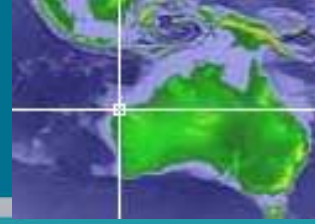

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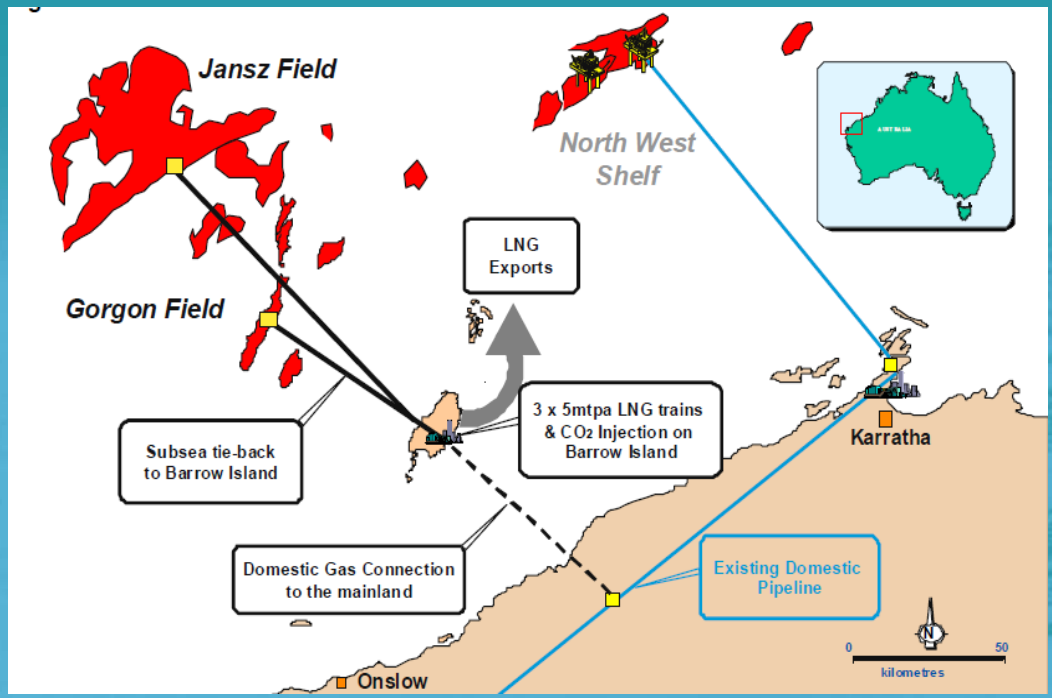
SITE SELECTION - GORGON CARBON DIOXIDE INJECTION PROJECT

Greg Leamon
Geoscience Australia

Gorgon Project

Joint Venture Participants

- Chevron (~47%) operator
- ExxonMobil (25%)
- Shell (25%)
- Osaka Gas (1.25%)
- Tokyo Gas (1%)
- Chubu Electric Power (0.417%)



Gorgon Project

- Australia's largest single resource project
- Estimated project cost A$43 billion (2009)
- Gas resource 40 Tcf methane
- Project comprises multiple gas fields 90-160 km offshore in water depths 220m to 1300m
- Additional fields are being evaluated
- CO_2 will be produced with methane
- Gorgon (14%) Jansz (<1.0%)
- LNG production requires removal of all CO_2
- LNG facilities located on Barrow Island
- LNG exported to international markets
- Construction is underway
- First gas scheduled for 2014
- CO_2 injection to start after first gas

