Role of Nuclear in Decarbonisation

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Nuclear power features

- ❑ Small carbon footprint
- ❑ Small land requirements
- ❑ Predictable, constant supply
- ❑ Yet flexible if needs to be
- ❑ Small fuel costs
- ❑ Secure fuel supply
- ❑ Potential for decarbonising other sectors

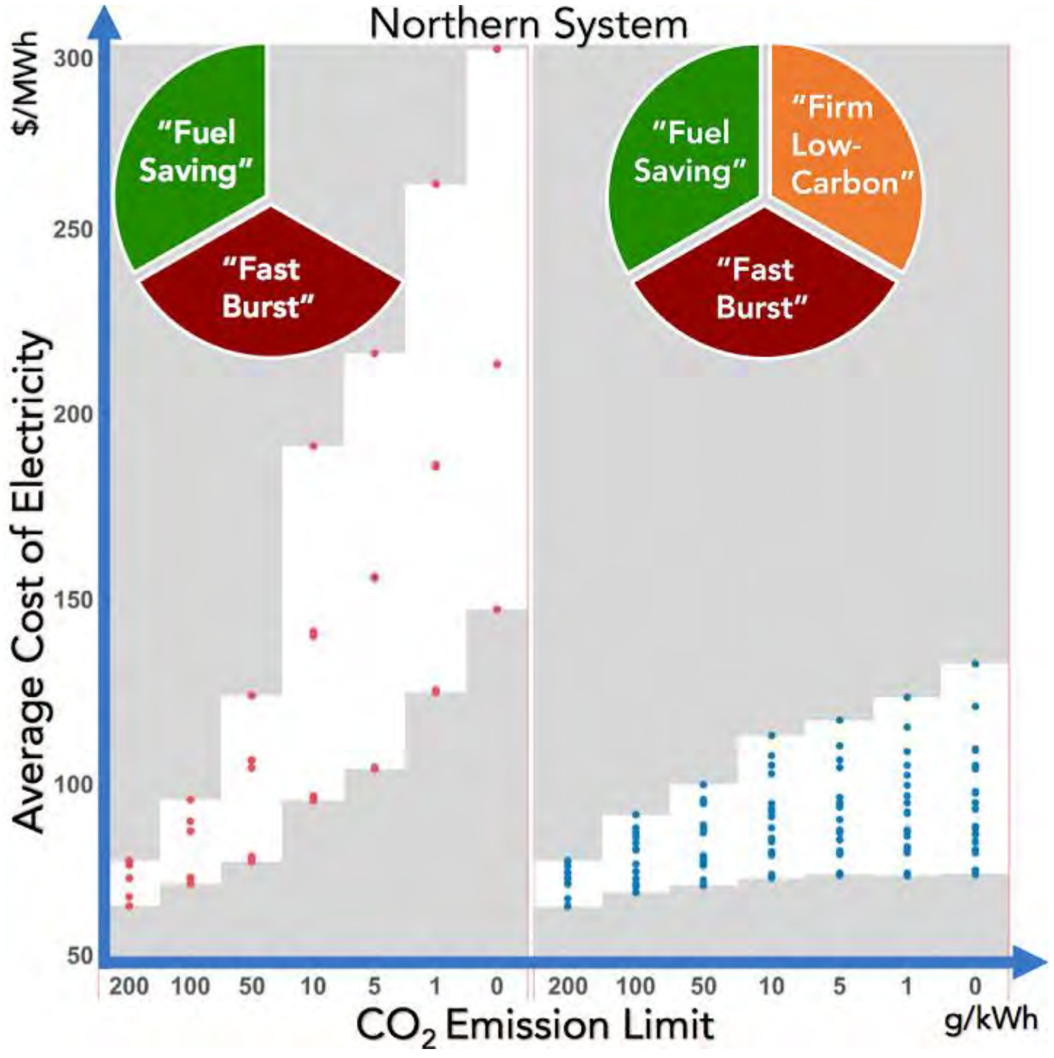
- ❑ High costs, implying government subsidy
- ❑ Long construction
- ❑ Heavy regulation
- ❑ Public perception of safety risks/radiation hazard
- ❑ Public perception of fuel sustainability
- ❑ Public perception of waste burden
- ❑ Nuclear security and non-proliferation

Historically, reactor vendors pushed for larger sizes in pursuit of economies of scale

(EPR, Areva)

