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Production Facilities

SPE London Seminar:
Introduction to Upstream Oil and Gas for the Net Zero World

Omer Khoshnaw
November 2025

Disclaimer

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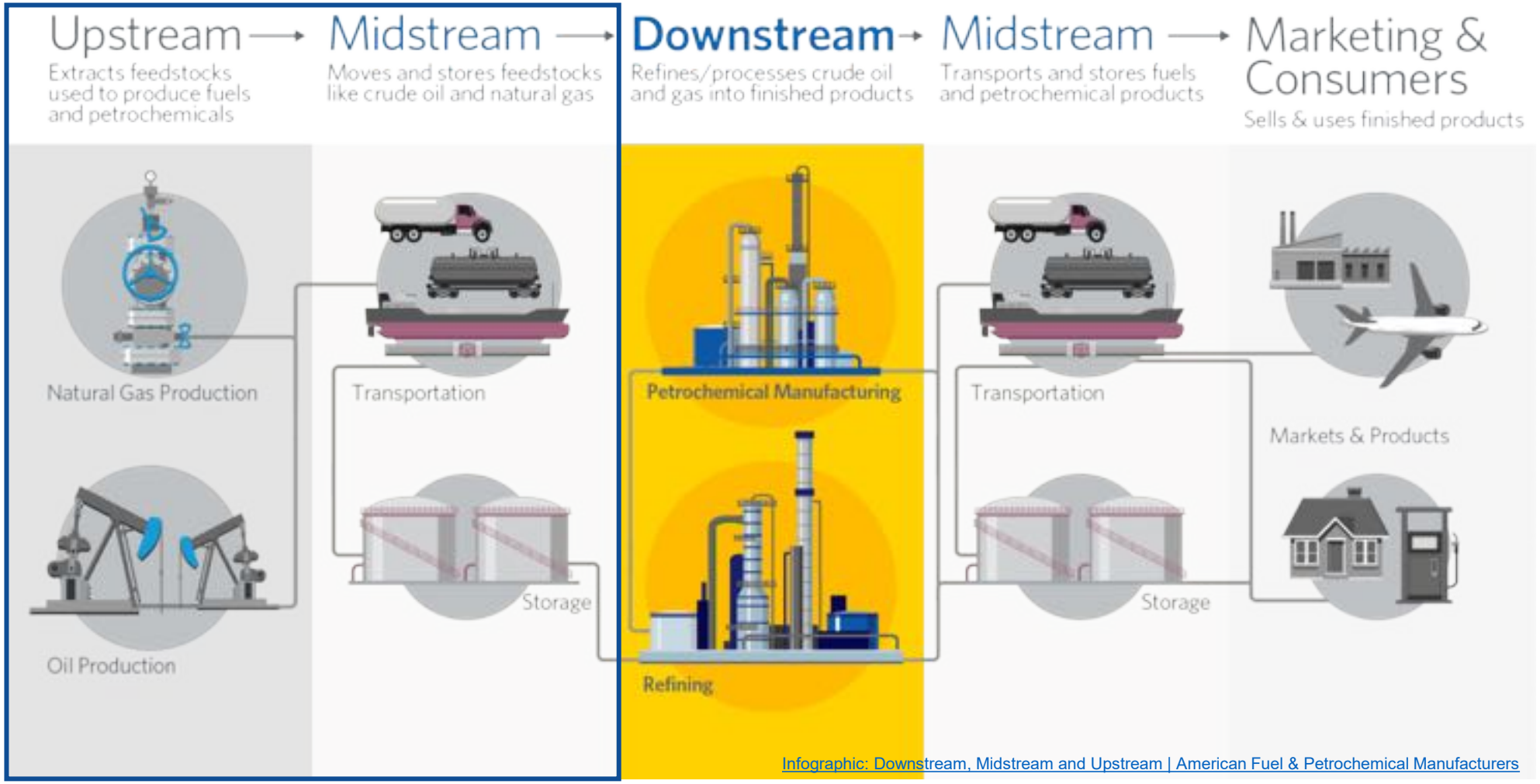
Agenda

- Production Systems Overview
- Surface Facilities
- Net-Zero Considerations

Production Systems Overview

From raw resources to usable energy for markets and consumers



Infographic: Downstream, Midstream and Upstream | American Fuel & Petrochemical Manufacturers

Production Systems Overview

What does an upstream oil and gas facility do?

- **Wells**
  - **Produce** and maintain production
- **Flowlines**
  - **Transport** well fluids from the well to a processing facility via pipes
- **Production Facility**
  - **Separate** products (oil and gas) from waste streams (water, sand & other contaminants)
  - **Treat** oil and gas to meet the sales requirements
  - **Treat** waste streams to meet the disposal requirements (environmental)
- **Transport**
  - **Deliver** products to the market


Oil Field Life |


Manifold-hero-300x225.jpg (300×225)


Facility (512×341)


Oil-and_gasIStock-639051976-scaled.jpg (2560×1322)


Oil gas pipeline (2560×1707)


Static LNG(940×627)


tanker-truck-(612×408)

Production Systems Overview

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- **Transport**
  - **Deliver** products to the market

Production Systems Overview

Wells: what are well fluids?

- Well fluids are a mixture of:
  - Oil
  - Water
  - Gas
  - Sand
  - Other contaminants (wax, scale, salt..)
- The nature of the well fluids will be a significant factor in the design of the facilities
- Product specifications impact facility design and can vary significantly
- **There is usually uncertainty in the composition and flow rates of the well fluids**

Petroleumroughnecks: Image

Image-117360730.jpg (1600×901)

Production Systems Overview

Production Systems Overview

Flow is everything – it's literally what we do!

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We speak in pressures….

Production Systems Overview

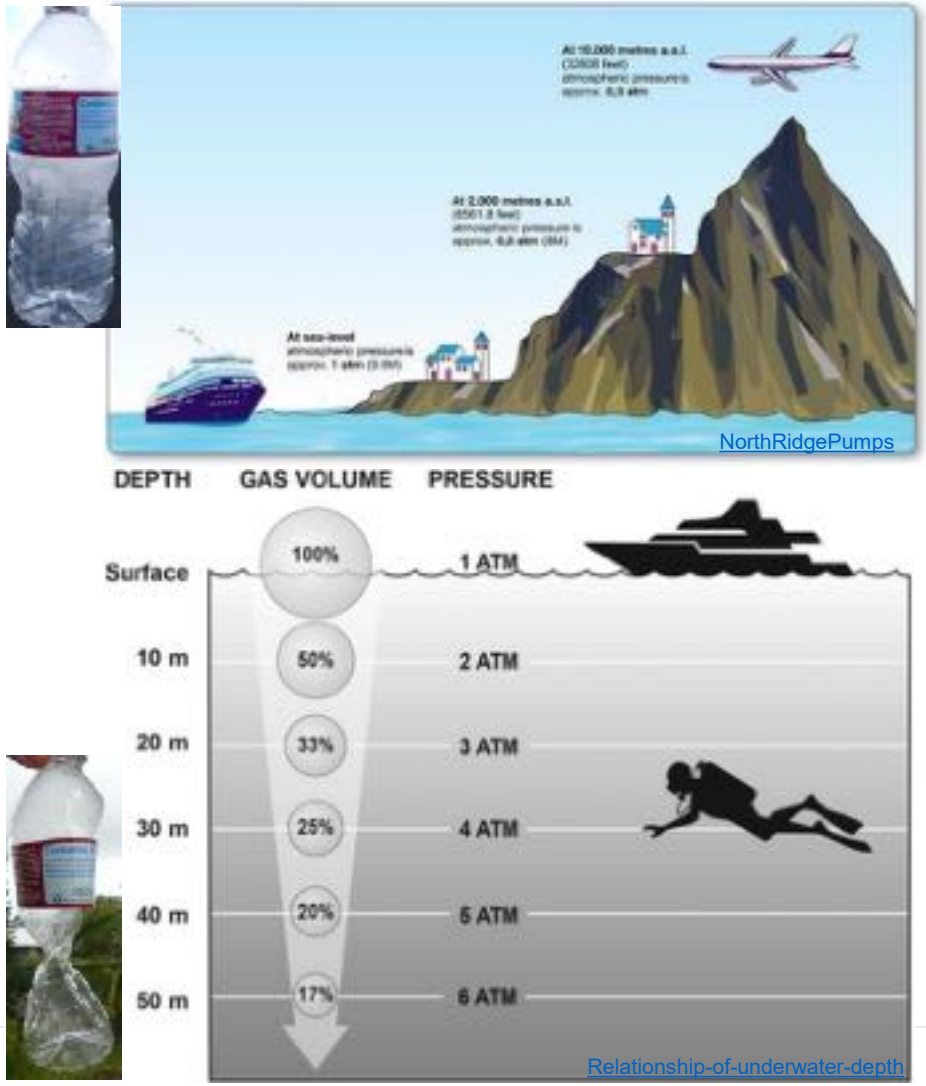
Flow is everything – it's literally what we do!

We speak in pressures….

Let's explore how fluids flow in the production system…

Production Systems Overview

Wells: how they flow? High pressure to low pressure

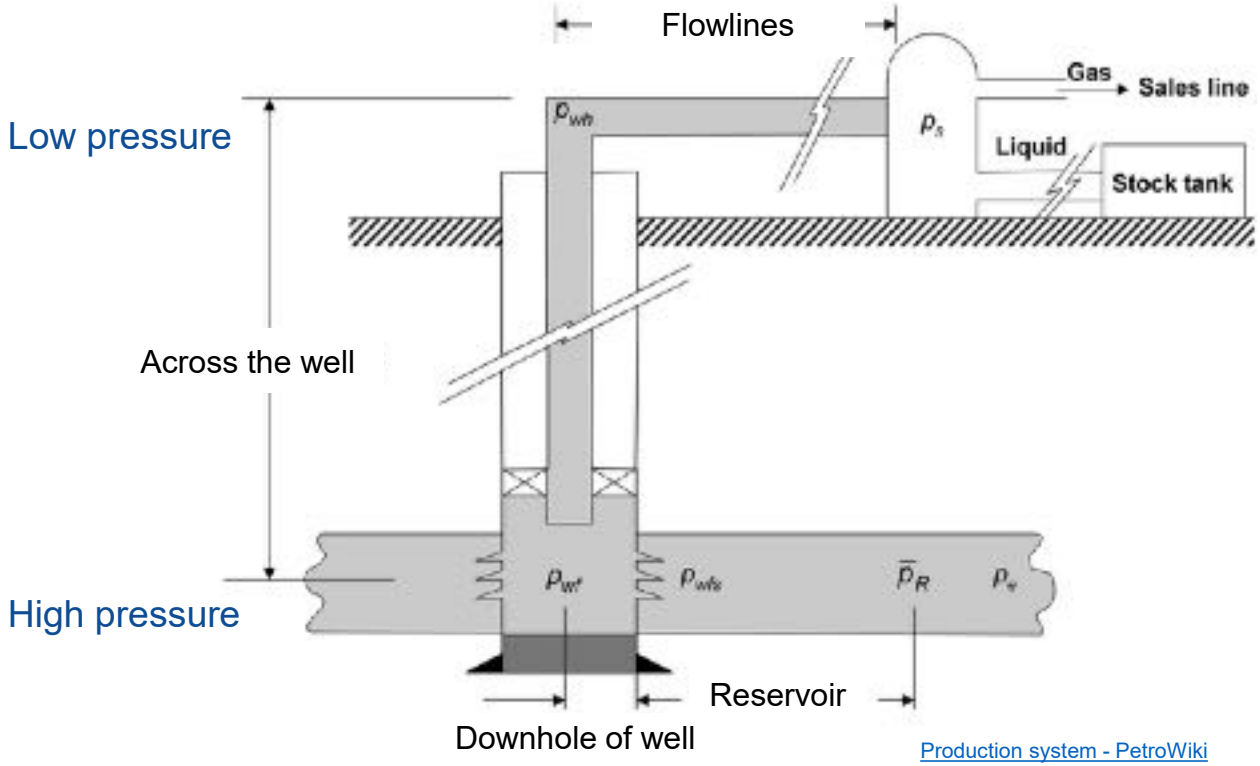


Production Systems Overview

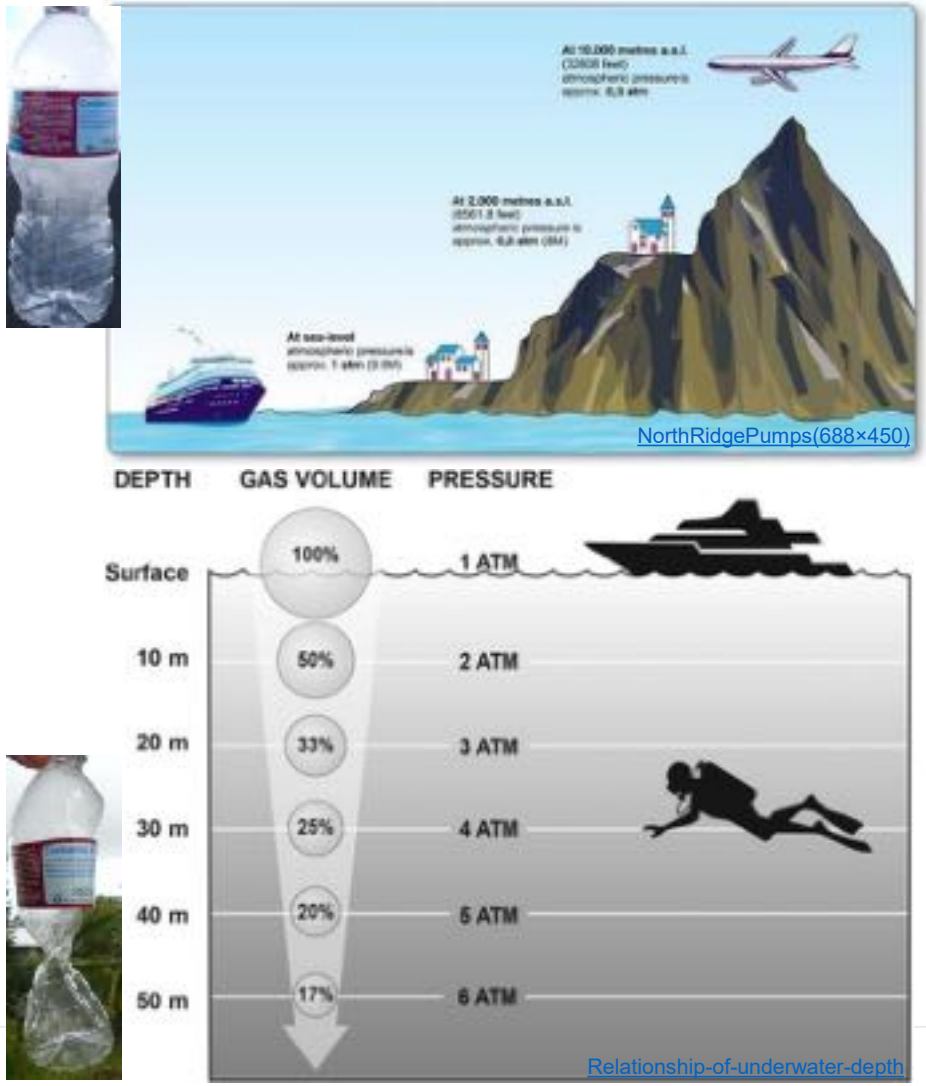
Wells: how they flow? High pressure to low pressure

