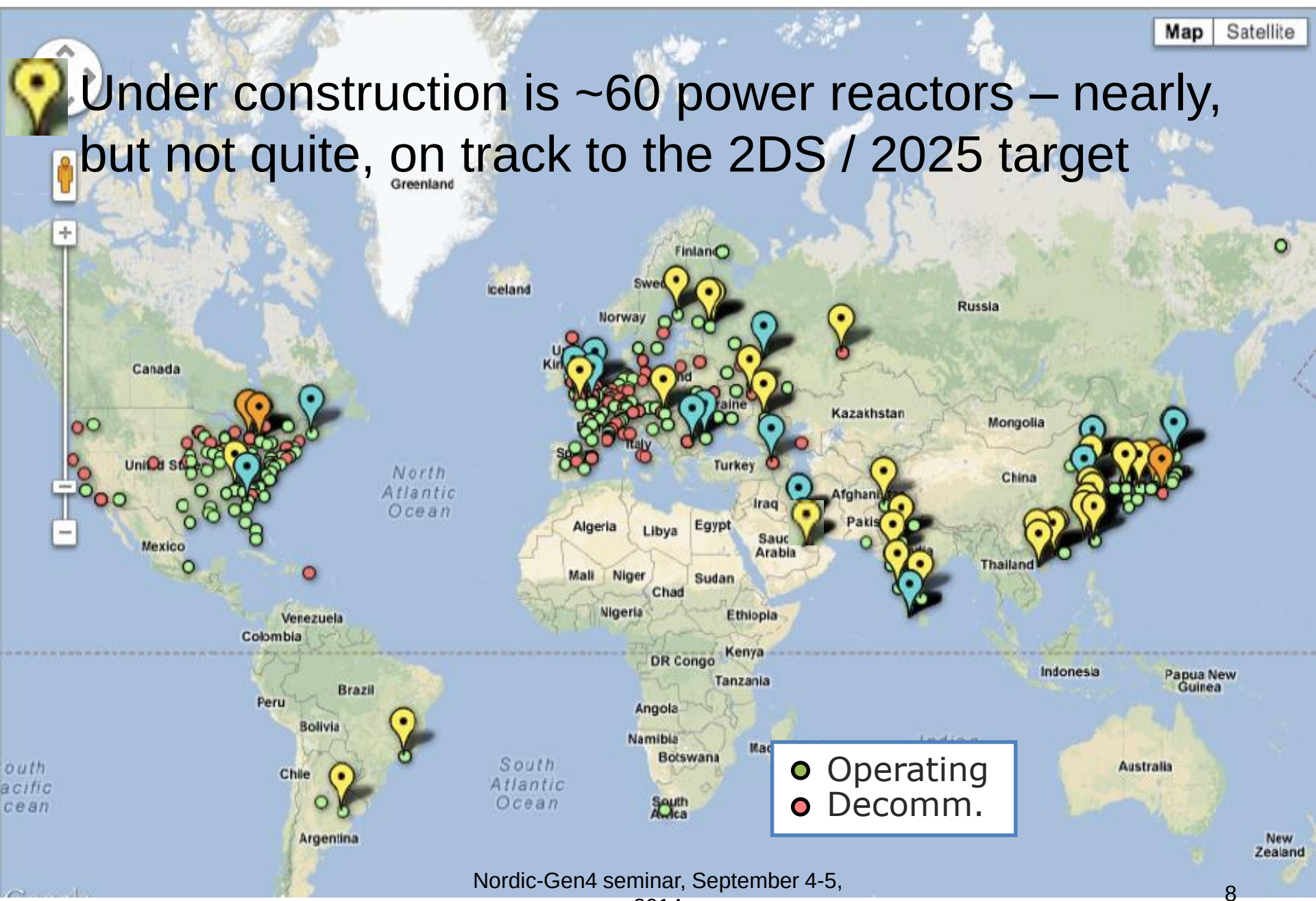
Note: EJ = exajoules.

Attaining the 4DS requires roughly doubling current nuclear capacity, attaining 2DS requires roughly tripling by 2050.

