**Institution: University of Birmingham**

**Unit of Assessment: UoA 9 - Physics**

**Title of case study: The Future of Nuclear Energy in UK: Birmingham Policy Commission**

## 1. Summary of the impact

The UK is on the verge of building a fleet of new nuclear power stations. The steps required to reach the point where the UK can build Generation III+ plants are a complex mix of energy and financial policy and technology. The issues connect with the fuel cycle, waste disposal and public opinion. Failure in one of these areas could derail the new build programme. Starting in 2011, finishing July 2012, the University of Birmingham led a Policy Commission into the Future of Nuclear Energy in the UK. The Commission has been part of a number of national processes which have influenced and shaped UK policy and thinking in nuclear energy. In 2013 the UK Government published its stance. Recommendations made by the Policy Commission on key topics such as nuclear research capabilities and national nuclear policy bodies are reflected in the Government's report and subsequent actions. Impact has been in terms of public engagement and influencing public policy. Nuclear new build could be an investment of £40bn into the UK economy.

## 2. Underpinning research

The University of Birmingham has a long history of research and education in nuclear power technology and applied nuclear research. The research programme of the nuclear (including applied nuclear) group since 1993 emphasises the core expertise and experience which underpins the work of the policy commission which forms the current impact case. Research topics demonstrating the underpinning expertise and experience in the nuclear sector include (selected examples only):

- New types of accelerator based neutron sources to substitute for the UK based DIDO test reactor, with applications to Boron Neutron Capture Therapy (1).
- Using neutron inelastic scattering to characterise $CaH_2$, a material that could be used for localised moderation of the neutron spectrum in the PHENIX Fast Reactor, to optimise the core for the transmutation of higher actinides using dedicated moderated targets (2).
- Characterisation and development of a variety of radiation detection techniques, including Passive Neutron Coincidence Counting (PNCC), which is one of the analytical techniques used to implement the international safeguards on special nuclear materials across the world (3). A combined gamma/passive neutron coincidence counter used as part of a suite of non-destructive assay instruments utilised for the enforcement of the Euratom nuclear safeguards within the European Union (5). Examination of the effects of nuclear radiations on the structural integrity of reactor pressure vessels (RPV) is important for reactor life extension. TAGSI is the UK Technical Advisory Group on Structural Integrity of nuclear plant sponsored by the Nuclear Power Industry. The Group has representatives from the companies and organisations involved in the industry, together with independent experts on structural integrity matters. Research was performed at Birmingham on behalf of TAGSI on the effects of gamma irradiation on the mechanical properties of irradiated ferritic steel reactor pressure vessels (4).
- Birmingham has a significant history in nuclear data, with Prof. Weaver's strong involvement in nuclear data for reactor technology, including delayed neutrons and fission yields (6).

This research has been led by Weaver (lecturer in Physics and part leader of the PTNR course from 1971 until 2004, honorary chair post 2004) and Beynon (lecturer in Physics and head of the applied nuclear group from before 1992 until 2002). The underpinning research provided the expertise and heritage for an authoritative contribution to the debate on "The Future of Nuclear Energy in the UK" through the Birmingham Policy Commission which had credibility both with the nuclear industry and Government.

## 3. References to the research

1. D.Ross, G.Constantine, D.R.Weaver, T.D.Beynon *Designing an Epithermal Neutron Beam for Boron Neutron Capture Therapy for a DIDO Type Reactor using MCNP*, Nucl. Instrum. Methods Phys. Res. A334, 596 (1993): http://dx.doi.org/10.1016/0168-9002(93)90827-5.
2. P Morris, D.K Ross, S Ivanov, D.R Weaver, O Serot, *Inelastic neutron scattering study of the vibration frequencies of hydrogen in calcium dihydride*, Journal of Alloys and Compounds, Volume 363, Issues 1–2, 28 January 2004, Pages 88-92: http://dx.doi.org/10.1016/S0925-

