The Proposed RAB Financing Method

Professor Steve Thomas[1], Peter Bradford[2], Tom Burke CBE[3], Dr Paul Dorfman[4]

1. Introduction

The rationale for the Regulated Asset Base (RAB) model, proposed by the UK government in its consultation paper of July 2019[5] for the Sizewell C project, is clear. One of the main factors behind the very high price (strike price) negotiated for the UK's proposed Hinkley Point C nuclear power plant is claimed to be the high cost of capital.[6] If this could be reduced, it is argued that the price of power from nuclear plants financed using the RAB model would be correspondingly lower. In this taxonomy, financiers would only offer a lower cost of capital if the risks (commercial and technical) falling on them were low. The RAB model proposed raises a number of issues:

- What is U.S. experience with the mechanisms in the RAB model?
- What are the commercial risks and who will bear them under the RAB model?
- What are the technical risks and who will bear them under the RAB model?
- Why is the cost of capital high for the Hinkley Point C project?
- Who are the potential investors?
- How will the energy be priced? and
- Who will regulate the RAB and what will its function be?

The overall question is: will the RAB model produce power that is competitive with other options for reducing climate change emissions, such as energy management and efficiency, onshore and offshore wind, and solar?

2. The Sizewell C project

The RAB model was proposed to the British government by Electricité de France (EDF) for the Sizewell C project to build two EPR reactors there. Little work has been completed at Sizewell C and, in its 2018 Reference Document[7], EDF reported it had spent only €133 million on it (compared to €7.5 billion spent on Hinkley Point C). It has been widely reported that the rationale for EDF's suggestion of RAB was that EDF does not have the financial resources to finance its share of the Sizewell C project under the model used for Hinkley Point C. The Sizewell C project was previously expected to be owned by a consortium of EDF (80 per cent) and the Chinese company, China General Nuclear, CGN (20 per cent). Under the RAB proposal, EDF, perhaps with the participation of CGN, would still be expected to build the plant, partly through its subsidiary reactor vendor business, Framatome,

[1] Business School University of Greenwich.
[2] Former Chair New York Public Service Commission and Maine Public Utility Commission and Commissioner at the U.S. Nuclear Regulatory Commission
[3] Chairman of E3G, Third Generation Environmentalism, and a Visiting Professor at both Imperial and University Colleges, London.
[4] UCL Energy Institute, University College London.
[5] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/825119/rab-model-for-nuclear-consultation.pdf
[6] Construction of the first unit started in December 2018 with the second unit expected to follow a year later
[7] https://www.edf.fr/sites/default/files/contrib/groupe-edf/espaces-dedies/espace-finance-en/financial-information/regulated-information/reference-document/edf-ddr-2018-en.pdf p 369.

and operate the plant. There has been no indication whether EDF or CGN might be among the investors,

Since the RAB model was first mooted for nuclear projects, the background for EDF has changed markedly. EDF, in its present form with 83 per cent state ownership, is seen as not financially sustainable. Under "Opération Hercule", it is proposed that EDF's nuclear assets – these, particularly the reactors in France, are the cause of EDF's financial problems – be separated into a new company, "EDF Bleu". This would be expected to be renationalised, with the other assets placed in a separate, part-privatised company, "EDF Vert". This reform, if it goes ahead, will face significant regulatory hurdles before it can be completed. At this stage, it is impossible to say whether EDF Bleu would still want to pursue the RAB model.

3. The RAB model

Under the RAB model investors would receive a "fair" rate of return on the amount invested in the asset which would be annually adjusted upwards for inflation and downwards for depreciation, plus they would recover their operating costs. The issue of how and when the value of the asset is initially set is examined below. The "fair" rate of return should equate to the rate return available for investments of comparable risk *to the investors* in the rest of the economy. A nuclear power plant's running costs are substantial - for example, the privatised nuclear generator, British Energy, collapsed in 2002 because its running costs were higher than its income from electricity sales. Large numbers of U.S. reactors have closed or are threatened with closure because they cannot cover their operating costs from sales of electricity. These running costs are likely to include provisions for decommissioning and (as was the case with the collapse of British Energy), if the owner of the plant collapses, then decommissioning cost above the amount already set aside will fall on the public, most likely taxpayers at the time the plant is decommissioned.

An important element of the proposal is that the developers will be allowed to start recovering their costs before plant completion and perhaps before start of construction. The RAB model would provide "A route for funds to be raised from energy suppliers to support new nuclear projects, with the amount set through the ERR [Economic Regulatory Regime], during both the construction and operational phases (the 'Revenue Stream')."[8] So there will be a mechanism, not specified in the consultation document, for consumer money to be paid to the project developer before the plant comes online, at least as soon as construction starts, but perhaps earlier.

The consultation document goes to great lengths to try to show that the RAB model is tried, tested and proven. It states (p 10):

> "In 2016 the model was applied successfully for the first time to a single asset construction project – the £4.2 billion Thames Tideway Tunnel (TTT) sewerage project. Much of the c.£1 billion of private sector equity finance that was raised to deliver the project came from UK pension funds, representing 1.7 million pensioners, or a quarter of the UK's largest 25 pension funds. RAB-funded infrastructure has received significant quantities of investment from private sector players over the last 20-30 years. As of 2018 the total RAB

[8] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/825119/rab-model-for-nuclear-consultation.pdf p 6.

value across the UK electricity, gas, water and airport sectors is c.£160 billion (2018 prices)." [9]

