Large Scale CCS infrastructure

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The Stella Maris CCS Project
Höegh LNG and Altera at a glance

**Alterna**

- **24** Shuttle Tankers
- **9** & **3** FPSO & FSO
- **10** Towing Vessels

- Industry leader and pioneer in harsh weather FPSOs
- Industry leader and market segment developer of Dynamically Positioned Shuttle Tankers
- 30+ years of experience

**Hoegh**

- **10** & **2** FSRU & LNGC

- Industry leader in the FSRU market
- 45+ years of gas handling experience
- Developend floating LNG import terminals worldwide
- Part owner & ship management of small LNG carrier fleet

Our collective competence and experience in these three industry segments makes us unique and puts us in a stellar position to lead our industry to a sustainable CCS future.
Offshore CO2 transport, injection and storage - FPSO, shuttle and FSRU business “in reverse”

Collection, Processing and Export

Transport and DP offloading

Offshore Injection and storage

O&G competence used to realize CCS
Stella Maris – Think Big

To get CCS costs down, large scale flexible solutions are required!

10 Mt CO₂/year
Infrastructure will include:

• Carbon Collection Storage Offloading units (2-3) to be located at key location(s) as export hubs
  Capable of receiving various grades of CO₂ from multiple emitters
• A fleet of large CO₂ shuttle carriers (3-4)
  50,000 m³ – low pressure tanks
• Offloading and continuous injection of CO₂ offshore
• Zero emission capable
• Scalable Worldwide – design one – build many
• Solution deployed for large scale emitters, clusters and/or nation states in 2025
• One stop-shop from collection to storage
• Cooperate close with industry and policy makers nationally and internationally
And for the Engineers in the audience

This is how the assets looks on the drawing board.

HUB

Transport

Injection
Opportunities for large scale CCS in UK

Utilizing Maritime solutions can:

• Increase resilience of UK Pipeline based projects.
• UKCS has a competitive advantage for receipt of international CO2 volumes.
• Cost effective enabler for emitters outside the scope of current cluster developments.
• Rapidly accelerate CCS capability
What is needed?

Development of business models that accommodate maritime (NPT) solutions.

Clarity around the Regulatory Framework for licensing of storage sites.

Early commitment to international agreements facilitating cross border transportation and storage.

Access rights to cluster infrastructure.
The CCS industry challenge is best solved in partnership

During the next year we will:

• finalize technical concept for the Stella Maris logistical solution
• establish cooperation & partnerships to deliver Stella Maris
• market our solution to individual companies, industry clusters and national authorities
• Become a one-shop-stop provider of a competitive and cost-efficient CO₂ solution from collection to storage.
The Stella Maris Project
Detailed Overview of Stella Maris
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<th>Barriers</th>
<th>Proposed Solution</th>
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<td>High cost of capturing and conditioning for emitters</td>
<td>Centralizing conditioning of CO2 in a Carbon Collection Storage and Offloading (CCSO) hub – More flexibility on-site capture design</td>
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<td>High logistics costs</td>
<td>Hub and spoke approach – collecting smaller volumes, and gathering and conditioning for large scale transfer to offshore reservoir</td>
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<td>High cost of land use (regional variance), and size restriction of large vessels in various ports</td>
<td>CCSO Hub can be floating</td>
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<td>Availability, cost and capacity of pipeline infrastructure</td>
<td>Maritime transport</td>
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<td>CO2 Transport condition in large quantities</td>
<td>Low pressure CO2 tanks</td>
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<td>Maintaining continuous reservoir injection</td>
<td>Offshore intermediate buffer storage by optimising use of the CO2 carriers.</td>
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**Carbon Capture, Storage and Offloading Unit (CCSO)**

Typical CCSO
Moored at jetty/quay or in protected area
50-80k cbm storage
(size adaptable to need/site)
Annual capacity 3 – 7 mt/unit
Designed for shore power

**Collection, Processing and Export**

- **High- & low-pressure gas from pipelines**
- **Medium & low-pressure liquid from trucks, rail, ships, barge**
- **Various qualities with different levels of impurity**

**Principal Dimensions (80k cbm design):**
- Length o.a.: 220m
- Breath (M): 58m
- Depth (M): 24.5m
- Design Draft: 13m
CO2 Shuttle Carriers

- New, state of the art CO2 shuttle carrier design
- 50,000 cbm - low pressure tanks
- CO2 stored and transported as liquid at 6.5 barg & -47°C
- Zero emission capable
- Electric Power distribution
- Battery hybrid installation
- LNG/Bio gas as fuel (base case)

Optional:
- Size to meet needs
- Direct injection capability

Principal dimensions:
- Length o.a.: 238m
- Breadth (M): 38m
- Depth (M): 22m
- Design draft: 13m
- Cargo cap: 50k cbm

Key Innovations
- Low pressure CO2 tanks
- Dynamically positioned CO2 carrier
- Equipment for offshore loading of CO2
- Power Source for injection unit
Floating Injection Unit (FIU)

- Allows continuous injection
- Heating and injection modules below deck
- Power from Shuttle carrier (+ battery back-up)
- Unmanned and operations from shore, communication via shuttle carrier
- CO2 heated and injected into reservoir in dense phase (>5°C & 65-160 barg)

**Principal dimensions:**
- Hull Diameter: 50m
- Bilge Box diameter: 62m
- Main Deck diameter: 50m
- Hull Depth: 22m
- Design draft: 13m
- Draft loaded: 14m

**Alternatives:**
- Injection facilities on an existing offshore installation or on new fixed offshore structure
- Direct injection from shuttle carrier

**Key Innovations**
- Power from CO2 Shuttle Carrier
- Normally Unmanned
- Equipment for offshore loading
- Zero emission capable
Several models possible with different services and collection/transfer points

Flexible model with different collection/transfer points (---)

Carbon capture offered by Stella Maris jointly with CC technology/EPC company

Carbon capture solution arranged by emitter

Stella Maris’ CCSOs

Fleet of CO₂ shuttling vessels: between export hubs – injection site

Carbon capture solution arranged by emitter

Independent tank farms

CO₂ injection and storage in saline reservoir