8388(03)00631-5
3. L.C.-A. Bourva, S. Croft, D.R. Weaver, *The effect of albedo neutrons on the neutron multiplication of small plutonium oxide samples in a PNCC chamber*, Nuclear Instruments and Methods in Physics Research Section A: 479, 1 March 2002, Pages 640-655: http://dx.doi.org/10.1016/S0168-9002(01)00944-5
4. J.F. Knott, C.A. English, D.R. Weaver, D.P.G. Lidbury, *Views of TAGSI on the effects of gamma irradiation on the mechanical properties of irradiated ferritic steel reactor pressure vessels,* International Journal of Pressure Vessels and Piping, Volume 82, Issue 12, December 2005, Pages 929-940: http://dx.doi.org/10.1016/j.ijpvp.2004.09.009
5. L.C-A. Bourva, S. Croft, H. Ottmar, D.R. Weaver*, MCNP modelling of a combined neutron/gamma counter*, Nuclear Instruments and Methods in Physics Research Section A, Volume 426, Issues 2–3, 1 May 1999, Pages 503-517: http://dx.doi.org/10.1016/S0168-9002(98)01448-X
6. A. Hill, J. Blackband, D.R. Weaver, *A PC-based program for displaying decay data from the Nuclear Energy Agency's JEF-2 database*, Nuclear Instruments and Methods in Physics Research Section A:, Volume 344, Issue 3, 15 May 1994, Pages 611-613: http://dx.doi.org/10.1016/0168-9002(94)90882-6

References 1, 5 and 6 best indicate the quality of the underpinning research.

**4. Details of the impact** (indicative maximum 750 words)

Birmingham's involvement in the nuclear sector dates back to the commissioning of the Calder Hall nuclear power station in 1956. The School of Physics and Astronomy has been delivering the Physics and Technology of Nuclear Reactors (PTNR) Masters course since these earliest days and many of the key people within the nuclear industry are graduates. Prof Weaver was head of the PTNR course before passing it on to Dr. Norman. The steering committee for the PTNR course includes most of the major companies across the UK nuclear industry, whose funding underpins the courses continuation. Members of the Birmingham Nuclear group have also participated in international reviews, for example Prof. D.R. Weaver served on the OECD Nuclear Energy Agency (NEA) 2009 review "Research and Test Facilities Required in Nuclear Science and Technology" and operated as a consultant to the International Atomic Energy Agency (IAEA) and Prof. M. Freer provided a review of National Nuclear Laboratory reports into characterisation of Gen IV technologies and fuel cycles for the Department of Energy and Climate Change (DECC). This, and the associated applied nuclear research programme, provided the foundations for the Policy Commission on the Future of Nuclear Power in the UK. Key elements of the report feature R&D capability and skills capacity, both of which link directly to the expertise of the Birmingham Nuclear group.

The Policy Commission examining "The Future of Nuclear Energy" was chaired by Lord Hunt of Kings Heath, and brought together key representatives from the nuclear industry, national policy, universities, NGOs, government agencies and the financial sector – the meetings were also attended by several international organisations. The process included two workshops held in Westminster, London, and debates at the Institution of Civil Engineers (London), the Lib-Dem Party Conference (Birmingham 2011) and Labour Party Conference (Manchester 2012). These workshops and debates were designed to draw out the key challenges facing the UK in the development of a new nuclear build programme. These include the impact on climate change, finance and the energy markets, nuclear supply chain, nuclear training and skills, public opinion and perceptions, waste storage and disposal and the nuclear fuel cycle. In addition, a more forward looking component of the policy review was an examination of future technologies (so-called Generation IV) and how these might fit into the UKs future energy plan. Altogether, there were >50 expert participants in the debates and workshops.

The commissioners included academics from disciplines across the University of Birmingham (Prof. David Weaver, Prof. Lynne Macaskie, Dr. Paul Norman, Dr. John Walls and Prof. Martin Freer) and external commissioners: Prof. Richard Green (Imperial), Richard Rankin (Idaho National Laboratory, US), Stephen Tindale (Centre for European Reform), Simon Webster (Head of the Unit responsible for managing the Euratom programme of EU-funded research activities in nuclear fission science & technology) and Prof. Andrew Worrall (Technical Authority for Reactors and Fuels at the UK National Nuclear Laboratory now ORNL, US). The connection between the research and track record of the nuclear group and the work of the policy commission exemplified through Prof. Weaver.

