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A RAB Model for New Nuclear Power Plants: The Economics of Investment Incentives

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Overview

The UK government is trying to change how it does business with investors in the energy sector. From July to October 2019, the UK Department of Business, Energy & Industrial Strategy (BEIS) consulted on the possibility of using a regulated asset base (RAB) model to encourage investment in new nuclear projects (i.e., power stations).[1] This proposal is unusual, because until recently the UK government promoted competition in British energy markets. The RAB model is more closely associated with regulated monopolies.

In this paper, we do not consider whether nuclear power is a necessary or desirable component of the future decarbonised energy mix, which is ultimately a matter for government to decide by balancing a number of policy considerations. However, taking as given that the government may pursue more new nuclear power projects, we describe how the RAB model works in general and discuss how the UK government would like to adapt it to new nuclear projects.

We conclude that the RAB model transfers risk (and some of the cost of capital) from investors to consumers. Any scheme that transfers risk to consumers and pays investors only for the risks they bear may lower the price of nuclear power. However, this reduction in the price of new nuclear may not reflect a reduction in the total cost of choosing nuclear power as a source of energy (including the cost of bearing risk).

The RAB model would only reduce the total cost to consumers if its implementation reduces the riskiness of developing nuclear power for society as a whole. Such a risk reduction could stem from better governance under a RAB model than is possible under the current, more market-orientated model. It could also stem from resolving imperfections in capital markets that cause financiers to overestimate the risks of nuclear projects. In any case, to keep any incentive for efficient investment, the new scheme must avoid transferring all the risks to consumers.

Only careful attention to the underlying economics will ensure that a new RAB model has any potential to resolve market failures and represents an improvement over alternative methods of support for nuclear projects.

Nuclear Power Stations Are Not Constructed without Government Financial Support

As part of its strategy on combatting climate change, the UK government has identified a need for new nuclear power stations to replace old ones reaching the end of their operational lives.

Private investors have shown no interest in new nuclear projects for the competitive electricity market without some form of government support (either in Great Britain or anywhere else). Such support takes many forms: a government guarantee intended to lower the cost of debt, a fixed price for the output of a nuclear power station, or a supplement to the revenues a nuclear power station earns from the market. For example:

- In recent years, the US government has provided direct guarantees for debt taken on during construction of a new nuclear projects.[2]

- Some US state governments have intervened to prevent closure of existing plants. For instance, in 2016, New York and Illinois implemented zero-emissions credit policies that pay nuclear generators for not emitting greenhouse gases. Payments of $17.48/MWh and $16.50/MWh are made to nuclear generators in New York and Illinois, respectively. The programmes have enabled five nuclear plants to avoid early closure.[3]

- At Sizewell B, the last nuclear power station to come into operation in Britain, construction began in 1987 under a state-owned electricity company with a national monopoly. It was effectively begun with financial backing from the UK government. However, Sizewell B did not begin to produce electricity until 1995, five years after the electricity market was opened up to competition.

- From 1990, nuclear power stations in the UK received a government-mandated supplement to their revenues, funded with a levy on electricity generated from fossil fuels. Sizewell B began to receive this support in 1995, but it ended in 1996, when Sizewell B was privatised, along with certain other nuclear stations, as British Energy.[4]

- The most recent new nuclear project to begin construction in the UK is Hinkley Point C in 2018, a project of EDF Energy. The project will eventually be supported by a government-mandated contract for its output. This contract guarantees a price of £92.50/MWh (in 2012 prices) for 35 years from the start of operations,[5] more than the plant might expect to earn in the competitive electricity market.

For the next new nuclear project, the UK government is thinking of moving away from the form of long-term contracts offering a fixed price for output in favour of remuneration based on the 'cost of service'. In future, new nuclear projects would receive a revenue sufficient to cover the approved cost of the investment (the regulated asset base, or RAB) and its operating expenses, an approach known as the RAB model. The switch in policy is driven by changing perceptions of the market failures that hamper investment in nuclear power stations.

Market Failures: One Thing after Another

To our knowledge, the private sector has never been willing or able to fund the construction of new nuclear projects in a competitive market. This reluctance reflects the high costs of nuclear power relative to alternatives, such as fossil fuel–fired technologies, and that the economic case for nuclear power hinges on an assessment of the positive and negative externalities (a form of market failure) that nuclear power projects create.

