UK/US Collaboration in Energy R&D: Clean Coal Technology

Workshop on New Research Areas

OMNI William Penn Hotel
Pittsburgh
PA, US
24th May 2010

Outline

- Background – MOU and IA
- Why Collaborate?
- Collaboration Framework
- Phase 1 Program – Advanced Materials and Virtual Plant Simulation
- Phase 2 Program - Advanced Materials, +

Background 1

MOU

- Signed 6th November 2000
- Covers fossil and renewable energy systems and all possible types of collaboration from exchange of samples, to workshops, to fully integrated projects
- Inputs from either side are funded nationally – there is no provision for cross funding
- Materials identified as a priority topic for collaboration

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Background 2

DOE/DTI Workshop

- Held in Knoxville, Tennessee in June 2001
- Workshop identified many topics of common interest where collaboration would be possible
- Text for Implementing Arrangement revised
- Materials, Virtual Plant Demonstration, Near-zero Emission Power Plants, CO_2 Capture & Sequestration, Distributed Generation listed as 'tasks' to be developed

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Background 3

Implementing Arrangement for Fossil Energy RTD

- Signed 10th March 2003
- Sets a framework for collaborative 'tasks' with named UK and US leaders
- Followed up with workshop at NETL, Pittsburgh in June 2003
- Agreed to proceed with collaborative tasks on Materials and Virtual Plant Simulation
- Draft tasks prepared at the workshop
- Joint Coordinating Committee established to oversee the activities under the Implementing Arrangement
- Annual meetings of the JCC receive reports on progress and look to develop new collaborations

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Background 4

Framework for Collaborative Tasks

- Contributions from nationally-funded public domain research
- Task proposals define equitable research collaboration
- Detailed work program aligning UK and US activities to maximise exchanges and benefits

Collaboration started April 2004

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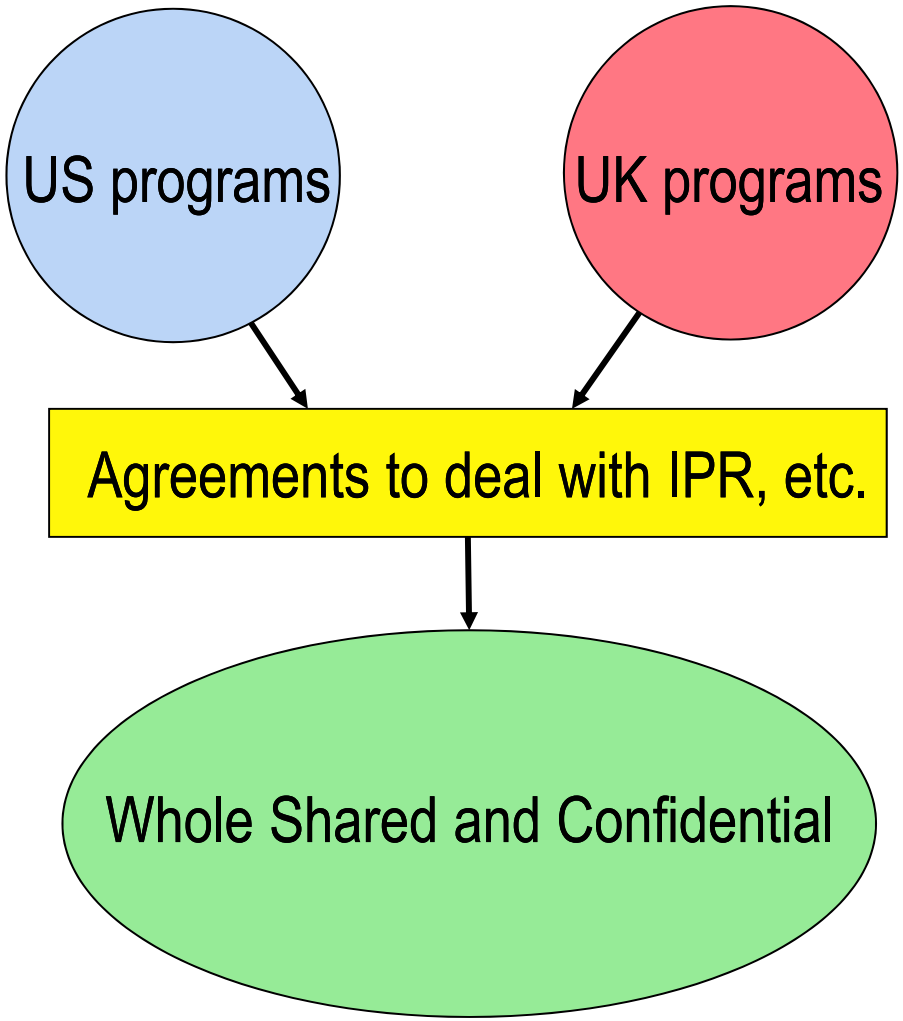
Collaboration Issues

