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Post-graduate Training and the Link to Research

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University Geoscience UK: "Future Science: a vision for the next 25 years"
Burlington House, London, 21-22 February 2017

My Links to Geoscience – analytical high pressure pyrolysis techniques

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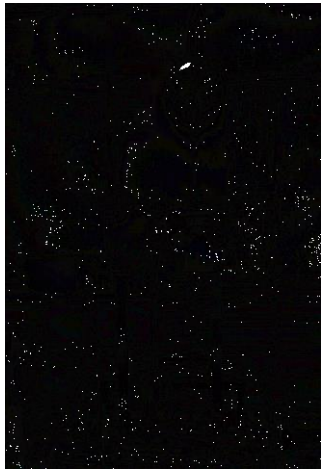
1. Hydropyrolysis (high P hydrogen) applications include:

- quantifying black or pyrolytic carbon in environmental matrices
- understanding the earliest life forms from severely altered organic material
– fingerprinting biodegraded oils and over mature source rocks.

- 13 systems sold globally – China, USA, Australia

2. High P water pyrolysis, realistic sub-surface simulation oil and gas generation

- Suppressing source rock maturation and oil cracking, high P/T petroleum basins
- Shale gas formation at high maturities, compare estimates with those from gas adsorption



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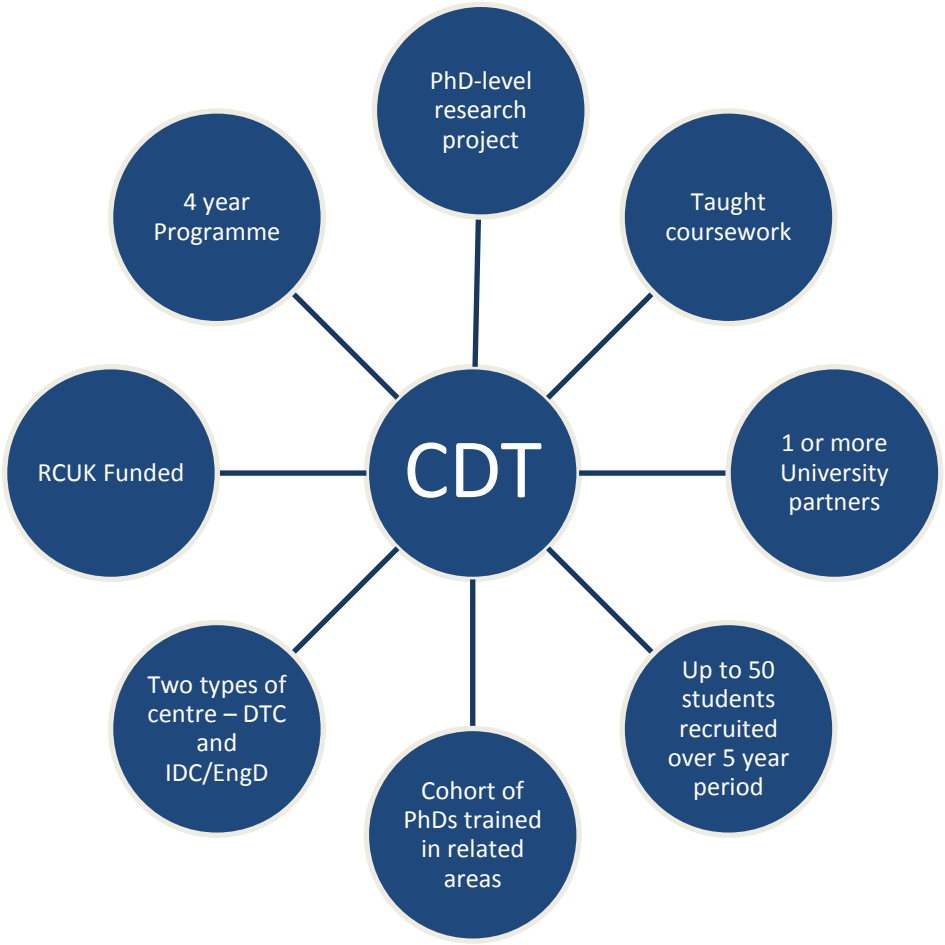
Scope

- Let's assume geo-energy, geothermal and zero-emission fossil, i identified as a Global Challenge.
- PhD training led by leading Research Groups, pre-requisite of the CDT model.
- How to we shape the broader research training in relation to a Grand Challenge?
  - Overall context, **P**olitical, **E**nvironmental, **S**ocial, **T**echnical, **L**egal and **E**nvironmental **(PESTLE)**
  - Underpinning knowledge of energy system and climate change
  - Leadership skills , entrepreneurship and communication/public engagement
- Explain how we've attempted to do this for CCS and cleaner fossil energy within a 4 year training programme.

