Pre-commissioning approaches for offshore CO_2 pipelines

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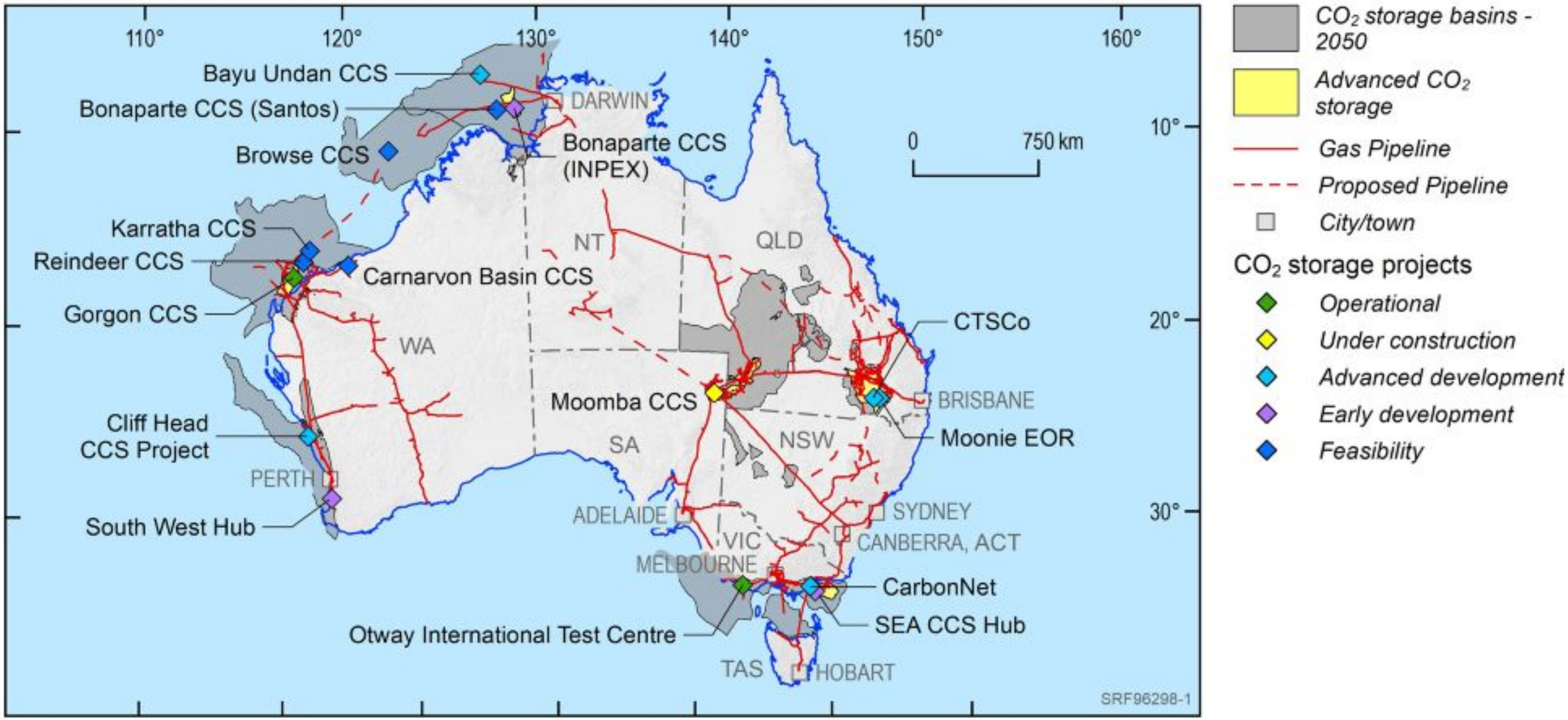
15th March 2024

#AOGENERGY2024



(Geoscience Australia, 2022; 2023) & Evaluating the economic potential for carbon sequestration projects, Walsh et al. 2023

I. Low Carbon Production

Offshore platform decarbonised via electrification or carbon capture technologies

