26th World Gas Conference

1 – 5 June 2015 – Paris, France

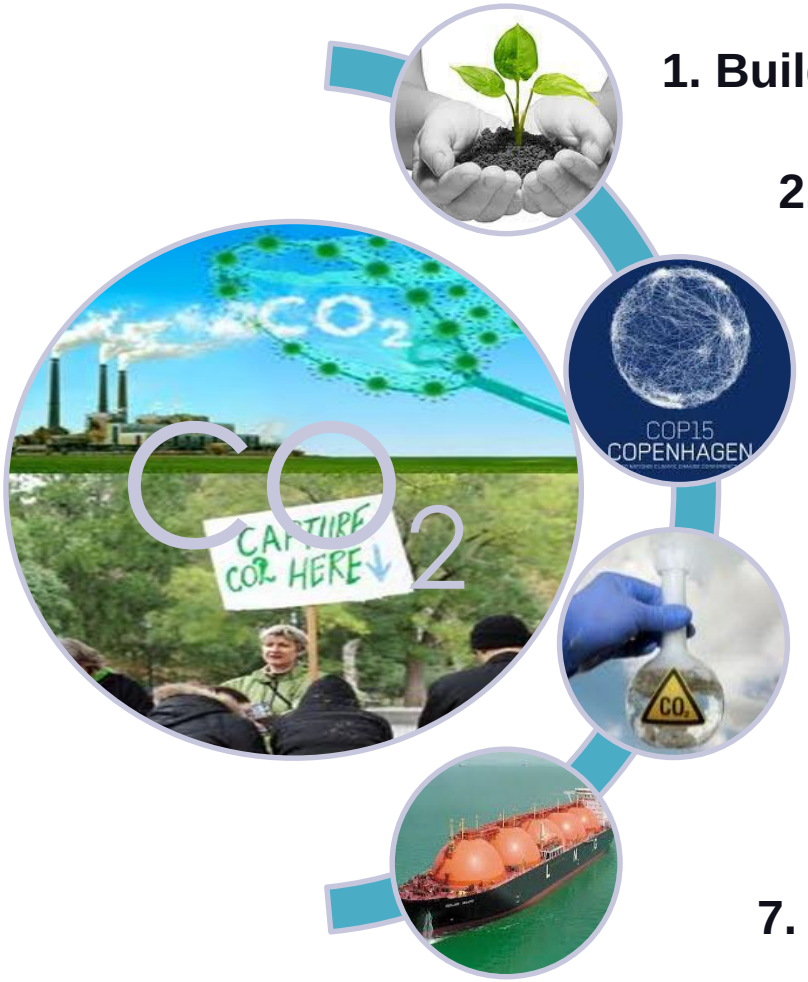
TS. WOC 1 1

TECHNOLOGY ENABLING HIGH CO_2 GAS FIELD DEVELOPMENT

Hatarmizi Hassan
PETRONAS

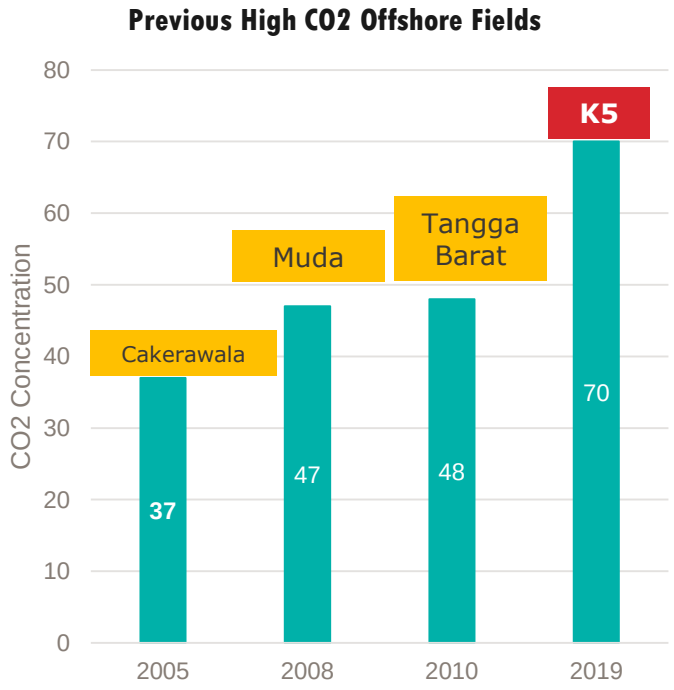
WGCPARIS2015
IGU
WORLD GAS CONFERENCE

Outline



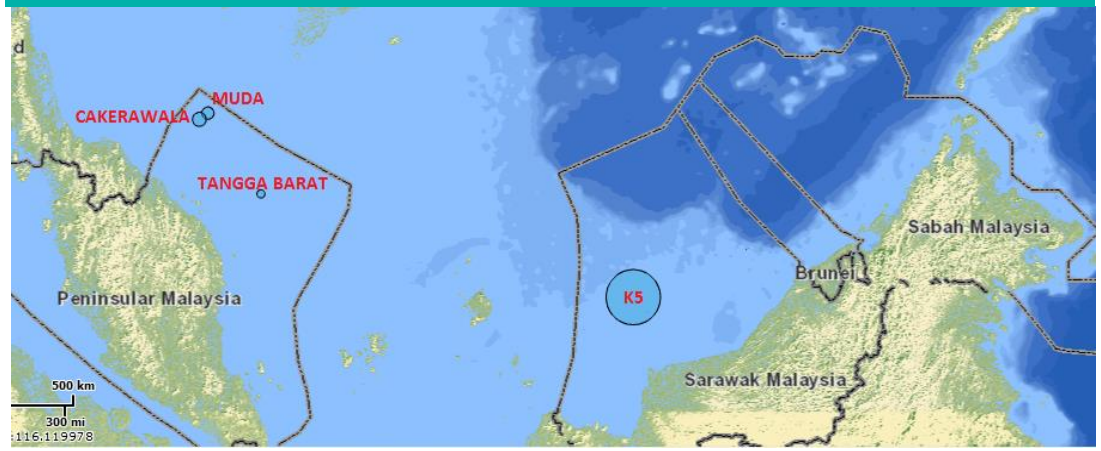
1. Building on our experience with high CO_2 fields
2. Technical Challenges
3. Economics Challenges
4. K5 Strategic Technology Project Development Concept
5. CO_2 Removal Technologies
6. Subsurface Technologies
7. CO_2 Storage
8. Conclusion

Building on our experience with high CO_2 fields



With several high concentration CO_2 projects under our belt, we are developing a field that's bigger, with a higher concentration of contaminants

K5: 250km offshore, 80m water depth, 21Tscf Gas in Place, 4Tscf recoverable, approximately 70% CO_2 concentration



