
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

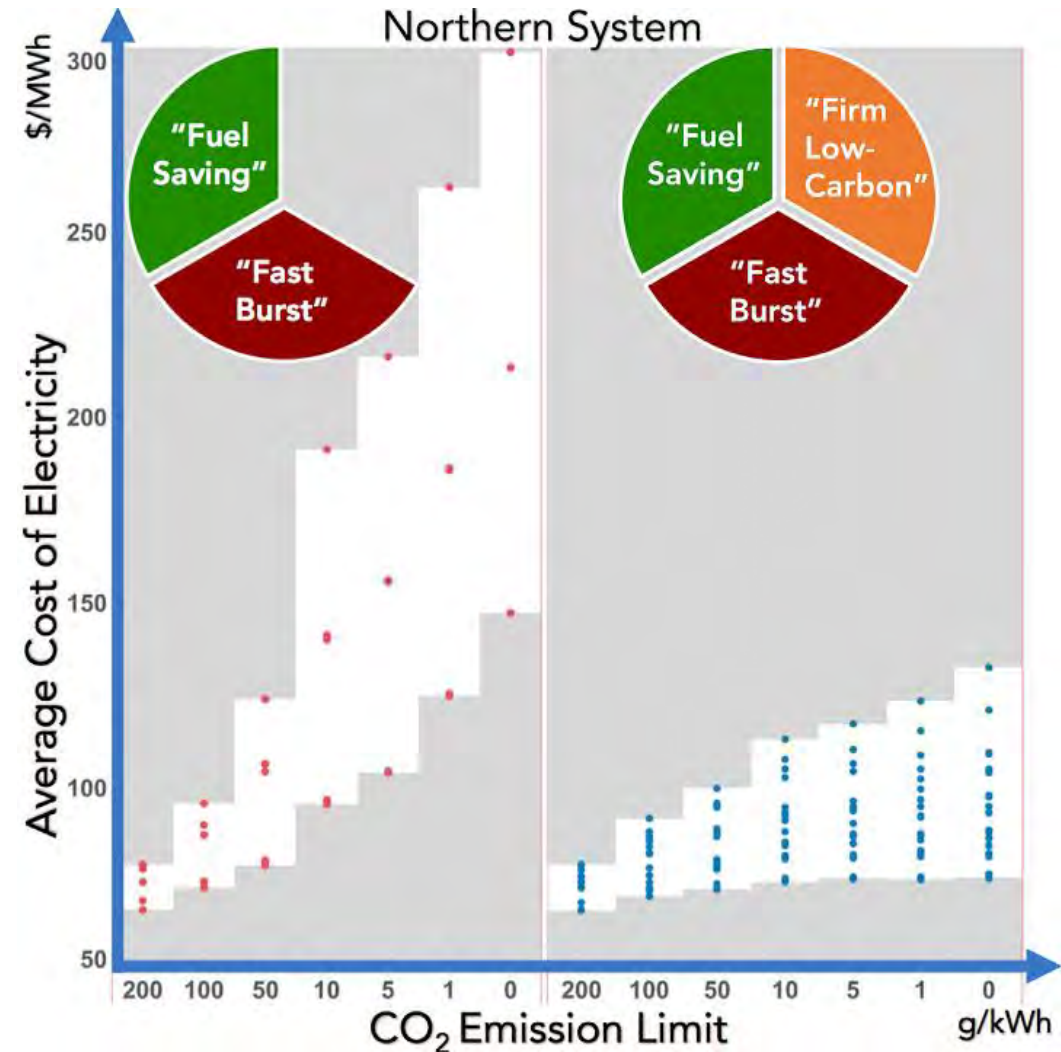
Historically, reactor vendors pushed for larger sizes in pursuit of economies of scale



(EPR, Areva)

