Decarbonisation of the Energy Supply by 2035
Consultation Response
30/06/22

Summary

The Nuclear Institute (NI) is the professional body and learned society for the nuclear industry. Representing over 3,000 professionals at all levels across the industry, from new build and operations to decommissioning, the NI sets the standards for nuclear professionalism.

The NI is supportive of the consultation on the Decarbonisation of the Energy Supply by 2035. Without nuclear technology, the route to Net Zero would be higher risk, more expensive and uncertain. A comprehensive power strategy is overdue, and the country must resolve to rapidly deliver on decarbonisation now.

Nuclear technology is the only currently deployable source of large scale, low carbon heat that can be used to decarbonise heat, transport and electricity directly and through energy vectors such as hydrogen and synthetic fuels.

As the voice of nuclear professionals in the UK, the NI looks forward to working with Her Majesty's Government to realise the advancement of nuclear technology and its role in decarbonising the UK electricity supply by 2035.

1) Is the proposed future electricity mix, as announced in the *Energy Security Strategy*, the most efficient and cost-effective way to deliver power sector decarbonisation by 2035? Are there any further policy details and / or legislation required by the end of this Parliament to achieve these goals?

In short, no. The decades of ineffective action regarding the renewal and buildup of the UK's energy system have resulted in some difficult choices having to be made now to achieve Net Zero and lower energy costs whilst increasing our energy security. The NI is pleased to see the release of the Energy Security Strategy. The UK's response to the Covid-19 pandemic may not turn out to be the most cost effective and efficient however, the goals were largely met in a timely manner. With the recognition of a climate emergency and recognising that the costs of dealing with the effects of climate change are likely to be significantly higher than the costs of decarbonising the electricity supply, it may be necessary to accept that our path now may not be the most cost effective nor efficient. This position will mean that it may be easy to repeat the mistakes of the past in order for a short-term gain and this must be guarded against to avoid the UK ending up in a similar situation in a few decades. The NI believe that by taking a long-term view, a robust, secure and cost-effective energy system can be built for future generations helping to ensure the UK's prosperity.

The NI believe that a fundamental redesign of the way large projects are delivered is required to meet the goals announced in the Energy Security Strategy and is pleased to be engaging in a number of areas to help and assist. This consideration should include and address the need to deliver several large projects in parallel, not in

sequence in order to address the scale of the challenge. This is particularly the case where Government and regulatory resource is required to bring a project to Final Investment Decision and great care must be taken to ensure that sufficient resource is available to progress parallel projects.

Whilst the NI supports a balanced energy mix, lessons need to be drawn from Germany's Energiewende and the performance of our own energy system over the last few years. The NI believe that the costs and lifecycle carbon emissions of generation required to backup intermittent sources of energy such as wind should be factored into the cost and environmental impacts of energy produced in this manner. In this way, generating technologies can be compared on a more level playing field. Given the war in Ukraine and the increasing shortage of gas, the use of gas to backup intermittent generating sources leads to higher prices for the consumer as can be evidenced by rising prices in the UK and more dramatically so by events in the German power grid; heavily dominated by renewable energy. This energy is backed with a large amount of gas fired plant, fuelled with gas predominantly sourced from the Russian Federation.

The inclusion of large amounts of renewables in the energy mix is complemented with large amounts of nuclear power. This can be seen in France where the symbiosis between intermittent renewables and high-capacity factor nuclear provide a low cost and low carbon energy grid which can adequately cope with providing reliable baseload and load following capability.

Electricity can only be stored in limited quantities and the efficacy and environmental lifecycle of battery installations is poorly understood today. Claims that battery storage could supplement renewables now or in the future, are, in the opinion of the NI, overstated.

All fossil fuels are finite resources and as such, as their production starts to decline, prices will naturally rise. The NI believes that the current strategy of maximising our North Sea gas production is necessary to increase the short-term supply of gas and alleviate high energy costs but that this is not sustainable in the long term. As North Sea reserves of natural gas continue to decline, the UK will be faced with having to import gas from other countries.

The continued push for Carbon Capture & Storage (CCS) is unlikely to contribute significantly, in the NI's view, to decarbonisation of the electricity supply by 2035. Its use is in danger of prolonging the UK's need for fossil fuels, increasing the risk from an energy security perspective and from a potential for rising prices, mirroring the volatility we see today in the gas market. CCS is not a mature technology and there are no guarantees it will be readily deployable at scale to contribute to the 2035 target even if gas were not a finite resource. CCS technology must achieve removal

efficiencies of 99 % otherwise this will cause difficulty in reaching our Net Zero targets, as highlighted by the Committee on Climate Change in various reports due to the residual emissions.

