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A UK SMR – SCRAM or 'going critical'?

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Introduction

The UK has a long and proud heritage in civil nuclear power. The UK was the first country successfully to develop, deliver and safely operate nuclear power stations, meeting all the scientific, technological and industrial challenges that this involved. It currently has an ambitious programme to add more than 20GW of new nuclear power by 2030 (per DECC) based on advanced large nuclear reactors such as the ABWR, AP-1000 and EPR driven in part by the need to meet binding carbon targets at an affordable cost and ensuring security of supply. In the words of the DECC Secretary of State, Amber Rudd in a speech delivered in November 2015, "We want a consumer-led, competition focussed energy system that has energy security at the heart of it and delivers for families and businesses" and that "New nuclear, new gas and, if costs, come down, new offshore wind will all help us meet the challenge of decarbonisation".

With Nuclear firmly seen as part of a diverse energy mix, there is growing interest in small and simpler units for generating electricity from nuclear power, and especially for process heat – for example in district heating solutions that currently use fossil fuels. This interest in small and medium nuclear power reactors is driven both by a desire to reduce the impact of capital costs and to provide power away from large grid systems. In line with definitions from organisations such as the IAEA, US Nuclear Energy Institute and the World Nuclear Association, we define Small Modular Reactors (SMRs) as nuclear reactors generally 300MWe equivalent or less, designed with modular technology using module factory fabrication, pursuing economies of series production and short construction times.

Is there a case for a UK SMR?

There are already an almost bewildering array of SMR technologies being developed, from the more mature and well known Pressurised Water Reactor technology to more 'exotic' High Temperature Gas Reactors with vendors and technology developers from countries such as the US, France, China, South Korea and indeed the UK fielding products such as the ACP100+ (CNNC), ANTARES (AREVA), mPower (B&W and Bechtel), Westinghouse SMR (Westinghouse) and NuScale (Fluor), SMART (South Korea) for example. Moreover, the economic case for SMRs in the UK are still a work in progress with issues such as timing for when these might be on stream in a commercially widespread way (even SMR proponents think this is likely the latter half of the 2020s given GDA issues, proof of concept, financing concerns, etc.) and the current perception that costs may not be much lower in £/Mwh terms than large nuclear plants given all the fixed costs around safety and security.

Add to this the uncertainty on what the UK energy market will look like by say 2030 in terms of commercially viable large scale energy storage systems, further growth in renewables at lower cost, and up to potentially 15GW+ of interconnection in the UK electricity market and thus impact on SMR deployment.

In his recent budget speech on 16 March 2016, the Chancellor announced that Government is launching the first stage of a competition to identify a small modular nuclear reactor (SMR) to be built in the UK, and will publish an SMR delivery roadmap later this year. So is there a case to develop a 'UK' SMR? Why not just 'buy' a SMR from this global offering for our use much like a gas fired plant or a wind turbine?

The answer in a nutshell is the idea that the UK could help commercialise SMRs and thereby establish itself as a global centre of manufacturing SMRs for export, adding thousands of high paying jobs to the economy. Developing this major export market for SMRs will not only generate jobs in the direct manufacturing of the units, but will also stimulate employment and growth with the supply chain for the production of SMRs by the primary vendors. A challenge to any SMR program is to have a large order book that attracts investors to build factories to produce SMRs on a cost effective production-line basis and thus help spread the large fixed safety related costs over a larger number of units helping bring down the £/Mwh costs. There just isn't enough of a market within the UK itself to generate these orders. This means a successful SMR program would use the UK as a launch pad to gain market share in Europe, Middle East and the far-East, for example for district heating and/or desalination applications. This is where the UK has a real opportunity to dominate the SMR market – the worldwide recognition that a UK nuclear safety regulatory stamp of approval brings will distinguish a 'made in UK' SMR and open up these export markets. Add in the rich UK nuclear skills base to deliver the required innovation, co-incidentally largely located in the 'Northern Powerhouse' area and one has the recipe for success. However, UK's competitors are ploughing resources into their own SMR programs and hence the next two to three years are critical for the UK if it is to successfully establish a market leading SMR program.

So how should we do it?

Industry estimates to develop an SMR system range from £700 million-£1 billion with the recognition that the market is not mature enough to make such a significant capital investment at this moment in time. Hence, to facilitate commercialisation, the UK will need to provide funding and support (the Chancellor's recent announcement of £30 million in R&D funding for advanced nuclear manufacturing is a positive step in this regard). This can be done through a variety of mechanisms and we present a possible way for Government to quickly move ahead with the commercialisation of SMRs in the UK and, more specifically, creating a sustainable SMR 'business'. We fully acknowledge that to implement this, further research, economic, financial, and technical due-diligence/appraisal, risk analysis, strategic analysis, and market engagement would need to be undertaken.