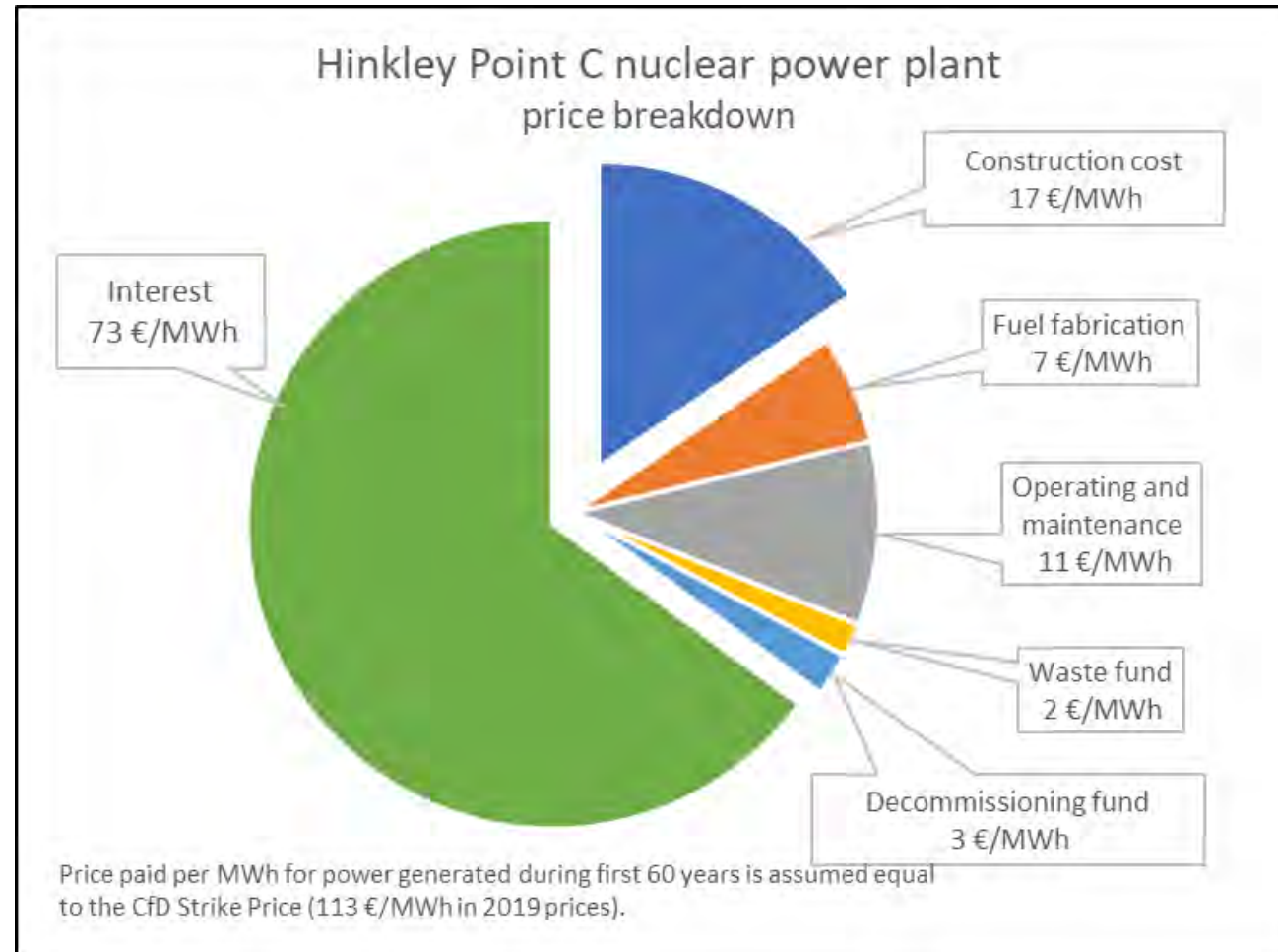
Value of firm power

- 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



Why is nuclear expensive? (per-energy cost)