These examples are misleading. Even if we accept EDF's dubious claim that Sizewell C will be 20 per cent cheaper than the current estimated cost of Hinkley Point C (including the cost of finance), the total construction cost of Sizewell C will be about £32 billion - seven times that of Thames Tideway. All experience with nuclear projects worldwide in recent years suggests it is almost inevitable that costs will substantially exceed estimates, and a total cost of at least £40 billion would be likely. Thames Tideway earns its return on investment simply by being there, there is no output to sell. For a nuclear power station the amount of output to be sold would vary substantially from year to year as would the price. It would require some form of power purchase agreement to provide assurance that all its output (plus any output available but not able to be used) would be paid for. The power purchase agreement would presumably be with a government entity like the Low Carbon Contracts Company, the body set up to buy the output from Hinkley Point C and offshore wind farms, which in turn would, presumably, compel all electricity retailers, including those claiming to sell only renewables, to buy their share of this output. For a nuclear plant financed by RAB there will be a need to establish a mechanism to sell the power that will give investors a high degree of confidence that their expected level of income will consistently be achieved. If there is not, investors will see the project as too risky.

Missing Information on Thames Tideway

While the consultation document states that the Thames Tideway scheme is the starting point for the RAB proposal, almost none of the relevant detail from the Thames Tideway project is given. The only relevant details given were that the estimated project cost was £4.2 billion of which £1 billion came from UK pension funds. Missing details include:

- Why was this scheme chosen for Thames Tideway, was it to save money or was it simply that the incumbent utility, Thames Water, would have been unable to finance it at reasonable cost?
- How is the risk of cost overrun dealt with, what percentage would be borne by consumers?
- Is there a cost ceiling beyond which any cost overruns would fall entirely on the public either as consumers or taxpayers?
- What is the experience to date with this project? How close to time and cost is it?
- What was the cost of finance, which financial institutes provided finance and at what interest rate, and how did this compare with the estimated cost of finance using alternative models?
- What were the cost implication on consumers of allowing the investors to begin to recover their costs before completion of the facility?
- Who were the investors other than the pension funds noted in the consultation document?
- What is the period over which investors will be allowed to earn their allowed rate of return and what happens to the ownership of this facility at the end of this period?

[9] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/825119/rab-model-for-nuclear-consultation.pdf

- How is the annual income allowed to investors calculated, how are allowed operating costs determined, and how frequently is the formula reviewed?
- What rate of return is allowed to investors, how is this determined and how frequently is it reviewed?

Thames Tideway's cost is being paid for by "Thames Water's 15 million wastewater customers through their bills, which will rise by no more than £25 per year."[10] For Sizewell C, its cost would be recovered from all consumers even if they have opted for a supplier that explicitly does not buy nuclear electricity and (as discussed below), if the method is to be viable, the additional cost cannot be capped in the way Thames Tideway seems to be.

The RAB analogy with infrastructure investment in regulated, privatised companies is also misleading. The figure of £160 billion may be the total investment in infrastructure in the 35 years since these regulated companies were privatised. This investment was carried out by companies holding a franchise, which they would lose - as was the case with the bankrupting of the UK's privatised rail track company, Railtrack - if they failed to provide the service required, including building new infrastructure. Investors in a RAB nuclear project would not be putting a long-term lucrative franchise at risk if the project failed as well as their reputation. They would have nothing more to lose than their losses on the project.

4. U.S. experience with financing nuclear construction by having customers begin paying when construction commences

Preface

This section was written by Peter Bradford who brings unrivalled experience of the economic and safety regulation of nuclear plants. He served as chair of the New York Public Service Commission from 1987-95 and as Chair and Commissioner of the Maine Public Utilities Commission from 1971-77. He served as a Commissioner at the U.S. Nuclear Regulatory Commission from 1977-82. He is the only person to have served on two state and one federal regulatory commission. There is experience of many of the features in the proposed RAB model in the U.S.A. and in his role as economic regulator he had intimate knowledge of them.

Introduction

In the United States, as in Britain, the high cost of building nuclear plants combined with the introduction of competition into the provision of electric generation brought an end to any possibility that new nuclear generation could be built without government intervention to override the market verdict[11]. One of the most significant of these interventions was the introduction of a U.S. version of the Regulated Asset Base (RAB) methodology. It was called Early Cost Recovery (ECR).

U.S. Background

Most electric generation in the U.S. was built by privately owned monopoly utilities regulated by commissions in each of the 50 states. Most of these commissions set rates according to a formula based on the depreciated original cost of investments multiplied by a commission-determined fair rate of return. The rate of return was a weighted average of the

[10] https://www.tideway.london/about-us/#sub-nav

[11] The U.S. Congress first required competition in electric generation with the Public Utility Regulatory Policies Act in 1978. No new reactors were ordered in the next 30 years.

interest rate on bank borrowings and the commission-estimated return necessary to attract equity investment. The regulatory commissions were required to disallow from rates any investment found to have been made imprudently.

All investment was required by law to be "used and useful", which meant that customers did not begin to pay for it until it went into service. Since nuclear units were capital intensive, took a long time to build and experienced frequent construction delays and cost overruns, their construction caused considerable economic stress even for monopoly owners. The cost overruns also led to substantial disallowances for imprudent costs, which compounded the stress.

With the introduction of competitive power markets, the constraint against charging customers for plant not in service combined with the fact that the price of power could not rise above the marginal cost of the "winning" generators to create conditions under which new reactor construction was impossible at the prevailing nuclear construction costs.

In 2001, U.S. energy policy included incentivizing a "nuclear renaissance". Congress passed a package of tax incentives, loan guarantees and other supports. Several states also undertook to revise their ratemaking practices to allow nuclear plant financing costs to be collected commencing when construction began and sharply curtailing the potential for disallowance of cost recovery on grounds of imprudence. As a result, these states – all in the U.S. southeast – had a rate-setting paradigm very like the RAB model currently proposed for Great Britain.