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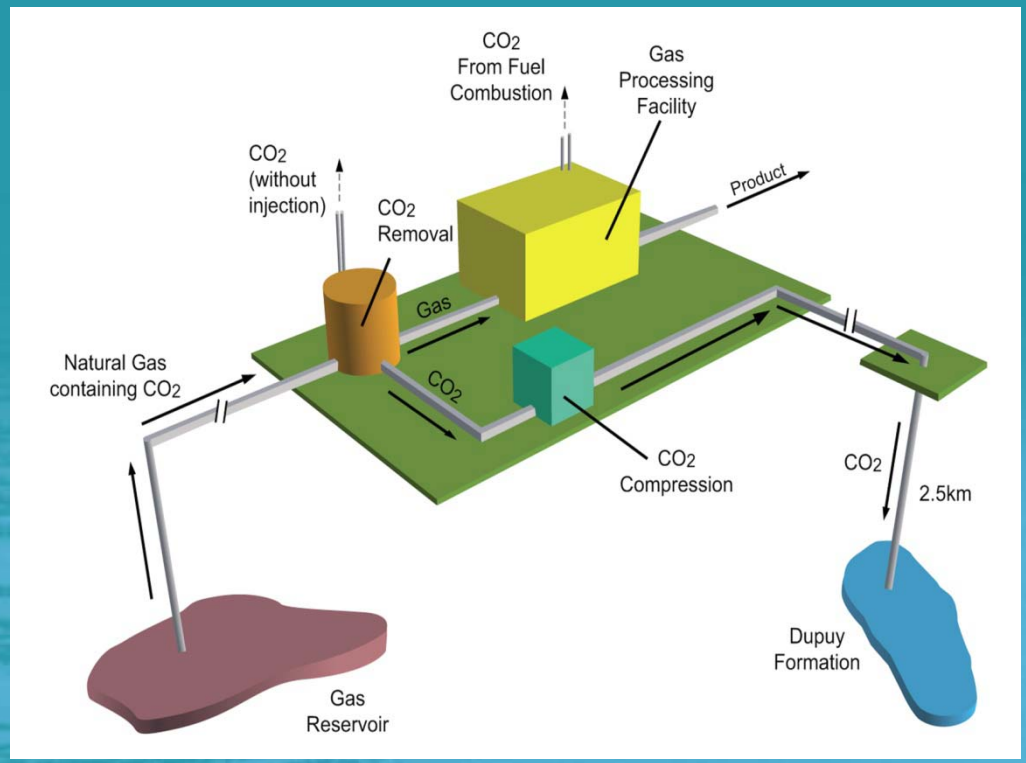
Gorgon Carbon Dioxide Injection Project

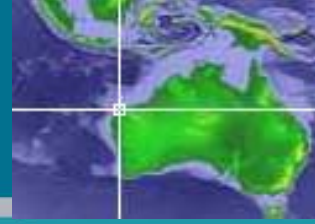
- The first project in Australia to significantly reduce emissions by the underground injection of CO_2
- Gorgon Project emissions are expected to be reduced by approximately 40%
- Injection will be between 3.4 and 4.0 million tonnes of reservoir CO_2 per year or more than 100 million tonnes over the life of the project
- Site appraisal cost $150 to $200 million
- Project capital cost will be around $2 billion
- Number of possible world firsts including –

✓ First greenhouse gas storage legislation – Barrow Island Act 2003 (WA)

✓ First CO_2 project to undergo detailed environmental impact assessment (including public review and comment)



Project history



1980 Gorgon Gas Field discovered

1992 Discussion started about use of geologic disposal as a way of managing reservoir CO_2

1996 Series of studies commissioned to consider ways of addressing greenhouse gas emissions

- Various ocean disposal techniques e.g. deep, aqueous solution and dry ice
- Storage in soil
- Disposal into deep aquifers
- Disposal into depleted oil and gas reservoirs
- Use of microalgae for CO_2 remediation
- Terrestrial storage of CO_2 as a solid in a thermally insulated repository
- Forestation offsets
- Commercial use of CO_2

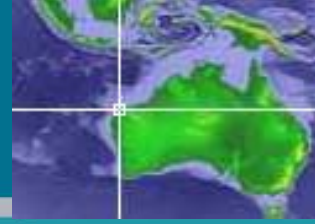
1998 Joint Venture held workshop to consider options for the disposal of reservoir CO_2

