



**FUTURE
ENERGY
EXPORTS**

Cooperative Research Centre

A decade of Australia – Korea R&D collaboration in energy

Professor Eric F May

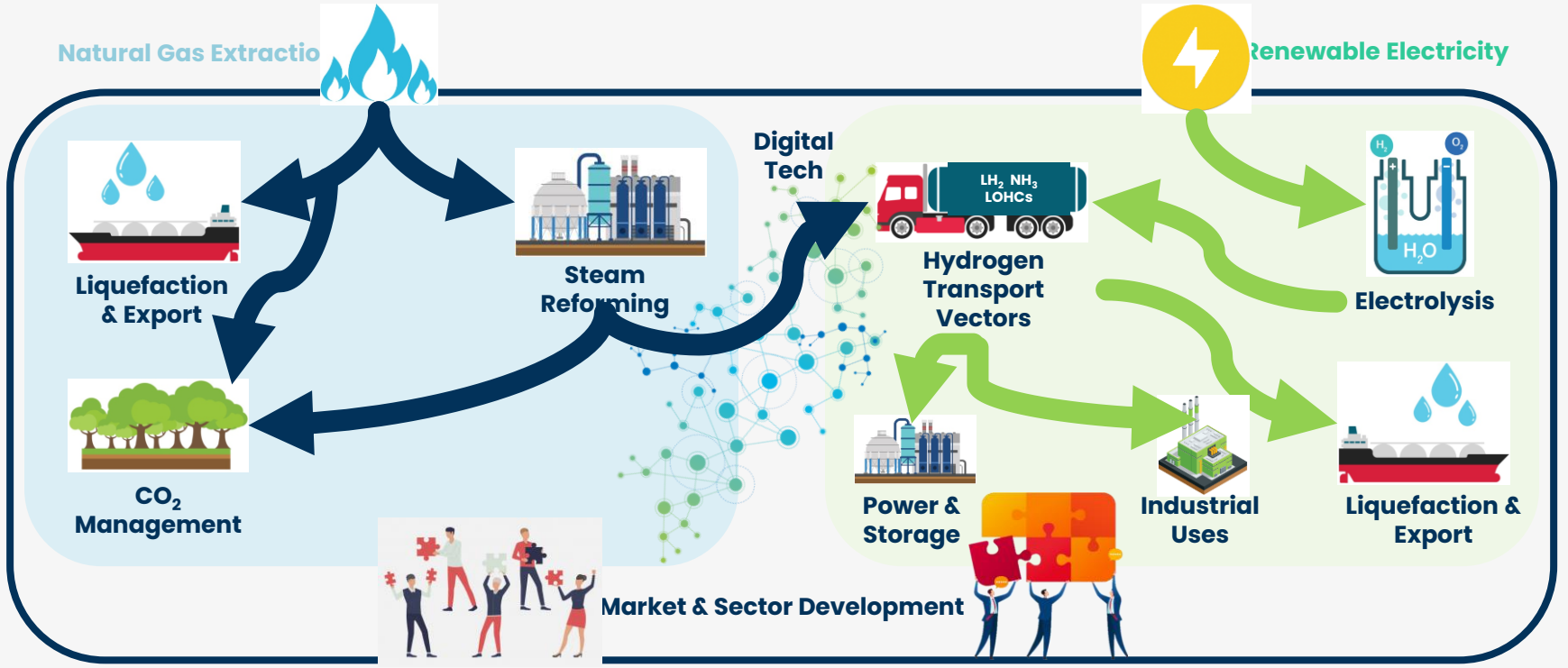
CEO

44th AKBC – KABC Joint Meeting

8 September 2023

Develop decarbonisation technologies for gas & LNG production

Help establish use & export of clean hydrogen



36 Participants in 2023

Australian and Global Companies



Government, Regulatory & Peak Bodies



Australian Research Capabilities



International Collaborators



Also work with 3rd parties on projects relevant to CRC mission

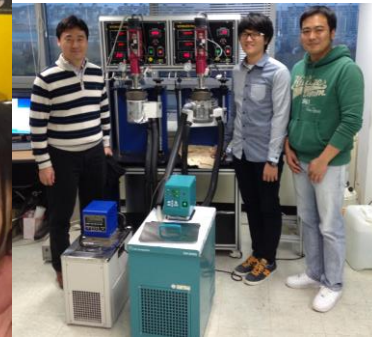
\$40M
Commonwealth Grant

\$38M
Participant Cash

A decade of R&D collaboration

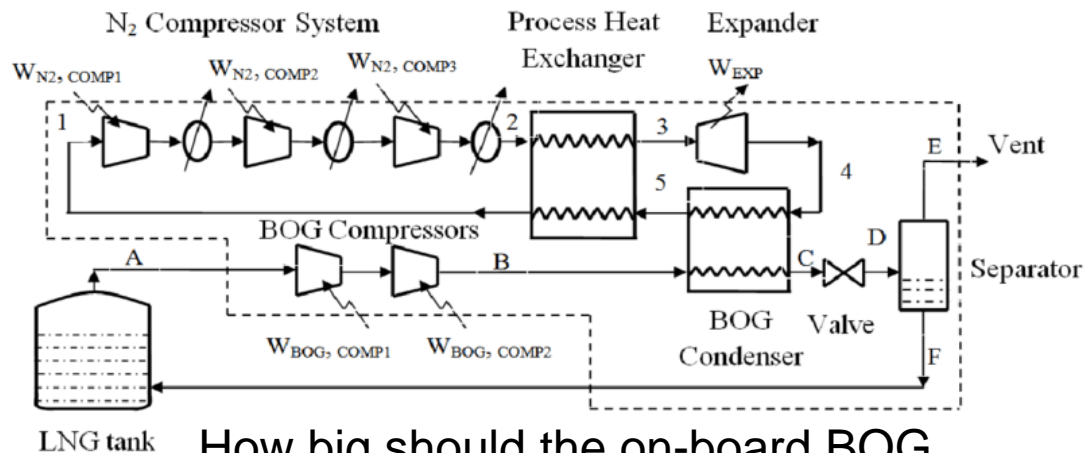
Since 2013

- 6 trips to Korea, 5 to Australia
- 5 projects funded by ARC &/or Heavy industry (Korea & Japan)