II. High CO_2 Reservoirs

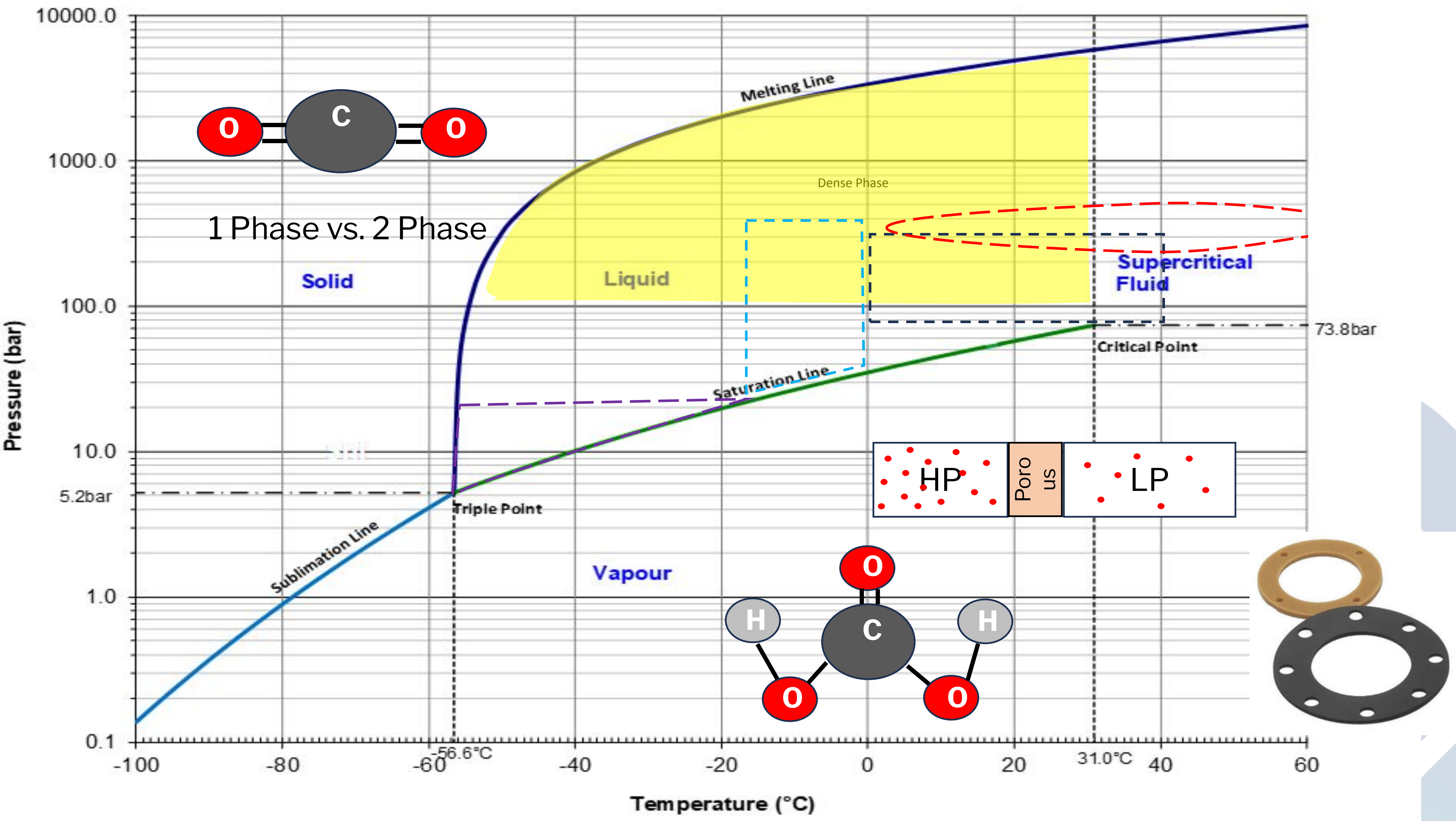
CO_2 separated from production stream and reinjected into a nearby aquifer or reservoir

III. Low Carbon Energy

Carbon captured from onshore plants is reinjected into reservoirs or aquifers. This includes blue hydrogen and onshore power plants