Evolution of EPSRC Centres for Doctoral Training (CDTs)



- Recognition of the limitations of the 100% research orientated 3 year PhD.
- Limited number of Engineering CDTs before 2008.
- Approximately 55 Centres launched in 2008, over 80 in total.
- 110 Centres starting 2014
- 13 Centres in Energy.
- Mix of Doctoral Training and Industrial or Engineering Doctorate Centres.
- 4 year PhD with one year's training activities.
- ***Cohort approach emphasised***
- Model adopted by the other Research Councils with some variants.

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EPSRC Engineering Doctorate Centre in Efficient Power from Fossil Energy and Carbon Capture Technologies (2009-2013 intakes)

EPSRC Centre for Doctoral Training in CCS and Cleaner Fossil Energy (2014-2018 intakes, industrial doctorate centre)

- £9M EPSRC and £5M industry funding.
- Over 100 doctoral students across the 2 Centres
- Over 25 industrial partners
- UK focal point for training in the field, links strongly to UK CCS Research Centre and allied to many EPSRC projects.
- Extensive international links, Summer and Winter schools

Core Disciplines

- Chemical Engineering
- Chemistry
- Physics
- Geology/Earth Science
- Mechanical Engineering
- Environmental Engineering
- Materials
- Mathematics

Alignment and Further Investment

- Aligns with EPSRC's 'balancing capability' agenda, addressing three 'research areas', namely fossil fuel power generation, combustion engineering and CCS, linking strongly to major initiatives, including the UK CCS Research Centre and Conventional Power consortia projects.
- Capital investment (EPSRC, DECC and Innovate UK, £4M for analytical equipment and pilot-scale facilities since 2014), increasing the range of research projects that can be delivered.

Partners in the CDT provide internationally recognised capability across the whole CCS and fossil energy spectrum

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The University Of Sheffield.

The Advanced Skills Gap

Over 50 years old and being forced to retire by emissions legislation

- Commonality between our ageing coal-fired power stations and the R&D work force in the fossil energy and power sectors!
- How do we develop and bring on new leaders quickly?
- What is the most appropriate form of PhD training to do this?
- The vision is to deliver research leaders and innovators with broad economic, societal and contextual awareness, having strong technical skills , capable of operating in multi-disciplinary teams covering a range of knowledge transfer, deployment and policy roles.

Distinctive Features of Industrial or Engineering Doctorate Centres

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- Students engaged fully with industrial partners
- Four year job interview, many doctorates join their sponsoring companies
- Well-resourced projects with industrial cash contributions of typically £30-50k per project.
- PhD requirement is still the same requiring an original body of research (3 years).
- The training programme has been designed in collaboration with our industrial partners to ensure its relevance to the UK to tackle the challenges in implementing technologies to reduce CO_2 emissions.
- ***Finance from industry and other stakeholders now required fro all CDTS***

David Willetts "The Government recognises that the Engineering Doctorate (EngD) qualification is an important and distinctive part of the UK's postgraduate landscape".

Industrial Partners

Distribution of Projects, 40% CCS

- CO_2 capture
  - Amines, post-combustion capture (5)
  - Adsorbents (5)
  - Oxy-fuel combustion (3)
  - Industrial capture (5)
- Transport, phase behaviour, properties and whole systems (4)
- Storage (3)
- Combustion, ash behaviour and modelling (7)
- High temperature materials (12)
- Biomass-related, preparation, conversion technologies (15)
- Oil-related, automobile - additives and engine deposits (4)

