Written submission from the Energy Technologies Institute to the House of Lords Science and Technology Select Committee Inquiry on Priorities for Nuclear Research and Technologies

Introduction

1. The Energy Technologies Institute (ETI) is a public private partnership between energy and engineering companies and the UK Government which is able to draw on the business and engineering expertise of key global players engaged in the UK energy sector (ETI private sector members: BP, Caterpillar, EDF, Rolls-Royce and Shell).
2. Over the past nine years the ETI has developed strong credentials in national energy system analysis, informed by the latest industrial and engineering expertise. This enables us to explore the lowest-cost decarbonisation pathways, under a range of assumptions, constraints and uncertainties. Our analysis has been widely cited by academics, government and by the Committee on Climate Change in its advice to government.
3. This submission is based on ETI analysis of projects we have commissioned and also on rigorous whole-system analysis informed by our public and private sector members and our portfolio of technology development and knowledge building projects[1].
4. The response concentrates on the potential benefits, challenges and opportunities of deploying small modular reactors (SMRs) in the UK.

Summary Of Response

5. The ETI's response concentrates on its recent projects and whole energy system analysis to better understand how SMRs can potentially contribute in the transition to a 2050 low carbon economy. Analysis indicates that SMRs could be potentially deployed as part of this transition, and their value depends on their expected capital cost. Potential UK deployment levels also depend on when an SMR design can be expected to receive regulatory approval together with the subsequent rate of UK deployment. Their value to a cost optimised UK low carbon energy system is enhanced if SMRs are connected to potential future city scale district heating systems and used to provide low carbon heat as well as generating electricity.

[1] Further details can be found in the ETI report 'Options, Choices, Actions: UK scenarios for a low carbon energy system transition', available via the ETI website www.eti.co.uk

Where if anywhere do you believe that responsibility should lie for ensuring that the UK has a coherent and consistent long term policy for civil nuclear activities including international collaboration and, within the UK, for cost-effective and efficient articulation of the different elements of nuclear work?

6. Responsibility should lie with Government ministers, supported by advice from expert departmental officials and interaction with industry. Guidance documentation from the International Atomic Energy Agency[2] describes the requirements for national Governments to put fundamental national frameworks in place including legislation, policies and regulation. Implementation of these policies into programmes of work can be undertaken by organisations outside of Government, but there is a clear role for Government in ensuring that the UK has a clear and consistent long term policy for its civil nuclear activities.

What are the potential benefits, disadvantages and risks from the deployment of SMRs in the UK and more widely?

7. Research projects delivered by the ETI have examined, within the UK context, the potential deployment of SMRs and Giga Watt scale reactors into a cost optimised transition to a low carbon economy[3]. The projects considered the range of sites potentially suitable for nuclear power station development[4], and the enabling activities necessary to bring forward an SMR development programme in the UK[5].
8. Nuclear power is a proven low carbon baseload technology. Provided that deployment is cost effective alongside other low carbon technologies, the ETI's analysis indicates that new nuclear power can have a significant role in decarbonising the UK's electricity generation as part of an affordable energy system transition.
9. The ETI's research in 2014 recognised that there was uncertainty regarding the economics of SMRs, and that it would require significant innovation in design, manufacture, construction and operation for SMRs to be more cost effective for baseload electricity generation than cost competitive designs of Giga Watt reactors[6].
10. However, SMRs could also be a cost effective solution for delivering low carbon combined heat and power alongside Giga Watt reactors generating electricity. This potential role for SMRs would depend on large scale district heating networks being deployed in the UK as part of the solution to decarbonising the use of heat in homes.
11. The economics of SMRs should be tested and uncertainties should be expected until plants are commercially deployed, successfully demonstrated and benchmarks created. Capital cost

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[2] Nuclear Safety Infrastructure for a National Nuclear Power Programme Supported by the IAEA Fundamental Safety Principles. INSAG-22 published September 2008. http://www-pub.iaea.org/MTCD/publications/PDF/Pub1350_web.pdf

[3] ETI Insight Report October 2015; The Role For Nuclear In a Low Carbon Energy System http://www.eti.co.uk/insights/the-role-for-nuclear-within-a-low-carbon-energy-system

[4] ETI's Power Plant Siting Study delivered by Atkins. August 2015 http://www.eti.co.uk/library/power-plant-siting-study-summary-report-and-peer-review-letters

[5] ETIs' SMR Deployment Enablers Project delivered by DAS Ltd http://www.eti.co.uk/library/das-summary-report-smr-deployment-enablers

[6] ETI's Alternative Nuclear Technologies project delivered by Mott MacDonald http://www.eti.co.uk/library/alternative-nuclear-technologies-summary-report-and-peer-review-letters

is the most important economic metric for SMRs and the ETI's sensitivity analysis using ESME regarding potential for SMR deployment was undertaken in 2015[7]. Within cost optimised whole energy system modelling for the UK, this analysis explored variations in capital cost, operations date for an initial UK plant, and potential use to satisfy heat demand through district heating systems. The analysis indicated the greatest value to a UK cost optimised energy system of SMRs delivering combined heat and power, with their value being further increased through first UK deployment dates of 2030 or earlier and at the lower range of indicative capital cost. The ETI's indicative cost analysis was intentionally undertaken without the input of a range of reactor vendors; the Government's subsequent SMR Techno Economic Appraisal was designed to engage participating SMR vendors to better understand costs and deployment timescales and is expected to provide a more comprehensive analysis regarding costs and deployment timescales than that reported by the ETI in 2015.

