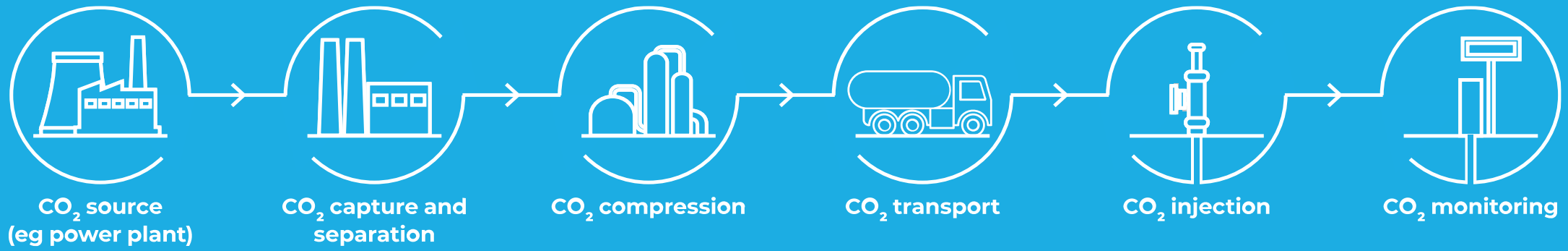
CTSCo
Carbon Transport & Storage

A GLENCORE Company



The tortuous pathway to commercial-scale CCS

QUPEX
6 June 2023

Word trivia

Ultracrepidarian

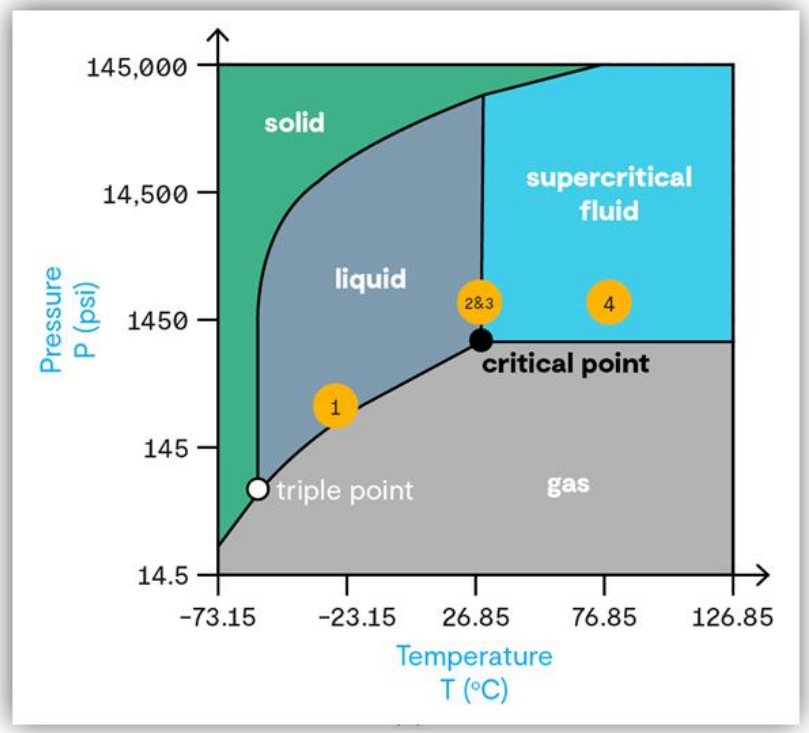
noun

Someone who gives opinions on subjects they know nothing about.

Agenda

- Quick CCS fundamentals
  - Capture
  - Transport
  - Storage
- Status of global CCS
- Challenges for Australian commercial-scale CCS
- Update on Glencore’s CTSCo Surat Basin CCS project