- **Type of Collaboration**
  - Sharing of samples, procedures, etc.
  - Joint workshops
  - Access to facilities
  - Integrated research
- **Intellectual Property**
- **Culture of Collaboration**
- **Funding requirement**

The Challenge

How can we get extra value from the $$ spent?

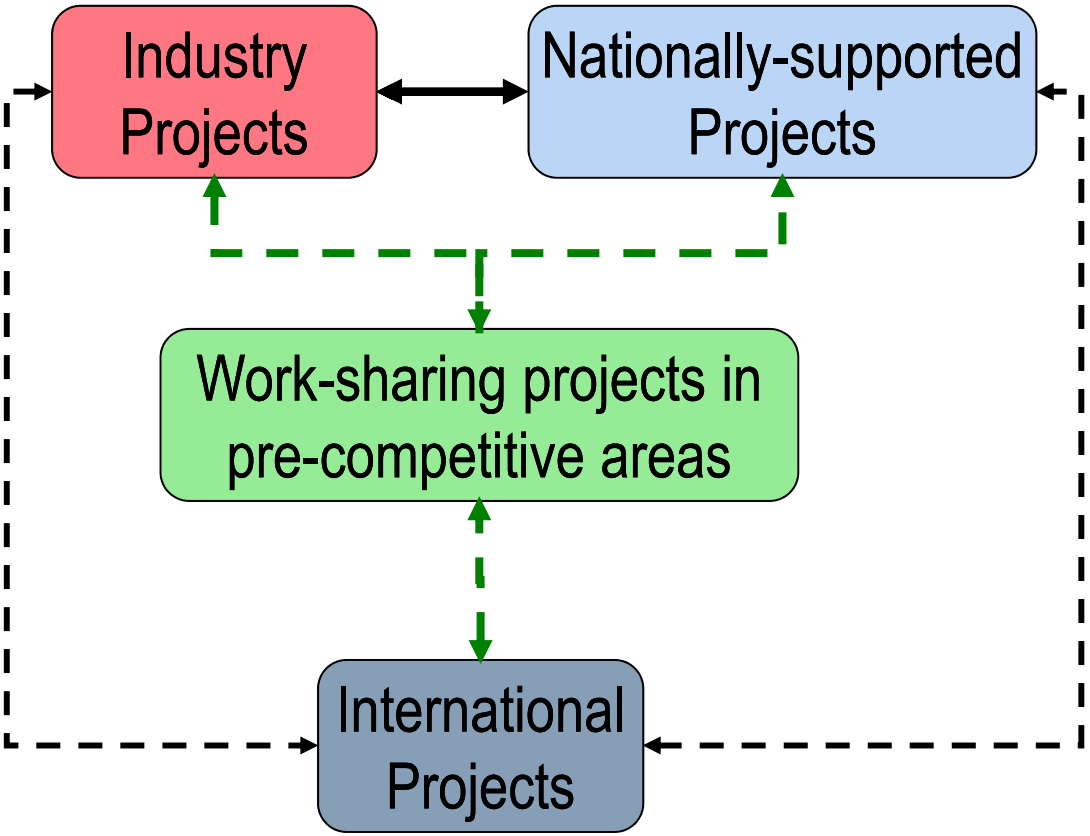
usual cooperative arrangements involve cumbersome, time consuming agreements



The Solution?

