Overview of Capacity Building in the UK

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Oak Ridge National Laboratory, TN, USA

20th INPRO Dialogue Forum on Challenges and Issues in Capacity Building for Ensuring Nuclear Energy Sustainable Development

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Calder Hall

- Official Opening 17th October 1956
- Based on a 65 MW design
- Rab Butler – “The first station anywhere in the world to produce electricity from atomic energy on a full industrial scale
- USA 1952 – 100 kW in Arco, Idaho
- USSR 1954 – 5 MW in Obninsk
First Fleet of Reactors – 26 Magnox

Calder Hall

Berkeley

Bradwell

Trawsfynydd
Dounreay Reactors – 2 Fast Reactors

- **Dounreay Fast Reactor**, 14 MW, connected in 1962, shut down in 1977

- **Dounreay Prototype Fast Reactor**, 250 MW, connected in 1975, shut down in 1994
Second Fleet of Reactors – 14 AGRs

Sizewell B – 1 PWR
Connected in 1995
Decommissioning due 2035

Sizewell B Public Enquiry
Report published on 26 January 1987
UK Natural Resources

Source: Parliamentary Standard Note: SN/SG/4046
Decline in the UK Skills Base
UK Public Fission R&D Funding
1999

Is this the end for nuclear energy in the UK?

How close to the end was it for nuclear energy?
BNFL University Research Alliances

• 1999 - Centre for Radiochemistry Research
  The University of Manchester

• 2000 - Particle Science and Engineering
  The University of Leeds

• 2001 - Immobilisation Science Laboratory
  The University of Sheffield

• 2002 - Materials Performance Centre
  The University of Manchester

• £2M core funding for each centre
HSE Nuclear Education in British Universities 2002

• “If nuclear education were a patient in a hospital it would be in intensive care”

• “Its health seems to depend more on the enthusiasm of individuals than the commitment of institutions”

• “Although nuclear courses are taught at 22 of the 130 or so universities in the UK, the level of nuclear teaching is very low at many of them and at 7 teaching is likely to disappear in the next few years”

• “There is a worrying decline in the already small number of students pursuing totally nuclear postgraduate courses”

• “It seems unlikely that, unless action is taken, nuclear education will not be robust and flexible enough to support the industry as it evolves”
### Nuclear Task Force 2003

<table>
<thead>
<tr>
<th>Main skill area</th>
<th>Skills</th>
<th>Supporting existing nuclear programme</th>
<th>Competence to select, license &amp; operate new systems</th>
<th>Keeping abreast of international developments</th>
<th>Competence in nuclear waste management</th>
<th>Total skills</th>
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<td>2</td>
<td>3</td>
<td>25</td>
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<td>7</td>
<td>5</td>
<td>10</td>
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<td>Thermal hydraulics</td>
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<td></td>
<td>5</td>
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<td>Control &amp; instrumentation</td>
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<td>3</td>
<td>5</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>35</strong></td>
<td><strong>50</strong></td>
<td><strong>50</strong></td>
<td><strong>200</strong></td>
<td><strong>20</strong></td>
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THE ISSUE in 2005
- A lack of highly educated scientists and engineers entering the UK nuclear industry

THE RESOURCES AVAILABLE
- Pockets of nuclear expertise within UK universities
- High quality educational programmes
  - Science, technology and engineering

THE STAKEHOLDER ANALYSIS
- Modular courses suitable for full-time and part-time students

THE SOLUTION PUT FORWARD
- NTEC Master’s Level Programme in Nuclear Science and Technology
NTEC Course Structure

Full-time:
- B.Sc. or B.Eng.: 3 years
- NTEC M.Sc.: 1 year

Part-time:
- B.Sc. or B.Eng.: 3 years
- NTEC M.Sc.: 3 years

University Education
Industry Training
NTEC Programme Structure

MSc Nuclear Science and Technology
- Full time: 12 months
- Part time: 3 years

1800 hours of study

Entry Point

35 hours at University
One week Monday - Friday
150 hours of study

One Module

Three Additional Modules

Four Additional Modules

Project & Dissertation

CPD

Postgraduate Certificate

Postgraduate Diploma

M.Sc.
Partnership with Industry

• Modules designed in partnership with industry
• External Advisory Board
• Industry location for projects
• Short-fat delivery optimised for industry
• Industry lecturers support the programme
• CPD income supports full-time students
• Industry recruitment of NTEC students is the real test
Full-time Student Destinations

- Employment - Nuclear: 63%
- Nuclear Related Research: 19%
- Employment - Other: 9%
- Unknown/Did not respond: 9%
The NTEC Effect – B.Sc.