CO_2 fundamentals

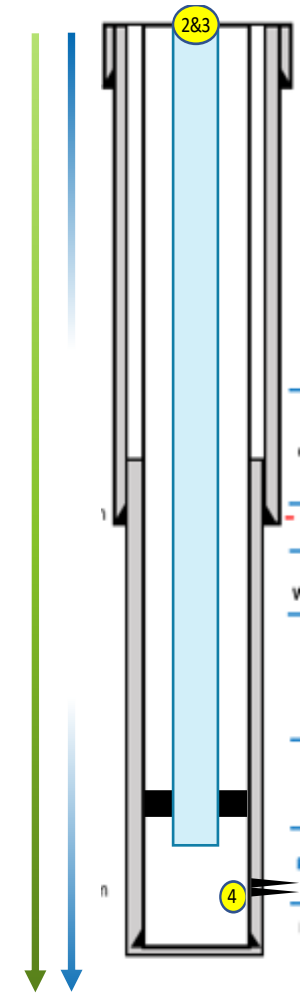


1 Truck transport– liquid state (-20degC, 2.3MPa)

- Captured GHG is predominantly (>98%) CO_2
- CO_2 can exist in several states
  - Captured as a gas
  - Transported via pipeline as a gas or supercritical fluid, or
  - Transported via truck as a cryogenic liquid
  - Injected for storage as a supercritical liquid
- Supercritical CO_2 is a dense fluid
  - Liquid like
  - Very low viscosity
  - Compressible
- CO_2 is miscible in water

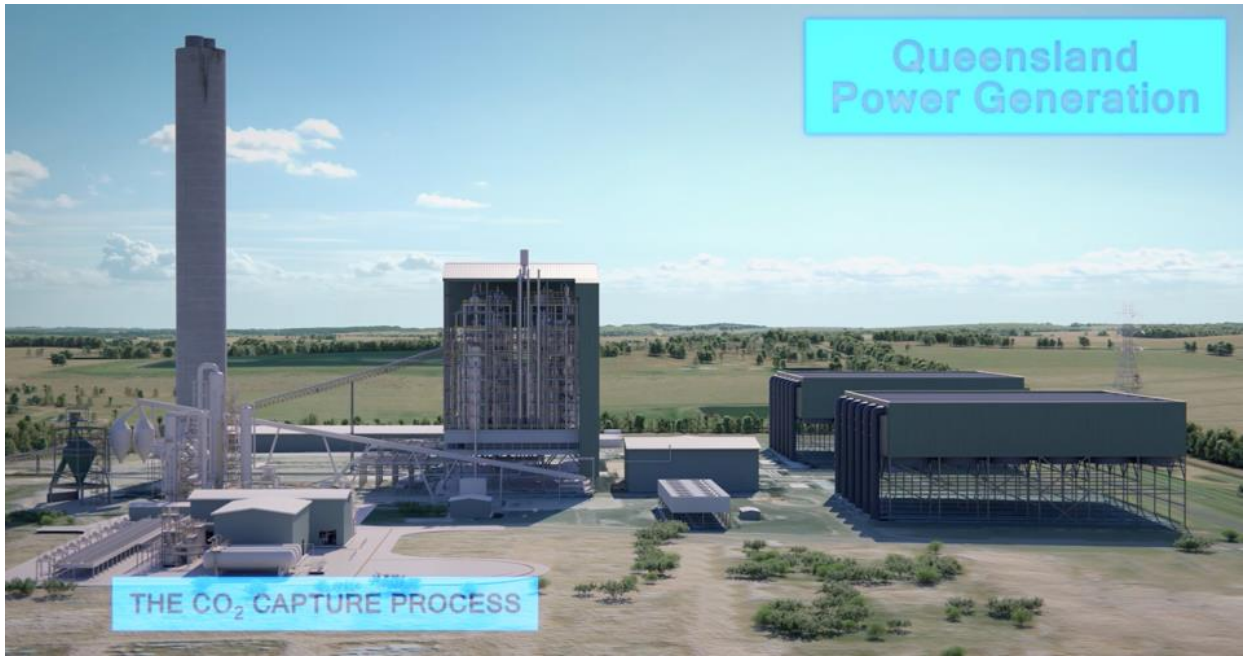
$$CO_{2\,(aq)} + H_2O \rightarrow H_2CO_{3\,(aq)}$$

  - Forms carbonic acid in low concentration
  - Reduces water pH
  - CO_2 in solution occurs naturally in rainfall (with pH 5 – 5.5)
  - Consumed as carbonated water



CO_2 capture

- Industrial or post combustion capture
  - Amine/solvent plants
  - Used to extract CO_2 from a mixed gas stream
    i.e. ~12% CO_2 in the flue gas from a power station
- Direct air capture (DAC)
- Direct CO_2 waste (i.e. from natural gas processing or from blue hydrogen production)