Most of the cost of a nuclear project is in financing

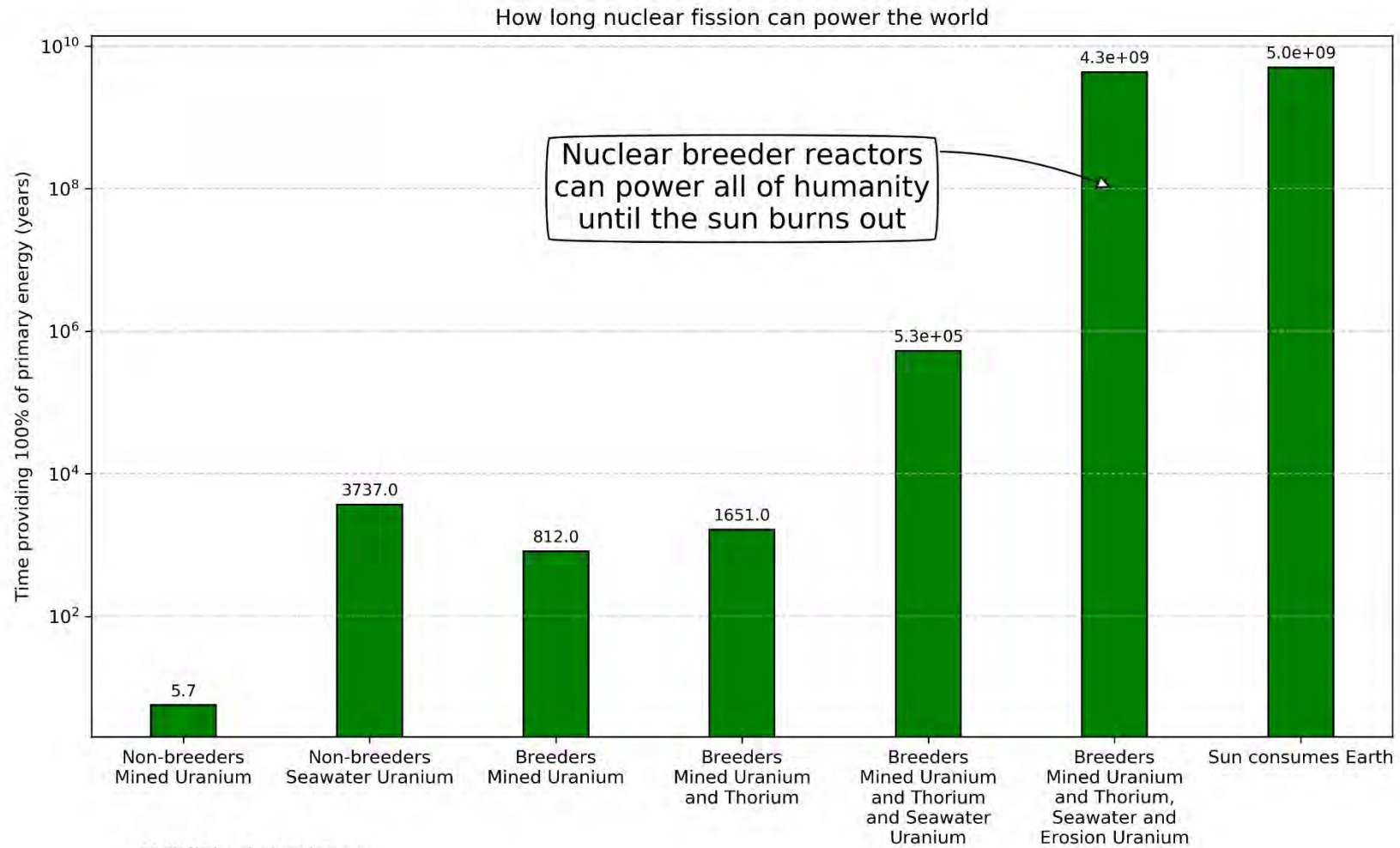


Why is nuclear expensive? (per-power cost)

