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Small Modular Reactors (SMRs)

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Climate Crisis - Why Nuclear is Not Helping

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Nuclear reactor history: ‘bigger is better’

- All past and current large Generation III nuclear reactor design based on ‘bigger is better’ concept.

Economies of scale

- Nuclear went bigger to achieve economies of scale.
- It’s cheaper to build one 1.2GW unit than a dozen 100MW units.
- The same for wind power - one of the main reasons why offshore wind costs have come down is the move to larger wind turbines.

But large Gen III reactors (1000+MW+) too complex, too expensive and require too much site-work

- EDF EPR, Westinghouse AP1000, KEPCO APR1400, CGN CNNC HPR-1.
- High-risk projects with significant delay and delay claims, cost growth and investor risk.

So, Small Modular Reactors (SMRs)

Main SMR designs

- Defined by IAEA as <300MWe.
- Two categories: Scaled down LWRs & non-LWRs (Gen IV).
- LWRs seen as maybe available sooner.
- Non-LWRs a mixture of design-build, but with poor record.
- HTGRs & sodium FBRs, lead-cooled and molten salt reactors all have ‘issues’.
- Non-LWRs generally require ‘advances in materials’ to be technically viable.

Light Water reactors (LWRs)

- NuScale (US), Rolls Royce (UK), Holtec SMR-160 (US), KAERI (South Korea), CAREM (Argentina).
- Shelved designs: Westinghouse, GE-Hitachi BWRX-300, B&W mPower.

Non-LWR SMRs

- China building 2 Pebble Bed reactors, but severely delayed and failed badly in South Africa.
- GE-Hitachi PRISM was under consideration in UK to ‘burn’ Pu stocks. But UK found: ‘*A major research and development programme would be required, indicating a low level of technical maturity for the option with no guarantee of success.*’
- ARC-100: some interest in New Brunswick.
- Molten Salt reactors: Terrestrial IMSR & Moltex SSR: some interest in Canada.

SMR concept assumptions

- Lower costs and shorter construction times per reactor makes project finance easier.
- Lost scale economies to be replaced by modular production-line.

SMR concept assumptions

- SMRs built as factory-made modules, assembled on-site.
- SMRs built in clusters of up to 12 reactors.
- Safety requirements less stringent: smaller evacuation zones.
- The talk is all about 'creating a technology base', 'building skills' and 'creating high-tech jobs’, which 'input into the economy'.

But there are significant doubts about the SMR concept

- SMRs will be more expensive than large reactors per KW/hr (kilowatt hour) - the key parameter.
- Significant government subsidy would be needed.

SMR concept won’t work

- The idea is that 'modular' (ie a factory run) will sort things out, is misplaced.
- In order to build modular capacity you need a very full order book – many hundreds of SMRs.
- In order to get a full order book you need to demonstrate that SMRs already work and can be produced on time and on cost.
- This can’t happen until a significant number of orders are placed - a circular dilemma.

Catch-22

- Modular production-line mistakes lead to generic defects that propagate through an entire fleet of reactors and are costly to fix (safety anomalies at Le Creusot / EDF steam generators).
- Experience with construction of modular parts for the nuclear industry has been troubling.

Investment risk

- Hugely expensive task to 'tool up' to create modular assembly lines.
- So investment will be needed for an entire supply chain to replace economies of scale with economies of replication.
- This means SMR investment risk is very significant.

Radioactive waste

- SMRs produce exactly the same rad-waste as conventional reactors per KWh.
- Same safety and security problems.

Beyond design-base cascading accidents

- For ‘Beyond-design base’ cascading accidents - multiple, diverse and highly reliable active back-up systems are needed.
- Complex back-up design is not compatible with small, compact, stripped-down design of the SMRs currently under consideration.
- SMR containment designs mean a coupling of core and the containment: negative safety consequences - as became clear with Fukushima Daiichi.

Proliferation

- SMRs to developing nations can give 'breakout potential' for proliferation.

Traditional reactor vendors abandoning work except where large public subsidies offered

- SMR deployment time-scales appear unrealistic.
- Industry predictions about developing SMR markets have never been fulfilled.
- Ironically these predictions also came from institutions who promoted very optimistic cost estimates for the stalled 'Nuclear Renaissance'.

‘Skeumorphism’

- *‘When an old technology attempts to clothe itself superficially, in showy attributes of its incoming successor’.*
- Flint blades did this when bronze came in: acquiring unsuitable pretend ‘casting seams’.
- SMRs are unsuited for new optimal renewable and smart-networked energy efficient infrastructures.

Do the maths

- UK Offshore wind now: £40 per MWh.
- Viable with no subsidy.
- What’s the use of SMR nuclear even at a very optimistic £60-80 per MWh?

Renewable evolution

- Investing in nuclear power is uneconomic - this holds for all plausible ranges of investment costs, weighted average cost of capital, and wholesale electricity prices.
- Renewable energy has both lower investment costs and lower generation costs than nuclear.

Energy Transition

- Expansion of renewable energy in all sectors.
- Rapid growth and modernisation of electricity grids.
- Improvements in energy efficiency, the use of modern technologies to minimise electricity consumption.
- Rapidly enhanced storage technologies.
- Market innovations from supply to service provision.
- Restructuring of the built and transport environments.

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Thank You

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