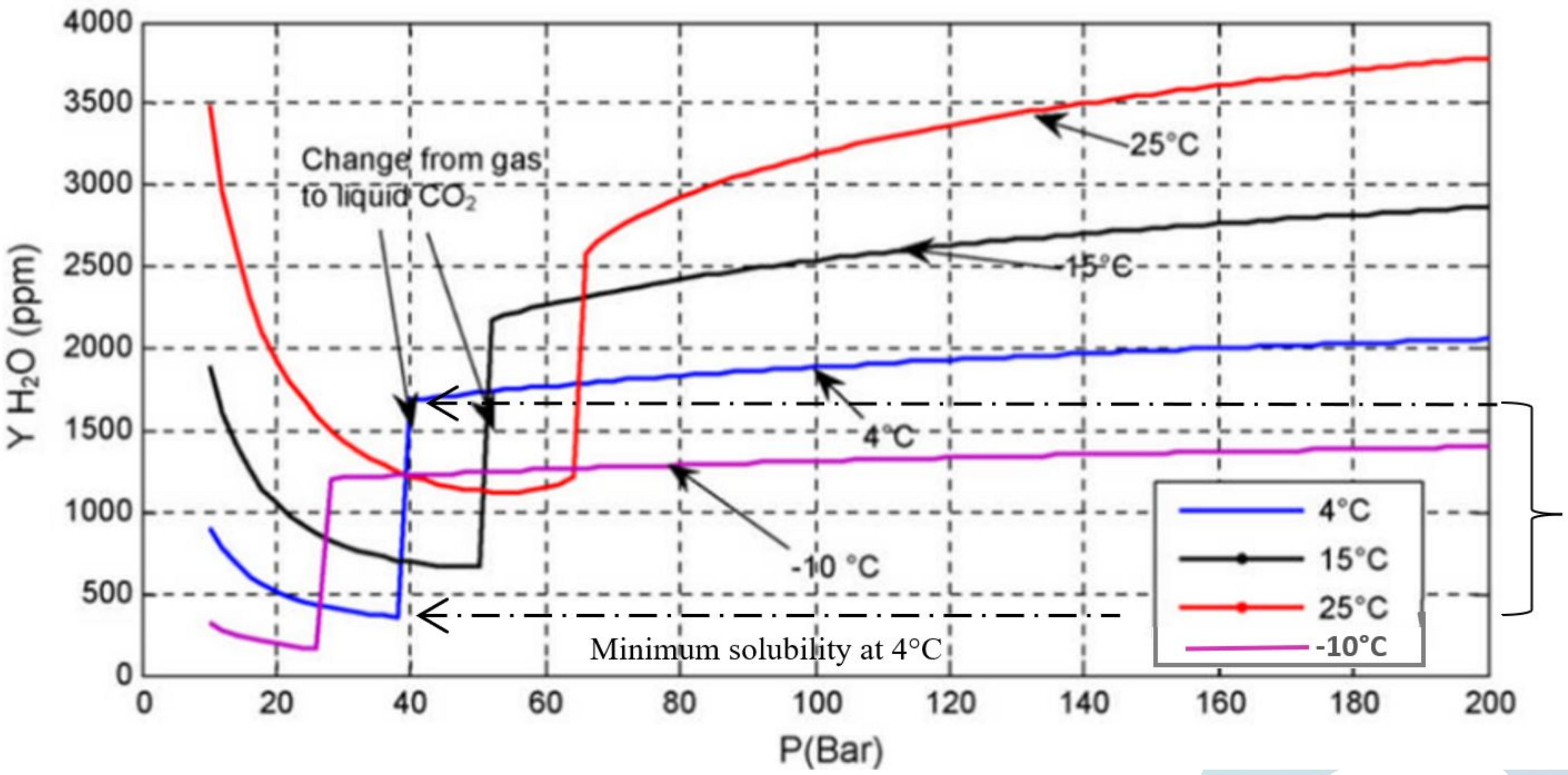
IV. Industrially Captured CO_2

Industrially generated CO_2 is transported to onshore terminal and injected into aquifers or reservoirs



