

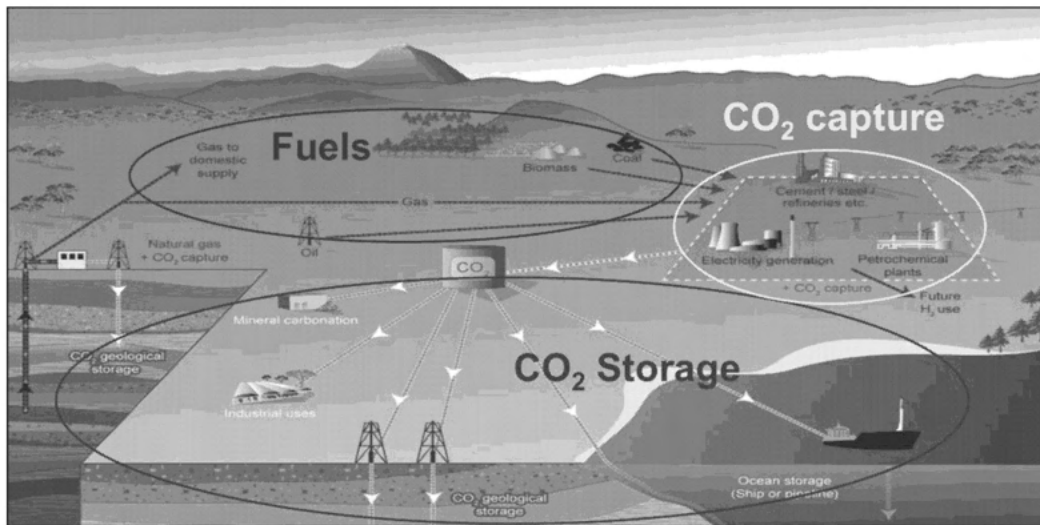


CO₂ Capture, Utilization and Storage (CCUS): Overview of the technology components, policy and value proposition

Carbon Solutions, Group Technology

15th June 2016

BP Confidential



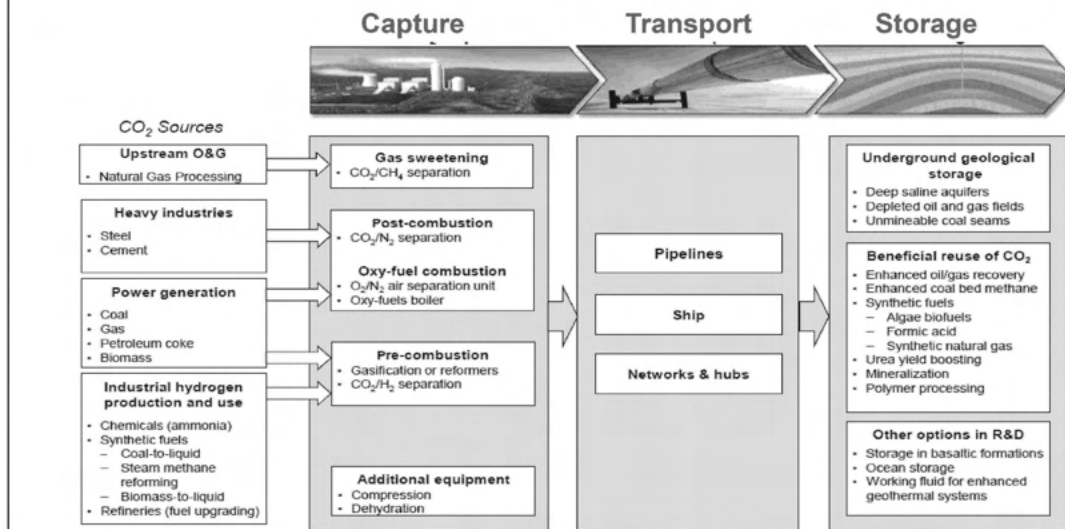


Overview

- What is CCUS?
- Technology Components
- Cost Picture and opportunity to reduce costs
- What is the value proposition for CCUS?
- BP Experience
- Competitor position and our view of drivers
- Policy – what is stopping CCUS and what needs to happen?
- What BP is working on in CCUS and with whom?



CCUS combines several technology components and operations...



...that need integration and scale up

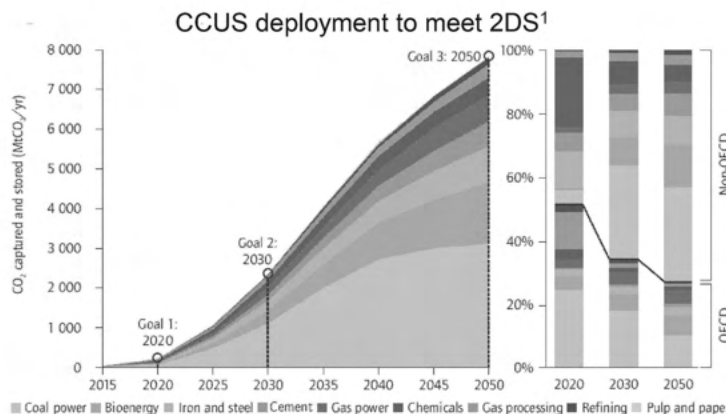


- CO₂ capture from any fossil fuel or biomass combustion or industrial processes, and is commercially available from technology licensors for all applications
- Transport by pipeline, ship and road all commercially practiced
- CO₂ storage has been demonstrated in saline formations and incidental storage with CO₂ EOR is commercially practiced
- CO₂ conversion and utilisation is commercially practiced for urea and methanol
- Key integrated CO₂ capture applications:
 - Coal-fired power generation – demonstrated at Boundary Dam
 - Gas-fired power generation – demonstrated at Bellingham

CCUS relies on a combination of technologies – components are proven but large-scale integrated demos are still needed to build confidence



Large scale CCUS is essential to meet global climate goals...