The results have not been such as to encourage use of this model.

U.S. Experience with the RAB Financing Method

As in Britain, RAB was sold to U.S. policymakers as a way to lower the cost of capital and thereby make nuclear power more competitive with other generating sources. As U.S. experience was soon to prove, the lower capital cost was not a true saving.

At its 2009 peak, the "nuclear renaissance" consisted of applications to build 31 units pending at the Nuclear Regulatory Commission. Twenty nine of the thirty one have been cancelled. Despite expenditures exceeding $20 billion, no new U.S. nuclear plants have gone into service.

The units in states without RAB were cancelled before large sums were spent on them. In states with RAB, the owners were more willing to incur exposure to large sums. In South Carolina the would-be builders of the two VC Summer units spent $9 billion before the bankruptcy of the lead contractor Westinghouse caused them to cancel the project. More than a billion dollars were spent on the Levy County units in Florida and several hundred million apiece on additional units in Florida, North and South Carolina[12].

Two of the original 31 "renaissance" reactors remain under construction. The Vogtle plant in Georgia has doubled its original cost estimate. The current estimate is $27.5 billion, with the reactors expected five years late in 2021 and 2022.

While the U.S. electric customers are exposed to paying more than $10 billion for cancelled nuclear plants and another $13.5 billion in cost-overruns, no reactors have come online as a

[12] In Mississippi under an RAB ratemaking regime, the Southern Company also spent $7 billion on the cancelled Kemper coal gasification project.

result of the U.S. shift to early cost recovery. Florida and South Carolina have repealed the laws allowing early cost recovery. No states have enacted such laws in the last decade.

Lessons of the U.S. RAB Experience

1) Allowing recovery of costs before nuclear units enter into service does not produce real cost savings. It does not reduce the real economic risks, such as plant cancellation or cost overruns. Unlike a lower steel or labour price, no costs actually declined.
2) Instead construction risk was shifted from lenders and investors (who charge for bearing such risks) to customers (who bore them without charge). This shift in risk together with having the customers begin to part with capital many years earlier produced not a saving but a zero sum game which could be made to seem a saving only as long as the gaze of the policymakers could be kept fixed on the years after the plant went into service.
3) In fact, paying large sums for cancelled plants means that electricity costs have not gone down relative to non-RAB ratemaking; they are higher than they would have been had a RAB model with its cancellations and cost overruns not been adopted at all.
4) RAB-type regimes encourage imprudent risk-taking by imposing economic risk on those with no project management capabilities or responsibilities. In U.S. states where power markets do not permit cost recovery before plants come into service, risk-taking and rewards/penalties have remained well-aligned. Expenditures on nuclear plants later cancelled have not been significant.
5) An additional societal cost of having customers finance construction is that the customer cost of capital may well be higher than that of the entities that normally finance power plant construction. If this is true for Britain, then the RAB model will cost society more than a non-RAB model even if the plants are built on budget and on schedule.
6) The regulator is unlikely to have sufficient expertise and independence to protect customers from excessive costs arising from the way that the RAB model shifts risks onto customers and encourages excessive cost incurrence by nuclear generation owners. Real regulatory competence and independence will be opposed by the nuclear generators because it will prevent the very risk shifting that causes them to prefer the RAB model in the first place.

5. What are the commercial risks and who will bear them?

Under the model introduced in 1990 for Britain's electricity industry, wholesale electricity should be sold into a competitive market. For any generator, this introduces a commercial risk that its output might not be sold or might be sold at below cost. However, producing a competitive market with sufficient liquidity to provide reliable and cost-reflective prices has yet to be achieved. Even if the market was liquid, by their nature, the prices in competitive markets are volatile and unpredictable. Investment in low-carbon sources, including nuclear power, has only been possible if the commercial risk is removed by a guarantee that all the power that is produced (or could be produced if the grid cannot accept it) will be paid for at a guaranteed fixed real price set to cover all costs, totally independent of the market price.

The take-or-pay element inherent in the RAB model will become increasingly important if the UK electricity generation mix becomes increasingly dominated by relatively inflexible sources, specifically wind and nuclear. Already, in summer months when demand is low and on a windy day, demand is not high enough to use all the available power that has been contracted on take-or-pay terms. Given the technical issues raised by varying the output of a

reactor, wind plants will have to be increasingly constrained and the power that could have been produced, will still be paid for by consumers. Yet, removing the take-or-pay element would make these contracts commercially non-viable.

For Hinkley Point C, the commercial risk was dealt with by giving a 35-year take-or-pay contract written by a government entity to buy all the producible power at a fixed real price. This risk was squarely placed with consumers through the Levy Control Framework (LCF). It is important to note that renewable power has not been given such an easy ride: The corresponding take-or-pay contracts for offshore wind are only for 15 years.

6. What are the technical risks and who will bear them?

The occurrence of a nuclear accident with serious international external health consequences cannot be ruled out. The UK is a signatory to the Paris convention that limits the liability of reactor owners for damages external to the plant to a figure orders of magnitude less than the potential damages and this would apply to UK reactors, however they were financed.

However, the cost of damage to the plant would fall on the owners. The likelihood of a less serious accident or equipment failure that does not have external health consequences is much higher. This might put the plant out of action for a year or more, or perhaps permanently and, logically, would end the income stream at least temporarily while repairs, often costly, were completed. In the UK, four reactors have been out of operation or have just returned from a shutdown of about a year or more while in the USA, about 50 of its reactors (about half) have experienced shutdowns longer than a year. This has significant consequences for how the power from a RAB plant would be priced and we return to this issue in section 9.

