The road to CCP4 – CCP history, vision, impact

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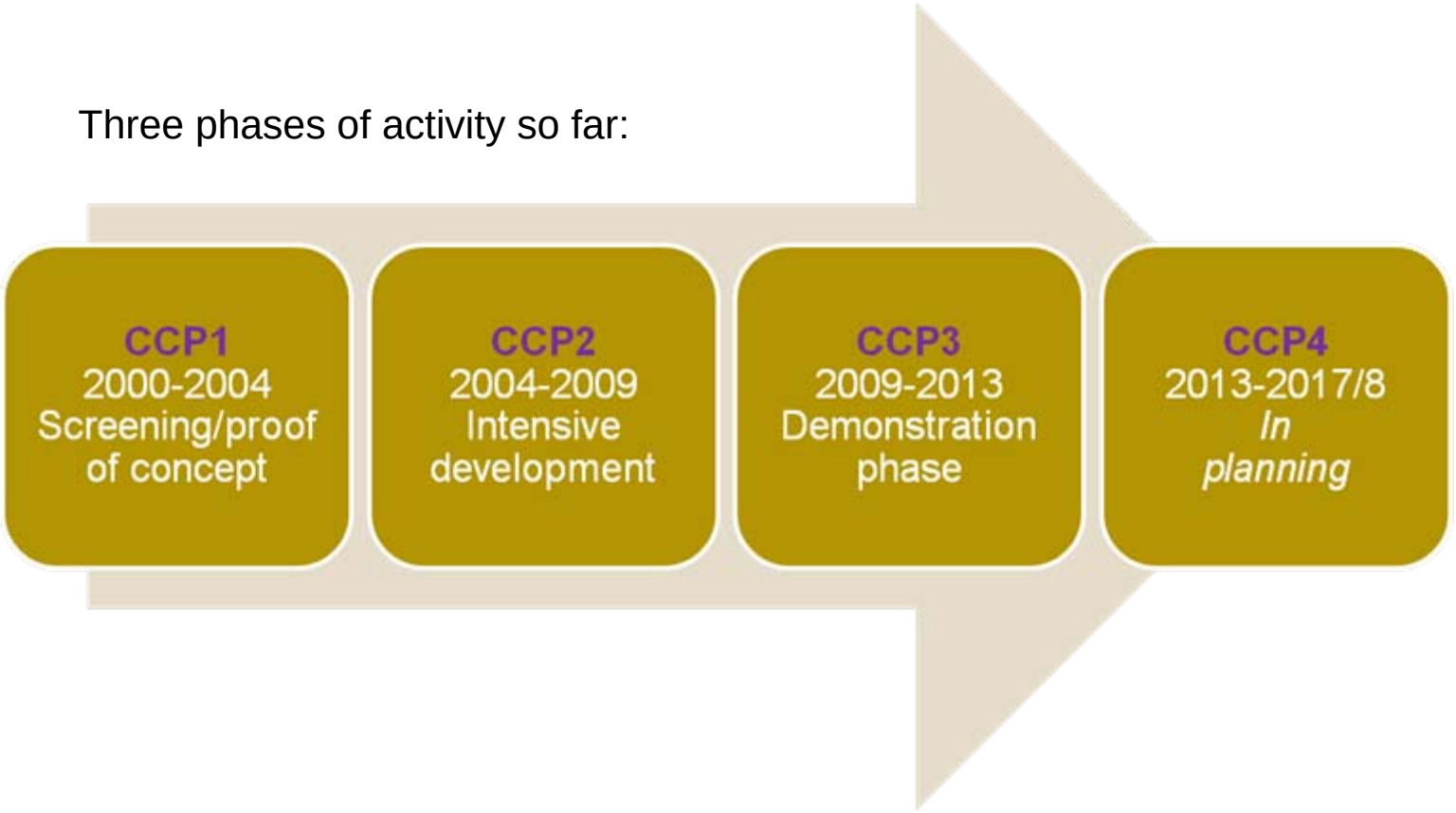
CCP – a brief history

- Founded in 2000
- Well over 150 projects undertaken by expert technical teams
- Collaboration with government organizations (US DOE and the European Commission) and more than 60 academic bodies and global research institutes
- Recognized by the Carbon Sequestration Leadership Forum (CSLF) for its contribution to the advancement of CCS
- Activities monitored and reviewed by an independent Technical Advisory Board made up of CCS industry experts

CCP – a brief history

Three phases of activity so far:



CCP – member benefits

A like-minded group of industry partners working together to identify the most cost-effective application of CCS technologies to reduce CO_2 emissions in the oil & gas industry:

- Leverages shared expertise and knowledge of member companies
- Leverages 3rd party financial support (EU, Alberta, University of North Dakota)
- Reduces development cost of next-generation CCS technologies
- Reduces reliance on external technology suppliers
- Provides access to global network of leading policymakers, NGOs and technology developers on all aspects of CCS
- Provides a platform for members to help shape future policy and regulation

CCP structure

The project consists of four work teams, supported by Economic Modelling:

- **Capture**: aiming to reduce the cost of CO_2 capture from a range of refinery, in-situ extraction of bitumen and natural gas power generation sources
- **Storage, Monitoring & Verification (SMV):** increasing understanding and developing methods for safely storing and monitoring CO_2 in the subsurface
- **Policy & Incentives:** providing technical and economic insights needed by stakeholders, to inform the development of legal and policy frameworks
- **Communications**: taking rich content from the on-going work of the other teams and delivering it to diverse audiences including: government, industry, NGOs and the general public
- **Economic Modelling:** building a fuller picture of the integrated costs for CCS

CCP3: CO_2 Capture

1. **Techno/Economic evaluation (Scenario-based)**
   - A detailed study by Foster Wheeler on capture of CO_2 using state-of-the-art technologies
2. **Technology demonstration**
   - Oxy-fired Fluid Catalytic Cracking (FCC) Pilot Plant catalyst regen demonstration
   - Oxy-fired Once Through Steam Generators (OTSG)
   - Capture of CO_2 from refinery heaters using oxy-fired technology
3. **Development projects**
   - Chemical Looping Combustion
   - Membrane Water Gas Shift
4. **Exploratory projects**
   - Testing of novel solvents for NGCC power stations at EERC

Image courtesy of Petrobras

Image courtesy of Cenovus

CCP4: CO_2 Capture

- **FCC:**
  - Continue work using the pilot plant in Sao Mateus (leveraging on CCP3 expenditure) on compressors & purification
- **Heaters & Boilers:**
  - Oxy-firing - multiburner testing, air ingress study, reducing cost of oxygen
  - Pre-combustion - More detailed technical study (size, H_2 purity, process schemes and locations, integration of chemical and fuel hydrogen), Hydrogen firing, Membranes
- **Heavy Oil:**
  - Chemical Looping Combustion - demonstration, focus on alternative carriers to Ni
  - Post-combustion - pilot/demonstration
- **NGCC Power:**
  - Pilot test program, economic evaluation on two-phase solvents, post-combustion membranes, solid sorbents
- **CO_2 Separation**
- **Novel Technologies**

CCP3: Storage, Monitoring, Verification

Theme 1: Assurance R&D

1. Well Integrity

- Alteration rate / extent and longer-term barrier performance prediction

2. Subsurface Processes

- Experimental protocols, impurities impacts, geomechanical case studies

3. Monitoring & Verification

- Retrospectives, modular borehole design, emerging sensors

4. Optimization

- Certification Framework, economics

Theme 2: Field Trialing – 3rd party site deployments

Theme 3: "Contingencies"

CCP4: Storage, Monitoring, Verification

Well Integrity - Conduct field and scale well surveys (logging, testing sampling) to assess CO_2-service alteration and mitigation options to inform best practices in D&C, maintenance/ workovers and P&A

Subsurface Processes – Lab and field pilot-based experiments to validate integrated, pore to system-scale coupled processes

Monitoring, Verification & Accounting (MVA) – Development of emerging and integrated sensors, (minimal surface footprint, thresholds), operational/intervention needs and risk to well access/integrity

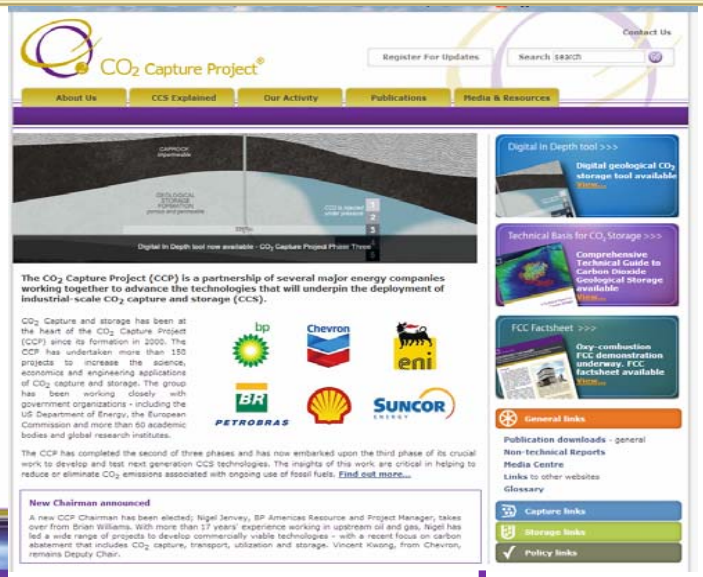
Optimization (Economics) – CO_2 storage project assessment, design and operation to minimize storage costs and synergies with other processes (EOR, EGR, geothermal)