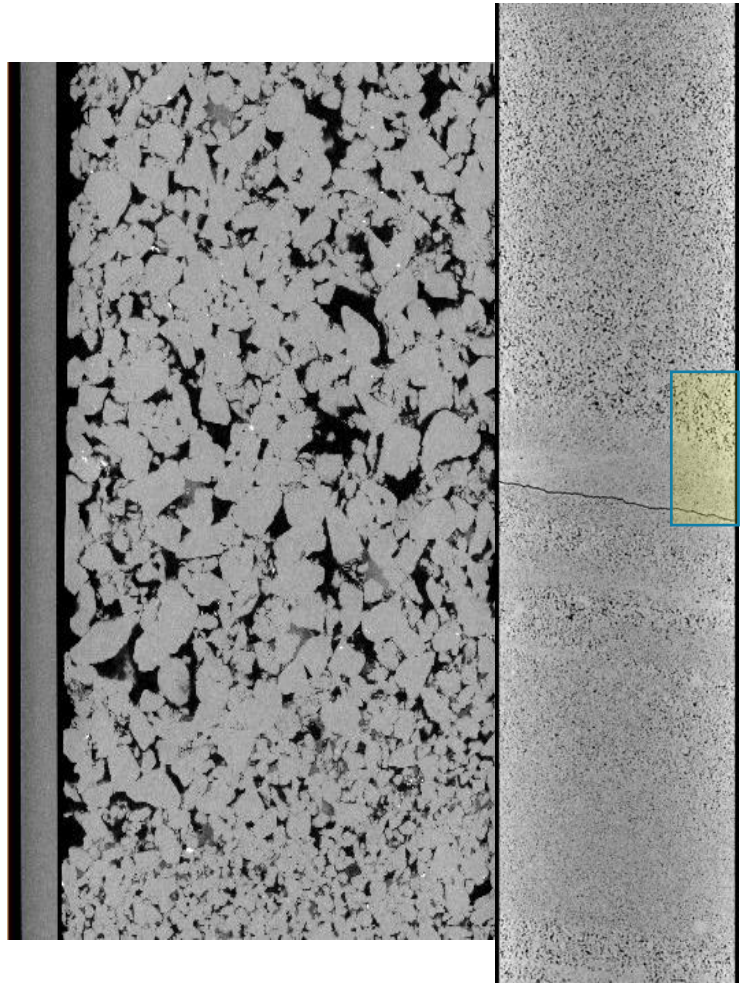


Huaneng Shanghai Shidongkou 120,000tpa PCC plant

CO_2 storage

Geological requirements for CO_2 storage

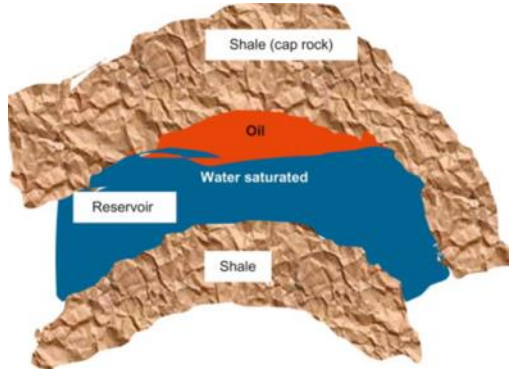
- Permeable and porous formation (sandstone)
  - Deeper than ~800m (above 800m CO_2 will be a gas)
- Competent sealing formation above and below the storage reservoir
- Non-potable/saline water – no sterilising a freshwater resource



