KNOWLEDGE SHARING

https://www.gov.uk/government/collections/carbon-capture-and-storage-knowledge-sharing

http://www.energy.alberta.ca/CCS/3845.asp
Pressure monitoring

IEA GHG Monitoring
Network meeting
(LBNL 2015)
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■ Capture at Scotford Upgrader
■ 1 million tonnes CO\textsubscript{2}/year, capacity for 25 years – about 1/3\textsuperscript{rd} of the upgrader’s emissions
■ 65 km pipeline
■ reduction: up to 250k cars (EU) equivalent (per year)
■ CCS – saline aquifer (BCS)

■ DNV – Storage & MMV plans certified
■ Quest in ‘Execute’ phase since Sept-2012
Capture:
- All modules on site July 2014
- All modules set in place mid August 2014
- Final mechanical completion February 2015

Quest Stripper Vessel Delivery
Quest Capture Site – Early Works construction site – August 2012
Quest Capture Site – March 2013
Quest Capture Site – March 2014
Quest Capture Site – September 2014
Quest Capture Site – March 2015
BCS Storage Complex

- Deep saline aquifer (~2km), porous sandstone (Por~16%, K>300mD to 1D)
- Multiple continuous seals to minimize containment risk
- No significant faulting visible from wells or seismic
- Well below hydrocarbon bearing formations(<1200m) and potable water zones (<200m)
- Few legacy wells, nearest at ~20 km

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<th>Layer</th>
<th>Depth</th>
<th>Description</th>
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<td>PreCambrian Basement</td>
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DEEP MONITORING WELLS

- A deep monitoring well is drilled on each well pad only a few meters from the injection well into the Cooking Lake Formation.
- The cooking lake is a major regional aquifer made up on extensive sheet-like carbonates. It is depleted.
INJECTION AND MONITORING WELLS
Technical feasibility for pressure monitoring

- **Sensitivity**: must reliably verify the expected absence of fluid pressure increases above the storage complex

- **Coverage**: must be able to detect any unexpected leaks with regions of greatest containment risk

- **Time**: time to detection of an unexpected leak should be sufficient to trigger correct measures to prevent migration of fluids from the BCS to the ground water protection zone
Example analysis: Winepegosis (pre-drilling)

- Formation properties:
  - Thickness: 18m
  - Permeability: 10 – 50 mD
  - Porosity: 6%
  - Pore compressibility: $4.5 \times 10^{-10}$ /Pa

- Brine properties
  - Viscosity: $0.9 \times 10^{-3}$ Pa.s
  - Compressibility: $3 \times 10^{-10}$ /Pa

- CO$_2$ properties
  - Viscosity: $0.6 \times 10^{-4}$ Pa.s

- Based analysis on constant rate leaks
- Actual rates will slow down as delta pressure decreases

Example modelled responses (not current)

- Modeled two hypothetical leak rates, 6 kg/day and 600 kg/day. For reference we inject 2700 tonnes/day: 4000 years to leak 1 day’s injection at 600kg/day
Detection performance and uncertainty - example

- 6 kg/day
- High perm (thick), and low perm (thin)
- Different distances from leak
- Grey denotes gauge performance of standard quartz gauge

- High perm – early arrival but small response
- Low perm – later arrival but larger response
- Both cases = good detection
Uncertainty

- Insufficient permeability – will only become apparent with the well has been drilled
- Insufficient connectivity – the further away the greater the exposure to this risk
- Third party activities – it is important to know what is taking place near the well penetrations. Having multiple monitoring wells allows the regional signal to be extracted from the local signal
Conclusions – for this example

- All monitoring is site specific, but in this example the site is well suited for pressure detection
- In this example expect to detect leak rates of at least 6 kg/day
- Wells are only a few meters from injectors, but, in this example are sensitive to more distant leaks:
  - 1000m ... 5-20 days
  - 3500m ... 50-120 days
Shell Quest
• S/U in Q2/Q3
• Commercial Operations by year end