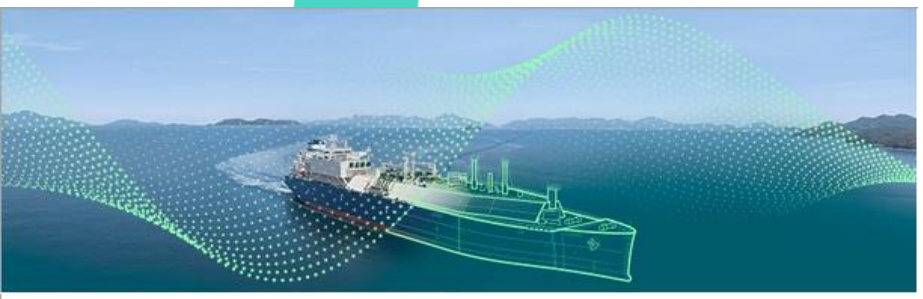
Autonomy and Electrification in Shipping – The MOSES project



DNV Research & Development Forum

Konstantinos Louzis,

PhD Candidate, NTUA

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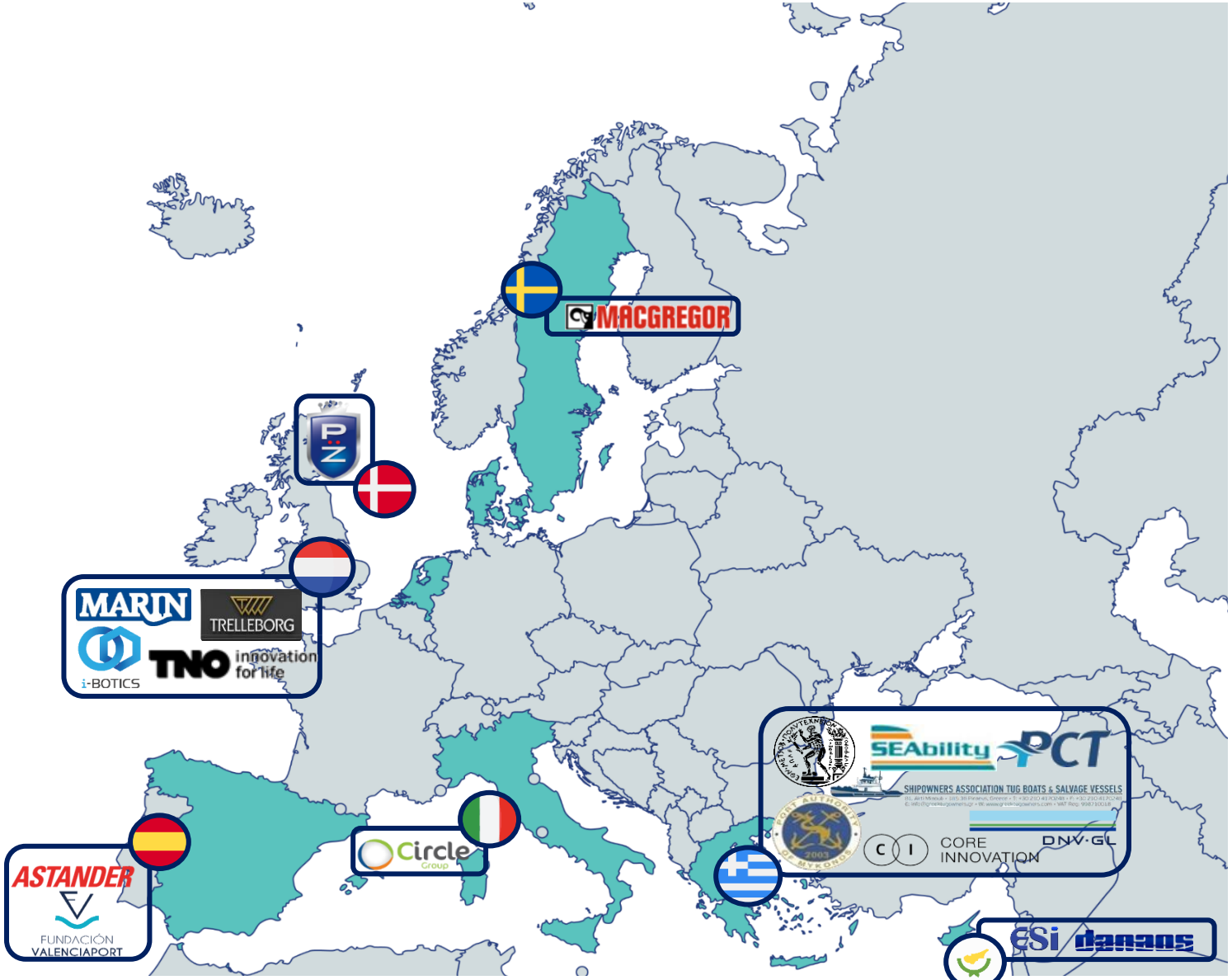
Facts about the MOSES project