Pressure Drops Along the Production System:

- Fluids (oil, gas, water) in a well flow naturally from high-pressure zones (the reservoir) to low-pressure zones (the surface)



Production system - PetroWiki



NorthRidgePumps(688×450)

Relationship-of-underwater-depth

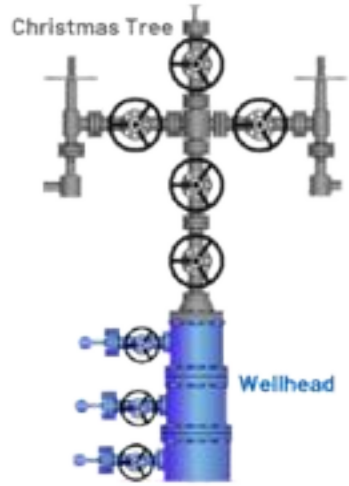
Production Systems Overview

Wells: Produce and maintain production

Connects reservoir to surface facilities for oil, gas, and water flow

- Provides a pathway for fluid extraction
- Wellhead and X-mas tree ensure structural integrity and safe fluid control
- Pumps are installed to lift the fluids to surface when natural pressure is insufficient
  - AKA artificial lift

christmas-tree



Wellhead-Christmas-Tree

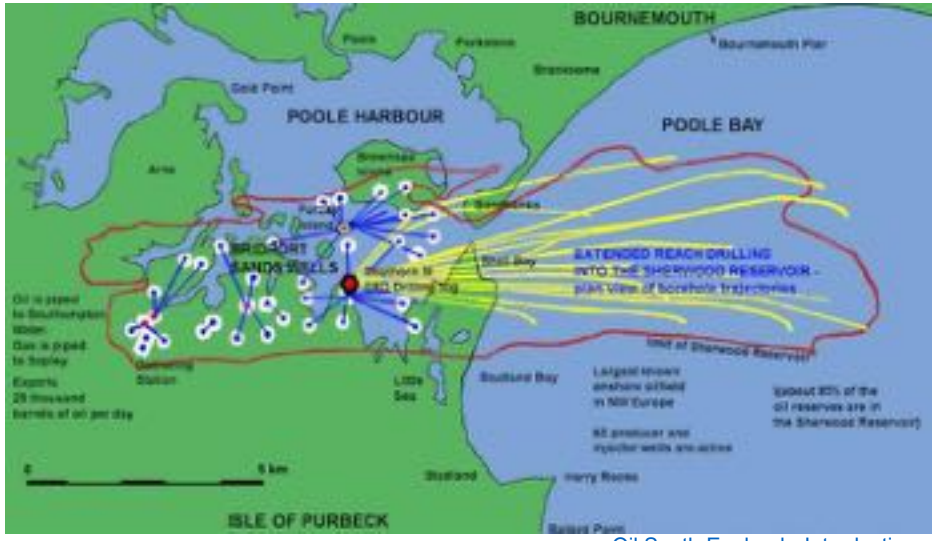
The Difference Between a Wellhead & Christmas Tree

Subsea Production System

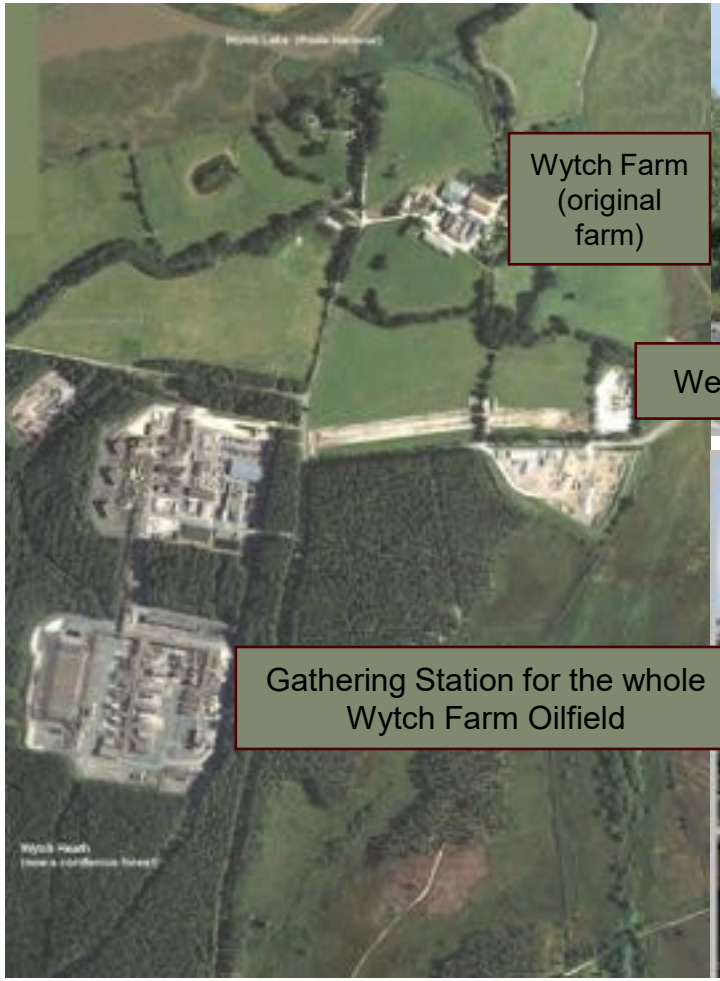
Production Systems Overview

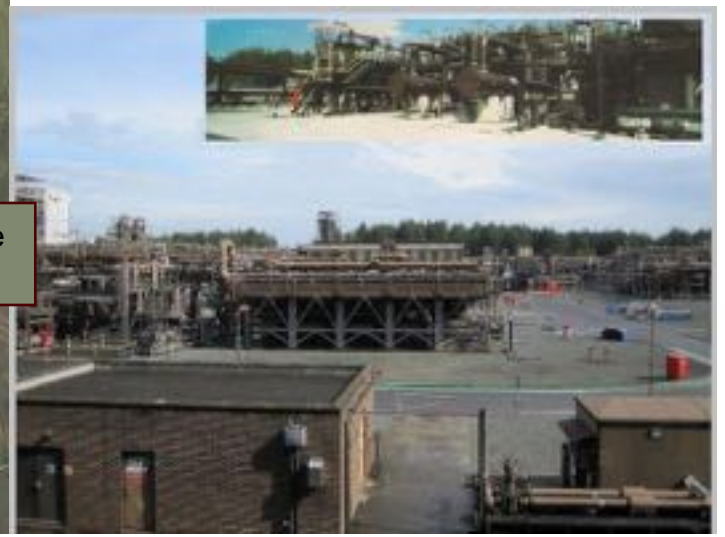
Oil and Gas Gathering: Transport well fluids from the well to a processing facility

- Pads/Manifolds: Centralize production from multiple wells
- Aboveground or buried flowlines for easy maintenance and environmental protection
- Reduce equipment duplication and improve efficiency



Oil South England - Introduction





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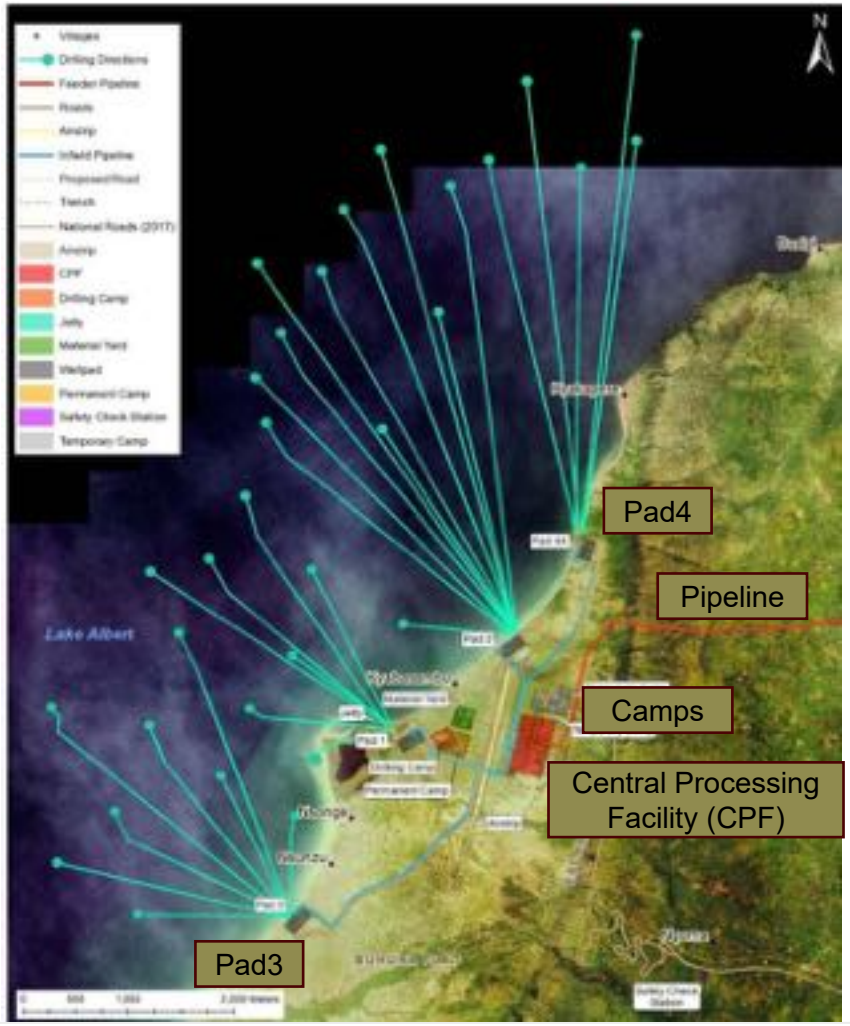
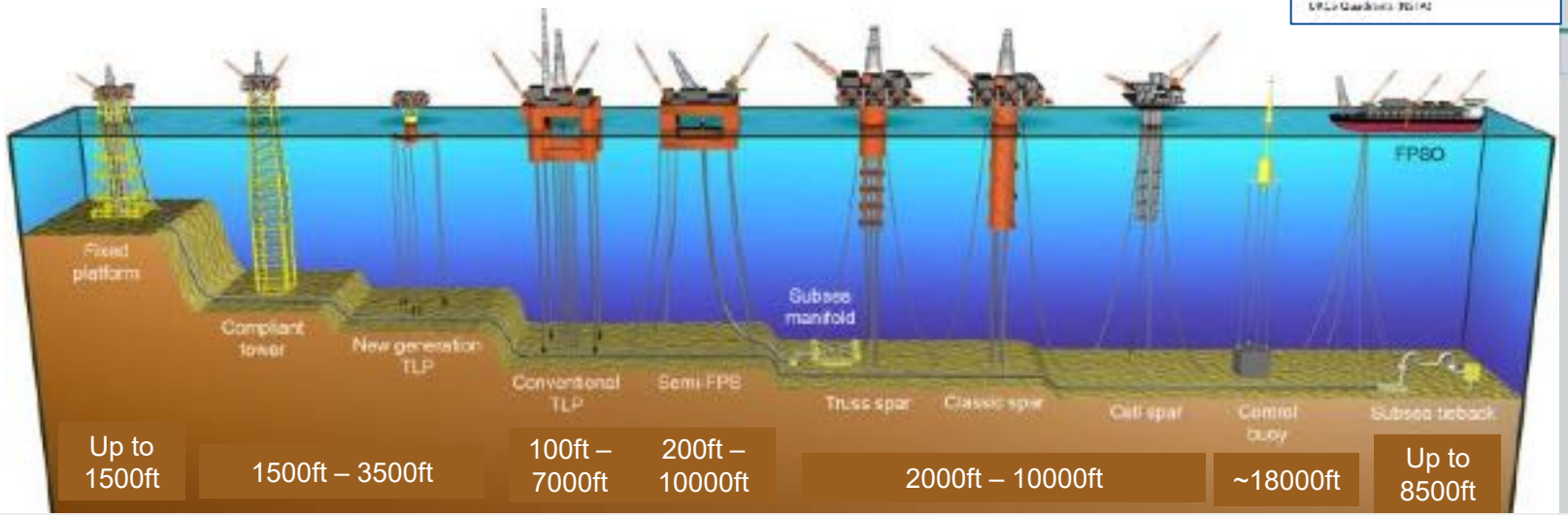