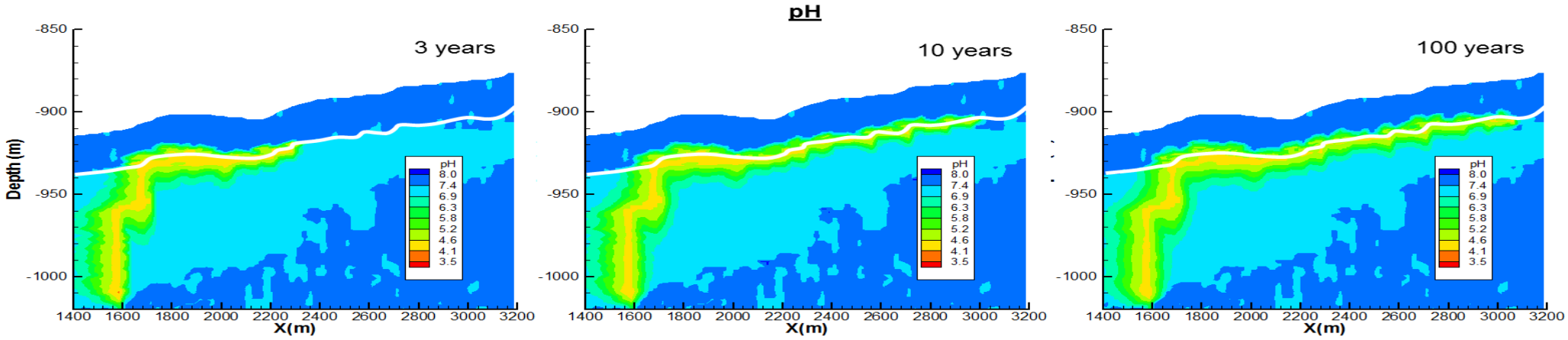
CO_2 storage

Trapping mechanism

- Anticline trapping
  - Such as legacy oil/gas fields
- Solution trapping
  - Requires a low-inclination seal
  - CO_2 displaces water around the injection well
  - CO_2 dissolves in the groundwater on the edge of the plume
  - Most large-scale CCS projects rely on solution trapping



