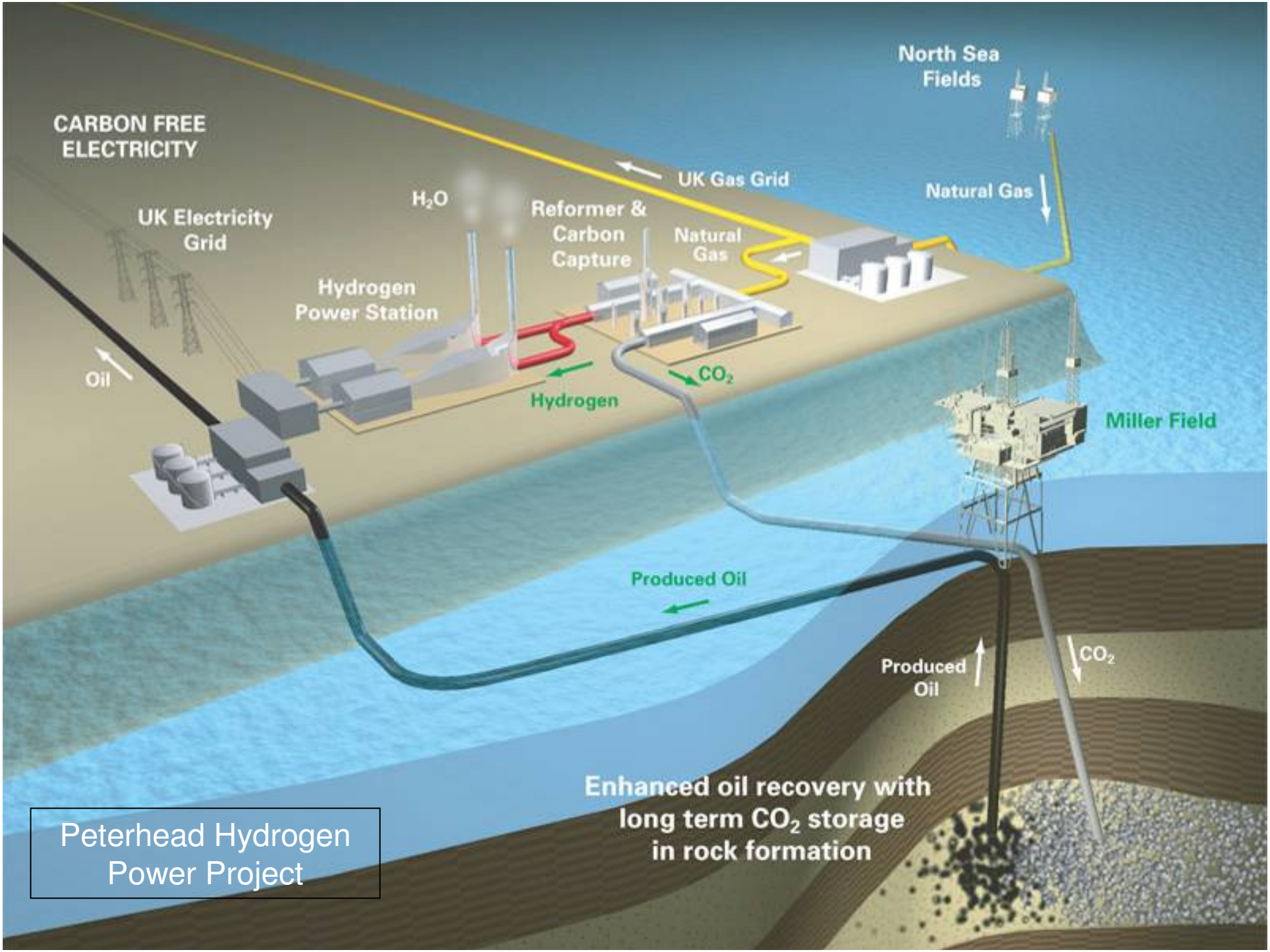
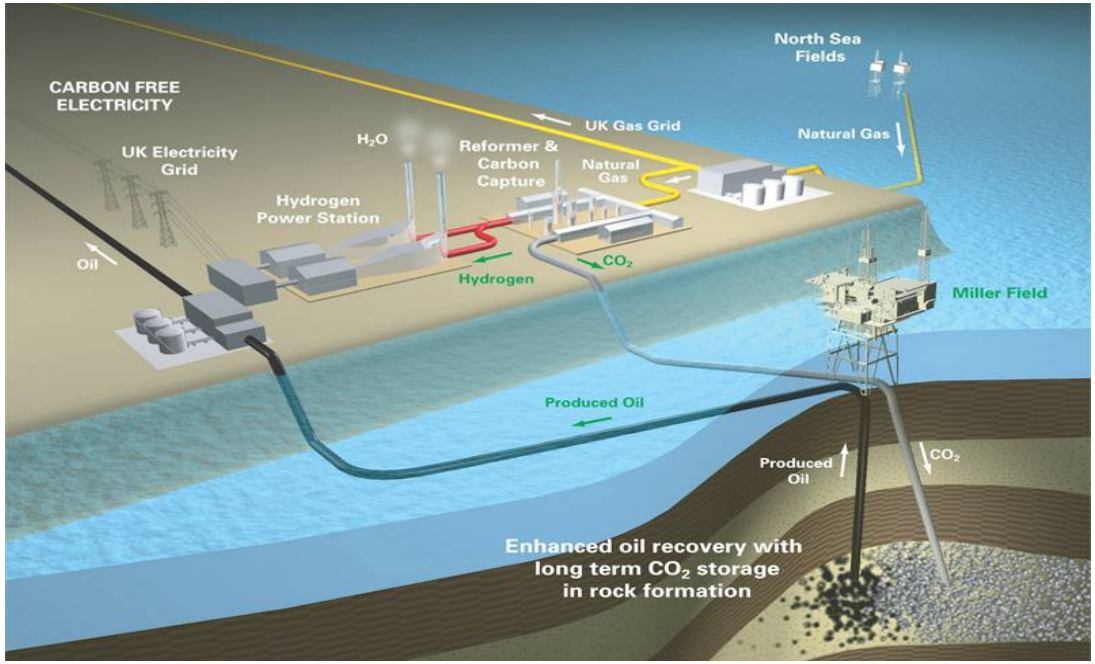
Pre-combustion capture from gas: "The Peterhead Hydrogen Power Project"

