Research Brief

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Nuclear industry in the UK: Back to the Future?

EXECUTIVE SUMMARY

The deployment of nuclear technologies has had a highly controversial history. SPRU now celebrating its 50th anniversary and the Sussex Energy Group (SEG) have undertaken important research on nuclear policy issues over the past few decades. Nuclear power has contributed to meeting energy needs in many parts of the world. The construction of existing nuclear power plants in the West took place in the 1960s 70s and 80s. However since the 1990s new nuclear construction has been minimal in Europe and North America. Today, around two thirds of new build is taking place in just three countries: China, India and Russia. Western nuclear plants are now generally old and decommissioning/ phase-out issues are emerging. The UK has great hopes for new nuclear however in terms of the potential role it can play in climate change mitigation, and in technological innovation potential of new reactor designs including small modular reactors (SMRs). However deep uncertainties and criticisms remain around the UK's nuclear ambitions, concerns that are understandable when the history of previous rounds of UK nuclear ambitions that failed to materialise are considered. This briefing provides an up to date appraisal of UK nuclear policy issues and highlights a history of SPRUs important research in the sector.

Key issues

- The UK has the most ambitious nuclear new build programme in Europe.
- Since the early 1970s firm commitments to ambitious nuclear programs have repeatedly failed to materialise.
- UK plans to construct at least three new types of reactor all of which have faced significant economic and technical problems elsewhere.
- Small Modular Reactors (SMRs) are commercially unproven and given significant uncertainties around technical issues, economics and licensing, they present a high risk energy strategy.
- Given the history of repeated new build programmes failing to deliver and the significant problems affecting UK nuclear presently, a low carbon energy strategy without nuclear should be planned for, as a matter of good policy making.

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HISTORY

Figure 1 provides a brief look at the history of nuclear industry and key SPRU research in this field from 1970s to the present day. As can be seen there are recurrent themes regarding economics and waste management. Insights developed in the 1970s are still relevant today alongside new issues mainly in climate change mitigation strategies.

LOOKING AHEAD

The UK faces a number of opportunities and challenges on the nuclear front – some new some old. This section explores:

- New Nuclear
- Small Modular Reactors (SMRs)
- Waste & Plutonium
- Nuclear Submarines

Figure 1: History of the UK's nuclear industry since 1970 and SPRU Research

Decade	Nuclear Events & Issues	SPRU Research
1970s	• Ambitious nuclear new build • Public opposition; safety concerns plus cost of construction and waste disposal • New reactor designs e.g. Advanced Gas-cooled Reactor	• New rise in nuclear opposition policy decisions should not just focus on best technology[1] • Lack of independence in policy decision making e.g. UKAEA acting as both reactor designer and advisor to the government[2]
1980s	• More reactor designs developed globally though lack of performance and costs assessments • Energy market liberalisation • Electricity market privatisation and subsequent abandonment of the nuclear programme	• Review of different reactor design and implications for UK[3] • Central Electricity Board costings critique[4,5] • Prospects and challenges for nuclear in developing countries[6]
1990s	• Rising nuclear costs • Reactor closures and decommissioning delays • Waste disposal hotly debated • Growing plutonium stocks as a result of military and civilian nuclear activities • British energy privatisation	• Higher safety standards and complex reactor design increase capital costs that are not offset from cost reductions through learning[7] • Technological and political implications of nuclear decommissioning[8] • Prioritise safe waste disposal repositories[9] • Plutonium stocks global inventory[10] • Policy options for plutonium[10,11]
2000s	• New Thermal Oxide Reprocessing Plant (THORP) at Sellafield despite opposition • British Energy bail out • Growing policy enthusiasm for a nuclear renaissance due to low carbon and potential role in climate change mitigation • 2006 Energy Review; nuclear a "necessity" • Rise of idea of "nuclear renaissance"	• Political and institutional lock-in creating technological "entrapment" decisions lack accountability and transparency[12,13] • Nuclear needs protection from liberalisation if new build to be undertaken[14] • Economics of nuclear in a low carbon economy; lowers investment in renewables, reduce grid flexibility, likely higher costs[15] • Critique on role nuclear plays in energy security[16] • Lack of robust financial assessment and long term implications from rushing energy policy through[17] • Nuclear policy an example of closing down rather than opening up[18] • Difference in framing and participation with the public in countries outside the UK e.g. Finland and France[19,20] • Prof Gordon MacKerron chair of Committee on Radioactive Waste Management (CoRWM) in 2006
2011 to present	• Generation IV technologies fast breeder reactors • Nuclear waste problem still to be resolved - Cumbria County Council rejects application for deep geological disposal site • Fukushima incident and abandonement of nuclear in several countries but not UK • Nuclear economics still hotly debated • Trident renewal	• Historical analysis of rise and fall of fast breeder reactors[21] • Report on nuclear waste for the government[22] • DECC report on the nuclear waste repository[23] • Plutonium management policy proposals collaborating with International Panel on Fissile Materials and Princeton University USA[24] • Discontinuation, democracy and civil-military interdependencies in nuclear policy[25,26]

NEW NUCLEAR

The UK's new nuclear build programme is the most ambitious in the developed world. 16GW of new nuclear is planned to be constructed by 2030. It is intended that 3.2GW of this will be completed by Christmas 2017 with the Hinkley Point C development with new reactor type European Pressurized Reactor (EPR). However no agreement has been signed between EDF and the government for Hinkley C. The government have now postponed making a decision on this until autumn 2016. Estimated costs have rocketed from £14 billion to £24 billion and many consider the 'strike price' that would be paid to EDF for electricity produced, £92.50/MWh, to be overly generous. But Hinkley C is one part of the story. The UK also seeks to develop two other new types nuclear reactors: The Advanced Boiling Water Reactor (ABWR) at Wylfa on Anglesey and a pressurized water reactor, the AP1000 at Moorside in Cumbria. These new builds are considered highly ambitious. Research into developing an understanding of why the UK has committed to such extensive new build program when other European countries such as Germany are not, has been undertaken at SPRU[25,26]. The research finds that the UK's continued commitment to nuclear is hard to justify given the poor performance in international comparisons. Political culture, military factors, and qualities of democracy are all key in influencing the direction of nuclear policy. The claim that nuclear commitment is a necessity for climate change mitigation has not been proven the case elsewhere.