Market failures that affect the incentive to develop new nuclear projects include markets that are missing (nonexistent) or flawed (existing but subject to constraints on behaviour or information).[6] Government support can increase efficiency if it overcomes such market failures.

Absence of Markets for Generator Output

The type of long-term, fixed-price contract offered to Hinkley Point C may be viewed as a response to the nonexistence of forward markets covering the operational life of a new nuclear project. Indeed, no forward products in the power sector cover the entire life of relevant assets. Hinkley Point C might operate for 35 years, but neither electricity markets nor the EU's greenhouse gas emissions trading scheme run that far into the future. Therefore, investors cannot approach traders to fix the price of the plant's output over its operational lifetime. The 35-year contract awarded by the UK government may be a solution chosen to overcome the market failure of 'missing markets'.[7]

In this contract, fixing the price (subject only to indexation for inflation) has other advantages for electricity consumers. As long as cost escalation produces no additional revenue but lowers the project's profitability, the contract encourages the owner of the project to do everything necessary to minimise construction costs and expedite the start of operations. It passes back to investors certain risks and costs, thereby creating strong incentives for efficient conduct.

In principle, this incentive for efficiency would have allowed the UK government to secure the lowest possible price for the plant's output. However, experience with Hinkley Point C and with attempts to promote interest in the next nuclear plant have shifted the UK government's view on the type of market failure holding back investment in new nuclear projects.

Constraints on Capital Markets and Investment Funding

The offer of a long-term contract no longer seems enough to attract investment in new nuclear projects, for at least two reasons. First, investors are wary of the risks associated with delays and cost escalation on these projects. These risks raise the total cost of capital (debt and equity) for new nuclear projects. Second, few institutions have balance sheets strong enough to cope with the negative cash flow caused by large investments spread over a long period, as with new nuclear projects. Even EDF Energy is constrained in its ability to borrow.[8] These constraints on investment funding seem to represent a different form of market failure, that is, a constraint operating within capital markets.

The UK government is looking for ways to relieve investors of some risk and provide a positive cash flow during construction. Rather than supporting new projects with a long-term contract for the sale of electricity generated once the plant has commissioned, the RAB model could be designed to allow investors to earn some cash flow during the construction period and pass some cost risk to consumers (potentially reducing the interest rate on the project's debt and its required return on equity).

The 'Incompleteness' of Franchises and Contracts

The UK government's new desire to switch from fixed-price contracts to a cost-based regulatory system is understandable and indeed predictable. The preference for awarding fixed-price contracts derives largely from the economic study of contestability and franchising. It has been known for a long time that natural monopolies cannot support efficient competition between multiple suppliers in a market. In 1968, in the provocatively titled paper 'Why Regulate Utilities?', Harold Demsetz suggested that such cases might support competition between potential suppliers in a contest for the right to serve a whole market.[9] These observations led some governments to use competition for a franchise as a way of issuing contracts for monopoly services. Such franchises offered contracts intended to promote efficient provision of the service concerned, usually by fixing a price and limiting the scope for cost overruns to be passed on to consumers. Potential suppliers competed to be the least-cost supplier, either by bidding the lowest contract price or by bidding to pay for a fixed-price contract.

This focus on franchising advantages was only ever half the story, as far as economic theory was concerned. First, deeper analysis showed that it would only produce the claimed benefits in certain restrictive conditions—such as the ability to offer perpetual contracts.[10] Second, detailed scrutiny of long-term contracts showed that it was impossible to draft them in a way that anticipated all possible future risks and that all contracts were therefore incomplete.[11] Under an incomplete contract, an unforeseeable event may cause costs to rise (or the value of the service to fall, or conditions to change) such that without any adjustment to the contract, it is no longer in the interests of the seller (or buyer) to fulfil that contract.

Transactions Costs in Enforcing Incomplete Contracts

In contracts between private entities, incompleteness creates disputes. These disputes require renegotiating contract terms (in accordance with the original intent of the contract). That explains the role of arbitrations and court proceedings as underpinning the settlement of contractual disputes. In relationships between a private entity and a government agency, in contrast, incompleteness explains the development of regulatory systems in which revenues for long-term investments are reset periodically in the light of changing conditions but in accordance with fixed regulatory principles. Such regulatory systems act like a long-term contract that anticipates the incompleteness of the current rules (subject to court proceedings to resolve disputes, of course).

