Negative Emissions Technologies in UK Mitigation Strategies

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Air Capture and its Applications in Closing the Carbon Cycle

Monday, April 14th 2014
Davis Auditorium, Schapiro Hall, Columbia University, Room 412

Annual Conference between the Lenfest Center for Sustainable Energy at Columbia University and the Department of Energy Conversion and Storage at the Denmark Technical University (DTU)

The UKCCSRC is supported by the Engineering and Physical Sciences Research Council as part of the Research Councils UK Energy Programme

About the UKCCSRC

The UK Carbon Capture and Storage Research Centre (UKCCSRC) **leads and coordinates a programme of underpinning research on all aspects of carbon capture and storage** (CCS) in support of basic science and UK government efforts on energy and climate change.

The Centre brings together nearly 200 of the UK's world-class CCS academics and provides a **national focal point for CCS research and development**.

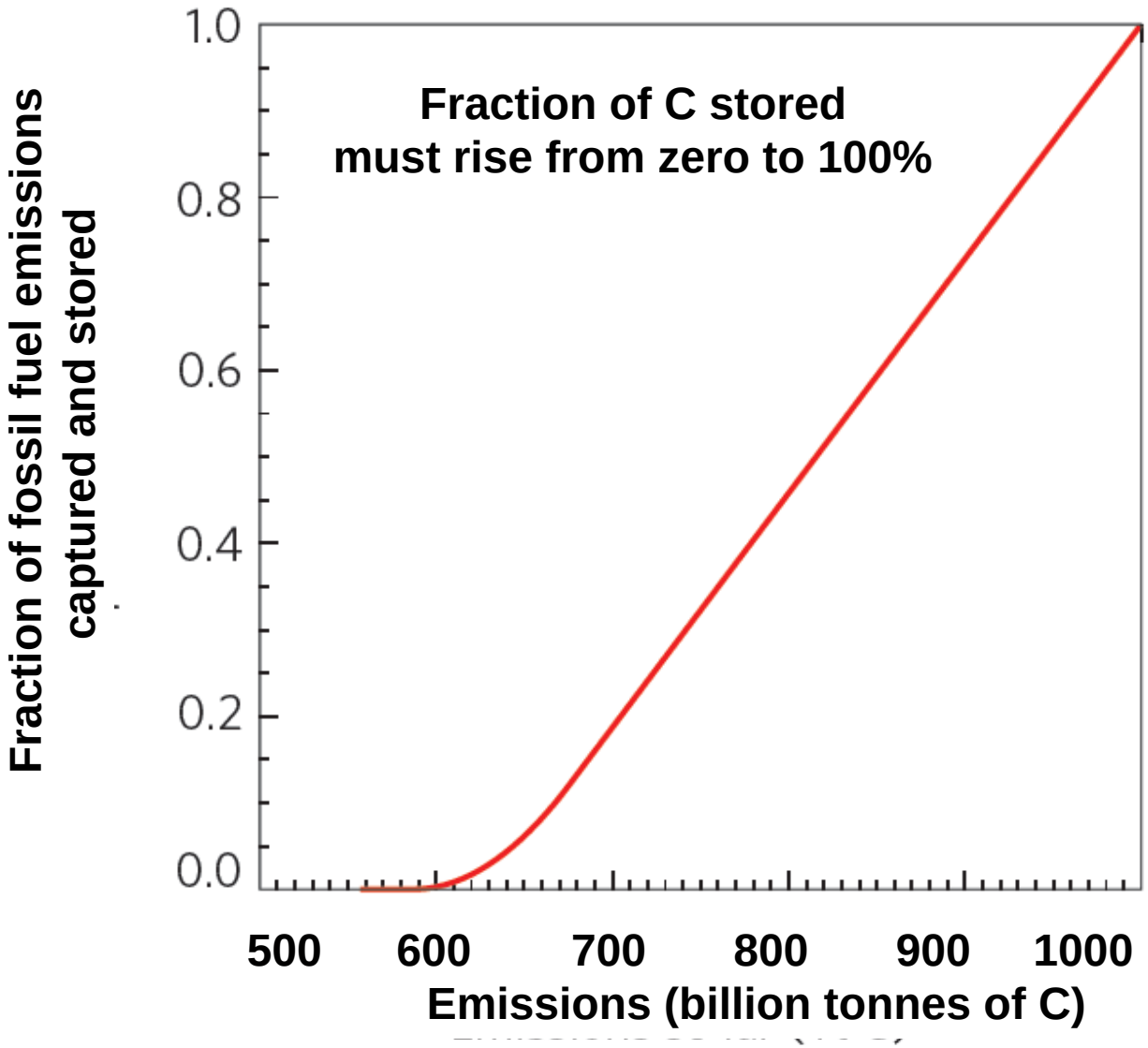
Initial core funding for the UKCCSRC is provided by £10M from the Engineering and Physical Sciences Research Council (EPSRC) as part of the RCUK Energy Programme. This is complemented by £3M in additional funding from the Department of Energy and Climate Change (DECC) to help establish new open-access national pilot-scale facilities (www.pact.ac.uk). Partner institutions have contributed £2.5M.