Sources: ¹IEA Technology Roadmap – Carbon Capture and Storage, 2013 (note: IEA ETP 2015 used later which has a lower CCS goal of 6GtCO₂/yr by 2050)

²Shell, OGCI CCS Workstream meeting, 2016

³Team analysis, 6MtCO₂=310mmcsfdCO₂ at downhole supercritical conditions (>800m depth)

Notes: rb = reservoir barrels (at downhole P, T conditions)

Natural Gas production currently at 2.5 Gt/yr

- 120 GtCO₂ are captured and stored by 2050 to meet 2DS¹
- Similar infrastructure build-out to natural gas²
- Over 70% of all CCS takes place in non-OECD countries by 2050¹
- 1 GW coal-fired power plant generates c. 6MtCO₂/yr (equivalent of 165,000 rbpd or 2.4Blnrbbls over 40 years)³
- Gas-fired power plants have roughly half the CO₂ emissions per GW



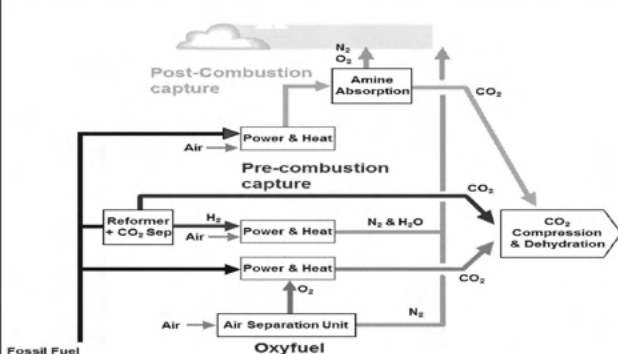
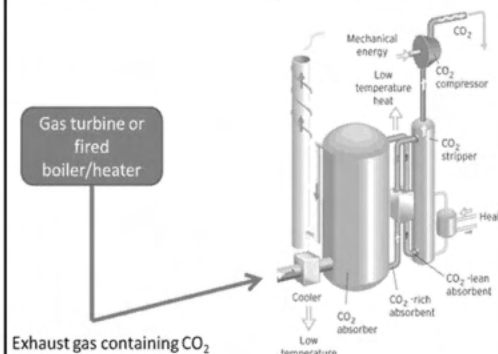
...but it has stalled and faces significant barriers

- CCUS is considered an essential component of the low carbon portfolio needed to meet global climate goals
- Gas-fired power with CCUS provides intermittent low carbon generation to balance intermittency of renewables
- CCUS is the only option for decarbonisation of certain industries and coal
- CCUS is the only technology that could enable continued large-scale use of fossil fuels in a tightly carbon-limited world
- Current commercial application of CCUS is focused on high purity CO₂ sources and EOR, but is limited in scale

Despite its importance and ambition to meet decarbonisation goals, CCUS has stalled and commercial deployment is very limited

Proven capture technology is available for different CO₂ sources

...

CO₂ Capture TypesPost Combustion CO₂ Capture

Post-combustion capture, Pre-combustion capture, Oxy-fuel



... but energy penalty & cost with existing technology is high

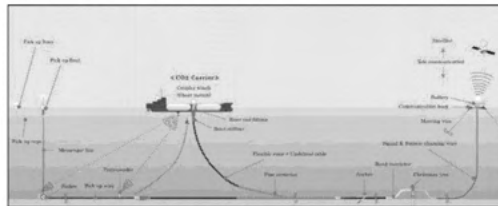
- In natural gas processing, CO₂ can be captured from contaminated gas
- For post-combustion processes (preferred for most applications including power generation) CO₂ can be captured by chemical (amine) solvent
 - Post-combustion has been demonstrated on gas and coal-fired power
- In the last decade, chemical absorption by aqueous amine solvent has progressed with the innovation of new amines which lower energy consumption and have less tendency to degrade and cause corrosion
- Many new technologies have been proposed and evaluated experimentally – some have not lived up to promise, but there are candidates with potential to deliver significant performance improvement and cost reduction

Capture is proven but integrated demos are needed to build confidence and new technologies are promising cost improvements

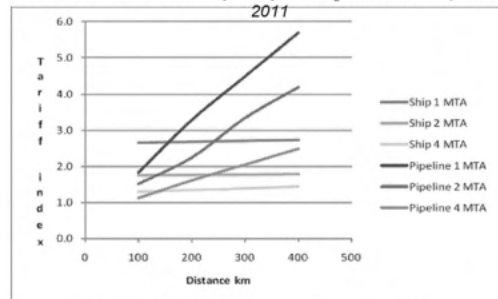


Shipping may have a material role in some regions ...

- Small scale CO₂ shipping (ca 2kte) in operation today for food/beverage
- Larger scale ship design (ca 40-80kte) is available
- Rotterdam hub business model is being developed based on ship transport of CO₂ offshore
- EU, US and Japan have looked at return cargo options – LPG out CO₂ return
- Source/sink flexibility, operational expense, and re-use are key advantages, but does require some buffer storage at hubs



Source: GCCSI Prelim Feasibility Study on CO₂ Carrier for Ship-based CCS,



Source: GCCSI CO₂ Liquid Logistics Shipping Concept, 2011



...whereas elsewhere new CO₂ pipeline infrastructure will be required

- ~4000 miles of CO₂ pipeline operational in the onshore L48
- ~ 810 miles of CO₂ pipeline operation in Europe
- Good operational safety record.
- Requires large Capital investment but networks and re-use can save considerable cost



Source: IEA GHG CO₂ Pipeline Infrastructure Report, Jan 2014

CO₂ transportation infrastructure is needed to link sources with sinks

Alternative ways of using and storing CO₂...

Utilisation

CO₂ Conversion (CCC)

Currently 200 Mtpa (mostly from industrial sources) used in making Urea, inorganic carbonates, methanol

BP refineries sell 0.4 Mtpa

CO₂ stored depends on the permanency of the product

CO₂ EOR

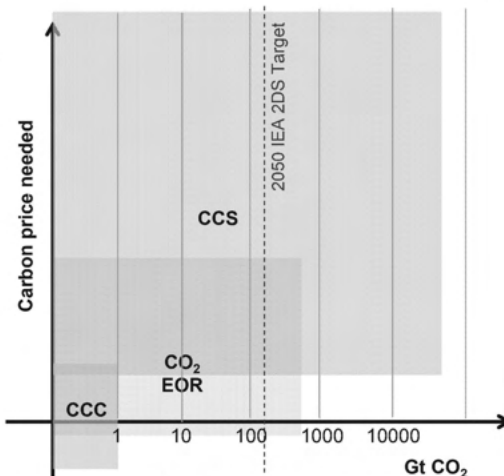
Current market mainly in US is 70 Mtpa (80% from natural sources, 20% from industry)

CO₂ goes through multiple injection and production recycles – but ultimately the vast majority of CO₂ supplied ends up stored in the reservoir

CO₂ Storage (CCS)

Currently 4 Mtpa operating geological storage projects in saline formations

2 in Norway (Sleipner/Snohvit), 1 in US (Decatur), 1 in Canada (Quest)



