



Financing Energy Infrastructure  
Business, Energy, and Industrial Strategy  
Committee - UK Parliament

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## Executive Summary

1. Nuclear Economics Consulting Group ([NECG](#)) is responding to the Inquiry on Financing Energy Infrastructure issued by the UK Parliament Business, Energy, and Industrial Strategy (BEIS) Committee on 28 February 2019.
2. This NECG submission focuses on new nuclear power plant (NPP) investments.
3. Nuclear power is essential to meeting UK long-term climate goals. The UK new nuclear build plan for 16 GWe by 2030<sup>1</sup> can be achieved by taking appropriate measures and extending the timeframe.
4. New NPP investment in the UK faces multiple challenges.
5. The UK NPP approach has resulted in one NPP under construction owned by nuclear State-owned Enterprises (SoEs). To attract private investors, the UK must address NPP completion risk and long-term revenue risk.
6. NECG outlines and evaluates several options for the UK.
7. We recommend a direct UK Government role in funding NPPs during development and construction, followed by a sale or refinancing when the NPP starts commercial operation (i.e., Option B2 in NECG's full submission). This option would:
  - Transfer completion risk to ratepayers and/or taxpayers;
  - Revive NPP project developer<sup>2</sup> interest in the UK market;
  - Transfer the NPP project to the commercial sector at the start of commercial operation through a refinance or sale transaction;<sup>3</sup>
  - Facilitate a wide range of financing approaches after the start of commercial operation; and
  - Lead to lower NPP investment cost and increased competition.

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<sup>1</sup> As outlined in Nuclear Industrial Strategy - The UK's Nuclear Future, 26 Mar 2013.

<sup>2</sup> The UK Government will need both NPP design/build and NPP operating expertise under different implementation models.

<sup>3</sup> Arrangements to ensure adequate long-term revenue could take multiple forms (e.g., power contracts, CfDs, regulated assets, etc.) and could be deferred until just prior to the commercial transfer (e.g., refinance or sale) date.

## I. Introduction

1. Nuclear Economics Consulting Group ([NECG](#)) submits this response to the Inquiry on Financing Energy Infrastructure issued by the UK Parliament Business, Energy, and Industrial Strategy (BEIS) Committee on 28 February 2019.

2. NECG is an economic consulting firm that applies in-depth analysis to complex economic, business, regulatory, financial, geopolitical, legal, and other challenges facing the nuclear power industry.

NECG experts combine consultancy experience with extensive real-world operational and corporate leadership. They have worked in the nuclear industry and on nuclear project development and investment decision support around the world. Our work is informed by extensive experience in electricity industry restructuring and its impact on the nuclear power industry.

Contributors to this submission are [Edward Kee](#) (USA), [Amjad Ghori](#) (UK), [Ruediger Koenig](#) (Germany), [Fabienne Pehuet Lucet](#) (France), [Paul Murphy](#) (USA), and [Xavier Rollat](#) (France), with a peer-review by [Prof. Graham Weale](#) (Germany).

3. BEIS is seeking evidence on “...potential investment across the energy sector, including power plants, system flexibility, heat decarbonisation and demand reduction.”

4. NECG’s evidence focuses on new nuclear power investments, which will provide reliable, clean, baseload electricity to help the UK meet climate goals (e.g., an 80% carbon reduction target by 2050).

5. The UK approach to new nuclear power investment depends upon the UK’s future relationship with Europe. If the UK remains in the EU, or leaves the EU but continues to be bound by certain State Aid<sup>1</sup> provisions, then most options for new nuclear power investment will be challenging.

6. This submission has three parts:

- Context for NECG submission;
- Options for UK nuclear power plant (NPP) investment (with NECG Recommendation); and
- Responses to Inquiry Terms of Reference questions.

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<sup>1</sup> If the UK leaves the EU, the UK will likely continue trading electricity with the EU across existing and planned interconnectors; this electricity trade may require the UK to follow certain EU rules, including those relating to State Aid.