www.ukccsrc.ac.uk

Myles R. Allen, David J. Frame & Charles F. Mason, The case for mandatory sequestration, Nature Geoscience 2, 813 - 814 (2009), doi:10.1038/ngeo709

The prime climate objective is not to end the use of fossil fuels.

The prime objective is to develop and deploy 100% CCS in time to cap cumulative emissions of carbon at a safe level.



UKCCS RESEARCH CENTRE

Presentations available on:
https://ukccsrc.ac.uk/news-events/blog/direct-air-capturenegative-emissions-workshop

DIRECT AIR CAPTURE/NEGATIVE EMISSIONS WORKSHOP

UKCCSRC has organised this workshop to bring together UK researchers and stakeholders in the area of carbon dioxide removal (CDR, negative emissions or air capture). This remains a strategic technology for long-term emissions reductions because of the potential difficulty in decarbonising certain sectors of the economy (e.g. air and marine transport, agriculture, etc.). The aims are:

- To build a UK community of researchers and stakeholders in this area
- To expose the audience to the state of the art
- To explore and prioritise the research challenges that are relevant to the remit of the UKCCSRC

The format is a combination of keynote type talks and facilitated discussions.

Date: **Tuesday 18th March 2014**

Venue: Boardroom, Grantham Institute for Climate Change, Imperial College London, Exhibition Road, South Kensington, London, SW7 2AZ. Directions

Time: 10.00-15.30

Agenda:

Chaired by Nilay Shah, Imperial College London

10.00-10.40 Ben Anthony, Cranfield University - Direct Capture of CO2 from the Air
10.40-11.20 Niall Mac Dowell, Imperial College London - Power generation in the UK: Carbon Source or Carbon Sink?

11.20-11.40 BREAK

11.40-12.20 Maria Chiara-Ferrari, University of Edinburgh - Capturing CO2 from the air: Research at the University of Edinburgh

12.20-13.40 LUNCH

13.40-14.20 Tim Kruger, University of Oxford - Greenhouse Gas Removal: Proposed Techniques to Remove Greenhouse Gases from Ambient Air
14.20-14.40 Alexandre Strapasson, Imperial College London – Global Calculator project
14.40-15.30 Discussion on research priorities in CDR/air capture

Global Calculator Project:

The Greenhouse Gas Removal Approach

Alexandre Strapasson

Centre for Environmental Policy
Imperial College London

Direct Air Capture / Negative Emissions Workshop, 18th Mar 2014

Department of Energy & Climate Change

CLIMACT

eit Climate-KIC

CLIMATE MEDIA FACTORY

Energy R&D International

LSE THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

Imperial College London

EY Building a better working world

国家发展和改革委员会能源研究所
Energy Research Institute, National Development and Reform Commission

Introduction

Global Calculator

Objective

To help make the case for tackling climate change by:

- Showing detrimental impacts
- Illustrating aspirational low emission pathways.

Target audience

Target audience for tool are business leaders, NGOs and Governments.

- Starting date: September 2013
- First public release: July 2014
- Final version: December 2014

Ahead of the 2015 negotiations, we want to use the Global Calculator to make a compelling case on the need to take action

Main institutions involved in the project

Global Calculator

Funding:

Total: £ 1030 K

£550K DECC ICF funds

£480K Climate-KIC.