Example anticline trap

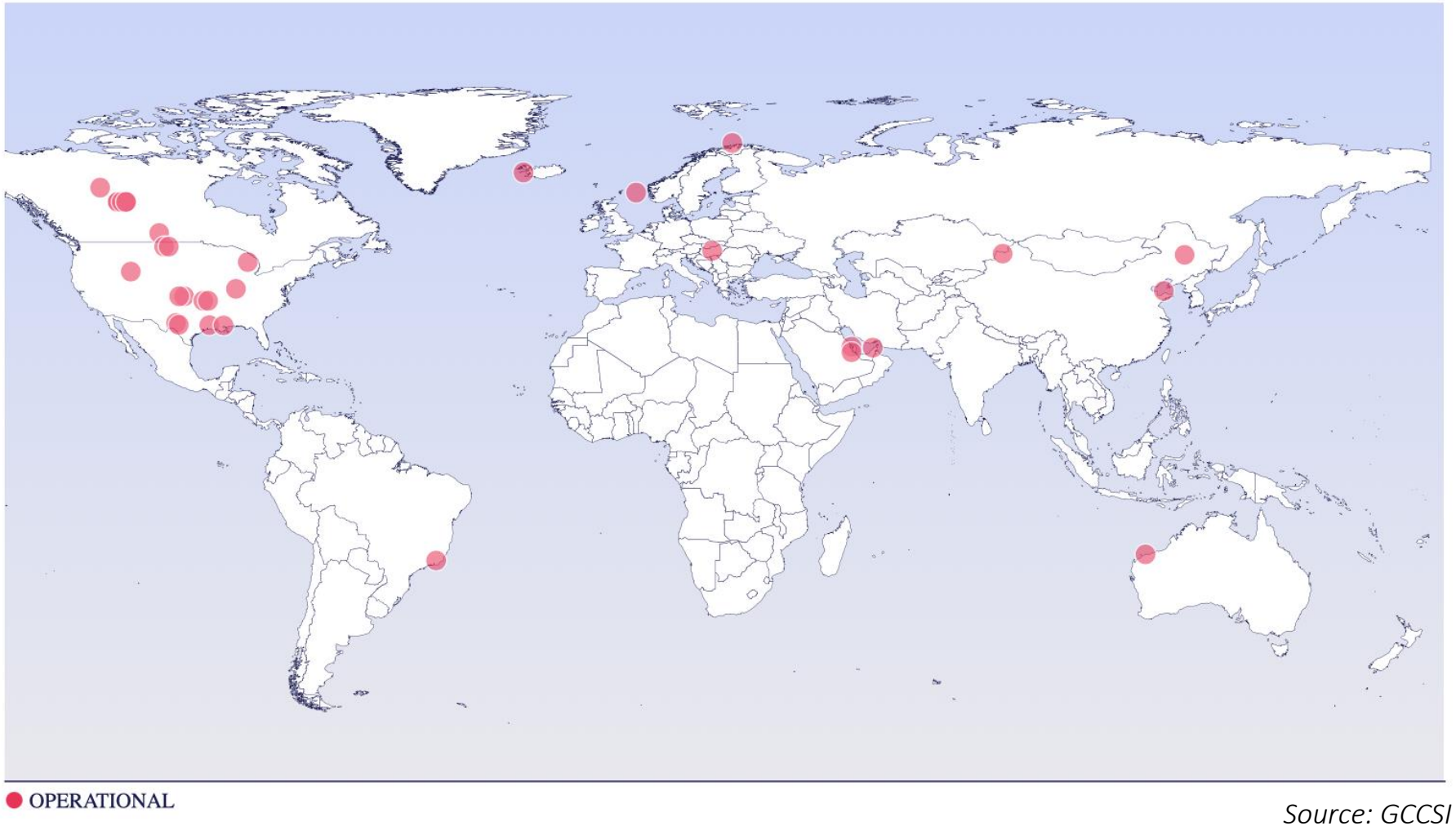


Example Plume pH/Geochem modelling

Status of global CCS

Most CCS activity in USA and Canada

- USA
  - 45Q
  - IRA
  - Mature E&P environment
- Canada
  - Carbon price
  - Mature E&P environment