Training Programme

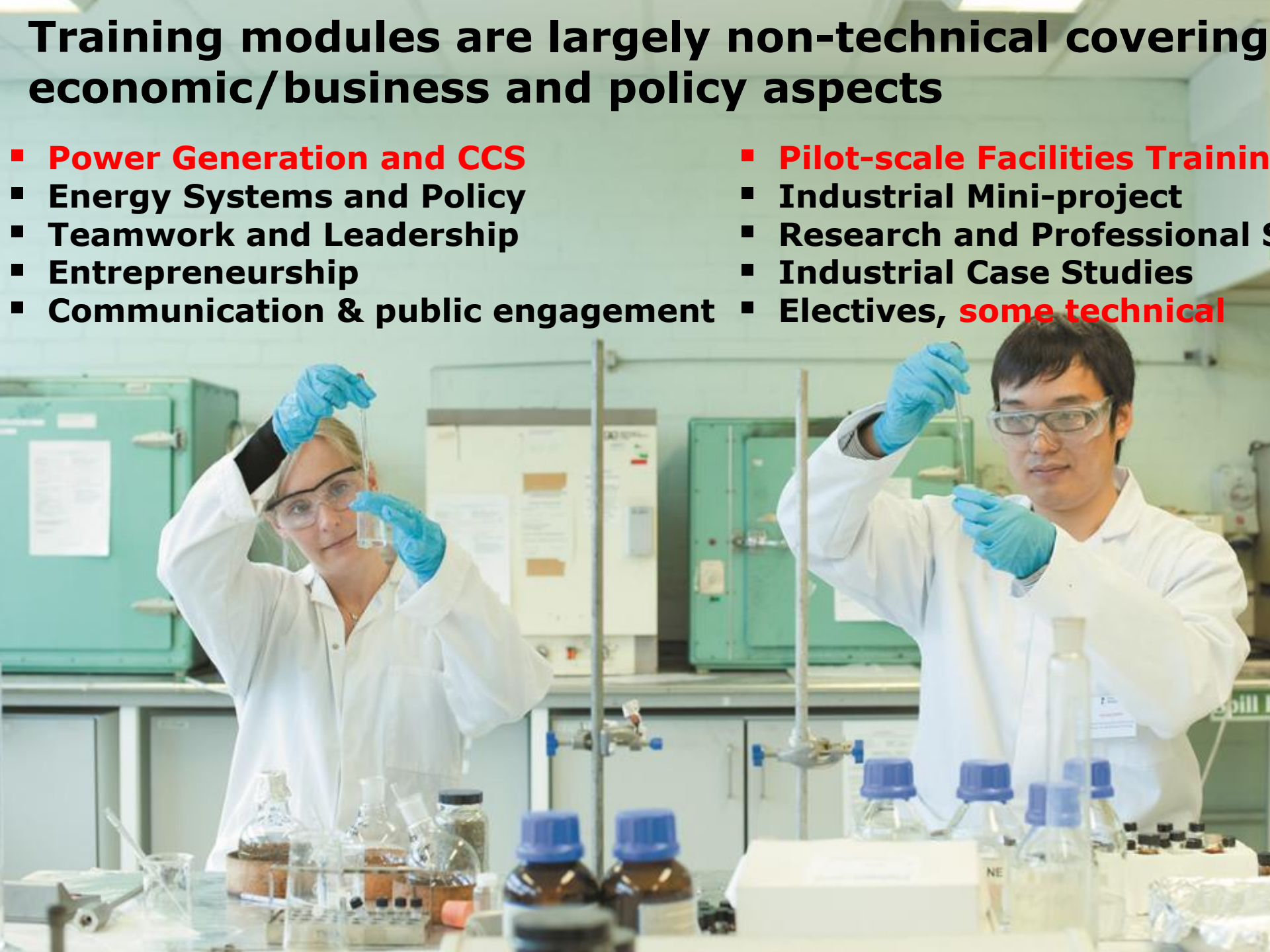
	Year 1			Year 2			Year 3			Y
Semester / Number of Credits	1	2	3	1	2	3	1	2	3	1
Team Building and Activity Week	*									
Core Taught Modules	60	30		20						
Optional Taught Modules				30						
Research Project Portfolio Modules		10			20					
Research Project										
Winter Conference		*			*			*		
International Summer School						10				

- Deliberately spread over 2 years to enable res commence in the first year.
- Block modules in year 2 when many EngDs ar companies.
- Winter conferences cement vertical integrati peer to peer learning between cohorts and E working on related topics.

Training modules are largely non-technical covering economic/business and policy aspects

- Power Generation and CCS
- Energy Systems and Policy
- Teamwork and Leadership
- Entrepreneurship
- Communication & public engagement

- Pilot-scale Facilities Trainin
- Industrial Mini-project
- Research and Professional S
- Industrial Case Studies
- Electives, some technical



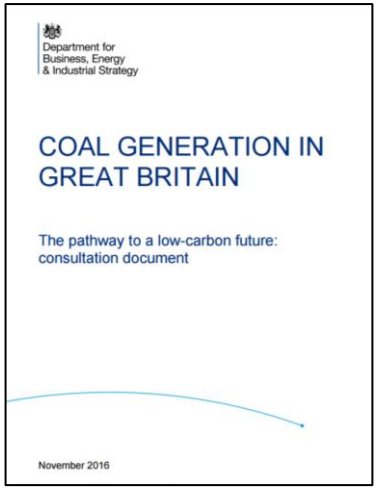
Communication and Public Engagement

- Schools events and University Mayfest (open day)
- Instruction in P.E. added to running events