Thus, the proposal to put investment in the next nuclear power station under a RAB model is not just a method of passing risks and costs over to consumers; nor is it just a way of giving investors some positive cash flows in the short term. A long-term contract could achieve those aims.[12] A well-designed RAB model provides a structured procedure for updating the project's revenues to deal with unforeseeable events and cost increases. In other words, a RAB model offers a method of striking a more flexible bargain that can respond to the unforeseen and that may be enforced at lower transactions costs. These features of a RAB model can help lower the riskiness of investing in a new nuclear project, making it cheaper and easier to attract funding—although by passing some risks and costs onto consumers.

The RAB Model Offers a Structured Way of Dealing with Changing Conditions

In principle, the RAB model is very simple. The regulator adds up the costs of the project—including the cost of capital—and allows the project a revenue that gives an opportunity to recover those costs. In practice, any regulator would have to decide which costs to approve and which to reject, which creates a degree of complexity. However, to reduce risk and preserve incentives for efficient investment and operations in the long term, decisions on costs need to be conducted in accordance with stable principles, which tends to simplify the decisions.

Elements of the RAB Model

The UK government's consultation document presents the RAB model in Figure 1. In summary, in any one year, the project's allowed revenue comprises the following building blocks:

1. The cost of capital (also known as the return *on* capital);

2. Depreciation (also known as the return *of* capital);

3. Project operating expenses, taxes, and any charges for using the electricity grid;

4. A provision (a contribution to a 'savings fund') to pay the future costs of decommissioning the plant; and

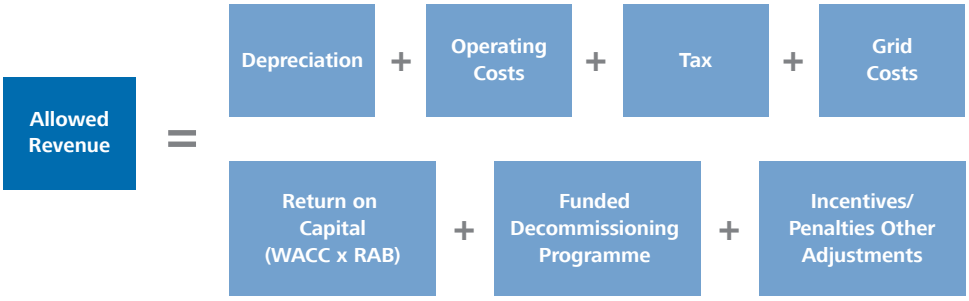
5. Additional revenues, or penalties subtracted from revenues, intended to provide incentives for particular forms of behaviour.

Further formulae convert this annual allowed revenue into specific customer charges, industry levies, or other means of recovery.

Of these building blocks, only item 4, a provision (a contribution to a 'savings fund') to pay the future costs of decommissioning the plant, is specific to a new nuclear project. The cost of decommissioning a nuclear power station is known to be significant, and it occurs after the power station has ceased to earn any revenue from generation. To prevent investors from walking away from the project, the regulator obliges them to set aside funds during the project's operating life that are sufficient to pay the (expected) cost of decommissioning.

The other building blocks can be found in the regulation of energy and water network companies, and of companies in other regulated sectors, in the UK and around the world. Indeed, as the consultation document notes, they have even been applied to a number of specific infrastructure projects (the consultation document mentions the Thames Tideway Tunnel project[13]). In each case, the RAB model applies with certain adaptations to accommodate special circumstances and project-specific risks.

Figure 1. **Allowed Revenue Building Blocks**



Source: BEIS (2019), *RAB Model For Nuclear: Consultation on a RAB model for new nuclear projects*, Department of Business, Energy and Industrial Strategy, 22 July 2019, Figure 1, p. 13.

Building blocks 1 and 2 of the model relate specifically to the RAB and require further explanation here. The RAB is simply the value of capital invested in the project that investors will be allowed to recover in future charges. Depreciation (element 2) is the amount of that value charged or allocated to each year for recovery in annual revenues. The annual return (element 1) is calculated as a percentage (the WACC) on the outstanding capital value (the RAB) and compensates investors for the opportunity cost of capital invested in the project.

