Pathways to Carbon Capture & Storage

The Role of Industry

...with a focus on large-scale deployment
What I will cover

• Context
  - Why a pathway to large scale CCS deployment?
    [Focusing on saline aquifer storage ]

• What do we mean by Industry?

• The role Industry sectors can and must play.

• The Business Case for Industry?
  - The driving forces versus constraining forces

• How government can facilitate Industry Involvement.

• Conditions to avoid sub-optimal Industry Involvement.
Contributions to emissions reductions in the 2DS (relative to 4DS)

> CURRENT GLOBAL OIL & GAS PRODUCTION CAPACITY ... within 35 years

> GLOBAL NATURAL GAS PRODUCTION within 20 years

IEA, ETP 2014
Coal fired power is an important but not the only target for CCS.

The *Industries* that *should* contribute to CCS development pathways include Carbon intensive industries:

- Power Utilities
- Coal producers
- Steel producers
- Cement producers
- Oil & gas processors

Those that *can* contribute most include:

- Oil & Gas producers
- O&G service providers
- Plant technology providers
- Pipeline investors
Large Investments are required

Up to several $100 millions to FID\(^1\) (~ 80% on Storage E&A)

Several $Billions Total Investment Cost (~ 80% on Plant)

After Garnett & Greig (2014) in IEA’s 2014 CCS Insights
Expectations are high for Power (coal and gas-fired)

But lack of electricity demand growth in many OECD countries constrains the case for new investment
The ballpark numbers (Australia)

**Levelised Cost of Electricity (LCOE $/ Megawatt hour)**
Currently >$200 /MWh but line of sight to <$160
Competes with NGCC with carbon tax of ~ $200

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Capacity (Gross)</td>
<td>750</td>
<td>MW</td>
</tr>
<tr>
<td>Plant Capacity (Net)</td>
<td>600</td>
<td>MW</td>
</tr>
<tr>
<td>Capacity Factor</td>
<td>85</td>
<td>%</td>
</tr>
<tr>
<td>Emissions Captured</td>
<td>80</td>
<td>%</td>
</tr>
<tr>
<td>Capital cost</td>
<td>10,000</td>
<td>$/kW</td>
</tr>
<tr>
<td>Fixed Operating cost</td>
<td>80,000</td>
<td>$/MW-yr</td>
</tr>
<tr>
<td>Variable Operating cost (Fuel)</td>
<td>15</td>
<td>$/MW h</td>
</tr>
<tr>
<td>CO₂ Transport &amp; Storage Cost</td>
<td>25</td>
<td>$/tonne</td>
</tr>
<tr>
<td>Operating Life</td>
<td>30</td>
<td>years</td>
</tr>
</tbody>
</table>

LCOE ~ $160 / MWh

- CO₂ Transport & Storage: $16
- Variable Opex: $15
- Fixed Opex: $12

**Capex (WACC of 7%)** $116

*Weighted Average cost of Capital*

Greig et al., (2013), *Mobilising Private Sector Employment for CCS* [For National CCS Council]
“Climate Change is the greatest moral, economic and social challenge of our time”...

• Proposed cuts to GHG emissions by 80% before 2050
• An expanded mandatory Renewable Energy Target
• An Emissions Trading Scheme proposed in 2008
• Established the Global Carbon Capture & Storage Institute and called for 20 large scale CCS demonstrations by 2020 including three in Australia by 2015
• A new Energy White Paper commissioned
In 2009 Kevin Rudd dropped plans for an ETS as it was unpopular. Labour dropped Rudd, and in 2010, new Prime Minister Julia Gillard: “there will be no carbon tax under a government I lead”

But in mid 2011, a re-elected Julia Gillard states:

- **Pricing carbon is this Government’s biggest reform yet.**
- **A vital economic reform which will build our clean energy future.**
- **Starting at $23 per tonne and escalating with CPI, this price on carbon gives investors certainty**
- **3 months later, diluted**
New Prime Minister Tony Abbott campaigned on Australia’s suffering under the weight of “world’s biggest carbon tax” and has promised to repeal it.

To be replaced by Direct Action Policy, and

A new Energy White Paper, in

An environment of austerity

In 2013, Australia elected Tony Abbott
Effectively ending Australian climate mitigation policies

In 2014, the carbon tax was repealed
Summarising key drivers for CCS

Understanding the **Positive** (✓) and **Restraining** (X) Forces for **Private Sector Investment**

<table>
<thead>
<tr>
<th>Driver</th>
<th>OECD</th>
<th>Non-OECD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Mitigation</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Increasing Fossil Fuel Use*</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Electricity Demand+</td>
<td>X</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>Electricity (wholesale) prices</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Generation fleet age (for retrofit)+</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Public Support</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Front End Investment (time, cost &amp; risk)</td>
<td>X X X</td>
<td>X</td>
</tr>
<tr>
<td>Project Capital Cost</td>
<td>X XnX</td>
<td>-</td>
</tr>
</tbody>
</table>

* excl. Gas in the USA

+ Opportunities to retire and replace – **tough decisions now, but will be necessary**
Qualifications & Exceptions

• Development timeframes and cost *may* be less for existing oil & gas fields where production data is extensive.