- **Project Title:** AutoMated Vessels and Supply Chain Optimisation for Sustainable Short SEa Shipping
- **Duration:** 01.07.2020 - 30.06.2023 (36 months) – *to be extended*
- **Budget:** 8 million €
- **Consortium:** 17 Partners



Modal shift from road transportation

	Target from road to other transport modes [billion tkm]	Achieved [billion tkm]
I (2003 – 2006)	48	21.9 overall (**46%**)
II (2007 – 2013)	143.5	41.9 overall, **35.3% (maritime)**

(Takman and Gonzalez, 2021)

Transport by inland waterways and short sea shipping will increase by 25% **by 2030**.

(EU Mobility Strategy, 2019)

Ports close to hub ports "*often lose with direct land transport*" (Kotowska, 2014)

Delays in liners → delayed feeder service → delayed delivery (Kotowska, 2014)

Capacity utilization → Increased costs for transporting small amounts of cargo by sea

Change in transport means → Administrative burden → Increased transportation costs (Perez-Mesa et al., 2012)

Ambition of the MOSES project

Significantly **enhance the SSS component** of the European container supply chain!

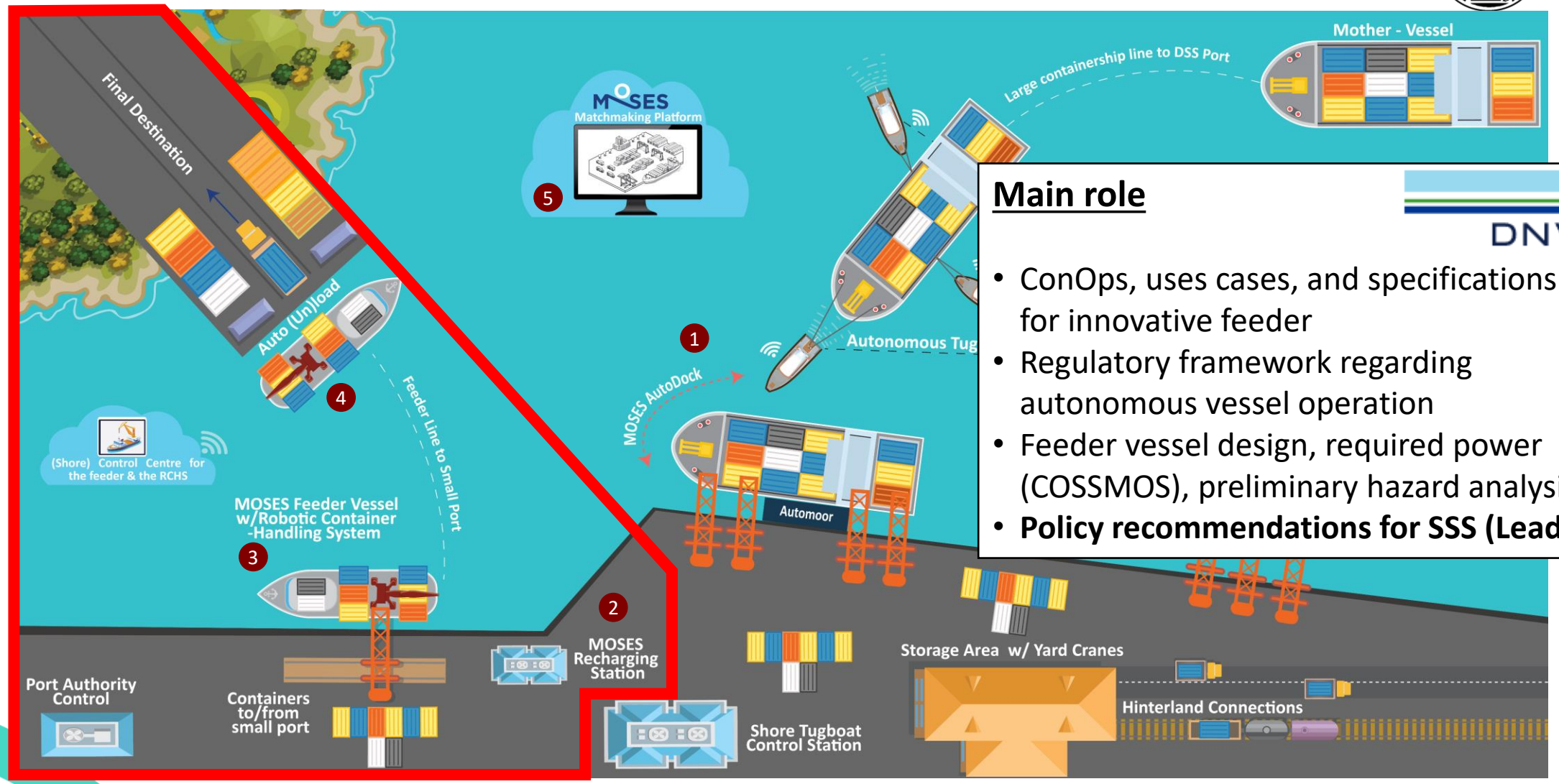
sustainable feeder services

5% Minimum decrease of end-to-end costs for container transport with feeder services

15% Increase of feeder traffic between large terminals and small ports

10% Modal shift to Short Sea Shipping in designated areas

The MOSES Concept



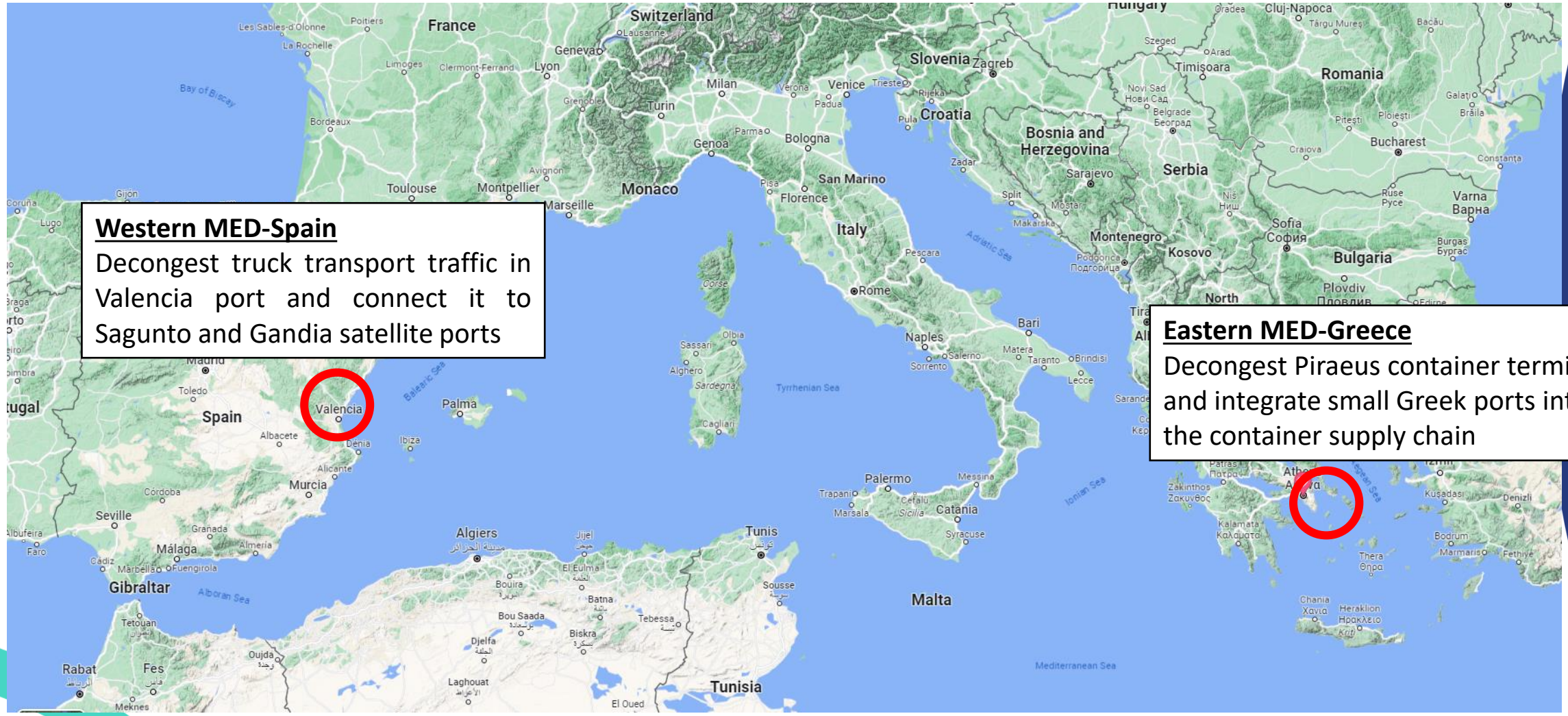
Main role

- ConOps, uses cases, and specifications for innovative feeder
- Regulatory framework regarding autonomous vessel operation
- Feeder vessel design, required power (COSSMOS), preliminary hazard analysis
- **Policy recommendations for SSS (Lead)**