Collaboration on common, pre-competitive topics offers a rational approach

without the need for complex agreements



Key Benefits

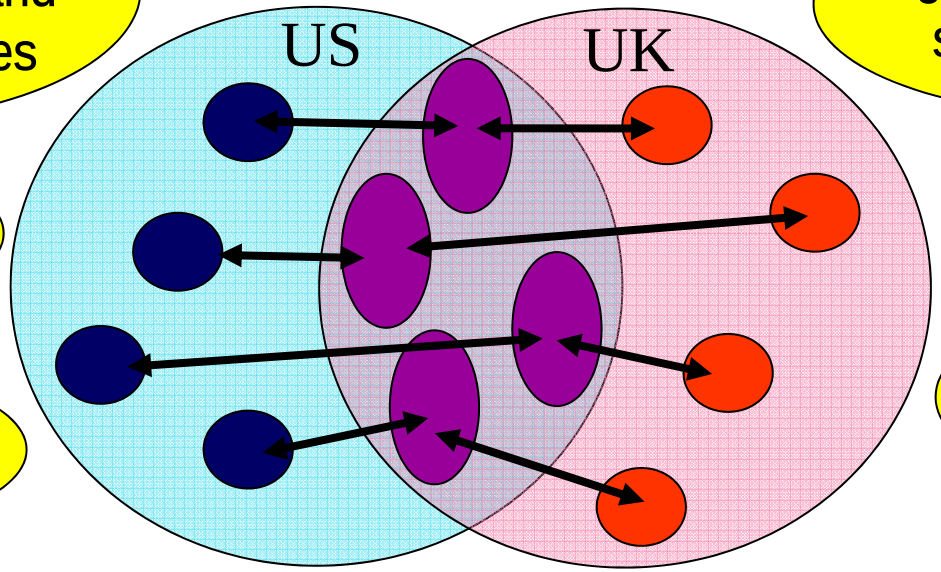
- Cost and Time Savings
- Access to Facilities, Skills and Capabilities
- Common Approach to Standards

Why Collaborate?