In collaboration with:

- World Resources Institute
- Utrecht University
- Potsdam Institute, Germany
- University of Reading
- Met Office
- Rothamsted Research
- University of Versailles, France
- Tyndall Centre
- University of Oxford

Preliminary version of the GGR approach

Global Calculator

Technologies included in the GGR lever with max. potential by 2050:

- Biochar (3.3 GtCO2/yr)
- Direct Air Capture (10.0 GtCO2/yr)
- Enhanced Weathering – Terrestrial (3.7 GtCO2/yr)
- Enhanced Weathering – Oceanic (10.0 GtCO2/yr)
- Ocean Fertilisation (1.0 GtCO2/yr)

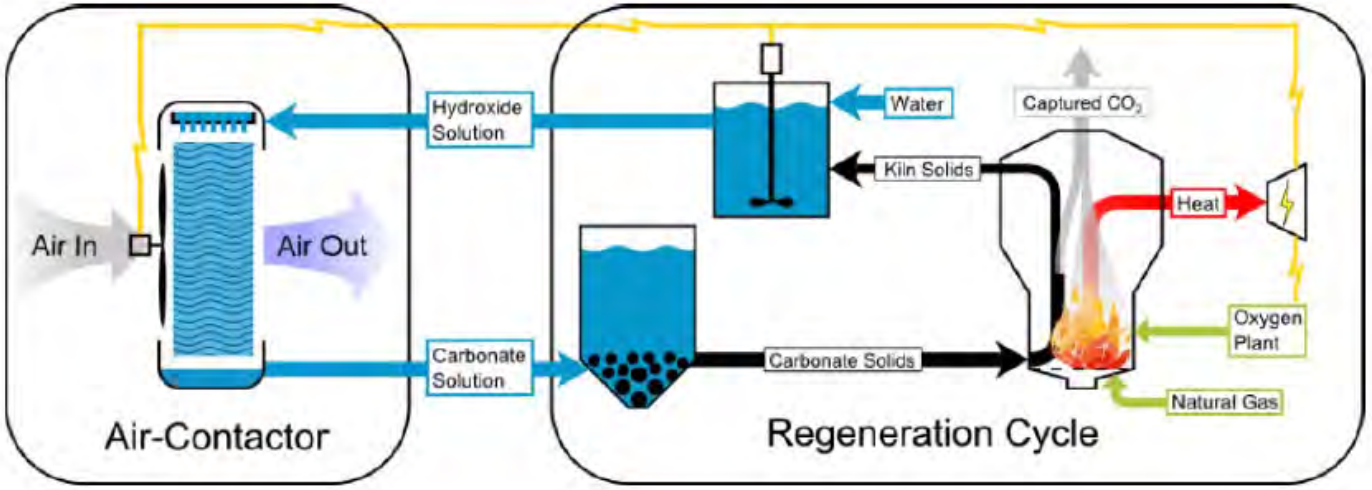
Technologies included elsewhere in the calculator:

- Afforestation / Reforestation
- Land Use Management / Soil Carbon
- BECCS

Direct CO_2 Capture from Air

Cranfield UNIVERSITY

Wet Scrubbing Process

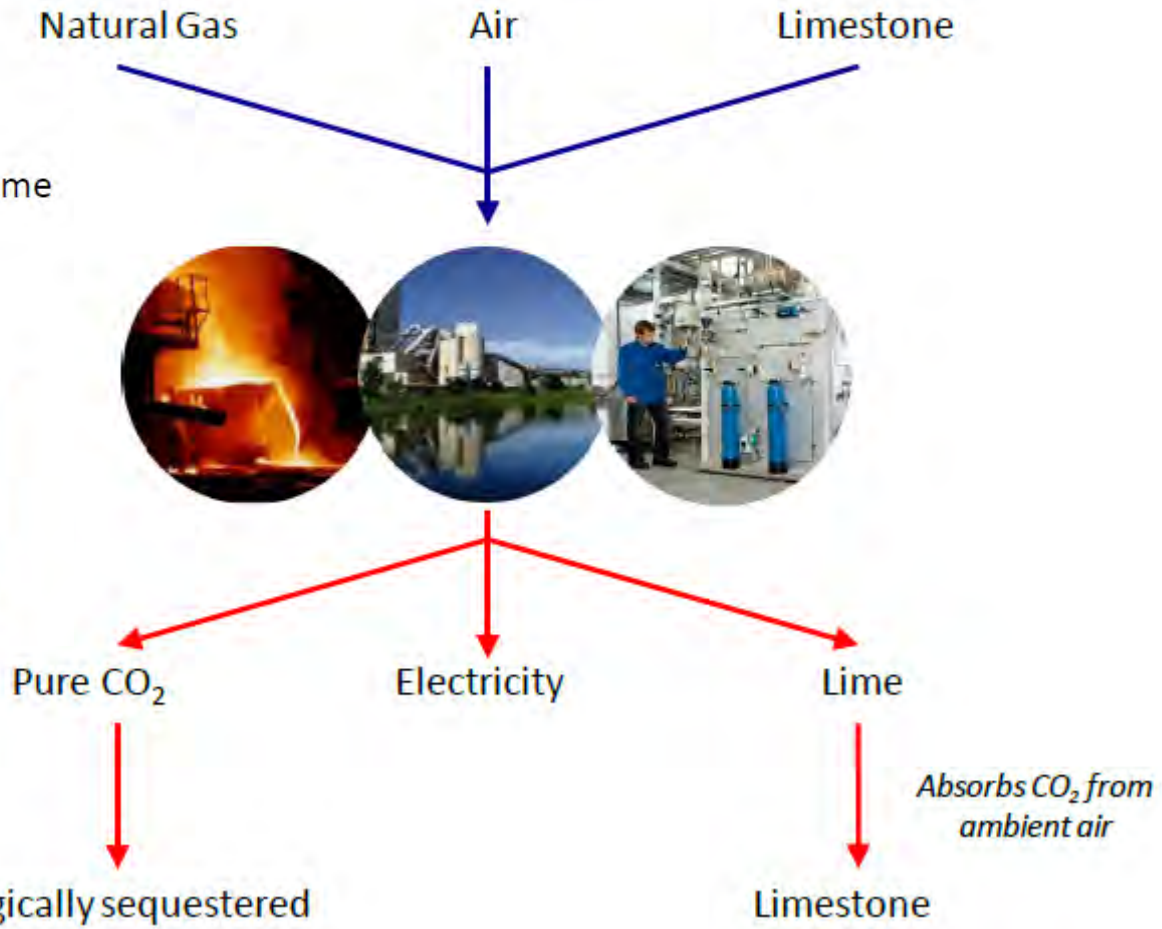


E.J. Anthony
Cranfield University

Carbon-negative power

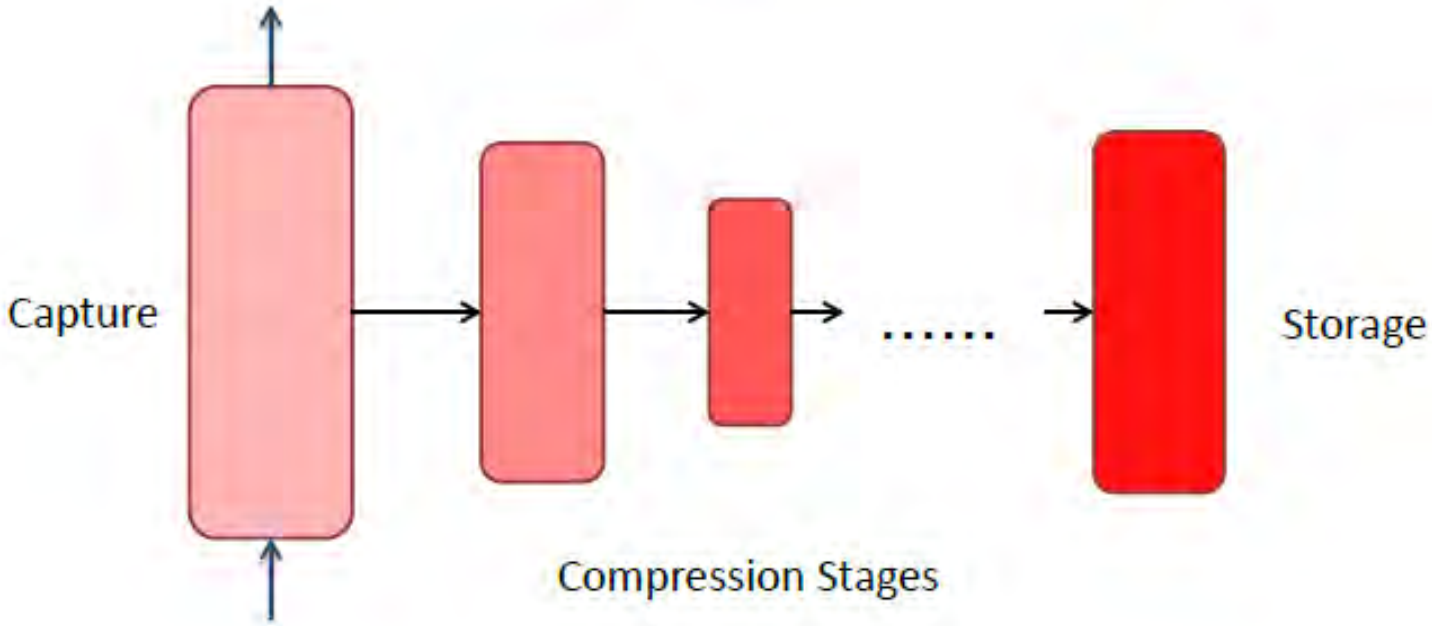
Tim Kruger
Oxford Geoengineering Programme
Oxford Martin School
University of Oxford
18 March 2014

