

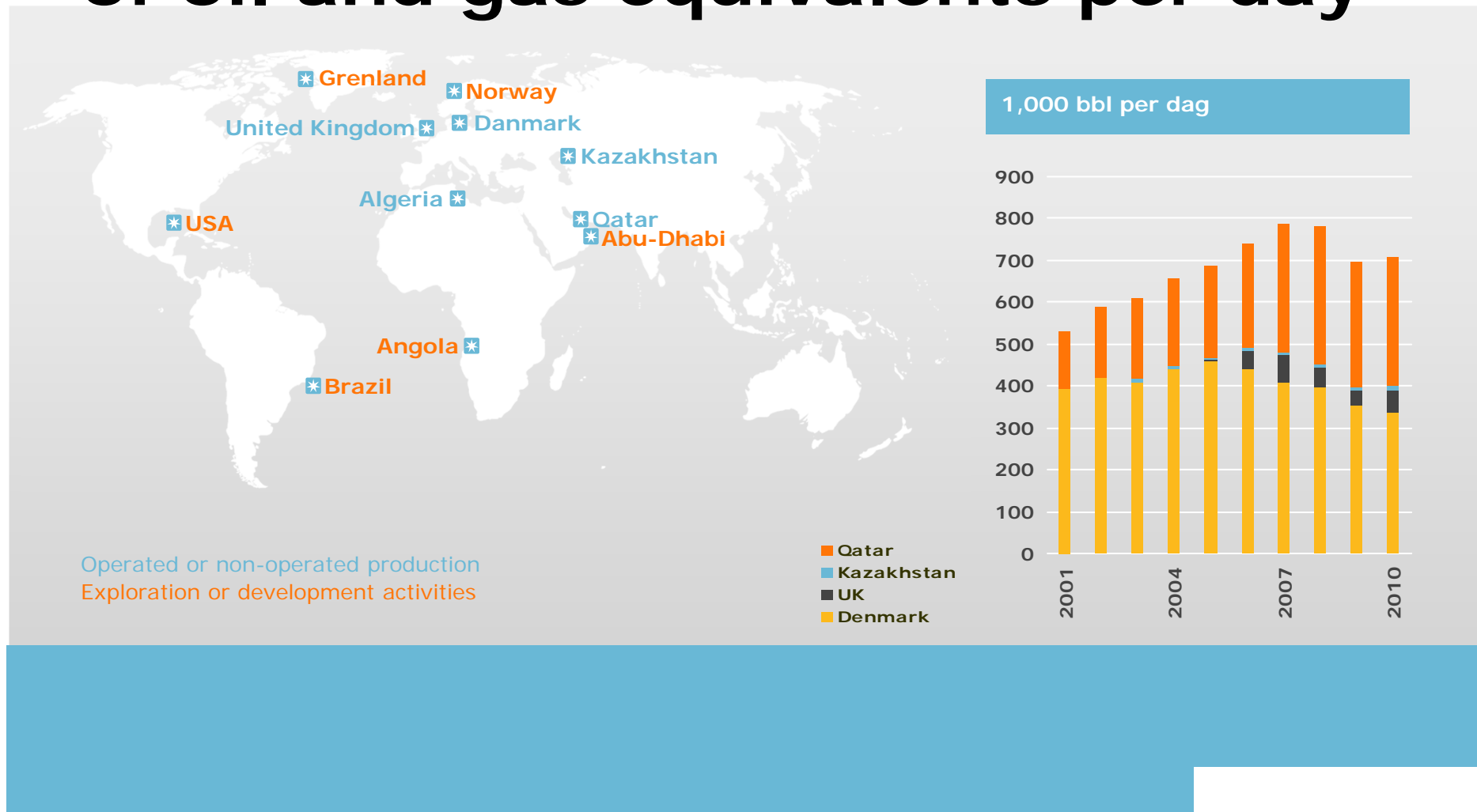
CCS with EOR in the Danish North Sea / TriGen as an CO2 EOR enabler

London 18 April 2012

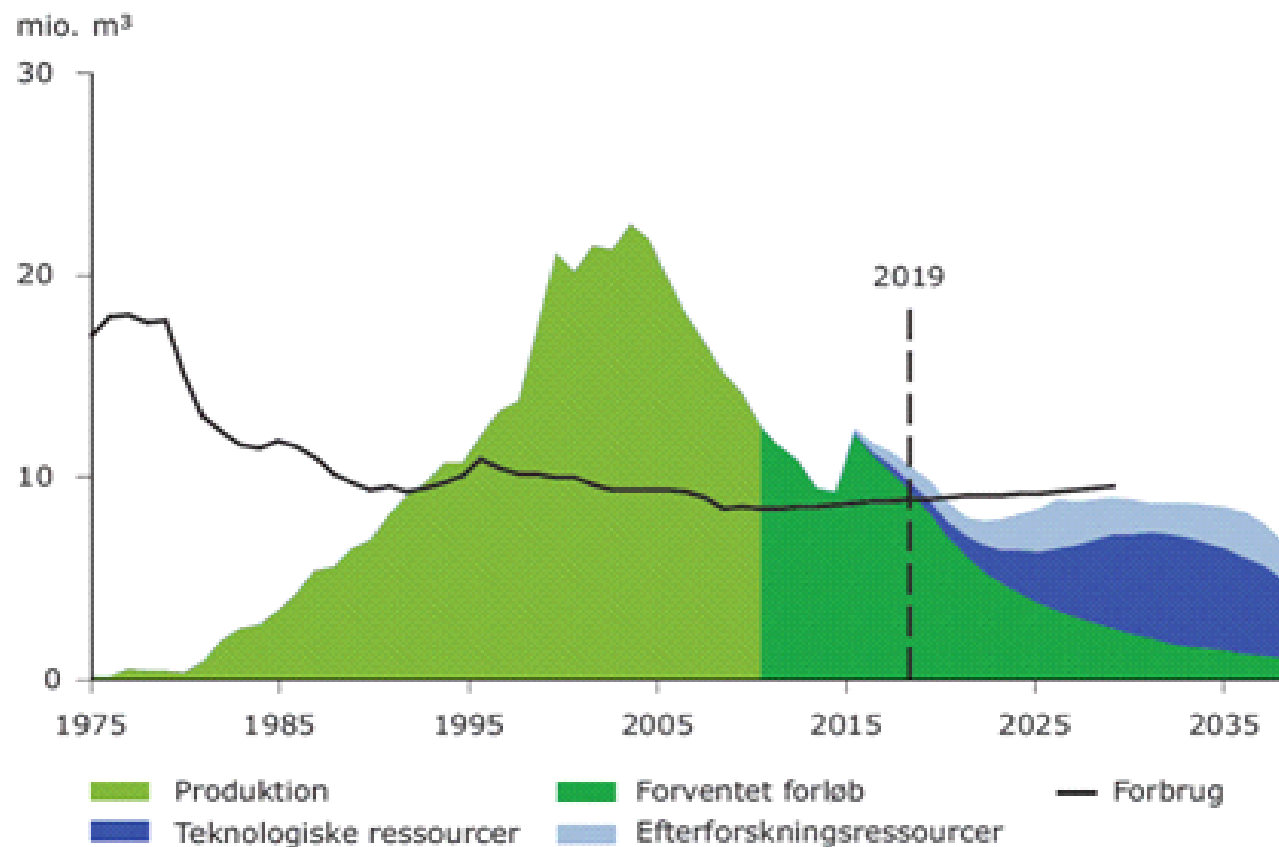
Lars Hende, Director Commercial & Strategy, CO2 EOR