Sources: IEA Technology Roadmap for CCS, 2013, Global Energy Assessment, 2012, IEAGHG/ARI CO₂ Storage in Depleted Oilfields, 2009, Niall McDowell, Imperial College, 2016



...have different storage potential and cost

A perspective on the contribution that CCUS (will vary based on regional costs, benefits and geology) could make to climate change mitigation;

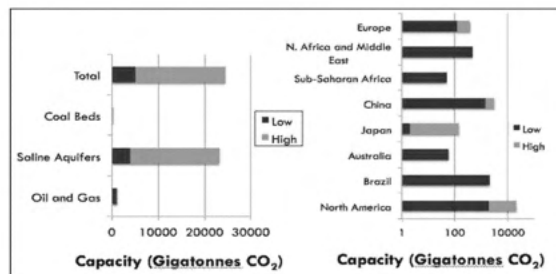
- CO₂ storage of 5,000-25,000 Gt has the largest potential but no benefit without a sufficiently high carbon price/incentive
- CO₂ EOR potential could utilize and store 65-370 Gt of CO₂ but won't be available/achievable everywhere and faces policy challenges at very large scale
- CO₂ conversion could utilize 1 Gt - is insufficient alone, but does give beneficial use

There appears to be sufficient technical storage capacity but there are a number of techno-economic constraints

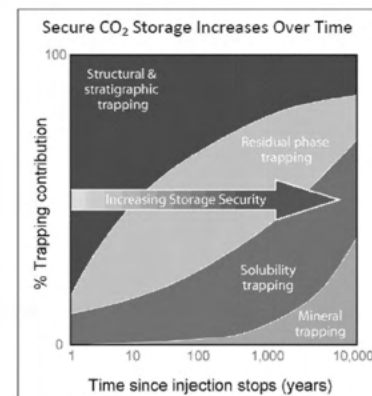


CO₂ geological storage has sufficient security and scale potential to make a material contribution to climate goals...

- Storage security increases over time but operational and lengthy post closure monitoring, measurement and verification (MMV) is required to satisfy regulators
- Sufficient storage capacity is available at global scale for CCS to make material contribution to emissions reductions



Source: Global Energy Assessment, 2012



Source: Sally Benson, Stanford University, 2008



...but storage resources are not uniformly distributed, uncertainty remains in some key areas, and little is being done to de-risk

- Site access, risks, injection rates and costs have to be taken into account to progress from resource to reserves
- Initial injection rates and pressure dissipation are key cost uncertainties that require either:
 - proactive site characterization (stratigraphic wells and well testing), and/or
 - reactive operational management (stimulation, injection wells, water production)



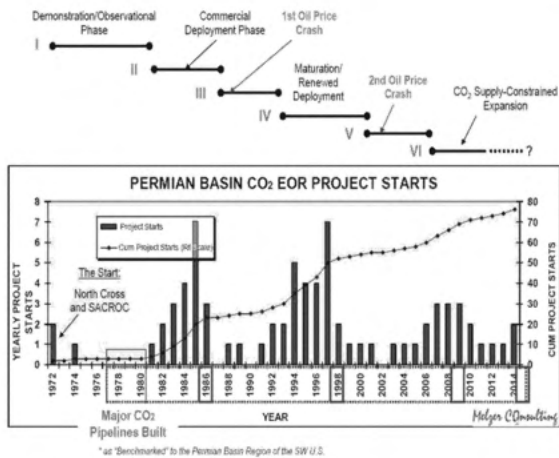
Source: GCCSI Global Storage Readiness Assessment, 2015

Further definition and action in reserves progression of CO₂ storage resources is needed in key areas



CO₂ EOR established itself in a few onshore US basins in the 1970-90's but ran out of low cost natural CO₂...

- The U.S. accounts for >90% of global CO₂ EOR production (~340 mstb/d) with 136 active CO₂ EOR projects injecting 3.5 Bscf/d (68 Mte/y).
- Demand is linked to oil price – peak in start-ups prior to 1986 and 1998 oil price shocks, but since 2005, CO₂ demand outpaced supply
- 80% of the CO₂ is from natural sources, remaining 20% from industrial sources (gas processing plant, H₂ and N₂ plant, chemical, power and other plant)



Source: Melzer Consulting, 2015



...but the emergence of CCUS gives an opportunity to expand and deploy in other regions

- Practice will change and technologies will emerge given a value associated with CO₂ storage:
 - Inject less water and more CO₂
 - Optimize well design and placement
 - Improve the mobility ratio (e.g. conformance control such as BP Jupiter)
 - Extend the miscibility range (e.g. solvents, surfactants)
- Leading to improved economics, and an increase in EOR and storage volumes

Figure 8 • Global storage potential for different CO₂-EOR practices [GtCO₂]

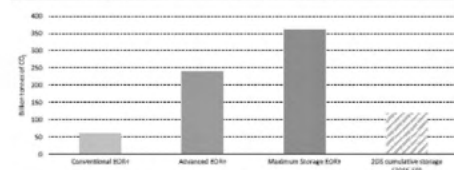
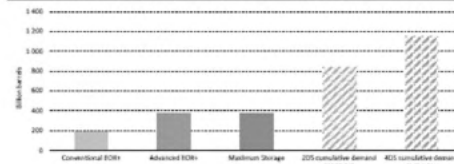


Figure 9 • Global incremental oil production potential for various CO₂-EOR practices



Source: IEA 2015, Storing CO₂ through EOR

CO₂ EOR performance and scale can increase if a value is attributed to CO₂ storage

Increasing the volume of CO₂ injected into the oil reservoir: this involves increasing CO₂ injection volumes from 1.0 hydrocarbon pore volume (HCPV), currently used in "state-of-the-art", to 1.5 HCPV. Higher HCPV's of injected CO₂ enable more of the reservoir's residual oil to be contacted (and even multiple contacted) by the injected CO₂.

Optimizing well design and placement: this includes adding infill wells to achieve increased contact between the injected CO₂ and the oil reservoir and using physical or chemical diversion materials to divert CO₂ into previously poorly contacted portions of the reservoir.

Improving the mobility ratio between the injected CO₂/water and the residual oil: this assumes an increase in the viscosity of the injected water as part of the CO₂-WAG process (increasing the viscosity of CO₂ with CO₂-philic agents could theoretically further improve performance). The viscosity of the injected water can be changed by adding polymers or other viscosity enhancing materials.