Field Trialing – Leverage 3rd party sites to deploy CCP-developed MVA technology (e.g., US DOE demonstrations, Member and/or participant company CO_2 assets)

Contingencies – Risk management methodologies (e.g., NRAP) with identified potential hazard characterization, modeling, surveillance and intervention workflows and incident response SOPs

Communications

www.co2captureproject.org



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CCP3

Policy & Incentives

CO2 Capture Project®

CCP MANAGEMENT BRIEFING
CCP REGULATORY REPORT: UPDATE

ISSUE 4 Q3 2013

Welcome to the latest edition of CCP's Management briefing and my first as chairman. I am very honoured to be taking on the chair's role at a time that will see the completion of the third phase of CCP's program by the end of 2013.

Although some of the policy-driven impetus for CO_2 Capture and Storage (CCS) and other CO_2 reduction technologies has dropped in recent times as a result of the global economic downturn and carbon market implementation issues, the potential for CCS remains as significant as before. The International Energy Agency estimates that CCS can contribute around 20% of the CO_2 emissions reductions needed to cut overall emissions to half those of 2005 levels and estimates that without CCS, the cost of reaching those targets would be around 70% higher.

The pioneering work of CCP in advancing CCS knowledge for the oil & gas industry is a tribute to the commitment and collaboration of its member companies and provides us with valuable proprietary research, along with access to knowledge and data that would otherwise be difficult or very costly to obtain individually.

The CCP Regulatory Report Update, developed by the CCP Policy & Incentives Team, headed by Arthur Lee at Chevron, is an important tool to help our member companies better understand the regulatory landscape across the main CCS markets. The Report updates the one issued in February 2011 and provides news of the latest developments as well as highlighting the impacts of evolving regulations and policy on actual emerging CCS projects. As such, this should be of great help to those companies involved in, considering project development, or monitoring the emergence of this technology.

This Management Briefing presents a summary of the main findings. I hope you enjoy reading it and if you would like more detail, the full report is available at: www.co2captureproject.org/reports.html

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REGULATORY UPDATE – HIGHLIGHTS BY JURISDICTION

Across the world, the regulatory environment pertaining to greenhouse gas emissions management and, more specifically, CCS, continues to evolve. A summary of the main developments in Australia, Canada, Europe and the United States follows, with full details available in the online Report.

AUSTRALIA

- National carbon tax introduced in July 2012 (AU $23/tonne CO_2 emitted)
- Federal Offshore Petroleum & Greenhouse Gas Storage Act finalised in 2011
- Victoria became the first state to have both state onshore and offshore regulations in place when offshore came into force in early 2012. Further state onshore regulations exist in Queensland and South Australia, and are under development in New South Wales and Western Australia.

CANADA

- Regulatory frameworks being developed in Alberta, Saskatchewan, British Columbia, Nova Scotia
- CAD$1.5bn allocated to funding CCS projects in Alberta Province; robust regulatory framework for CCS is evolving through the development of the Carbon Capture and Storage Statutes Amendment Act (2010), Carbon Sequestration Tenure Regulation (2011) and the CCS Regulatory Framework Assessment (2011).

EUROPE

- Transposition of the 2010 CCS Directive on the geological storage of CO_2 completed in 10 Member States. Provides a robust framework but further development of practical and technical detail is needed at Member State level
- Questions remain around its provisions for environmental liability (see more below) and third party access to transportation and storage facilities, in the event that they are required to accommodate new and additional sources of CO_2
- It is expected that a more robust regulatory process will evolve as the first CCS projects progress through the approval process.

UNITED STATES

- EPA Underground Injection Control Class VI rule finalised in December 2010. CO_2 storage projects now need to gain a Class VI permit and meet stringent regulatory requirements to minimise risk to underground sources of drinking water. To date no such permits have been issued, despite four applications having been submitted
- Enhanced Oil Recovery (EOR) excluded from this and is regulated under UIC Class II regulations. Criteria and guidance on transitioning from a Class II EOR well to a Class VI CCS well are due to be published in the near future
- EPA also finalised a rule whereby all CO_2 storage facilities must report greenhouse gas data annually.

www.co2captureproject.org

- Financial support mechanisms for CO_2 capture and storage
- Regulatory Updates
  - Update on selected regulatory issues for CO_2 capture and geological storage (2010)
  - Review of regulatory issues for CCS projects (2012)
- CCS stakeholder issues review and analysis
- Community benefit sharing study: Local community benefit sharing mechanisms and options for CO_2 storage projects

CCP3