## II. Context for NECG submission

### A. UK generation portfolio must continue to have nuclear power

7. The UK requires new nuclear power plant (NPP) investment to provide reliable and clean electricity.
8. Nuclear power is a proven, large-scale, dispatchable generation technology with load-following capability, minimal carbon emissions, a fuel cycle supporting national energy security, a small environmental footprint, high energy density, and long asset operating life.

### B. Current electricity framework does not support new NPP investment

9. Nuclear power provides public goods (e.g., emission-free electricity, energy security, energy diversity) that are not included in most Levelized Cost of Electricity (LCOE) estimates and have little value in the current electricity market. This is market failure.<sup>2</sup>
10. Liberalized electricity markets do not provide adequate financial incentives, without out-of-market subsidies, for new generation investment in high-capital-cost generation assets, like NPPs.<sup>3</sup> Electricity spot market prices may not be high enough to cover annual cash generating costs for baseload plant, such as NPPs<sup>4</sup>, let alone depreciation and financing.

### C. UK Government must take further action to resolve market failure

11. Enabling public goods resulting from new NPP capacity investments in the current UK electricity market will require significant UK Government intervention.
12. The UK Government measures to address this market failure have worked to a degree,<sup>5</sup> but have not resulted in new NPP investment needed to close the nuclear gap. In addition, the level of NPP incentives for the Hinkley Point C (HPC), such as the Contract for Differences (CfD) strike price, are controversial.

### D. UK must address NPP financing challenges

13. NPP financing challenges include the large size and duration of the investment; a long and uncertain development and construction period; an unfavourable new build track-

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<sup>2</sup> See <https://nuclear-economics.com/21-market-failure/>.

<sup>3</sup> See <http://www.world-nuclear-news.org/V-Can-nuclear-succeed-in-liberalized-power-markets-0420152.html>.

<sup>4</sup> See <http://nuclear-economics.com/wp-content/uploads/2014/08/2014-04-EJ-Merchant-nuclear-rescue-article-Kee-Zoli.pdf>.

<sup>5</sup> The UK nuclear new build programme since 2007 has seen massive investment by multiple firms, but only one NPP has started nuclear construction. In addition, EdF's decision not to utilize the UK Guarantees Scheme shows the need for a rethink of risk allocation structure in certain financial tools.

record; the complexity, cost, tenor, and uncertainty of nuclear safety regulation<sup>6</sup>; and uncertain revenue after commercial operation. Project returns may not be adequate to compensate investors for overall project risk.

14. Historically (i.e., for most existing NPPs), NPP completion and revenue risk was shifted to governments (i.e., taxpayers or ratepayers or both) or to the ratepayers of regulated investor-owned utilities.
15. The UK Government has addressed NPP revenue risk through the CfDs, but must also address NPP completion risk.

### **E. UK new NPP investments must reflect finance industry realities**

16. After the 2008 financial crisis, stricter regulation reinforced prudential requirements and the finance industry shifted to less capital-consuming activities, developed new financing strategies based on shorter cycles,<sup>7</sup> and instituted aggressive asset rotation policies.
17. New NPP investments, with high capital-intensity and long operating life, may not be “bankable.” Financial institutions also see NPP financing as having negative reputation implications.
18. Straight commercial finance<sup>8</sup> or corporate finance is not available nor viable to fund the development and construction of a new NPP due to a lack of investors with required capital capacity.

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<sup>6</sup> The nuclear safety regulation process is long and uncertain, with a propensity to change requirements after construction starts, and there is not a harmonized set of international standards (e.g., in contrast to the airline industry).

<sup>7</sup> Loans issued on the primary market by banks are “typically” re-packaged and sold on the secondary market within a few years, as banks must deal with cumbersome capital adequacy requirements, which make long-term lending and / or holding onto assets (e.g. loans) expensive for them.