- Geological disposal was deemed the most credible

1998 to 2002

- Work focused on assessing potential storage sites within 300km of Gorgon Field

Site Screening and selection



Four criteria considered for site screening and selection –

1. Containment risk – e.g. security of top seal, distance to faults, number / condition of existing well penetrations
2. Storage capacity – e.g. gross rock volume, regional structure capacity, reservoir architecture, extent of connected aquifers
3. Injectivity - e.g. permeability, thickness and extent of target reservoir sands
4. Risk to other assets – e.g. risk of fluid / pressure interference with other operating, discovered or undiscovered hydrocarbon fields (note - no fresh groundwater)

19 sites / concepts initially assessed in screening study –

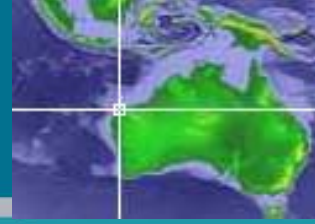
- Saline aquifers
- Existing hydrocarbon fields
- Enhanced Oil Recovery opportunities

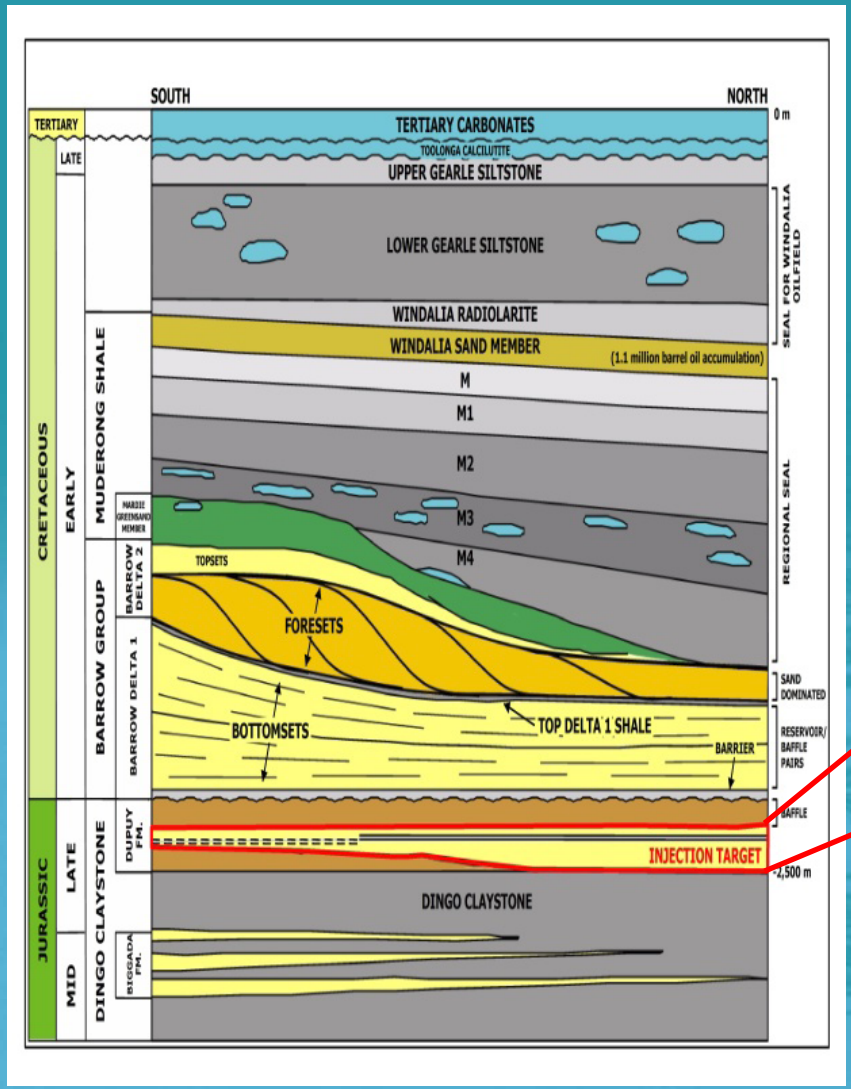
Five sites further assessed with screening-level simulation studies

Barrow Island Dupuy Formation only site that adequately satisfied all criteria

Since 2002 activities have focused on further appraising the selected site and refining the configuration of the injection project

