Research Brief:

A Half-Built, High-Priced Nuclear White Elephant

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Executive Summary and Comparisons

Hinkley Point C, the over-budget and delayed 3,200 megawatt (MW) nuclear power project in Somerset, may never enter commercial operation—and the U.K. government needs to either be planning now for that possibility or risk being left holding the bag for a half-built, multibillion-pound white elephant.

Britain has signed on to buy power from the facility at a generous £92.50 per megawatt-hour, and sees it as a major piece of its climate change mitigation and energy security plans. Further, EDF (Électricité de France), the French state-owned utility building the plant, swears that all is good, with outgoing CEO Vincent de Rivaz telling *The Guardian* in July that there was "absolutely, definitely, totally" no chance that ratepayers would be required to pay any more for future delays and/or cost overruns.

But the similarities between Hinkley, which is now finally under construction after years of delay, and other troubled European and U.S. projects, particularly the recently shelved V.C. Summer plant in South Carolina, cannot be ignored.

Perhaps the most important similarity is in the question of what the project ultimately will cost.

Hinkley already is frequently described as the world's most expensive power plant, with EDF estimating that the project will require £19.6 billion to build by the time it enters commercial operation, currently set for 2025. But others see higher costs, and any delays (more on that below) would inevitably lead to an increase in total costs. For example, the U.K.'s National Audit Office (NAO), which advises on the use of public money, calculates that the public subsidy for the plant could top £30 billion, and says the government needs a Plan B just in case.

Rising costs were the leading factor in the decision by SCANA Corporation and Santee Cooper, the two South Carolina utilities building the Summer facility, to cancel that project. Costs there soared from an originally estimated $11.5 billion to upward of $25 billion by the time the utilities said they would abandon the two unit, 2,200 MW project.

Other parallels with struggling and failed projects in Europe and the United States, which argue strongly for the development of a Plan B as NAO and others have suggested, include:

1. They all use untested technologies.

The 2.2 gigawatt (GW) Summer project was based on the new Westinghouse AP1000 nuclear plant design. Hinkley's 3.2 GW project will use Areva's European Pressurised Reactor (EPR). Neither has been tested on a commercial scale. Delayed EPR construction projects are still unfinished at the 1.6 GW Olkiluoto 3 power plant in Finland and at the 1.6 GW Flamanville in France. After the Summer cancelation, the sole remaining developer of the AP1000 design in the U.S. is Southern Company, which is building a two unit, 2.2 GW expansion at its existing Vogtle power plant in Georgia. Further EPR and AP1000 construction projects are under way in China.

2. These projects have all seen construction delays, of five to nine years so far.

Areva's EPR reactor at Olkiluoto 3 broke ground in 2005 and was scheduled for completion in 2009; after multiple missed deadlines it is now due online in 2019. The planned EPR reactor at Flamanville broke ground in 2007, for completion in 2012, and is now also scheduled to begin service in 2019, but that date may slip further. The two Vogtle AP1000 units broke ground in 2011 and were due for completion in 2016/17. They now won't be finished until 2021-2023 at the earliest.

3. They have all seen massive cost overruns, ranging from 79% to 250% to date.

The expected cost of the Olkiluoto EPR has risen to €8.5 billion (2012 estimate) from the original €3.2 billion. The cost of the Flamanville EPR has soared to €10.5 billion (2015 estimate) from the original €3.3 billion, without accounting for the recent regulatory finding that the entire reactor cover must be replaced by 2024. And even though EDF has barely broken ground on the Hinkley plant, it already has raised its cost estimate, as of July, to £19.6 billion from £18 billion. The estimated construction and financing cost of the Vogtle project is now above $25 billion, from a $14 billion original estimate.