<sup>8</sup> Commercial bank debt without any form of support, whether ECA insurance, loan guarantees, etc.

### III. Options for UK NPP investments

19. Multiple options for the UK to address market failure for nuclear power and obtain near-term new NPP investments are presented below.
20. Of these, NECG recommends a UK Government role in funding construction (i.e., Option B2) as the preferred way forward.
21. The UK Government should invite industry<sup>9</sup> to discuss how to implement Option B2, reflecting findings from this BEIS Inquiry, findings from the [Infrastructure Finance Review](#) consultation, and nuclear industry practice.<sup>10</sup>
22. Such considerations should recognize:
  - Mitigating NPP completion risk means limiting private sector participant financial exposure in the event of project failure;
  - To enable the UK Government's role (i.e., holder of nuclear site licenses), the UK Government should consider buying back designated nuclear projects sites;<sup>11</sup> and
  - To ensure project completion, ownership of the site and the work in progress would transfer to the UK Government if a developer defaults.

#### A. Options to provide adequate incentives to third party developers

23. This set of options keeps the current approach to enable NPP development primarily with a price support system for the NPP developer/owner to resolve market failure. These options do not address completion risk, may result in more SoE-owned<sup>12</sup> NPP projects, and face political pressure<sup>13</sup> due to the large incentives provided.

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<sup>9</sup> Relevant nuclear industry participants should include the nuclear power industry (e.g., international utilities, UK experienced OEMs, other firms experienced in foreign new build projects) and the financial industry (e.g., lenders, insurers, investment funds, and rating agencies).

<sup>10</sup> This should include input on how to develop a competent, competitive, flexible structure for NPP development and construction from reactor, turbine generator, balance of plant and civil works suppliers; engineers; experienced operators; and other parties. NECG would be pleased to present suggestions.

<sup>11</sup> This would primarily concern the Wylfa, Oldbury, and Sellafield sites, with special consideration to be given to the Bradwell and Sizewell sites. Hinkley Point would likely be excluded.

<sup>12</sup> Increased reliance on nuclear SoEs is because private investors are unlikely to participate unless the UK Government takes NPP completion risk.

<sup>13</sup> The CfD strike price for HPC may not be politically acceptable for future projects.

### **1. Status quo (Option A1)**

24. HPC, the UK's only new NPP project to have started construction, is owned by two foreign nuclear State-Owned Enterprises (SoEs).<sup>14</sup> The UK approach to new NPP investments may be viable only when the project developer is a nuclear SoE.

### **2. Status quo with enhanced incentives (Option A2)**

25. The suspension of the Horizon NPP project and termination of the NuGeneration project suggest that current incentives may not work when the NPP developer is a private nuclear industrial company or utility.

26. This option would enhance incentives (e.g. a reformulation of the UK Guarantees Scheme), to compensate for the significant capital risk faced by private NPP developers and their investors.

### **3. Critical Infrastructure Power contracts (Option A3)**

27. Replace CfDs with power purchase contracts with critical infrastructure entities to enable significantly higher NPP revenue that does not flow to normal electricity consumers, to reduce the political issues with the current CfD approach.

28. Require certain UK Government-designated "critical infrastructure" activities to purchase electricity from NPPs, including new NPP projects. The power contracts could have appropriate prices and tenors to provide adequate incentives for private NPP developers. If these critical infrastructure activities are UK Government-owned activities, the Crown would pay the cost directly. If these critical infrastructure activities are private activities, the UK Government could reimburse these companies.

29. Depending on the nature of the critical infrastructure, this option could provide a platform for longer-term development of new advanced reactor or small modular reactor (SMR) NPPs that are dedicated sources of localized power.

## **B. Options for direct UK Government involvement**

30. These options involve UK Government taking a more direct role in new NPP development and ownership to resolve market failure.

### **1. UK Government ownership of nuclear power industry (Option B1)**

31. The UK Government returns to its historical role as the owner and operator of nuclear power plants. This need not involve re-nationalization of existing NPP assets.