Geology

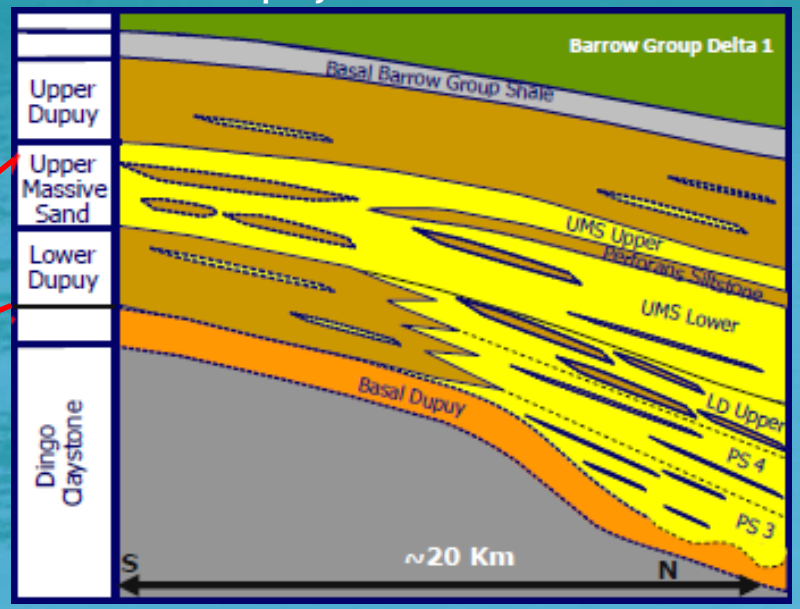




The Dupuy storage formation has adequate permeability for injection while still low enough for good residual gas trapping.

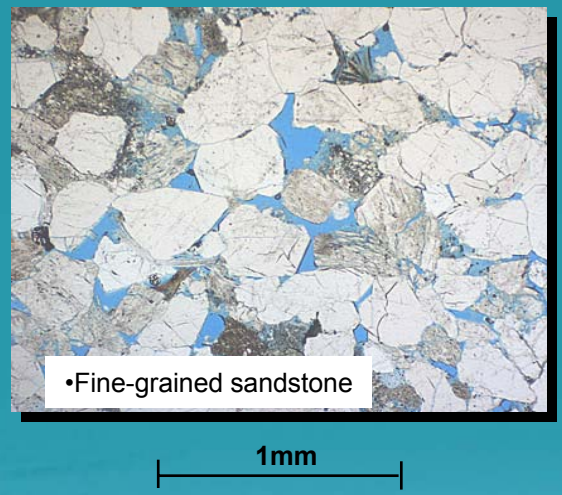
- Several seals exist between injection zone and surface
- Adequate existing subsurface data to characterise the site

Dupuy Formation



Dupuy Formation Containment Mechanisms

Dupuy Formation is an ideal CO_2 container with moderate permeability and many baffles.

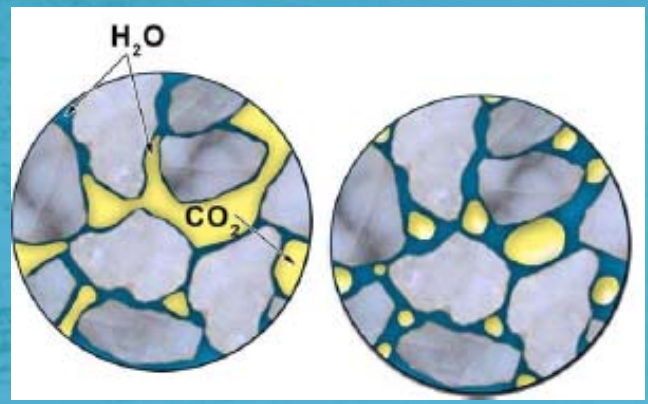


Two main trapping mechanisms

- CO_2 solution into formation water
- Residual gas trapping (CO_2 sticks to rock grains)

Other mechanisms

- Large scale geometric trapping is not required (smaller scale structural/stratigraphic trapping will occur).
- Dupuy Formation is chemically inert so mineralogical trapping will be a longer term effect.



