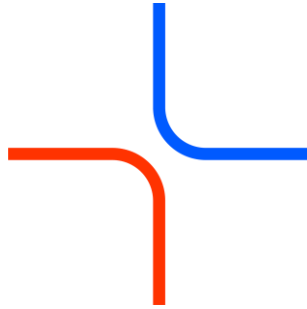


Large Scale CCS infrastructure

Westminster Energy Forum – December 7th 2021

Christian Fjell
Director, Sustainability – Altera Infrastructure



**The
Stella Maris CCS
Project**

Höegh LNG and Altera at a glance

Altera

24

Shuttle
Tankers

9

FPSO

&

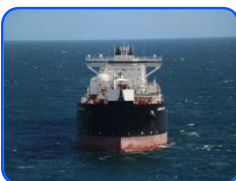
3

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



Höegh

10

FSRU

&

2

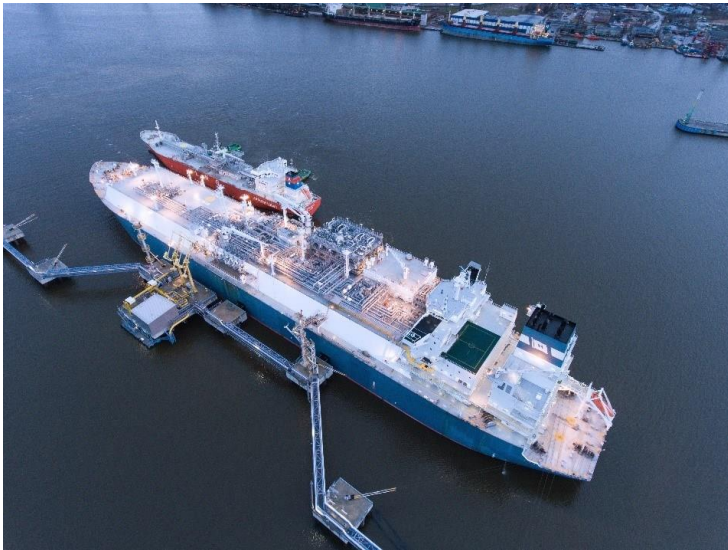
LNGC



- Industry leader in the FSRU market
- 45+ years of gas handling experience
- Developend floating LNG import terminals worldwide
- Part owner & ship managmmnt 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 000m³ – 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

Infrastructure/ownership



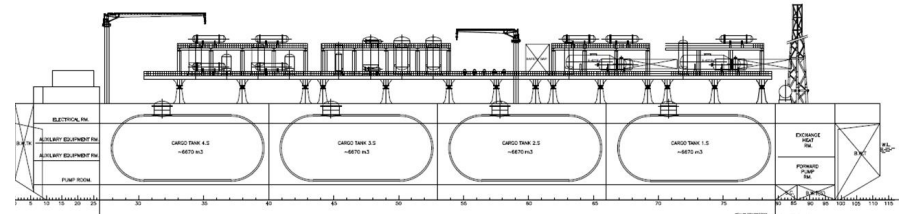
Industrial partners



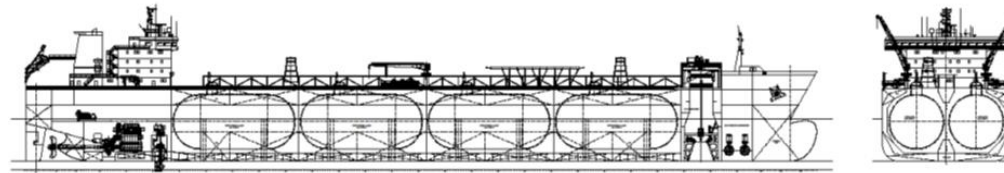
And for the Engineers in the audience

This is how the assets looks on the drawing board.

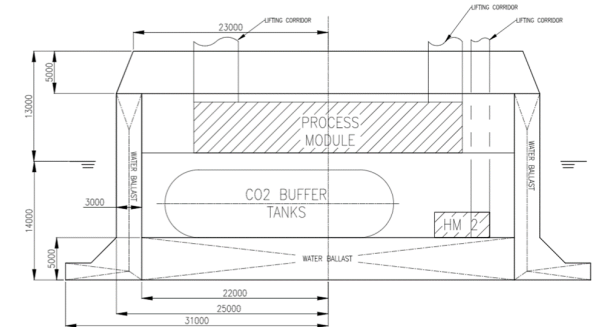
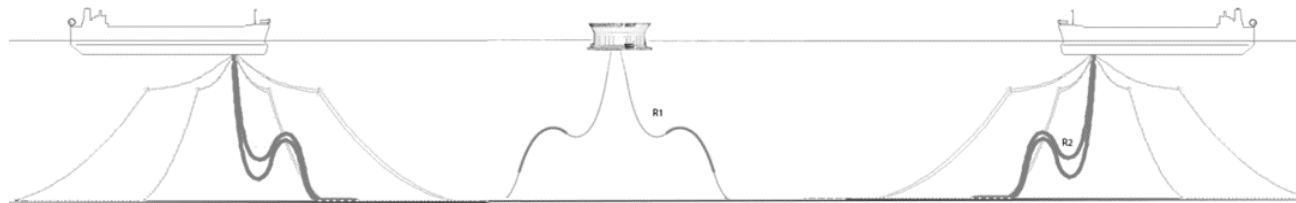
HUB