Nuclear power is a proven technology, deployable now and at low risk. The low rate of building new plants has meant that the restart of new programmes is more costly than building nth of a fleet, although the current Hinkley Point C strike price looks very competitive against the backdrop of current day ahead wholesale prices. Rapidly increasing our nuclear generation capacity is a 'safe bet' – the technology is deployable now and can help the UK to meet Net Zero in a highly efficient manner. The costs of large scale, SMR and AMR new build will reduce with a fleet build programme and new advances in construction and modularisation, which have already been amply demonstrated in other industries will be applied to Small Modular and Advanced Modular Reactor (SMR & AMR) deployment. SMRs and AMRs offer a product commodity approach, whereby concurrent design, manufacturing, licensing and commercialisation can be progressed in parallel, which presents an appealing prospect to future investors. Private investment is already being made into SMR and AMR technology (e.g. Rolls-Royce SMR, Nucleo, Moltex Energy) highlighting that investors' due diligence has concluded that this is acceptable. Investment needs to be encouraged and accelerated through clearly articulated plans which allow investors and project developers to understand the process by which sites may become available and appropriate mechanisms to engage on negotiation of power/energy off take agreements.

2) Beyond current Government ambitions, how else can energy demand be reduced and how much of an impact will this make on reaching power supply targets? What action is required to ensure consumers engage with and are protected during the power sector transformation?

The NI believe the Government should conduct assessments to determine the cost and phasing of energy demand reduction measures compared to the production and introduction of new carbon-free generation at scale and the resultant effects of each.

An education and awareness campaign is needed to explain the decarbonisation of energy to the general public, why it is important and how this can be achieved. This is especially important given the scale of the challenge and the amount of Net Zero generating capacity and grid infrastructure that will be required. This should also extend to the supply chain capability required through to factors such as support for construction and operational workers at these sites. Such a campaign, including local community engagement, should help address host community concerns and ensure a lower risk planning and deployment phase.

The planning regime should be carefully examined to ensure that the urgent need for Net Zero generation and the need to decarbonise the energy system to address a national priority is accounted for in planning decisions.

3) What are the key challenges faced by each generation technology (e.g. nuclear (traditional, small and advanced modular and fusion), offshore and onshore wind, solar, hydrogen, tidal, biomass and gas combined heat and power) regarding both their deployment and scaling up within the current policy framework? What can be done to overcome these challenges? What generation capacity is required and what role will each technology play?

The table below outlines the NI view on the key challenges faced by each generation technology.

Technology	Key Challenges
Traditional nuclear	High cost of capital Public acceptance
Small Nuclear	Availability of sites Public acceptance
Advanced Nuclear	Technology Readiness Level, availability of sites Public acceptance
Nuclear Fusion	Technology Readiness Level Availability of skilled resource
Offshore wind	Capacity factor
Onshore wind	Siting, capacity factor and public acceptance
Solar	Low power to area, siting, cost, lifecycle analysis, capacity factor
Hydrogen	Public acceptance, infrastructure*
Tidal	Cost, Technology Readiness Level
Biomass	Availability of land in the UK to produce biomass Lifecycle analysis of shipping biomass in from overseas. Untested at scale CCS would likely be required to ensure carbon neutrality
Gas Combined Heat and Power	Use of a finite resource, Volatile wholesale price of gas, Reduction in the long term of the UK's energy security, Untested at scale CCS required to abate carbon dioxide emissions leaving residual emissions to be dealt with

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Nuclear energy is the only proven primary source of low carbon heat deployable now. This provides a huge potential advantage in the decarbonisation of the UK electricity and industrial sectors and other energy vectors. Energy generation such as wind and solar cannot generate heat and are thus limited in their decarbonisation potential. In terms of nuclear power; the Government is already progressing the nuclear financing bill. The addition of nuclear to qualify for green financing will further accelerate its deployment and lower the cost of doing so. Whilst there are sufficient sites currently available for new nuclear build, in order to truly release the potential of nuclear, the Government must make available more sites and this should be done sooner rather than later. Advanced nuclear and nuclear fusion may be able to contribute to the UK's energy infrastructure in the future and the recent funding and Research & Development work for both AMRs and nuclear fusion is welcome.

