CAGS Technical Workshop
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DEFINING STORAGE READY

Purpose of session
分组会议的目的
- Engage and elicit comments
- Consider issues raised in other presentations
- Identify what is reality now
  - Technically & commercially
  - Policy & regulatory & legal
- What is required for future
- Stimulate thoughts for Panel Session (afternoon)
  - “Are China and Australia Storage Ready?”

Who are CGSS?
Who are CGSS?
- CGSS = CO2 Geological Storage Solutions
- CO2 geological storage services firm
- Provide geoscience advice for geological storage of CO2:
  Technical, Legal, Regulatory, Strategic
- Assist in deployment of geological storage at industrial scale:
  Regional Assessment, Prospect Exploration, Site Injection
- Combined 60 years experience in CO2 storage
- Main Office in Canberra- with Associates and Alliances nationally (Perth, Melbourne, Adelaide, Brisbane) and Internationally

Storage Ready questions?
储存就绪涉及到的疑问
- How do we define Storage Ready?
  - And implement Storage Ready?
- When is a geological storage site Storage Ready?
  - How much drilling and modelling required?
- Are there other technical issues to consider?
  - Monitoring, long term sustainability
- Are there stages of Storage Ready?
  - Milestones, levels of proof and certainty
- Are there advanced technologies that may affect Storage Ready?
- Or is it just a policy matter – not technical?

Is “Storage Ready” simply knowing / believing you have a viable and nearby sedimentary basin
“储存就绪”是否仅仅意味着知道和相信你已经有了一个可行的和近距离的沉积盆地？

and a friendly geologist
以及一个友善的地质学家？

How much detailed geological knowledge would qualify?
需要多少详细的地质知识你就够资格了？
- Extensive广泛的
- Thick深厚的
- Reservoirs储层
- Seals密封
- Faults裂隙缺陷
- Migration Pathways迁移路径
What data sets do you need to have?

你需要具有哪些数据库？

How much money will it cost to qualify?

需要花费多少资金来获取合格的资质

Fine grained marine sediments = seal

Organic rich mud & silt in coastal swamps = coal & seal & poor reservoir

How big is the challenge?

面临的挑战有多大？

Are some geological solutions / sites going to be a lot better, more manageable, than others?

存在一些地质解决方案和场所比其他的方案和场所更好和更易操控管理吗？

-and how do we predict in advance –

· 此外，我们如何提前预知呢？

Reservoir Pressure Build up: considerations

储存地层压力蓄积：需要考虑的方面

- Will impact across all aspects of geological storage
  - Technically
  - Legally
  - Regulatory
  - Commercially

Can you think of any now?
Depositional Environments

- Understanding reservoir and seal heterogeneity will influence numerous outcomes
  - Technical
  - Commercial

- …… this is just doing our homework properly – normal business practices
- – or is it

Does it matter the level we are working at?

World Map of CO₂ Storage Prospectivity

Highly Prospective 高预期前景
Prospective – High to Low 预期前景·高至低
Non-Prospective 无预期前景

All Basins & Storage Sites examined

- 48 basins were considered viable sites for study (out of > 300)
- 102 sites analysed
- 65 proved viable Storage Sites
- 22 sites not viable; 15 regional basin overviews

Queensland CO₂ Storage Atlas

- Stage 1 of QDMR Carbon Geostorage Initiative: 768 – 1,296 Mt storage capacity required for major emission nodes
- 36 Queensland basins assessed for geological storage prospectivity
- High-grade basins for more detailed studies & data acquisition to identify storage sites
- Geological assessment – excludes existing resources
- Product includes A3 hardcopy atlas and GIS (ArcGIS and MapInfo formats)
What is geological storage prospectivity?

Prospectivity is a qualitative assessment of the likelihood that a suitable storage location is present in a given area based on the available information.

By nature, it will change over time and with new information.

Estimates of prospectivity are developed by examining data (if possible), examining existing knowledge, applying established conceptual models and, ideally, generating new conceptual models or applying an analogue from a neighbouring basin or some other geologically similar setting.

The concept of prospectivity is often used when it is too complex or technically impossible to assign numerical estimates to the extent of a resource.

World Map of CO₂ Storage Prospectivity

Remember: (“this is a geologists map”)

Like any Prospectivity map, this is a map of where to begin to look for CO₂ storage space

Not a map of where it actually is?