Erik Bek-Pedersen, Senior Process Engineer, Technology & Innovation

Maersk Oil operates 650.000 bbl of oil and gas equivalents per day

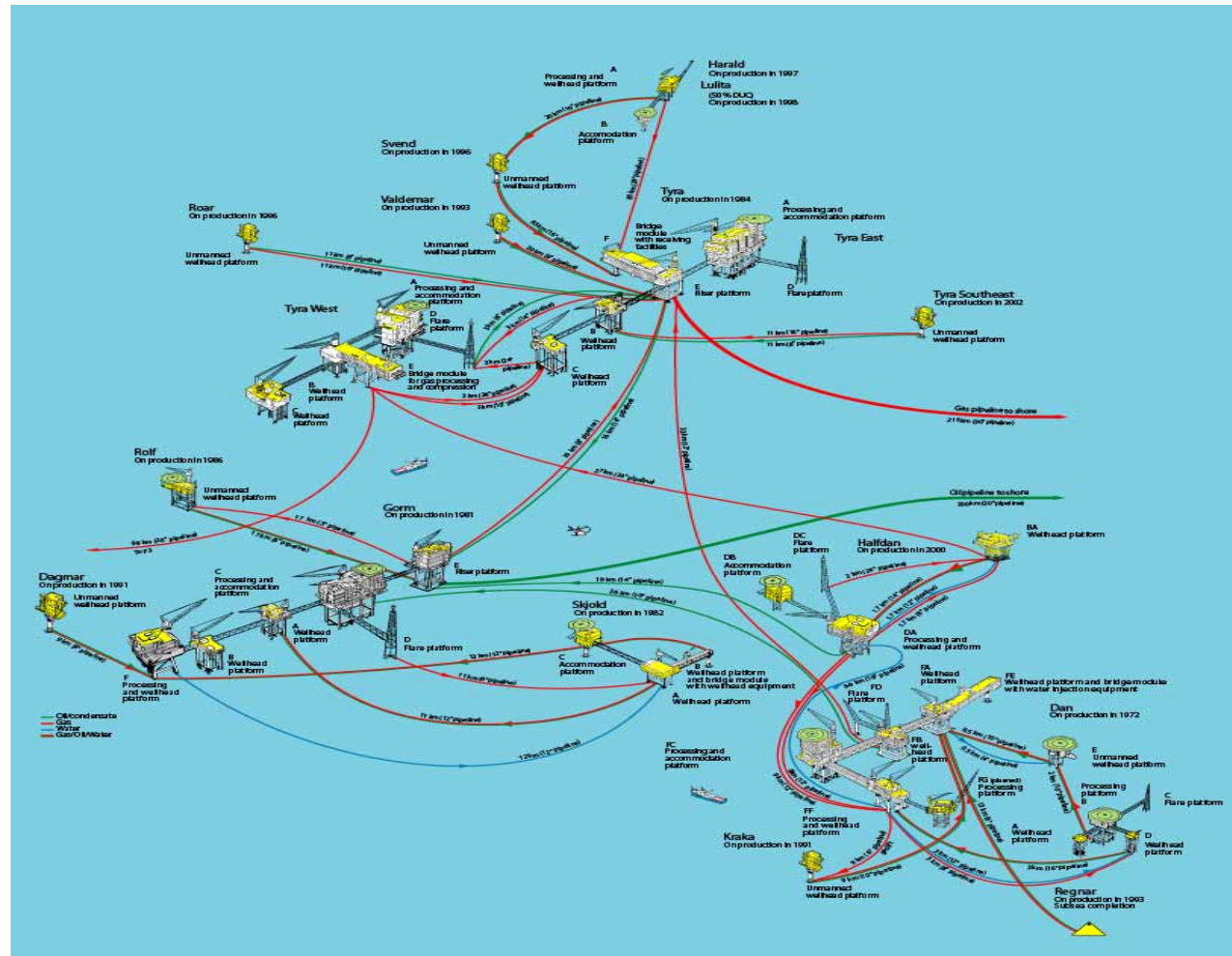


Declining Production in Denmark (2011)