Installed nuclear capacity is now ~400 GW



Under construction is ~60 power reactors – nearly, but not quite, on track to the 2DS / 2025 target



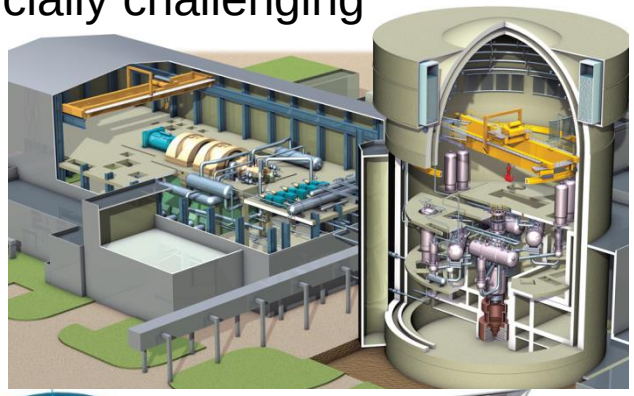
Current Products… and related experience

Commercially available reactors are (mostly) large LWRs

- 1000 – 1200 MWe range: AP1000, AES-1200, …
- 1600 MWe range: ABWR, EPR, …

Projects are unique, large, slow, expensive → commercially challenging

Licensing well established but burdensome



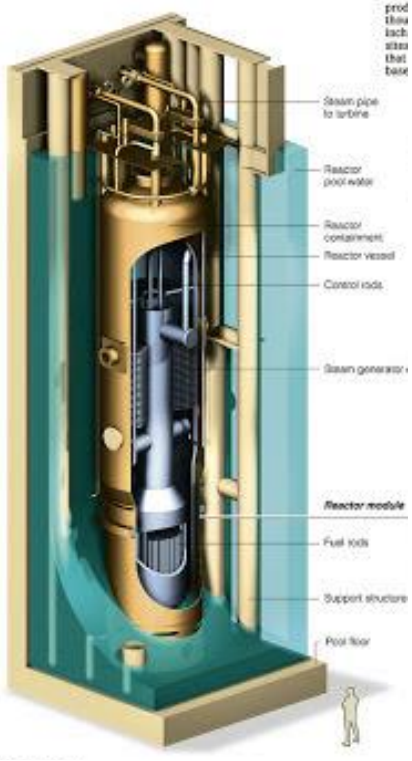
Good Ideas 1: Mass Production - SMRs

LWR based Small Modular Reactors (SMRs), < 300 MWe, have the potential of serial production, fast construction, standardised deployment

But this requires

- reasonable unit cost
- mass licensing and oversight: type approval of standard designs
- large LWR safety philosophy needs to be adapted, but basic technological base is same

In addition to minimising project management challenges, SMRs allow *geographic decentralisation*: power plants could be distributed around the country



NuScale, 45 MWe

mPower, 180 MWe

Good Ideas 2: Breeding & Transmutation – Gen4

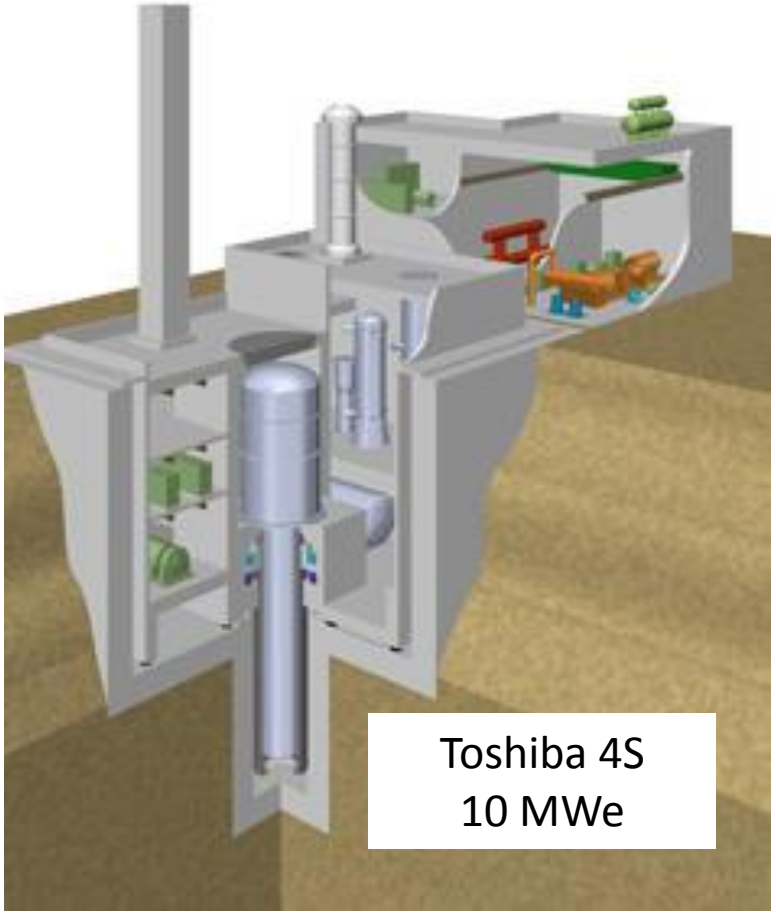
Many variants available in both “large” (1200 MWe) and “small” (< 300 MWe) ranges