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<sup>14</sup> SoEs combine nuclear OEMs and nuclear utilities, such as CGN, CNNC, Framatome/EdF, KHNP/KEPCO, Rosatom. Nuclear SoEs see nuclear investments in other countries as a viable strategy to increase nuclear world market share, to enhance geopolitical and economic influence, to import nuclear jobs back to their domestic supply chain, to earn hard currency, and to achieve other objectives.

32. The UK Government resolves market failure by taking direct responsibility for the costs of building, owning, and operating NPPs. Taxpayers and/or ratepayers would pay for the public goods so obtained.
33. A variation on this option would have the UK Government as partial owner and/or funder of last resort (to cover contingencies).
34. It may take time to establish and fund the new UK Government nuclear entity, after which the new entity could develop, build, own, and operate the new NPP fleet.

## **2. UK Government role in construction phase only (Option B2)**

35. To overcome the challenges with private NPP financing, the UK Government would address NPP completion risk by funding NPP development and construction.
36. The UK could fund NPP development and construction by acting as the project developer/owner (i.e., taking full responsibility for funding) or by providing loans to the project developer (e.g., construction loans/senior debt, subordinated/junior debt, and/or equity bridge loans).
37. In both approaches (i.e., as owner or as construction lender), the UK government would need support (e.g., commercial, legal, technical, financial) to manage commercial relationships and responsibilities vis-à-vis the NPP asset.
38. After NPP project completion and start-up, operation with a long-term, secure, stable, and economically viable offtake arrangement<sup>15</sup> will provide an attractive long-term opportunity for a new class of investors and lenders to invest in operational NPPs.
39. If the UK Government takes a developer/owner role, this ownership role would cease soon after commercial operation, through a sale (in whole or in part) of the operating NPP in the market, to utilities or capitalizing on the long-term hold strategies of pension funds, insurance companies, and certain other private equity investors. The new owner would arrange NPP permanent financing as a part of the transaction.
40. If the UK Government provides loans, private capital (both debt and equity) would replace UK Government loans in a refinancing transaction by the NPP owner after the NPP starts commercial operation.
41. The sale or refinancing transactions would enable the UK Government to redeploy its capital into other projects after each NPP is completed and placed into commercial operation.
42. This option would renew interest among potential NPP project developers in the UK market, increasing competition and facilitating a wider range of financing approaches after commercial operation. Reducing or removing completion risk and increasing the

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<sup>15</sup> Arrangements to ensure adequate long-term revenue could take multiple forms (e.g., power contracts, CfDs, regulated assets, etc.) and could be deferred until just prior to the commercial transfer (e.g., refinance or sale) date.



number of players would likely lower total cost for the new NPP fleet compared to other alternatives.

43. The overall cost of capital will be lower, compared to current approaches, during the development and construction phase, due to the UK Government's sovereign credit rating, and after project completion, due to private sector refinancing of an operating NPP.
44. The UK Government might retain a golden share, in cases where foreign ownership could be of national security concern.

### **3. Creation of UK nuclear champion (Option B3)**

45. The UK could use its commitment to build a new fleet of NPPs to grow the national nuclear industrial sector. The UK Government (or a new regulated nuclear utility) would own new NPPs and ensure that UK suppliers get most of the contracts to build new NPPs.
46. This option would use the UK NPP new build commitment to develop the UK nuclear industry.
47. Such a programme would likely depend on an acquisition of, or cooperation with, an NPP technology developer (private or government owned)<sup>16</sup> that would be willing to make appropriate, long-term commitments to the UK, including partnering with UK industry for domestic and global deployment.
48. This option could meet the UK need for new NPP capacity, grow the UK nuclear industrial capability to compete in the world market, help achieve other public objectives,<sup>17</sup> and could include the development of UK-based advanced reactor and SMR technology.<sup>18</sup>

## **C. Options to change electricity industry structure and/or markets**

49. This set of options resolves market failure by either placing NPP assets into a regulated asset model or by changing the electricity market.

