

A Generator's perspective

R&D in RWE npower

University of Nottingham EPSRC EngD Centre

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Dr Gerry Riley

Engineering (Boilers & Combustion Team)



An **RWE** company

RWE npower overview

Retail

- > Has around 6.8 million electricity and gas customers and is in the top three UK energy suppliers under the “npower” brand.

Generation

- > Operates over 10.3GW of coal, gas and oil plant in the UK, including biomass co-firing. Our sister company RWE Innogy, also operates one of the most diverse portfolios of renewables plant, such as wind and hydro.

Cogen

- > Operates generation facilities on customer sites, such as Lancaster University and Esso.

Power International

- > A collaboration between RWE Npower plc and RE GmbH providing services including Asset Development, Operations and Maintenance, Risk Assessment, Decommissioning, Environmental Management and Mining (through Rheinbraun Engineering).



RWE npower R&D organisation

- > R&D manages the portfolio of R&D projects in the npower generation business and also co-ordinates other npower R&D activities. The R&D portfolio is structured into a number of strategic themes addressing the key needs of the business
- > R&D is organised into technical and commercial activities including assessment of new technologies, management of information, determination of R&D strategy to meet the needs of the business and co-ordination of the project portfolio
- > R&D projects are undertaken by operating departments mainly within Technology Services but any group within npower can undertake R&D
- > Currently the key R&D providers are:
 - Boilers and Combustion
 - Plant Life and Integrity
 - Environment
 - TSG Ferrybridge Workshops
 - Construction and Operations Support

A generator's drive for R&D

- > Uncertainty over fuels, materials, skills and other commodity availabilities and costs
- > Government energy policy subject to review
- > Demand expected to rise and need to replace ageing power plant
- > Climate change agenda and more rigorous environmental performance standards
- > Increased competition as new players may enter the market
- > Energy affordability and fuel poverty
- > Developments in technologies and emerging new technologies
- > A possible longer term trend from primary fuels to electricity e.g. from gas with domestic heating and from oil with electric cars

R&D is an enabler of our future vision



- > Ensures we are an informed buyer with the ability to value risk and opportunities associated with new and emerging technologies
- > Allows us to deliver our strategic investment plans through providing expert and credible input to the regulatory and consenting agenda
- > Allows us to identify and implement incremental improvements to our existing power plants to improve economic performance
- > Positions us as a credible partner to regulator's and Government
- > Allows us to make strategic investments in technology



npower's R&D themes 2009 to 2012

Theme	Illustrative topics
Reducing CO ₂ from fossil plant by lowering emissions or by CO ₂ sequestration	Low-carbon: Efficiency improvements in existing plant, carbon capture (oxyfuel and post-combustion facilities at Didcot, development of Aberthaw pilot facility and studies on transport and storage
Reducing costs of operating plant and minimising risks of new plant	Operational: Materials for supercritical plant, new NDT methods for plant maintenance, development of plant monitoring and optimisation techniques and development of repair capability for turbine components to minimise cost and outage time
Lower non-carbon emissions and use of resources (e.g. ash and water)	Sustainability: Minimising emissions to air, options for avoiding fly ash to landfill and life-cycle analysis of emissions control technologies
Distributed generation and grid and network issues	Distribution: Evaluation of options for electric vehicles e.g. enhanced distribution networks for recharging

Collaboration at the heart of our R&D

- > Critical to our R&D programme is collaboration in external networks and specific projects
- > An example: CO₂ reduction

Internal projects

- Didcot 1 t/d PCC
- Oxyfuel test facilities
- Aberthaw 3 MW_e
- Demonstrator plant

External collaboration

- DBERR CASS-Cap amine capture
- Doosan Babcock-led OXY-COAL Project
- RFCS ECO-SCRUB hybrid CO₂ capture, 7 partners, 5 EU states
- EC FP7 CESAR PCC consortium member

Networks

- UK CCSA
- EC CO2NET
- Support University of Regina and University of Texas

External funding and support to universities

Key relationships deployed to supplement knowledge, introduce new areas of technology, develop capacity and skills in key strategic areas



VATTENFALL



Doosan Babcock Energy



Carbon Capture & Storage Association



An RWE company

CCS development a current priority

CCS tested and commercially available for 2020

2007		2008		2009		2010		2011		2012		2013		2014		2015		2016		2017		2018		2019		2020			
H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2

Timescale

Issue	Phase 0	Phase 1	Phase 2
Operation	2008	2010	2014 - 2016
Capture	☑	☑	☑
Transport	☒	☒	☑
Storage	☒	☒	☑

Benefits

Phase 0	Phase 1 (~3 MW)	Phase 2 Demonstration
CTF development	Pilot plant	(Government competition)
<ul style="list-style-type: none"> > Basic chemistry of capture solvent > Environmental issues > Design criteria > Energy requirements > Plant size and materials > Ongoing development 	<ul style="list-style-type: none"> > Scale up capability > Design optimisation > Integration issues > Availability/maintenance > Operating costs > 2 years operation 	<ul style="list-style-type: none"> > Scale up capability > Impact on boiler plant > Interface with FGD/SCR > Thermodynamic plant integration > Capture optimisation > 15 years operation