There are several technical risks that must be specifically allocated, to the public either as consumers or taxpayers, or to the developers. The most obvious risks are of construction cost and construction time overrun and experience with the technology proposed for Sizewell C, the EPR, is far from encouraging. The Flamanville (France) and Olkiluoto (Finland) EPR projects are not complete after 12 years and 15 years construction respectively - with at least three more years and one more year of construction respectively still to go before the plants enter service. The most recent cost estimates show costs are at least 3.5-4 times the estimate at start of construction and an even greater rate of escalation compared to when the investment decision was taken. The two EPRs in China, Taishan, are both now complete although one was still only in the testing phase in October 2019, but in both cases, construction took 9-10 years. Reliable cost estimates for Taishan are not available. The expected cost of the Hinkley Point C reactors had escalated by 66 per cent in the six years from when the project was agreed to when construction started.

There are other major risks: plant reliability and plant operating costs; plant lifetime; and decommissioning costs. Whilst these are mentioned in the consultation document, there is no discussion of how these risks will be dealt with.

Throughout the history of nuclear power, the reliability of reactors (as measured by its load factor[13]) has fallen short of expectations. Although typically expected to be 85-90 per cent,

[13] Load factor is calculated as the power produced in a given period as a percentage of what the plant would have produced had it operated uninterrupted at full design output level.

load factor has varied widely from year to year. The most reliable UK plant (Sizewell B) has a lifetime load factor of 84 per cent, with a range of 46-100 per cent. The least reliable (Dungeness B) has a lifetime load factor of only 41 per cent with a range 4-74 per cent.[14] If the kWh cost is fixed in any future contract, this means that income for the owner will vary hugely from year to year, and there is a significant risk it could fall short of costs in the long-term.

If we take Hinkley Point C (3200MW) as an example, and we assume it is expected to average a 90 per cent load factor - if it only achieves 84 per cent, then the annual income shortfall would be £155m. If it achieved 100 per cent in a particular year, it would earn £260m more than expected, but if the load factor was only 46 per cent in a given year, there would be an income shortfall of £1140m. Investors are therefore unlikely to accept this level of reliability risk and will demand a more certain income stream.

While many reactors worldwide have operated for longer than their design life, a significant number have been retired early. From a project appraisal point of view, discounting[15] means that the benefits of a longer than expected life will have a much lower weight than the cost of a shorter than expected life. However, if the reactor has to be retired after, say, 20 years, the owners will face a significant shortfall in their income.

The decommissioning risk is large but (as with nuclear plant lifetime), it occurs far into the future at the end of the life of the plant, when decommissioning costs can be estimated more accurately. Only a handful of commercial nuclear reactors worldwide have been fully decommissioned – most retired plants have progressed no further than demolishing uncontaminated buildings and sealing the radioactive parts of plant. And there are good reasons to believe the costs at this handful of plants are not likely to be representative. So the reality is that the decommissioning cost estimate can only be a rough guess at this stage. Thus, there is a clear risk that if the decommissioning cost is not accurately estimated, the funds are not securely invested and do not earn the expected rate of return, or the funds are not in place well before the end of the life of the plant, the risk will fall on the public. Already, failure to provide sufficient funds for reactor decommissioning has meant that the vast majority of the cost of decommissioning Britain's existing civil nuclear facilities (estimated to cost in excess of £100 billion) will fall on future taxpayers, up to a century into the future.

The consultation document (p 6) claims there will be "A fair sharing of costs and risks between consumers and investors, set out in an Economic Regulatory Regime (ERR)." The risks would be allocated via a "Government Support Package" (GSP), which would offer "protection to investors for specified low probability but high impact risks that the private sector would not be able to bear." The examples given are: "risk of cost overrun above a remote threshold; disruption to debt markets; certain risks for which insurance is not available in the market, and political risks." All these risks are important but for these purposes, we focus on the first.

[14] Figures are taken from the IAEA PRIS data base and are based on the design rating rather than the authorised rating. Note, Dungeness B is only allowed to operate at 86 per cent of its design rating.

[15] Under discounted cash flow calculations, the value of costs and benefits is lower the further into the future they occur.

The consultation document states: “it is envisaged that the threshold capital expenditure amount (the ‘Funding Cap’) would be identified prior to the GSP being issued and set by Government at a level at which there was only a remote chance of construction costs reaching this level. The Funding Cap would be set, based on robust project diligence and global benchmarking of comparable projects.”

However, it is far from clear how high the level of costs over-run would have to be set for there to be only a “remote chance” of the cap being exceeded. The clear examples are the only current nuclear projects with significant construction in Europe (Flamanville and Olkiluoto) and the USA (VC Summer and Vogtle), all of which have overrun by a factor of between two and four. For Hinkley Point C, the UK government’s White Paper of 2008 forecast a construction cost for a pair of reactors of £4 billion. In 2013, right up to the announcement of the agreement of the strike price, EDF was forecasting a construction cost of £12 billion - yet the 2013 announcement saw this rise to £14 billion, and in 2015 it increased to £16 billion. Costs increased again in 2016 to £18 billion, in 2017 (more than two years before construction start), it increased to £19.6-20.3 billion and in 2019 it increased £21.5-£23.2 billion. It appears that the uncertainty about overall cost has increased through time, rather than decreased.

Up to the cap, there is a sharing of costs above the expected cost, although no indication is given as to the relative share of these extra costs between the public and the nuclear plant owners. Even if the cap was set at a factor of twice the estimated cost, clearly far from a remote risk, this would place a huge risk on the investors, depending on the share of this risk allocated to them, of having to absorb such a large cost overrun. It is inconceivable that the target investors would take such a risk unless their share was very low.