- 7 Korean students or guest researchers worked at UWA
- Unique experimental & modelling facilities developed
- Offshore & subsea engineering
- LNG production & shipping
- Next generation refrigerants



Industry Challenge:

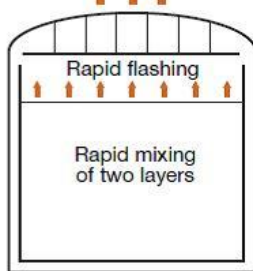
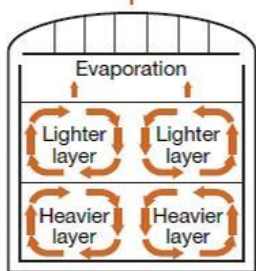
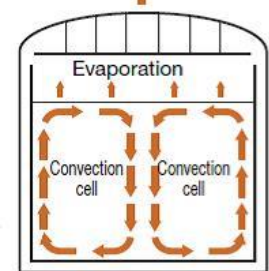
LNG Boil-off Gas Handling



Normal rate of boiloff-gas production

Reduced rate of boiloff-gas production

Rapid rate of boiloff-gas production



A. HOMOGENEOUS LNG

B. STRATIFIED LNG

C. TANK EXPERIENCING ROLLOVER

How big should the on-board BOG compressors be? Over-design expensive

BOG rate estimates in large tanks are *empirical* – charts provided by vendor

Complex scale-dependent process: hard to model or measure accurately

Cryogenic Boil-off Gas Test Facility

Temperatures $\geq -196\text{ }^{\circ}\text{C}$ (77 K)