Source: DEA, 2011

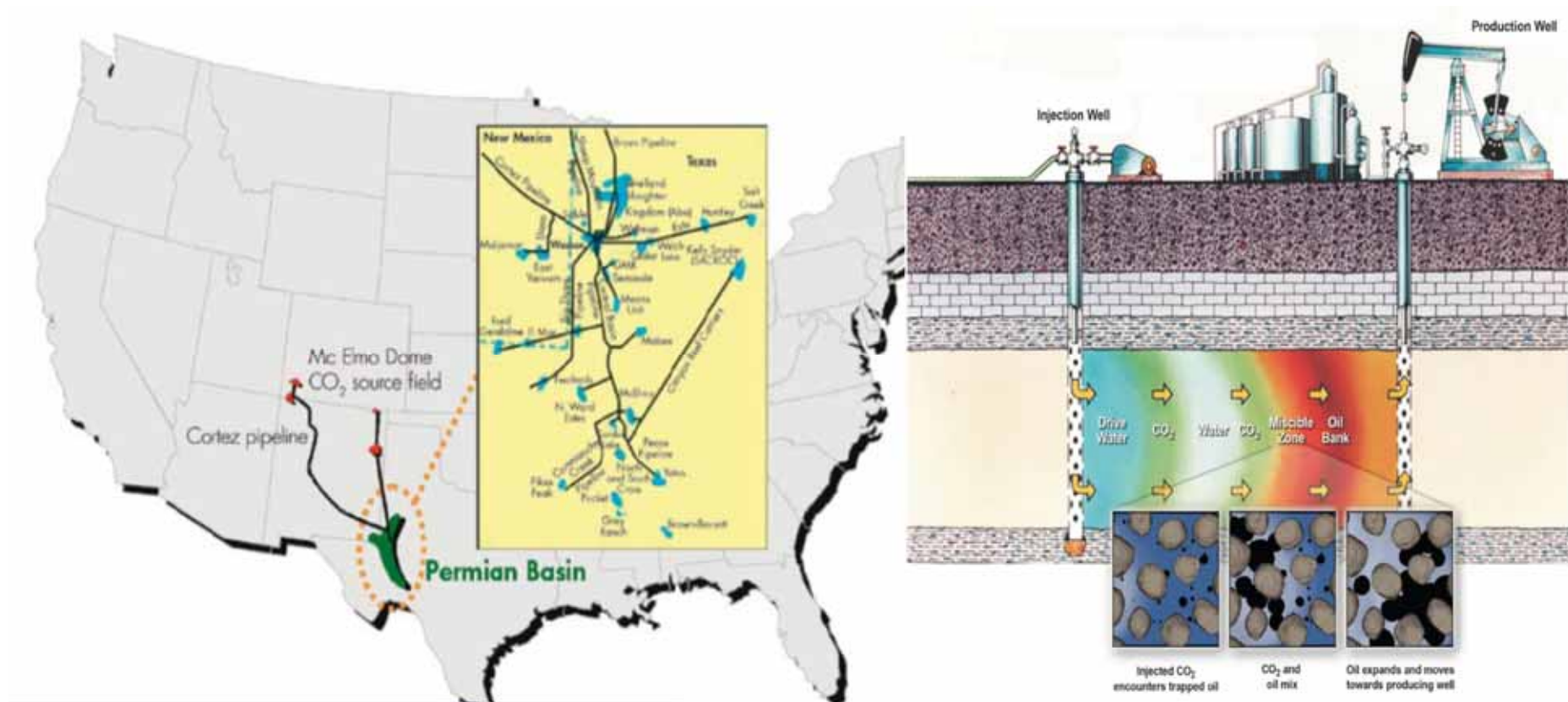
DUC Infrastructure



Base assumptions for CO2 EOR in Denmark

- CCS remains accepted as a necessary climate change mitigation measure in Europe
- CO2 is suitable for enhanced oil recovery in selected mature oil fields in Denmark
- CO2 will be readily and timely available around the North Sea on acceptable terms to support profitable oil business
- The London Protocol does not prevent cross boarder transport of CO2 for EOR and CO2 EOR is appropriately recognised in the ETS system.

CO₂ EOR Onshore US



CCS with EOR in Denmark as a CO₂ Emissions Abatement Measure

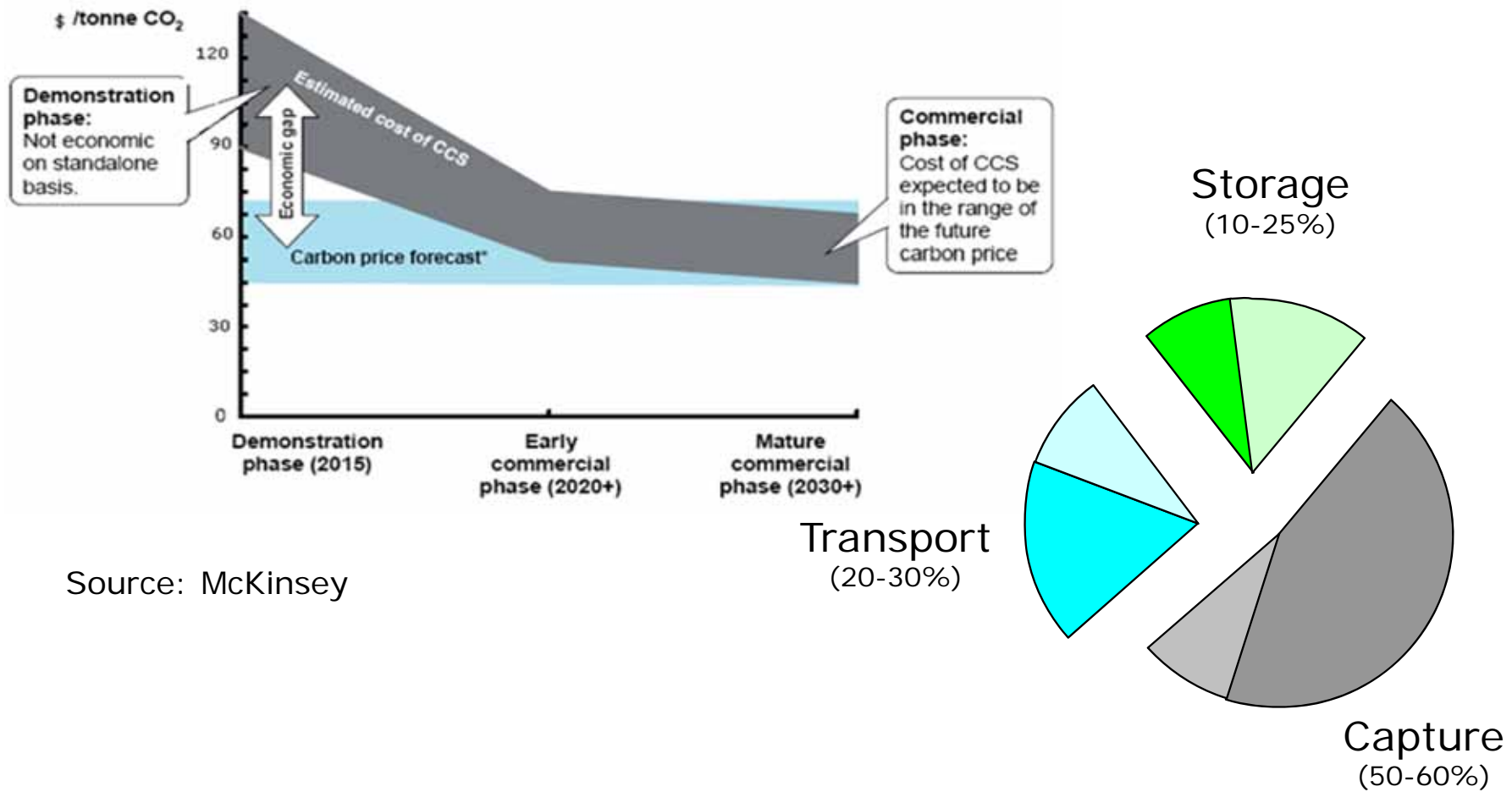
Advantages

- Reduces CCS costs (may avoid storage costs)
- Provides energy security
- Accelerates CCS implementation
- Reduces geological risks
- Provides revenues to society
- Uses current infrastructure and facilities
- Offshore – not onshore

Challenges

- High Capex
- Oil recovery risks exists
- Long-term liability
- Chain complexity
- Public perception issues