Value of firm power

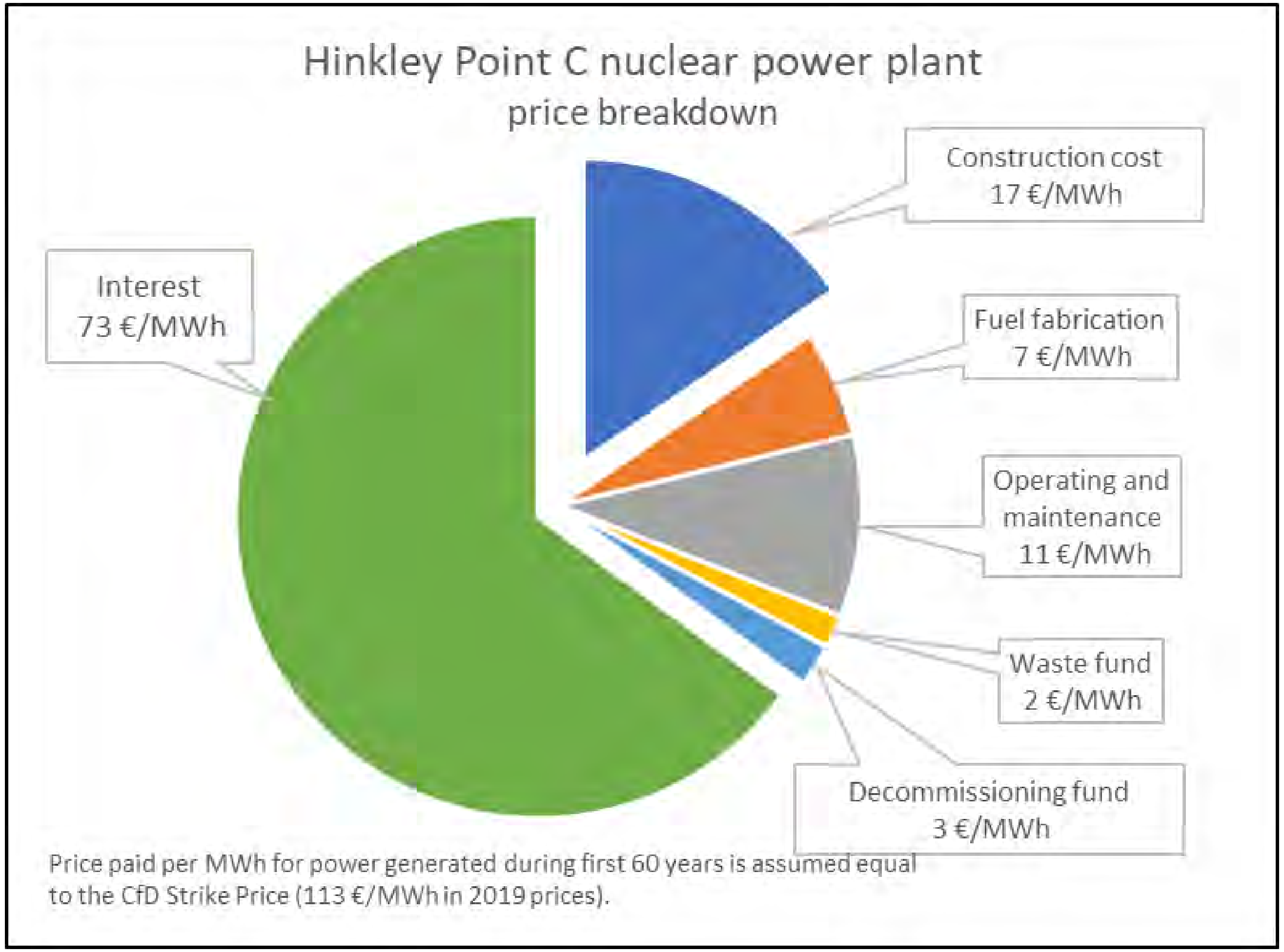
- Consistently lowers electricity costs across all studies
- Per-unit-energy cost (LCOE) comparisons can be misleading in system design
- Major effect at near-zero emissions
- Batteries and demand flexibility do not substitute for firm low-carbon power