4. The delays and cost overruns have caused extreme financial distress to the technology vendors.

Finnish utility TVO and French state-owned Areva are mired in multibillion-euro litigation over responsibility for cost increases at Olkiluoto. Areva already has recorded a €3.9 billion impairment on Olkiluoto, forcing a €5 billion bailout by investors including the French state, and also forcing Areva's merger with French utility EDF. Westinghouse was liable for some, but not all, of the Vogtle and Summer cost increases, causing it to file for bankruptcy in March. That in turn triggered Toshiba, its corporate parent, to warn of a 1.01 trillion yen loss this year. Toshiba is on the hook for 794 billion yen in Westinghouse guarantees.

5. Internal turmoil at the developers indicates misgivings among those closest to the projects.

At EDF, Finance Director Thomas Piquemal resigned last year over the decision to push ahead with Hinkley. Media reports said that he preferred a delay. Union members of the EDF board have warned that the Hinkley project threatens EDF's financial stability. Meanwhile, in the United States, a recently published audit of the abandoned South Carolina project revealed a 17% turnover in management and engineering staff during the audit period, which the auditor, Bechtel, described as "high for a typical nuclear project." Bechtel also described low morale among on-site workers.

What Are the Project Risks in EDF's Hinkley Plant C?

The now-stumbling renaissance of nuclear power in Europe and the U.S. has been a story of delays and cost overruns, with a new generation of untested nuclear power designs proving much harder to build than anyone imagined and even the project developers admitting to high levels of risk.

EPRs are untested, and those under construction have been more expensive and take longer to build than expected. While lessons have been learned, the history of recent nuclear projects makes it very likely, perhaps probable, that Hinkley will cost substantially more and take far longer to build than its advocates are claiming.

Additional risks to Hinkley include:

- Further delays at Olkiluoto and Flamanville, stretching completion beyond the targeted date for each of 2019.
- Difficulties encountered once Olkiluoto and Flamanville are up and running, assuming they are completed, as experienced with all first-of-a-kind technologies.
- Difficulties encountered due to the size of Hinkley, double that of Olkiluoto and Flamanville.
- Another nuclear disaster, such as at Fukushima in 2011, which could prompt regulators to re-think the EPR design.
- Power market risks, where nuclear power is not an obvious fit in an increasingly digitalised and decentralised grid, even though it does contribute significantly in cutting carbon emissions compared with natural gas and coal. The growing competitiveness and installed capacity of renewable power may lead to falling load factors (running times) for nuclear power. Growth in intermittent renewables will also put a premium on flexibility where nuclear scores lowest among all conventional generation. In other words, by the time Hinkley is fired up, in 2025 or later, it may already be out of date.

A highly lucrative power purchase agreement (under a so-called contracts for difference scheme) with the U.K. government, for £92.50 per megawatt hour (in 2012 prices, £100.24 in 2016 prices), for 35 years, insulates EDF from falling wholesale power prices. But it doesn't protect the power plant from falling load factors. Renewables growth also may exceed expectations, a growing likelihood with the latest UK auction showing offshore wind power now costing a fraction of the power price of Hinkley.

All these risks might affect EDF's rate of return on its Hinkley investment. In fact, EDF cut its expected rate of return on the project in July to 8.5% from 9%, as a result of higher than expected construction costs.

The Effect of a Cash Crunch at EDF

Given EDF's already delicate finances, large budget overruns at Hinkley would threaten its balance sheet, precipitating calls for a further French state bailout, or a renegotiation of the terms of its existing contract with the U.K. government.

In a June report, the U.K. NAO discussed just these possibilities. It found plenty of precedent for governments throwing more money at struggling infrastructure projects. One of these was "High Speed 1", a high-speed railway project where the U.K. government was forced to add a loan guarantee to the original grant, after the developer ran out of funds.

> "A further deterioration of EDF's financial profile or costs escalating at Hinkley could raise questions about its ability to fund Hinkley's construction. If the project runs into trouble, the government may need to fund alternatives to ensure secure supply, or come under pressure to renegotiate its deal."

In other words, the U.K. government would face two options: throw more money at the project, making it even more expensive than at present; or allow EDF to walk away, and pay for replacement generating capacity.