CCS costs



Source: McKinsey

Financial incentives for CCS with or without EOR are insufficient

EUA Prices



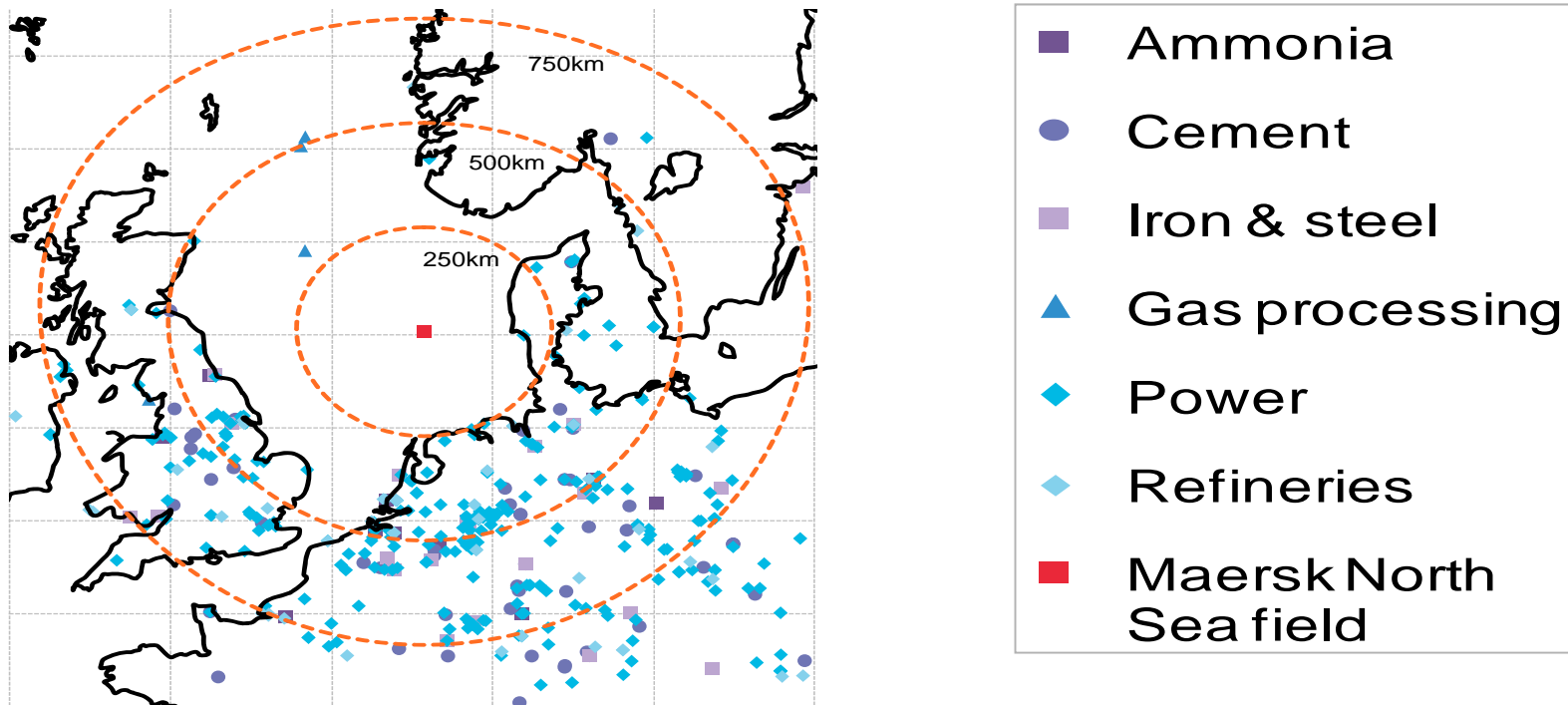
- Current CCS projects increasingly challenged despite available funding from NER300 and EERP –EUA prices too low and uncertain
- Additional measures required to kick start CCS
- Emission standards may be required to ensure acceleration of CCS
- EOR may need separate encouragement

Business Model

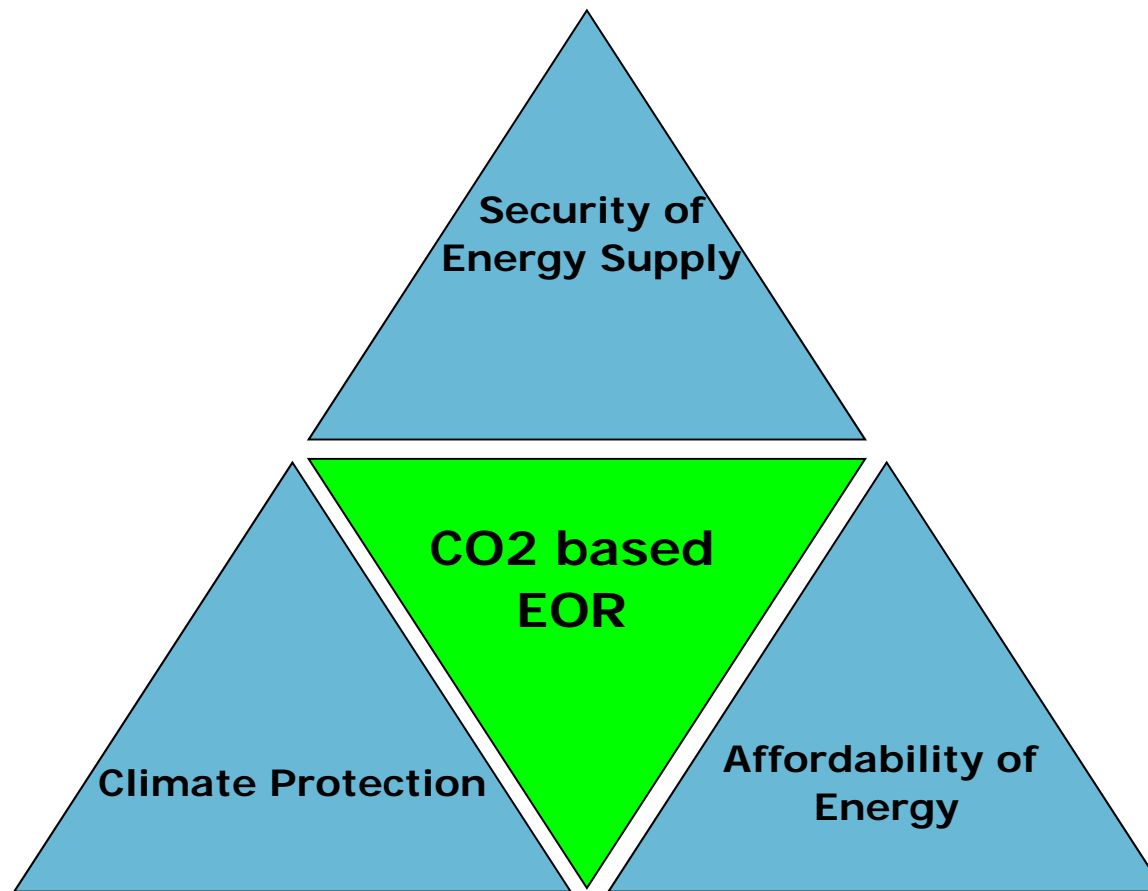


- Emitter to capture and transport CO2 in agreed volumes to the EOR/storage site at its risk and cost
- Storage provider to provide permanent storage of all volumes received at its risk and cost
- ETS allowances generated for the sole benefit of the Emitter
- Subsidies (NER300 and EERP) for the sole benefit of the emitter
- EOR generated for the sole benefit of the storage provider