Sepulveda et al., Joule 2, 2403–2420, November 21, 2018

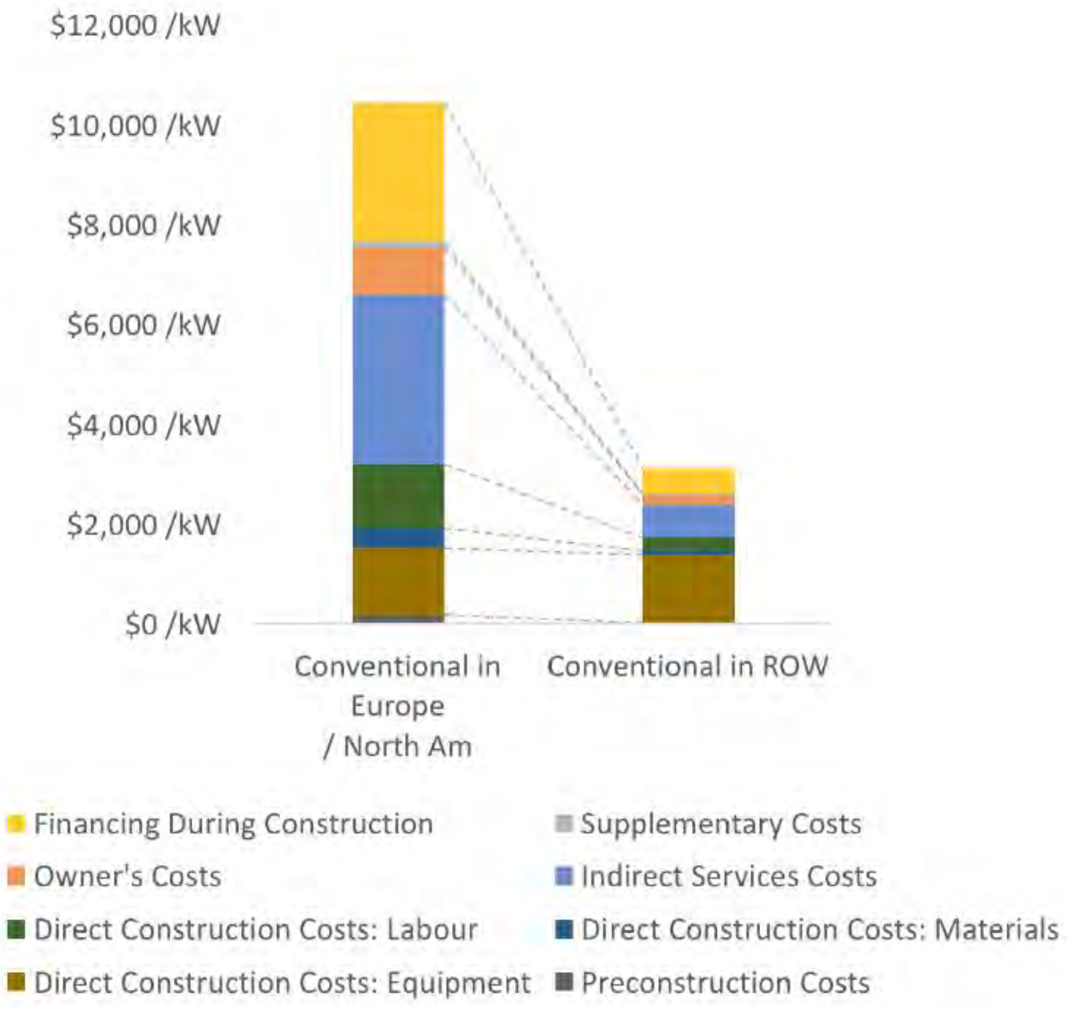
Why is nuclear expensive? (per-energy cost)