Extending the miscibility range: this helps more reservoirs achieve higher oil recovery efficiency. It assumes that "miscibility extenders" are added to CO₂-EOR process that reduce minimum miscibility pressure requirements and use of other (to be developed) miscibility pressure or interfacial tension reduction agents.

Other forms of CO₂ use (materials, chemicals, fuels) are emerging...BP experience of CO₂ conversion technologies through Venturing

Conversion and utilisation technologies provide differing extent (but often minimal) and amount of storage

Process	Global Annual CO ₂ Usage	Typical source of CO ₂	Lifetime of storage
Urea	65-146Mt [^]	Industrial	6 Months
Methanol	6-8Mt	Industrial	6 Months
Inorganic Carbonates	3-45Mt #	?	Decades
Organic Carbonates	0.2Mt	?	Decades
Polyurethanes	10Mt	?	Decades
Technological	10Mt	?	Days to Years
Food and drink	8Mt	?	Days to Years
TOTAL	102 – 227Mt		

Notes:

[^], # The demand for CO₂ in Urea and Inorganic Carbonate production is particularly uncertain. Various sources have quoted figures with orders of magnitude differences.



...but CO₂ storage is not always long-term

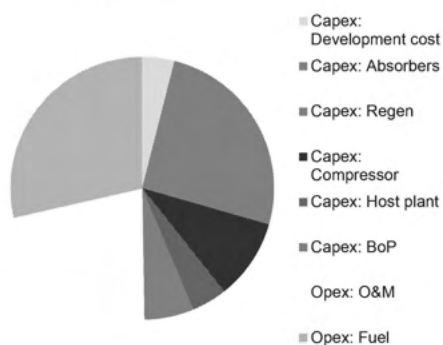
- Cost effective availability of low carbon/renewable hydrogen is likely to be a constraint on industrial scale deployment of many CO₂ conversion technologies
- However, limited opportunities might exist in;
 - CO₂ to plastics (Bayer DREAM process)
 - Mineral carbonation of industrial waste
 - CO₂ replacing H₂O as a hydraulic fracturing fluid in water stressed regions
- Other CO₂ conversion processes may need substantial state subsidy and/or technology breakthrough
- Some CO₂ conversion processes may use excess/'free' energy from renewables sources to effectively store energy through conversion processes

There are interesting opportunities for some CO₂ conversion processes but the extent of CO₂ storage is variable



Capture accounts for ca 80% of the cost of CCS...

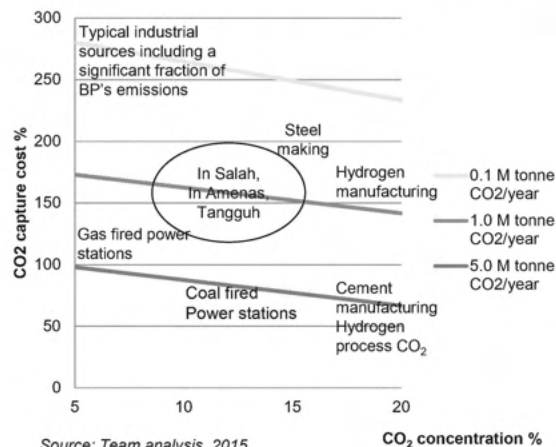
Capture cost breakdown



Notes: * post-combustion 85% capture rate applied to natural gas fired power plant located in the UK
Sources:

Source: UK CCS Cost Reduction Taskforce, 2014

Capture cost by scale and concentration*



Source: Team analysis, 2015



... with large heat and power consumption that varies with scale and CO₂ concentration of the source

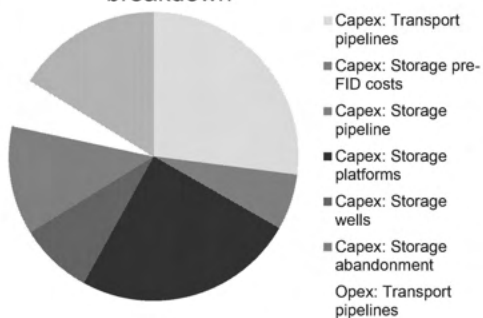
- Capex:Opex is ca 50:50 which results in significant economies of scale – the maximum train size of absorbers is approaching power station scale
- Capture fuel (energy penalty) is split ca 50:50 for solvent regeneration and CO₂ compression
- The largest sources of CO₂ typically have the lowest cost of capture
- Most of the CO₂ emissions from BP operations would have high capture cost (at least double the cost of capture from power stations)

Improvements in CO₂ capture technology (with lower energy requirements and lower cost) could substantially improve the competitiveness of CCS



Transport and storage cost...

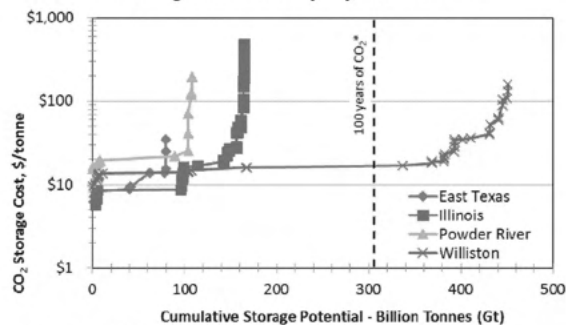
CO₂ transport and storage cost breakdown



Notes: assuming CO₂ transport by pipeline and storage of the CO₂ in a depleted oil and gas reservoir in the North Sea

Source: UK CCS Cost Reduction Taskforce, 2013

Storage costs vary by formation



*90% capture of CO₂ emissions from U.S. electric power and industrial sectors

Source: US NETL, Quality Guidelines for Energy System Studies: Carbon Dioxide Transport and Storage Costs in NETL Studies, 2014