Sustainability advantages:

- Breeding to eliminate uranium resource concerns
- Actinide transmutation / burning to reduce long-lived radiotoxicity of waste

Technologies have been demonstrated, but the path is long

- Demos needs to be commercialised
- Economy, industrial interest
- Safety and licensing – many new challenges present in the technology and philosophy



The World needs nuclear – and we, the nuclear community, need to deliver

Nuclear electricity generation capacity needs to increase if global warming is to be counteracted

- 2DS / 2050 requires roughly tripling the nuclear generating capacity
- Several technologies are available to do this:
  - Large LWRs are mature, but present practical challenges
  - Small LWRs are promising, but present cost and licensing challenge
  - Gen4 is very attractive, but presents technology commercialisation challenges (and cost, and licensing)

  A mixture of technologies appears most desirable.

Significant nuclear contribution to heating or transport sectors appears unlikely.

Politics is manageable. *Where there is will, there is a way.*

Thank you!

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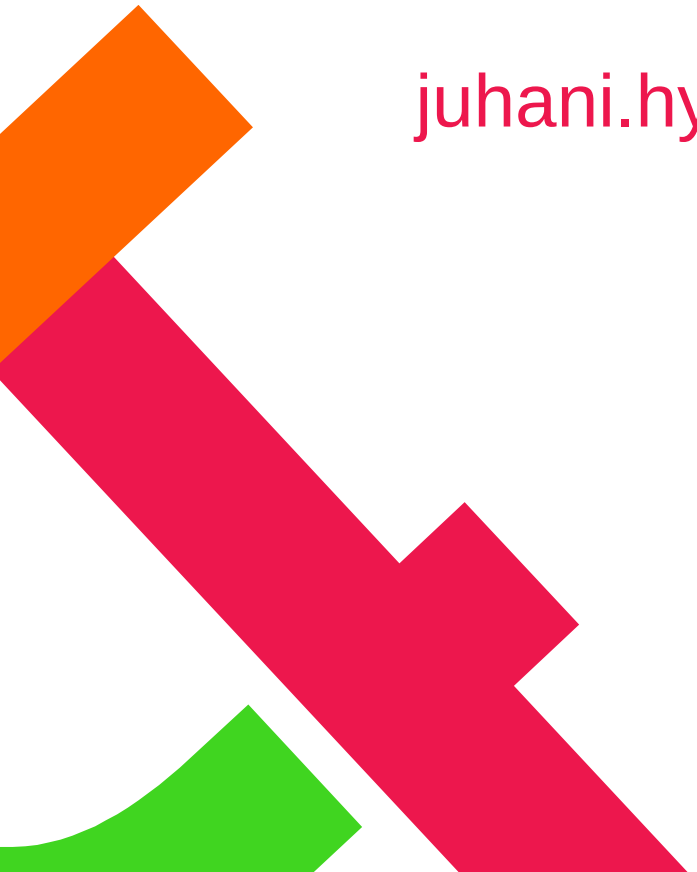

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