Now need real data with appropriate testing (Dedicated CO₂ wells, focussed seismic, aquifer tests)

Do we need these in place to be “Storage Ready”

*From Bradshaw & Dance 2004

Data & knowledge? 数据&知识？

How much 多少

At what level of detail 细至到什么程度

What will regulators require 法规制定者需要什么

What levels of proof and certainty 有何种水平的验证和确定性

Are there fundamental conceptual issues?

有没有基础科学问题？

Will industry integration be an issue？

工业集成会存在问题吗？
How big does Storage have to be?

- 100
- 1,000
- 10,000
- 100,000

- 40
- 500
- 22.3
- 6349

- 260
- 22000
- 3.3
- 22.3
- 100
- 6349

**Source Sink Matching**

Qld:
- 896 Mt
- 16.7 Tcf
- 2290 MMcf/d

SA:
- 411 Mt
- 7.7 Tcf
- 1055 MMcf/d

WA:
- 411 Mt
- 7.7 Tcf
- 1055 MMcf/d

NWS:
- 386 Mt
- 7.2 Tcf
- 986 MMcf/d

NT:
- 9.2 Mt
- 0.2 Tcf
- 27 MMcf/d

Viable – but not optimal reservoirs?

Superb reservoirs. But, require offshore development?

Very good reservoirs. Distant from major sources

Large emissions – “No reservoir”

Source distance?

Note: map excludes industrial point sources

NSW:
- 1167 Mt
- 21.8 Tcf
- 2986 MMcf/d

Vic:
- 1185 Mt
- 22 Tcf
- 3014 MMcf/d

SA:
- 180 Mt
- 3.4 Tcf
- 466 MMcf/d

Stationary energy point sources

Unproduced large gas fields with high CO2 %

KEY

1 TCF CO2 = 53.65 Mt

CO2 = 28.3 BCM

- 1055 MMcf/d

- 1055 MMcf/d

Large emissions – “No reservoir”

Reservoir/Seal relationship.

Proximal to sources?

Distant from major sources

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Subsurface Certainty

- Half described as failures
- delivering as promised on project management and business perspectives.
- Difficulties associated with
- the facilities and
- subsurface reservoir, and
- working to deadlines rather than making decisions based on the timing of arrival of accurate information.

Subsurface Certainty

- Whilst uncertainty quantification has improved over a 10 year period
  - this has not improved decision making in the oil and gas industry,
- The highest ranking of uncertainty in the investment decisions were
  - with subsurface considerations,
  - above other matters such as a volatile oil price
  - (82% of 494 respondents).

Time & Cost: Storage

How much is required to find & develop storage sites

<table>
<thead>
<tr>
<th>Work Plan</th>
<th>Task</th>
<th>Time (Years)</th>
<th>Cost $mill (Onshore)</th>
<th>Cost $mill (Offshore)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening for In-Site Datas</td>
<td>Desk Top Compilation</td>
<td>6 – 12 months</td>
<td>5 – 10</td>
<td>5 – 30</td>
</tr>
<tr>
<td></td>
<td>Exploration Assessment</td>
<td>1 – 3 years</td>
<td>5 – 200</td>
<td>50 – 1500</td>
</tr>
<tr>
<td></td>
<td>Development</td>
<td>1 - 50 years</td>
<td>20 – 300</td>
<td>95 – 1830</td>
</tr>
<tr>
<td></td>
<td>Abandon Storage site</td>
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Note: Estimate are for Australian conditions and in $AUS

Plus add $2 – 3 + billion for Power Plant with Capture
**Significant upfront investment required until CCS is commercially viable**

![Graph showing cost of CCS, public and private investments, and costs under CO2 emissions regimes over time.]

**DEFINITIONS**

**What is Storage Ready?**

The processes and outcomes from identifying, proving and securing a geological storage site that is capable of having commercial quantities of CO2 injected and stored in the deep subsurface on a sustainable basis, whilst maintaining high geological integrity in the geological structures and formations both during and after the injection and storage period.

**BUT:**
- does not describe the processes involved in proving a storage site,
- does not elaborate on levels of proof and certainty that may be required,
- does not express the conceptual nature of the understanding of the geological attributes of the deep subsurface, and
- does not document the actual impacts that the geological characteristics of the deep subsurface may have on a site being proven to be storage ready.

**What if not Storage Ready?**

- Delay the whole CCS Chain
- Wrongly locate power stations
- Build pipelines to sites that aren’t sustainable
- Without Storage Ready, does CCS exist at all?

If you would build an LNG plant first?
- Then explore for a gas field!!
- Without Storage Ready, does CCS exist at all?