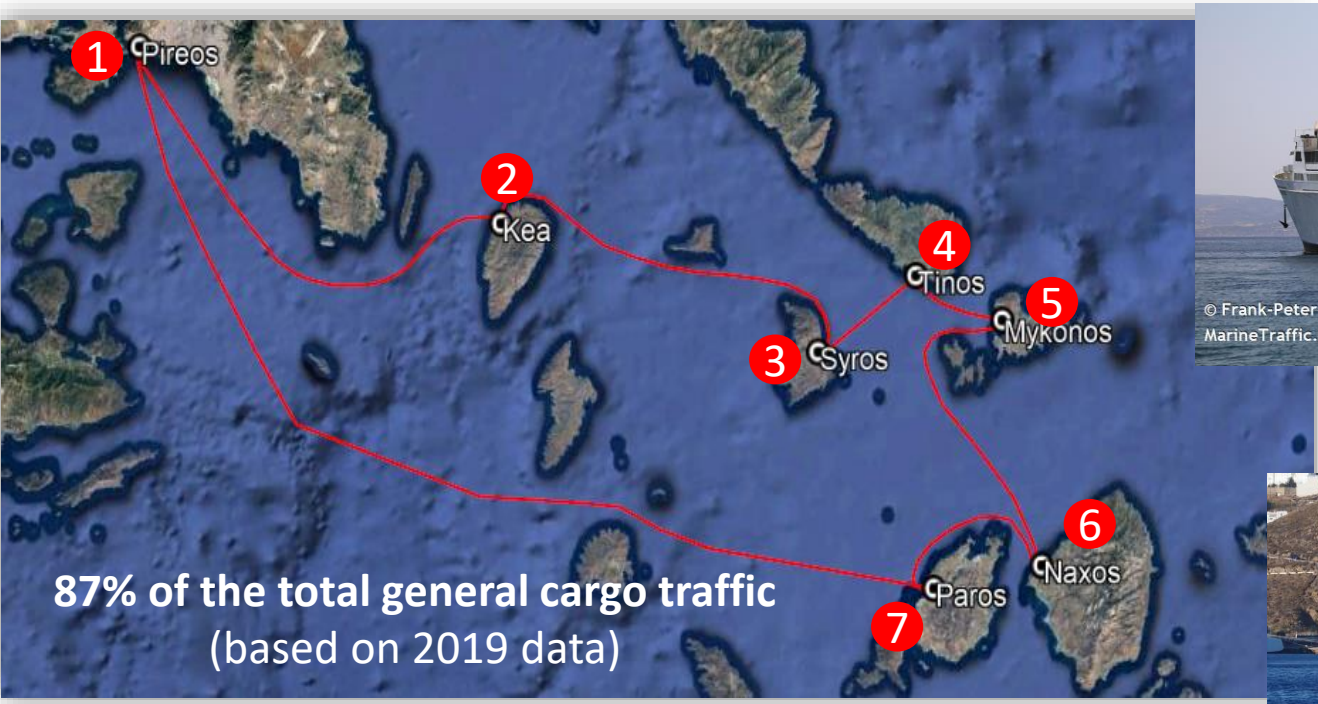
MOSES Innovations:

1. MOSES AutoDock (MOSES Autonomous tugboats + AutoMoor)
2. MOSES Recharging Station
3. Innovative Feeder Vessel
4. Robotic container-handling system
5. MOSES matchmaking platform

The MOSES Use Cases



“Eastern MED-Greece” use case



The feeder would be competitive (i.e. **-3.5% cost / cargo unit**) IF:

- **80% of the maximum estimated demand** is captured.
- At least **two weekly services** in each port.
- Capacity between **100 - 200 TEUs** (40% and 80% captured demand respectively).

