Small Modular Nuclear Reactors: Are they an energy solution in North Wales?

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Outline

- SMRs: What & why?
- UK SMR policy
- Trawsfynydd
- Rolls Royce & NuScale SMRs
- Are SMRs a good idea?

SMRs: What

- IAEA: '…small modular reactors are defined as advanced reactors that produce electricity of up to 300 MW(e) per module. These reactors have advanced engineered features, are deployable either as a single or multi-module plant, & are designed to be built in factories & shipped to utilities for installation as demand arises.'
- Modular means built in factories & assembled on-site and/or built in clusters of up to 12 interdependent reactors
- Proposed for small electricity grids, water desalination or process heat
- Two types: Light Water Reactors (LWRs), scaled down versions of type built at Hinkley (PWR) & proposed for Wylfa (BWR) & advanced non-LWR reactors
- LWRs & similar heavy water reactors account for more than 90% of world's reactors
- LWRs expected to be deployable by 2030
- Several non-LWR advanced reactor types. Some built in small numbers but unsuccessful (fast & high temperature reactors) some not built as prototype (molten salt & lead-cooled fast reactors). Not deployable till after 2030

SMRs: Why

- Large reactors very expensive & always late & over-budget. Too economically risky for financiers unless taxpayer/electricity consumers take the risk
- Hinkley, consumers guaranteed to buy all the output at high price for 35 years. Too risky for later projects. For Wylfa, UK government offered to take a large equity stake & lend all the money
- Assumed that high costs & overruns because reactors built as one-offs & built on-site which is difficult to manage
- Production line manufacture & building in factories leaving just assembly for sites would more than compensate for lost scale-economies
- Building in factories would minimise the risk of cost & time over-runs. So financiers would be prepared to offer loans

UK SMR policy

- 2014: government commissioned feasibility study for SMRs (<300MW). It found a UK market of 7-21GW (2.5-7 Wylfa Bs) & world market of 65-85GW by 2035
- First SMRs expected to be competitive with large reactors but costs of SMRs would come down faster than large reactors
- Nov 2015: Government announced £250m by 2020 to be spent on SMRs
- March 2016: Competition launched to find the best SMR to be complete by end 2016 when an 'SMR delivery roadmap' would be published
- Dec 2017: 33 SMR 'eligible participants' announced but SMR Competition abandoned & roadmap never published, most of £250m not spent

UK SMR policy

- 2017: Rolls Royce design, 450MW PWR, announced offering power at 6-7p/kWh. Cf 10p/kWh for Hinkley Point C

- June 2018: Government, at Trawsfynydd, announced ‘Nuclear Sector Deal’ offering £200m but with no end date. £86m for nuclear fusion & £56m for non-LWR SMRs. Nothing specific for LWR SMRs like Rolls Royce’s

- Nov 2018: SMR replaced by ‘Advanced Nuclear Technology’ to include larger than 300MW reactors

- UK SMR policy in disarray & lacking any direction

Trawsfynydd

- Trawsfynydd, site of Magnox station, ran from 1965-1991, expected to host first UK SMR
- Comprised two reactors, each designed to produce 250MW but from 1973, only allowed to produce 195MW
- Lifetime load factor 80% (cf 70% for Wylfa)
- Fuel (the vast majority of the site's radioactive inventory) removed in the first years after plant closure & sent to Sellafield for reprocessing
- Uncontaminated buildings removed & remaining plant expected to be sealed by 2029 for safe storage until radioactive reactor vessel is cut up & disposed of
- Removal of radioactive structures not expected to take place 2074-83, 3rd of 10 Magnox stations to do this (Wylfa is the last 2097-2105)

Rolls Royce SMR

- Announced 2017, 10 or more years later than competitors.
- Appears to be old-style 450MW PWR design. Factory-made modules delivered by road & assembled on-site. No mention of interdependent clusters
- UK partners: Amec Foster Wheeler, Nuvia & Arup
- No interest outside UK – deal with Jordan collapsed (chose NuScale)
- No forecast of when it will be submitted to UK safety authorities
- Rolls Royce trying to sell its nuclear business excluding submarines & SMRs

Conditions for Rolls Royce to proceed

- Choosing one preferred technology preferably with input from a selected UK team to deploy & maximise local content
- A UK industrial policy that supports IP, advanced manufacturing & long-term high value jobs
- Match funding (at a minimum) up to the end of the licensing phase
- A Generic Design Assessment (GDA) slot
- A suitable site to develop a First of a Kind (FOAK)
- A guaranteed UK electricity market of 7 GWe [16 reactors by 2035]
- Sustainment of a national nuclear supply chain capability across both Defence & Civil Nuclear
- If a UK-only technology is selected for the UK SMR programme, assistance identifying & developing export markets; &
- If a non-UK technology is selected for the UK SMR programme, assistance dealing with the relevant partner government(s) in order to secure IP & a role for the UK nuclear supply chain

- Rolls Royce wants to be UK government partner whichever design is chosen

- No government could or should agree to such conditions

NuScale SMR

- 60MW reactor designed to be built in clusters of up to 12 reactors
- Has features of most advanced large reactors, e.g. AP1000
- Under development from 2000, backed by large US engineering company, Fluor. UK partners Rolls Royce & Sheffield Forgemasters
- Only design under serious comprehensive safety review. US safety authority since 2016
- No firm orders but three serious US customers & provisional agreements with Jordan, Romania & Canada
- If Rolls Royce doesn't get the government commitments it is asking for, can it effectively block NuScale?

Are SMRs a good idea?

- Depends on economies from large scale component manufacture more than paying for loss of scale economies
- Will scaling down mean issues of construction cost & time overrun are solved making nuclear easier to finance?
- For Rolls Royce, this would mean a commitment now for a future government to buy 16 reactors from about 2028-2033. No government could (or should) do this
- Designs also depend on not being required to incorporate all the safety features a large reactor now needs, like back-up generators
- Until the designs have been fully worked out & thoroughly assessed by safety regulators, cost forecasts are at best guesses & history says highly optimistic ones