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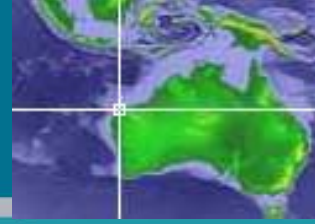
Injection location - Barrow Island



Barrow Island

- 55km from mainland
- 30km long & 10km wide
- Class A nature reserve since 1910
- Coral reefs around island
- No freshwater aquifers
- Restricted access
- No local community, only workers
- Strict quarantine regime

Barrow Island Oil Field

- Australia's largest onshore oil field
- Oil production began in 1967
- 95% of oil from shallow Windalia Sand
- Approx. 420 producing wells and 208 water injectors
- Production will continue for many years
- Different ownership to Gorgon Project

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Carbon Dioxide Injection Project

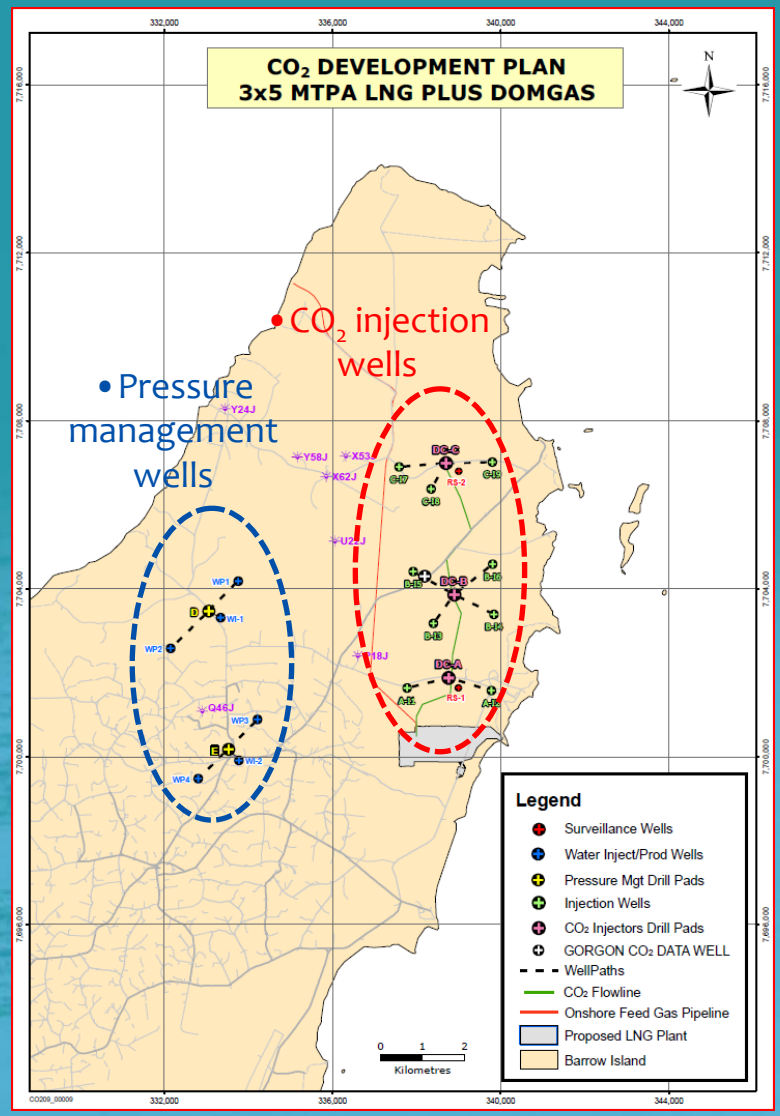
Approved Development Plan

- Project sited on north-east of island
- 4 stage compression at gas processing facility
- Buried CO2 pipeline extends north 7 km
- 9 CO_2 injection wells (from 3 drill centres)
- Pressure management (2 drill centres)
  - 4 water production wells
  - 2 water injection wells