Phase 0: CTF Amine Test Rig (2008)

- > Pilot scale amine unit interfaced with 0.5 MW_{th} test facility
 - Processes approximately ~33% of pilot rig gas flow
 - Equivalent to approximately 1 tonne per day
 - Extended test periods using synthetic gas option
 - Use with coal or biomass co-firing and in air or O₂/CO₂
- > Opportunity to learn from design, build and operation
- > Generate data for desktop and modelling studies
- > Develop low cost screening capability for solvents
- > Improve understanding of technologies on offer
- > Collaboration with key EU university partner programmes

Post Combustion Capture at Didcot



Aberthaw pilot facility (operational 2010)



- > Key role in capability development
 - build operational experience
 - assist in technical decisions for demonstration and in troubleshooting plant in early years
- > Evaluate issues requiring longer operation and larger scale
 - Long-term degradation of solvent
 - investigate solvent losses and estimate replacement costs
 - understand by-product quantities and treatment
 - develop analytical capability e.g. on-line analysis
 - Materials
 - effect of conditions on materials
 - know-how to plan maintenance regime for full scale plant
 - Scale-up
 - thermodynamics of process
 - evaluate model performance

Oxyfuel Studies

Conversion of CTF to oxyfuel

- > Storage tanks for O₂ and CO₂ with mixing and safety systems
- > Provides the capability to investigate hybrid systems with oxygen enhanced post-combustion capture
- > System commissioned in 2008



Oxyfuel programme objectives

- > Fundamental combustion studies
- > Safety/Heat transfer
- > Optimum Recycle rate
- > Wet/Dry recycle options
- > Coal impacts
 - Emissions;
 - Carbon in Ash
 - Ash behaviour

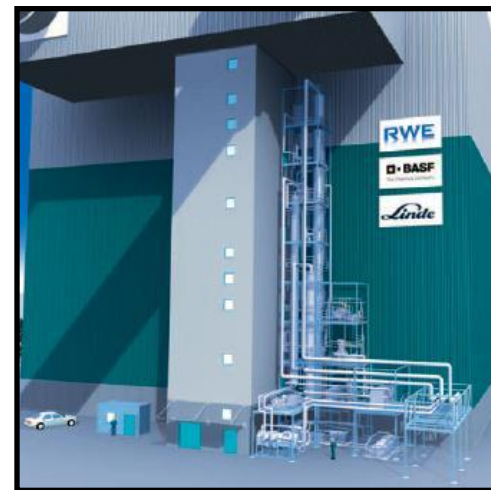
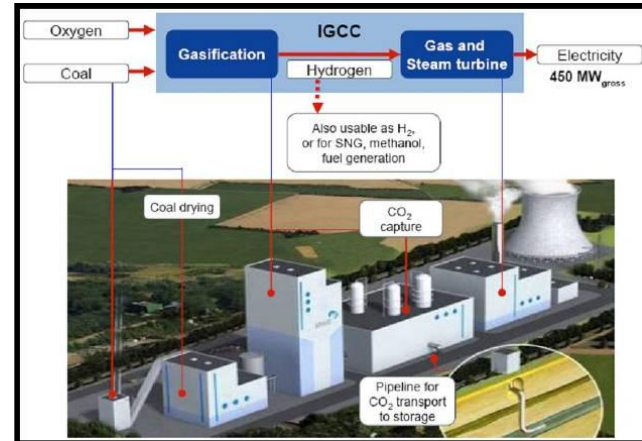
CO₂ current collaborative projects



- > We are involved in a number of research programmes funded in part by UK Government or the EC, looking at a range of CO₂ capture and storage issues
- > ECCO project aims to overcome the barriers to the storage of CO₂ by developing models for petroleum reservoirs and deep saline aquifers
- > CASS-cap 'Carbon dioxide amine separation and storage for capture' investigates the use of absorption processes for post-combustion CO₂ capture
- > CESAR project aims to increase the efficiency and reduce the costs of post-combustion capture
- > CO₂Net is a carbon dioxide knowledge transfer network

CCS activities - Germany

- > Lignite fuelled IGCC with CCS to be constructed in Huerth near Cologne
- > 450MWe_{gross} with CO₂ transportation and storage infrastructure
- > Request broad-based support and appropriate development assistance
- > Post-combustion CCS pilot plant to be constructed at Niederaussem
- > Treat flue gas from full-scale power plant
- > Collaboration with Linde Group and BASF for long term testing of new solvents and process development



Electro-mobility “e-mobility Berlin”



- > Joint project with Mercedes Benz and Smart to produce 100 electric vehicles and 500 charging points in the city of Berlin
- > RWE responsible for the development, installation and operation of the charging infrastructure including the supply of electricity, and central control of the system
- > Payment system takes the form of data exchange between in-car communication system and intelligent charging point
- > UK effort mainly focussed on desk-top studies
 - rechargeable hybrids may have more potential than pure electric vehicles
 - Potential for 20% or more growth in our electricity sales within 15 years