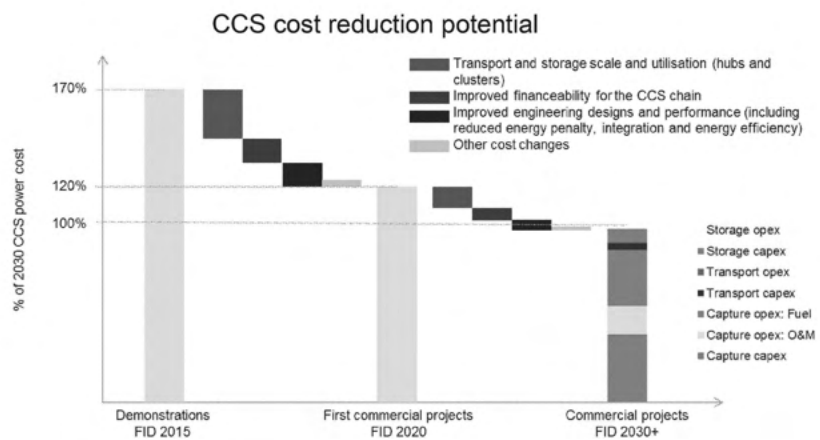
...can be optimised at scale

- Compressed CO₂ is transported by pipeline – cost is proportional to length (ca 1.5 M\$/km)
- The cost and economies of scale for CO₂ storage are formation specific
- There is a technology dimension to optimising storage economics, but there is no substitute for accessing the best geology
- If CO₂ is used for EOR then CO₂ value can help offset CO₂ supply costs, and in some cases can achieve an economic value chain

Improvements in CO₂ storage technology can improve storage performance but securing the best geology is fundamentally important to storage economics



Plausible incremental cost reduction pathway...



Sources: UK CCS Cost Reduction Taskforce

Note: No account for cost reduction associated from potential utilization revenues have been made. These are CCS not CCUS costs.



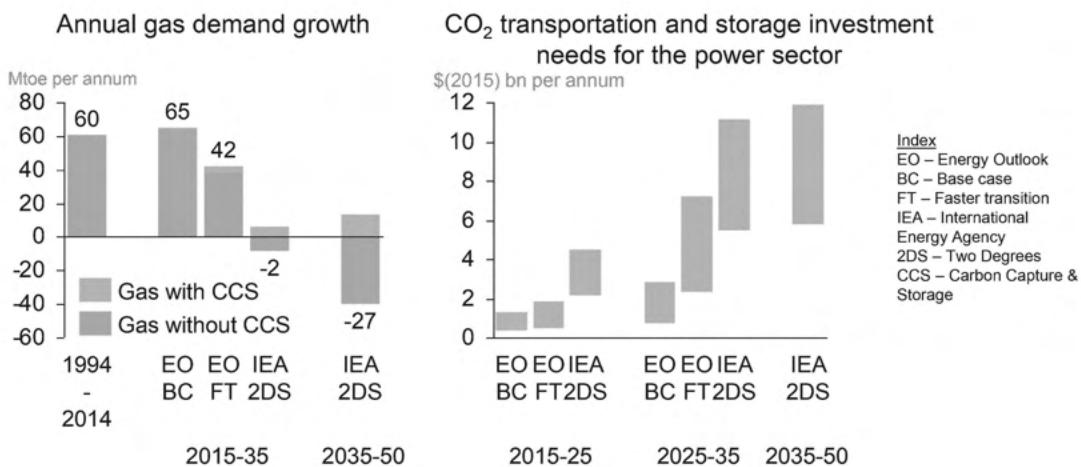
... for existing technologies to achieve competitive CCS costs at full-scale

- Reaching commercial stage requires the build-out of infrastructure and proving of the integrated value chains
- Optimising transport and storage infrastructure for large-scale CCS is important to driving cost reduction
- Developing the ability of the supply chain, managing risk and accessing low-cost finance is also important for cost reduction
- Technology innovation could deliver substantial further cost reduction - particularly from capture

Early demo projects have high cost but a pathway for cost reduction is possible



CCUS creating value for natural gas and ...



Sources: BP Energy Outlook 2035, IEA Energy Technologies Perspective 2015, Team analysis



... as a potential new investment opportunity

- The charts illustrate the importance of CCUS to the scale of gas-fired power and therefore the incremental gas demand growth (or decline) across tightening carbon scenarios.
 - To meet carbon policy requirements without CCUS, even oil demand could be lower as compensating greater levels of abatement are potentially sought by transport sector
- Large scale global deployment of CCUS for the power sector would require \$4-12bn/year of Transport and Storage investment from 2020 to 2050
 - An 800 MW gas-fired combined-cycle plant with CCUS could require investment of up to \$1 bn in the early stages of a CO₂ transportation & storage network.
 - CO₂ transport and storage market is not currently financeable

CCUS could help sustain gas demand growth for longer, supporting gas markets, the value of gas and potentially liquid fuels

CCUS may be needed to reduce BP's CO₂ emissions ...High purity CO₂ sources offering lowest cost CCUS possibilities for BP

Segment	Process	Applicable Sources
Upstream	Gas separation	North Africa, Tangguh, Alaska, L48, Brazil & Angola (Pre-salt)
Refining	Hydrogen production – 95% purity	Gelsenkirchen, Cherry Point, Toledo*
	Hydrogen production – 50% purity	Whiting*, Lingen, Castellon, Rotterdam
Biofuels	Fermentation	Brazil (Tropical, ITB, ITT)

Source: Provisional 2016 update of BP AE Study, 2009
Notes: * Third Party supply



... driven by regulations and license to operate in near term and increasing carbon prices in longer term

- In some regions CCUS deployment in reducing BP's emissions may be required.
- The focus is likely to be on high purity CO₂ sources with >90% CO₂ concentration such as upstream gas processing and hydrogen plants.
- These plant types have relatively low incremental capture costs (e.g. < \$25/tonne), but would increase cost of supply
- Industry precedents include Gorgon (Australia) and Lula (Brazil) for upstream gas processing

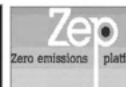
Deployment of CCUS may be required in BP assets to reduce emissions as climate policy strengthens or becomes a license to operate requirement



BP was an early mover in CCUS and has broad experience

Research

Fundamental science
& policy/regs



Technology development

Programmes to reduce
risk/costs of CCUS



Technical demonstration

Assurance framework
& risk assessment
(In Salah JIP Ph 1 & 2)



Commercial-scale projects

Project experience
across full value chain

Hydrogen Power
projects;
Peterhead, HECA,
HPAD, etc.