Shaping Policy –Preparing Evidence for Parliamentary Committees

Group activity, energy-related topics

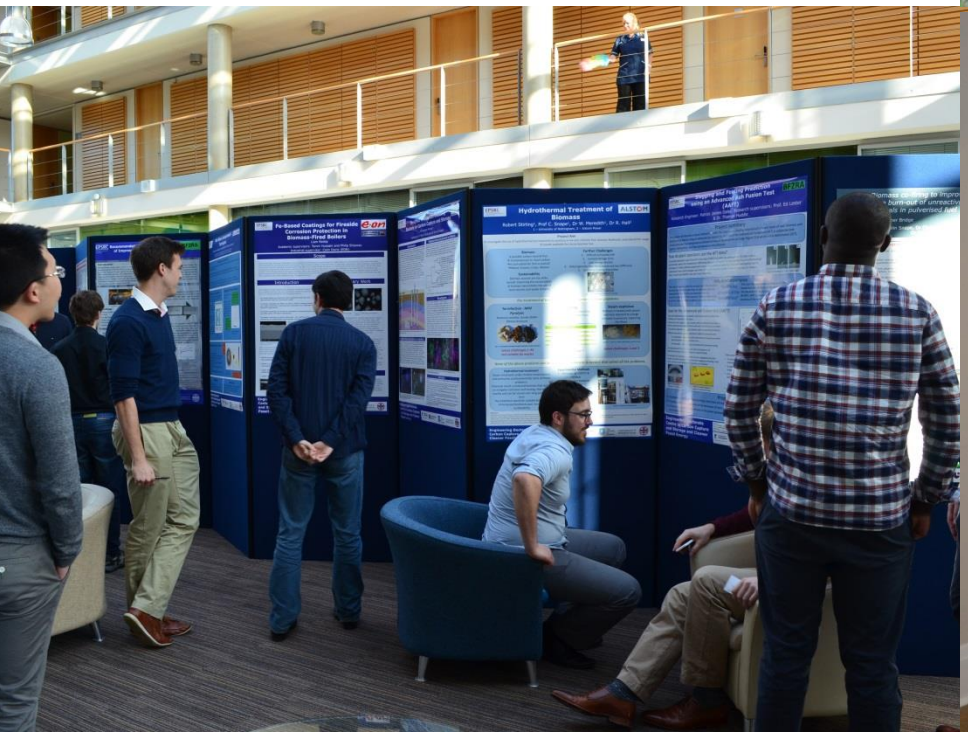
- Government's industrial strategy
- Fracking in Scotland, Scotland's energy sector
- Phasing out of coal-fired power stations
- Smart meters



International Summer School 2014
Pusan National University, Korea

- Focus on Far East – China,
  and Korea –due to the sca
  developments.
- Involves Group work with
  from host organisation, w
  and keynote presentation

Winter Schools – joint with UK CCS RC



Using the CDT Model to Grow Collaborative PhD Training Internationally

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- Industrial Doctorate Innovation Centre (IDIC) established at Nottingham's Ningbo campus in China.
- Funded by Ningbo Government, China MOST and industrial partners, £15M.
- 120 PhDs across energy and the digital economy.
- Same training programme as the CDTs.
- One year at Nottingham and 3 years at Ningbo.

Has well has the CDT Training Programme worked?

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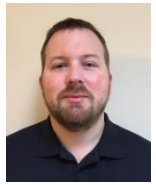
Hayden Morgan: Sulphate reducing bacteria in carbon dioxide

"Overall the CCSCFE CDT has provided me with a great range of valuable experience to help me complete my doctorate and to bring with me to my future work"

Thomas Hoey, Gradated 2016, RWE

The EFET Centre has provided me with a solid foundation in the energy industry which I hope to build upon for many years.

Dr. Scott Barham
Lead Engineer, Testing



"The EngD Centre has offered an excellent environment allowing us to combine our customers' requirements with the deep technical knowledge of the supervisors at the University of Nottingham to create something commercially viable and novel"

Dr. Robin Irons
Head of Innovation

"We believe that the CDT arrangement has been highly beneficial for us, for the students involved, for the Centre itself and the wider scientific community"

er Information on the CDT in CCS and er fossil energy and the training amme

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http://www.efetedc.ac.uk/ccscfe/

dge financial support from EPSRC for the CDTs:
45/1 (2009-2018) Engineering Doctorate Centre in Efficient Power from Fossil
d Carbon Capture Technologies,
62/1 (2014-2023) Centre for Doctoral Training in CCS and Cleaner Fossil Energy