Most of the cost of a nuclear project is in financing

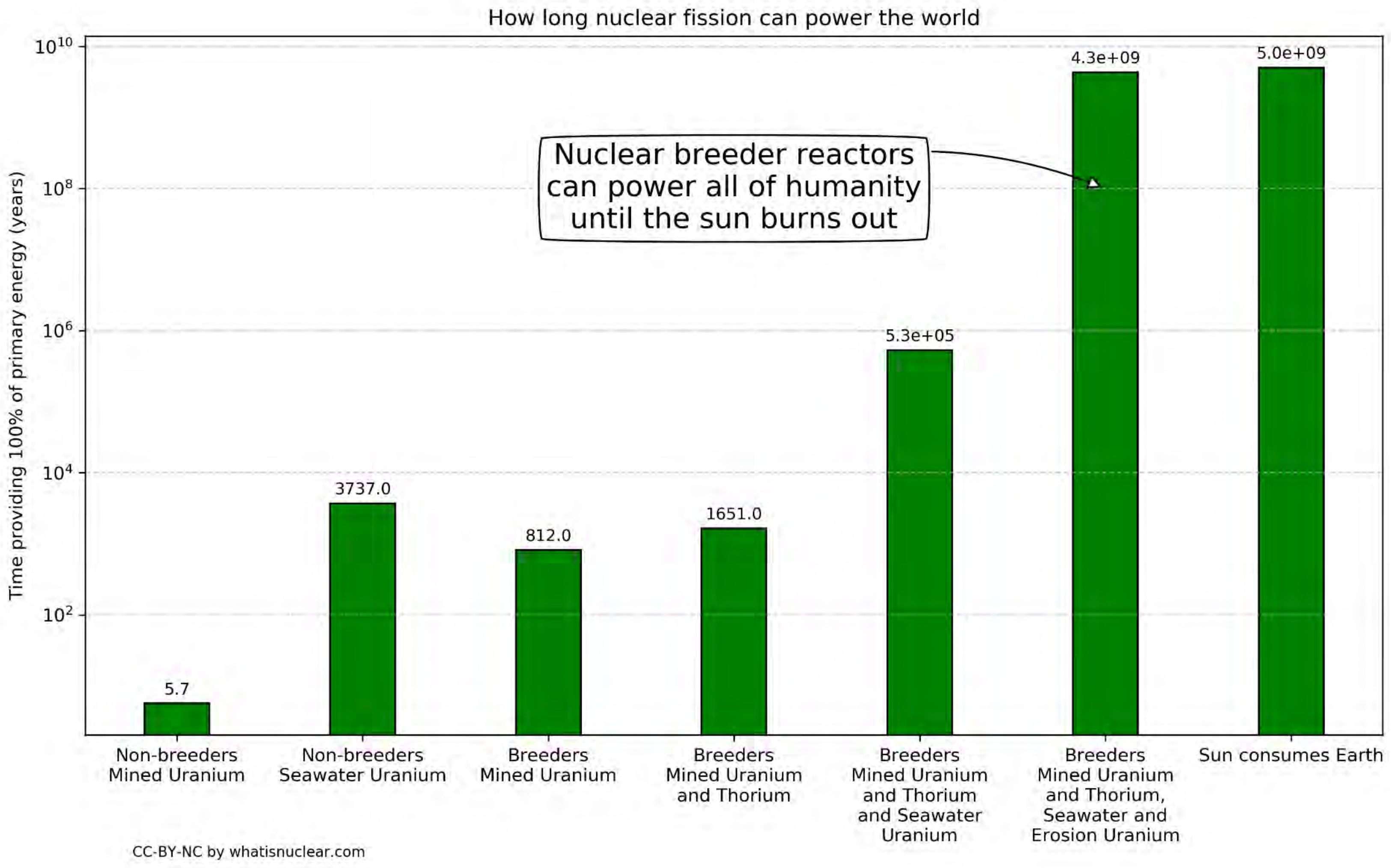


Why is nuclear expensive? (per-power cost)

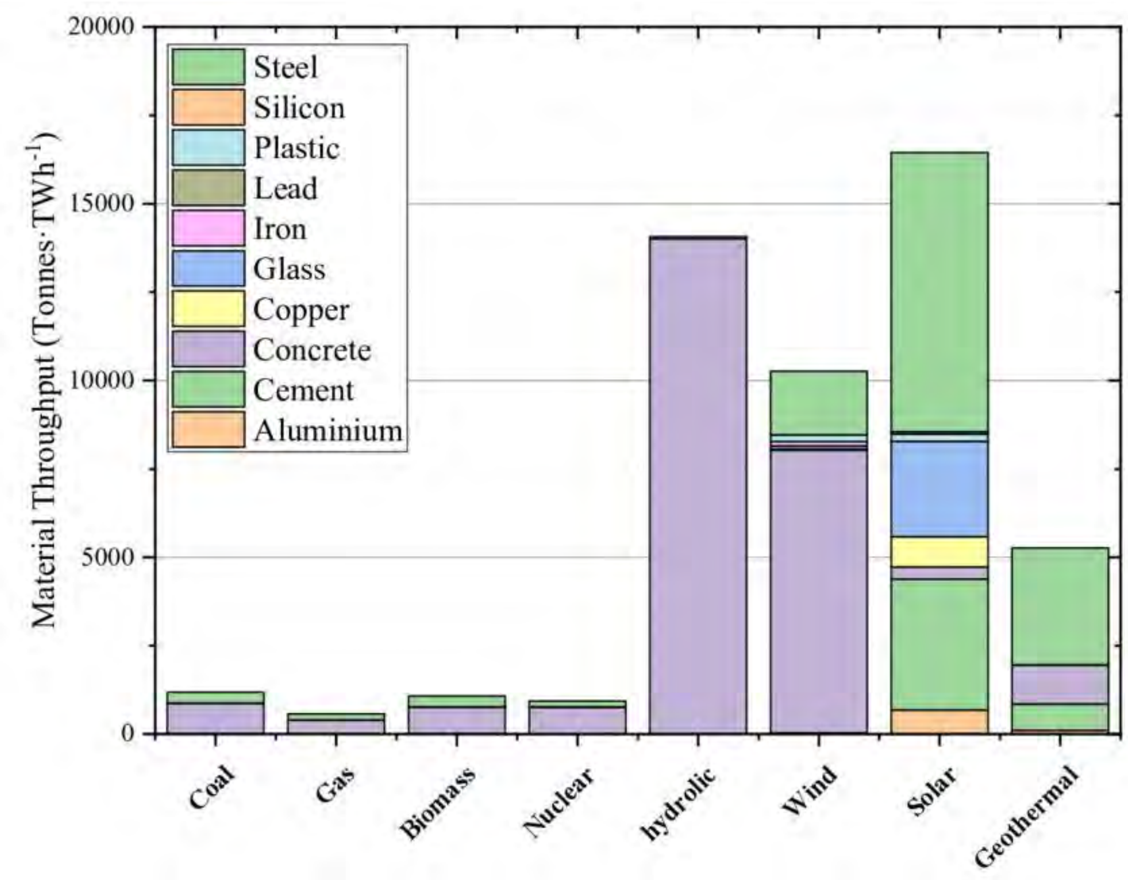
First-of-a-kind projects in the West versus focused programmes