The WACC is equal to an average of (a) the cost of debt (i.e., interest) and (b) the cost of equity (i.e., the return required to attract capital from shareholders). That average is weighted by the relative proportions of debt and equity in company financing—hence the weighted average cost of capital or WACC.[14]

Allowing Costs into the RAB

No reasonable regulator would accept just any cost into the calculation. At the very least, the regulator would have to check that all the costs concerned had been incurred on the project itself and not on other activities. Performing this check usually requires detailed accounting rules—to establish the allocation of company overheads and joint costs with other projects—and some scrutiny of the accounts.

In addition, the construction of a RAB (or its equivalent in other regimes) requires the regulator to check that the firm constructing the project incurred each cost in accordance with certain standards, to prevent costs from rising unnecessarily. In the UK (and much of Europe), the corresponding check is often described as a test of efficiency, but in practice it is impossible to measure or to assess the efficiency of actual costs. A better description of the standard applied to regulated costs is the US term 'prudence'. Prudence, a test invented by US Supreme Court Justice Louis Brandeis with considerable legal guidelines, checks whether the decision to incur a cost, and the process of incurring a cost, were carried out prudently, that is, in accordance with good industry practice.[15] For instance, the regulator would assess whether:

- The project design conforms to agreed industry standards (and is not 'gold plated');
- The contractor decides to incur a cost in accordance with defined plans and procedures;
- The contractor procures goods and services at market prices (or at least cost), using competitive tenders whenever possible; and
- The process of construction and installation follows good project management practices to prevent unnecessary delays and cost overruns.

No project runs perfectly. The theory of incompleteness tells us to expect some variation in costs, and the regulator will need to assess whether any variation against the planned cost is due to 'imprudent' behaviour by the contractor or to changes in external circumstances (such as exogenous increases in the price of inputs to the project). In principle, the regulator should add actual costs of investment to the RAB, unless there is convincing evidence of imprudent behaviour. Otherwise, the calculation of the RAB and the return to investors would become too subjective, arbitrary, and risky to attract low-cost capital. But the rules must allow for some costs to be disallowed and others to be added to allowed revenues, as appropriate.

Ex Ante and Ex Post Approval of Costs

The consultation document draws a distinction between ex ante and ex post settlements for variation in costs.[16] Ex ante settlements would apply a cost-sharing element in a predefined formula for allowed revenue, whereas ex post settlements would be applied to individual cost items after regulatory scrutiny. Ex ante settlement encourages efficiency in costs that are influenced mainly by the decisions of the firm running the project. However, any cost may be inflated (or reduced) by unforeseen circumstances that undermine the financial security of the firm (or that permit unnecessarily high profits). In practice, any ex ante scheme is bound to be incomplete and will require amendment from time to time, just like any long-term contract or agreed set of rules. Designers of the RAB model must therefore anticipate the need for ex post settlements. That requires the prespecification of the criteria and procedures used to appraise whether unforeseen increases in cost should be added to the RAB and hence to allowed revenues.

Allowing a Return on RAB during Construction

Once the regulator has calculated (or confirmed) the value of capital tied up in the RAB and has calculated the WACC, it is possible to calculate a return on capital (the WACC multiplied by the RAB). In many regulatory systems, the share of the total return representing the 'return during construction' is simply added to the RAB and recovered from consumers via allowed revenues once the project is completed and starts to produce output.[17] For new nuclear projects in the future, the UK government is proposing an innovation intended to make it easier to attract capital.

Instead of adding the return during construction to the RAB, the UK government is consulting on the possibility of paying it out to investors whilst the project is under construction.[18] Such payments would provide cash flow sufficient to cover interest and dividends on capital invested in the project during construction. The goal of this policy would be to attract capital from a wider pool of investors, including some who are not prepared to wait for returns over the relatively long construction period of a new nuclear project.

Allowed Revenues during the Production Phase

Once the new nuclear project started to produce electricity, it would be allowed an annual revenue defined by the building blocks listed above. At that point, the RAB would not include the return during construction, which would have been recovered earlier. The allowed revenue would cover all the building blocks of cost, but including a return on RAB only from that time onwards.

Some (or even all) of the allowed revenue would come from the power station's sales to the market. The regulator would therefore calculate a net allowed revenue, to be recovered through a levy on electricity consumers, after deducting actual or expected revenues from the market. Adjusting for actual revenues would destroy the incentive to maximise revenue or manage risks. Adjusting for expected revenues, based for example on forward market prices, leaves in place the incentive for prudent trading of the power station's output.[19]

As with the calculation of the RAB during the construction phase, the RAB model must anticipate some unforeseen variation in operating costs in the production phase. Testing these costs will require the same mixture of ex ante and ex post settlement procedures as during the construction phase.