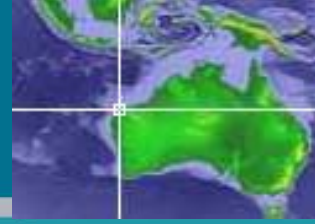
Fit for purpose monitoring program

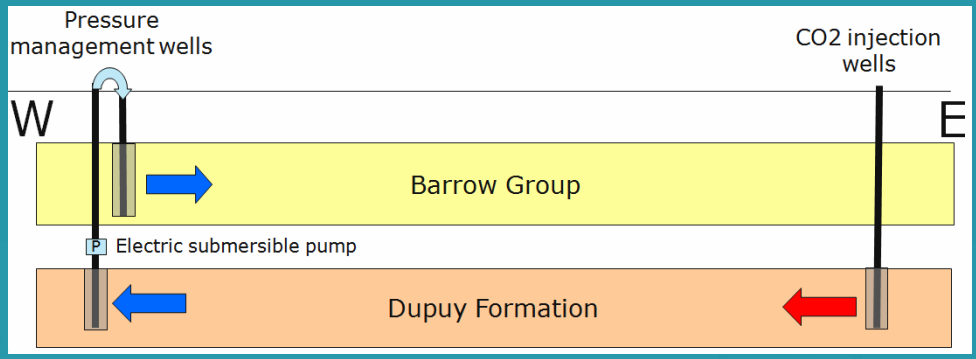
- 3D baseline seismic survey and repeat 2D and 3D seismic surveys to map lateral extent and broad vertical distribution of CO2
- 2 reservoir observation wells
- Soil gas flux sampling over the 3D seismic source grid and at potential near-surface seepage points

- **Program for ensuring existing well penetrations in the plume area do not provide seepage pathways**
- **Joint Venture commitment to make data from the ongoing monitoring program available to the public**



Pressure Management



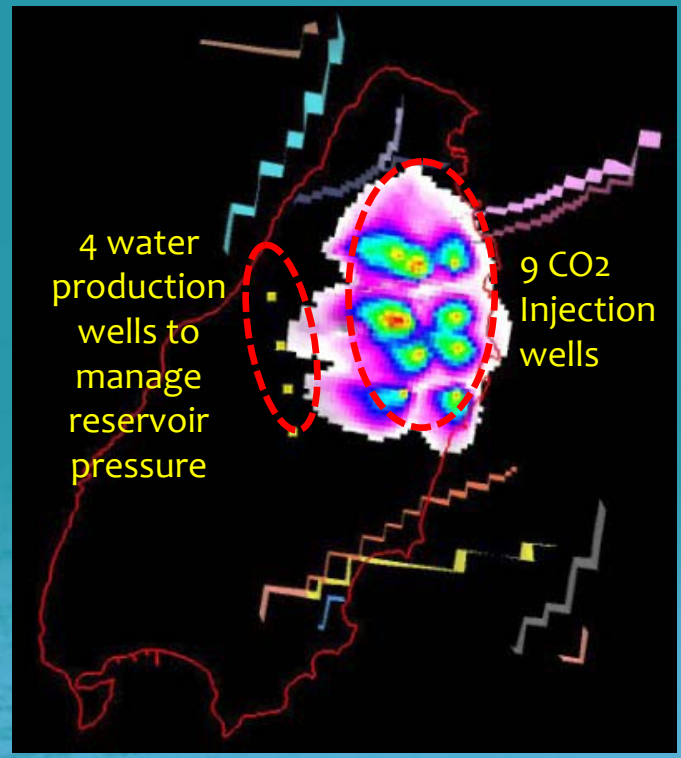


Pressure management required to reduce impact of rising pressure on CO_2 injection performance:

- Maintain injection rates
- Avoid reaching bottom hole pressure limit
- Optimise storage capacity