Increased specialist knowledge pool

Improved vision of industrial needs and national strategies

Highly cost effective - small extra cost



Critical review of methods & results

Reduced risk of wasted effort

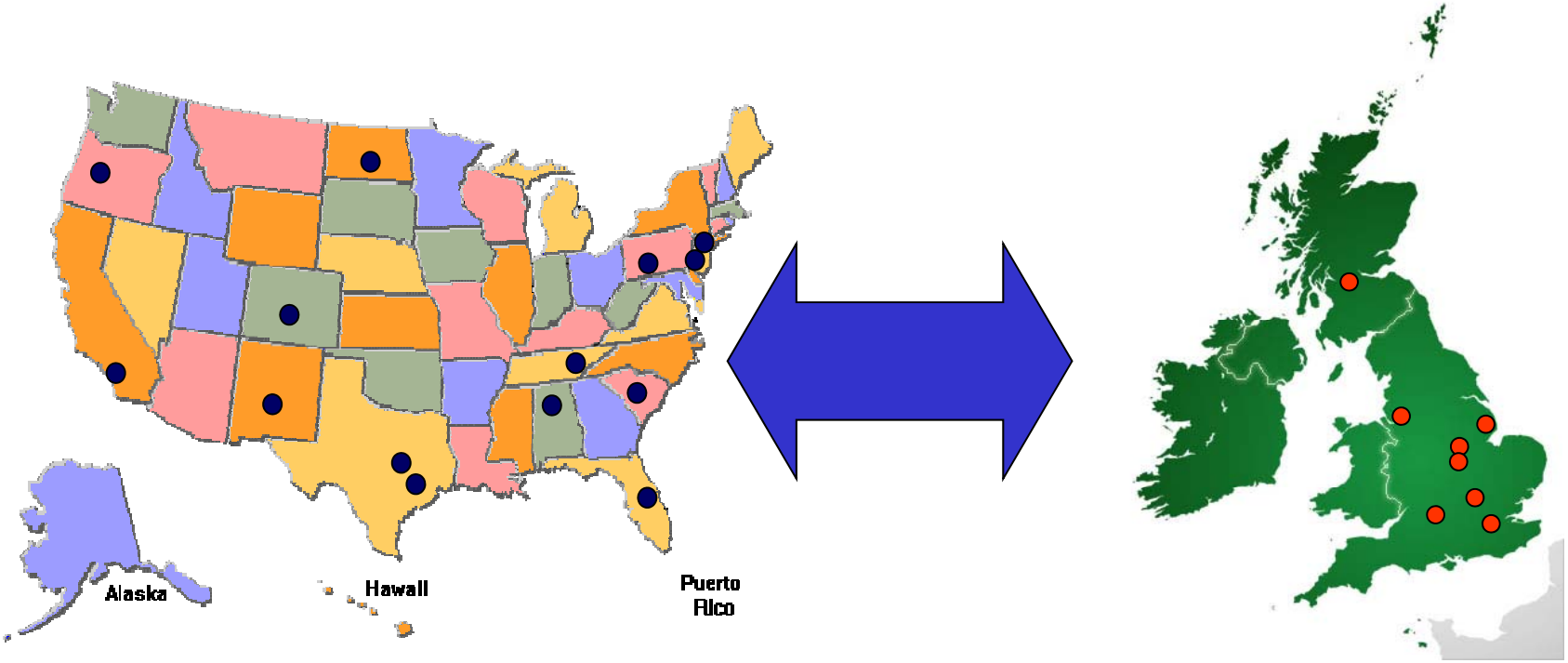
Access to unique facilities

Improved confidence in outputs

Less time to develop design & modelling capability

Improved quantity & quality of data

UK/US Collaboration on Advanced Materials



Advanced Materials
Phase 1 Tasks

All tasks aimed at increased plant efficiency and reduced emissions

- **Steam Oxidation**
- **Boiler Corrosion & Monitoring**
- **Gas Turbines Fired on Syngas and Other Fuel Gases**
- **Oxide Dispersion-Strengthened (ODS) Alloys**
- **Standards & Databases**

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Summary of Advanced Materials Phase 1 Experience

- Accelerated progress in complex areas
- Extensive and faster data development
- Effective working relationships to face new challenges
- Shared experience improves outputs and reduces risks
- Awareness of current testing limitations
- Formulation of new approaches
- Effective benchmarking and data qualification
- Improved awareness of industrial needs and national priorities

Active Advanced Materials Phase 2 Tasks

- **Steam Oxidation**
- **Materials for Advanced Boilers and Oxy-Combustion Systems**
- **Gas Turbine Materials Life Assessment and Non-Destructive Evaluation**
- **Oxide Dispersion-Strengthened Alloys**

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Virtual Plant Simulation
Key Objectives

- Improve focus and efficiency of UK **Virtual Plant Demonstration Model (**VPDM) and **Advanced Process Engineering Co-Simulator (**APECS) R&D activities through information exchange and dissemination
- Provide software interoperability between APECS and VPDM
- Increase leverage for influencing software vendors and open standards organizations
- Develop potential for long-term cooperation in virtual plant simulation from experience gained during project collaborations

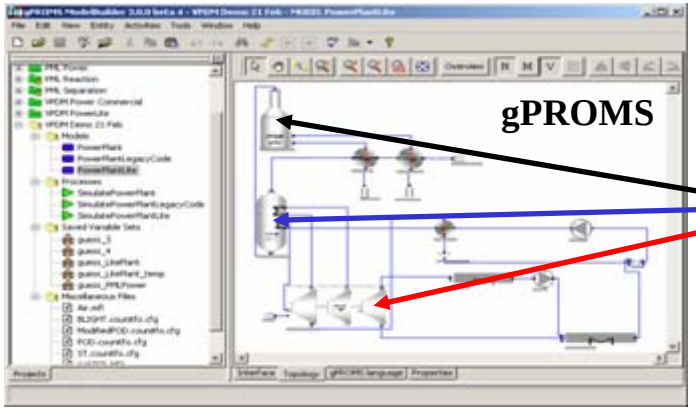
Virtual Plant Simulation
Major Accomplishments

- Provided compatible process/equipment co-simulation software platforms – APECS and VPDM
  - Exploited process industry CAPE-OPEN software standard
  - Demonstrated model interoperability: CFD, CEMs, ROMs

- Applied to advanced fossil-energy power generation systems
  - Used VPDM/APECS to demonstrate FLUENT CFD and neural network ROM furnace model running in gPROMS co-simulation of a UK coal-fired power station

VPDM
Power Plant Demonstration

- UK conventional coal-fired power station
  - Plant: PSE (gPROMS)
  - Equipment
    - Furnace – RWE; CFD (FLUENT), ROM (ANN)
    - Boiler – Doosan Energy
    - Turbine – ALSTOM