**Reach**

The final report of the commission was published on 2nd July 2012, and launched at an event involving a panel discussion with Tim Yeo MP (Chair, Energy and Climate Change Committee), Professor Martin Freer (Policy Commission Academic Director) and Stephen Tindale (Climate and Energy Consultant, Associate Fellow at the Centre for European Reform and a member of the Commission). The discussion was chaired by Fiona Fox (Chief Executive, Science Media Centre).
The aim of the workshops, described above, was to generate debate on some of the key areas across parties who would not normally be brought into contact; these included; AREVA, French Alternative Energies and Atomic Energy Commission (CEA), Nuclear Information Service (anti-nuclear), OECD Nuclear Energy Agency, UK Atomic Energy Authority, Culham Centre for Fusion Energy (CCFE), Weinberg Foundation, Chatham House, Department of Energy and Climate Change, Environment Agency, Babcock International, Nuclear Industry Association, Social psychologists (Cardiff University), National Nuclear Laboratory, EDF Energy, The Royal Society, Office for Nuclear Regulation, journalists, Energy UK, University academics (Birmingham, Oxford, Manchester, Imperial, Cardiff), Nuclear Decommissioning Authority, GE Hitachi, Committee on Climate Change, Office for Nuclear Development and the Senior Advisor to the Secretary of State for Energy & Climate Change and Department for Public Health and Health Professions, Welsh Government.

In addition to the workshops, a first debate was held in September 2012 at the Lib Dem conference, chaired by Prof. David Eastwood (VC Birmingham), including Lord Hunt, Rt Hon. John Hemming (Liberal Democrat MP, Birmingham Yardley), Dr Susan Juned (Director and Senior Consultant, Greenwatt Technologies Sustainable Solutions) and Prof. Martin Freer. A further debate was held at the Institution of Civil Engineers, London, chaired by Lord Hunt, with a panel formed from Sir Jonathon Porritt (Co-Founder, Forum for the Future), Dame Sue Ion (former Group Director of Technology for British Nuclear Fuels Ltd), Ron Bailey (anti-nuclear), Keith Parker (Chief Executive, Nuclear Industry Association) and Prof. Martin Freer. This second debate formed part of the discussion for a BBC world service 'One Planet' programme on nuclear energy and the "Naked Scientist". Comment pieces authored by the commission were covered in newspapers in 22 countries and 8 languages: Arabic, Chinese, English, French, Macedonian, Polish, Portuguese and Spanish (including Al Jazeera - English).

The conclusions of the report were covered in Public Service Europe [1], an exclusive in the Sunday Telegraph [1], NEI Nuclear Notes blog 'Whither British Nuclear Energy', Out-Law.com 'Government must take some of the financial risk of new nuclear to encourage investment, says report', Securing the Future [1] and Nuclear Future (magazine of the nuclear industry). Elements of the report were also featured on BBC Sunday Politics Show, featuring a section with Prof. Freer and an undergraduate student on the future of nuclear in the UK and the policy commission. The Commission also hosted a fringe debate at the 2012 Labour Party conference in Manchester involving Tom Greatrex MP (Shadow Energy Minister) and Geoffrey Lean (Environment Correspondent, The Telegraph).

**Significance**

The report [2] was submitted to the department of Business Innovation and Science (BIS) to help shape their review of UK Nuclear R&D capabilities performed by the Government's Chief Scientific Adviser, Sir John Beddington. Several hundred copies of the report were circulated to DECC and leading policy makers in the UK and organisations in the EU and US. The report outlined a number of measures that UK policy makers must take to deliver Nuclear New Build and is designed to inform those with the opportunity to affect energy policy – feedback has been good: "*With so many publications and views in the energy space it is difficult to pick out those that really make a difference. Your July 2012 Nuclear Report is however very, very good. Well done to your team and thank you*." [redacted] - Chief Executive Ofgem. [3] [redacted] of the National Nuclear Laboratory observed "*It is clear that the work through the Policy Commission has already made an impact and it is likely that many of the recommendations that the report makes will be considered and enacted upon*." [4] [redacted] remarks "*I have received a number of comments from Parliamentarians concerning the quality and impact of the report. I have no doubt that it is proving to be highly influential and authoritative*". [5, 6] The report was also cited in the 2012 IoP review of "A Review of UK Nuclear Physics Research". [7] [redacted], Head of Nuclear