Two approaches are outlined for setting the base cost: *ex ante* and *ex post*. An *ex ante* approach is used in Britain for regulating energy network investment. This approach was used for Thames Tideway, and is currently favoured by the UK government. It would involve setting the target cost at the time the RAB agreement was signed with cost overruns shared between the public and the plant owners. Under the *ex post* method, a target cost would be set at the start of the project and then increased as the project progresses. The problem with both approaches is that when full commitment to the project is made, its cost will not be known. Under most normal contracts, the price would be set, for example, by fixed price purchasing, so all sides knew exactly what they were signing up for - and on that ground alone, neither approach is desirable. It is important to note that no such cost adjustment is allowed for the UK’s off-shore wind projects, where the construction risk is borne wholly by the plant owner. As with all risks, investors will only be attracted if the balance of risk is heavily tilted towards public money taking the risks.

7. Why is the cost of capital high for the Hinkley Point C project?

The rationale for the RAB proposal is that the high price for power from Hinkley Point C was explained by the high cost of capital. In fact, the cost of capital is lower than it would have been if the commercial risk inherent in the project had not been passed on to consumers via the fixed price take-or-pay power purchase agreement and this reduced risk must have been reflected in a lower cost of capital. EDF claims it is taking the technical risk of overrunning construction costs and times, poorer than expected reliability and higher operating costs, through the fixed price power purchase agreement. There is scope to increase the allowed

operating costs after 15 years of operation. However, these claims of EDF taking the risk are not necessarily realistic as the plant will not be owned by EDF, but by a public limited company (NNBG), made up of EDF (66.5 per cent) and the Chinese company, CGN (33.5 per cent). If the project runs into difficulty either during construction or operation, there is no reason for EDF or CGN to "throw good money after bad" to save the company and the consortium will either go bankrupt, writing off any loans and leaving the government with a loss-making facility, or the government will renegotiate a higher strike price so the losses are covered.

No bank will lend money to a nuclear project in which it is exposed to the risks EDF is taking on with Hinkley Point C, so when the strike price was negotiated in 2013, it came with an offer from the UK government of sovereign loan guarantees to make borrowing feasible. This means the banks would essentially be lending to the UK government and taxpayers would pay back the loans if the project failed. Given the very high credit rating of the British government, the interest rate would be at rock bottom levels. With those terms on offer, there could be no scope to reduce the interest rate short of providing a loan at below minimum rates.[16] Reflecting the risks it appears to be taking on, EDF was targeting an internal real rate of return on capital of 9.75-10.25 per cent when the terms were agreed. Cost escalation since then has reduced the expected internal rate of return to 7.6-7.8 per cent.

Given the offer of loan guarantees for Hinkley Point C minimising risk to lenders, it is hard to see why the cost of capital under RAB would be any lower.

8. Who are the potential investors?

There have been no indications as to whether EDF and CGN might be among the investors in a Sizewell C RAB. The only investors specifically identified for Thames Tideway were UK pension funds. It seems unlikely this source would be an option for the RAB model if applied to a nuclear power plant. The Thames Tideway scheme was not seen as economically risky and, while some expressed doubts about its value for money, the technology was not controversial. Many pension fund members would see a nuclear project as economically risky and may be unwilling to see their funds invested in nuclear power on ideological grounds, in the same was as some funds will not invest in military or tobacco shares.

Thames Tideway is owned by a consortium of investors, representing pension funds and other long-term investors. It comprises Allianz, Amber Infrastructure, Dalmore Capital and DIF, providing £1.275m in equity. Thames Tideway does not specify where the balance of the cost will come from. If pension funds are not feasible, this leaves other long-term investors such as sovereign wealth funds, (e.g. Saudi Arabia) and venture capital funds (e.g. MacQuarie).

It is this type of institutional investor that owns a significant proportion of Britain's electricity and gas distribution companies. While such long-term investors will generally have no principled objection to nuclear, they will be unwilling to invest in risky ventures. Before investing in a project such as Sizewell C, they will carry out a rigorous due diligence to ensure that all major risks fall on other parties - and that can only mean UK electricity consumers and UK taxpayers. Thames Tideway was seen as a huge project, but in cost terms,

[16] See Appendix 1 for details about how Hinkley Point C will be financed.

Sizewell C would be almost an order of magnitude larger. Whether such funds would have the capability to provide such huge sums is not clear.

9. How will the energy be priced?

A feature of the Hinkley Point C deal of 2013 was that the price was fixed in real terms at £92.5/MWh (in 2012 money). At the time, the price seemed high - but since then, sharp reductions in the cost of renewables (e.g. Hinkley Point C's price was 130 per cent higher than 2019 offshore wind prices), and the continuing low wholesale electricity price, have shown how appallingly high the Hinkley Point C price really is.

The consultation paper states (p 20): "a nuclear RAB model would entail a variable £/MWh price (calculated by reference to the Allowed Revenue from time to time) allowing for the revenue stream to be adjusted by the Regulator as circumstances change." This will appear to consumers, rightly, as signing a blank cheque. The way in which the construction phase income will be paid to the plant owners is not specified. It seems likely that some form of levy will be imposed on consumers to generate the income required. All that will be known at the point the plant enters service will be the asset value. The rate-of-return will vary according to prevailing interest rates. The operating costs and the number of units of output over which the fixed and variable costs can be spread will vary from year to year.

For RAB-financed plants a balance will have to be struck such that the owners of the plant would have a high enough level of confidence that the income from power sales would cover costs as a well as providing the agreed rate of return to investors, while limiting the variability of the cost of power from the plant to a reasonable range and not blunting incentives for the owners to operate the plant efficiently.

