



# The Role of Government in the Assessment and Deployment of SMR – UK Model

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# 1. Introduction & Expert Finance Working Group (“EFWG”)

In January 2018, a small group of nuclear sector experts across all disciplines, with an emphasis on finance, were given the remit to independently propose role/s that the UK Government (“HMG”) can play to catalyze the design, development, financing and deployment of Small Modular Reactor (“SMRs”) technology and projects in the UK. EFWG’s task was to:

- Address the “market failure” in getting small nuclear technologies and projects to commercial delivery in the UK, especially the inability to secure private sector financing;
- Review and analyze risks specific to small nuclear and propose a methodology to appropriately allocate and manage/mitigate these risks over the project’s lifecycle, including barriers to investment from an equity and debt perspective;
- Explore a range of potential financial models for SMRs which HMG could “support” to engender market confidence, especially from private sector investors/financiers; and
- Deliver a set a concrete recommendations to assist HMG to de-risk (perceived and real risks), motivate and catalyze private sector investment, development and financing of small nuclear projects and technologies.

EFWG Methodology and Conclusion: (1) Evidence from multiple interviews with equipment Vendors/Stakeholders; (2) Developed a Risk Register; and, (3) Examined 9 different potential financing structures to assess risk tolerance and allocation amongst the Project Participants and highlight the most effective models that could be adopted to attract private sector financing in support of SMR design, development and deployment. ([Market Framework for Financing Small Nuclear](#))

**EFWG concluded that UK could be well placed to develop First-of-a-Kind (“FOAK”) small reactor projects with overght costs of less than GBP 2.5 billion by 2030**

## 2. Why SMRs?

### Nature of small nuclear technologies and projects:

- **DO NOT** require a “bespoke” approach for each project assuming the design allows for...
  - **Modularization** - The ability to split a plant into packages (modules) which can be factory manufactured, transported and assembled on site; and,
  - **Modularity** – the ability to replicate identical small reactors to achieve a “fleet” effect and lower costs.
- **DO REQUIRE** a policy framework to get **FOAK** projects financial support during design, development and construction stages to reach commercialization;
- **DO REQUIRE** “Fleet” approach vs one off, bespoke NNB megaprojects to get to.....
- **NOAK** (“Nth of a Kind”) projects where the real benefits from SMRs can be realized w/LCOE between GBP 40Mwh to GBP 80Mwh;

### Vendors interviewed by EFWG:

<b>GE Hitachi:</b> (Gen III) 300MWe BWR based on Gen III technology	<b>GF Nuclear:</b> Supporting the SMART 100MWe PWR based Gen III technology for cogen / desalination uses
<b>NuScale:</b> (Gen III+) 60MWe PWR that can be built in an array of up to 12 modules to create 600MWe station	<b>Moltex Energy:</b> (Gen IV) 300MWe Molten Salt Reactor that uses conventional fuel assemblies
<b>Terrestrial Energy:</b> (Gen IV) 192 Mwe Molten Salt Reactor new technology with standard fuel enrichment	<b>Rolls Royce:</b> (Gen III PWR) UK Consortium for 440MWe UK SMR, based on conventional technology
<b>U-Battery:</b> 4MWe Micro reactor based on high temp gas-cooled tech – cogen use	<b>Westinghouse:</b> (Gen III) 225MWe PWR and 400MWe Lead-cooled Fast Reactor (LFR)

**Estimated costs for these technologies ranged between GBP 100mn to GBP 2.5bn**

### 3. EFWG Premise and Methodology

- EFWG concluded very early in the process that the reluctance of the private sector to finance FOAK risk **necessitates a strong Government role to motivate / catalyze financing for SMRs;**
- With this very realistic backdrop, EFWG examined nine (9), financing models / structures employed in the financing of large scale energy and infrastructure projects and “tested” them against a set of the dozen criteria listed below, including State A

Impact on HMG balance sheet	Risk Allocation
Impact on Policy	Revenue risk
Ability to attract equity / debt (2)	Applicability to small nuclear
Impact on cost to consumers / taxpayers (2)	Maximum gearing
Ease of setting up	WACC

- Of the 9 potential financial models / structures examined, four were derivations off a Project Finance approach (reliance on cash flow for repayment of equity/debt), while others were models / structures previously employed to finance nuclear on a global basis;
- EFWG concluded that four potential models/structures could be adapted for financing small nuclear in the UK and outlined the various roles the government can potentially play in each scenario.