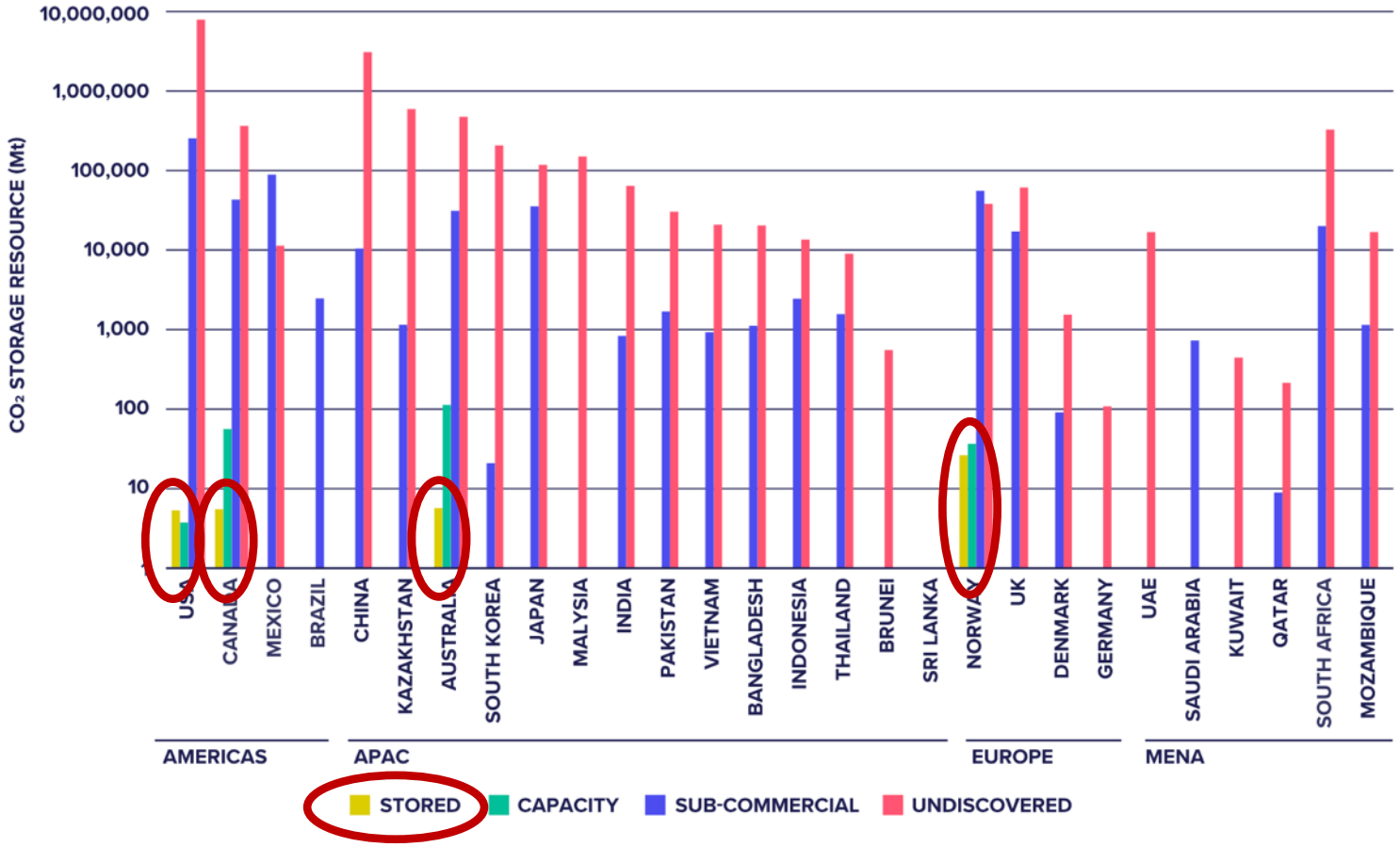


Source: GCCSI

Status of global CCS

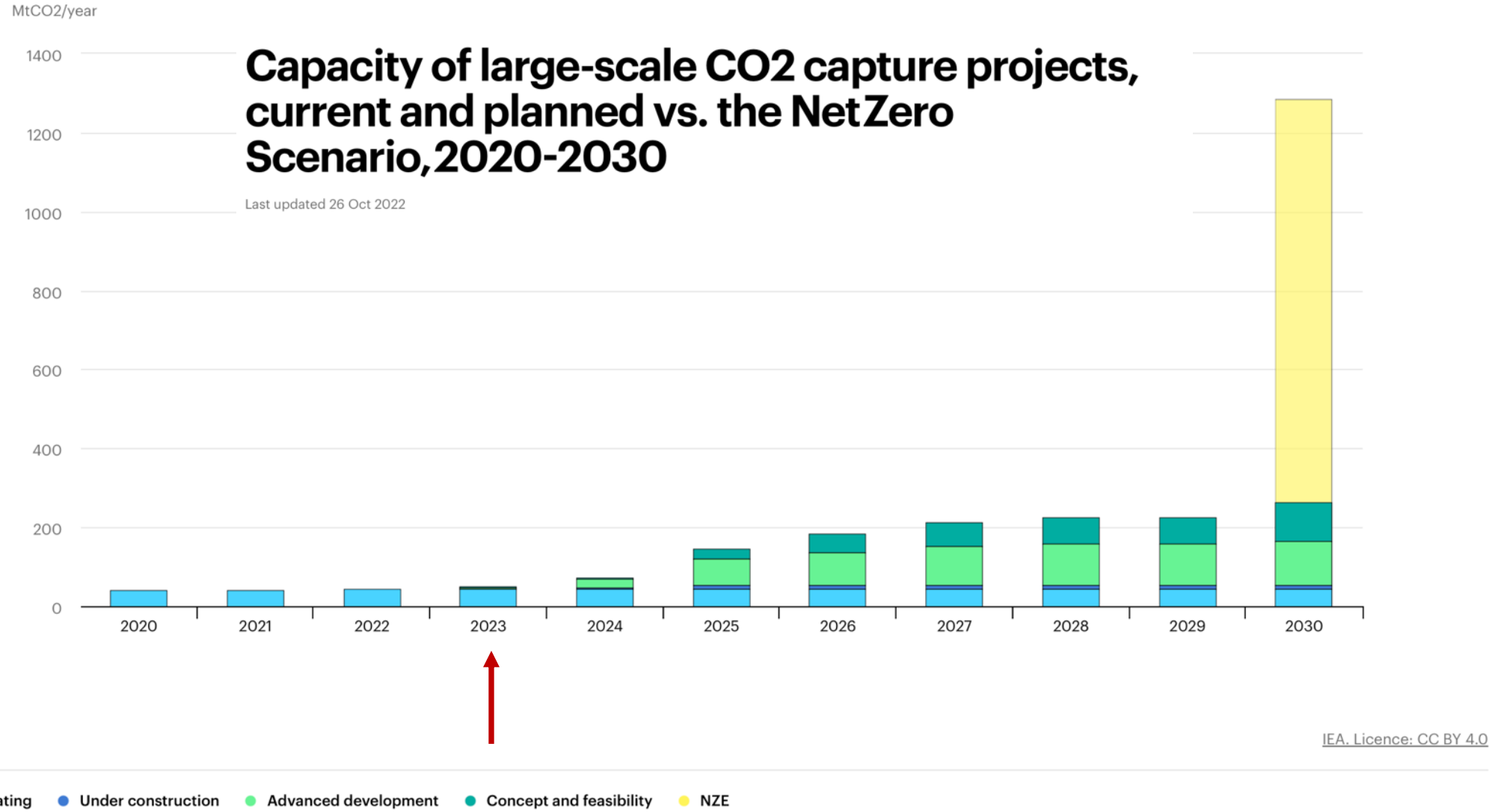
- Actual dedicated geological CO_2 storage (i.e. non-EOR) volumes are small to date
- Majority of current CO_2 injected has been for EOR
  - Where there was an economic incentive