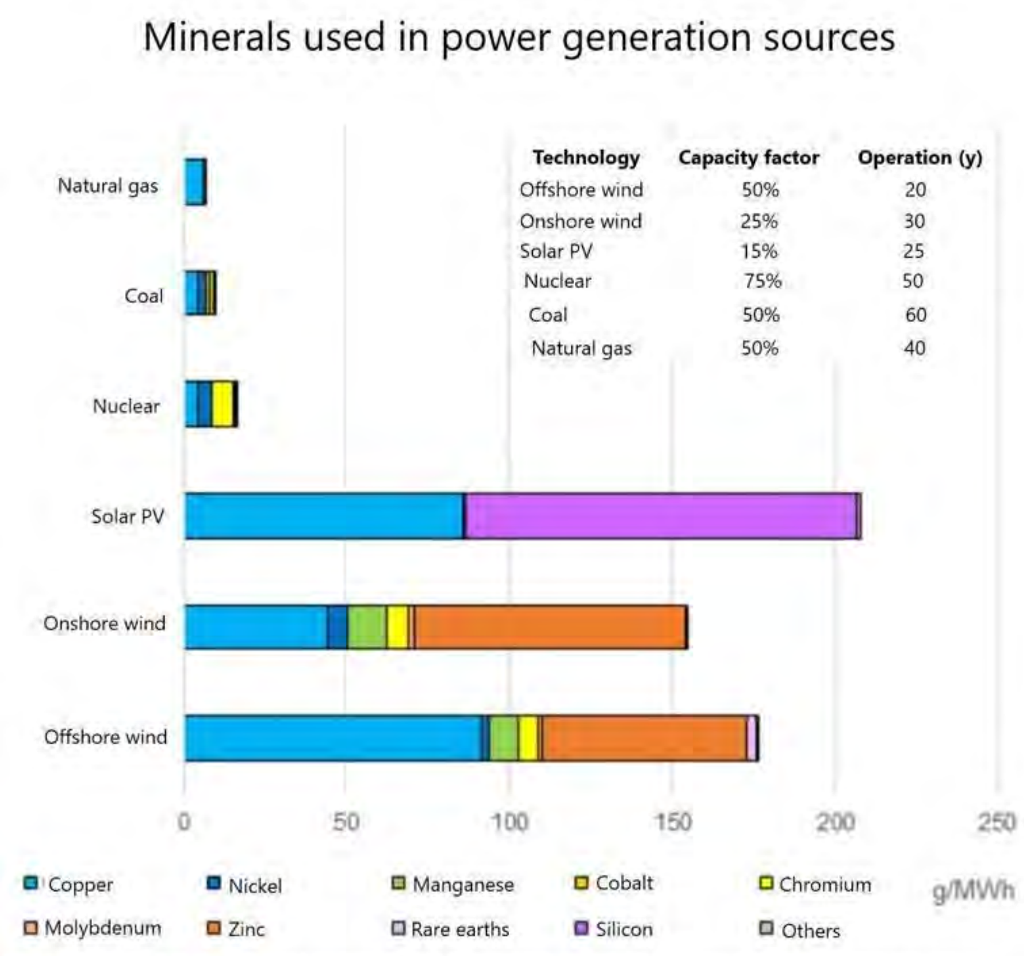


Fuel availability



Raw materials requirements

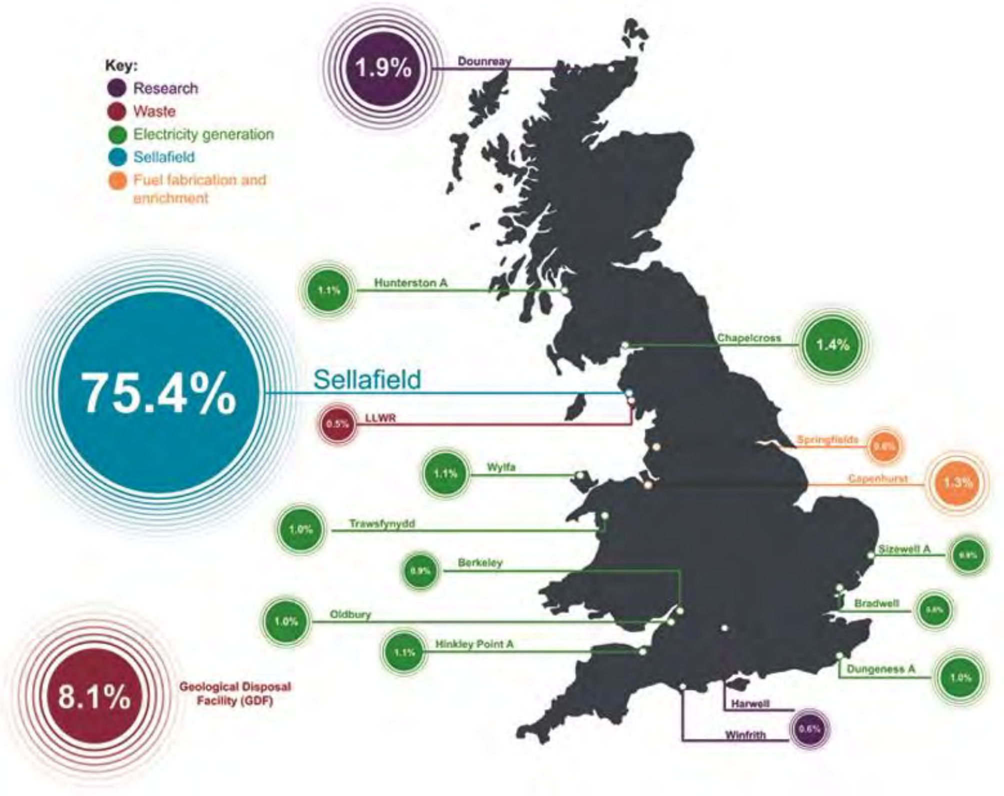