KINGFISHER Project – UNOC: Uganda National Oil Company

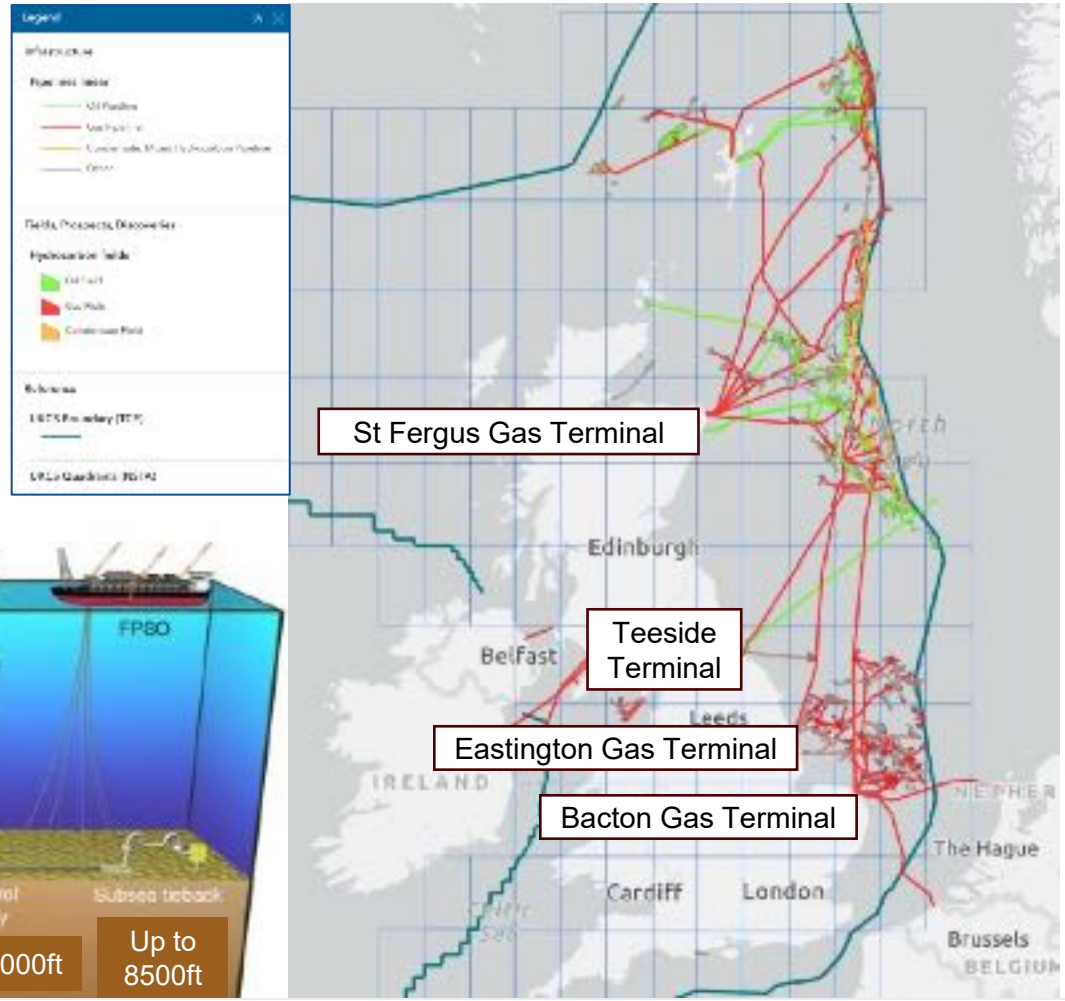
Production Systems Overview

Oil and Gas Gathering: Transport well fluids from the well to a processing facility

- Offshore facilities are designed based on the conditions and location of an asset
  - Fixed platforms: Shallow water, stable foundation
  - Floating platforms: Deepwater areas, adaptable to ocean conditions
  - FPSOs: Floating Production Storage and Offloading units, ideal for remote locations
- Flowlines connect subsea or surface wells to platforms
- Gathering Centers in the UKNS consolidate production from multiple fields for processing and transport



Offshore Location - an overview | ScienceDirect Topics

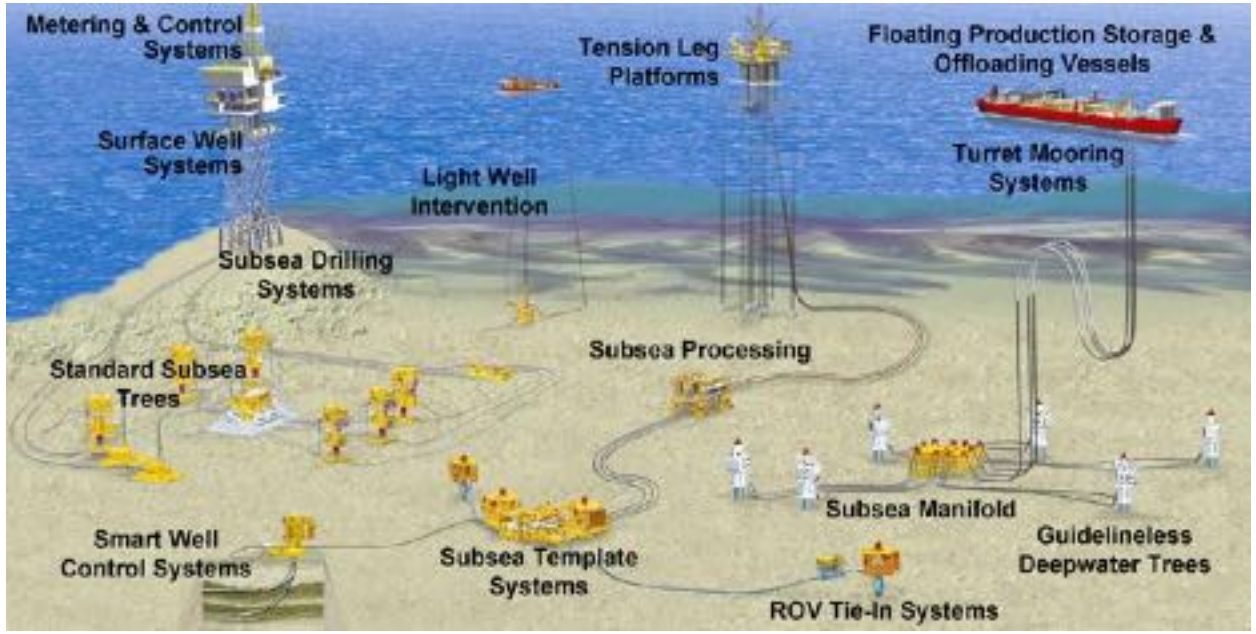


North Sea Transition Authority: Lease Agreements

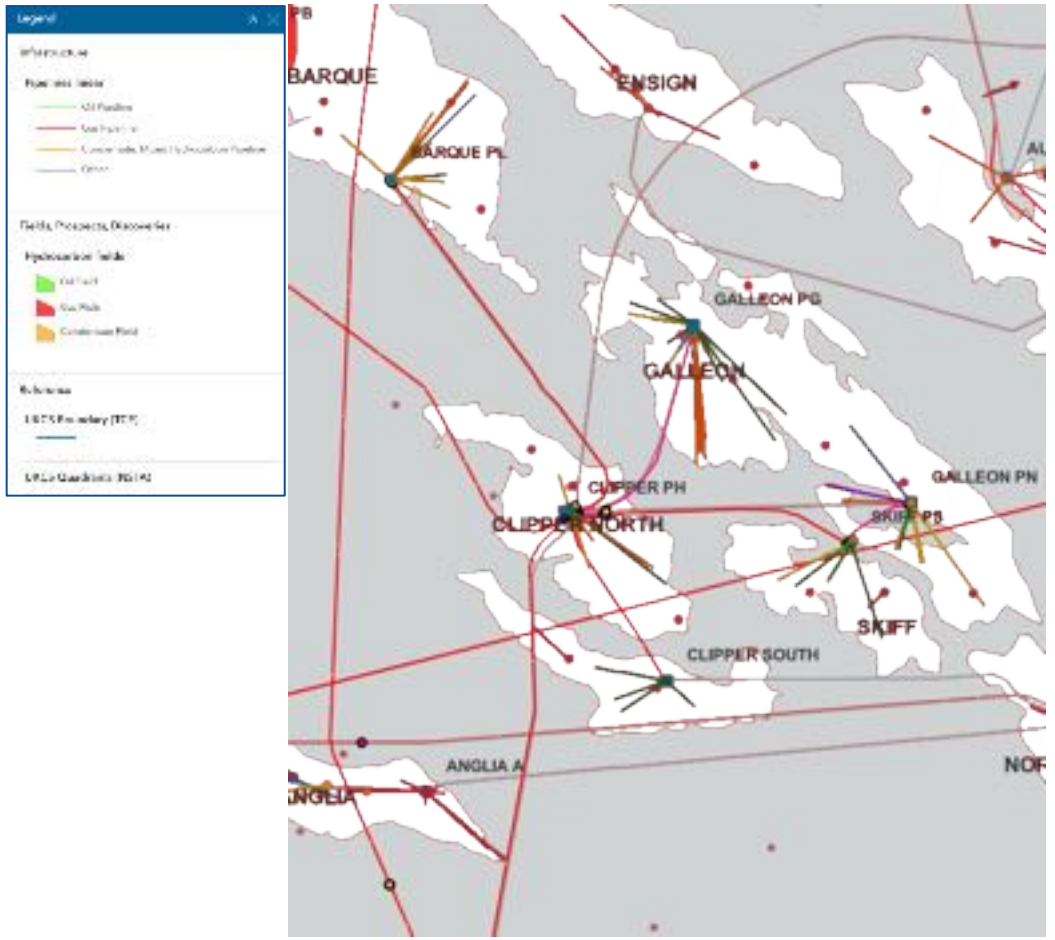
Production Systems Overview

Oil and Gas Gathering: Transport well fluids from the well to a processing facility

- Subsea Systems
  - Subsea wells and manifolds transport fluids via flowlines to platforms or hubs
  - Enable production from deepwater or remote fields
  - Designed to withstand high pressures and extreme temperatures



OWOE - Oil And Gas - What is a subsea development?

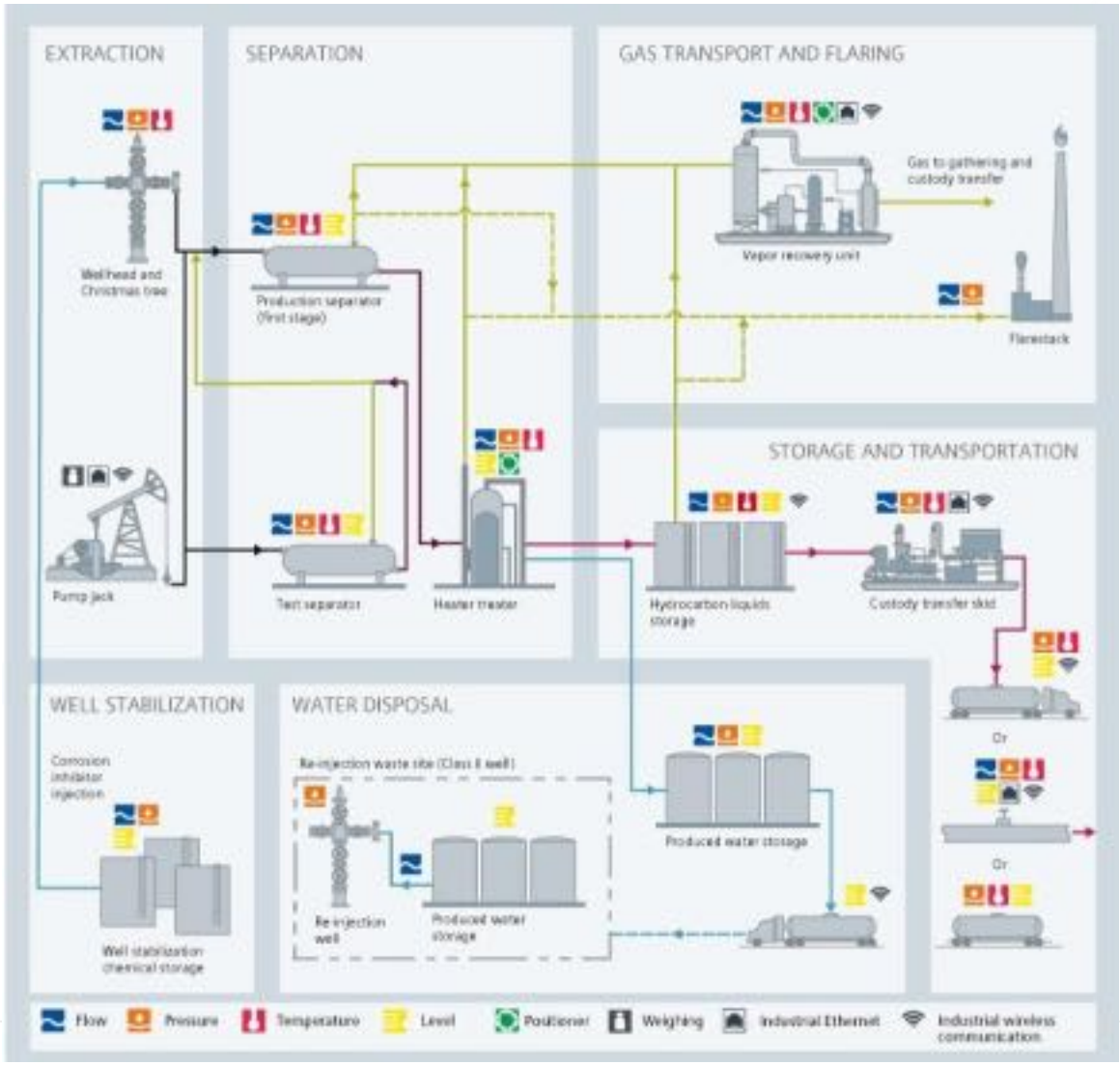


North Sea Transition Authority: Lease Agreements

Surface Facilities

Overall Process Flow Diagram

- **Extraction:** Fluids flow from wells under natural flow or artificial lift
- **Separation:** Oil, gas, and water are separated in stages
- **Gas Handling:** Gas is compressed, dehydrated transported and/or re-injected, or flared if excess
- **Oil Storage and Transport:** Stabilized oil is stored and sent to pipelines or tankers
- **Water Disposal:** Produced water is treated and safely disposed of or reinjected
- **Well Stabilization:** Includes chemicals to protect equipment and ensure safe and stable flow