As noted earlier, the output from a nuclear plant is likely to vary significantly from year to year. If the income level for the plant owners is reasonably fixed, this will mean the price will vary by a small amount if the load factor varies by a few percentage points. However, if the load factor is, say, 20 per cent rather than the likely expectation of 80+ per cent, the price of power could also vary four-fold. If the plant produces no power, would the owners receive any payment? The more fixed the income is, the lower the incentives on the plant owners to operate the plant efficiently. However, the more variable the income is, the higher the perceived risk, perhaps prohibitively risky, to the plant owners would be. The consultation paper does not even recognise this "Catch 22", much less analyse it.

10. Who will regulate the price and what will be their function?

There are as number of references to the role of a regulator and there would appear to be two options as to who should regulate the facility: setting up a new regulatory body or allocating the task to the existing British energy regulator (Ofgem). For Thames Tideway, the British water regulator (Ofwat) was allocated the regulatory role. Clearly whoever gets the task, it is vital that the regulator has the expertise and the resources and the independent integrity to do a thorough job, plus the powers to impose their decisions. Ensuring these conditions are met will be more important than whether the job goes to a new or existing regulator.

The consultation document lists a number of areas that will be under the control of the regulator. For example, the regulator will decide whether extra costs would be passed on to consumers and the allowed rate of return. Wherever the regulator has scope to exercise

judgement, this will all be interpreted by investors as risk, and investors will want as much of the regulatory procedure to be codified and predictable as possible, leaving little scope for the regulator to do more than implement these rules.

11. Will the RAB model produce competitively priced power?

While EDF has made very optimistic predictions about cost reductions for Sizewell C compared to Hinkley Point C, given EDF's hopeless record of cost forecasting at Flamanville and Hinkley Point C, little weight should be put on these forecasts. All experience suggests real construction costs will continue to rise, so the only way to produce a lower price than Hinkley Point C will be to use a significantly lower cost of capital based on reducing the risks to investors. However, since risks often transform into outcomes with nuclear technology, this apparent cost reduction will prove illusory. In other words, when costs and build-time inevitably ramp, it will be UK consumers who will pay through higher electricity prices. Given UK's poor economic record with nuclear power, it would be extraordinarily arrogant to believe that none of the issues that have affected nuclear projects in the USA and Europe will apply to Britain.

It also seems unlikely that, even if we assume the reduced price projections for Sizewell C compared to Hinkley Point C can be realised, that Sizewell C will be anywhere near competitive with renewable wind alternatives. When announcing the abandonment of the Wylfa project[17], the then energy minister (Greg Clark) talked about requiring a strike price of no more than £75/MWh[18] - which would represent a 20 per cent reduction compared to Hinkley Point C. This would be based on the UK government taking a one third equity share, with government rather than banks providing all the required loans. This should have made the cost of capital very low indeed, but despite this, developers were unable to commit to achieving £75/MWh. So it seems that the lowest achievable price is more than £75/MWh.

The capacity auction of 2019 yielded offshore wind prices of less than £40/MWh (2012 money) with none of the risk-sharing required by the RAB model and with a power purchase agreement for only 15 years. Onshore wind was ruled out in 2015 on the implausible grounds that it was too expensive. If bids for onshore wind were solicited, there is little doubt prices would be even lower than those for offshore wind. The scope for cost-effective energy efficiency measures which, if well-targeted, would yield significant welfare benefits, as well as reducing greenhouse gas emissions, is far from well-exploited. In this context, the promise of low nuclear prices using the RAB model seems profoundly illusory.

12. Missing information

As with the Thames Tideway scheme, the consultation document fails to provide much of the information necessary for the proposal to be evaluated.

The consultation document provides no illustrations of how the RAB model will save money compared to the alternatives, in particular the Hinkley Point C Contract for Differences model. The consultation merely asserts the cost of borrowing will be reduced but with no evidence to back up this assertion. These would illustrate, using data from Hinkley Point C as a comparison, how much lower interest rates would save.

[17] A project to build two reactors of the Japanese ABWR design at a site in North Wales

[18] https://www.gov.uk/government/speeches/statement-on-suspension-of-work-on-thewylfa-newyddnuclear-project

Missing information that would be needed to assess the proposal includes:

- What will be the scale of payments made by consumers before the reactors are completed, how will this be calculated and how will consumers pay this?
- To what extent do any savings assumed from use of this model arise from allowance to begin cost recovery before project completion and to what extent from a lower cost of borrowing because more of the project risk will fall on the British public?
- Is there a limit on the extent, for example in percentage terms, to which any shared risk would fall on consumers? For example, could a split of 95 per cent on consumers compared to 5 per cent on the investors be proposed?
- How will the major risks other than construction cost escalation, notably those arising from construction time, plant reliability and operating costs, plant lifetime and decommissioning, be dealt with?
- What is the expected duration of the power purchase agreement?
- Who would own the facility at the end of the period the power was contracted for?
- How will the energy be priced?
- Will it be possible to strike a reasonable balance such that the income for the owners is assured enough to ensure the project is not intolerably risky to them while at the same time not blunting incentives on the plant owners to operate the plant efficiently?
- How any electricity from the plant would be priced after the completion of the contract and what would be the consequences if the plant failed to operate as long as expected?
- Which entity would be the initial purchaser of the power and what measures would be taken to ensure that all electricity retailers were forced to buy the power?

13.Conclusions

The consultation and the proposal it contains suffer from four major problems.

1. There is too little information in the document about the proposal to make an informed judgement. For example, we do not know the allocation of risk between investors and consumers/taxpayer, we do not know what the size and basis of payments before the completion of the unit will be.