Policy, EDF, advises "*I know the work has been a reference source for policy officials within the Departments of Business, Innovation and Skills and Energy and Climate Change. The work has also been useful and relevant to the Advisory Group on Nuclear R&D chaired by Sir John Beddington*…..". [8] In 2013 the Government published "The UK's Nuclear Future". [9] The report, including its many sub-documents, refers to the work of the Birmingham Policy Commission and many of the Commission's recommendations are reflected in the conclusions of the Government report and subsequent actions. For example, the commission report recommended "Development of world-class nuclear research capabilities should be a national priority. Materials research, involving both nuclear fuel post-irradiation examination and characterisation (fission) and development of advanced structural materials (fusion and fission), is a critical area for advanced nuclear technology in general, and the solid basis of UK expertise in these fundamental fields would benefit considerably from enhanced national support." – DECC has now funded £15M for a new world class National Nuclear Users Facility for nuclear materials research and £12.5M for a UK stake in the Jules Horowitz materials test reactor. Similarly, the commission suggested "The Government should set up a statutory Nuclear Policy Council, or similar, modelled on the Committee on Climate Change, that can establish and champion a long-term, technically informed, roadmap for nuclear energy in the UK.", and subsequently a series of national committees have been formed which include Nuclear Innovation Research Office (NIRO) which will develop and take forward the work of the newly created Nuclear Innovation Research Advisory Board (NIRAB). It is not possible to establish direct cause and effect, but the statements from those involved in the development of the Government position [4, 8] indicate the importance of the report in shaping the government's conclusions.

The Commission's report and the subsequent debates on its findings have informed the complex policy debate surrounding changes in UK policy, with the potential nuclear new build programme estimated to correspond to an investment of over £40billion in the UK economy, not to mention the potential for energy security.

**Sustainability**

As part of broadening public understanding of the issues around UK energy policy, nuclear energy and nuclear safety a number of activities have been coordinated. These include presentations to the Birmingham Lunar Society and Manchester Literary and Philosophical Society (both "learned societies") and to 6th form school students and teachers. Following on from the Commission Freer has been asked to provide input to a report by the Committee on Climate Change on greenhouse gas emissions from nuclear power, participate in debates on the economic conditions surrounding the Electricity Market Reform bill, on the future of energy organised by the FSB and to contribute to a meeting on nuclear energy at the Royal Academy of Engineering. He has also written a number of comment pieces for the "Conversation" and "Pan European Networks".

**5. Sources to corroborate the impact** (indicative maximum of 10 references)

1. Web references: http://www.publicserviceeurope.com/article/2169/nuclear-power-in-the-uk-from-drift-to-shift
http://www.telegraph.co.uk/earth/energy/nuclearpower/9366922/Government-must-share-financial-risk-of-nuclear-plants.htmlhttp://www.securingthefuture.co.uk/index.php?option=com_content&view=article&id=11956&catid=54&Itemid=202

2. *The Future of Nuclear Energy in the UK*, Birmingham Policy Commission Report, July 2012
3. Email from Chief Executive Ofgem, dated 16/8/12
4. Corroborating statement from Chief, Science and Technology Office, National Nuclear Laboratory, dated 11/12/12
5. Corroborating statement from the Chair of the Commission, dated 5/12/12
6. Letter from Chair of Commission to University of Birmingham Vice- Chancellor summarizing impact of report, dated 20/8/12
7. *A Review of UK Nuclear Physics Research*, Institute of Physics Report, October 2012
8. Corroborating statement from Head of Nuclear Policy, EDF Energy, dated 5/12/12
9. *Nuclear Industrial Strategy: The UK's Nuclear Future*, Dept. for Business, Innovation and Skills, 2013 (BIS/13/ 627; www.gov.uk/bis)