Innovative Feeder – Technical characteristics

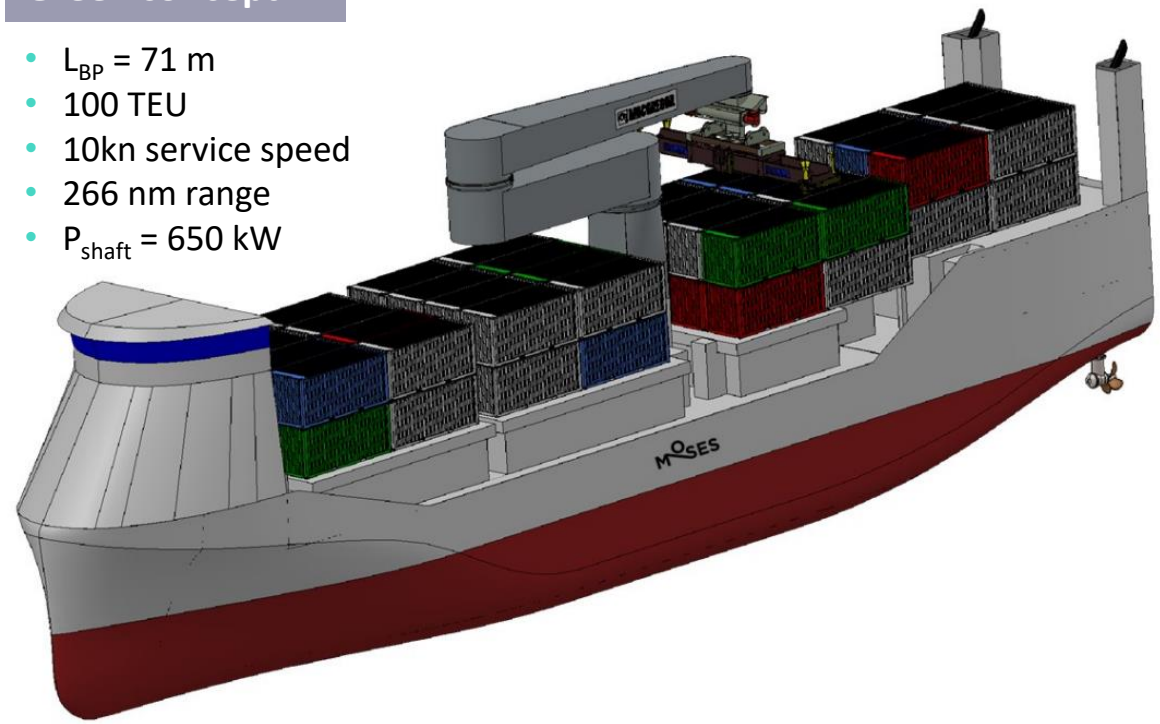
Greek concept I

- L_{BP} = 80 m
- 180 TEU
- 10 kn service speed
- 266 nm range
- P_{shaft} = 800 kW

Available power for safe navigation in adverse weather conditions was **verified through simulations** (based on 2011 – 2016 weather data)

Greek concept II

- L_{BP} = 71 m
- 100 TEU
- 10kn service speed
- 266 nm range
- P_{shaft} = 650 kW



<u>Innovations</u>:

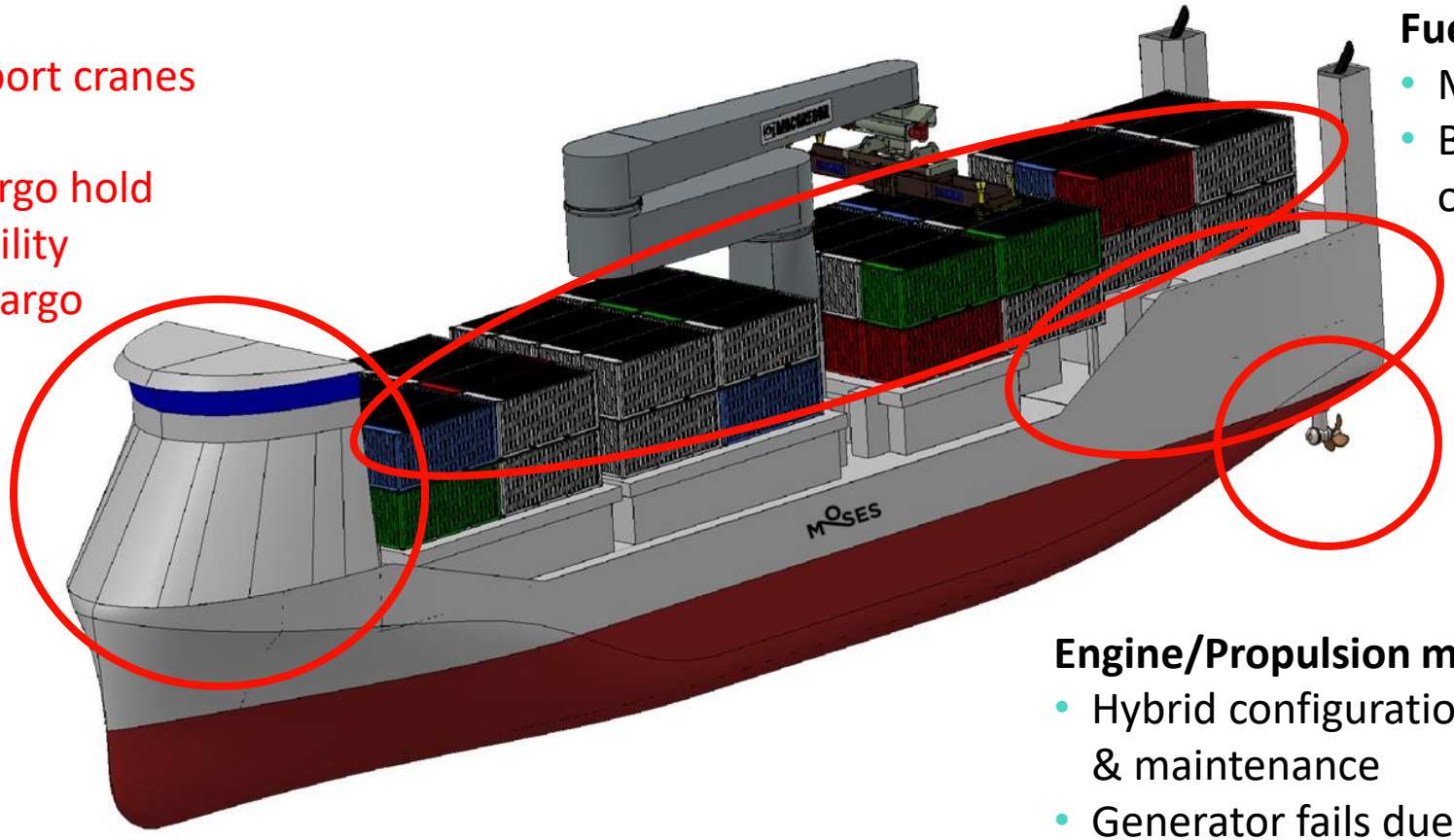
- Sustainable propulsion (Hybrid methanol ICE + batteries, Full electric)
- Azimuth thrusters for enhanced manoeuvrability
- Automated cargo-handling, *as first step towards higher autonomy*

Innovative Feeder – Preliminary Hazard Analysis

9 High risk events / system component

Cargo space:
- Onboard crane impedes port cranes → Slower cargo handling
- Water accumulation in cargo hold (open top design) → Stability degradation, damage to cargo

Accommodation:
- Mustering process takes too long
- Limited visual monitoring of the cargo space → Fire, cargo shift/loss not detected

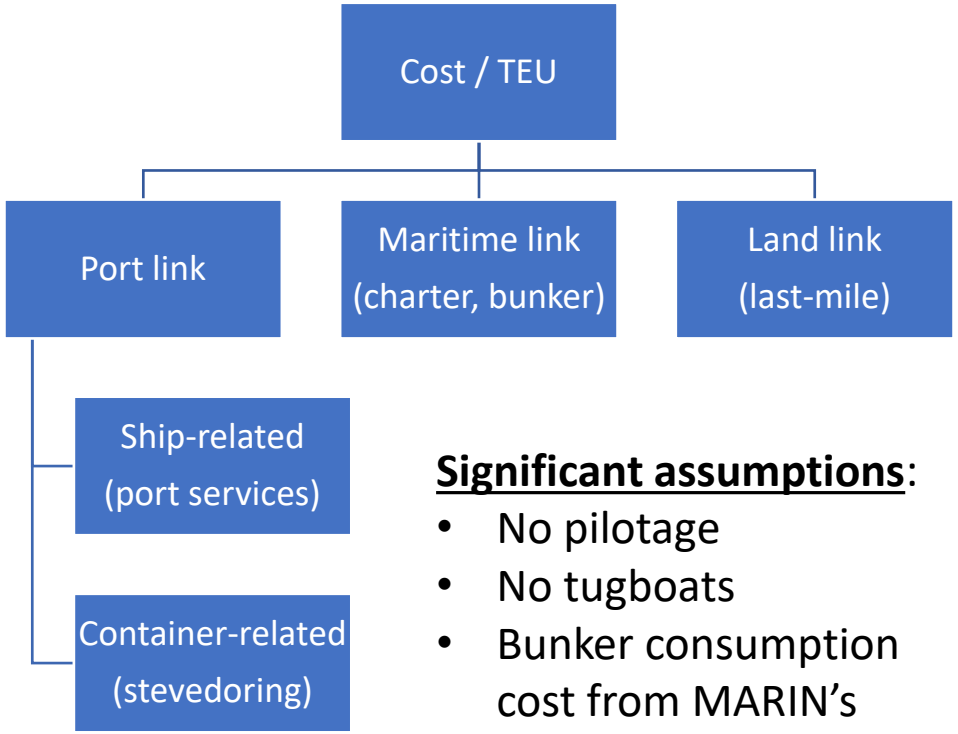


Fuel/Energy storage:
- Methanol leakage
- Batteries overheating

Engine/Propulsion machinery:
- Hybrid configuration operation & maintenance
- Generator fails due to load variations in extreme weather
- Design speed too specific