2. The proposal violates two of the major principles behind the reform of the electricity industry: that companies should make investment decisions based on their commercial expertise and judgement, and they should be required to bear the consequences if the investment goes wrong; and that consumers should have choice. Under these proposals, consumers will no longer be able to opt for green, renewable electricity.

3. The proposal breaches two important tenets of good regulation: that consumers should only pay for facilities once they are complete and proven to be “used and useful”: and that they should only pay costs that were “prudently” incurred.

4. The implicit requirement for all suppliers to purchase their share of electricity from Sizewell C implies that the value for money and fairness tests should properly be applied to these costs as system costs required to maintain the integrity of the grid not as electricity costs since Sizewell C’s electricity has, in effect, been withdrawn from

the market. This would make the correct comparator other possible routes to a similar level of system integrity.

The RAB model proposes to reduce the expected cost of power and attract investors by shifting most, if not all, the commercial and technical risk to consumers. However, the lower forecast price will prove illusory when the inevitable problems and their extra costs are passed on to consumers. It remains to be seen whether this transfer of risk will be publicly acceptable and whether investors will be forthcoming on the scale required.

The UK government has now proposed three models for financing new nuclear power plants. The model adopted for Hinkley Point C produced very high power prices, and the main recipient of the contract (EDF) does not appear willing to consider this model for follow-on projects. It therefore seems likely this model will not be used again. The second model, proposed for the Wylfa project, involved a significant UK government equity stake, a promise for the government to provide all the required loans and support from the Japanese government to find Japanese investors. Despite this, the expected price of power was too high, investors were not forthcoming and the project collapsed. There is no evidence to show why the cost of capital under RAB would be any lower than it was for the Hinkley Point C project or for the Wylfa project. In both cases, the borrowing would have been fully underwritten by the UK government and would therefore have been at rock-bottom levels. Therefore, any savings can logically only come from the provision to recover costs from consumers at start of construction. U.S. experience shows this to a reckless risk of consumers' money.

The UK's experience with nuclear power is in stark contrast to that with offshore wind projects. Unlike the nuclear projects, which have been carried out via bilateral negotiations, wind projects have been allocated through a competitive process. The contracts required are for only 15 years and no loan guarantees have been required yet there has been no shortage of potential investors. Prices in 2019 are about a third of what they were five years before and are about 40 per cent of the level negotiated for Hinkley Point C. The lead-time from project approval to first power (likely to be at least 12-14 years for Hinkley Point C) has been no more than about four years. A programme of energy efficiency measures targeted at low-income households may also be as cost-effective as renewable power sources in reducing greenhouse gas emissions, as well as providing significant welfare benefits by ensuring energy bills are affordable as fossil fuels (especially for space heating) are replaced.

Overall, the problem for nuclear projects is not that the right model for financing them has yet to be found, it is that nuclear power is simply too expensive and economically risky. The continued attempts to identify feasible financing models will therefore be unsuccessful and, more importantly, will divert resources and attention from options that can deliver the emissions reductions more cost-effectively and much quicker.

Consultation Questions and Responses

Question 1: Have we identified a model which could raise capital to build a new nuclear power station and deliver value for money for consumers and taxpayers?

No. This can only be established when the willingness of the target investors is tested, their ability to raise the sums of money required is established, and the degree of risk they will be willing to take is defined. There is too little information provided on the Thames Tideway project to evaluate experience with it. However, it has limited relevance on several grounds: A nuclear power station would cost an order of magnitude more than the Thames Tideway project; the Thames Tideway technology is much lower risk technologically and economically; the Thames Tideway project has no output to sell (which makes the payment arrangements much simpler); and since nuclear technology is highly controversial, some potential investors (particularly pension funds) may prove unwilling to invest, in the same way as they might be unable to invest in military or tobacco companies.

A key question is how much risk any willing investors will be prepared to take. Based on experience of trying to finance nuclear projects by conventional project finance methods, it is likely they will only be willing to take on minimal technical and commercial risks, leaving these with the public either as tax-payers or electricity consumers.

This distribution of risks might allow a lower cost of capital, and while this would translate into lower "indicative" or forecast electricity prices, the actual price is likely to end up no lower than for Hinkley Point C when some of the risks turn into outcomes. The certainty over cost that the power purchase agreement gives for Hinkley Point C will be lost.

It should be remembered that the risk profile of a nuclear project is highly asymmetric. Nuclear projects are very rarely completed to time and cost, much less at lower cost – indeed, cost and time overruns appear almost inevitable, and when things do go wrong, the additional costs can be huge. Recent projects in Europe at Olkiluoto (Finland) and Flamanville (France), are both at least a decade late, and costs are more than three times the estimate at start of construction. Due to the clear imperative of the climate change emergency, these delays alone should rule out nuclear as a significant element in any strategy to combat climate change. Given that the main alternatives to nuclear that are being actively pursued by government require no such risk transfer to the public, have generally been completed on time and much quicker than a nuclear power plant - the RAB model and any other planned method of financing a nuclear power plant represents very poor value for public money.

A particularly imprudent element of the model is the proposal that consumer money should be paid to the developers from when the project is agreed, not when first power is produced. It is not clear from the consultation paper whether this would be at start of construction or even earlier, when the deal is agreed. The only nuclear projects in the USA agreed since 1978, Vogtle (Georgia) and Summer (South Carolina), were only feasible partly because of Federal subsidies but mainly because the regulators gave strong indications that all costs (no matter how high) could be recovered from consumers, and because consumers began to pay for these projects through their electricity bills as soon as the project were approved by the state economic regulators. All the other reactors planned

in 2009 in the USA (there were 31) collapsed, in most cases because state regulators were not willing to grant these conditions. The folly of the regulators' decisions in Georgia and South Carolina has been well illustrated by the huge cost burdens these projects have imposed on consumers. The Summer project was finally abandoned in 2017, leaving consumers with nothing to show for the very large amounts of money invested in the plants. Whilst the Vogtle project is still proceeding, if completed it will burden consumers with extremely expensive electricity for decades to come.