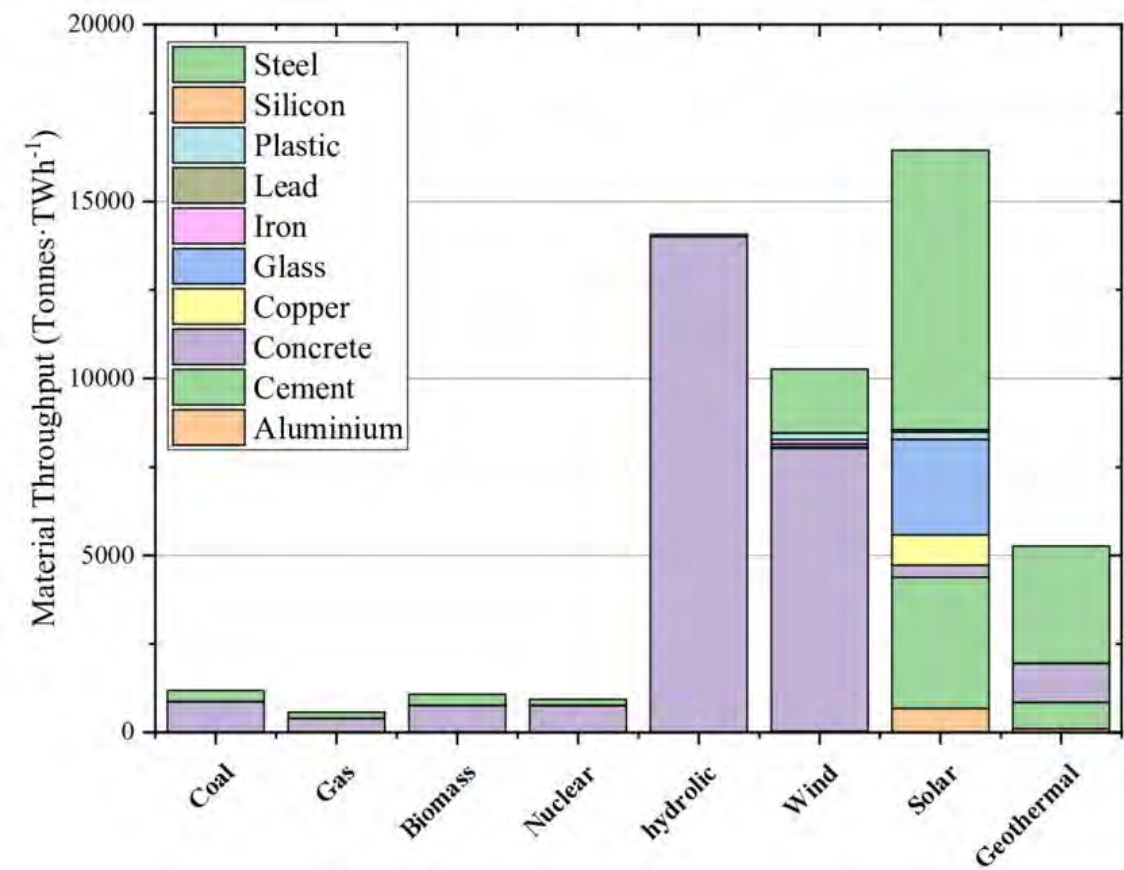
First-of-a-kind projects in the West versus focused programmes