Transport



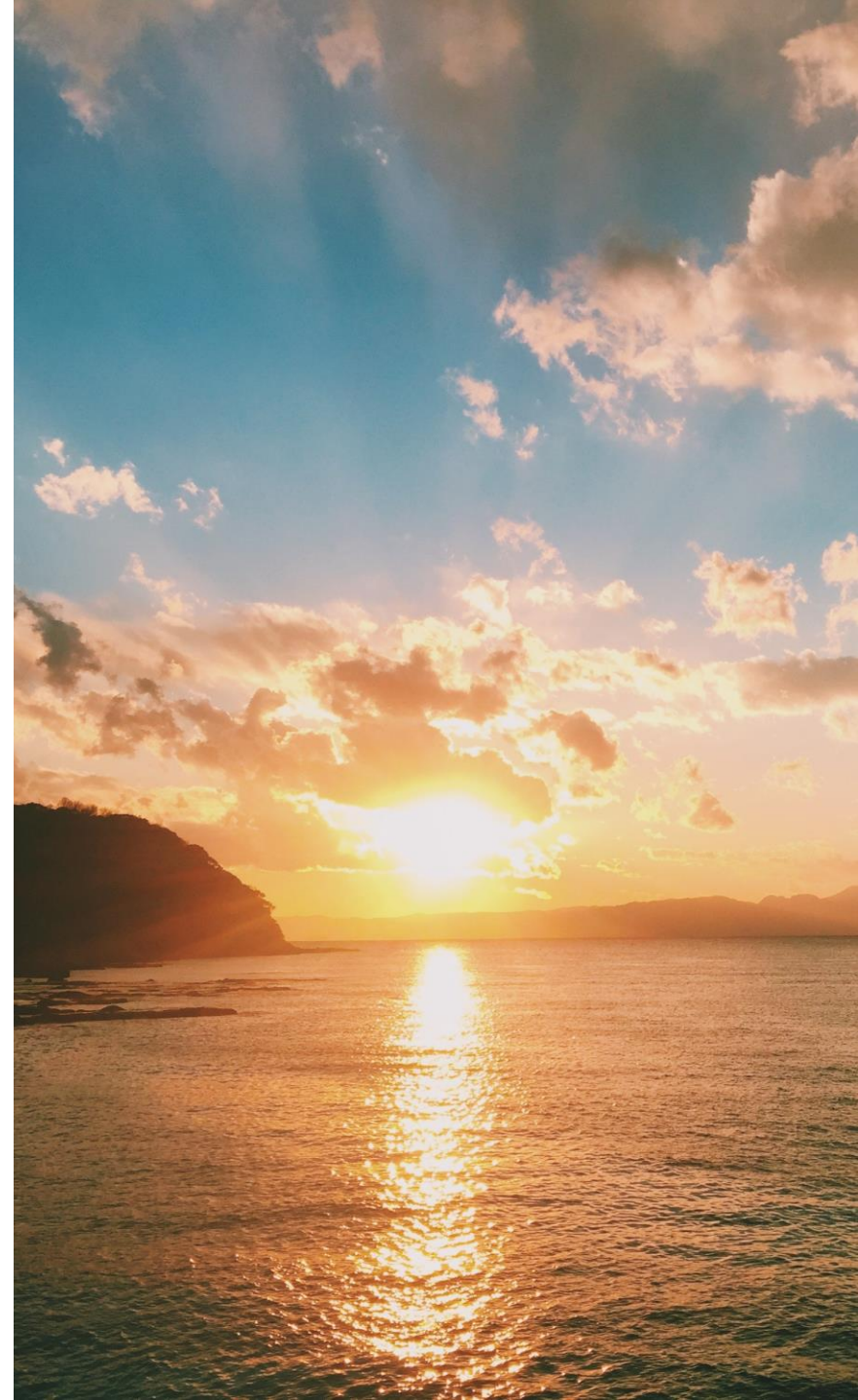
Injection



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.