CO_2 phase diagram, adapted after DNV RP-F104

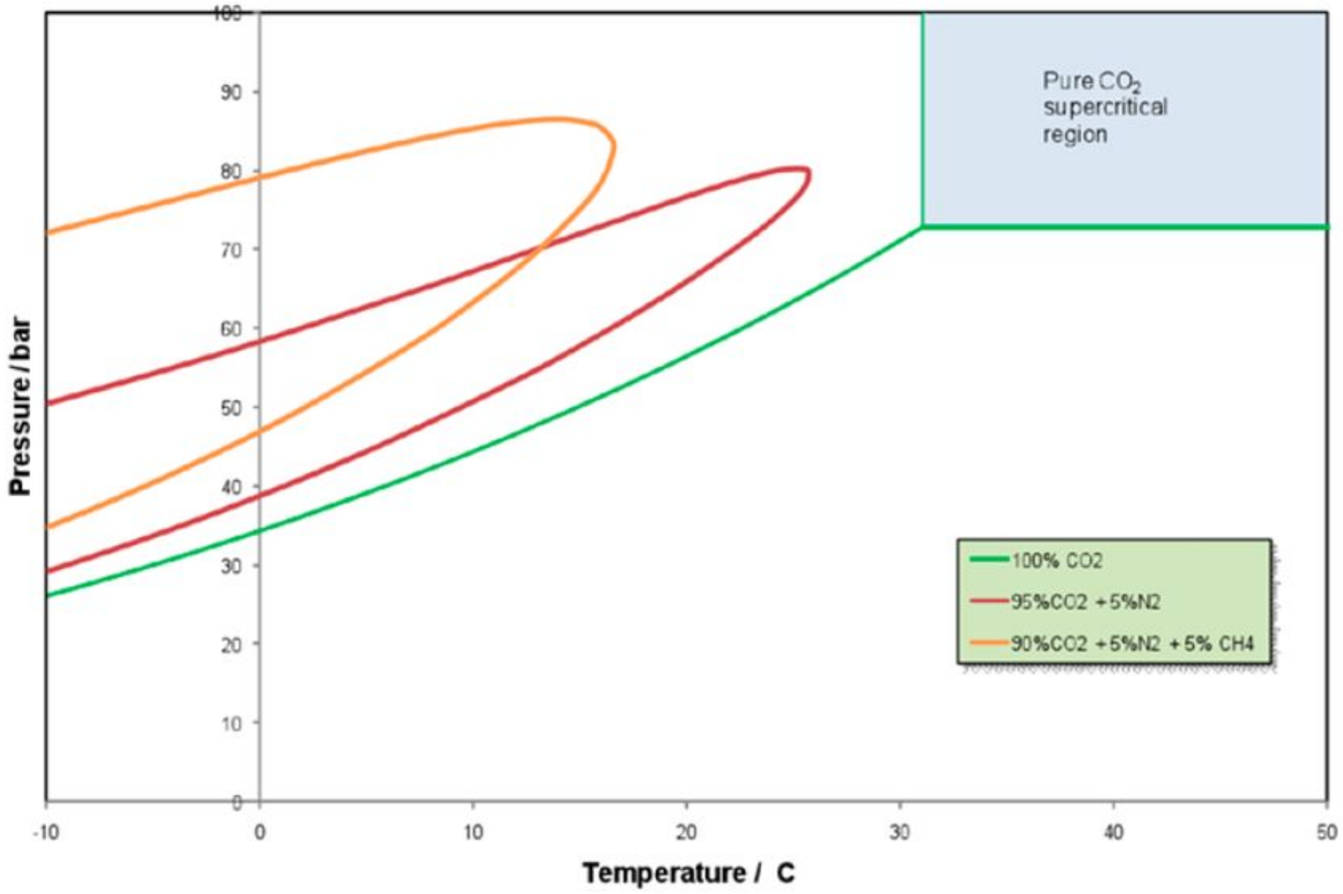
I Al-Siyabi 2013 Effect of Impurities on CO_2 Stream Properties