Gardiner Hill
Director Technology

CSLF Workshop: " Overcoming Barriers to CCS deployment"
Paris, March 2007


CARBON FREE ELECTRICITY
UK Electricity Grid
UK Gas Grid
North Sea Fields
Natural Gas
H_2O
Reformer & Carbon Capture
Natural Gas
Hydrogen Power Station
Oil
Hydrogen
CO_2
Miller Field
Produced Oil
Produced Oil
CO_2
Enhanced oil recovery with long term CO_2 storage in rock formation
Peterhead Hydrogen Power Project

Peterhead Hydrogen Power Project, Scotland



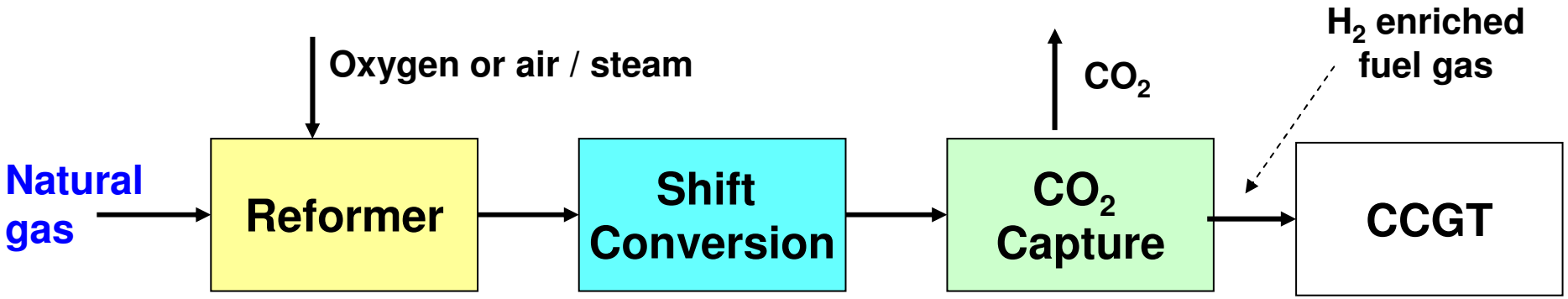
Project Milestones

- Europe's largest hydrogen-fired power generation facility
- Largest CO_2 EOR project in North Sea
- 1st CO_2 storage in an offshore oil field
- Uses Auto Thermal reforming technology

Climate Change Milestones

- 475 MW of clean electricity - enough to power about 300,000 homes
- Capture 1.8 million tpa of CO_2 and sent via pipeline to Miller field for use in CO_2 EOR and permanent storage -- equivalent of removing 500,000 cars from the road
- This one project is almost equivalent to the UK's entire wind farm capacity combined

Peterhead Hydrogen Power Project – Key Technology Elements



Key challenges for CCS

- **Reducing Costs of CCS:** Managing project costs and developing and applying technology to further drive down the cost curve especially for conversion with carbon capture
- **Mitigating technical risks:** technology risks mitigated through the application of known technologies (where possible)
- **Enabling Support Policy from Government:** Support for development of commercial mechanisms to enable the generation of low carbon electricity from decarbonised fuels
- **Public and regulatory acceptance of CCS:** Develop protocols with relevant parties to assure safe transportation, storage and monitoring of CO_2. Reaching agreements on long-term public stewardship of storage sites
- **Building Internal Capability:** Develop people and know-how across several core technologies to support business development