12. The economics of SMRs are expected to be improved through an increased proportion of the plant being standardised for factory manufacture. Deployment of a standardised design in the UK and more widely elsewhere has the potential to further reduce unit costs. If SMR deployment in the UK involves significant UK content, then there is the potential for such a programme to support UK economic growth but this was not evaluated within the ETI's projects.

What is the scale of the global market opportunity for SMRs? What would the cost be if the UK does not take full advantage of the opportunities of SMRs?

13. The market opportunity for nuclear depends on a number of factors including the cost of nuclear alongside other technology choices. If SMRs can become more cost effective than Giga Watt reactors then a larger market may be accessible. However, if the economics for SMRs are uncertain or uncompetitive compared with Giga Watt reactors then there may still be a smaller niche market for SMRs in remote off grid locations, where the reliable supply of power and heat are the most important requirement.
14. Depending on SMR economics, this niche may grow to include other cogeneration opportunities such as water desalination or district heating energisation. A feasibility study into potential Russian deployment locations for SMR CHP demand[8] and CNNC's SMR development for deployment in China demonstrate[9] the potential interest in cogeneration from SMRs. Finally this niche may include deployment opportunities in markets and locations where there is interest in nuclear, but for which Giga Watt reactors are too large, insufficiently flexible or unaffordable. SMR market projections are indicated the National Nuclear Laboratory's 2014

[7] ETI's sensitivity analysis using ESME regarding potential SMR deployment http://www.eti.co.uk/library/nuclear-sensitivity-study

[8] World nuclear news http://www.world-nuclear-news.org/NN-Small-reactors-for-heat-and-power-in-Russia-1212161.html

[9] CNNC's presentation at the IAEA in August 2015 https://www.iaea.org/NuclearPower/Downloadable/Meetings/2015/2015-08-25-08-28-NPTDS/DAY2/2._ACP100_technical_and_economic_aspects.pdf

SMR Feasibility Report[10]. There are further more recent estimates regarding SMR market potential in the more recent 2016 report by the Nuclear Energy Agency within the OECD[11].

15. If the UK can lead or participate in the development of an SMR project with the prospect of better economics than current large reactors in deployment elsewhere, then there is the opportunity to:
    i. Improve the security and cost effectiveness of UK transition to low carbon economy by 2050
    ii. Increase UK manufacturing and construction content comprising high quality jobs compared with deployment of imported reactor designs
    iii. Export elements of the supply, construction and through life support to other jurisdictions with associated UK economic benefits
    iv. Acquire learning in respect of design integration, design for manufacture, and organisational integration using digital tools to strengthen potential participation in Gen IV reactor development.
16. Without SMRs, the UK could still potentially deploy a significant capacity of up to or beyond 18 GWe of new large reactors by 2050 using imported reactor designs and as part of a balanced energy mix (the capacity of 18 GWe represents projects already announced by developers at Hinkley Point, Sizewell, Wylfa, Oldbury, Moorside and Bradwell and with reactor designs already committed in regulatory assessment). Alongside life extension of the existing civil nuclear power plants, the NDA's decommissioning programme, the development and construction of a nuclear waste repository, and replacement of the UK nuclear deterrent, such a programme is not unambitious for the short to medium term, but would provide a weaker platform to engage in international collaborative efforts to develop future nuclear fission technologies.

About the ETI

17. The Energy Technologies Institute (ETI) is a public-private partnership between global energy and engineering firms and the UK Government.
18. Our mission is to accelerate the development, demonstration and eventual commercial deployment of a focused portfolio of energy technologies which will increase energy efficiency, reduce greenhouse gas emissions and help achieve energy and climate change goals.
19. We carry out three key activities:
    - modelling and strategic analysis of the UK energy system to identify the key challenges and potential solutions to meeting the UK's 2020 and 2050 targets at the lowest cost to the UK

[10] NNL's SMR Feasibility Study Report December 2014. http://www.nnl.co.uk/media/1627/smr-feasibility-study-december-2014.pdf

[11] Small Modular Reactors: Nuclear Energy Market Potential for Near-Term Deployment. Published 2016 by the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development https://www.oecd-nea.org/ndd/pubs/2016/7213-smrs.pdf

- investing in major engineering and technology demonstration projects to de-risk and build capability both technology and supply-chain solutions for subsequent commercial investors
- enabling effective third party commercialisation of project outcomes.

20. The ETI has developed an internationally peer-reviewed national energy system design tool (known as 'ESME' - Energy System Modelling Environment[12]), to underpin our strategic techno-economic analysis of the UK energy system. ESME models choices across power, heat, transport and infrastructure sectors and is informed by evidence drawn from our private sector members, our technical projects and a range of expert advisers. As such it enables the ETI to deliver evidence-based insights on how to deliver affordable, secure and low carbon energy for Britain in the decades ahead, including identifying credible, lowest-cost pathways to secure low-carbon energy in future.

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[12] http://www.eti.co.uk/project/esme/