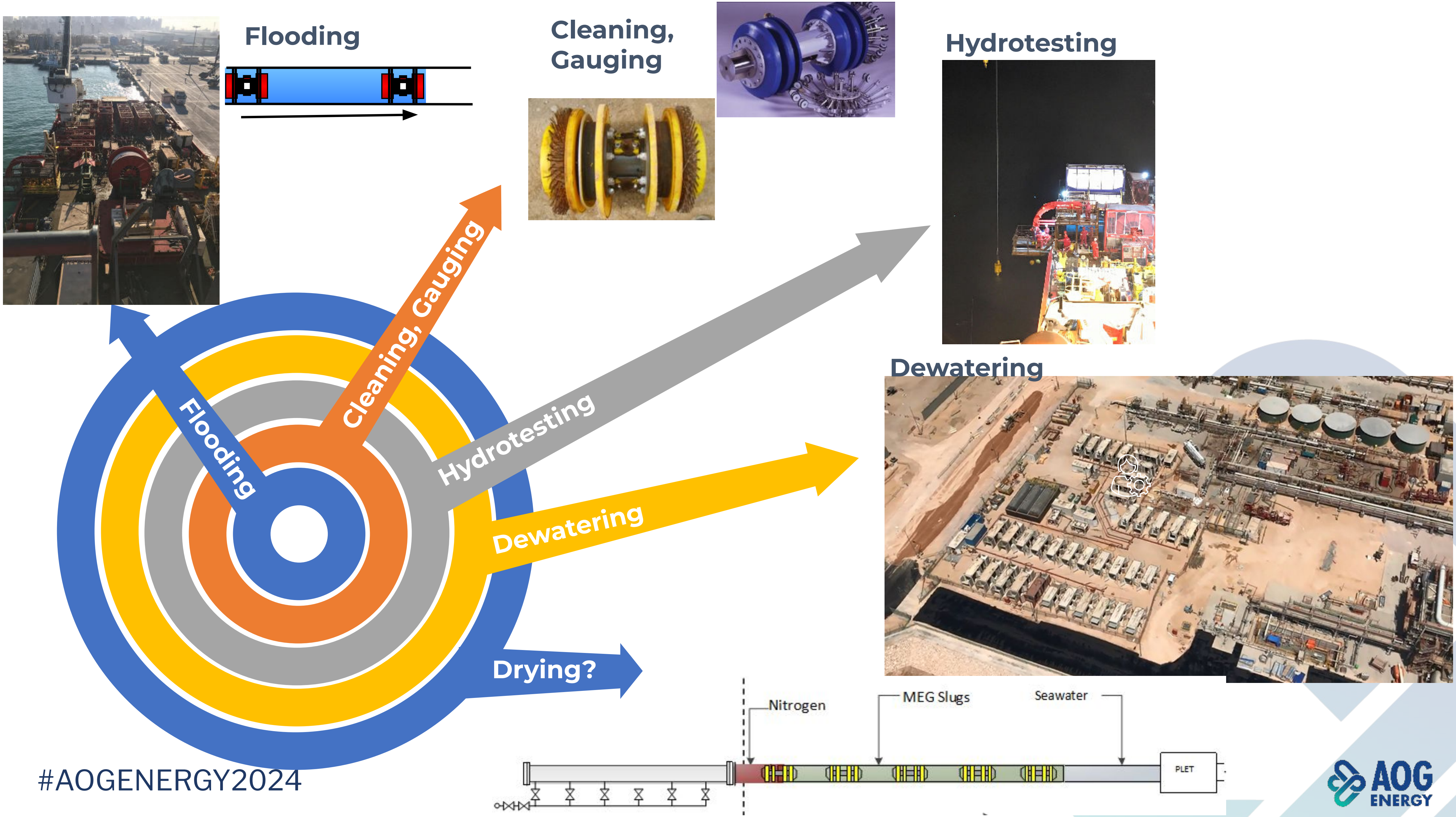
Water Saturation Concentration in CO_2 (Erika de Visser, 2007)

Impurities

- Low levels of impurities including Nitrogen significantly impact the properties of CO_2
  - Increases pure liquid phase transition pressure
  - Reduces water solubility
- N_2 can cause higher pressure and temperature drops
- Archetype 4 – H_2S, NOx, SOx, O_2 – Stronger Acids



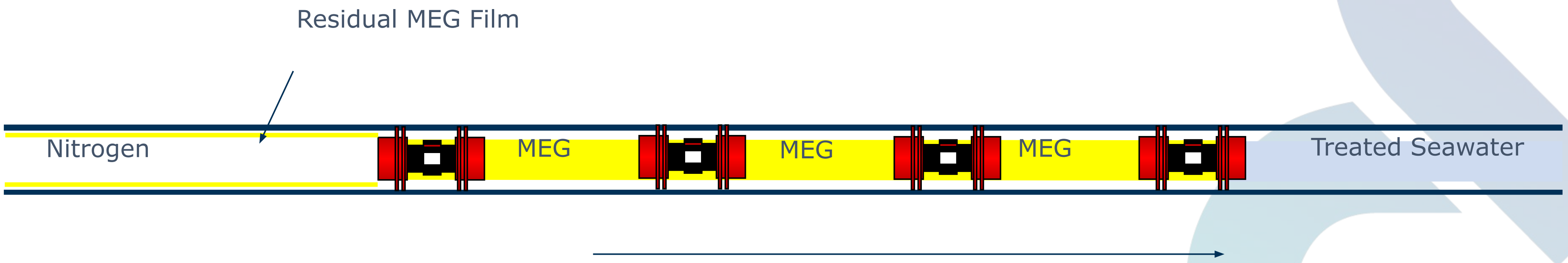
CO_2+ N2 Phase Diagram (Chris Mills, 2022)


Flooding
Cleaning,
Gauging
Hydrotesting
Dewatering
Flooding
Cleaning, Gauging
Hydrotesting
Dewatering
Drying?
Nitrogen
MEG Slugs
Seawater
PLET