SPRU's Prof Gordon Mackerron and Dr Phil Johnstone gave written and oral evidence to the Welsh Affairs Committee's inquiry; 'the future of nuclear power in Wales'[27,28]. This included the proposed development of an ABWR at Wylfa. The proposed schedule for the ABWR outlined is for construction to start in 2019 and for completion in 'the first half' of the 2020s. This timetable seems optimistic given the various hurdles that this project still needs to tackle. Another point of concern is the lack of evidence for the economics of the ABWR. Very few global examples provides scant evidence on the financial performance of the ABWR.

SMALL MODULAR REACTORS (SMRS)

The UK government is being particularly proactive in encouraging SMR development. Currently there is a competition to find the best design of SMRs, plus further research & development (R&D) support as part of its £250 million total commitment to the nuclear sector. This financial commitment represents 50% of the entire energy R&D for the next 5 years. The UK is not the only country interested in SMRs but has limited experience in their development. The construction of the reactors for Trident and other nuclear powered submarines by Rolls Royce do have similarities to some SMRs. Rolls Royce is one of the key companies involved in the SMR development competition.

Economies of scale have traditionally applied to nuclear i.e. the bigger the better. However costs associated with the construction of large reactors and the changing nature of grids with the increasing penetration of renewables have made such application problematic. SMRs (reactors below 300MW) produced in a 'modular' fashion i.e. in a factory and then transported to the site, could provide a solution. The potential to supply district heat is another factor cited as being important in making SMRs economically viable.

However looking over the history of UK's nuclear industry it is clear that such claims should be treated with scepticism. It is proposed that the UK could have the first SMRs operating by 2035, however there are none in commercial operation anywhere in the world at present. Caution must be given also to the optimistic economic assessments promoting the value of SMRs. Factory production of SMRs requires a large factory with a large number of customers in place to justify constructing such a facility. Factory cost and where it would be built remains unclear. Licensing overburdens could also be a significant issue with a diverse array of designs and an already burdened Office for Nuclear Regulation (ONR). Challenges with smaller nuclear reactor designs include new control room features, evacuation zones, and differences between licensing one as opposed to a fleet of SMRs at one site.

The future of nuclear power in Wales inquiry, was specifically interested in developing SMRs at the Trawsfynydd site in Wales. This particular site has a sparse population therefore it is unlikely to meet the district heating criteria for economic viability. SMRs are a technology to watch, but the long history of broken promises around new nuclear build programs, the consistent cost underestimates, licensing issues, planning, and the importance of public engagement means that critical social science research is vital in this area.

WASTE AND PLUTONIUM

Research into nuclear waste continues to be a hot topic with recent significant policy developments. Taking a more participatory approach, Cumbria County Council rejected the siting of a Geological Disposal Facility. This is despite the Parish Councils where it would be sited being in favour. The dismantled Department of Energy and Climate Change (DECC) had to review once again, UK's nuclear waste disposal policy. SPRU contributed to this consultation. In this it was recommended that an independent body is established to run new consultative frameworks. SPRU also pointed out other substantial concerns such as trust, the type of nuclear waste to be disposed, uncertainties around plutonium and MOX fuel and uncertainty in the new nuclear build programme itself. This makes assessments over the potential lifetime of the disposal facility difficult.

The UK's plutonium stock, the largest civil plutonium stock in the world, remains an acute policy issue. A report involving SPRU's Prof Gordon Mackerron evaluated the latest in direct disposal methods for plutonium. It was concluded that direct disposal may be safer and more cost effective than continuing with the mixed oxide (MOX) fuel option[24]. Government policy on this is uncertain and decisions have now been postponed for several years. One idea being explored is the development of a Fast Breeder Reactor known as PRISM to 'burn' the plutonium stock. There are no firm plans for this however. SPRU PhD student Maria Cristina Silva is undertaking research looking at the drivers behind the UK's plutonium policy with a focus on the most recent suggestions around PRISM and other alternatives.

NUCLEAR SUBMARINES

The UK and five other countries (China, India, Russia, France and USA) operate nuclear propelled submarines. In the UK, the need to sustain a 'drum beat' of submarine orders and maintain the highly skilled British 'nuclear-ready' work force is a significant challenge. SPRU have explored this issue and policies relating to UK nuclear employment skills and found that this intensified from 2003 onwards. A nuclear skills institute has been established catering for training of both civilian and defence related aspects of nuclear developments.

Ongoing research has highlighted that the UK's internationally anomalous intense enthusiasm for new nuclear is driven in part by the need to maintain the capabilities required to build, operate, and maintain nuclear powered submarines, a key component of the UK's nuclear weapons system[29]. This research has had significant impact in challenging some of the orthodoxies of the separation of civil and military nuclear through highlighting the previously neglected 'industrial interdependencies' between the UK's submarine and civil nuclear programmes[30] which has important implications for both the economics of nuclear and the state of British democracy more broadly[31].

TRANSRISK

SPRU is leading on a new large research consortium looking at Transitions Pathways and risk analysis for climate change mitigation and adaptation strategies (TRansRisk). Led by Prof Gordon MacKerron; SPRU will be focussing on understanding nuclear's role in climate change mitigation pathways and what risks and uncertainties exist around this potential future role.

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