Many studies document the lifecycle analysis of nuclear power (EDF Energy, MIT, UNECE et al) but such information is scarce for new technologies such as CCS. As such the basis of use for some forms of generation may be skewed through lack of information on the full lifecycle and resource use impact and analysis of these technologies.

The main challenge for offshore wind is the capacity factor and in strict terms there is very little that can be done to substantially address this. Countries such as France with high levels of renewable and nuclear generation benefit from the low carbon and low-cost nature of the resultant energy mix whilst addressing the intermittency of renewables. Ensuring the whole system costs to support wind (such as the requirement for backup generation) are reflective of the true costs of wind power will enable a more realistic comparison of the energy mix and aid in future energy systems planning.

Solar power is an attractive energy source however the technology has a large land requirement. The NI feel that solar power should be limited to rooftop applications or those sites where land that could otherwise be used for agricultural purposes or housing is not required.

The inclusion of hydrogen in the list is confusing in that hydrogen must be produced from one of the other sources of generation listed. Burning hydrogen for the production of electricity is of course possible and straightforward, with relatively little modification to existing gas/combustion turbine engines required. The production of electricity by burning hydrogen produced from another energy source makes little sense for anything other than small scale generation. Hydrogen can already be blended up to a certain percentage in the existing natural gas infrastructure and this may be the quickest and easiest way to start decarbonisation; providing the hydrogen can be adequately produced from low carbon sources. Replacement of the existing

gas infrastructure and boilers will be required in the pursuit of 100 % hydrogen displacement of natural gas for heating and industrial use but could be done progressively as existing infrastructure ages and requires replacement. Public attitudes towards hydrogen should be explored and coupled with an energy awareness campaign.

Further to a number of reports from the Committee on Climate Change, the available land use for the production of biomass in the UK is limited and therefore it is difficult to see how a significant proportion of our energy could be fulfilled using this route. The use of biomass from overseas will need to address concerns over energy security and the increased carbon emission involved in transporting such biomass to the UK along with the entire lifecycle of the technology.

The use of CCS to abate emissions from gas or biomass fired power stations is not proven at large scale and has encountered problems in test units in Canada and elsewhere. The production of carbon dioxide as a waste stream and its storage requires further research and analysis with no guarantee that sufficient carbon dioxide will remain sequestered for geologically significant periods. The costs of CCS are not well known and capture efficiencies of around 99 % are required to ensure the country can reach Net Zero (Committee on Climate Change).

4) **What are the challenges for the current grid infrastructure in delivering the proposed energy mix by 2035 and how can these be overcome in a cost-effective manner? What role does digitalisation of the grid infrastructure play and developing a smart network? Are current regulators enabling this transition and flexibility within the system? What role will storage play? Please consider this question from generation source to in the home.**

Discussions in industry conclude that smart (digitised) grids will allow for flexible generation across the generation power curve, but regulatory hurdles may be set too high for the early adoption of this technology especially from a nuclear power generator perspective.

Electricity can only be stored in limited quantities and the efficacy and environmental lifecycle of battery installations is poorly understood today. Claims that battery storage could supplement renewables now or in the future, are, in the opinion of the NI overstated.

5) **What key milestones and indicators are needed to scrutinise and measure progress in delivering the UK power sector's targets? Should new reporting requirements be required and what role should Ofgem, or the proposed new energy systems regulator play?**

A full lifecycle assessment of each proposed generating technology should be performed to understand the full impact of each technology, particularly for 'newer'

technologies such as solar, tidal and CCS. Only then can the full impact of such technologies be understood as they are for nuclear (EDF Energy, MIT, UNECE et al). The system costs of intermittent generation should also be taken into account to ensure that all technologies can be compared on a level playing field. Clear reform of, and the provision of a new mandate to, Ofgem must also be considered in order to address the regulation of pricing of energy in light of recent events.

6) Does the UK have the right skills, industrial and labour capacity, and materials required to effectively deliver on the proposed energy security strategy by 2035, and if not, how can the supply chain be scaled up?