If investors under the RAB model are required to wait until the plant is completed to start recovering their costs (as is the case with the Hinkley Point C project), this will be factored into a higher price demanded for the power produced.

Question 2: Do you have any comments on the components of the Economic Regulatory Regime as described?

If the model is to be sold to investors, any discretion in the regulatory regime will be seen as risk and will be unacceptable. So the Economic Regulatory Regime will have to be codified exhaustively, leaving little discretion to whichever regulatory body is allocated the task of carrying it out.

Question 3: Do you have views on how consumer interests are protected under the proposed approach? What else should be considered to protect consumer interests?

As stated above, the RAB model will only be commercially feasible if the risks are borne effectively and exclusively by the public, either as taxpayers or as electricity consumers. The amount of risk allocated to taxpayers rather than electricity consumers could be varied, but the public will care more about the size of the burden that falls on them than whether they are paying through tax or electricity bills.

Question 4: Do you agree that consumer risk sharing could be value for money for consumers if it achieves a lower expected overall cost for consumers compared to a Contract for Difference model?

No. As argued above, any projected reduction in cost will be at the expense of consumers bearing large risks. The putative benefits will be at least balanced by and (given the open-ended nature of nuclear project risk) probably more than covered by the extra costs incurred when risks inevitably turn into outcomes.

Question 5: Do you have views on the potential way to design the revenue stream for a nuclear RAB model that we describe, and are there alternative models we should consider?

The RAB model should not be adopted.

Question 6: Do you have views on our proposed approach to assessing a new nuclear project under a nuclear RAB model and determining whether it is value for money for consumers and taxpayers?

The terms of any RAB agreement will be set by potential investors and the conditions they impose. The government will have to accept these conditions or the project will not go forward.

Appendix 1 Financing Hinkley Point C

Since the strike price for Hinkley Point C was announced in September 2013, the issue of how it will be financed has been clouded by the government's Base Case Condition, which was only placed in the public domain by the European Commission in its verdict on the State-Aid inquiry.[19] This stated (p 51):

> "During the period up to the Base Case Condition being met there is a cap on the amount of debt drawn." The amount of the cap was redacted.
>
> And
>
> "The Base Case Condition is that satisfactory evidence has been provided that Flamanville 3 has completed the trial operation period and that the requirements of the Guarantor in respect of performance during such period have been met. The Guarantor has the option to extend the date for meeting the Base Case Condition into the future by increasing the amount of Base Equity and procuring that such increase benefits from the required credit support. The Base Case Condition date cannot fall later than 31 December 2020."

By 2016, there were doubts that Flamanville 3 would be in operation by end 2020, and in 2019, EDF acknowledged that the earliest it can be in commercial service would be 2022. A Parliamentary Question was asked in 2017, when doubts about Flamanville were increasing, as to whether the Base Case Condition still applied - but the government did not answer the question[20], so it is not clear whether the government has quietly abandoned it.

In September 2015, George Osborne, on a visit to China, announced the availability of £2 billion in loan guarantees in the form of bonds, presumably up to the level of the cap noted in the Commission State-Aid inquiry.[21] However, given that Hinkley Point C had not started construction at that point and that, as the National Audit Office report states (but not acknowledged in the official announcement of the guarantees), the bonds would have to have been repaid by end 2020, this guarantee was essentially useless to EDF and was not taken up.[22]

EDF's 2018 Reference Document shows that of the €7.5 billion spent on Hinkley Point C by end 2018, interest charges were only €108 million, demonstrating that borrowing so far has been minimal.[23] Given that EDF does not have the money to continue to fund construction solely from equity (its profits) and without loan guarantees, the money cannot be borrowed, it is unclear how EDF expects to finance construction of Hinkley Point C.

[19] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2015:109:FULL&from=EN
[20] https://www.parliament.uk/business/publications/written-questions-answers-statements/written-question/Commons/2016-04-29/36126/
[21] https://www.parliament.uk/business/publications/written-questions-answers-statements/written-statement/Commons/2016-10-25/HCWS216/
[22] https://www.nao.org.uk/wp-content/uploads/2017/06/Hinkley-Point-C.pdf
[23] https://www.edf.fr/sites/default/files/contrib/groupe-edf/espaces-dedies/espace-finance-en/financial-information/regulated-information/reference-document/edf-ddr-2018-en.pdf p 369.

Appendix 2 Relevant experience of the authors

Professor Steve Thomas is Emeritus Professor of Energy Policy in the Business School at the university of Greenwich. He has more than 40 years' experience in British universities in energy policy research with particular emphasis on nuclear power economics and policy.

Peter Bradford served as chair of the New York Public Service Commission from 1987-95 and as Chair and Commissioner of the Maine Public Utilities Commission from 1971-77. He served as a Commissioner at the U.S. Nuclear Regulatory Commission from 1977-82.

Tom Burke CBE. Tom Burke is the Chairman of E3G, Third Generation Environmentalism, and a Visiting Professor at both Imperial and University Colleges, London. He was Special Adviser to three Secretaries of State for the Environment from 1991-97.

Dr Paul Dorfman is Honorary Senior Research Associate at UCL Energy Institute, University College London.