CO2 emissions concentrations



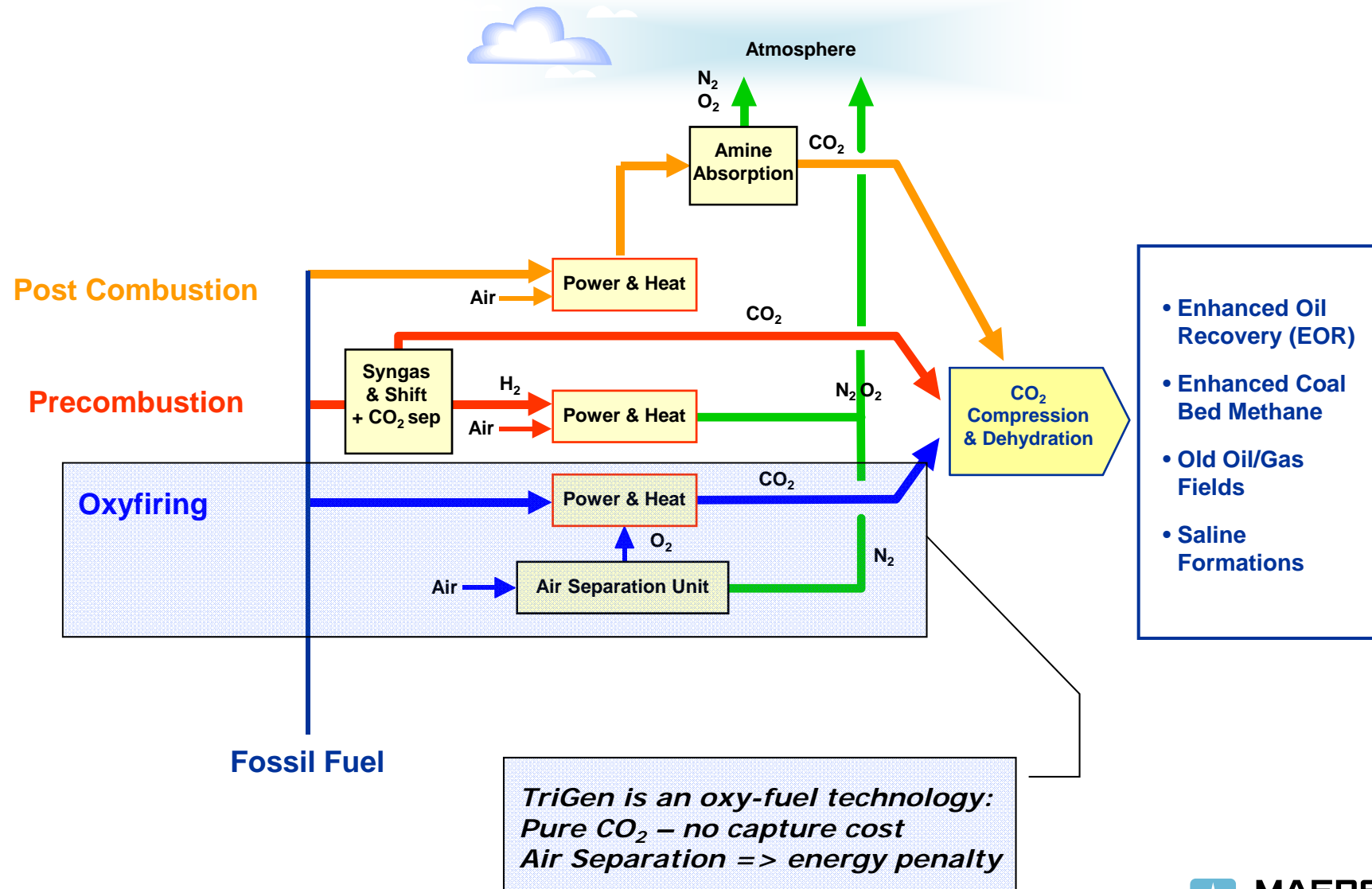
CO2 based EOR provides a bridge between several geopolitical agendas



TRIGEN MOVIE

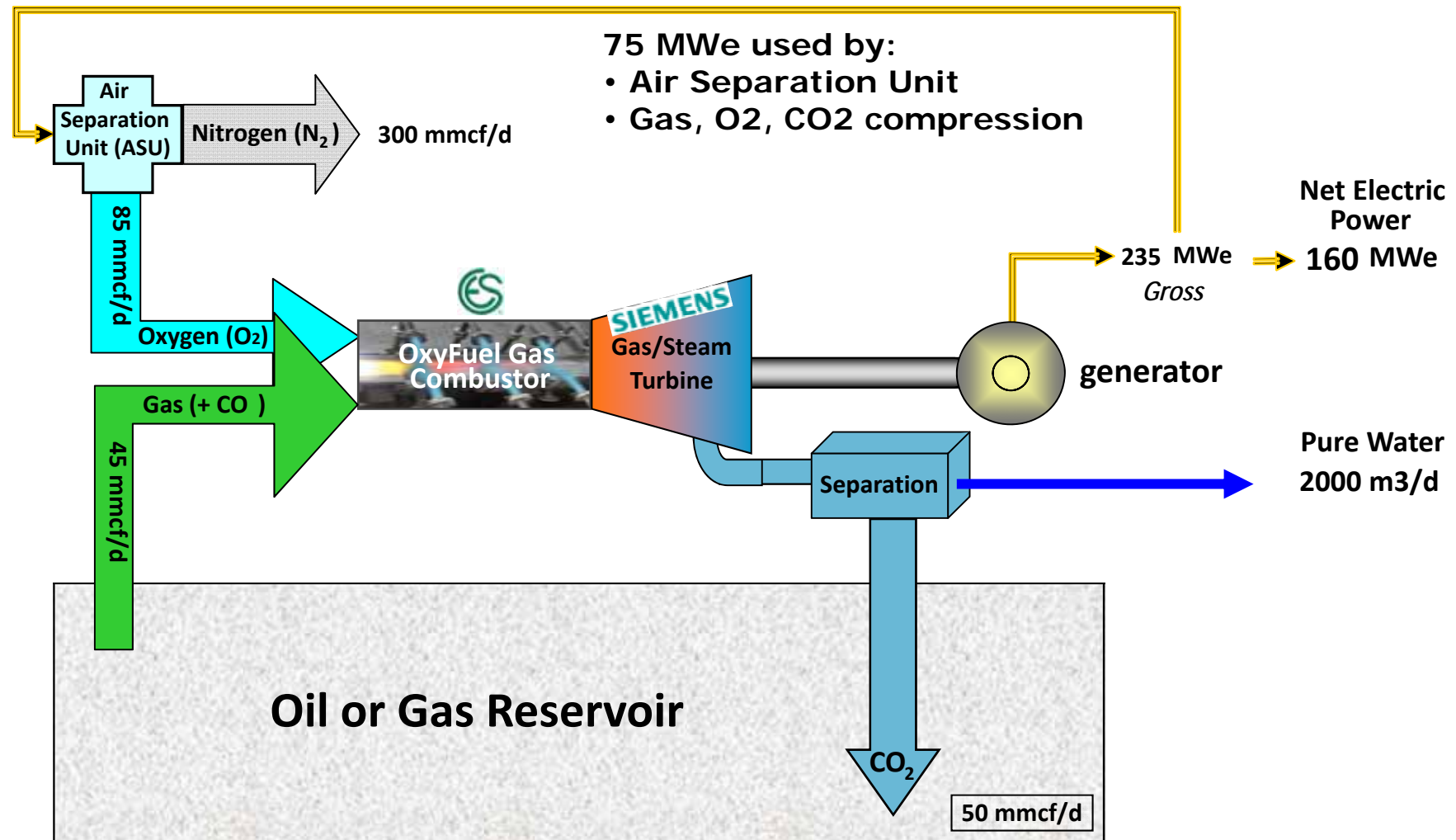
TriGen: Clean Power, Pure Water and Reservoir Ready CO2