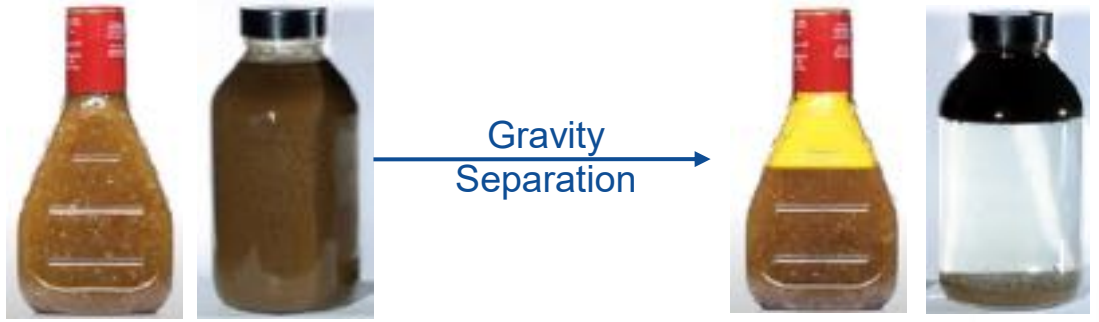


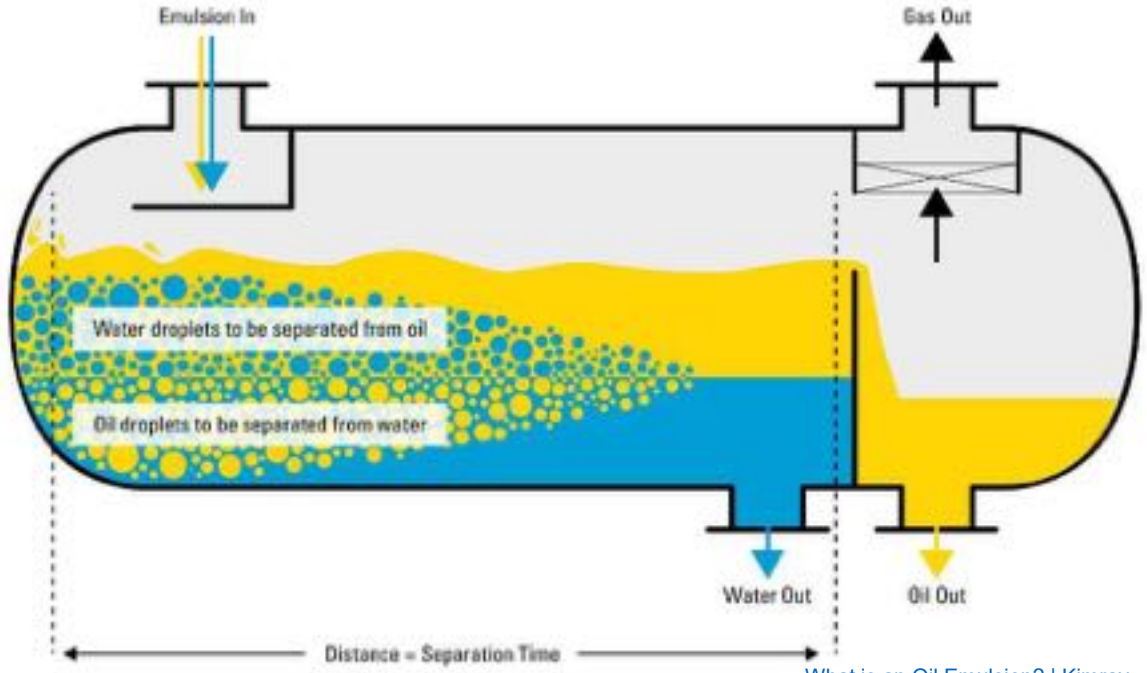
Automation & Instrumentation_Luoyang Runcheng Petrochemical Equipment Co.,LTD.

Surface Facilities

Separation

- **3-Phase Separator:**
  Separates oil, gas, and water
- **Controlled Separation:**
  Prevents instability and safety risks
- **Difficult Fluids:**
  Heating/chemicals needed for separation
- **Residual Impurities:**
  Products often require further treatment
- **Contaminated Waste Streams:**
  Water/sand typically contains oil



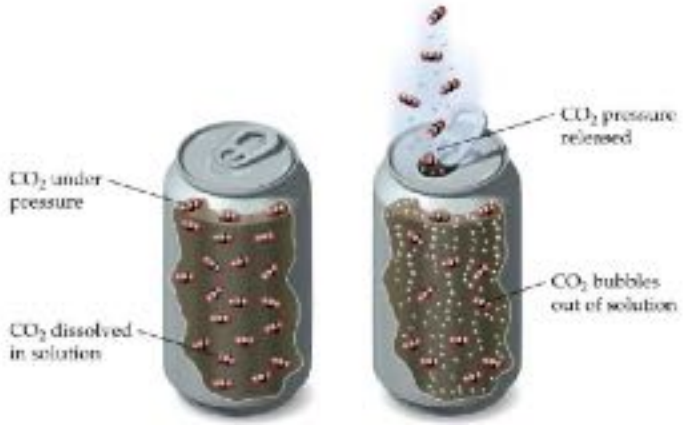


What is an Oil Emulsion? | Kimray

Surface Facilities

Separation: Oil treatment

- **Degassing: Stabilizing Oil**
  - Oil contains gas which may be released if the pressure or temperature changes
  - The ‘’extra’’ gas must be removed, reducing ‘vapour’ pressure, ensuring safe storage and transportation



Henry's Law


IDMON Engineering & Construction Co.

Surface Facilities

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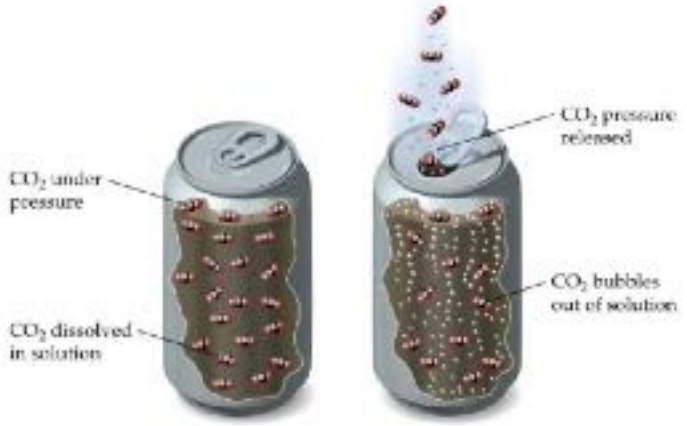
  - Oil contains gas which may be released if the pressure or temperature changes
  - The ‘’extra’’ gas must be removed, reducing ‘vapour’ pressure, ensuring safe storage and transportation

- **Dehydration and desalting:**
  - Remove water content from crude oil to meet pipeline and refinery specifications
  - Removes salts dissolved in water to prevent corrosion and fouling in downstream equipment



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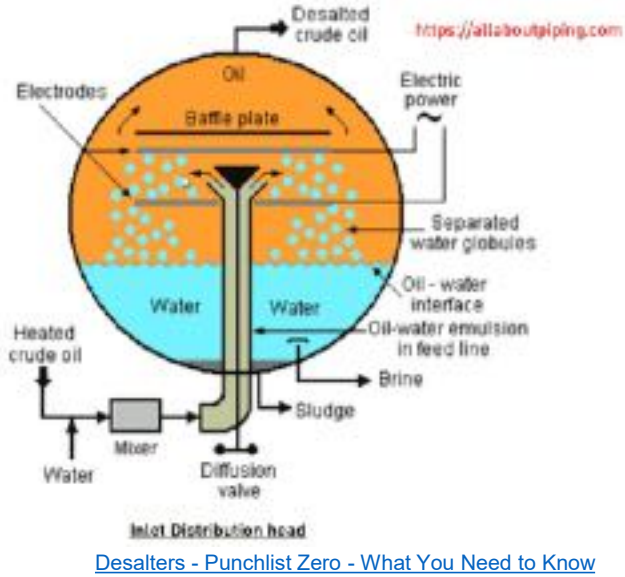


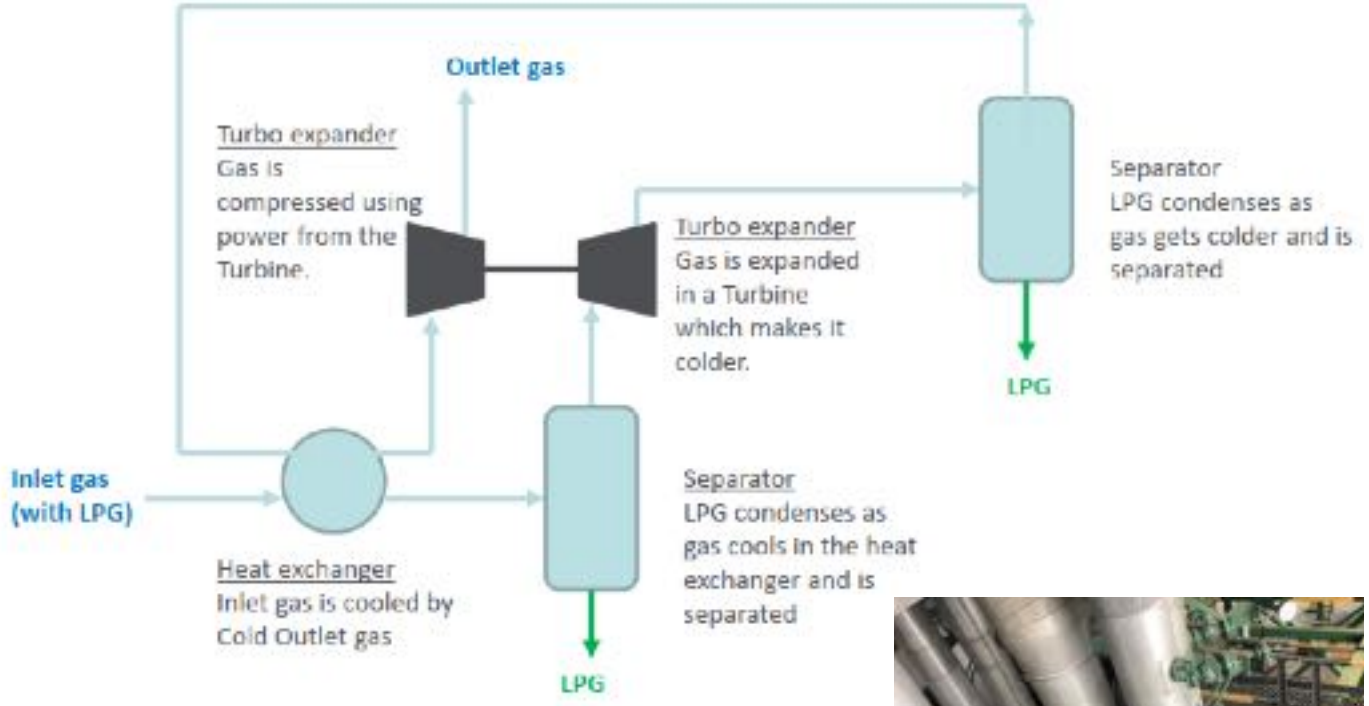
Desalters - Punchlist Zero - What You Need to Know

Entekhub

Surface Facilities

Separation: Gas handling and treatment

- **Gas compression**
  - Increases pressure for transport or injection into well or reservoir for storage
  - Compensates for pressure losses in pipelines



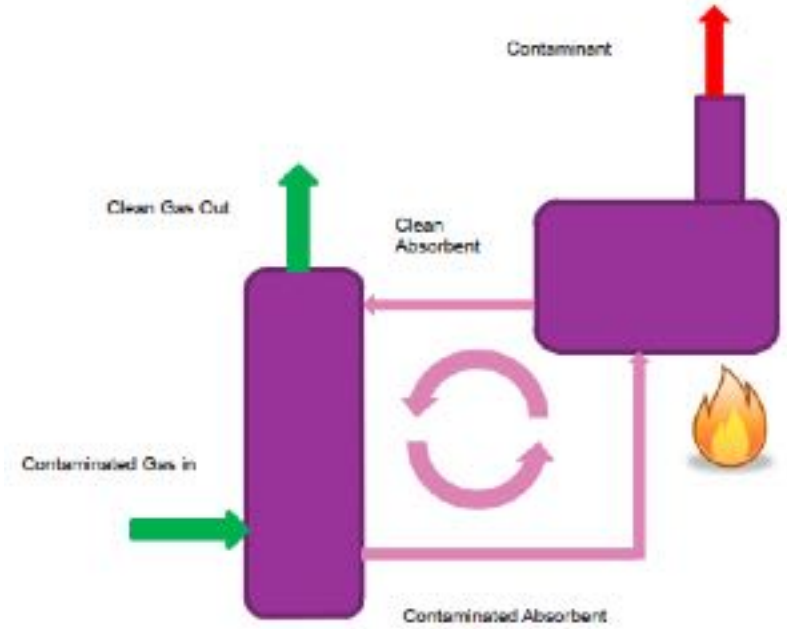
Overview of Gas Compression Facility - EPCM

Surface Facilities

Separation: Gas handling and treatment

- **Gas compression**
  - Increases pressure for transport or injection into well or reservoir for storage
  - Compensates for pressure losses in pipelines

- **Gas treatment:**
  - Removes water vapor, CO2, H2S to prevent corrosion and blockages in pipelines
  - Gas Dehydration: Triethylene glycol (TEG) absorbs water from the gas stream
  - Ensures gas meets pipeline specifications for safe transport and use