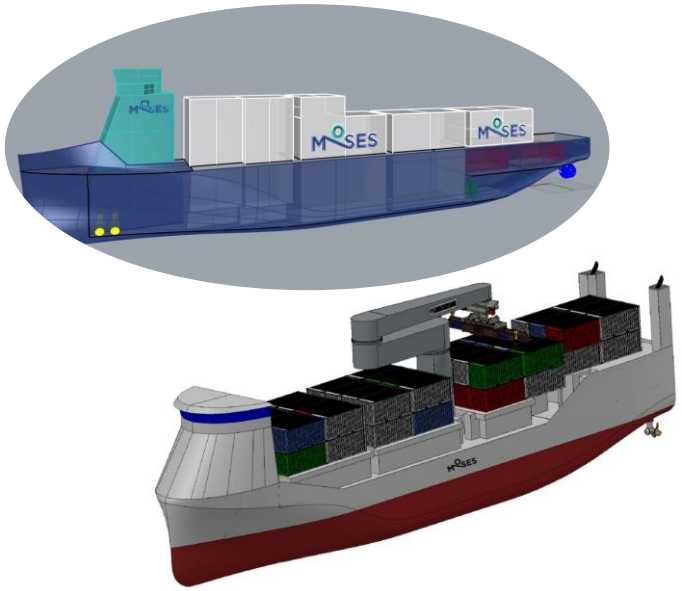
*** Hazards apply to both concept designs**

Innovative Feeder – Operational Costs



Significant assumptions:

- No pilotage
- No tugboats
- Bunker consumption cost from MARIN's SPEC tool

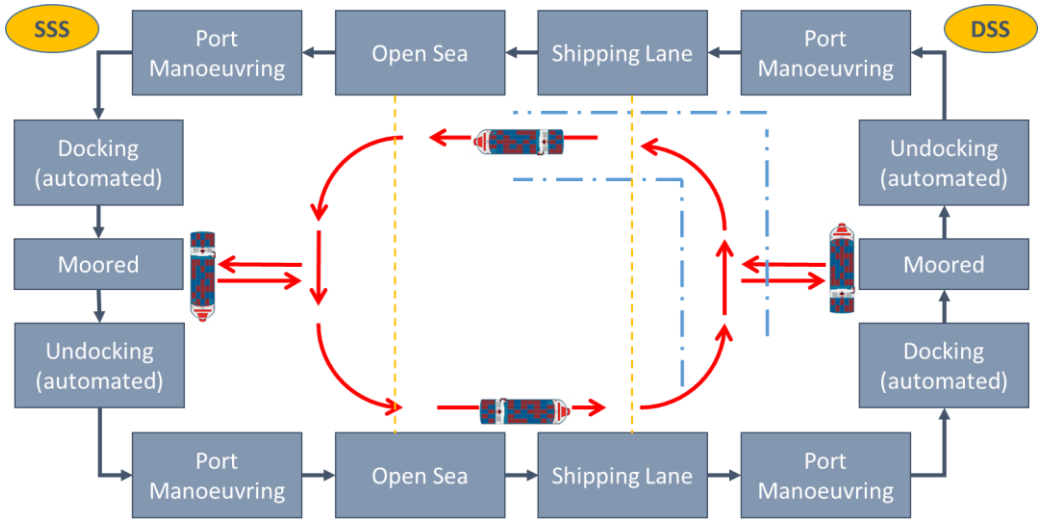


End-to-End cost

13% - 14% > Conventional

- Higher prices of the selected **energy carrier**
- Not accounting for possible **crew reduction onboard** due to automated functionalities

Innovative Feeder – Autonomous round-trip simulation



Fully autonomous round-trip by integrating different vessel control models:

- way-point/track following,
- Dynamic Positioning (DP) while manoeuvring,
- docking