Principal CO₂ Capture and Use Concepts



TriGen for Upstream Oil and Gas: Principles

Converting (low quality) hydrocarbons into electricity, CO₂ and water



Technology Partners

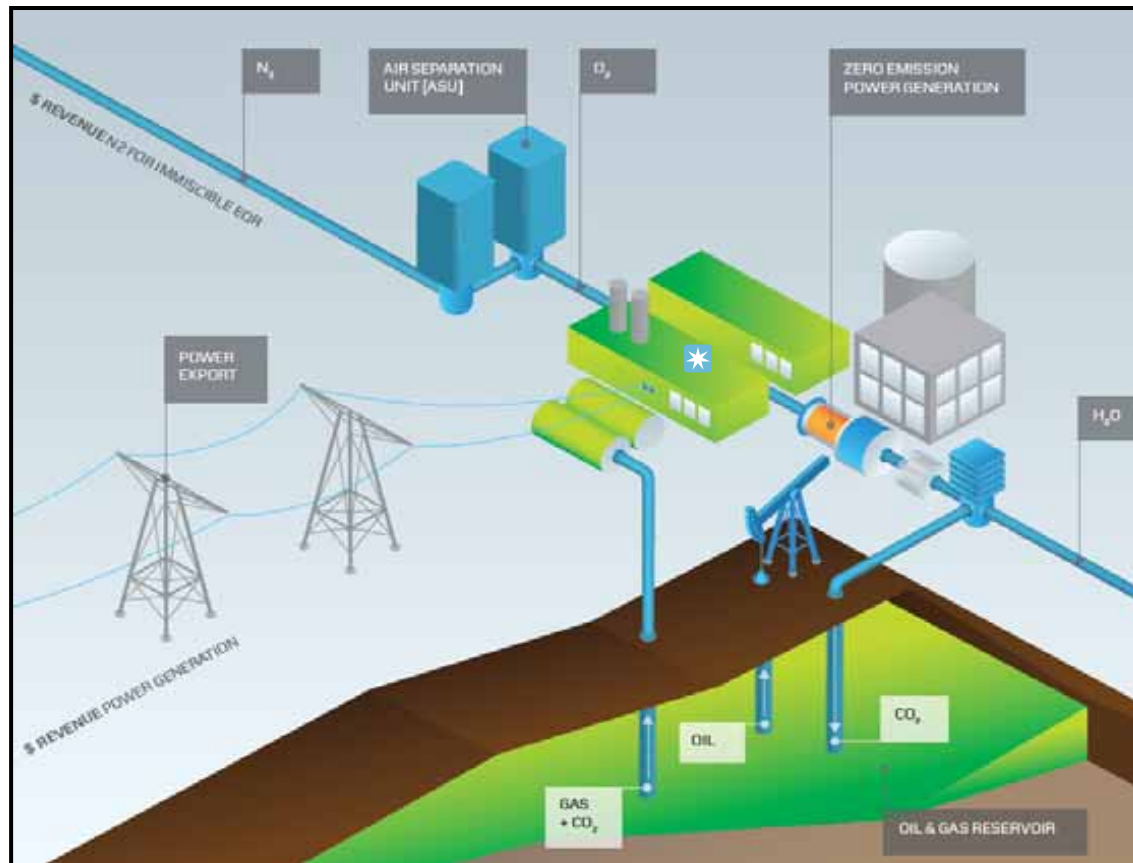


SIEMENS



MAERSK
OIL

Zero Emission Energy and Low Cost CO2

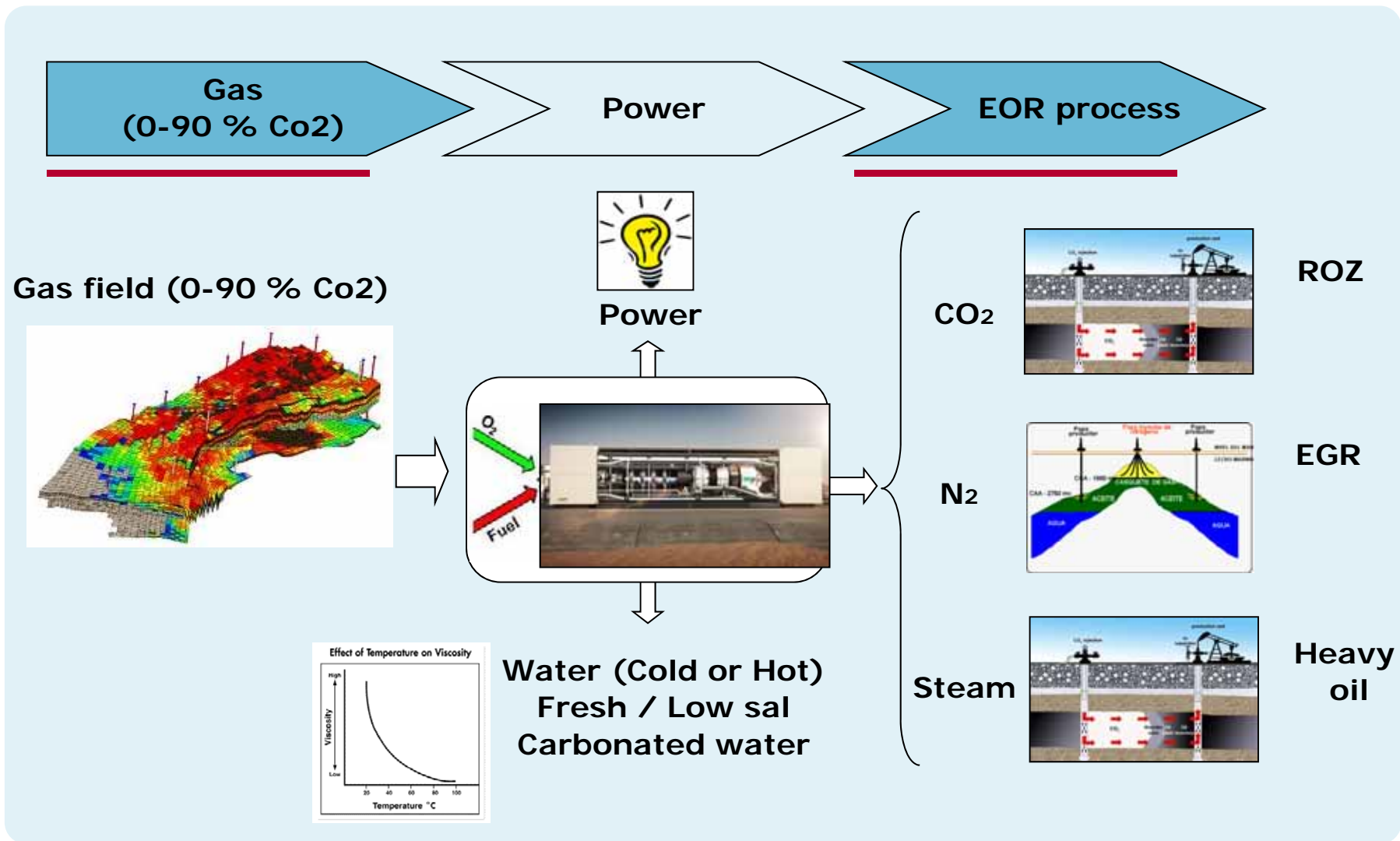


Maersk Oil's TriGen Technology links up the energy value chains

- TriGen's oxyfuel combustion process delivers very pure CO_2 and N_2 without the high cost of carbon separation
- CO_2 and N_2 injectants can be used to replace valuable methane for secondary and tertiary oil/gas recovery
- Clean power and pure water for domestic use
- Enables "zero emission" fossil fuel power generation