Gas Dehydration System Overview | Kimray

Surface Facilities

Storage and Export

- **Deliver products to the market**
  - Midstream step to transport the end products from production facility to downstream
    - Refineries, petrochemical plants
- **Oil**
  - Pipeline
  - Tanker
  - Rail
  - Road
  - Power Generation
- **Gas**
  - Pipeline
  - Power generation
  - LNG

Aukevisser Super tanker

Oman - LNG Prime

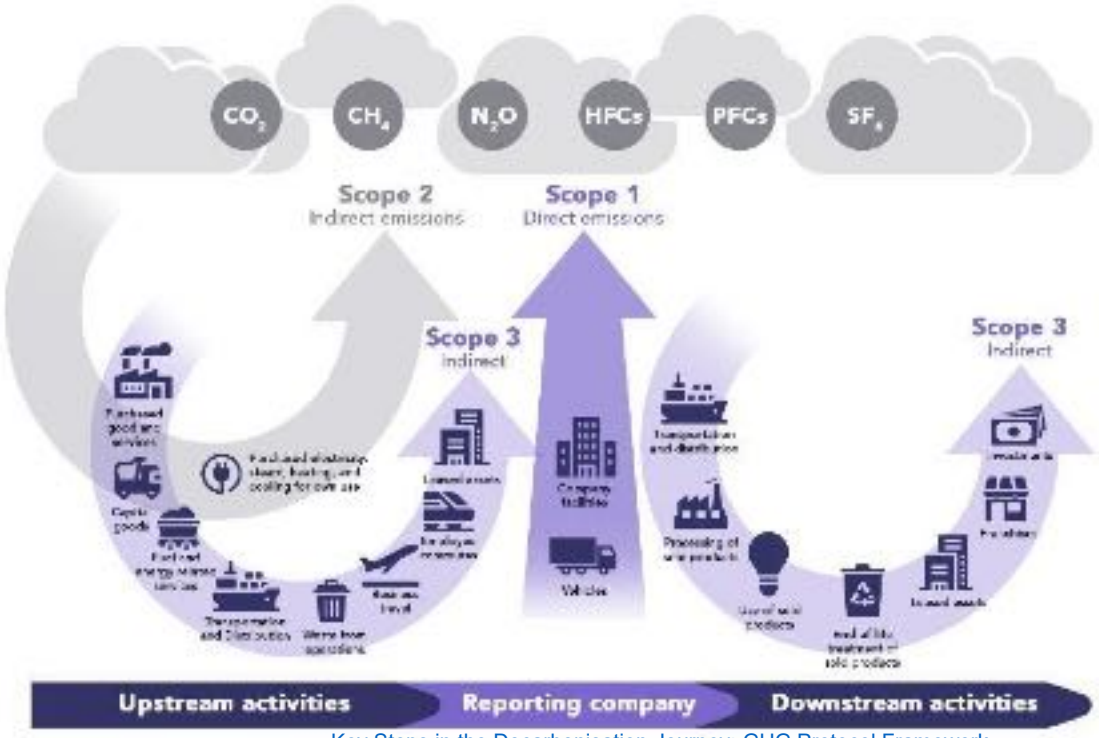
Net-Zero Considerations

What is Net-Zero in Production Facilities?

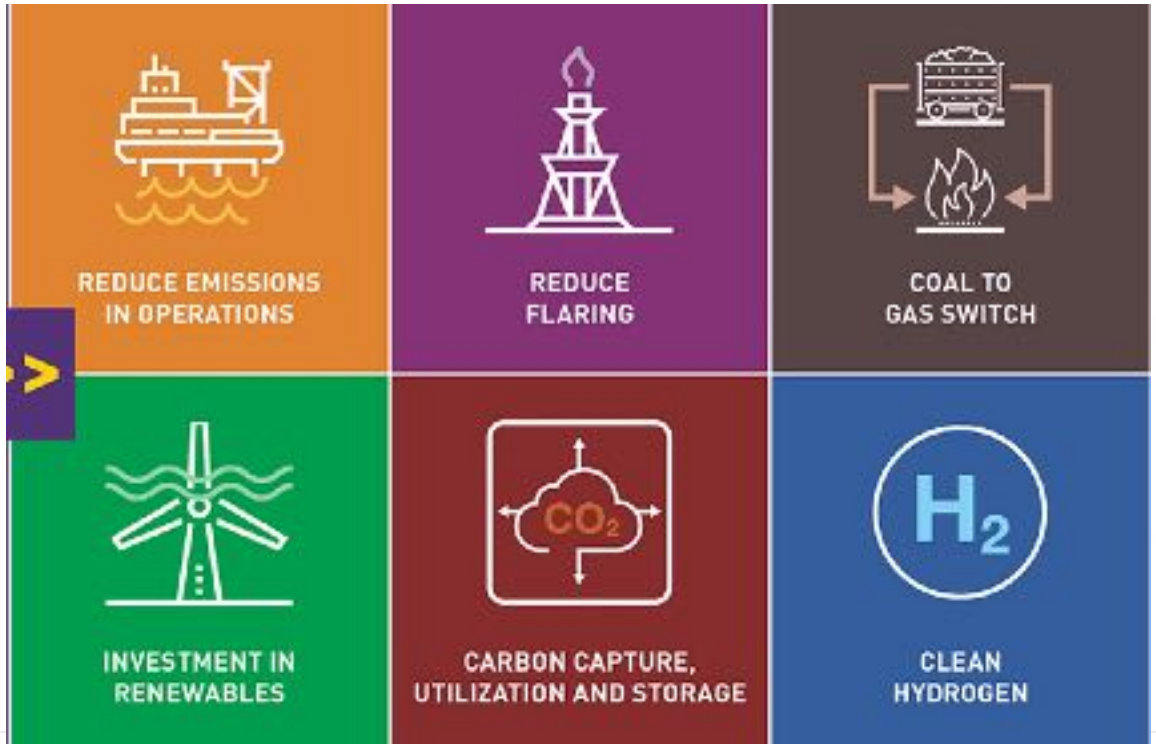
Achieving a balance between emitted and removed greenhouse gases

What are we doing to get there?

- Reduce emissions at every stage of the value chain (extraction to export)



Key Steps in the Decarbonisation Journey: GHG Protocol Framework



How the oil and gas industry contributes to a lower carbon future | IOGP

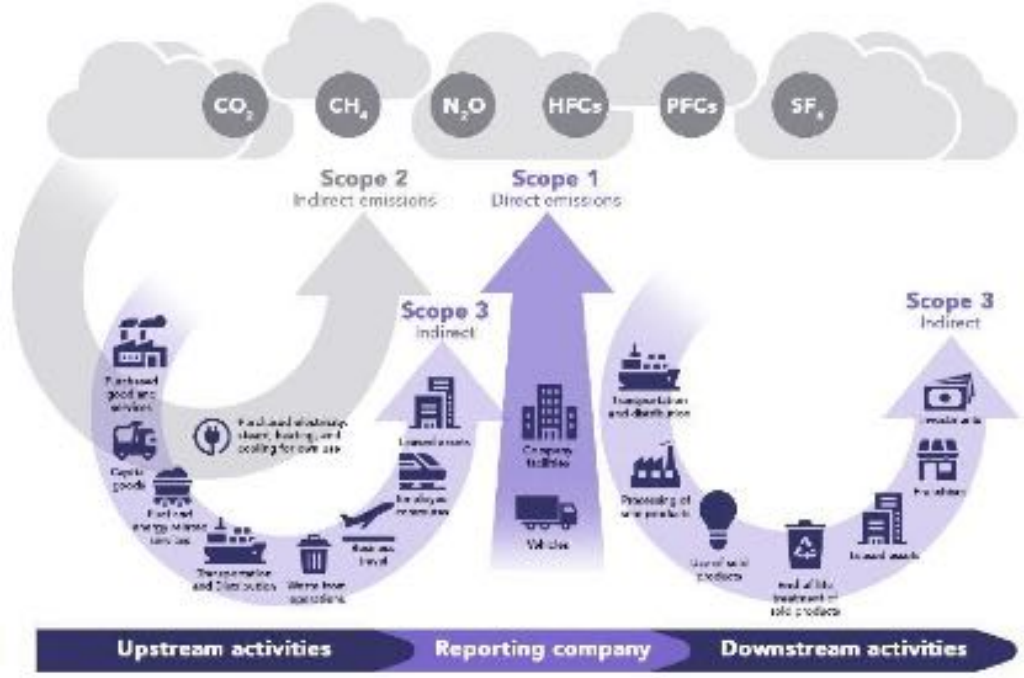
Net-Zero Considerations

What is Net-Zero in Production Facilities?

Achieving a balance between emitted and removed greenhouse gases

What are we doing to get there?

- Reduce emissions at every stage of the value chain (extraction to export)
- **Carbon Capture, emissions reduction and energy efficiency**, few examples:
  - Fewer offshore interventions = fewer helicopter flights
  - Piping modifications to reduce venting
  - Methane sensing cameras to identify fugitive gas leaks from pipework and fittings
  - New LED lights for efficient energy consumption
  - Fuel swapping from diesel to HVO (hydrotreated vegetable oil) to reduce emissions from offshore power generators
  - Electrification of the platforms from offshore wind power to displace diesel powered generators
  - Influence third parties to make technology upgrades



Key Steps in the Decarbonisation Journey: GHG Protocol Framework

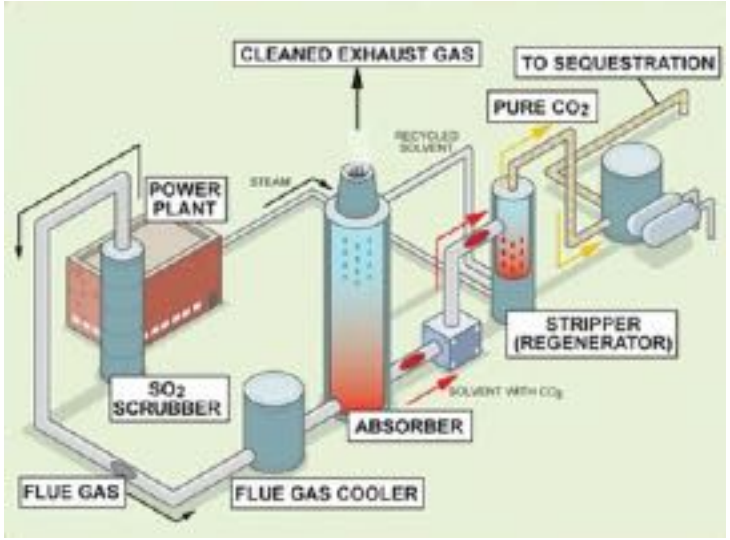
Offshore Rig (800×449)

Offshore wind

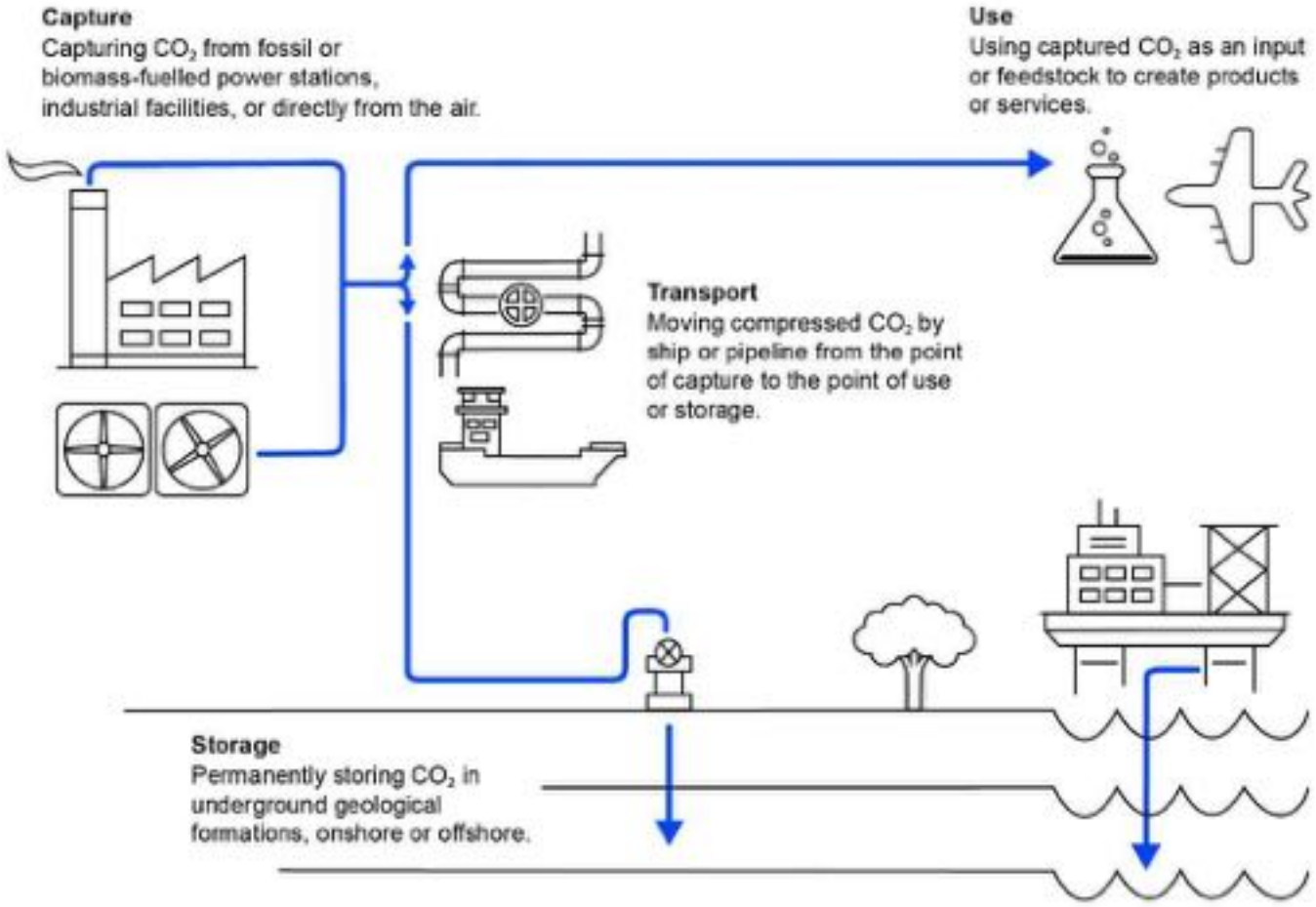
Net-Zero Considerations

Carbon Capture, Utilization & Storage (CCUS)