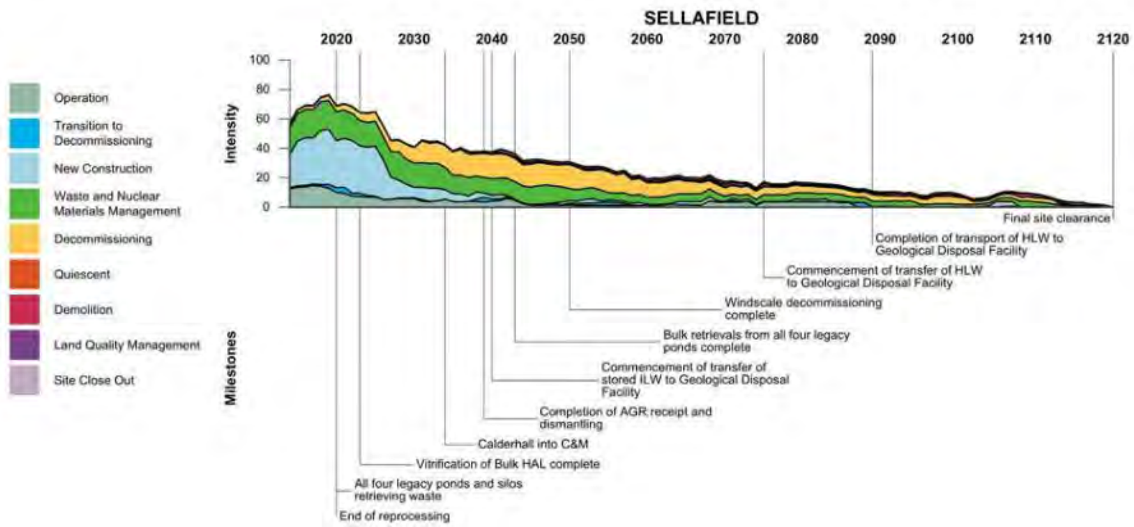


https://www.iea.org/data-and-statistics/charts/minerals-used-in-clean-energy-technologies-compared-to-other-power-generation-sources