### **1. Shift to regulated nuclear assets (Option C1)**

50. The UK Government would shift completion and performance/revenue risk to ratepayers using a regulated asset approach for NPPs.

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<sup>16</sup> Developing a new UK indigenous reactor design would take a long time, apart from other concerns.

<sup>17</sup> These public objectives include keeping more economic benefit from new UK NPPs in the UK.

<sup>18</sup> See <https://www.gov.uk/government/publications/market-framework-for-financing-small-nuclear>.

51. The NPP developer/owner can get a fair return on and of its NPP capital investment and recovery of generating costs. The ratepayers (i.e. customers of the regulated utility) would bear completion risk within agreed parameters.<sup>19</sup>
52. The details of the regulated nuclear utility approach could take multiple forms and could provide the UK Government with a high degree of control and oversight, like the Regulated Asset Base (RAB) approach used in other sectors.

## **2. Fundamental re-work of UK electricity system (Option C2)**

53. This would involve a total re-think of the UK electricity supply system in the context of a new energy market design that would also facilitate new NPP investments.<sup>20</sup>
54. This new electricity/energy market could reflect total system costs,<sup>21</sup> including environmental impacts, of electricity generation from all generation types.

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<sup>19</sup> This would be determined and monitored through *ex ante* agreements with, and *ex post* reviews by, the economic regulator that oversees the NPP (e.g., “prudency” reviews by US state-based economic regulators).

<sup>20</sup> [NECG Commentary #17](#) discusses this concept.

<sup>21</sup> As covered in the recent [report](#) by the OECD/NEA.

## IV. Response to Terms of Reference Questions

### A. Question 1

*How do recent investment decisions on nuclear and trends in low carbon investment affect the UK investment outlook for energy infrastructure? Is there a case for changing the Government's current approach to delivering a low cost, low carbon energy system? How could the 'nuclear gap' be filled?*

55. The recent nuclear investment decisions (e.g., the withdrawal of Horizon) reflect a fundamental market failure in the UK.
56. The UK Government should change its approach to delivering a low-cost, low-carbon energy system.
57. The UK new nuclear build plan for 16 GWe by 2030<sup>22</sup> can be achieved, if appropriate measures are taken (i.e., one of more of the options discussed in Section III above) and the timeframe is extended.

### B. Question 2

*How attractive is the UK energy sector for investment compared to other countries? Are there particular technologies which are more – or less – attractive to investors under current arrangements?*

58. The UK has relative advantages that make new NPP investments more attractive,<sup>23</sup> including:
- A strong legal system and property rights;
  - An established nuclear power and fuel cycle industry, with nuclear power regulatory, safety, and administrative infrastructure; a skilled nuclear workforce; and local supply chain capabilities; and
  - A large economy, with easy access to domestic and international financial markets.
59. The level of government support needed for new investments in the UK energy sector, regardless of the developer type or generation technology, should be lower than for countries with fewer or none of these advantages.
60. NPP technologies available to the UK today each has a unique time-to-market,<sup>24</sup> vendor, and country of origin. New advanced reactor and SMR technology options may result in

<sup>22</sup> As outlined in Nuclear Industrial Strategy - The UK's Nuclear Future, 26 Mar 2013.

<sup>23</sup> The uncertainty surrounding Brexit has added strong disincentives to investment or other new engagement in the UK and will continue to do so in the future. However, this should not prevent interested parties to participate in the UK debate on future market designs, in view of the fundamental, historical importance of the UK.

<sup>24</sup> Factors influencing time-to-market include: development status in the UK (i.e., does a reactor design have an approved GDA, has it undergone advanced UK design and site licensing work), reactor design maturity (i.e.,

lower total capital cost, shorter development and construction period, and other advantages that might help mitigate completion risk.