## 4. Risk Register and Risk Allocation

- EFWG developed a Risk Register that examined critical risk inherent to NPPs and allocated these risks amongst the various Project Participants in the table below

<u>Risk</u>	<u>Description</u>	<u>Allocation</u>	<u>Comments</u>
Technology	Viability of technology	Vendor / Technology Provider	Reference plants are emerging but site-specific differences still pose risk
Siting / Licensing	Securing suitable land and GDA	Developer / Sponsor	Consideration by UK Govt to reduce approval times
Financial / Equity	Heavy up front investment	Investor / Sponsor / Govt	Does Govt need to act as Super Investor
Construction	Long construction period	Sponsor	Govts unwilling to support in non-sovereign model
Revenue / Price	Unpredictability of future prices	Government	Subsidies such as FIT / CfD
Political / Regulatory	Change in Law / Policy or regulatory requirements	Government	Critical to avert future Energiewende repeat
Insurance	Adequacy of coverage	Sponsor / Operator / Govt	Govt must stand behind any gaps in coverage
Operational	Suitability of operator / plant performance	Operator / Lenders?	Lenders should consider if satisfied with regulatory risk
Nuclear Liability	Nuclear accidents	Operator / Government	Protocols define limits but Govt must be ultimate backstop

## 5.1 PF base w/Cfd and PPA with HMG as Investor

Criteria	Impact	Criteria	Impact
Impact on HMG balance sheet	High	Risk Allocation	Positive – more genuine partnership between public and private sectors
Impact on Policy	Low if Cfd / High if PPA – legislation requirement	Revenue risk	Low
Ability to attract equity	High – will provide confidence to co-investors	Applicability to small nuclear	Medium – HMG role positive for FOAK Low to Medium NOAK
Ability to attract debt	High – will help rating and confidence to lenders	Maximum gearing	FOAK 50/50 NOAK 60/40
Impact on cost to consumers	Low - CfD well established	WACC	Medium – subject to HMG return requirements
Impact on cost to taxpayers	Low – reduces overall cost of project	State Aid	High – State Aid challenge likely
Ability to set up	High – markets well versed		

### Comments:

- HMG as equity investor strengthens transaction in eyes of co-investors, lenders and other project participants
- High impact on balance sheet but will catalyze private sector finance
- Very helpful for FOAK projects

## 5.2 PF Based with CfD and PPA and HMG Guarantee

Criteria	Impact	Criteria	Impact
Impact on HMG balance sheet	Very High – depending on depth of guarantee provided	Risk Allocation	Medium – subject to construction risk
Impact on Policy	Low if CfD / High if PPA legislation requirement	Revenue risk	Low – lower long term price risk
Ability to attract equity	Medium – helps rating structure and availability of finance	Applicability to small nuclear	Low – FOAK Medium to High - NOAK
Ability to attract debt	High – increases availability of finance across classes of debt	Maximum gearing	FOAK 60/40 NOAK 70/30
Impact on cost to consumers	Low - CfD well established	WACC	High – lower financing costs
Impact on cost to taxpayers	Low – reduces overall cost of project	State Aid	High – State Aid challenge likely
Ability to set up	High – markets well versed		

### Comments:

- Very helpful to attract debt; 100% coverage of bonds and 80% coverage of debt
- Very high balance sheet impact – subject to depth and amount of guarantee provided
- Positive WACC impact due to lower financing costs on larger quantum of debt



## 5.3 Regulated Asset Base Model (“RAB”)

Criteria	Impact	Criteria	Impact
Impact on HMG balance sheet	Low to Medium – depending on level of top-up payment and CfD risk structure	Risk Allocation	Medium – careful structuring of decommissioning risk
Impact on Policy	High – need to create new regulatory regime	Revenue risk	Low – transparency in price calculation
Ability to attract equity	High – easier to raise equity and easier to secure rating	Applicability to small nuclear	High – for both FOAK And NOAK
Ability to attract debt	High – debt would be raised with lower cost of capital	Maximum gearing	FOAK 70/30 NOAK 80/20
Impact on cost to consumers	High – will bear the costs not established on market basis	WACC	High – low rate of return
Impact on cost to taxpayers	Low to No Impact	State Aid	High – State Aid approval required if straightforward
Ability to set up	Medium – Have TTT example with permutations for nuclear		

### Comments:

- Growing debate that RAB model is best suited for small and large nuclear
- Existence of precedent (TTT Project) allows for adjustments for nuclear to achieve success
- Strong rating potential will attract different classes of investors / financiers – competitive tensio

## 6. Conclusions and Recommendations

- SMRs offer many advantages over nuclear megaprojects based on smaller size, modularity, shorter time to delivery which are all factors that contribute towards de-risking projects and lowering costs;
- **Absolutely essential to establish transparent regulatory framework that addresses nuclear liability issues and Change-in-Law / Political Risks that are best borne by Government;**
- **Create a baseline financing support structure that clearly addresses allocation, mitigation and management of associated risks that can be fine-tuned for project and technology specificity; and,**
- **Avail HMG balance sheet at each stage of small nuclear project lifecycle to catalyze and motivate private sector financing:**
  - Design Risk – provide much-needed early stage financing support in return for IP rights;
  - Manufacturing Risk – create/incentivize supply-chain dynamic for job creation and skills development;
  - Development Risk – mitigate construction risk through deployment of **RAB Model**
  - Revenue Risk - mitigate through **CFD and PPA** contractual structure
  - Financing Risk – participate as investor or guarantor or through RAB model all of which will attract private sector financing
  - Operations Risk – accept responsibility for regulatory risk

Recognition that UK Government needs to play a critical role in the advancement of nuclear sector, including SMR and AMRs. Great example evidenced by offer to Horizon NPP where UK Govt offered to provide CfD, debt guarantees and as co-investor. Continued collaboration with technology providers to establish policy framework to achieve commercial viability.