Power Plant Model

Distributed Equipment Models

Workshop Aims

- Background to existing US-UK Collaborations
- Update on industry-focused RTD priorities in Fossil Energy
- Forum to explore potential collaboration opportunities

Workshop Approach

- Presentations on possible 'offerings' and 'interests' from workshop participants – open session

- Break-outs
  - to consider areas of overlap and common interest
  - if common interest established, to identify US and UK leaders to take forward agreed collaboration topics
  - report back to workshop

- Next steps
  - to prepare 2-page task proposal for JCC consideration

Process for Developing Collaborations

- Identify topics of common interest between UK and US
- Prepare 2-page task proposal highlighting the areas of interest and 'quid pro quo' for JCC review
- When agreed, JCC will appoint UK and US task leaders
- Start collaboration and report back annually to the JCC

2-page proposal

- Project Title
- US and UK Task Leaders
- Introduction
- Objectives
- Deliverables
- Start Date and Completion Date
- Detailed Description of Work
- Quid Pro Quo – person years and $/£
- Key Milestones and Dates

Workshop Approach

Presentations on possible 'offerings' and 'interests'

- **Materials**
- **Sensors and Monitoring**
- **CO2 Capture**

Offerings could form a new task if 'quid pro quo' possible <u>or</u> could join as an extra input to an existing Phase 2 task (Materials)

Materials		
Mike Santella	ORNL	Creep strength-enhanced ferritic steels
Peter Tortorelli	ORNL	Creep strength-enhanced ferritic steels
Patricia Rawls	NETL	Creep strength-enhanced ferritic steels Steam Oxidation Phase 2 Boiler Corrosion – Phase 2 Gas Turbine Materials Life Assessment and NDE – Phase 2 ODS Alloys – Phase 2
Nigel Simms for Ilias Nikolaidis	Cranfield (RR – not attending)	Corrosion LIfing Methods And Testing (CLIMATE)
Craig Degnan	EON	Innovative Materials, Design and Monitoring of Power Plant to Accommodate Carbon Capture
Geert Verhaeghe	TWI	Verified Approaches to Life Management & Improved Design of High Temperature Steels for Advanced Steam Plants (VALID)
Nigel Simms	Cranfield	Carbon Abatement Using Surface Engineering Technologies (CASET) Steam Oxidation – Phase 2 Boiler Corrosion – Phase 2 Gas Turbine Materials Life Assessment and NDE – Phase 2 ODS Alloys – Phase 2

Sensors and Monitoring		
Susan Maley	NETL	Sensors for High Temp GTs in Harsh Environments
Evan Lally Anbo Wang (dial-in)	Virginia Tech University	Sensors for High Temp GTs in Harsh Environments
Hia Xiao	Missouri Science & Technology Center	Sensors for High Temp GTs in Harsh Environments
Steve Goodstine	Alstom Power	Sensors for High Temp GTs in Harsh Environments
Nancy Ulreich	Siemens Power - telecon	Sensors for High Temp GTs in Harsh Environments GT, Life Assessment and NDE – Phase 2
Brian Strazisar	NETL	CO2 Sensors
Junhang Dong	Uni Cincinatti	Sensors for High Temp GTs in Harsh Environments
Stephen Fasham	Oxsensis - telecon	Fast REsponse Temperature Sensors for GAs Turbine Efficiency
Scott Hoover	RR - telecon	
Kevin Dodds	BP Alt Energy	Nanoscale Gravity Sensors for Monitoring CO2 Storage

CO2 Capture		
Frank Morton	Southern Companies	PSDF – Gasification
Tim Fout for Jared Ciferno	NETL	National Carbon Capture Centre FE Post-combustion solvent capture program
Michael Knaggs	NETL	Overview of FE Algae R&D Program
Malc Hillel	RR – not attending	CO2 separation by compression
Peter Tune	CPI	Industrial CO2 as a precursor to sustainable biomass: reducing energy consumption and CO2 footprint.
Kevin Dodds	BP Alt Energy	Efficient Water Gas Shift Technology for Low-Carbon Electric Power Generation from Fossil Fuels
Bryony Livesey Sean Black	Doosan	CCPilot100+