Monitoring

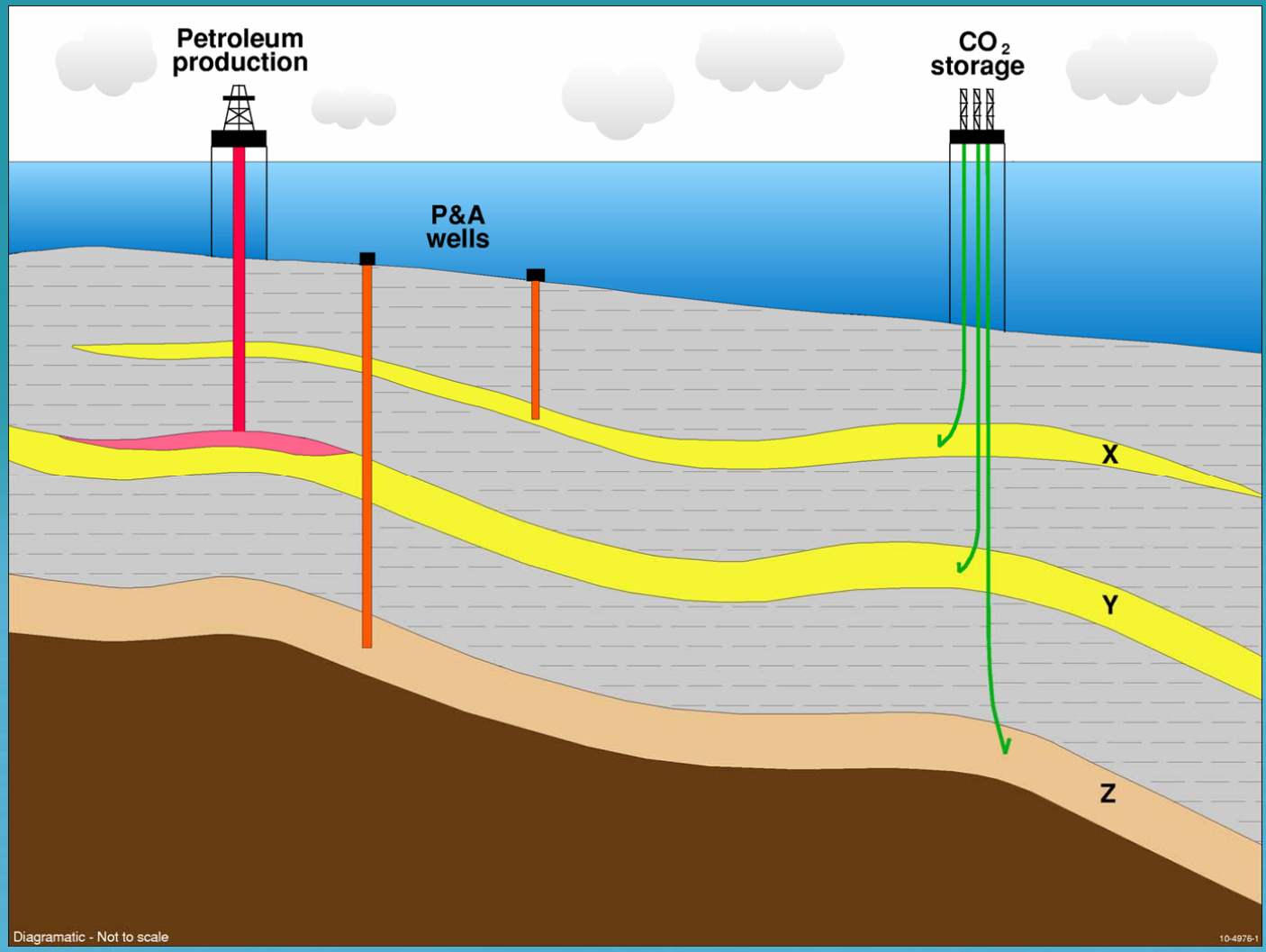
- Wellhead pressure and flow rate
- Continuous down-hole pressure gauges



- Plume movement is influenced by water off-take, reservoir and structure.
- Growth in plume area is most rapid at start of injection

THANK YOU FOR YOUR ATTENTION

Risk to other resources



- X – Sleipner
- Y – In Salah
- Z – Snohvit & Gorgon