Drying

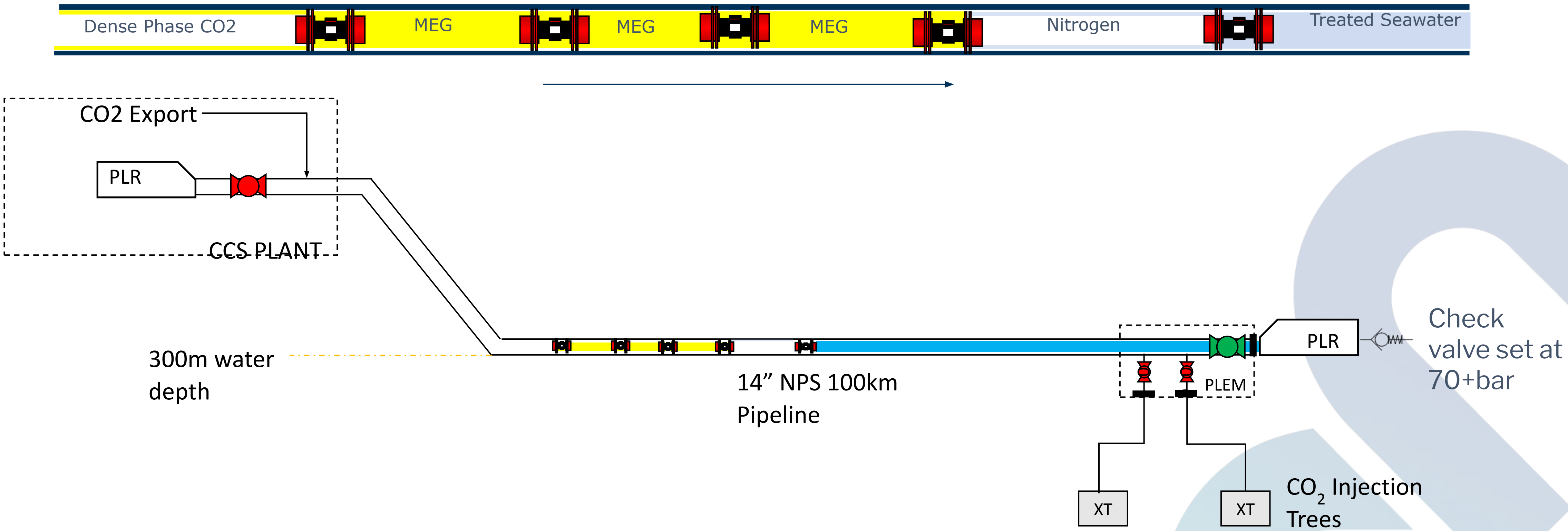
- Air Drying / Vacuum Drying

- Monoethylene Glycol (MEG) Swabbing
  - MEG lowers humidity of gases left with a greater portion of water being held in liquid solution on the pipe wall
  - Liquid water will cause some corrosion but is slowed significantly by MEG
  - CO_2 corrosion rates are reduced by over 99% for MEG concentration >95%



Drying

- Dewater Directly with CO_2



Consequences of CO_2 pipeline failure

High latent heat of vaporization causes:

- A rapid drop in temperature.
- Pressures to remain elevated for an extended period

0 secs

30 secs

120 secs

Large scale pipeline rupture tests to study CO_2 release and dispersion (Mohammad Ahmad, B. L.)

Fracture Propagation in Dense Phase CO_2 (Russell Cooper & Julian Barnett)

Summary

Pipeline Corrosion is most likely to occur during startup if CO_2 is introduced in gas phase

- **Systems with CO_2 storage**
  - Condition pipelines MEG while dewatering directly with liquid or dense phase CO_2

- **Systems without CO_2 storage**
  - Test project specific CO_2 composition with any gases left in the line to establish dryness criteria
  - Systems may be air dried (if feasible) or conditioned with MEG
  - Compression station should be designed to introduce CO_2 in gas phase
  - Gases left within the line should be minimized or displaced with CO_2 prior to startup.

Pre-Commissioning to be risk assessed and engineered on a bespoke basis

Acknowledgements

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Mohammad Ahmad, B. L. (2015). COSHER joint industry project: Large scale pipeline rupture tests to study CO_2 release and dispersion,. International Journal of Greenhouse Gas Control,.

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Walsh et al. 2023 Evaluating the economic potential for carbon sequestration projects