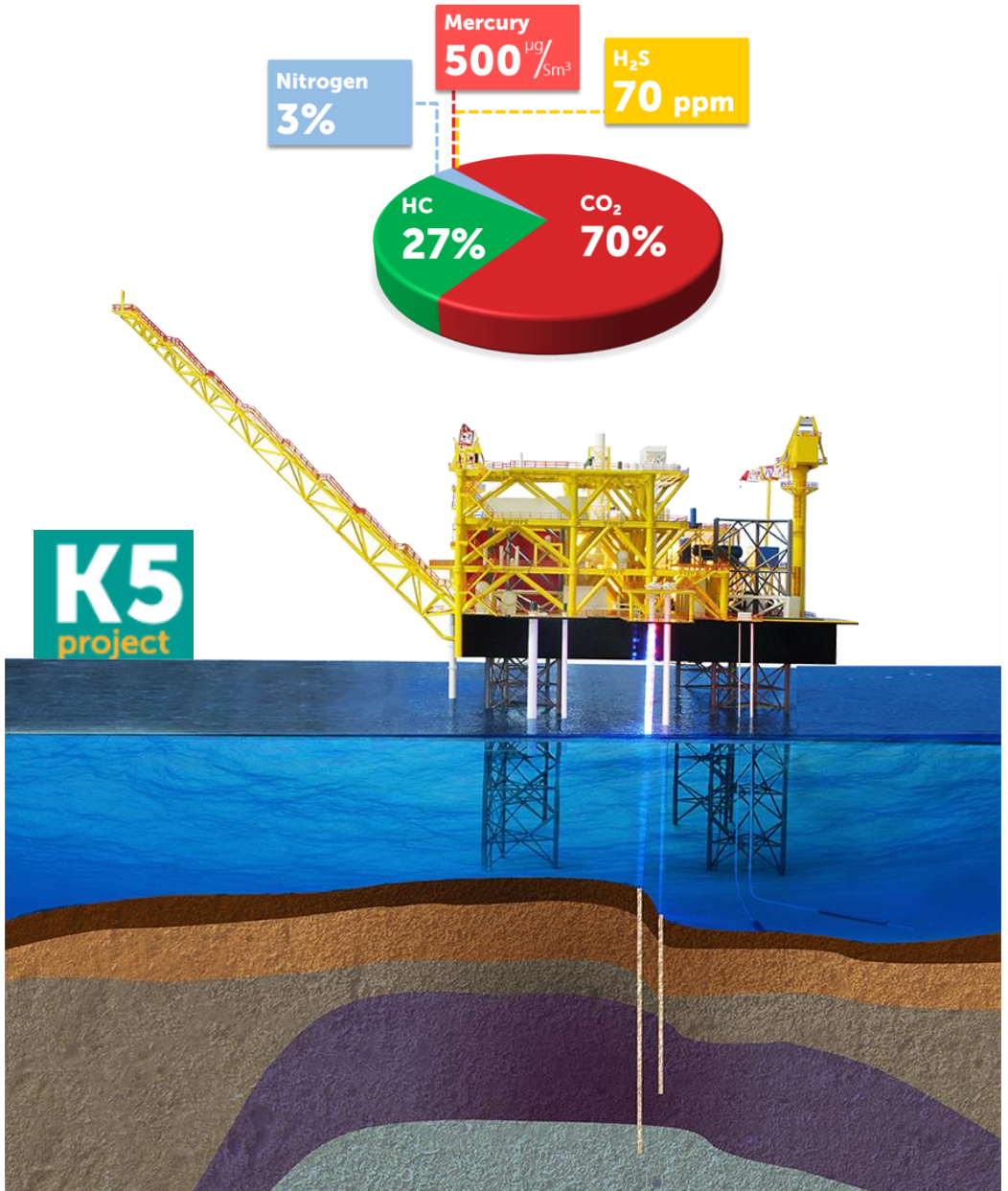
World's First Offshore CO_2 Cyrogenic Distillation Facility

World's Highest CO_2 Concentration Gas Development Project Offshore

Monetization of high CO_2 fields such as K5 is technically challenging

Technical Challenges

- No process system and Acid Gas Removal Unit (AGRU) readily available for the removal of high CO_2 gas (70% CO_2) at offshore.
- Complex fluid requires multiple gas treatment systems.
- Process system using different types and combination of AGRU has posed issues and constraints in terms of topside weight, hydrocarbon loss, and energy consumption.
- To protect the environment, CO_2 produced has to be injected and stored in the reservoir.