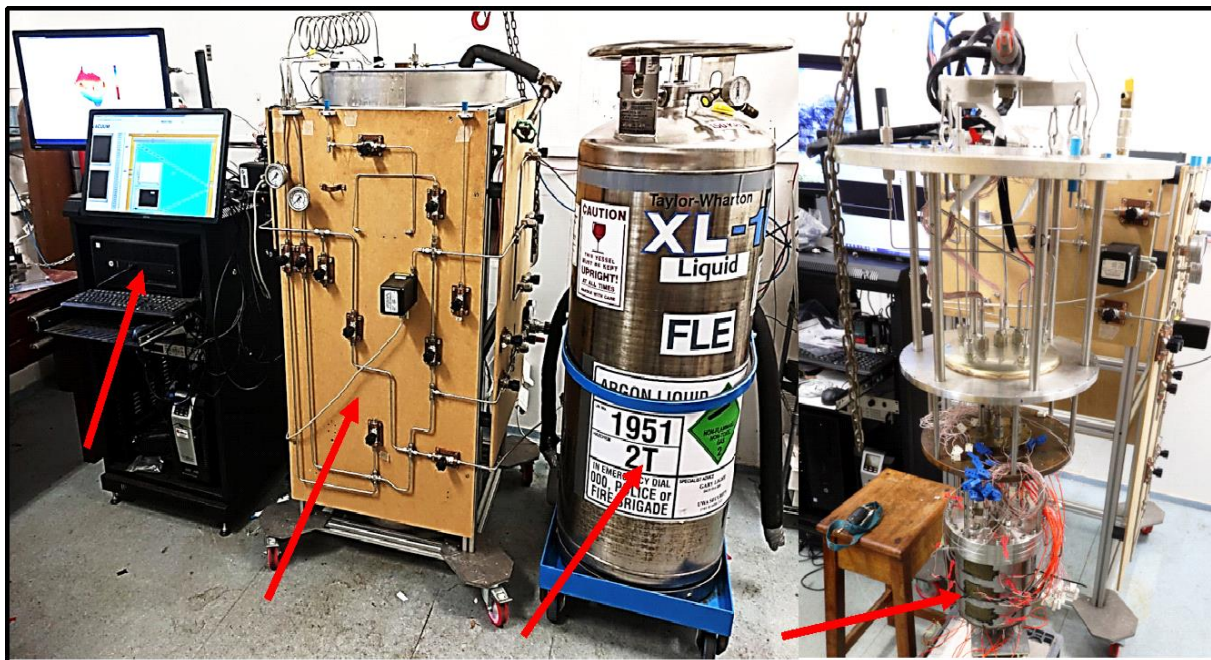
Pressures ≤ 10 atmospheres

6.7 litre cell with variable heights & diameters possible

35 thermometers measure temperature profiles & liquid level

Excellent control of boundary temperature

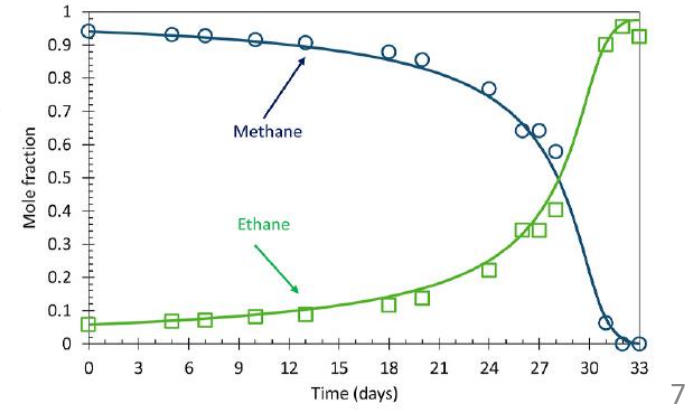
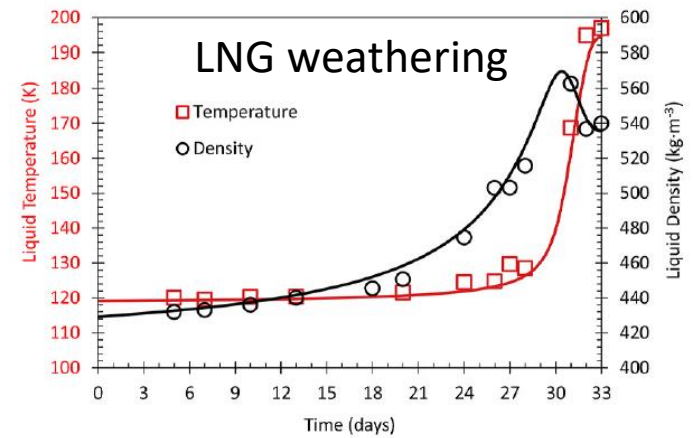
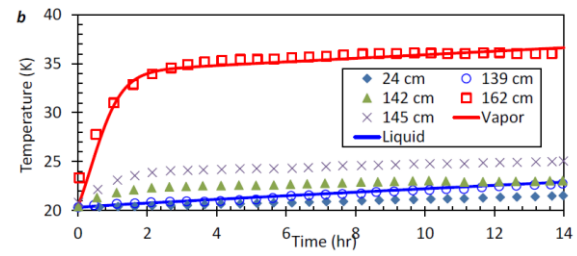
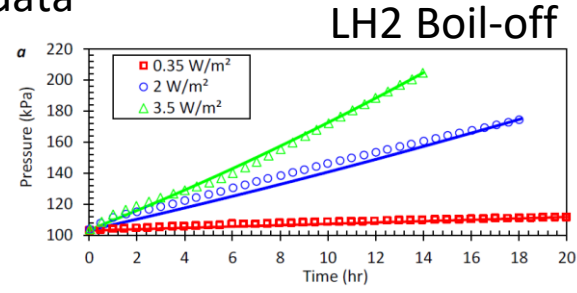
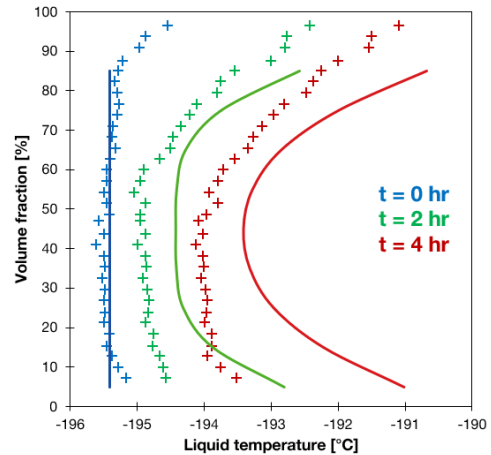
In-situ liquefaction and bunkering scenarios can be tested