Conclusion

The UK government has been consulting on whether to apply the RAB model to new nuclear projects in the future. The purpose of the proposal is to reduce the riskiness, and hence the cost of capital, of such projects and thereby widen the pool of potential investors. However, the consultation recognises that this goal will not be achieved simply by passing all risks and costs from investors to consumers. Some risks and costs must remain with the owners of the new project to preserve incentives for efficiency. In particular, the revenue formula must allow for recovering cost increases brought about by changing circumstances, but the project owners must bear the costs of decisions to incur costs imprudently during the construction and production phases. Making this distinction will require some ex post procedure for appraising the reasons behind unforeseen increases in cost and for awarding additional revenue when appropriate.

In setting up such a procedure, there is a danger that it injects additional risk into the allowed revenues of the project, thereby undermining any attempt to reduce investment risks and costs. The consultation document describes the ex post cost settlement as being conducted 'on a discretionary basis, in accordance with regulatory principles'.[20] This wording is unfortunate, since the use of regulatory discretion is not consistent with a low-risk regime.

Ideally, such decisions would be conducted in accordance with a set of criteria or procedures that were defined tightly enough to make the outcomes predictable in any particular case. Defining such criteria and procedures in full might take time through the accumulation of custom and practice (case law). However, a well-designed RAB model would draw on the experience of similar decisions in the UK and elsewhere (including Europe, Australia, and the US[21]). The goal of the design for any RAB model—and particularly one for new nuclear projects—should be to provide as much guidance as possible from the outset as to whether any particular cost will be recovered from allowed revenue. Achieving that goal means not just complying with investor requests but designing the optimal allocation of the underlying economic risks and incentives.

Notes

* The authors acknowledge the help of Graham Shuttleworth in shaping this paper, and Jeff Makholm for his comments.

1 BEIS, *RAB Model For Nuclear: Consultation on a RAB model for new nuclear projects*, Department of Business, Energy and Industrial Strategy, 22 July 2019. The closing date of the consultation was 14 October 2019.

2 The Southern Company's investment in new nuclear generation at Vogtle receives this kind of support on up to US$12 billion of loans. See US Department of Energy, *Secretary Perry Announces Financial Close on Additional Loan Guarantees During Trip to Vogtle Advanced Nuclear Energy Project*, US Department of Energy, 22 March 2019. Available at https://www.energy.gov/articles/secretary-perry-announces-financial-close-additional-loan-guarantees-during-trip-vogtle.

3 The plants that avoided early closure are Ginna Nuclear Power Plant, Nine Mile Point Nuclear Station, and FitzPatrick Nuclear Power Plant in New York; and Clinton Power Station and the Quad Cities Generating Station on the Mississippi River in Illinois. See Nuclear Energy Institute (2018), *Zero-Emission Credits*, pp. 3–5. Available at https://www.nei.org/CorporateSite/media/filefolder/resources/reports-and-briefs/zero-emission-credits-201804.pdf.

4 From 2002, British Energy faced financial difficulties. The company was taken over by the UK government in 2004 and sold to EDF Energy in 2008.

5 See https://www.gov.uk/government/collections/hinkley-point-c.

6 Note that 'market failure' is a technical term, denoting the absence of a particular market or a flaw in the conditions pertaining to an existing market, such that market participants cannot achieve the efficient outcomes attributed to competitive markets. A market failure is therefore identified by reference to market conditions, not market outcomes. (Failure by a market to achieve government policy objectives is not, per se, a market failure.)

7 This view would have more support if the contract had been awarded through a competitive tender. However, the lack of alternative bidders left the UK government with no option but to negotiate the price of the new nuclear project, to which it was committed. The concept of 'missing markets' concerns the ability of power markets to provide funds to encourage sufficient investment in capacity and ensure security of supply. See David Newbery, *Missing Money and Missing Markets*, EPRG Working Paper 1508 (2015), p. 3.

8 Being largely owned by the French state might be expected to give EDF Energy an advantage in attracting low-cost debt, but it is constrained by its debt/equity ratio and cannot easily issue more equity.