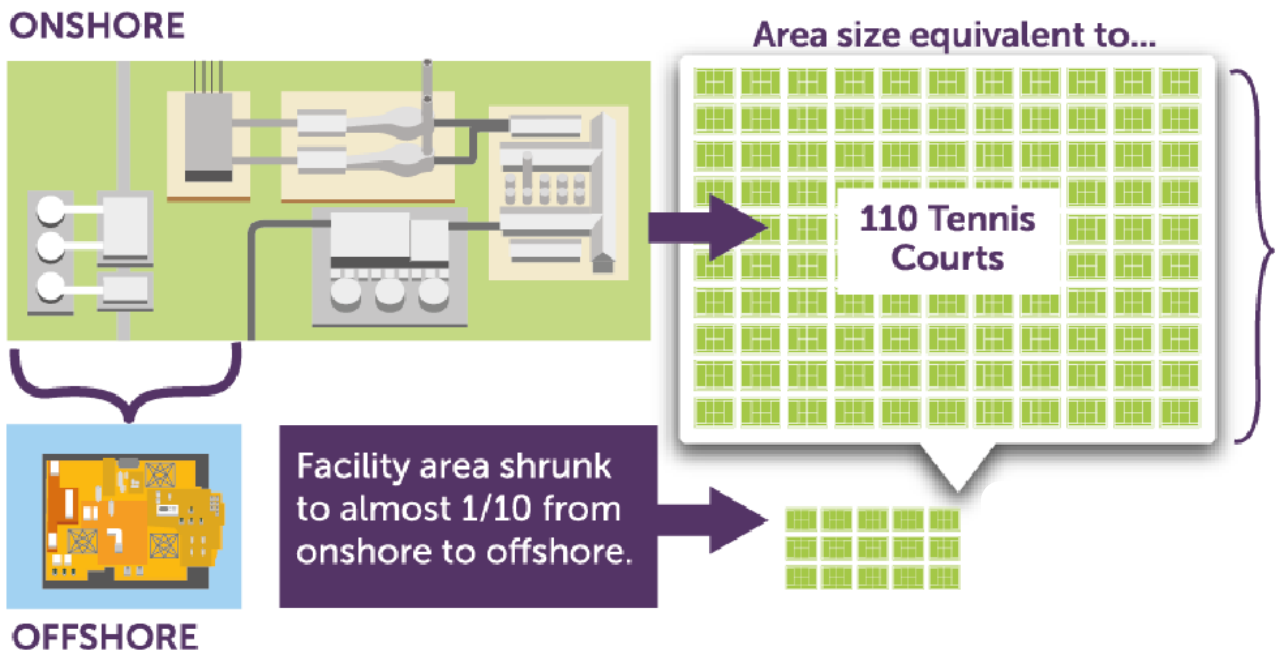


Innovations of process engineering and design are required to overcome economic challenges

Economic Challenges