Waste and Decommissioning

Nuclear Decommissioning Authority

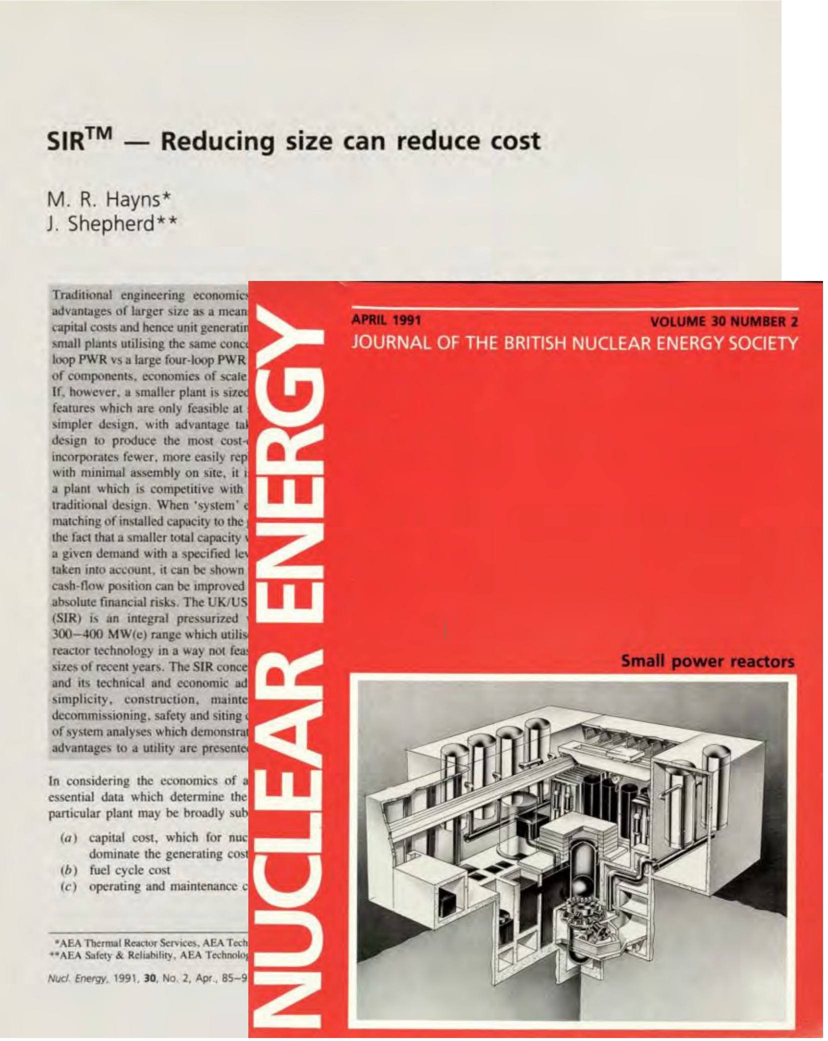


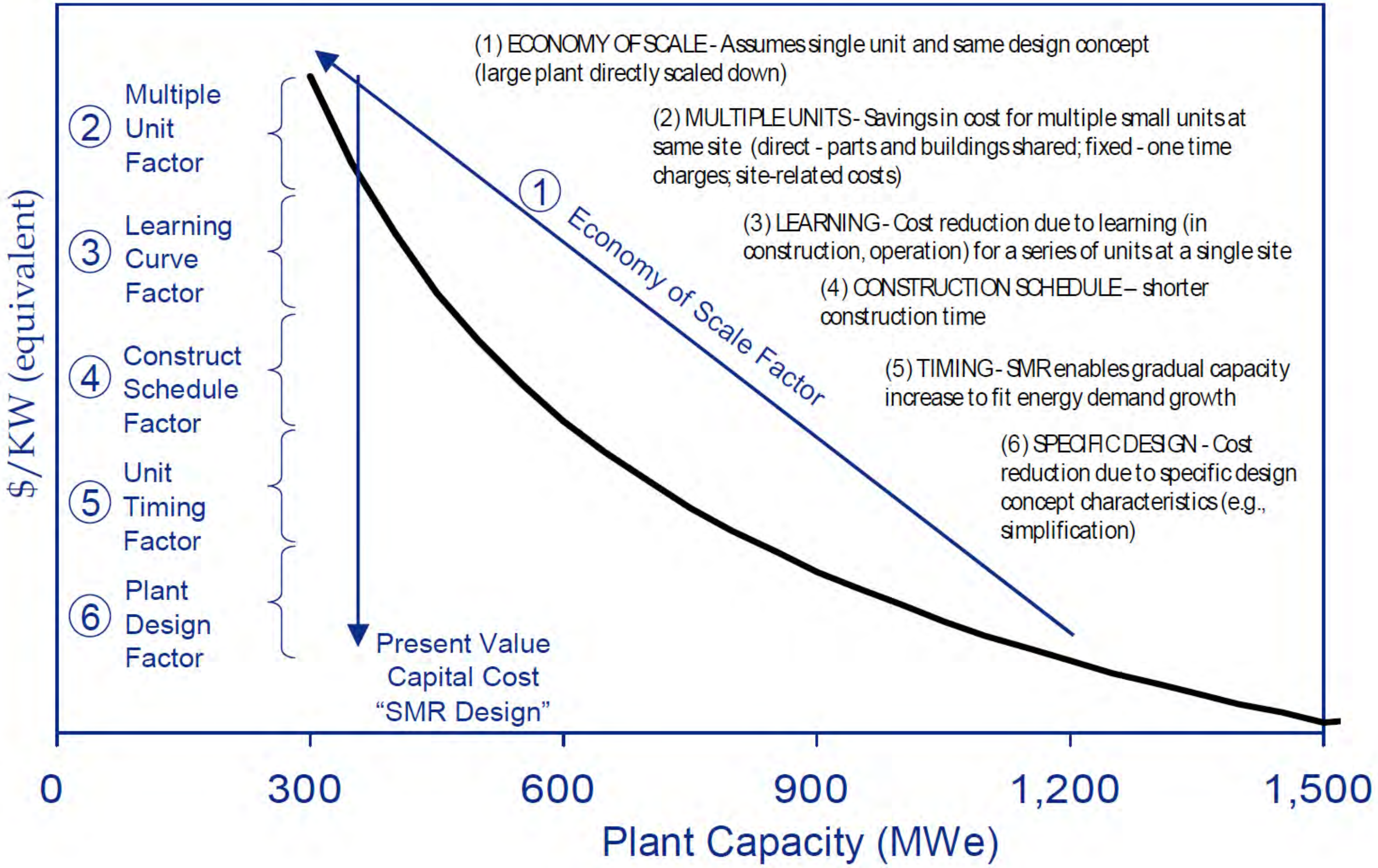


- **~ 100 years of clean-up**
- **~ 90 - 200 B£ in liabilities**

Nuclear Provision: the cost of cleaning up Britain's historic nuclear sites, NDA (2018)