No; not at this moment in time. The key factor required to build this capacity in skills and the supply chain is certainty. Nuclear produces high numbers of high-quality jobs (Employment in the Nuclear and Wind Generating Sectors, World Nuclear Association, 2020) both directly and indirectly, employing over 60,000 people in the UK (Nuclear Industries Association, 2022). Energy policy over the last decades has meant this certainty has not been forthcoming. Subsequently, confidence in the energy market and construction has been so low as to see that when new energy generating capacity is required the designs have to be imported from overseas, whether this is for wind turbines (where the majority of manufacturing jobs are not in the UK), for gas turbines (supplied from Europe or the USA) or nuclear plants (currently from France). Sending a sure signal to the market such as the welcome recent announcement of 24 GW at least of new nuclear by 2050 will help and encourage the market to rise to the challenge and boost domestic manufacturing. The advent of the Rolls-Royce SMR as a UK product will help to boost UK manufacturing, but certainty in orders will be a key requisite for this. For the UK's previous nuclear programme, certainty in the build schedules ensured British manufacturers could plan ahead to build the necessary pressure vessels, turbines, fuel and pumps required. There is no reason why this could not be repeated and the creation of Great British Nuclear as a delivery vehicle could be instrumental in providing this confidence.

For skills, the NI is heavily involved in promoting the STEM and non-STEM subjects with nuclear energy. There are no particular issues with nuclear skills the NI wishes to draw attention to but rather the shortage of STEM skills in the UK in general. A look at education and the education system including the potential for streamlining vocational and academic routes in STEM subjects is likely necessary in this regard.

7) How should Government work with industry to ensure proposed projects are ready when needed and on-budget? Are there domestic or international examples of time and cost-effective delivery of large-scale power generation schemes?

The NI feel that the key to such delivery is providing the market confidence to invest and build such infrastructure in addition to helping overcome hurdles associated with building the first of a kind.

8) **Does the Government's strategy incentivise investment that enables decarbonisation of the power sector by 2035? Do current financing mechanisms allow for the required investment? What are the risks for taxpayers and/or consumers? Are there national security and investment considerations we should understand?**

The NI is encouraged by the Government's current strategy and the passage through Parliament of the Nuclear Financing Bill. Nuclear should immediately be eligible to qualify for green financing in the same way as other forms of clean energy are. These two key items should help ensure a lower cost and greater uptake in financing and construction of new nuclear power stations.

In regard to risk, taxpayers and consumers are largely the same group of individuals as energy is required by all citizens, increasingly so as mass transport and industries are electrified or switched to alternate fuels produced using renewables and nuclear energy. With the privatisation of the Central Electricity Generating Board (CEGB), the Government left it to the market to determine what technologies were constructed and when. Private developers in the market must produce a return on their investment and the higher returns often asked for on perceived riskier projects make the end cost to the consumer higher than otherwise need be. Risk can be assigned to the taxpayer or the consumer (or both), but the balance of where this lies needs to carefully consider the allocation of risk and its impact on the end cost to the consumer. Risk passed onto the consumer through the developer will likely incur higher overall end costs to the consumer as developer companies usually require higher rates of return for a perceived riskier investment. This will continue up to a point until the level of risk becomes too great for a private entity to shoulder. Project risk apportioned to the taxpayer may present a lower cost to the consumer in the end.

The NI firmly believes there are national security implications for the Government's current strategy and believes these lie acutely in the opportunities that this may bring. The collaboration of civil nuclear and defence in respect to supply chain and skills can help meet the demand for both industries to the benefit of jobs and economic growth in the UK. The UK has both conversion and nuclear fuel fabrication facilities which could continue to manufacture and produce nuclear fuel domestically not only for the UK's current and planned nuclear fleet but could also be used to export fuel to other countries, providing jobs and economic security in the UK, safeguarding existing facilities and generating export income for the country.

By using nuclear technology, along with renewables, to generate hydrogen and other synthetic fuels, the UK can secure the chemical and oil and gas industry in the UK

whilst ensuring a transition to Net Zero. The production of these fuels at home will reduce the imports of fossil fuel required, both increasing jobs and economic prosperity whilst reducing volatility of prices as well as prices themselves. Given sufficient capacity, the UK could become a net exporter of clean fuels globally.

The use of SMR or AMR nuclear reactors to provide power, heat, clean water and synthetic fuels for our major military bases and overseas territories should be explored. Such deployment could increase the benefits of building a fleet of reactors along with the resultant lower costs and higher economic and employment opportunities that would bring. Whilst helping with achieving the UK's Net Zero goals, a remote territory or installation able to produce its own power, water, heat and fuel in situ will greatly reduce the impacts of complex logistics chains and increase the resilience and efficacy of such places further enhancing national security.