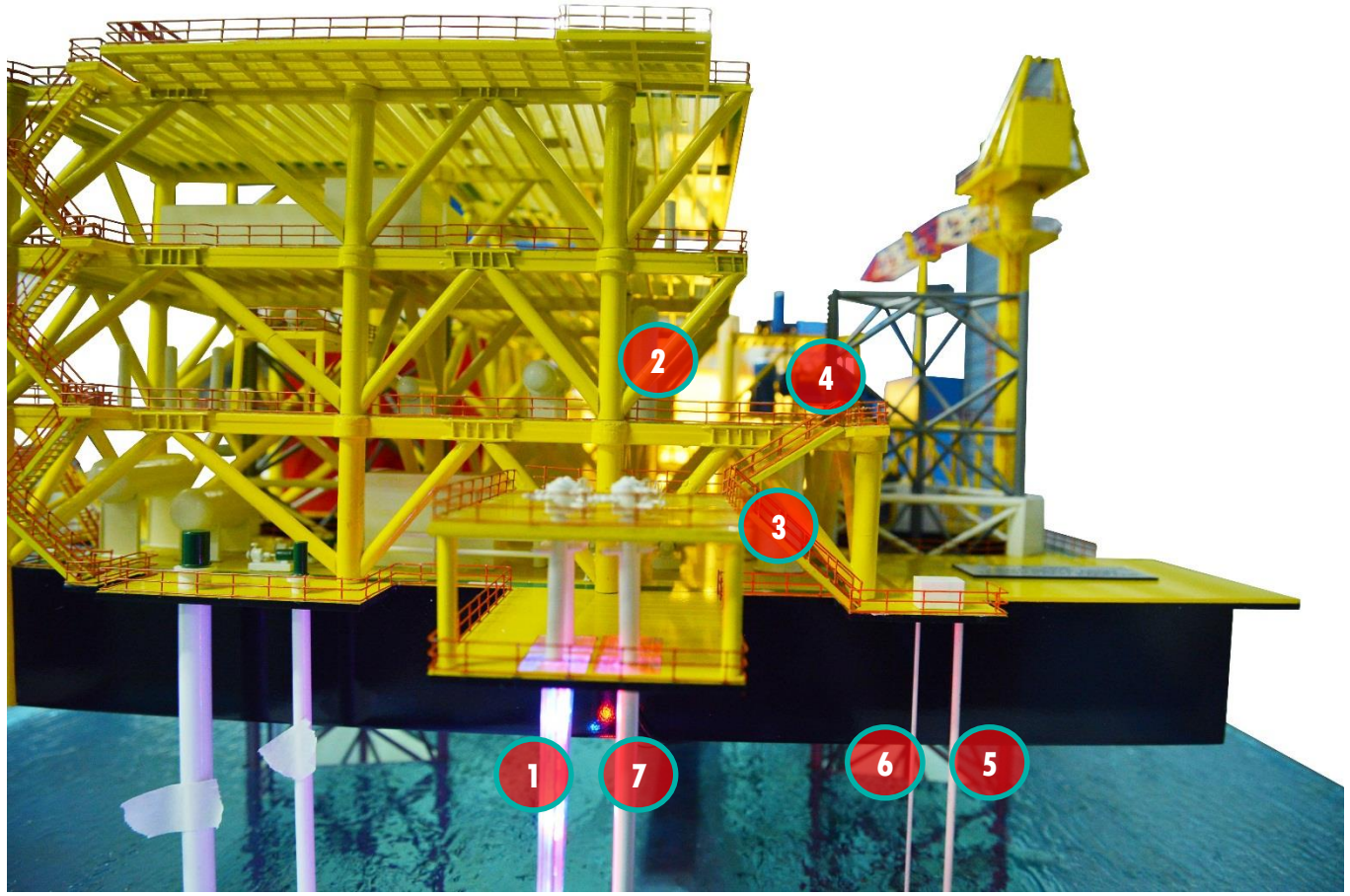
- Due to the complex gas treatment and processing required, the process scheme and number of equipment have increased the topside weight.