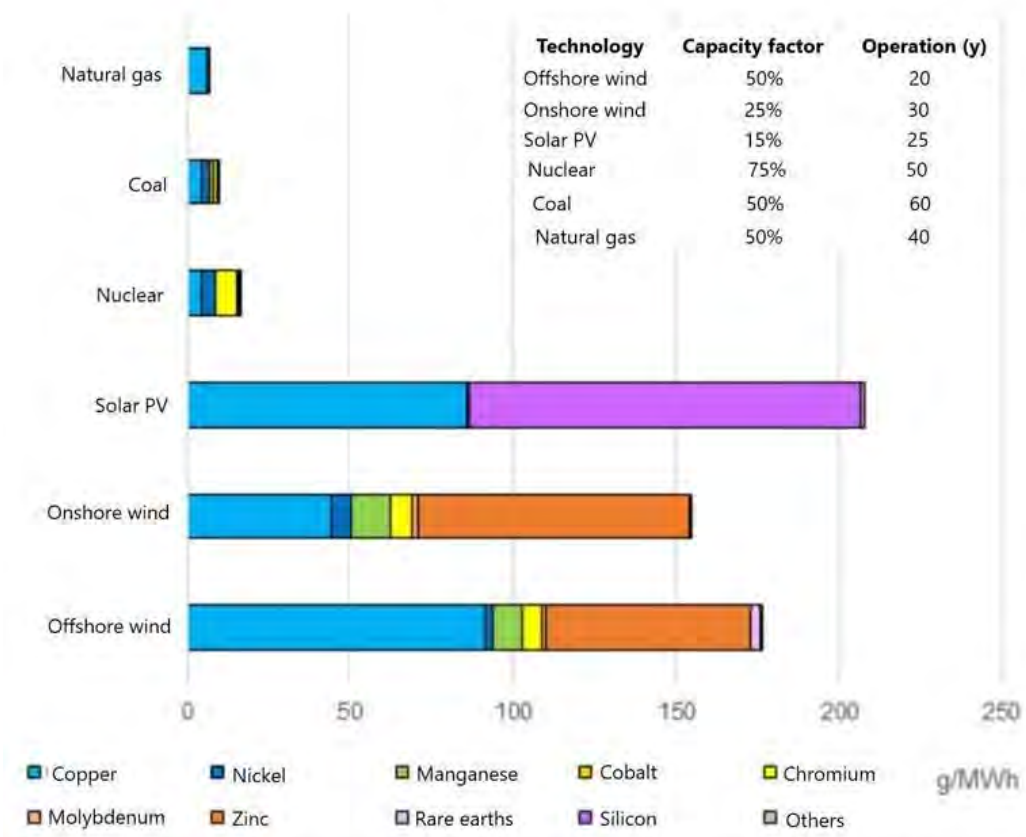
Fuel availability



Raw materials requirements

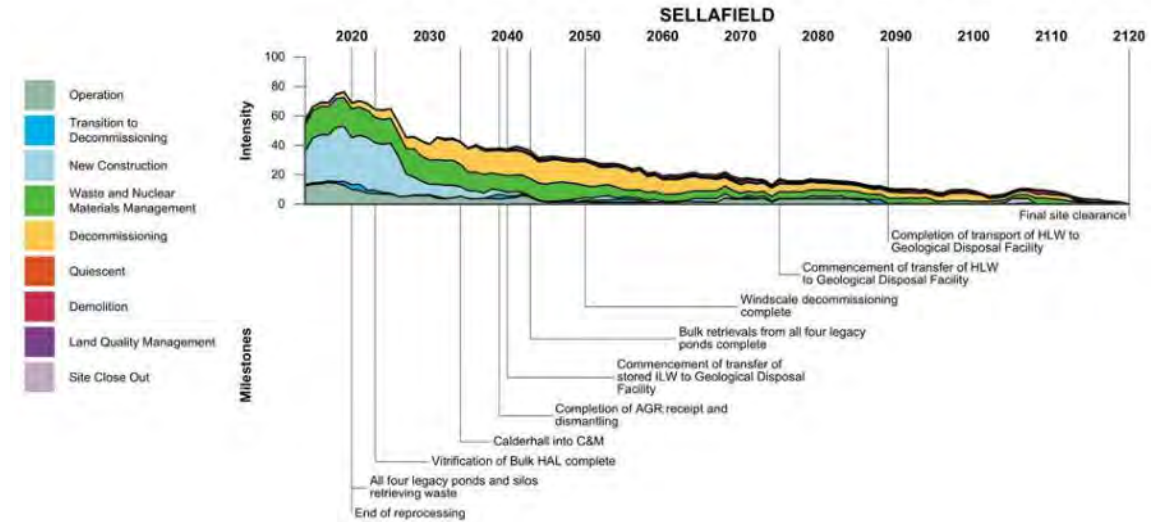
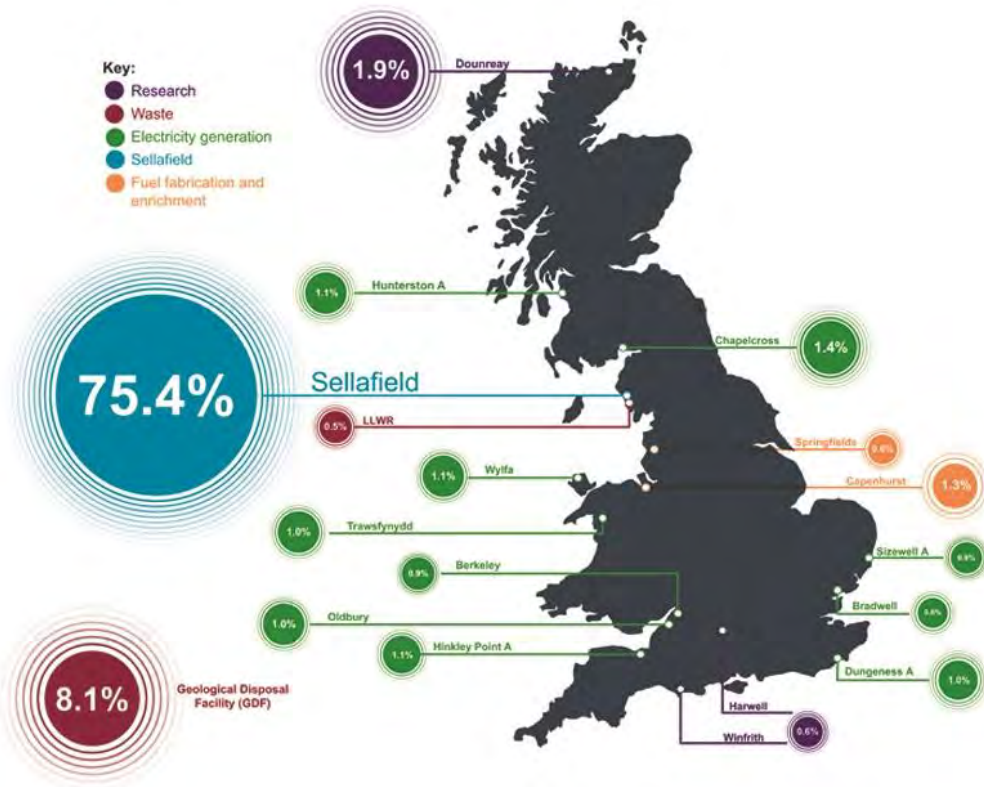


