American Startups Are Working on Safer Mini-Nukes

Recently, *Exponential Investor* looked at the omnishambles that is the Anglophone nuclear industry. Westinghouse Electric Company is bankrupt. Three Mile Island – the plant that kicked off the industry's demise – is slated to shut down in two years. Hinkley Point is a ludicrously expensive folly – built mainly to appease the French and Chinese, post-**Brexit**.

In South Korea, nuclear energy is going strong. However, its replication-based approach introduces vulnerabilities into the entire national electricity supply.

Is there a better way to achieve a nuclear renaissance?

An alternative approach is to create a large number of small, modular nuclear reactors. These are designed to be inherently simpler, cheaper and safer than existing designs. By relying on fail-safe approaches, the complexity of each reactor can be vastly reduced. Conventionally, nuclear plants are kept safe by relying on huge concrete containment vessels, and teams of highly skilled operators. Instead, small, automatic reactors instead rely just on design. If they break, they will stop generating power – but they won't leak radioactive waste, or explode like Fukushima.

At least, that's the idea…

There are a variety of these small, modular nuclear reactors in development. The US has a range of startup companies operating in this market. Firms like Transatomic Power and X-energy are worth a look – if you'd like to familiarise yourself with the relevant technologies (molten salt and pebble bed, respectively). Of the two, Transatomic looks to have a more appealing technology, and a much more realistic timescale.

These new designs permit very small plants indeed – around the size of a few shipping containers. They're typically buried in the ground – meaning they're every bit as discreet, as they are different from the huge traditional reactors you'll have seen on the news.

So, what are the (dis)advantages of this more modern, modular approach?

Clearly, systematising manufacture of small reactors has cost advantages. It's easier to automate cheaply, when you're producing thousands. However, there are losses from using itty-bitty power stations. The need to have "walk away safe" designs means that operating efficiencies are potentially compromised.

Additionally, the potential siting of these reactors in distributed locations is an issue. While aiding the stability of the electricity grid, it opens up new risks for fuel transportation and security – as well as for operational efficiency. Terrorists might struggle to easily attack buried nuclear plants – but fuel in transit is a different matter. Delivering fuel to disparate locations makes securing the supply chain much harder. This inevitable side-effect undermines the benefits of the location flexibility – which is a major selling point of these smaller reactors. In practice, far from being small-town nukes, these reactors may end up being kept in giant arrays, similar to wind farms. These would be just as vulnerable to site-specific disasters as any large power station would be. Fukushima taught us all about the risk of allowing a single, large power complex to get knocked out by one single incident.

The proliferation risk also cannot be ignored. Some of the more advanced designs use alternative fuels. For example, Terrestrial Energy uses thorium. Until recently, this fuel was thought to be (quite literally) bomb-proof – although that's since been called into question. These alternative fuels could therefore reduce the risk of nuclear material falling into the wrong hands. However, many of the more basic modular reactor designs still require enriched uranium. This enrichment process is fundamentally the same, whether you are making a power reactor or a nuclear bomb – you just need "more of the same" to make a bomb. Accordingly, a worldwide proliferation of small, modular reactors could build supply chains that are at risk of being repurposed to make weapons. Obviously, it's hard to put a dollar-figure on the costs of proliferation risks – but nevertheless, the enhanced security and administration needed for such a risky supply chain would inevitably increase costs.

Meanwhile, the cost background for nuclear power is getting more and more challenging. We've seen from Hinkley Point project just how far above market prices nuclear energy is currently priced – while renewables are reliably dropping in price. For only a little more cash than Hinkley, we could have had ultra-reliable, clean and safe tidal power. By contrast, wind is currently far, far cheaper – although its intermittency issues clearly remain to be addressed.

But, as I'm fond of saying, the elephant in the room is solar. While solar is only available in the daytime, that's starting to matter much less. Advances in demand management, long-distance transmission, and storage mean that the need for "dispatchable" baseload is reducing. It's now looking increasingly likely that we can get to near-100% renewables penetration, without reliance on nuclear power – particularly using this new take on an old idea. Accordingly, the key issue is whether or not nuclear energy will be cheap.

Ordinarily, costs of technologies tend to fall as they scale. This has **not held true for the nuclear industry**. As new risks have been identified, these surplus costs have been passed on to bill payers, and taxpayers. This has often included the large costs for decommissioning and waste disposal – problems which have still not been fully solved.

As we envisage a future in which small modular reactors could be scaled to fill a significant portion of our energy needs, it's certainly feasible to imagine that the plant construction costs would fall dramatically. However, this is predominantly a function of scale, not time. If the modular reactor industry never gets out of the blocks, its costs will not fall. Right now, that's looking as questionable as it always has been. We're no more fulfilling Cold-War nuclear dreams than we are taking proper advantage of the Apollo legacy.

Meanwhile, the solar train keeps on chugging away. Due to the effect of Swanson's law (similar to Moore's law in computing) solar power is currently halving in price around every seven years. It's already the cheapest form of electricity in the world – albeit only in optimal locations. Within 14 years – clearly within normal investment horizons – it will be around quarter of current prices. That's an astonishing drop. It's very hard to see how nuclear will ever catch up. Even when you add in storage costs, solar is still going to put nuclear under **severe price pressure**.

So, in summary, can we imagine a future where every small town has its own nuclear reactor? Yes, that's certainly possible. But, quite frankly, it doesn't seem to make much economic sense. Even if the technology could work, in principle, the barriers to entry are still significant. Solar is already halfway round the racetrack, while modular reactors are still trying to tie their shoelaces.

Modular reactors may have advantages – but undercutting solar on price, or deliverability, are probably not among these. And ultimately, that's all that matters.

Have you become super-critical? Let us know: **andrew@southbankresearch.com.**

Best,

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