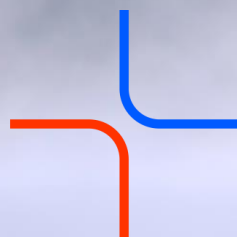


Stella Maris – Large Scale, Flexible, Scalable Maritime CO₂ Logistics Solution

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.



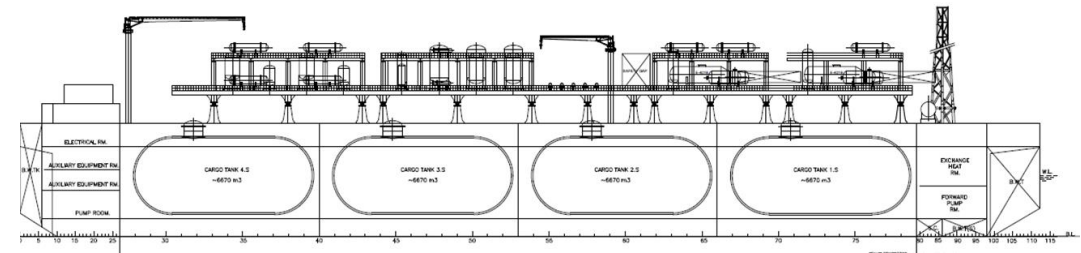
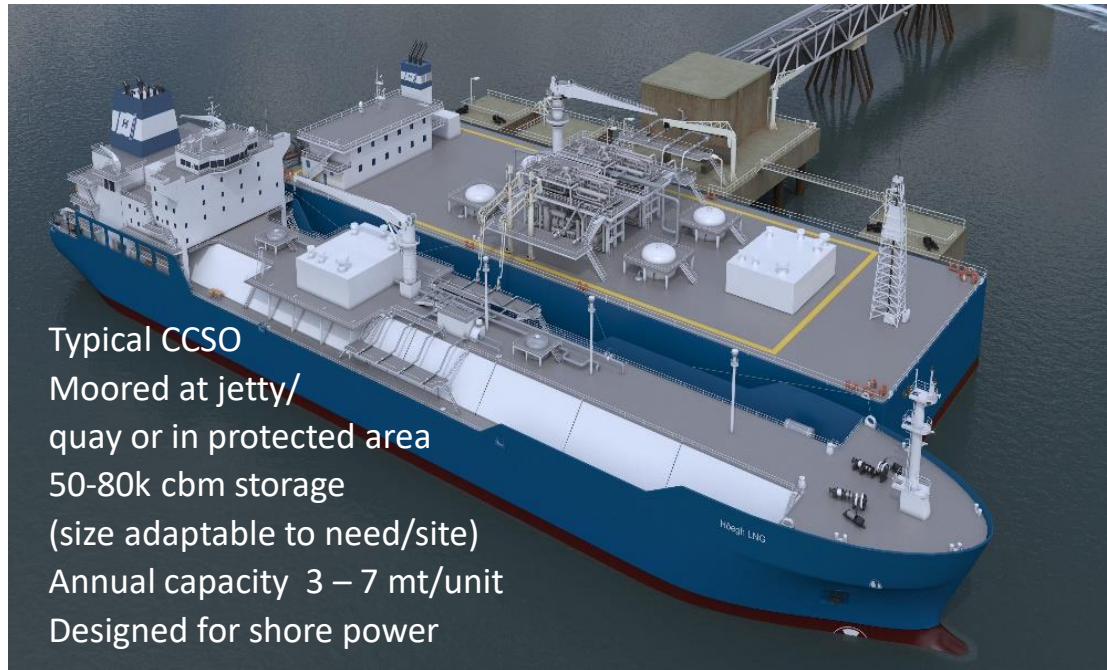
**The
Stella Maris
Project**

Detailed Overview of Stella Maris

Barriers for realizing large scale CCS

Barriers	Proposed Solution
High cost of capturing and conditioning for emitters	Centralizing conditioning of CO2 in a Carbon Collection Storage and Offloading (CCSO) hub – More flexibility on-site capture design
High logistics costs	Hub and spoke approach – collecting smaller volumes, and gathering and conditioning for large scale transfer to offshore reservoir
High cost of land use (regional variance), and size restriction of large vessels in various ports	CCSO Hub can be floating
Availability, cost and capacity of pipeline infrastructure	Maritime transport
CO2 Transport condition in large quantities	Low pressure CO2 tanks
Maintaining continuous reservoir injection	Offshore intermediate buffer storage by optimising use of the CO2 carriers.