Minerals used in power generation sources



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

Waste and Decommissioning



- ~ 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

SIR™ — Reducing size can reduce cost

M. R. Hayns*
J. Shepherd**

Traditional engineering economics advantages of larger size as a mean capital costs and hence unit generating small plants utilising the same concept loop PWR vs a large four-loop PWR of components, economies of scale. If, however, a smaller plant is sized features which are only feasible at simpler design, with advantage to design to produce the most cost-effective incorporates fewer, more easily replaced with minimal assembly on site, it is a plant which is competitive with traditional design. When 'system' matching of installed capacity to the fact that a smaller total capacity at a given demand with a specified level taken into account, it can be shown cash-flow position can be improved absolute financial risks. The UK/US (SIR) is an integral pressurized 300–400 MW(e) range which utilises reactor technology in a way not feasible of recent years. The SIR concept and its technical and economic advantages, construction, maintenance, decommissioning, safety and siting of system analyses which demonstrate advantages to a utility are presented.

In considering the economics of a essential data which determine the particular plant may be broadly subdivided into:

- (a) capital cost, which for nuclear dominate the generating cost
- (b) fuel cycle cost
- (c) operating and maintenance cost

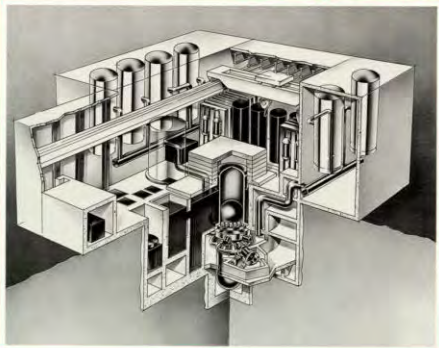
*AEA Thermal Reactor Services, AEA Technology
**AEA Safety & Reliability, AEA Technology