9 Harold Demsetz, 'Why Regulate Utilities?', *Journal of Law and Economics* 11(1) (1968): 55–65.

10 Contestability only works as an efficient constraint on the prices of a monopoly if potential competitors can enter into and exit from the market without cost. Having to leave behind a long-term investment at the time of exit imposes a cost on any actual attempt to enter the market, making it less likely to occur and less effective as a constraint on the incumbent.

11 As with contestability, this concept has been adopted as standard by the wider community of economists, but the early work on it (in the 1980s and 1990s) is usually attributed to prominent academic economists O. E. Williamson, S. J. Grossman, O. D. Hart, and J. H. Moore. For an explanation and discussion of the concept, see Sean Gammons, Richard Druce, and James Grayburn, *Why PFI Holds No Lessons for Utility Regulation*, NERA Economic Consulting, 29 March 2018. Available at https://www.nera.com/publications/archive/2018/why-pfi-holds-no-lessons-for-utility-regulation.html. Williamson argues that 'bounded rationality' inhibits the ability of individuals to envisage all possible scenarios, and it is therefore impossible to specify a contract able to mitigate against all eventualities. See O. E. Williamson, "Transaction Cost Economics," in *Handbook of New Institutional Economics*, ed. Claude Ménard and Mary M. Shirley (New York: Springer, 2005), p. 46.

12 If the only problems were known risks and negative cash flows, a long-term contract could address them by including formulae for risk-sharing and for interim payments at key milestones in the construction process.

13 BEIS, *RAB Model For Nuclear: Consultation on a RAB model for new nuclear projects*, Department of Business, Energy and Industrial Strategy, 22 July 2019, Box 1, p. 10.

14 Most regulatory regimes in the UK set a single return on capital equal to the WACC. Some other regulatory regimes, like that in the US, treat the actual cost of interest on debt as an operating expense, leaving only the cost of equity to be calculated as the return on the portion of capital represented by equity.

15 'The term "prudent investment" … is applied for the purpose of excluding what might be found to be dishonest or obviously wasteful or imprudent expenditures'. See: *Missouri ex rel. Southwestern Bell Tel. Co. v. PSC*, 262 U.S. 276 (1923), footnote 1.

16 BEIS, *RAB Model For Nuclear: Consultation on a RAB model for new nuclear projects*, Department of Business, Energy and Industrial Strategy, 22 July 2019, p. 14, para. 40.

17 The standard approach in the US is to calculate only 'interest during construction', that is, the cost of debt. Investors have to recover any cost of equity during construction, along with the expected level of costs disallowed for imprudence through the return on equity for completed projects.

18 BEIS, *RAB Model For Nuclear: Consultation on a RAB model for new nuclear projects*, Department of Business, Energy and Industrial Strategy, 22 July 2019, p. 20, para. 62.

19 No such deduction will leave market incentives entirely undisturbed. Under this approach, any mismatch between the power station's expected sales revenue and the actual sales revenue would expose the project to commercial/regulatory risk. It might bias the power station's trading strategy towards selling its output on the same basis as that assumed in the regulator's calculations.

20 BEIS, *RAB Model For Nuclear: Consultation on a RAB model for new nuclear projects*, Department of Business, Energy and Industrial Strategy, 22 July 2019, p. 14, para. 40.

21 Regulators in Europe, Australia, and the US all apply systems comparable to those in the UK, albeit with some differences in procedure. In literature produced in the UK, the regulatory system of the US is often misrepresented, either as a system of automatic cost pass-through with a guaranteed rate of return (rate of return regulation), or as a cumbersome system of legal rules and procedures. In fact, US regulation is similar to UK regulation in many ways, and its longer track record offers many useful lessons. Federal and state regulators in the US also set prices (tariffs) for extended (indefinite) periods, rather than fixing an annual rate of return. Moreover, the pass-through of costs into those tariffs is not guaranteed, since regulators are only obliged by law to offer the opportunity to recover prudently incurred costs (including the cost of capital). Regulated companies may fail to recover some costs if they incur them imprudently (during construction) or unexpectedly (before tariffs can be revised). Finally, the accumulation of experience with clearly defined rules means that most US regulatory procedures are conducted as a matter of routine—indeed, they may pass more quickly and cheaply than UK regulatory reviews, although the contentious issues surrounding nuclear power plants can be as troublesome in the US as they are in the UK. The design of a RAB model for nuclear power plants could therefore learn from US practices, among others.

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