## 7.1 Update on UK SMR and AMR Support Initiatives

### Key UK Government Announcements

- **June 28 2018 – Nuclear Sector Deal – Objectives**
  - 30% reduction in the cost of new build projects by 2030
  - savings of 20% in the cost of decommissioning compared with current estimates by 2030
  - 40% women in nuclear by 2030
  - a more competitive supply chain equipped to win domestic and foreign contracts of up to £2 billion by 2030
- **Nov 6 2018 - Advanced Manufacturing and Construction Programme (“AMCP”)**
  - UK Government announced it will be providing £32 million for businesses to test small modular nuclear reactors and bring them to market;
  - AMCP will allow companies to bid for a share of the funding and help them commercialise the technology, which could “radically reduce” the costs associated with the nuclear industry;
  - Developers will also be invited to submit design proposals to identify potential risks with proposals early on, in an effort to reduce investment risks for potential backers
- On **October 29, 2019** ONR issued **New GDA Guidance** for all future GDA work and reflects:
  - Improved safety standards in the previous decade;
  - The potential for Small Modular Reactor designs to enter in the GDA process in the future;
  - Lessons learned from previous GDA processes; and,
  - GBP 5mn provided to ONR to “modernize” GDA process to take future licensing decisions on SMRs and AMRs

## 7.2 Update on UK SMR and AMR Support Initiatives (Cont...)

- September 5, 2018 – Advanced Modular Reactor Feasibility and Development Project (“AMR F&D”) Project**
  - BEIS is to invest up to £44 million in Advanced Modular Reactor (AMRs), defined as a broad group of advanced GEN IV nuclear reactors (vs GEN III SMRs), which use pressurised or boiling water for primary cooling.
  - Phase I : funding (up to £4 million, excluding VAT) to undertake a series of feasibility studies for AMR designs. Contracts are worth up to £300,000 (excluding VAT)
  - Phase 2: subject to phase 1 demonstrating clear value for money and government approval, a share of up to £40 million (excluding VAT) could be available for selected projects from phase 1 to undertake development activities. Up to a further £5 million may also be made available to regulators to support this

- The following 8 organizations have been awarded contracts to produce feasibility studies as part of **Phase 1 of the AMR F&D** project in **October 2018**:

Advanced Reactor Concepts LLC	DBD Limited
Blykalla Reaktor Stockholm AB (Lead Cold)	Moltex Energy
Tokamak Energy Ltd	U-Battery Developments Ltd
Ultra Safe Nuclear Cooperation	Westinghouse Electric Company UK

- As part of Phase 2 funding in **July 2020**, Tokamak Energy (Fusion), U-Battery Developments and Westinghouse (LFR) were each awarded an additional GBP 5mn after their technologies demonstrated “clear value for money.”

## 7.3 Update on UK SMR and AMR Support Initiatives (Cont...)

- **On Jan 28, 2019** - A consortium led by Rolls-Royce, requests £200 million (about \$263 million U.S.) in government funding to continue its development of SMRs.
  - The consortium has said it would match the government funding and use the funds to advance its nuclear licensing process, with a goal of then attracting private investment.
  - Rolls-Royce UK SMR needed HMG support (matched by Consortium) to continue development of 220-MW SMR, a unit that could be doubled for a larger-scale project to 440 MW, at a cost of US\$ 2.3bn.
- **On November 5, 2019** - Rolls Royce receives £18mn from the Industrial Strategy Challenge Fund (“ISCF”) to create £36mn joint investment with RR Consortium, as part of UK Research & Innovation’s (UKRI) Low Cost Nuclear Challenge
  - ISCF is worth up to £500mn (including co-investment from private sector) to promote SMR and ATR growth in the UK.
- **August 2020** – UKRI working closely with Rolls Royce to deliver commercial investment based on a solid business case which considers:
  - **Innovation Scope** – end goal to achieve fleet deployment;
  - **Commercial Scope** – Cost competitiveness on an LCOE basis; and,
  - **Policy Scope** – policy statement from HMG that clearly outlines commitment in support of fleet deployment including incentives for supply chain development and enhancement.
- **Rolls Royce** to establish a UK SMR Ltd (JV) and will be responsible for all bilateral negotiations with potential equity investors. Focus on industrial partners, market providers (international) and Strategic / Sovereign investors.
- **White Paper** outlining HMG Treasury support measures close to finalization and to be issued in late October.

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