GCRF Concept Note- The Role of Nuclear Energy in Meeting Global Challenges

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**Institutional Background.**

1. The University of Manchester has by far the largest nuclear research and training portfolio in UK academia.[1] The Dalton Nuclear Institute acts as an umbrella for this, with activities spanning all nine Schools in the Faculty of Science & Engineering, and also linking into the Faculty of Humanities, particularly the School of Law, School of Social Sciences, and the Alliance Business School. DNI also connects into Manchester Energy and Tyndall Manchester, putting the nuclear energy portfolio in a broader context. Manchester is therefore uniquely placed to support work on nuclear energy as part of the GCRF programme.

**Nuclear Energy as a Sustainable, Low Carbon Resource.**

2. Nuclear energy is a high energy density, reliable, low carbon source of baseload power, which is increasingly being adopted across much of the World. Such energy resources underpin all eight GCRF Challenge Areas. 440 reactors are in operation worldwide, with 60 more under construction and 165 firmly planned.[2] The DAC list includes seven nations which are expanding their current nuclear energy programmes[3] and a further nine 'new nuclear' nations.[4]

3. In the short term, new nuclear reactors will be well established, uranium fuelled systems and, in the development context, the challenge will be to ensure safe and efficient operation through the whole plant lifecycle. The International Atomic Energy Agency (a UN agency) has specified the requirements for establishment of a legal regime, safeguards and security measures, and a regulatory framework, as well as human resource development.[5]

4. Research needs in the short term are:

- understanding social, cultural, political, legal, financial and economic aspects of nuclear energy in new nuclear nations to ensure efficient, safe implementation;
- power distribution from large nuclear stations providing baseload power;
- the use of small and micro-reactors to provide combined heat and power;
- research-led training and capacity building to develop indigenous subject matter experts; and
- 'cradle to grave' fuel and waste management

5. A very wide range of novel nuclear energy concepts has been proposed for implementation in the middle years of this century. These include advanced, 'Generation IV' reactor types; recycling of used fuel; thorium fuelled reactors; 'small modular' reactors; and 'micro' reactors for combined heat and power. Some of these may be particularly attractive to developing countries; for example India has large thorium resources which could fuel an indigenous thorium reactor programme, while small modular and micro-reactors could reduce the need for a sophisticated power distribution network as well as providing heat energy for industrial and desalination applications.

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[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/168039/13-631-a-review-of-the-civil-nuclear-r-and-d-landscape-review.pdf

[2] http://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx

[3] Armenia, Pakistan, Argentina, Brazil, Iran, South Africa

[4] Bangladesh, Egypt, India, Vietnam, Belarus, Jordan, Kazakhstan, Malaysia, Thailand, Turkey

[5] Milestones in the Development of a National Infrastructure for Nuclear Power (IAEA NE-Series NG-G-3.1)

6. In addition to the research needs associated with implementation of a nuclear power programme, identified in para 4 above, advanced nuclear energy systems would require research into technical aspects of development and implementation (e.g. manufacturing, structural integrity, control & instrumentation, fuel and fuel cycle, materials performance, thermal hydraulics, decommissioning, waste management) . Such technical work would not be delivered by a university alone, but would require collaboration with industry and almost certainly be an international effort.

**Nuclear Fuel Resources- Extraction, Exploitation and Remediation.**

7. For over half a century, the World's uranium resources have been exploited and the high grade deposits are largely exhausted, leading to increased interest in low grade and 'unconventional' resources. Many developing countries are uranium producers,[6] have substantial but currently unexploited resources[7], or have historically produced uranium and now have to manage the legacy.[8] There is also persistent interest in thorium as a future nuclear fuel and developing countries host a large part of the World's thorium resources.[9]

8. Research needs are:

- understanding social, cultural, environmental, political, legal, financial and economic aspects of uranium and thorium extraction and processing in developing countries;
- mitigation of environmental impacts from uranium and thorium extraction and processing;
- research-led training and capacity building (e.g. in support of mining, processing, remediation, regulation); and
- fabrication of fuel from precursor materials, including thorium, and the through-life management of such fuels.

[6] Kazakhstan, Niger, Namibia, Uzbekistan, Malawi, Ukraine; http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/uranium-mining-overview.aspx

[7] South Africa, Brazil, Mongolia, Botswana, Central African Republic; http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/uranium-mining-overview.aspx; http://www.world-nuclear.org/information-library/country-profiles/others/uranium-in-africa.aspx

[8] Gabon, Democratic Republic of Congo; http://www.world-nuclear.org/information-library/country-profiles/others/uranium-in-africa.aspx

[9] India, Brazil, Egypt, Turkey, Venezuela, South Africa, Kazakhstan; http://www.world-nuclear.org/information-library/current-and-future-generation/thorium.aspx