- University of Birmingham
  - B.Sc. in Nuclear Science and Materials
  - M.Eng. in Nuclear Engineering

- University of Cumbria
  - B.Sc. in Radiation Protection

- Imperial College London
  - M.Eng. in Mechanical/Chemical/Materials and Nuclear Engineering

- Lancaster University
  - M.Eng in Nuclear Engineering

- University of Leeds
  - M.Eng./B.Eng. Mechanical/Chemical and Nuclear Engineering

- University of Liverpool
  - B.Sc. in Physics with Nuclear Science

- The University of Manchester
  - B.Eng. in Mechanical Engineering and Nuclear Engineering
  - M.Eng in Mechanical Engineering and Nuclear Engineering

- Nottingham Trent University
  - B.Sc. in Physics with Nuclear Technology

- University of the West of Scotland
  - B.Sc. in Physics with Nuclear Technology
The NTEC Effect ?? – M.Sc.

- University of Birmingham
  - M.Sc. in Physics and Technology of Nuclear Reactors
- University of Cambridge
  - MPhil in Nuclear Energy
- University of Dundee
  - Master of Laws (LLM) and associated Diploma in International and Comparative Nuclear Law and Policy
- Imperial College London
  - M.Sc. in Nuclear Engineering
- Lancaster University
  - M.Sc. in Decommissioning and Clean-Up
  - M.Sc. in Safety Engineering
- University of Liverpool
  - M.Sc. in Radiometrics: Instrumentation and Modelling
- Nuclear Technology Education Consortium (NTEC)
  - M.Sc, Diploma, Certificate and CFD programme
- University of Sheffield
  - M.Sc. in Nuclear Environmental Science and Technology
- University of Surrey
  - M.Sc. in Radiation and Environmental Protection
  - M.Sc. in Radiation Detection and Measurement
The Size And Experience of the Academic Nuclear R&D Workforce in the UK
NUCLEAR Network

Nuclear Universities Consortium for Learning, Engagement And Research

Widen academic and industrial collaboration and enhance knowledge transfer

Expanding Network

Access to Facilities

Facilitate access to unique nuclear research facilities in the UK and overseas

Support Government, Regulator, Industry and Academia in nuclear programme development

Strategic Advice

Promote UK capability and knowledge internationally

International Engagement
National Nuclear User Facility

- Network large-scale nuclear R&D facilities alongside smaller distributed projects
  - Optimise facilities for UK nuclear R&D
  - Facilitate access for UK research community
UK Public Fission R&D Funding
EPSRC Fission Funding Since 2004
Government Funded Facilities Since 2013

- Pyrochemical Processing Lab
  Edinburgh
  DECC 2015
  £0.9M

- NNL Central Lab
  Phase 3
  BIS 2013
  £5.5M

- NNUF
  NNL, Manchester, Culham
  RCUK 2013-15
  £15M

- UTGARD β/γ Lab
  Lancaster
  DECC 2015
  £0.8M

- ADRIANA
  Lancaster/Liverpool/Culham
  DECC 2013
  £1M

- RACE
  Culham
  BIS/Oxford LEP
  £7.8M

- Nuclear Fuel Centre of Excellence
  NNL and Manchester
  BIS/DECC 2013-15
  £10.5M

- Sir Henry Royce Institute
  RCUK 2016-22
  £30M

- MIDAS - Material Separation
  Sheffield
  DECC 2015
  £0.8M

- Jules Horowitz Reactor
  France
  DECC 2013
  £12.5

- NNUF
  Multiple Locations
  RCUK 2018-21
  £60M

- High Temperature Facility – AMEC FW
  DECC 2015
  £2M

Total: £146.8M
Nuclear AMRC

Members Include:
Canadian Nuclear Laboratories
Cavendish Nuclear
EDF
Electric Power Research Institute (EPRI)
Framatome
Jacobs
Nuclear Decommissioning Authority (NDA)
Rolls-Royce
Sheffield Forgemasters
Westinghouse
National College for Nuclear

• “To create world-class nuclear curriculum that employers need and learners aspire to”

• Create a “higher level vocational pathway” providing routes into jobs in the nuclear industry.