APPENDIX FIGURE 5: CO_2 storage resources (which are associated with storage projects) by country and SRMS maturity class



Source: OGCI et al. (2022)

Status of global CCS



Source: IEA

Key challenges for Australian commercial-scale CCS

- Carbon pricing uncertainty
- Environmental approvals/regulation uncertainty
- Community and government perception of CCS risks
- Community and government perceptions of the need for CCS
- Perceived completion with high-intensity agriculture for groundwater resources
- CO_2 source
  - High cost of capture from existing industrial/generation emitters
- Scale
  - Large-scale is ultimately essential for reducing transport and storage costs
  - Storage hubs offer the opportunity to achieve this scale

Opportunities

- Australia holds substantial geological storage potential
- Costs for onshore Australia storage are potentially some of the lowest globally
- Others are already making significant advances in capture cost reduction

CTSCo project update

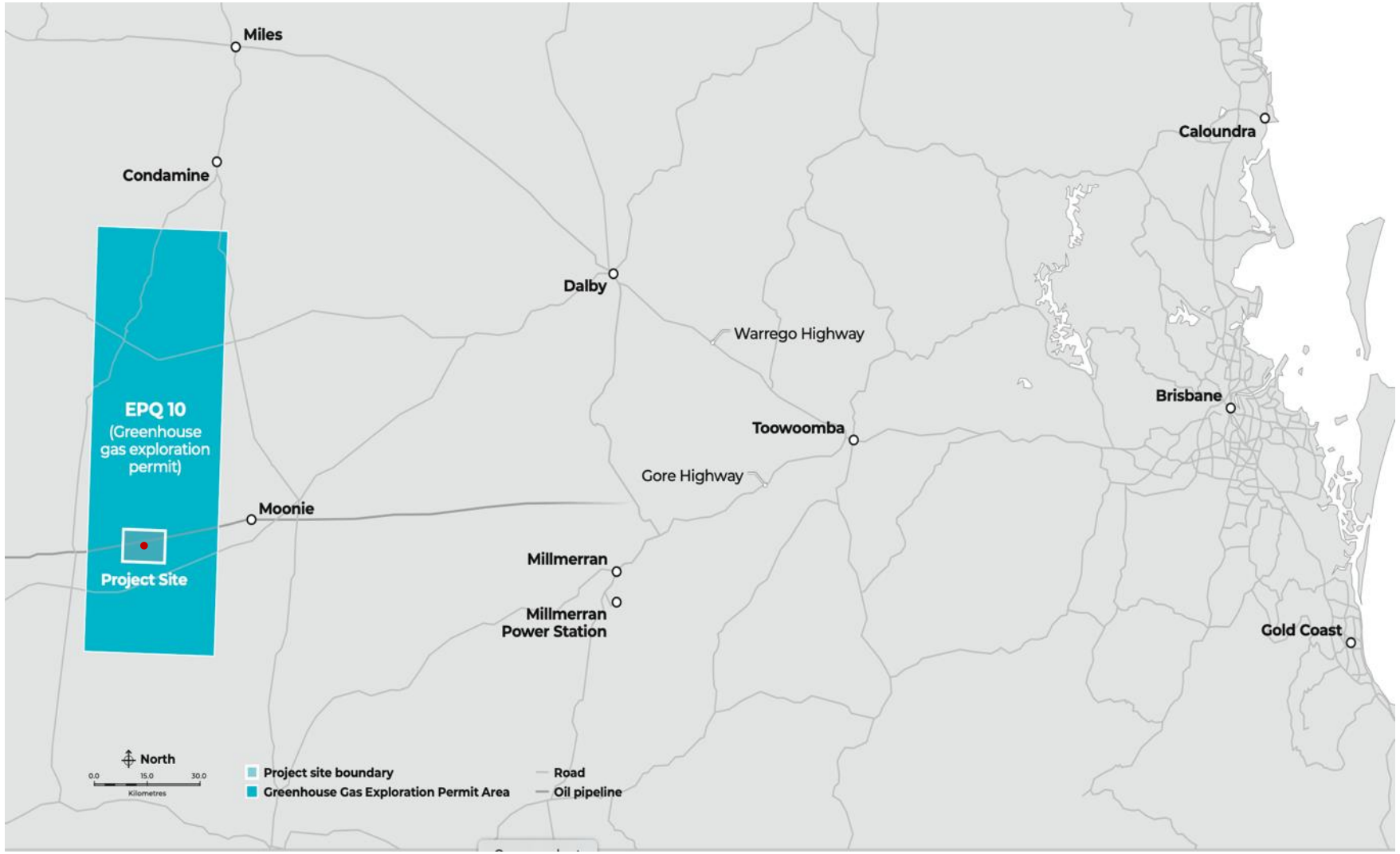
The proposed CTSCo project is as demonstration-scale injection of GHG in the southern Surat Basin EPQ10 tenement