JAMES MARTIN 21ST CENTURY SCHOOL



Air capture: domestic system

Compression and concentration of CO_2 with fixed beds



Maria-Chiara Ferrari

University of Edinburgh , School of Engineering, Edinburgh
SCCS – Scottish Carbon Capture and Storage Centre

EPSRC grant EP/I016686/1 - Nanotubes for Carbon Capture

BECCS Network: Conclusions

- Using existing generation assets, proven technology and indigenous biomass, its possible to remove 27 – 31 Mt_{CO2}/yr from the atmosphere
- This is equivalent to 23 - 26% of the UK's ground transport emissions in 2012
  - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/193414/280313_ghg_national_statistics_release_2012_provisional.pdf
- The MINLP framework we have developed provides a useful platform with which to investigate the potential of other BECCS technologies
  - For example, BIGCC + CCS and so forth

An indicative illustration of Drax Power Station (left) and the White Rose Carbon Capture and Storage Project (right)

White Rose CCS Project

- New standalone power plant at the existing Drax Power Station site near Selby,
- State-of-the-art coal-fired power plant with the potential to co-fire biomass.
- 426MWe (gross) oxyfuel power and carbon capture and storage
- 90% of all CO_2 emissions captured
- Capturing approximately 2 million tonnes of CO_2 per year
- Anchor project for Yorkshire CO_2 transportation and storage network

http://www.whiteroseccs.co.uk

White Rose CCS Project

Fuel (http://www.whiteroseccs.co.uk/your-questions-answered/fuel)

What mix of fuels will be used at the plant?
The primary fuel will be coal that is already fired at the existing power station. It is anticipated that the plant will be capable of co-firing biomass with the coal to reduce further the CO2 emissions.

How much fuel will the plant need?
The plant is expected to require approximately 1.2 million tonnes of coal and 300,000 tonnes of biomass per annum (assuming the combustion of 15% biomass).

Where will the fuel come from?
It is likely that the coal and biomass required will come from the same sources as the coal and biomass already delivered to the existing power station. These are a mix of imported coal and coal mined in the UK, as well as biomass sourced from abroad and from over 100 local farmers who have contracts to supply Drax with biomass products.

How will the fuel be stored?
The coal and biomass will be stored onsite within the existing coal stock area and transported to the new power station by a conveyor belt system. There will also be some fuel storage available on the project site.

Will biomass energy crops be grown at the expense of food crops?
Energy crops sourced by Drax are grown on land that is unsuitable for food production in order to comply with the company's robust sustainability criteria. Drax only purchases biomass from sources that are considered sustainable.

Peterhead CCS Project

Shell UK Limited and SSE

Post-combustion capture on one of three existing GT units

Approximately 400MW equivalent capacity (Siemens SGT5-4000F) and 1MtCO_2/yr

Gas turbine and heat recovery steam generator (HRSG)

http://www.shell.co.uk/gbr/environment-society/environment-tpkg/peterhead-ccs-project.html

Negative Emissions Technologies in UK Mitigation Strategies

Clear interest in negative emissions (between UKCCSRC and CO2Chem network – www.co2chem.co.uk)

BECCS well-established (but still no incentive)

Some fundamental R&D on other systems

Cross learning with conventional CCS

Mitigation via CCS and via negative emissions/air capture is seen on a spectrum of actions to achieve very low or even net zero or negative CO_2 emissions.