- ➡ TriGen can accept low quality fuel gas (up to 90% CO_2)
- ➡ This makes TriGen a 'full life cycle' solution for CO_2 EOR

TriGen Integrates Gas and Oil Field Developments



Oxyfuel Combustor using Space Technology

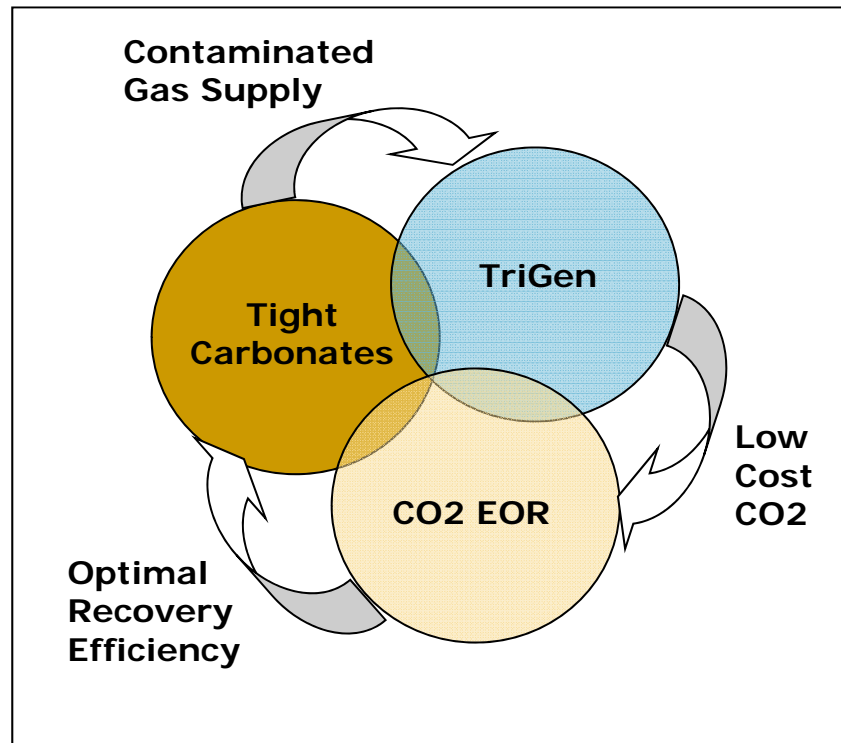
Operating in California since 2005



12" Gas Generator



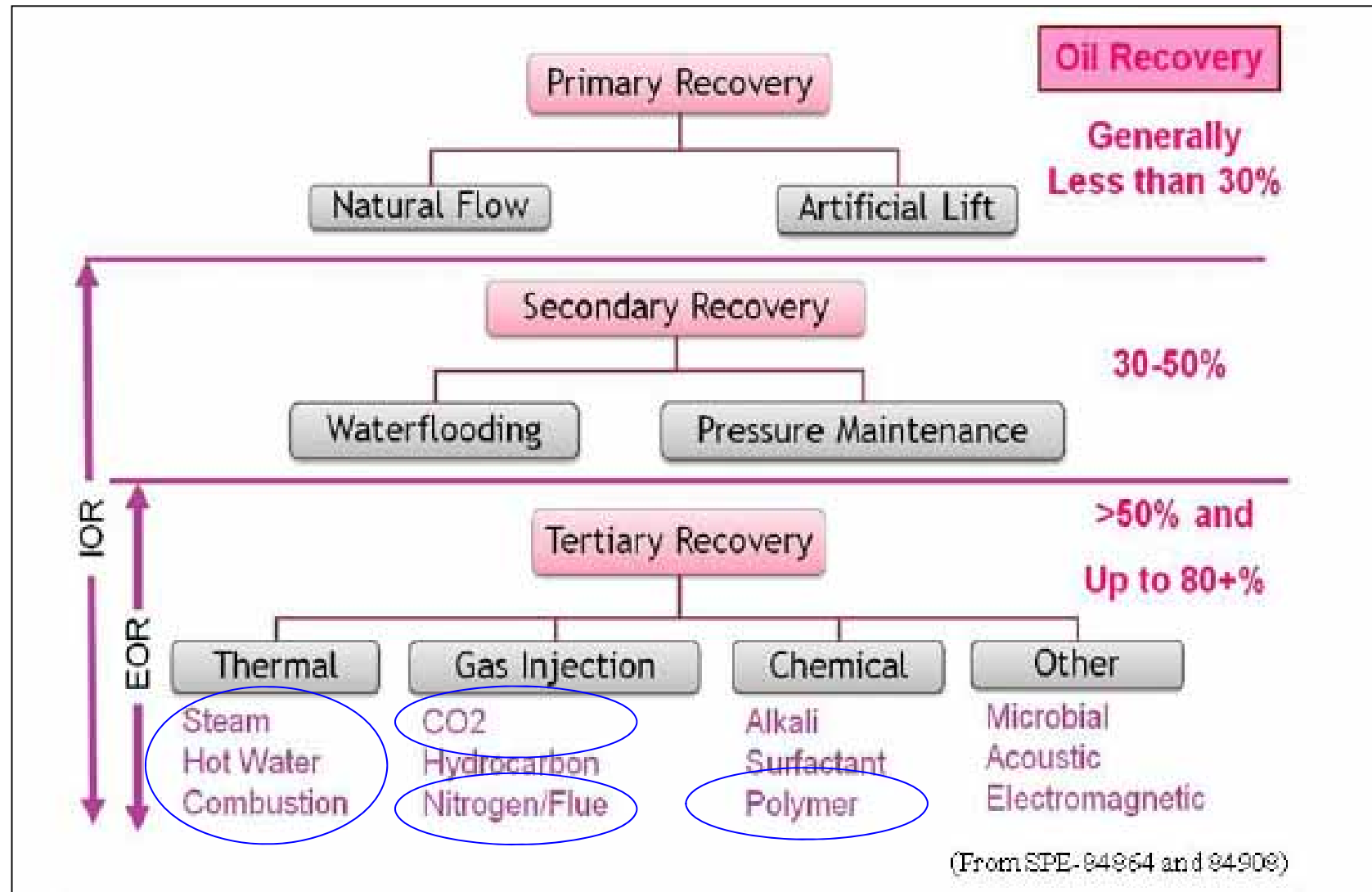
TriGen Technology Fit to CO₂ EOR and Low Perm Carbonates



TriGen Unlocks Value* From More Challenging Reservoirs

*TriGen makes EOR economic by supplying low cost CO₂

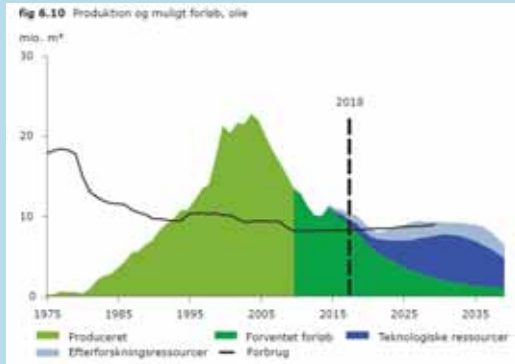
Advanced EOR potential enabled by TriGen...