• Development time frames and costs *will* be less in EOR applications but without sophisticated MMV\(^1\), this is *not* CCS.

• Plant construction costs *may* be less in retrofit cases but difficult to justify on aging plant.

• On the other hand, the USA and many OECD countries is facing a very serious dilemma with significant capacity likely to be long past design life during the next 1-2 decades.

• Natural **gas processing** – CO\(_2\) removal a prerequisite – e.g. Gorgon

• *Plant construction costs will be less in Non-OECD countries but not enough to make CCS commercial*
The Role for Industry?

Findings of the National CCS Council Finance Working Group:

There is currently no Business Case to support Private Sector CCS investment.

If CCS is to be progressed as an option for widespread deployment, government will need to incentivise and facilitate early deployment.

So, reframing the question....

How can Governments facilitate .... the role of industry in developing pathways for CCS?

And then...

Should Governments intervene to promote pathways for CCS?
Clearly **transitional government support** is required ...

For early mover projects - before the technology is able to deploy commercially without assistance and in an uncertain policy / regulatory environment:

- Facilitate exploration and appraisal (E&A) of GHG storage resources (starting now) in advance of integrated projects.... *with/by O&G companies*;

- Lower the amount of capital that needs to be raised by project proponents (grants, loan guarantees, etc.,);

- Support the operating-phase cash flows e.g. Feed in Tariffs (FiT’s), Contracts for Difference (CfD’s); and

- Mitigate specific project-related risks, (e.g. long term CO₂ storage liability & Public-Private-Partnerships to reduce commercial complexity & impact of policy uncertainty).
A public sector *risk-sharing* model?

*For integrated projects involving multiple parties* in different parts of the CCS Chain with commercial risk and policy uncertainty …..

**Government Backed Entity**

- Residual CO2 price risk
- Residual CO2 volume & downstream availability risk
- Regulated return underwritten by Government
- Regulated return underwritten by Government

**Generator Co**
- Produces and sells electricity at commercial price
- Supplies pre-capture CO2 on known price basis
- Maybe the same entity as Capture Co

**Capture Co**
- Supplies captured & compressed CO2 on known price per tonne
- Technology backed by OEM performance guarantees to the extent possible

**Transport Co**
- Contracted to provide desired throughput capacity (limited volume / price risk)
- Physically handles CO2 but Capture Co may retain title and risk

**Storage Co**
- Basin characterisation initially funded / subsidised by government
- Known price contract per tonne stored with guaranteed minimum volume
- Long-term CO2 leakage liability transfers.

Greig et al., (2013), *Mobilising Private Sector Employment for CCS* [For National CCS Council]
Sub-optimal Industry Involvement create barriers to deployment pathways

- IP & Information sharing
  - To achieve learning by doing industry needs to share its experiences
  - Many cases of project proponents, technology providers and EPC’s guarding IP, know-how and even lessons from failure.
  - Should facilitate information sharing with and access for research community – to inform and facilitate next generation technologies

- Storage resources are the first critical issue for deployment
  - especially E&P expertise on storage
  - especially in non-OECD countries

- Oil & gas expertise is reluctantly shared with / accepted by coal fired power & industrial players
  - Only the oil & gas sector has the capability and capacity to effectively and efficiently define, develop and manage sub-surface storage resources
• **CCS is the only technology that will enable continued large-scale use of fossil fuels** in a carbon constrained world & it will need to be deployed at tremendous scale across many industries.

• **Oil & gas Exploration & Production expertise is critical** - Storage can be performed safely and securely, but there will be challenges at scale (e.g. reservoir dynamics, monitoring) – **non-oil & gas players cannot manage this**.

• **Megaproject execution capability is critical** – Industry **must** be involved.

• **But no business case** to underpin significant industry involvement today.

• Therefore, **Government should intervene to facilitate industry involvement** to support / mitigate
  - Early Exploration & Appraisal of storage resources
  - High initial capex & opex *(carbon price + reduce capex → coal + CSS competitive post 2030?)*
  - Commercial complexity and multi-party risks across the value chain + policy uncertainty

• **Such support should be conditional on** IP & information sharing, access to E&P expertise & research community involvement.
Thank you

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Reference is also made to reports prepared for National CCS Council, an advisory body established by the Australian Department of Energy Resources & Tourism, in conjunction with private sector fossil fuel companies.