- Capture of atmospheric CO2 using direct air capture technology
- Capture CO2 before combustion, easier to separate from other gases due to high CO2 concentration
- Capture CO2 after combustion from exhaust gases using advanced technologies like amine-based absorption to separate dilute CO_2



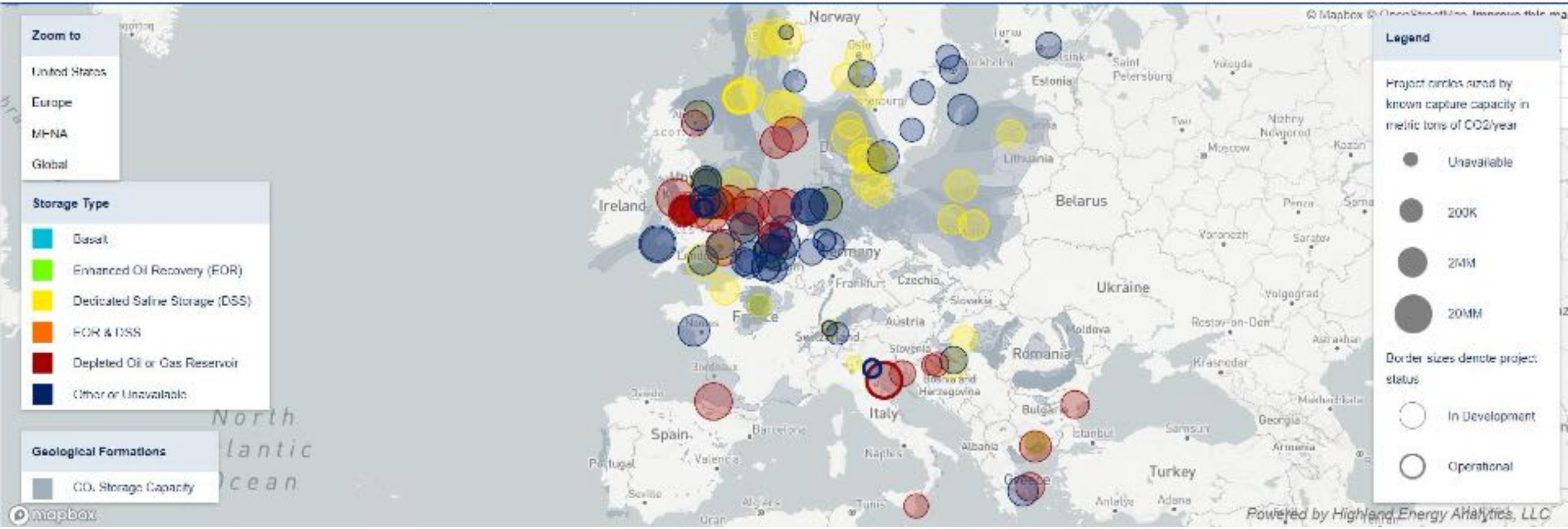
UKCCSRC - Carbon Capture & Storage (CCS) Carbon capture



A new era for CCUS – CCUS in Clean Energy Transitions – Analysis - IEA

Net-Zero Considerations

Carbon Capture, Storage (CCS) Projects



Europe Carbon Capture Project Map – Clean Air Task Force

Net-Zero Considerations

Carbon Capture, Storage (CCS) Projects transport type

Project Greensand, En route to deliver Danish CO2 storage capacity in the mid twenties: INEOS

Net-Zero Considerations

Carbon Capture, Storage (CCS) Project Stages

- Project Greensand, as the first in the world, has demonstrated that CO2 can be transported across national borders and stored offshore to mitigate climate change

2021-2023

Pilot Project
at Nini West

- CO_2 is captured at the INEOS Oxide factory in Belgium is transported in containers to the Nini West platform
- Injected through an existing well for permanent storage

[Hvad er Project Greensand | Project Greensand]

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2022-2025/2026

Full-Scale
at Nini West + main

- CO_2 is transported on specialized ships to Nini platform,
- New wells and pumping systems support higher capacity injection

Hvad er Project Greensand | Project Greensand

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2025/2026-2030

Expansion
Siri Fairway

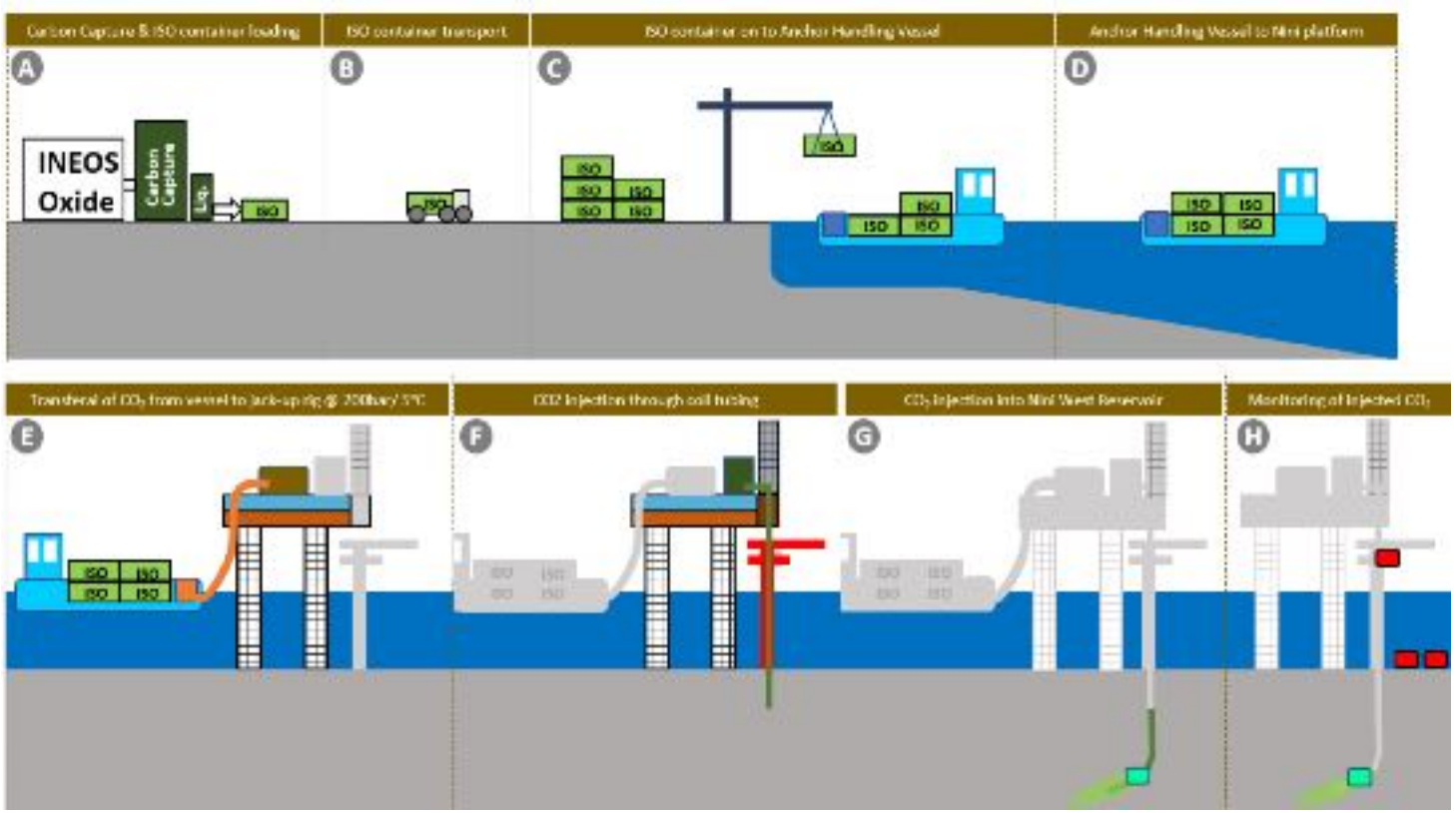
- Storage area extends to cover additional fields
- Storage capacity increases for long-term carbon sequestration capabilities

Hvad er Project Greensand | Project Greensand

Net-Zero Considerations

Carbon Capture, Storage (CCS) Project Stages

- Pilot: CO2 is capture at the Antwerp INEOS oxide site → CO2 is transported by ship to the north sea (800 tons per journey) → CO2 is injected and stored in the North Sea subsoil



energiforskning.dk Final report Greensand Phase 2.pdf

INEOS - The Chemical Engineer

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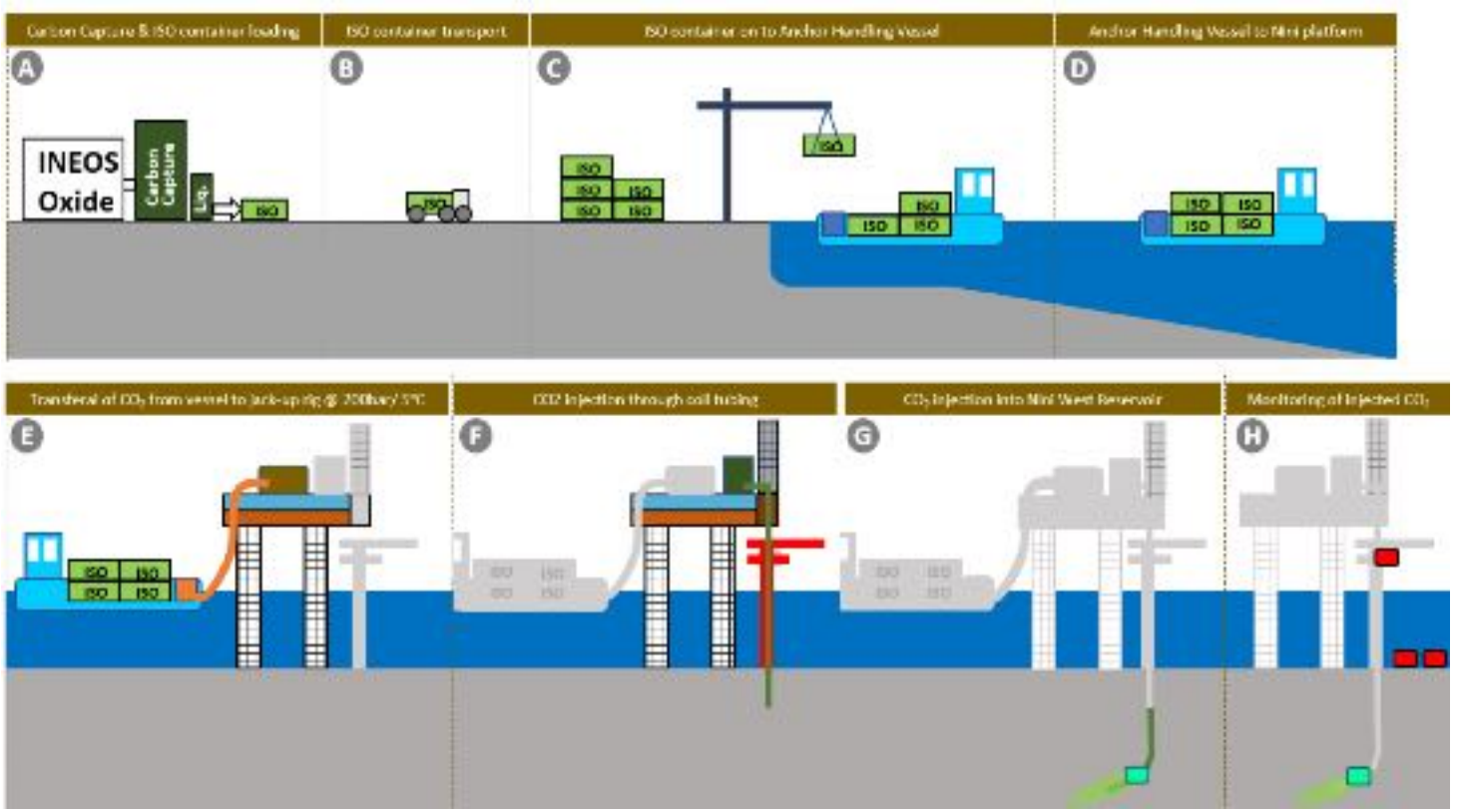