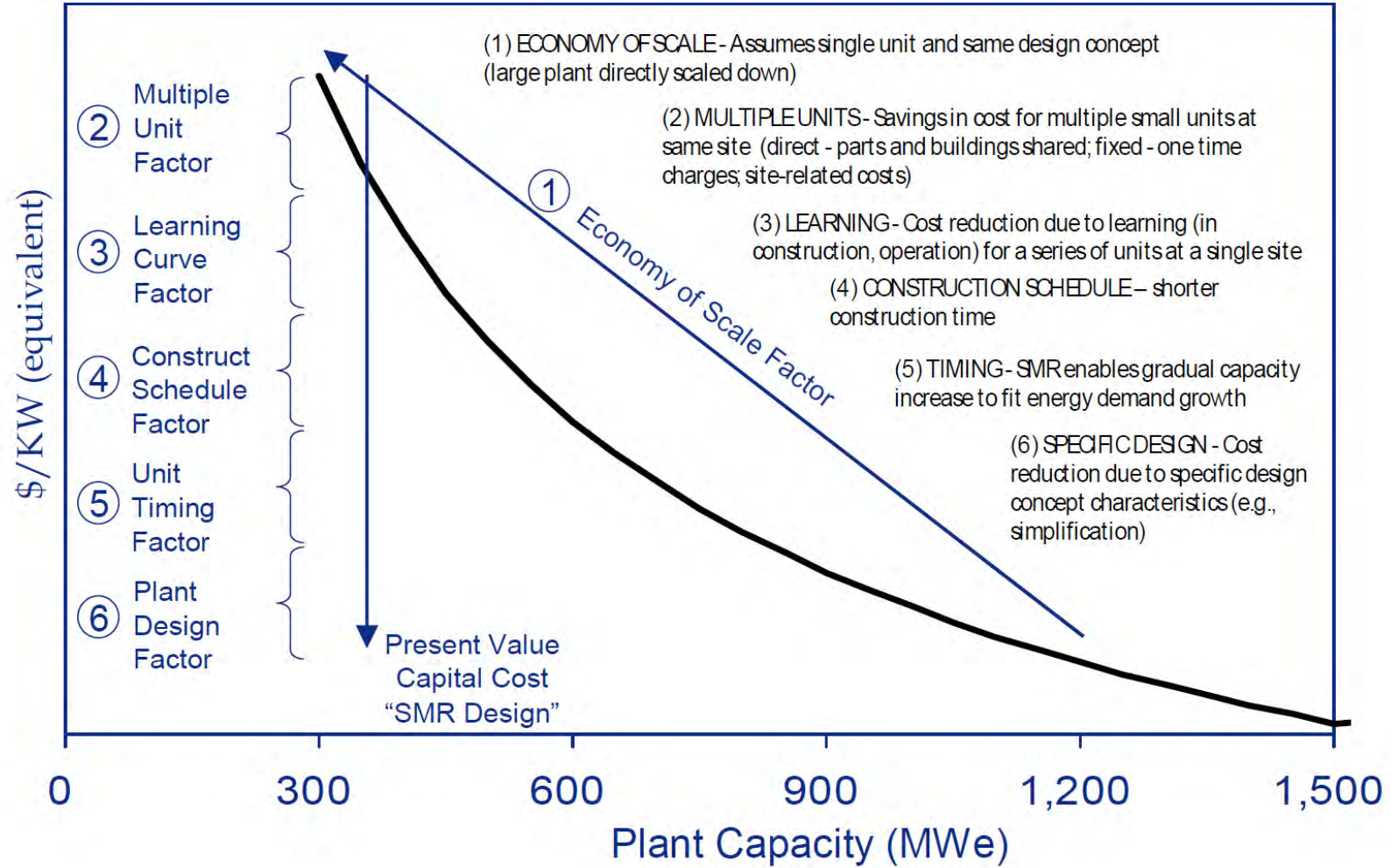
Nuclear Energy, 1991, 30, No. 2, Apr., 85–9