- As a result, this incurs a high capital expenditure (CAPEX) for high CO_2 gas field development, causing the development to be economically challenging.



K5 Project Technology Development Concept

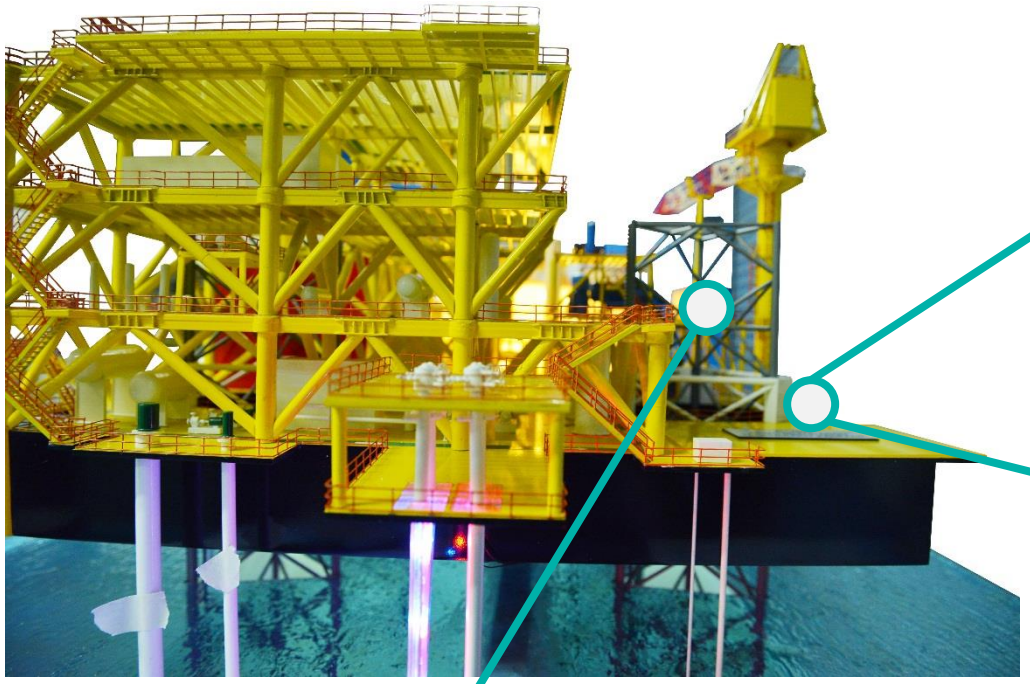
Overview of Gas Processing Facilities
1. Well Head Producer
2. Inlet Separation
3. Pre-Treatment Unit
4. Cryogenic Distillation Unit
5. Gas Export Pipeline
6. Condensate Processing and Export
7. Reinjection Well



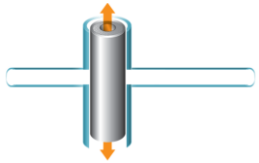
CO_2 removal technologies are being matured at K5 offshore facilities towards future application and monetization of K5 and other high CO_2 fields in Malaysia and internationally.

Maturing CO_2 technologies via deployment of technology at K5 offshore facilities

- **PN2 Membrane, Supersonic Gas Separation & Cryogenic Distillation**

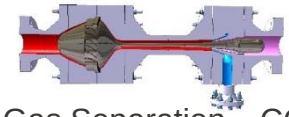


PN2 Membrane



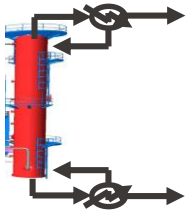
PN2 Membrane – CO_2 and Hydrocarbon are separated based on their molecule size and ability to select only CO_2 to be absorbed.