Venturing

Access and insight
into CO₂ utilization





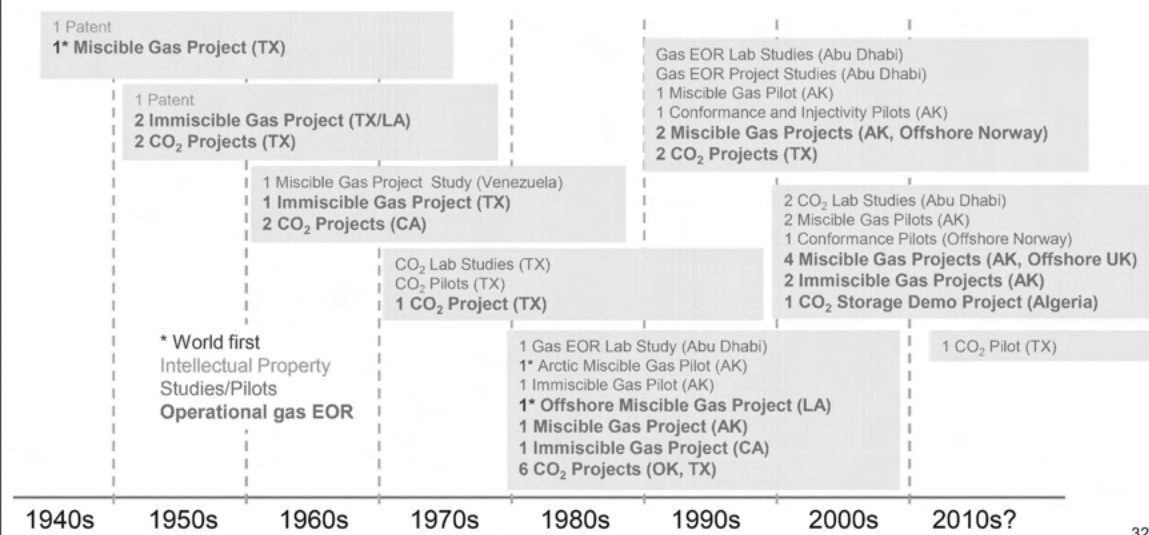
... but we have greatly reduced our CCUS resources and technology effort following the demise of Hydrogen Power

- Our experience spans from 2000 with the CMI and CCP projects leading on climate science and technology research and development
- In Salah has provided valuable "learning by doing" even although this is a sub-optimal reservoir for CO₂ storage
- The Hydrogen Power (H2P) business provided "full value chain" experience as well as work to understand a case for CO₂ storage business
- Withdrawal from H2P has precipitated a loss of BP experience on projects, technology development and people capability
- Venturing have identified a few examples of CO₂ utilization, but it is of limited scale

BP has extensive experience, but corporate know-how is at risk of being lost while competitors continue to build



BP experience and expertise has been established in gas EOR...





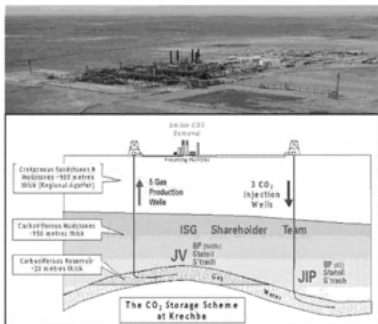
....and a recent BP CO₂ commercialization study shows this offers the potential for new opportunities for BP

- BP has been involved in miscible gas EOR for 70 years, e.g. BP led the development of CO₂ EOR in the U.S. (divested in 2003) and currently operate the world's largest enriched hydrocarbon gas EOR project at Prudhoe Bay
- Pioneered innovative Designer Gas™ technologies in Alaska & involved in sweep-enhancing technologies
- Deployment limited by access to an economic source of miscible gas
- New opportunities may be commercial: renewal/abatement in the L48 and Alaska, access opportunities in the Middle East, and large-scale EOR deployment may be enabled with an appropriate price on CO₂

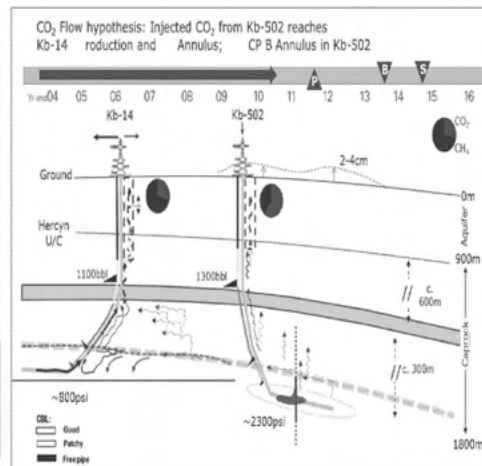
A price on CO₂ could make CO₂ EOR an interesting opportunity that also enables CCUS



In Salah was a first of a kind technical demonstration project for CO₂ storage at industrial scale ...



- Industrial Scale Demonstration of CO₂ Geological Storage (Conventional Capture)
- Deep Saline Storage Formation common; Offset & downdip from Krechba Field GWC
- Storage started August 2004 via 3 Injectors; ended June 2011
- 3.7 MMtCO₂ Stored to date @ cost of ~\$50-60/t
- No CCS Policy or Regulation hence no commercial benefit
- Test-bed for CO₂ Monitoring Technologies \$30mm Research Project: BP leverage 1:3.5





... that has not performed as expected, requiring early P&A and liability uncertainty

- Development and operational key learnings include:
 - Exceeding the recommended maximum CO₂ injection pressure, resulted in CO₂ migrating into the cap rock and accessing the annuli of nearby wells
 - Poorly abandoned wells exposed to the CO₂ plume offer a potential leak path
 - The importance of an integrated subsurface view/model to recognise presence of natural fractures in the system should include the overburden
 - CCS must be fully integrated into Field Development Plan and Operations
 - In the absence of regulations, the relationship with regulator is critical
- The final phase of site closure and preparing the terms by which we hand responsibility of the stored CO₂ back to the state will be another leading edge learning project

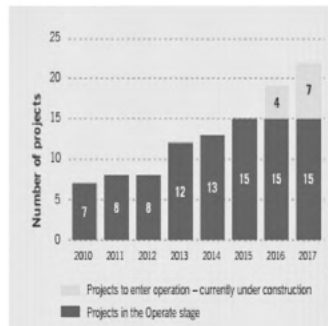
CCS is doable, but needs careful site selection and operational management



Limited progress in large-scale CCUS deployment ...