NUCLEAR ENERGY

APRIL 1991 VOLUME 30 NUMBER 2
JOURNAL OF THE BRITISH NUCLEAR ENERGY SOCIETY

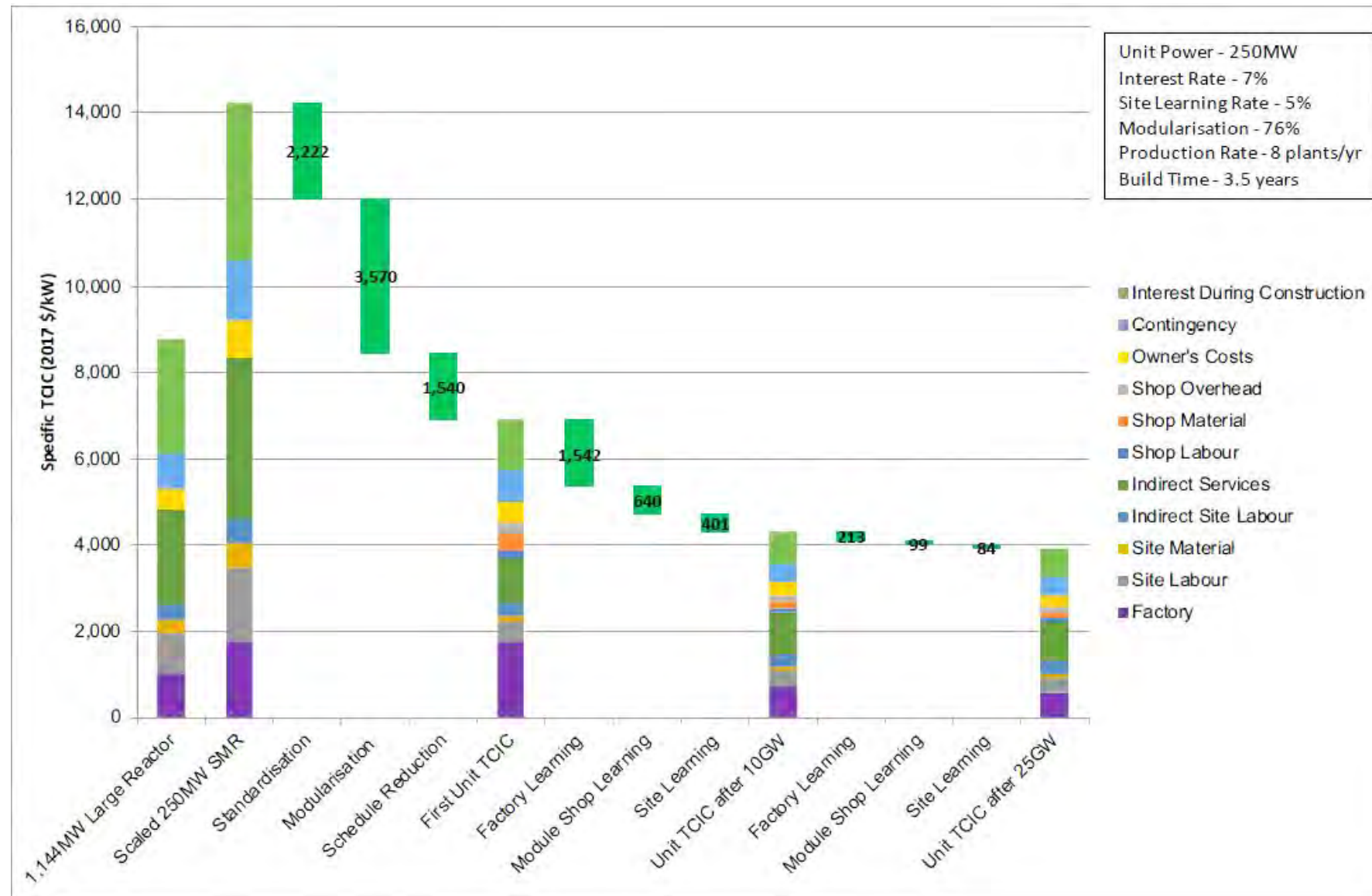
Small power reactors





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



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