Reducing Costs of CCS

Managing project costs and developing and applying technology to further drive down the cost curve especially for conversion with carbon capture

Research

CMI Carbon Mitigation Initiative Princeton University

PEI Princeton Environmental Institute

Industry / Academic Initiatives

CO_2 Capture Project

Technical Demonstrations

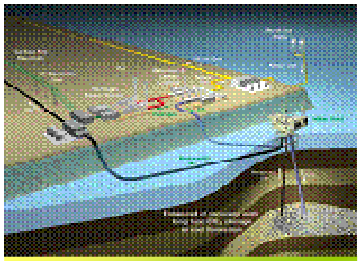
Source-sink matching
CO2CRC, EUGeocapacity, Coach, US Regional partnerships

Public policy support
CSLF, ECCP, EU-ZEPP, CDM

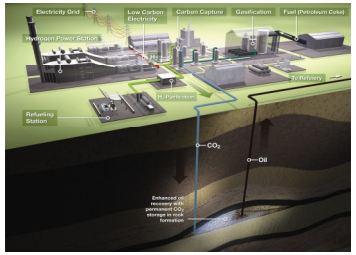
Assurance framework
CO2CRC, CSLF, IMCO2, WRI

3rd Party Demonstrations
Sleipner, Weyburn, CO2Remove

Industrial Scale Projects



DF1

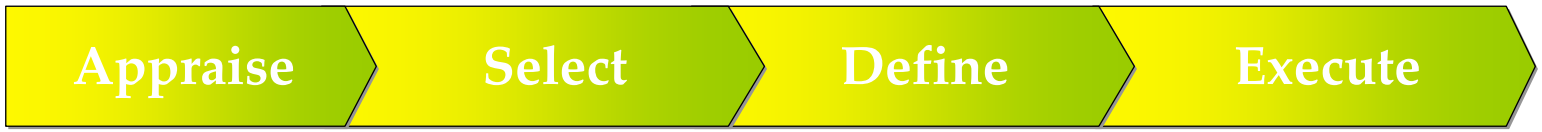


DF2

DF3, 4, 5 . . .

Mitigating technical risks

Technology risks mitigated through the application of known technologies (where possible) and rigorous TCVP



- Apply proven technologies in combination for commercial scale project
- Industry has experience with reformer technologies for syngas
- Upstream and downstream experience with carbon capture technologies
- Significant power industry experience with CCGTs (combined cycle gas turbine)……Choosing the right partners
- Power and Downstream experience with syngas and H2 firing in gas turbines

Enabling Support Policy from Government

Support for development of commercial mechanisms to enable the generation of low carbon electricity from decarbonised fuels

Needs:

- Policy --- CCS is already competitive with renewables so only needs the same level of policy support as currently provided to renewables
- Large Scale Demonstration --- to build confidence and gain broader public acceptance

Missing:

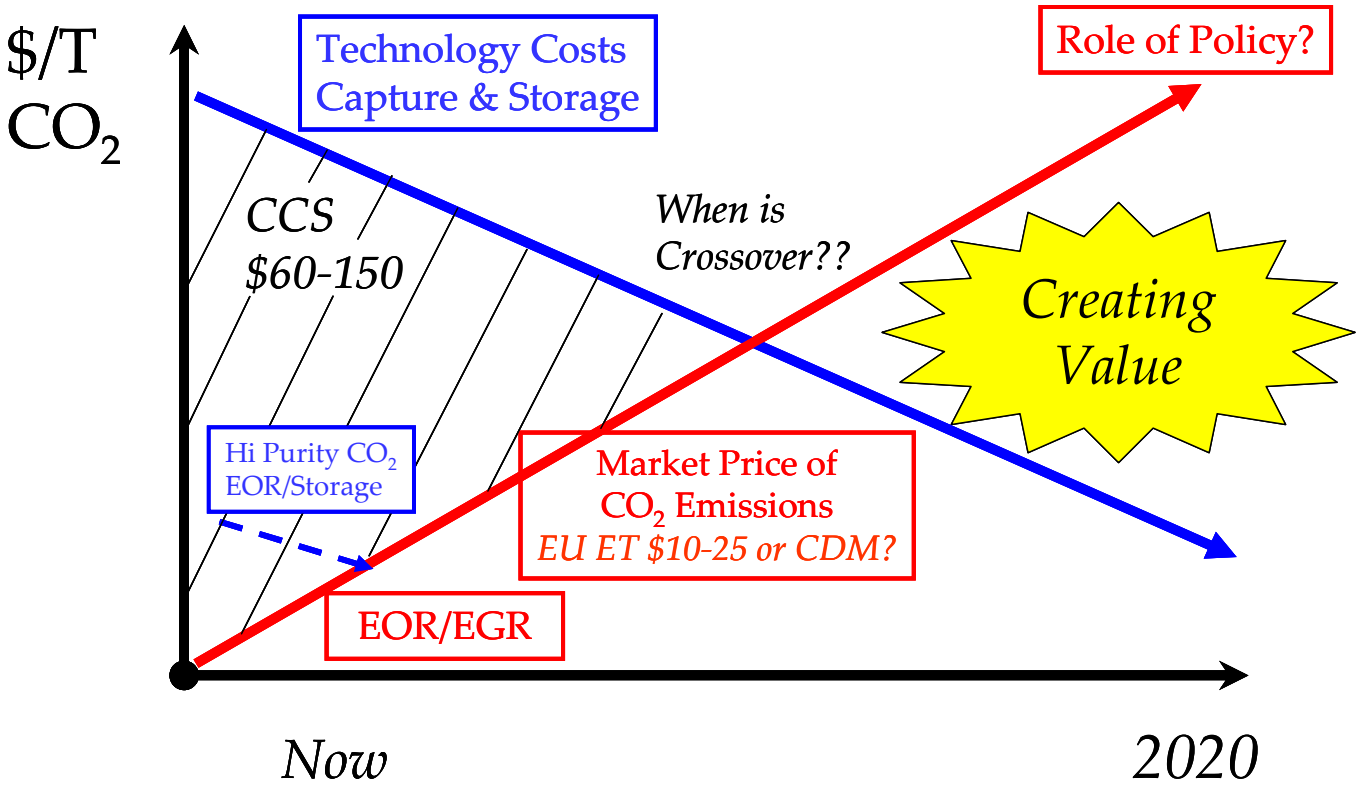
- Create a policy framework that is Stable, Predictable for a project
- EU ETS would be a good start **if** there was certainty about it being in existence long term beyond 2012……but currently not sufficient to make CCS happen…more is needed

Understand the risks: Early mover risk – project, financial, & cost, etc.

Recognise and value the Co-benefits that CCS offers …….

Energy diversity
Energy security
UK Leadership and New Industry/skills
Extend life for UKCS
Improved air quality (Developing world)

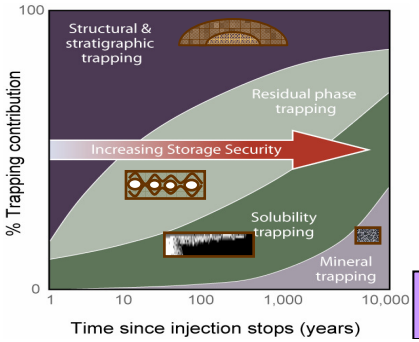
Policy



- There is existing policy supporting technology R&D
- There is no policy in place to enable economic deployment of CCS Technology
- We are moving closer with the process that the UK and EU are following but much more needs to be done and time is of the essence

Public and regulatory acceptance of CCS

Develop protocols with relevant parties to assure safe transportation, storage and monitoring of CO2. Reaching agreements on long-term public stewardship of storage sites



- No regulations currently exist to cover the injection of CO_2 underground for long term storage
- In many countries it is unclear which agency has jurisdiction
- Key issue is the long term aspect of CO_2 storage
- DF1 can be permitted under current Petroleum Act due to EOR aspect

- London Convention, 1972
- UN Convention on the Law of the Seas, 1982
- Framework Convention on Climate Change, 1992
- Convention of Biological Diversity, 1992
- OSPAR Convention, 1992
- 1996 Protocol to the London Convention
- Kyoto Protocol to the Climate Change Convention, 1997
- EU ETS Directive, 2003
- Strategic Environmental Assessment Protocol, 2004
- Marine Strategy Directive, 2005 (Draft Amendment 2006)

Clarity on Storage Long term liability is missing:

- Storage security increases over time
  - Secondary trapping mechanisms
  - Pressure decline
- Time frames are site specific
- Projects can be engineered to enhance trapping
- Monitoring can demonstrate longer term performance
- Eventually, a high degree of assurance will be achieved

Understand the risks: Early mover risk – regulation development etc.

Building Internal Capability

Develop people and know-how across several core technologies to support business development

- **Reservoir and EOR experience:** BP upstream has over 30 years EOR and CO2 pipeline experience
- **Technology:** Access to BP's "know how" including learning's from its North Sea and California Project; research projects like CCP, etc.
- **CO2 trading :** BP has an active CO2 trading team with a deep understanding of the market
- **Syngas and hydrogen experience:** BP has an extensive experience in handling Syngas and hydrogen in its chemical and refinery plants

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Thank you