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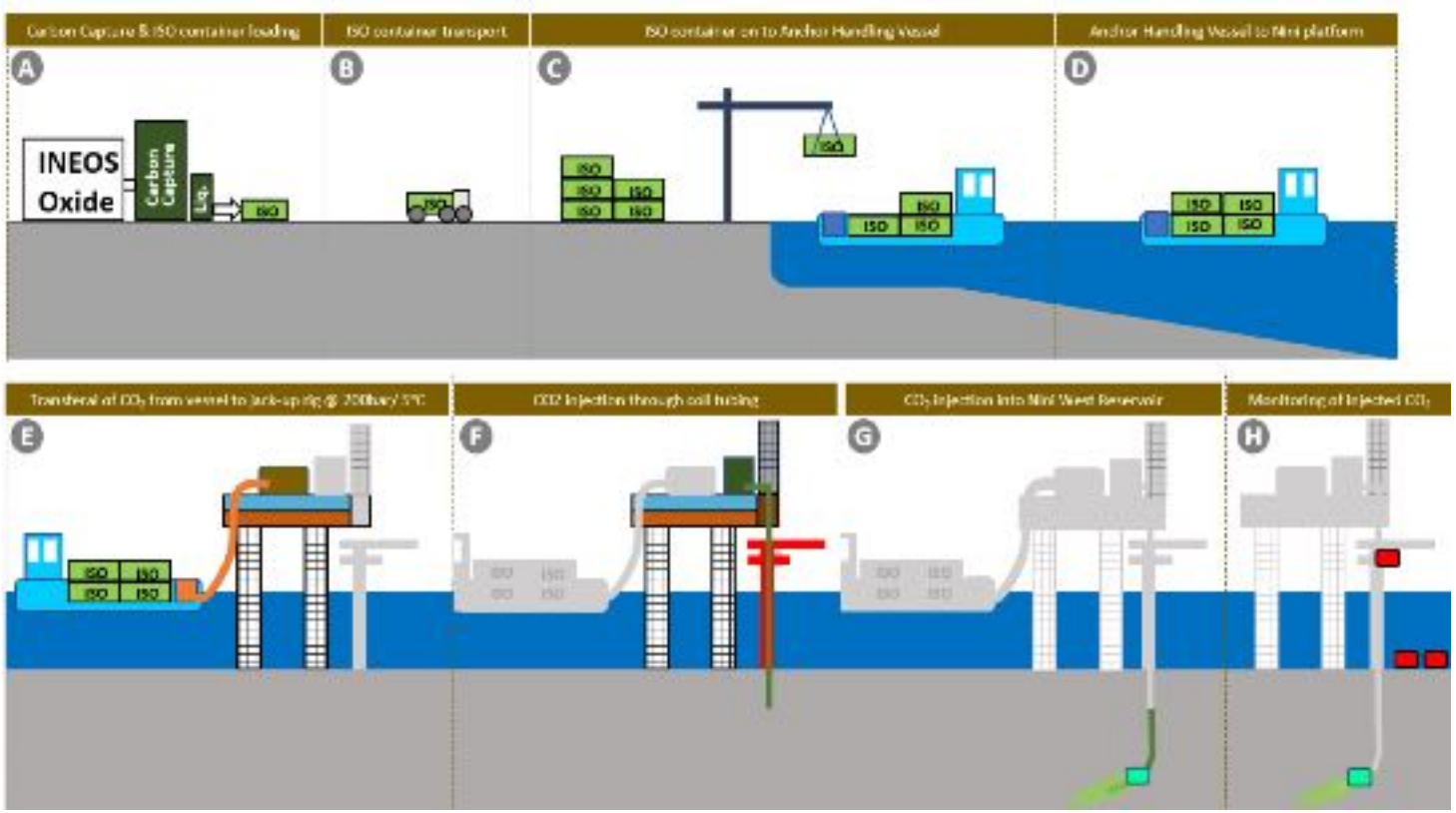

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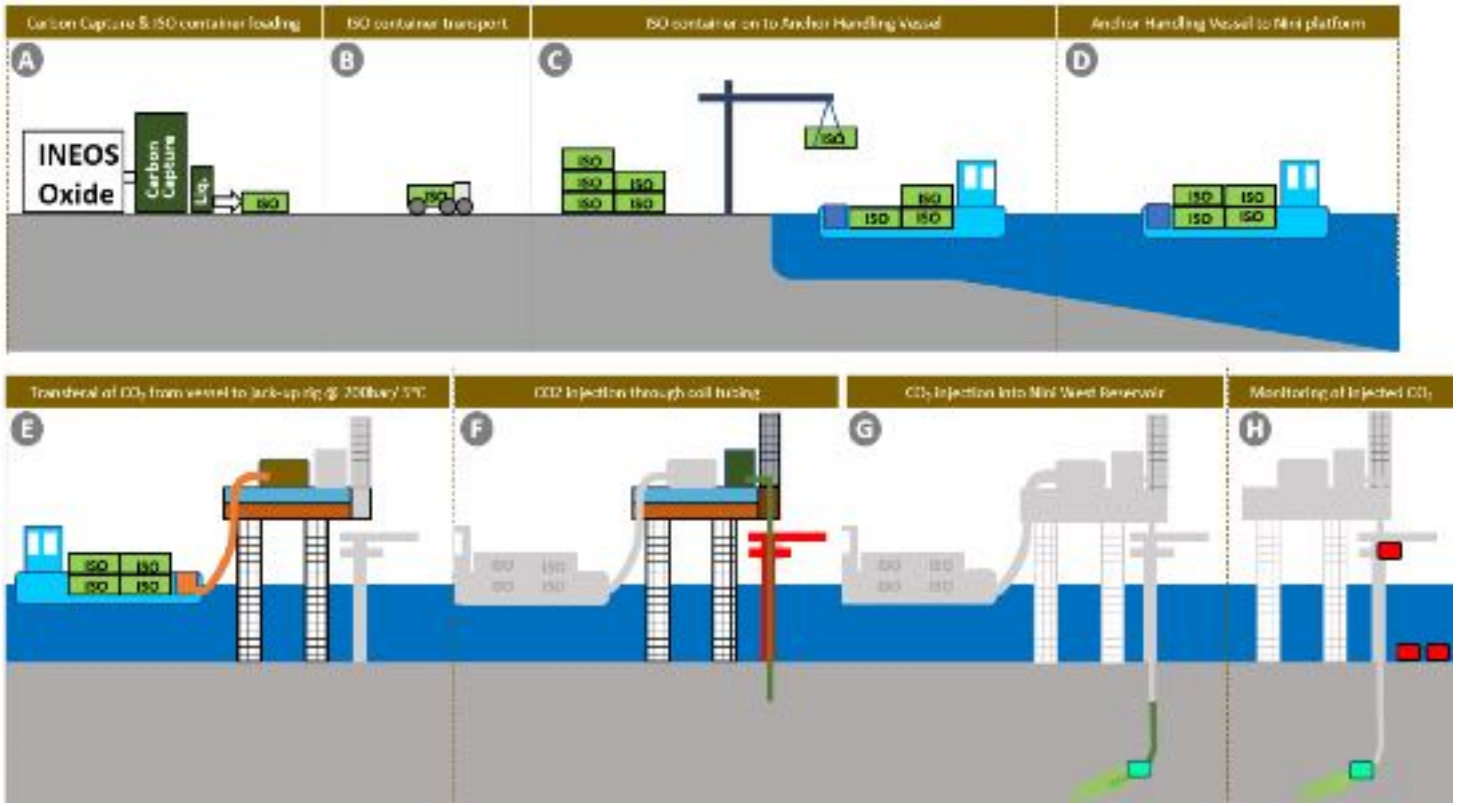


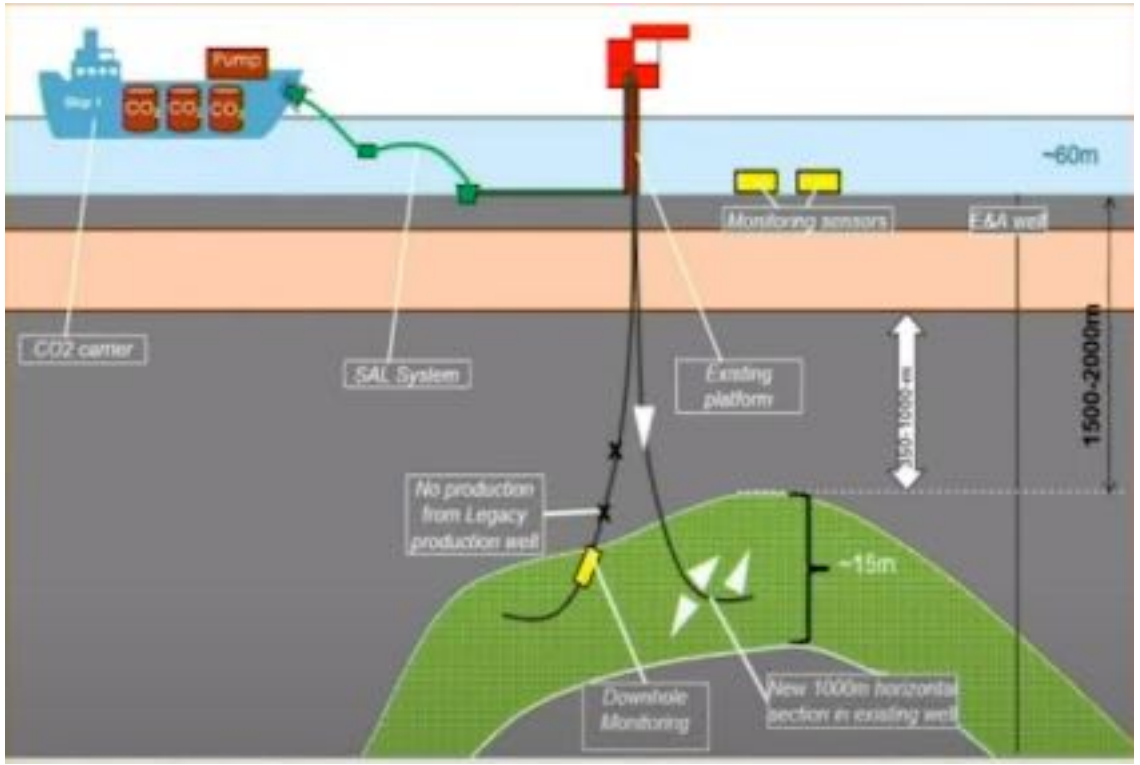
energiforskning.dk Final report Greensand Phase 2.pdf

Project Greensand heralds CCS breakthrough | CCS | gasworld

Net-Zero Considerations

Carbon Capture, Storage (CCS) Project Stages

- Full Scale: CO_2 is transported on specialized ships with higher capacity → transferred via a pumping system → injected into newly established CO_2 injection wells



Project Greensand, En route to deliver Danish CO2 storage capacity in the mid twenties: INEOS - YouTube

Video: Carbon Destroyer 1, EU's First CO2 Carrier for CCS is Launched

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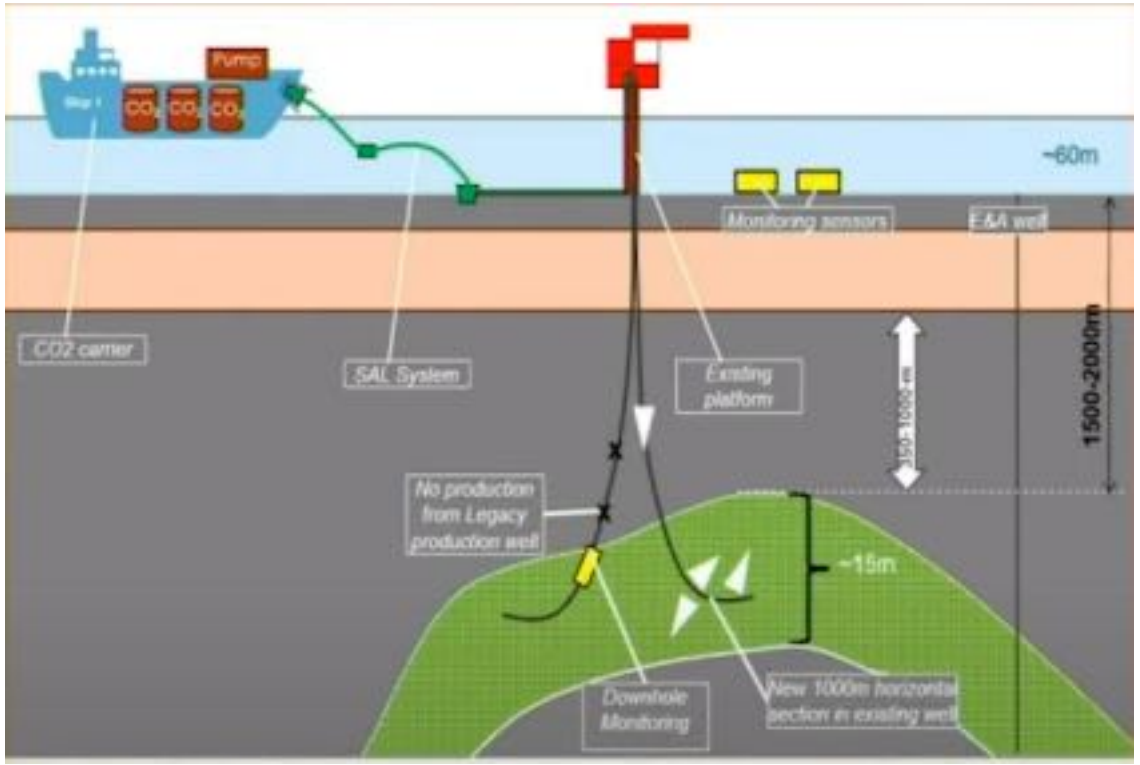
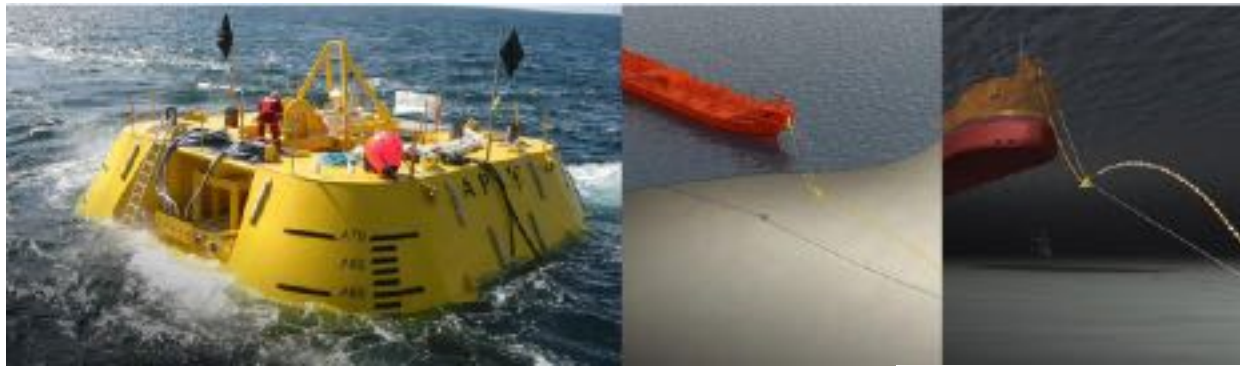
  → transferred via a pumping system → injected into newly established CO_2 injection wells



Project Greensand, En route to deliver Danish CO2 storage capacity in the mid twenties: INEOS - YouTube