• Meet employers’ needs – including the defence sector – for nuclear-specific qualifications and other training solutions.

• Support the UK’s nuclear industrial strategy by helping to tackle key skills gaps.

• Bringing together industrial experience and academic insight

• Build a reputation for innovation and a high quality learning experience, and consequently achieve international recognition for nuclear vocational training
UK Nuclear Planning Timeline

UK Civil and Defence Nuclear Workforce Demand

![Graph showing workforce demand from 2016 to 2036 for various sectors including New Build, Decommissioning, Generation, Research and Development, Regulation, Waste Management, Manufacturing, Fuel Processing, Defence, and Defence (Tier 2+ Supply Chain).]
Forecast Required Inflow by Role

### 64,988 UK Nuclear Jobs

#### Regional Totals

<table>
<thead>
<tr>
<th>Region</th>
<th>2017</th>
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<tbody>
<tr>
<td>East Midlands</td>
<td>3,608</td>
</tr>
<tr>
<td>East of England</td>
<td>1,849</td>
</tr>
<tr>
<td>London</td>
<td>1,551</td>
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<tr>
<td>North East</td>
<td>1,268</td>
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<td>North West</td>
<td>28,293</td>
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<tr>
<td>Northern Ireland</td>
<td>33</td>
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<td>Scotland</td>
<td>4,118</td>
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<tr>
<td>South East</td>
<td>6,074</td>
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<tr>
<td>South West</td>
<td>8,210</td>
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<tr>
<td>Wales</td>
<td>1,341</td>
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<tr>
<td>West Midlands</td>
<td>1,094</td>
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<tr>
<td>Yorkshire and the Humber</td>
<td>1,213</td>
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<tr>
<td>Various Sites and Home Based Workers</td>
<td>6,336</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>64,988</strong></td>
</tr>
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Nuclear Industry Retirement Profile

Nuclear Industry Total Retirement by Skill Level by 2025

Managers and Senior Management
Professional
Technician
Skilled
Semi-Skilled

Civil Nuclear Workforce
UK Workforce

# Maintaining the Capability

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>NTEC</td>
<td>Master’s level education</td>
</tr>
<tr>
<td>CDTs</td>
<td>PhD level education</td>
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<tr>
<td>NUCLEAR</td>
<td>Nuclear Universities Research Consortium</td>
</tr>
<tr>
<td>NSAN</td>
<td>National Skills Academy for Nuclear</td>
</tr>
<tr>
<td>NAILS</td>
<td>Nuclear Academic Industry Liaison Society</td>
</tr>
<tr>
<td>NAMRC</td>
<td>Nuclear Advanced Manufacturing Centre</td>
</tr>
<tr>
<td>NIRO</td>
<td>Nuclear Innovation and Research Office</td>
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<tr>
<td>NIRAB</td>
<td>Nuclear Innovation and Research Advisory Board</td>
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<tr>
<td>NCfN</td>
<td>National College for Nuclear</td>
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<tr>
<td>NIA</td>
<td>Nuclear Industry Association</td>
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## Maintaining the Capability

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<th>Acronym</th>
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<tr>
<td>NSSG</td>
<td>Nuclear Skills Strategy Group</td>
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<tr>
<td>NIC</td>
<td>Nuclear Industry Council</td>
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<tr>
<td>NWNA</td>
<td>North West Nuclear Arc</td>
</tr>
<tr>
<td>NI</td>
<td>Nuclear Institute</td>
</tr>
<tr>
<td>NNL</td>
<td>National Nuclear Laboratory</td>
</tr>
<tr>
<td>NDA</td>
<td>Nuclear Decommissioning Authority</td>
</tr>
<tr>
<td>ONR</td>
<td>Office of Nuclear Regulation</td>
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<tr>
<td>EA</td>
<td>Environment Agency</td>
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<tr>
<td>GBN</td>
<td>Great British Nuclear</td>
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Hinkley Point C

https://www.edfenergy.com/media-centre/medialibrary/63969763226
Hinkley Point C

https://www.edfenergy.com/media-centre/medialibrary/63969763226
2023

Was 1999 the end for nuclear energy in the UK?

Emphatically No

But it could have been
Thank you!