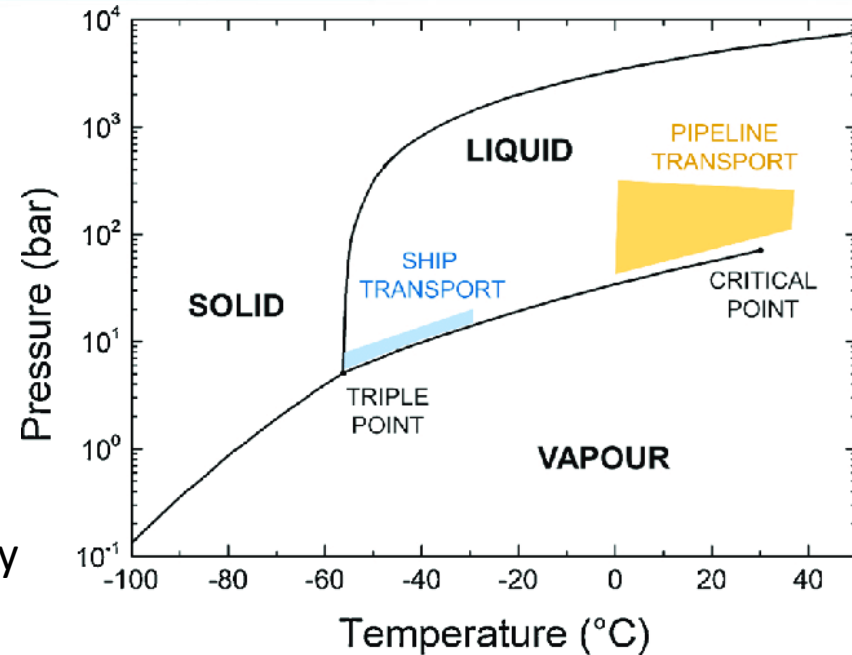
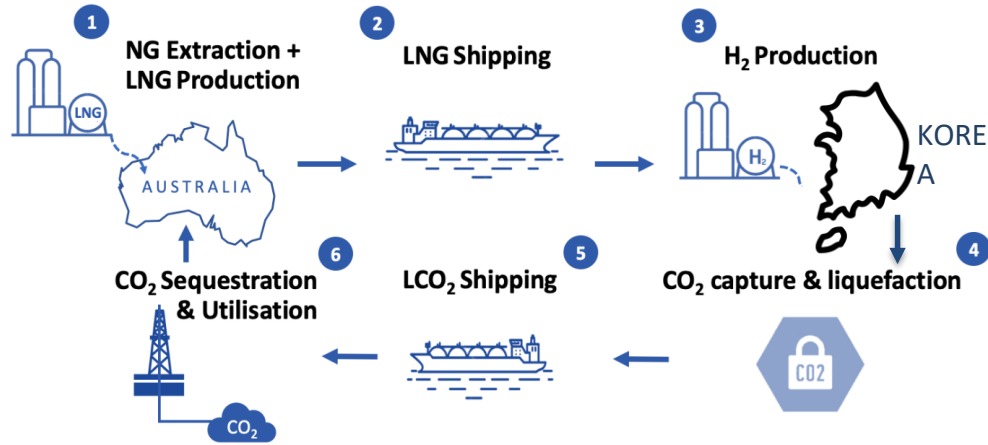
(a) Monitor and control system, (b) cryogenic thermostat, (c) Dewar of liquid nitrogen, and (d) BOG cell (which is inside the cryogenic thermostat during operation). Data acquisition & gas-handling manifold also shown.

BoilFAST: Cryogenic Boil-off Simulator

- Free simulation tool from www.fenex.org.au/software/
- Predict BOG generation from LNG, LH2, ammonia
- User sets tank design and heat transfer parameters
- Uses highly-accurate reference models for properties
- Anchored to lab & industry data



New collaboration: Low (T, p) liquid CO₂ shipping technology



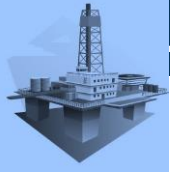
FEnEx CRC including UWA & Seoul National University now starting industry-funded project to

- 1) Understand boil-off & solidification fundamentals of industrial specification LCO₂ at -50 C
- 2) Develop demonstration project to move Low (T,p) technology beyond TRL 3.

CO₂ phase diagram. approximate operative ranges for transport Knoope et al., 2015

Thank

NG & Blue Hydrogen



Natural Gas Extraction

Green Hydrogen



Renewable Electricity