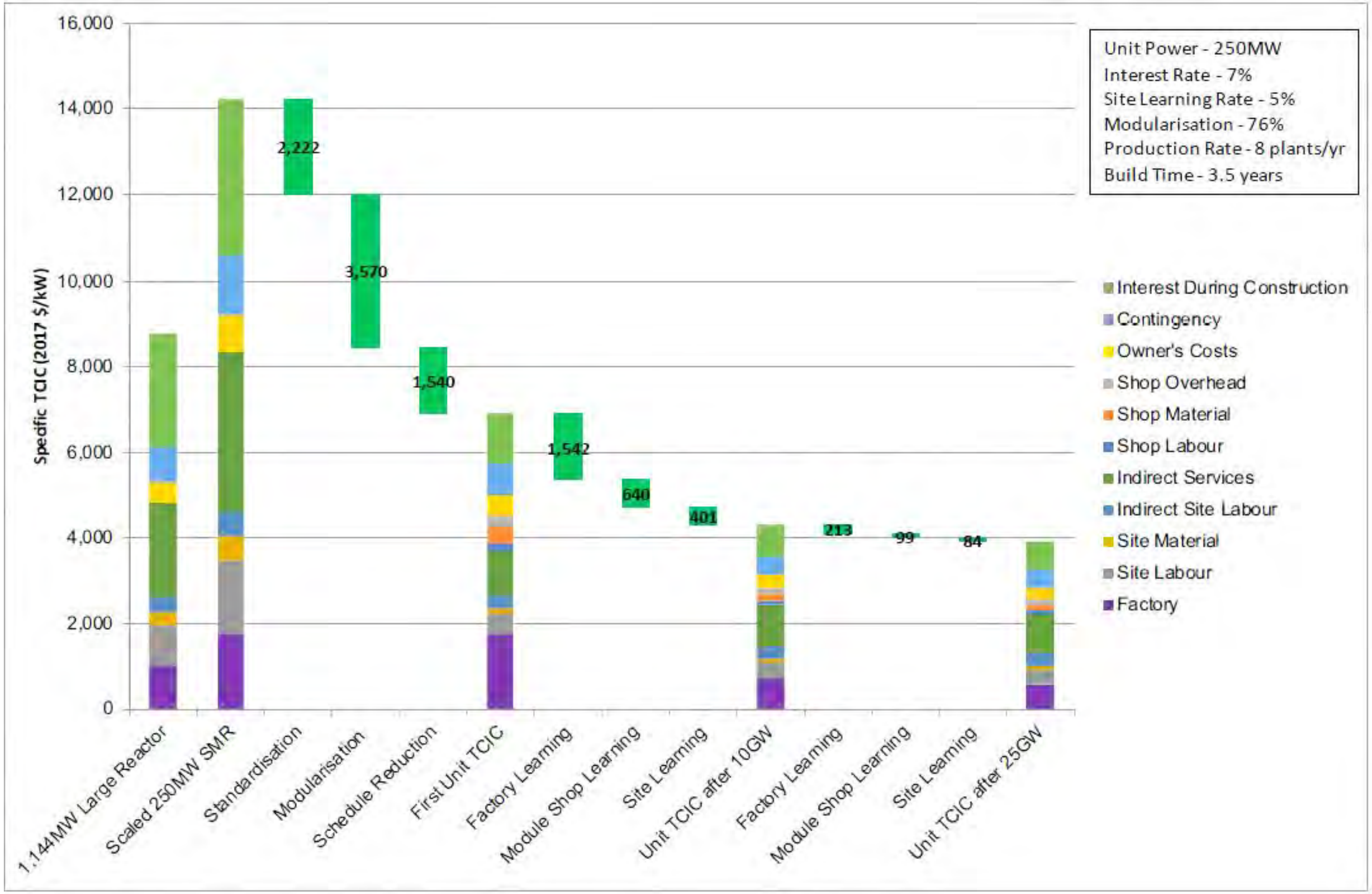
Economics case for SMRs





M. D. Carelli et al., Competitiveness of Small-Medium, "New Generation Reactors: A Comparative Study on Capital and O&M Costs" ICONE-16, 2008.

Combined Effect of Modularisation and Learning



Roulstone, Lloyd, Lyons, "Expanding Nuclear's Contribution to Climate Change with SMRs" (2020)

Small Modular Reactors

- SMR economic case
  - High production volumes and degree of modularisation
  - Short construction schedule
  - Licensed in more than one country
  - Global supply chain
- SMR safety case – needs development, testing, licensing
  - Integral configuration, canned pumps, internal control rod drives
  - Reactivity control, boron free operation, natural convection
  - Multiple units on same site, staffing, control from central facility
  - Oversight of off-site construction, shared ownership of modules
- High T heat from advanced reactors is a valuable commodity/game changer
- HTGRs are close to market, salt-cooled reactors are promising because of low pressure