Supersonic Gas Separation



Supersonic Gas Separation – CO_2 and Hydrocarbon are separated based on phase separation, CO_2 in liquid and Hydrocarbon in gaseous form.

Cryogenic Distillation (PeCro™)



- CO_2 and hydrocarbon gas is separated by its boiling point difference.
- CO_2 concentration is reduced to 20%.
- CO_2 will be in liquid form while hydrocarbon gas will be in gaseous form.

Subsurface technologies are being developed for high concentration CO_2 fields

Some of these technologies are being qualified / to be applied at K5 field.

1 Wells Drilling

- Pore Pressure and Fracture Gradient (PPFG)
- High risk K5-1 P&A remediation
- Shallow gas presence study
- Optimize drilling design

2 MMV

- Well monitoring
- Time lapse seismic
- Measurement, Monitoring and Verification (MMV) facilities and surveys

3 Production Technology

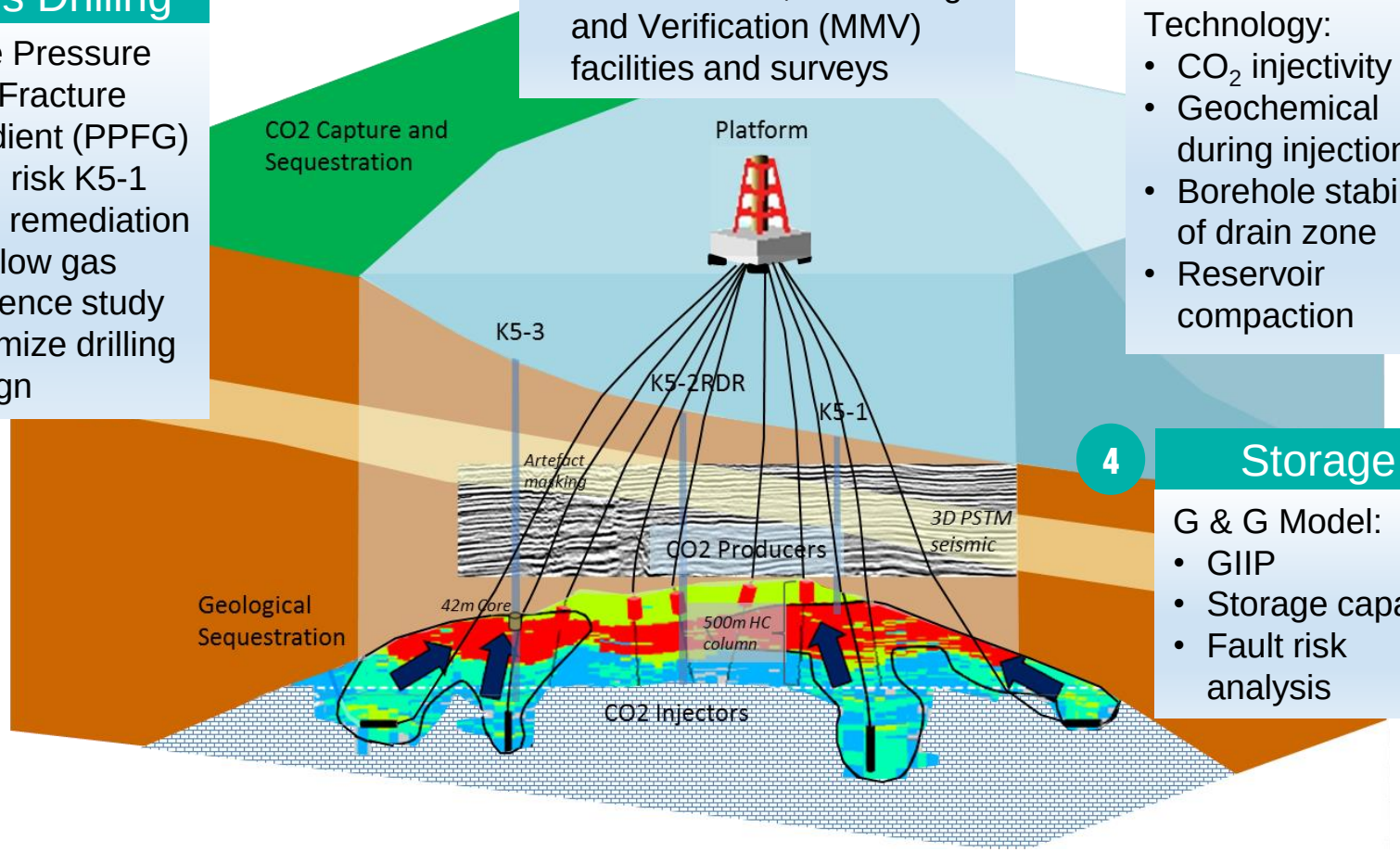
Production Technology:

- CO_2 injectivity
- Geochemical during injection
- Borehole stability of drain zone
- Reservoir compaction

4 Storage

G & G Model:

- GIIP
- Storage capacity
- Fault risk analysis

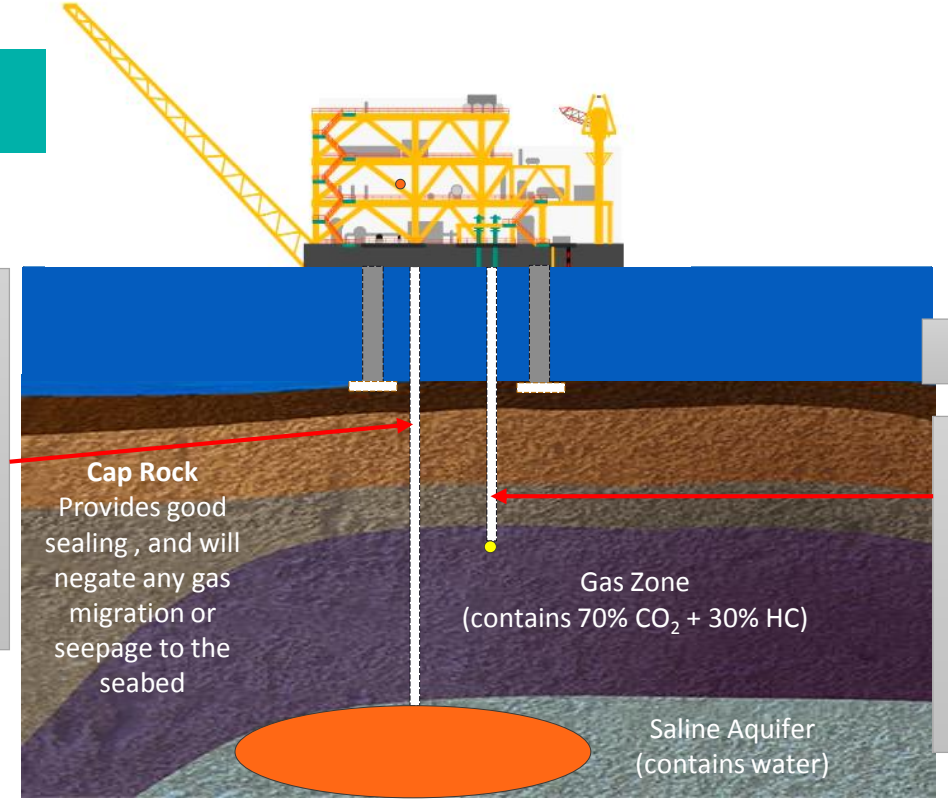


CO_2 Storage

- K5 is an environmentally friendly project as all CO_2 produced is permanently stored in the reservoir 2.2 km beneath seabed.

Zero emissions

- Liquidified CO_2 will then be injected through Injector wells, which penetrates, below the gas zone, into the saline aquifer
- At rate 115 MMscf/d



HC Gas Export

- Producer Wells
- To transport gas from Gas zone of Reservoir to Processing Facilities

Conclusion

- **Technologies to Unlock Hydrocarbon Potential:**
  - Building on PETRONAS' experience in developing high CO_2 fields, CO_2 technologies are being matured at K5 offshore facilities towards future application and monetization of high CO_2 fields in Malaysia and internationally.
  - Comprehensive approach
    - Surface & Subsurface
    - Carbon Separation, Transportation, Storage
    - Commercially viable
    - Environmentally sustainable

- Cryogenic distillation, advanced membrane and supersonic gas separation are the new technologies which can be the game changer to commercially develop high CO_2 fields.

- K5: first project to incorporate the extraction of CO_2 gas, contaminant removal until end of field life

- K5 is an environmentally friendly project as all CO_2 produced is permanently stored in the reservoir.

World's First Offshore CO_2 Cyrogenic Distillation Facility
World's Highest CO_2 Concentration Gas Development Project Offshore

Thank you