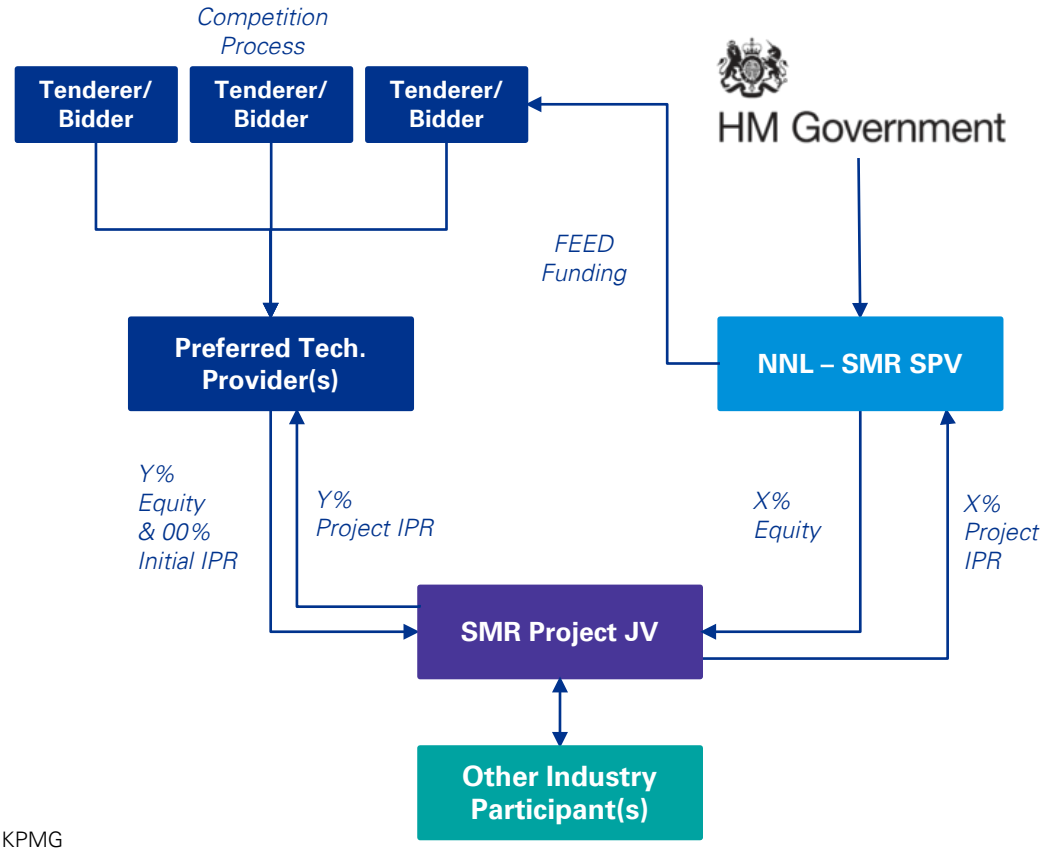
We would suggest that in order to quickly move forward with the opportunity presented, Government could leverage the National Nuclear Laboratory (NNL) as its SMR delivery agent in partnering with a SMR technology provider via a Joint Venture (JV) arrangement whereby it would have a stake in a potential SMR project, exit from the project at some stage, and involve some level of project level intellectual property transfer.

This process would involve:

1. The NNL, as Government's SMR delivery agent, through a wholly owned special purpose vehicle, 'SMR SPV', provides funding and support for a SMR project.
2. HMG may consider providing a licensed site and GDA slot to assist the project – this could be in lieu of actual 'equity'.
3. SMR SPV enters into a JV with a SMR technology provider which also provides co-funding.
4. The process to identify the preferred SMR technology provider that SMR SPV will JV with is determined by way of a competition at an appropriate time (perhaps even as early as later this year). The appropriate time would be after the NNL has reported back to Government on key questions such as confirming the business case for a UK SMR, what competition looks like – e.g. should one technology or two be taken forward?, what the competitive process looks like – e.g. prequalification, bid evaluation factors, etc.?, what commitments the selected technology provider is required to make, etc.
5. During the competition process HMG, or through SMR SPV, could provide FEED(a) funding to assist the technology providers in developing the SMR technology as was done in the CCS competition to foster increased competitive tension between various technology providers.
6. The Technology Provider brings technology IPR, and develops new IPR through the SMR Project – IPR developed from the project is proportionally owned by SMR SPV and the Technology Provider.
7. Other industry participants to be brought into the project as sub-contractors etc.
8. SMR SPV sells down its stake once stable operations are established.

Note: (a) Front End Engineering and Design – a commonly used method to de-risk development of new technology

The diagram below illustrates the simplified potential structure



Source: KPMG

This approach provides Government with the opportunity to provide certainty of funding and spark real interest, innovation, and tangible progress from the private sector, including the respective IPR through FEED while preserving competitive tension on technology pricing. Further, this approach requires the technology provider to have some 'skin in the game', incentivising progress/development of project designs and provides HMG the ability to specify its requirements upfront and select the JV partner based on merit using a transparent process. As with any competitive process, the risk of not attracting sufficient tenders resulting in Government being at the mercy of bidders and/or withdrawing process completely exists as well as the generally longer timelines to competitively select a partner. Such a drawn out competition process could be more damaging than partnering with a sub-optimal technology provider/ technology purchase and there is also a risk that the selected technology does not materialise to a commercial project or fundamental flaw is found. However, a well-structured procurement process with appropriate technical and financial criteria and well defined HMG requirements of the selected technology provider would go a long way to mitigate these risks. Obviously, guaranteeing UK industry participation may be a procurement/competition and/or state aid issue and would require appropriate analysis but potential solutions that could be explored include using State Aid block exemption rules for industrial R&D if 50% of the funding is non-HMG.

In conclusion

The UK has a unique opportunity to seize the initiative with a made in the UK SMR that could then be exported globally creating much needed UK investment and jobs – literally powering the Northern Powerhouse. There is a current window of opportunity to do so and Government should use all the tools available at its disposal and leverage the skills of organisations it already owns, such as the National Nuclear Laboratory, to capitalise on this SMR opportunity.

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