Carbon Capture, Storage and Offloading Unit (CCSO)



Designed to receive and process:



High- & low-pressure gas from pipelines



Medium & low-pressure liquid from trucks, rail, ships, barge

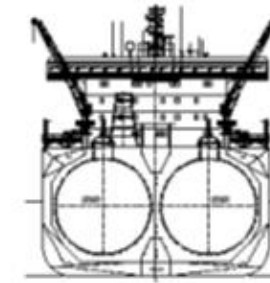
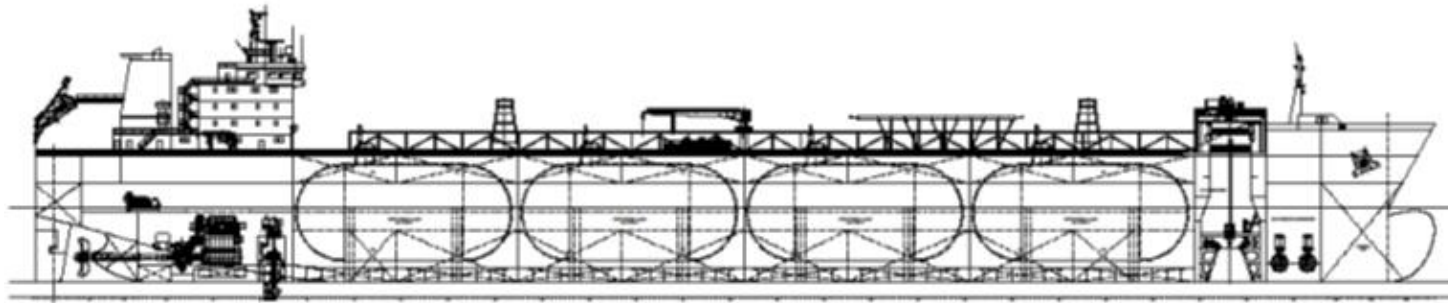


Various qualities with different levels of impurity

Principal Dimensions (80k cbm design):

Length o.a.	220m
Breath (M)	58m
Depth (M)	24,5m
Design Draft	13m

CO2 Shuttle Carriers



Principal dimensions:

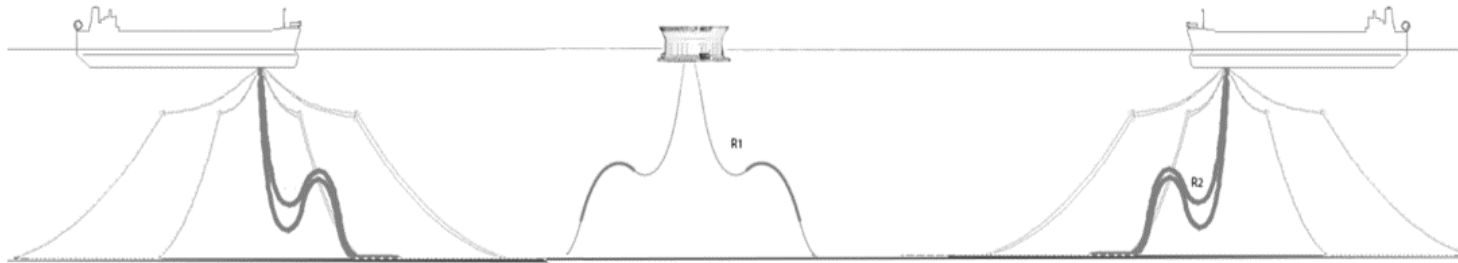
Length o.a:	238m
Breadth (M):	38m
Depth (M):	22m
Design draft:	13m
Cargo cap:	50k cbm

- 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

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)



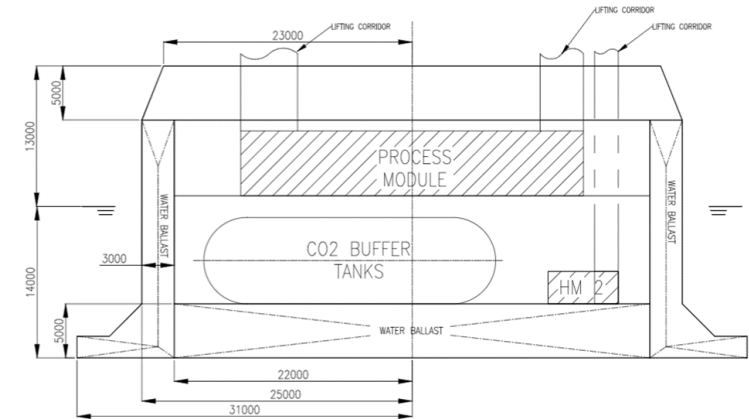
- Allows continuous injection
- Heating and injection modules below deck
- Power from Shuttle carrier (+ battery back-up)
- Unmanned and operations from shore, communication via shuttle carrier
- CO₂ heated and injected into reservoir in dense phase (>5°C & 65 -160 barg)

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 of CO₂
- Zero emission capable

Several models possible with different services and collection/transfer points

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