These not-attractive U.K. options reflect what is happening now in the U.S.:

1. The Vogtle option.

The U.S. utility, Southern Company, wants to finish its nuclear power units at Vogtle by shifting billions of dollars in cost risks from Toshiba/Westinghouse to ratepayers in the state of Georgia.[1]

The U.K.'s equivalent option would be to renegotiate EDF's existing 35-year PPA to make it more generous. The trouble is, the PPA already is ridiculously lucrative. In 2016 prices, at £100.24/MWh, it is nearly three times average wholesale power prices of £35. The level of public subsidy on the project is the difference between the fixed PPA price and the wholesale power price (i.e. the difference between (£100 and £35 in 2016). Over the lifetime of Hinkley, this subsidy has risen to £30 billion, the NAO calculates, because of falling wholesale power prices. EDF's present PPA is nearly double the most recent, lowest-priced offshore wind PPAs, announced in September, of £57.50. Given such competitive alternatives, it may be impossible for EDF to re-negotiate the PPA upward.

2. The SCANA Corporation option.

The owners of the Summer project have said that they are cancelling it. However, we note that there may be some wiggle room in this cancellation, as other parties may seek to purchase and complete the two units.

Risks if EDF took the cancellation route are three-fold. First, the U.K. government would suffer losses on any loan guarantees. The U.K. has offered to guarantee up to £13.1 billion of bonds issued by EDF to finance Hinkley construction. To date, EDF has said it does not plan to

[1] Source: August 31, 2017 Georgia Power Company *Seventeenth Semi-Annual Construction Monitoring Report for Plant Vogtle Units 3 and 4*. http://www.psc.state.ga.us/factsv2/Document.aspx?documentNumber=169459

exercise such support, but that could change if, as can be expected, construction costs escalate. If EDF did turn to a U.K. guarantee that also would likely lock the U.K. into the project. Second, Britain would lose the prospect of a 3.2 GW power plant. This could have implications for energy security if the country has made no plans for such a contingency. Third, abandonment would also probably kill any prospect for a bigger nuclear power programme in Britain, with implications for the country's carbon emissions targets.

Conclusion

The NAO in June described the Hinkley deal with the U.K. government as a "risky and expensive project with uncertain strategic and economic benefits." It openly discussed the risks to the U.K. government if EDF failed to deliver on its promises.

Like the NAO, we assume it is unrealistic for the U.K. government to reverse its support for Hinkley now, given that would mean breaking its contract with EDF.

However, the U.K. can and must still plan against a fiscal disaster. In the event EDF threatens to walk away, the U.K. would have two options. First, it could let EDF leave, and face the ensuing energy security consequence associated with losing 3.2 GW of planned capacity. Second, it could engage in a costly bailout.

IEEFA's view is that power generation trends tilt dramatically in favour of the first option and away from a bailout:

1. Renewable power including offshore wind is now less costly than nuclear power, as well as being much faster to build, while avoiding risks around cost overruns and radioactive waste disposal. As a result, it would be almost impossible to justify throwing more public money at a single nuclear power plant that is already expected to receive a public subsidy of £30 billion.
2. The falling cost of renewables makes the first option far more comfortable. It is difficult to foresee blackouts from cancelling Hinkley, given the availability of a combination of distributed renewables and interconnection, plus flexible generation including gas peakers and demand response, all of which can be implemented in four to five years or less.
3. A digital grid based around these alternative options will also have less need for massive, inflexible power plants, such as nuclear, in the first place.

How can Britain prepare a Plan B?

First, it should act on its plans, published this week, for the electric grid in the 2020s, to meet its carbon emissions targets in 2030. This "Green Growth Plan" includes plans for renewables, interconnection, demand response, storage, electric vehicles and energy efficiency.

Second, where possible, the government should avoid extending a loan guarantee to EDF, as allowed under the terms of its contract. If EDF exercised this option, the cost to the U.K. government of allowing the utility subsequently to walk away would rise dramatically, potentially boxing it into an expensive bailout.

Institute for Energy Economics and Financial Analysis

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Important Information