- Transportation by truck of up to 330,000 tonnes of GHG stream across 3-years
  - Up to 110,000 tonnes per year
- Injection of the GHG stream into the Precipice Sandstone ~2.3km below surface
- Monitoring of the injected GHG stream
  - Baseline monitoring prior to injection
  - Monitoring during the 3-year trial injection
  - Monitoring for 2-year post injection or until no further plume movement is demonstrated
- Seeking environmental approval to inject CO_2 from the QLD government via an EIS
  - Currently responding to EIS public submissions

- Verify a large-scale CO_2 storage basin that can be used by industry, generators, and potential future blue hydrogen projects
  - **Provide regulatory certainty for GHG storage in Queensland**
  - Develop a large-scale, long-term, and cost-effective CO_2 storage solution that is close to the source
  - Provide foundation storage infrastructure for potential future large-scale storage

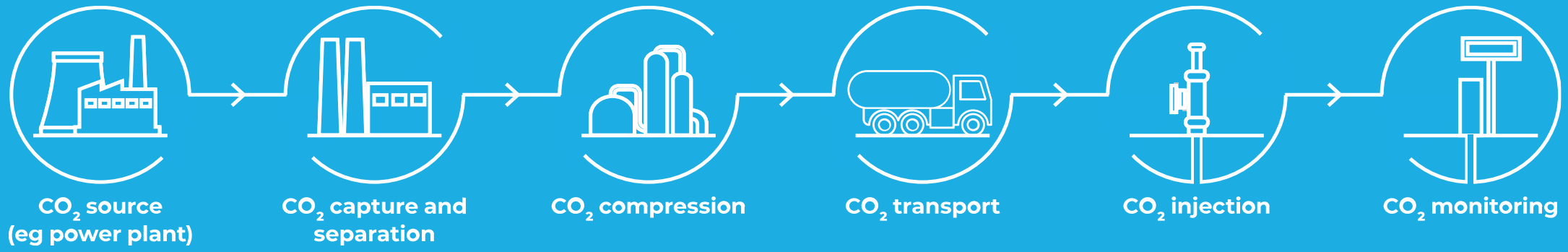
CTSCo project update

- Close to transport infrastructure
- Close to existing and future CO_2 sources
- Tenure held 100% by Glencore
  - Currently the only active greenhouse gas exploration tenure in Queensland
  - 3652 km^2 area
  - ~500 million tonne storage potential
- Test injection project has both a tiny surface footprint and subsurface impact



Closing comments

- CCS is a proven technology with over 30 projects operating globally
- No global examples of leakage of stored CO_2 from existing storage projects
- Level of community and government understanding of Australia's groundwater is low
  - This generates a fear of technologies such as CO_2 storage
  - Perceived competition with agriculture for water resources
- Regulation for CCS in Australia is relatively untested
- Geological CO_2 storage remains a substantial decarbonisation tool
  - For reducing emissions from fossil fuels
  - For storing large-volumes of CO_2 from hard to abate industries
  - For future large-scale DAC
  - Not the only technology – but hard to beat for large-scale abatement
- Only by delivering more successful CCS projects will the technology become better accepted
- Nothing is for free ….


CO_2 source
(eg power plant)
CO_2 capture and
separation
CO_2 compression
CO_2 transport
CO_2 injection
CO_2 monitoring

Questions?