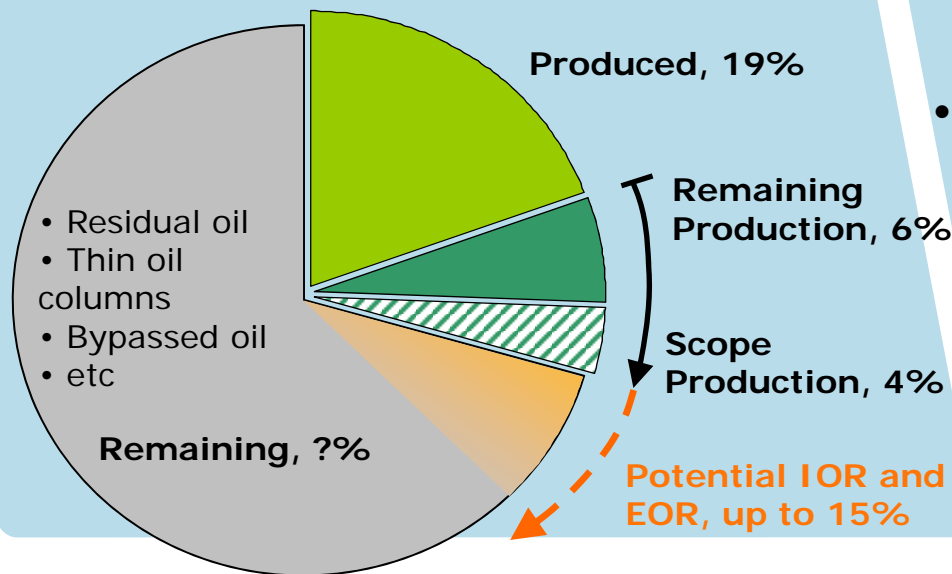
TriGen's multi product streams offers several attractive displacement process options to optimise reservoir recovery

Maersk Oil objectives of EOR

Total Danish Oil Production



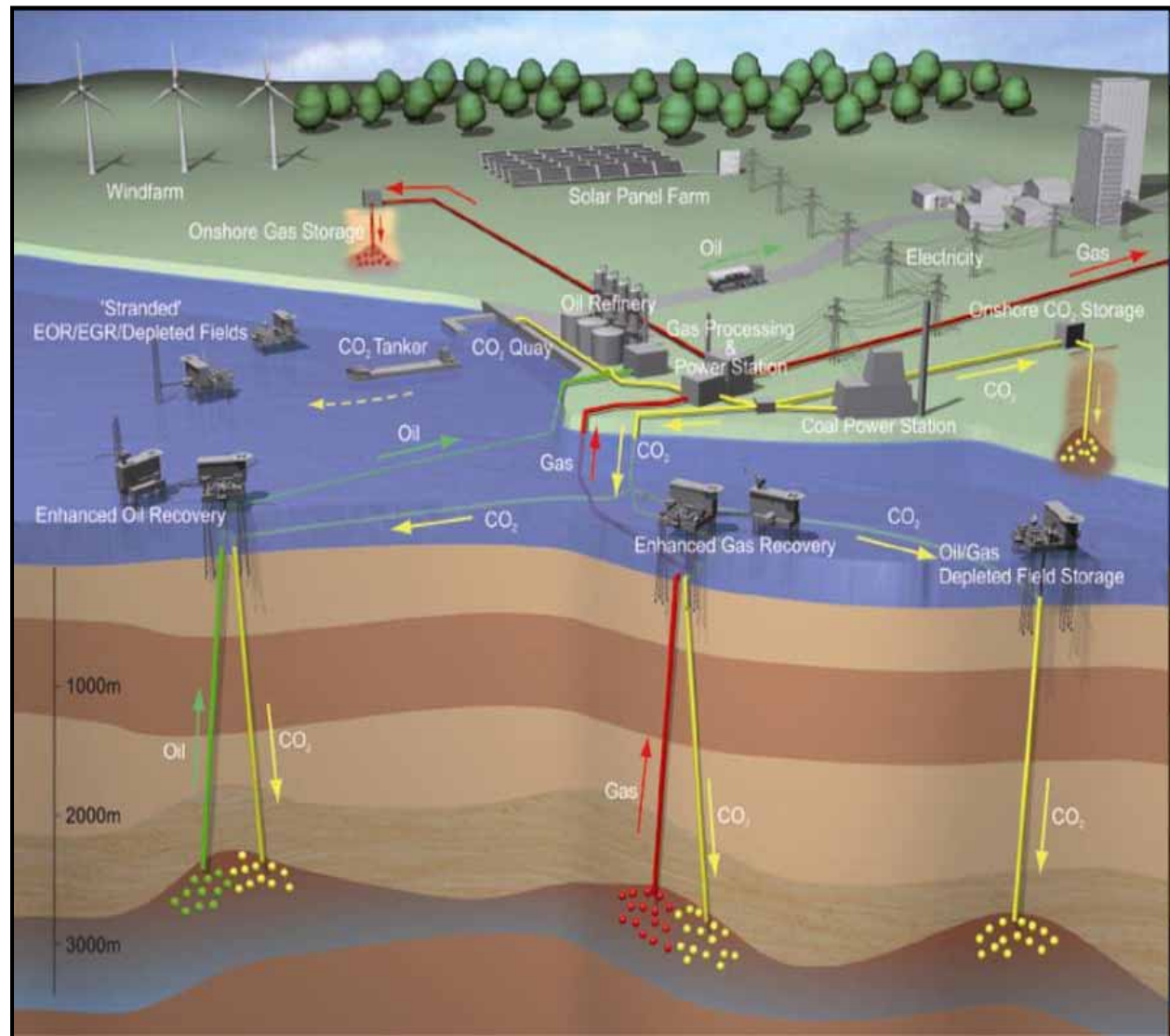
Source: DEA



- Maximize recovery to the benefit of all stakeholders
- Arrest declining production
- Easy oil is produced – maximize use of existing facilities
- Focus on sustainability and reducing carbon footprint

TriGen Value Summary

- **Low cost CO₂ and N₂**
 - Replacement of methane injection
 - Enabler for EOR and EGR
- **Zero emission power** from fossil fuels
- **Pure water** for WAG or domestic use
- **Full life cycle CO₂ EOR field** development solution





Thank you for your attention

Back-Up

Maersk EOR Activity Around the Globe