CCUS project deployment

TWh per annum



Sources: GCCSI, Saskpower, Shell, Saudi Aramco

2014/15 CCUS project additions



Saskpower Boundary Dam Project

Alberta, Canada

125 MW coal-fired power

1 Mt/year CO₂ for EOR, partly aquifers



Shell Quest Project

Alberta, Canada

1 Mtpa CO₂ capture capacity

CO₂ stored in saline aquifer



Saudi Aramco Uthmaniyah Project

Kingdom of Saudi Arabia

0.8 Mtpa CO₂ capture capacity

CO₂ used for EOR pilot in Uthmaniyah field



... though notable recent projects on power and by oil and gas companies

- The charts illustrate that globally there are 15 large-scale CCUS projects in operation, with the capacity to capture up to 28 Mt of CO₂ per year, with a further seven under construction
- The majority of projects in operation to date have been gas processing with over half of these in turn linked to EOR
- Most of the projects in operation or execute are in North America
- The world's first large-scale power sector CCUS project – the Boundary Dam Carbon Capture and Storage Project on a coal –fired power plant became operational in October 2014

CCUS industry is in its infancy, to date only 0.5% has been deployed of the total amount projected to 2050 in the IEA 2DS Scenario



Oil and gas supermajors are active in CCUS projects ...

Project Name	Location	Company	Capture	Storage	Size (Mtpa)	Duration
Schute Creek	WY, USA	ExxonMobil	Gas Processing	EOR	7	1986-
Weyburn	Canada	Cenovus and Apache	Pre-combustion (Synfuel Gasification)	EOR	3	2000-
Gorgon	Australia	Chevron (47.3%), ExxonMobil (25%), Shell (25%), others	Gas Processing	Saline Aquifer (with water production)	4	2016-
Lost Cabin	WY, USA	ConocoPhillips	Gas Processing	EOR	1	2013
In Salah	Algeria	JV (BP, Sonatrach, Statoil)	Gas Processing	Saline Aquifer	1	2004-2012
Sleipner	Offshore Norway	Statoil, ExxonMobil, Total	Gas Processing	Saline Aquifer	1	1996-
Quest	Canada	Shell (60%), Marathon (20%), Chevron (20%)	Pre-combustion (Oil sands SMR upgrader)	Saline Aquifer	1	2015-2025+
Lula	Offshore Deepwater Brazil	Petrobras (65%), BG (25%), others	Gas Processing	EOR	0.7	2013-
Snøhvit	Offshore Norway	Statoil, Petoro, Total, GDF Suez, Hess	Gas Processing	Saline Aquifer	0.7	2008-
Lacq	France	Total	Oxy-fuel combustion	Saline Aquifer	0.1	2009-2017

Source: IOGP, 2015

Notes: This is a subset (10) of all (15) projects currently underway.

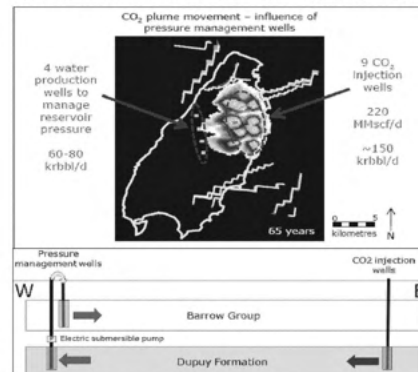
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...where it supports core business in CO₂ separation from gas processing and CO₂ EOR

- Once leader, BP has been overtaken by Shell, ExxonMobil, Statoil, Petrobras and Chevron
 - Shell only are promoting saline aquifer storage and CCS on gas-fired power
- Shell & ExxonMobil have strong IP positions
 - Controlled Freeze-Zone (Exxon), Fuel-Cells (Exxon) and Cansolv (Shell)
- Case-study – Gorgon
 - 4Mtpa CO₂ separation from produced gas prior to LNG at an additional ~\$1.5-2 bn cost
 - LTO requirement
 - Compression and injection into a saline aquifer immediately below the plant

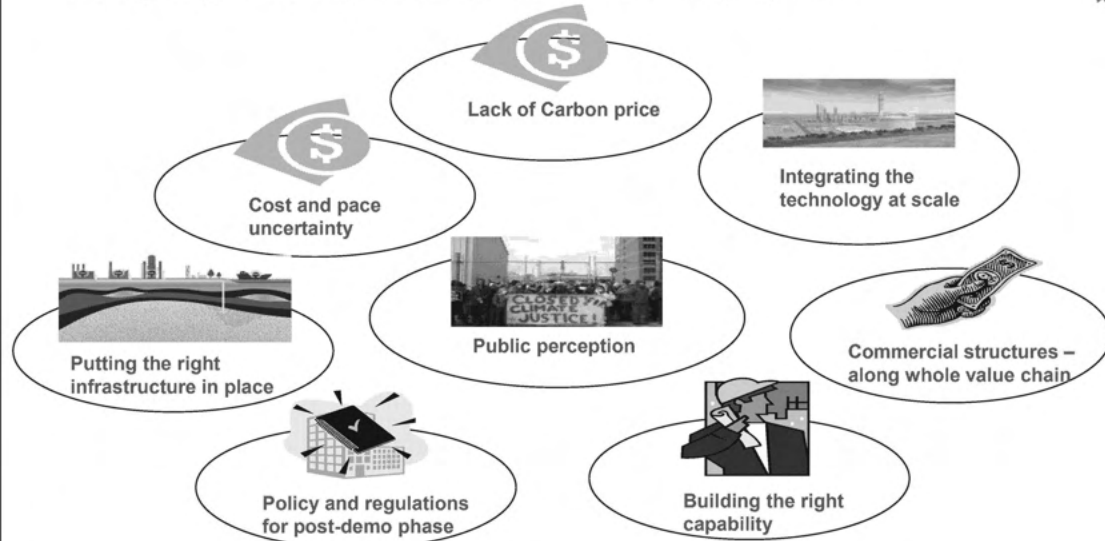
Gorgon: Injection of produced CO₂ for low cost LNG carbon abatement



Our competitors are progressing CCUS for core business needs, but not at a pace to offer CCUS as a climate solution



Policy support is key to accelerating CCUS deployment ...





... as commercialising CCUS is not a technical challenge

- CCUS has not been afforded sufficient policy support, especially when viewed in terms of its ability to achieve deep CO₂ emissions reductions
 - Since 2007, total CCUS investment has been less than US\$20 billion, ~100 times less the amount for renewable energy technologies over the same timeframe
- Application of the principle of 'policy parity' can strengthen the foundations for widespread deployment by an equitable level of consideration, recognition and support being given to CCUS
 - Specific areas in the application of this principle include:
 - Predictable and enduring policy arrangements
 - Extending CCUS law and regulation across the globe
 - Incentivising storage site selection to support project development
 - Continuing research & development to reduce costs

CCUS at scale is not commercial today and requires policy support that underpins a commercial investment decision



Demonstration projects require substantial capital investment which have largely been provided by governments ...