### C. Question 3

*How has Government policy improved the UK energy investment environment over the last three years?*

61. Under current arrangements, NPP investment in the UK is not attractive, principally due to the current electricity market structure, the (lack of) financing options available, and short-term Brexit concerns.

### D. Question 4

*What types of investor can we expect to finance future UK energy infrastructure? What are their criteria for investment, including on risks and returns? Does it matter if investors for specific technologies are largely from overseas?*

62. The following traditional types of investors might finance future UK NPP investments:

- EDF (i.e., European/OECD nuclear SoE with UK presence);
- Other Nuclear SoEs;
- Nuclear industrial companies;
- International nuclear utilities; and
- UK Government.

63. Criteria for investment, risks, returns for investors and companies differ:

- Nuclear SoEs see a UK NPP project as an opportunity to achieve geopolitical, economic, reactor design market share, and domestic supply chain objectives. SoE project investment returns and financial outcomes may have lower importance compared to private investors and SoEs may be more willing to accept NPP performance risk;
- Nuclear industrial companies must undertake a corporate transformation into an NPP developer/owner/operator and then get shareholder approval to make the NPP investment; and
- International nuclear utilities may see a regulated NPP development in the UK as attractive, but may be reluctant to undertake an NPP project in the UK until there is a track record.

64. Financial investors have shown a limited interest in NPP projects, but have not found nuclear power industry partners consistent with their investment criteria. These investors warrant further analysis, particularly in refinancing approaches.

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only a few Gen III/III+ reactor designs have a track record and SMRs/Gen IV reactor concepts are still in early stages of technology development).

65. New NPP investments in the UK are likely to involve equity investors and other parties from outside the UK. The UK Government may be able to take a role in NPP investment, including the construction phase approach discussed in NECG's Option B2.
66. There should not be fundamental objections to foreign investment in UK NPPs, but a UK NPP strategy that relies heavily on SoEs raises issues due to foreign ownership of large critical infrastructure (i.e., NPPs). The UK Government should assess the national security and other implications of foreign NPP ownership.
67. An NPP with adequate and certain long-term revenue from a credit-worthy counterparty would, in a refinancing after project completion and the start of commercial operation, be an attractive investment for new classes of investors, such as pension funds, insurance companies, and certain private equity interests.

### E. Question 5

*What role should the Government play in providing financial support and sharing risks for new energy infrastructure? Are existing financing mechanisms, notably the Contracts for Difference, fit for purpose? Are there any practical issues, or potential unintended consequences, that could affect the feasibility of implementing alternative support models (such as a Regulated Asset Base)?*

68. UK Government must provide support for NPP completion risk and long-term revenue/market price risk.
69. CfDs reduce revenue/market price risk for an NPP investor, but do not directly address NPP completion risk.<sup>25</sup>
70. A regulated NPP approach might address NPP completion risk, but the details matter. Experience in the United States is mixed.<sup>26</sup> The UK Government needs other options (e.g., NECG's Option B2).

### F. Question 6

*What further steps should the Government take to increase investor confidence in the UK energy sector?*

71. Clarify the UK approach towards foreign NPP investment. Consider industrial policy and national security policy in concert with NPP policy, including objectives for new nuclear technology development (i.e., advanced reactors and SMRs).

<sup>25</sup> CfDs could, depending on strike price, provide high operating margins that would provide an *ex post* reward for completion risks taken, but investors face completion risk if the project is significantly delayed or is abandoned (i.e., operating margins are far in the future or non-existent).

<sup>26</sup> For example, the abandonment of the V.C. Summer NPP during construction, despite recovery of work-in-progress by the regulated utility owner under a South Carolina regulatory approach that supported new nuclear investment.

72. Confirm the UK commitment to nuclear power, provide political support for energy infrastructure development incentives, and establish workable policies in a post-Brexit context.
73. Engage in a discussion with industry on implementation models for UK Government role in NPP development and construction as in NECG's Option B2.



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