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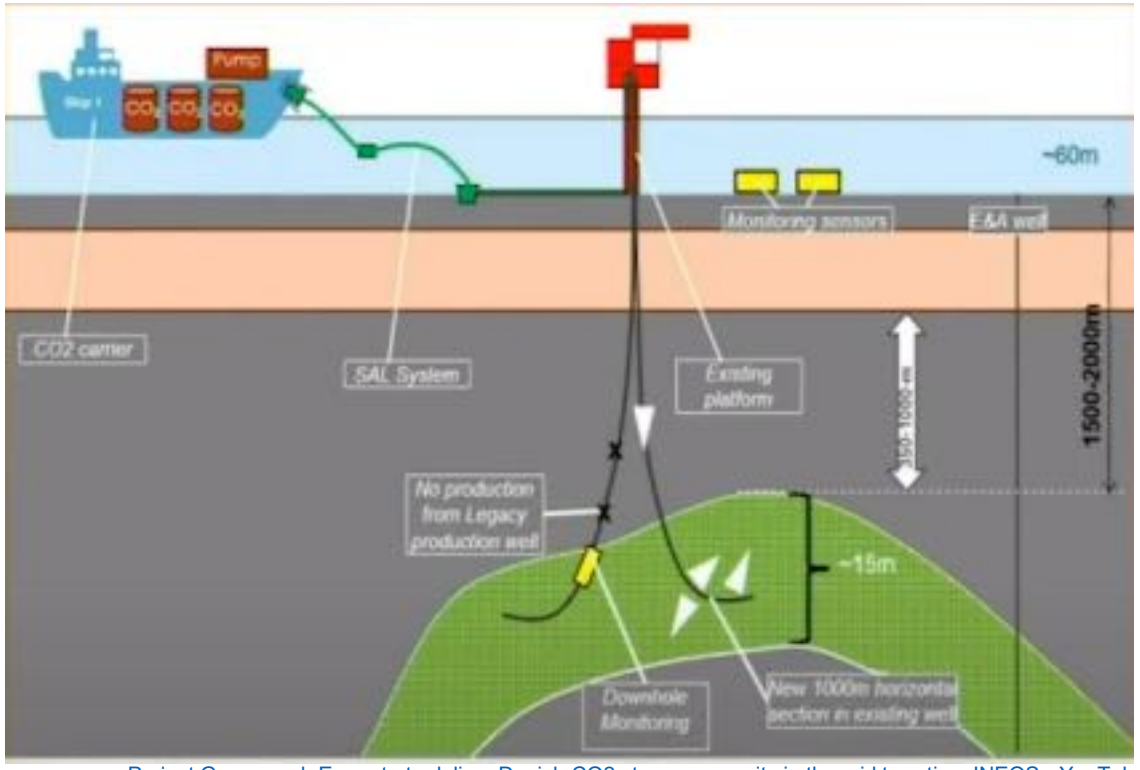
Net-Zero Considerations

Carbon Capture, Storage (CCS) Project Stages

- Full Scale: CO_2 is transported on specialized ships with higher capacity → transferred via a pumping system → injected into newly established CO_2 injection wells



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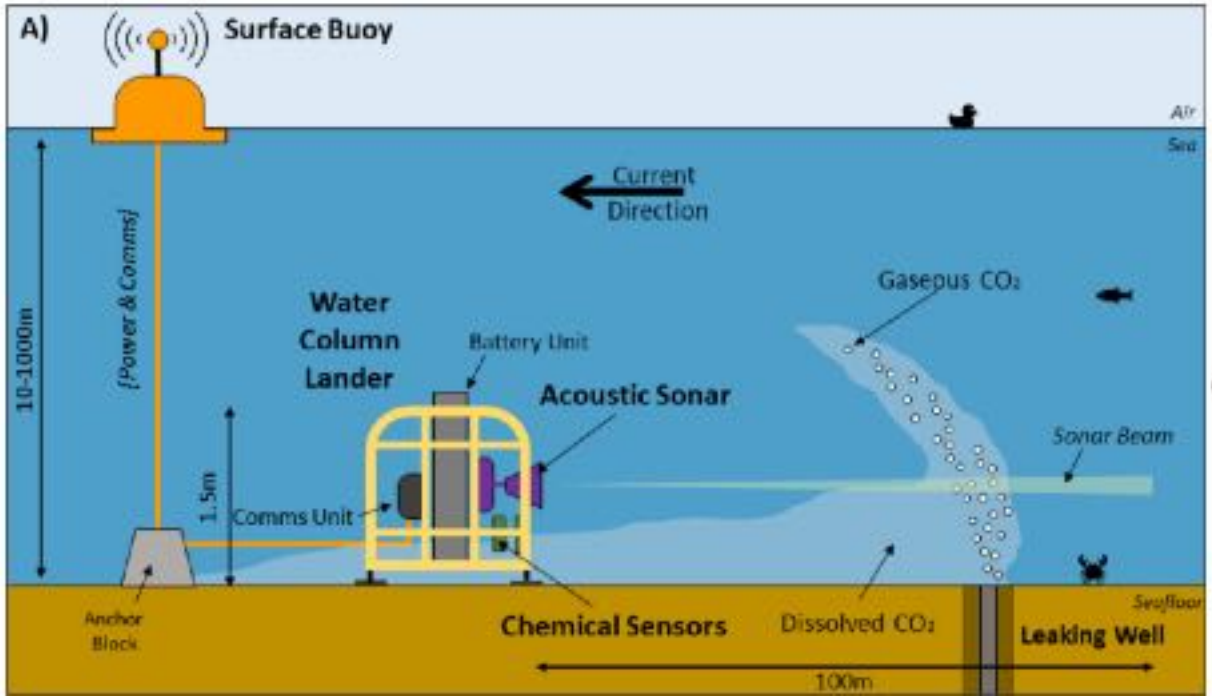

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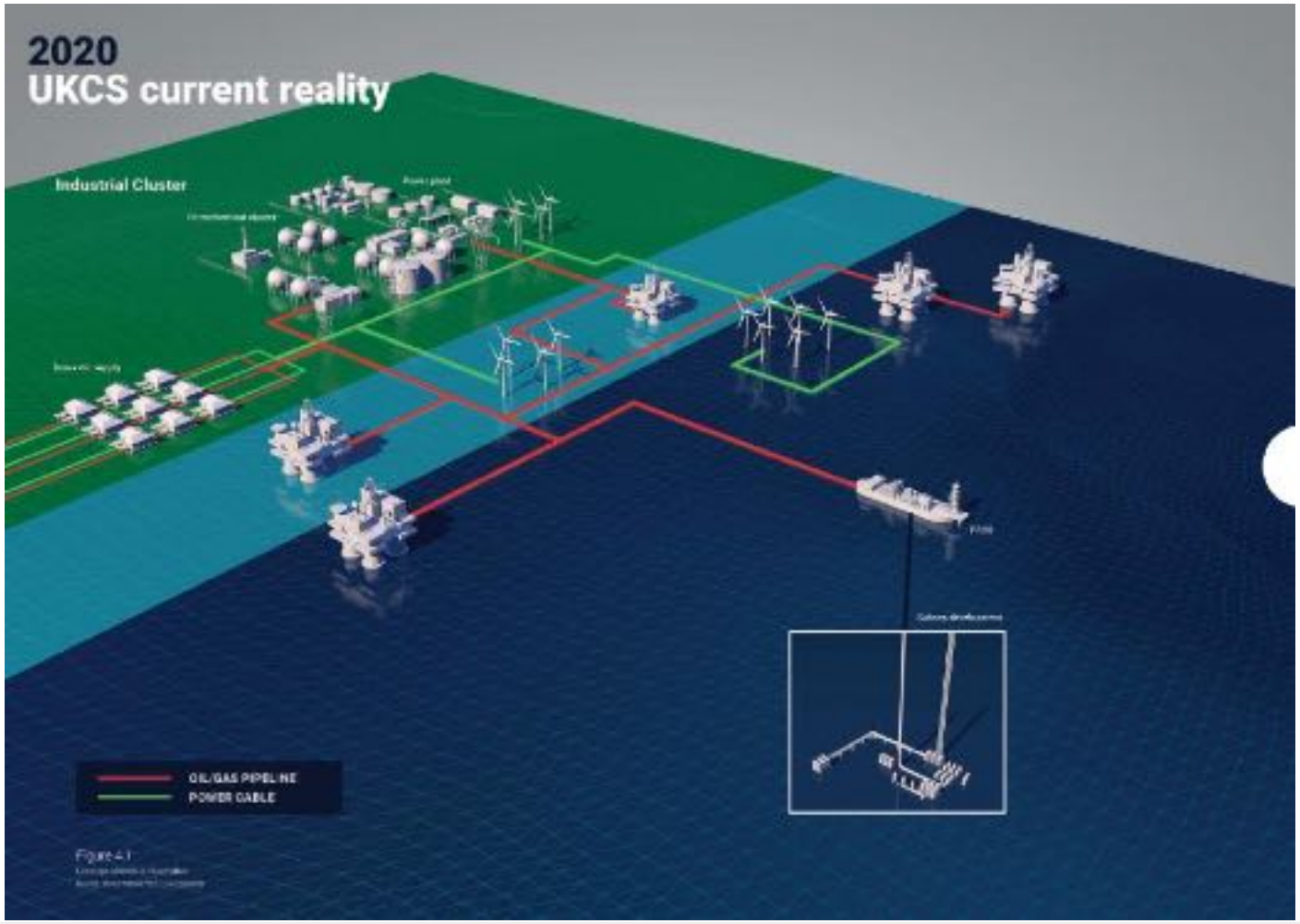
Net-Zero Considerations

Future Trends and Net Zero Roadmap



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Net-Zero Considerations

Future Trends and Net Zero Roadmap

Emerging Technologies:

- Hydrogen-ready facilities for blending natural gas with hydrogen
- Integration of renewable energy sources (wind,solar) to power operations

Digital Solutions:

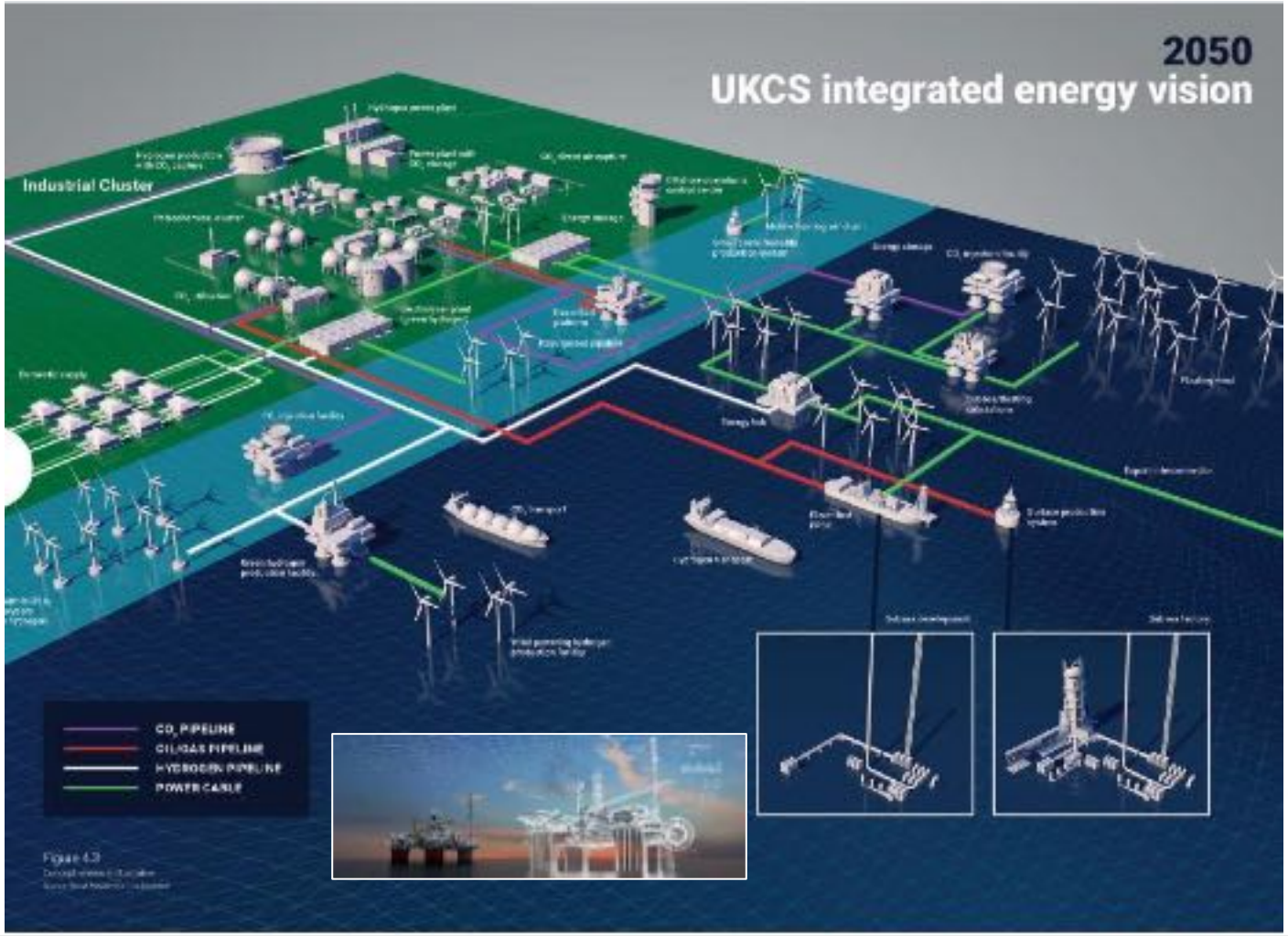
- AI for predictive maintenance and process optimization
- Digital twins for emissions modelling and tracking

Circular Economy Initiatives:

- Reuse of produced water and waste materials

Long-Term Goals:

- Full decarbonization of operations
- Collaboration across the industry for large-scale impact



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Thank you
Questions...?