USA, West Parish – NRG/JXNippon/Hilcorp
1mtpa post-combustion capture from coal power w/ CO₂ EOR
US DOE Capital Grant of **\$167Mln**



USA. Port Arthur – Praxair/Denbury
1mtpa CO₂ capture from H₂ SMR w/ CO₂ EOR
US DOE Capital Grant of **\$284Mln**



Canada. Scotford Upgrader – Shell
1mtpa CO₂ capture from oil sand upgrader w/ saline aquifer storage
Canadian Federal and Alberta Province Capital Grant of **\$425Mln**, plus double carbon credits

Average capital grant = \$300Mln/mtpa capacity



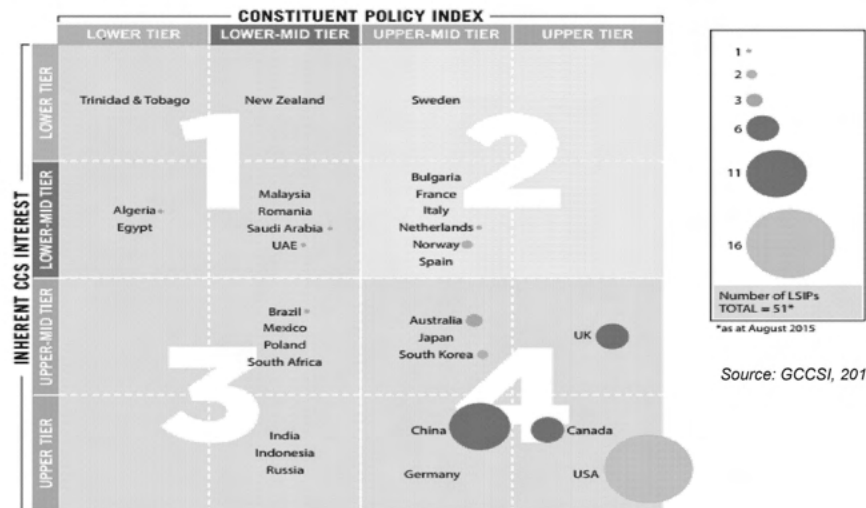
...yet much of this has been withdrawn and the policy window is closing

- A series of large scale CCUS demonstration projects around the world are considered necessary as a stepping stone to large scale deployment. Early projects require government incentives and financial support, typically grant funding
- Efforts have been made to develop large integrated CCUS demonstration projects through public private partnerships in USA, Canada, Australia, Middle East, Europe including UK
- Progress has been slower than anticipated and many projects have been cancelled ahead of investment, including BP's DF projects
- Costs have been cited as a reason for cancellation of the UK demonstration programme where £1bn of public capital had been earmarked to support 2 commercial scale integrated power and CCS projects

Integrated CCUS demonstration projects have been enabled by specific government funding for demonstrations, but government funding is wavering



GCCSI 2015 Policy Indicator shows the variance in CCUS interest and policy between regions ...





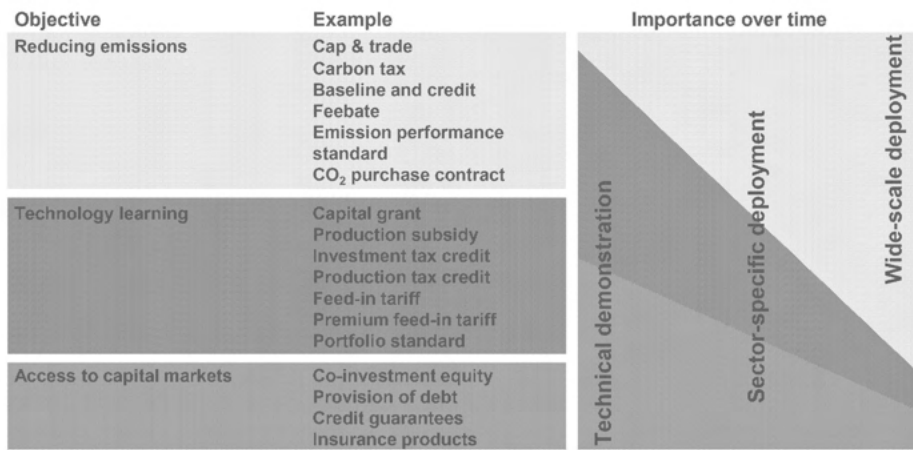
... interest is focused on a few countries, and on demonstration rather than deployment

- Interested countries appear to be USA, Canada, Norway, Europe, China, Australia and Middle East
 - 10 Countries list CCUS as part of their Intended National Determined Commitments (INDC's)
 - There is limited interest in CCUS from other countries but then CCUS is not applicable everywhere
- Policy focus is mainly R, D&D - pilot and demonstration projects have been implemented in some interested countries
- Regulatory framework for storage has been developed in North America and Europe and ISO is underway for CCUS

Interest in CCUS varies considerably by region and the emphasis is mostly on Research, Development & Demonstration



CCUS incentives will vary in type/scale over the demonstration to deployment period ...





... and a range of policy options exist

- A robust carbon price is needed to stimulate CCUS deployment
- Until the carbon price is high enough, transitional incentives are required to underpin investment
- A variety of policy instruments are being considered, from performance standards, to Feed in Tariffs, to CCUS mandates (e.g. no new coal without CCUS)
- CCUS will not happen without government policy support
- Perhaps the appetite for significant policy support for CCUS is reducing, since it supports continued use of fossil fuels?

An ambitious and collaborative approach will be required to develop effective policy frameworks that enable CCUS deployment



BP maintains a reduced but relevant capability ...

Research

Fundamental science
& policy/regs



Technology development

Programmes to reduce
risk/costs/uncertainty of
CCUS



Technical demonstration

Risk management and
site closure planning



Venturing

Access and insight
into CO₂ utilization





... to manage a growing GHG risk that may require CCUS for some businesses and to support CO₂ EOR opportunities

- Based around a focused technology programme and working in partnerships
 - CCUS programmes have reduced in the last 5 years, though activity levels have grown considerably over the last 12 months, with the addition of OGCI focus on CCUS and Methane
 - Our technology focus is on reducing CCUS costs, identifying and managing risk and performance prediction around storage
- Business interest and awareness has also grown, with new opportunities in Alaska (LNG and CCUS) and the Middle East (CO₂ EOR) being supported
- New work at integrating and leveraging CMI with Harvard and Tufts on Climate change technology/policy interface will also have a CCUS dimension

BP is taking a collaborative approach integrating new activities with the current programme to take full advantage of synergies and reduce duplication