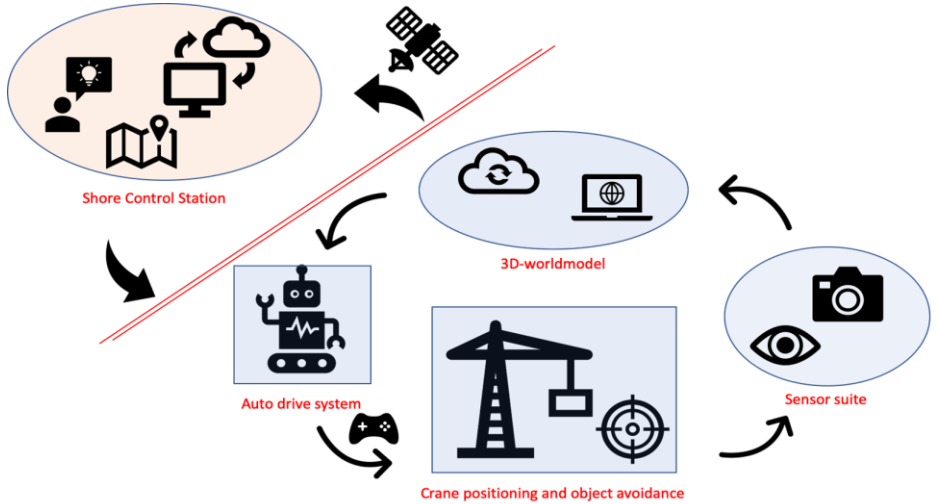
Simulation of fully automated vessel control from the port of Mykonos to the container terminal in Piraeus!

Innovative Feeder – Robotic Cargo Handling System

Automated Crane

- Compensation of pendulation (ship motions, weather conditions)
- Identification of container to load

Intelligent Operator Support System (IOSS)



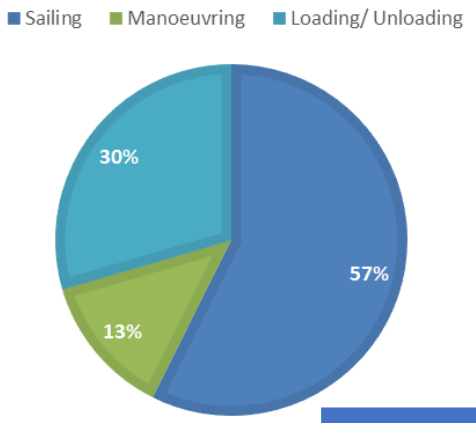
- Enabling local situation awareness – anomaly detection
- Robot self awareness in problem detection
- Control Intelligence
- Dynamic task allocation (One-to-many)
- Risk assessment for problem solving

MOSES Recharging Station – Feasibility study

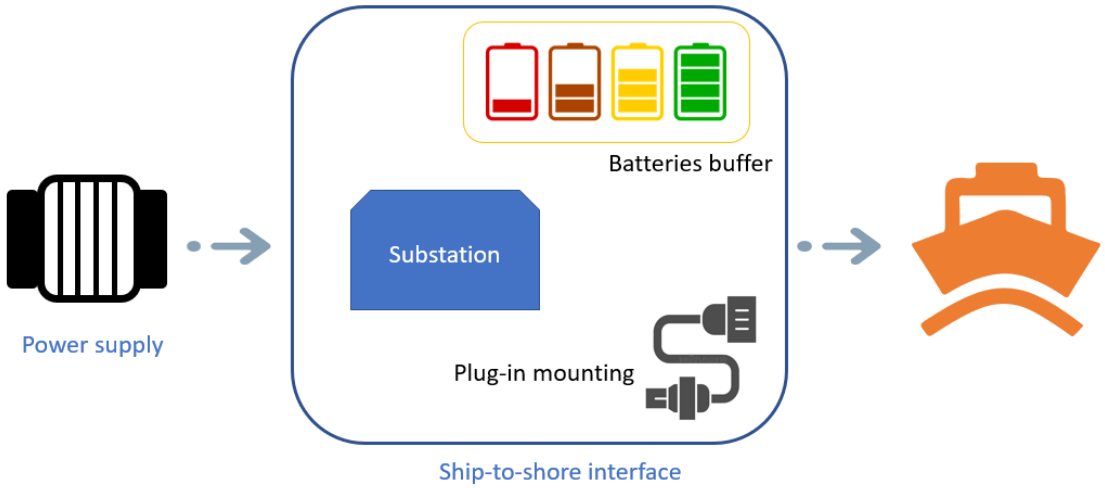
Criteria:

- Recharging should not disrupt the ship's or the port's operation
- The required power needs to be available from the grid
- Port real-estate needs to be available for the station

Feeder operational profile:



Port	Time for charging (h)
Piraeus	2,72
Mykonos	7,09



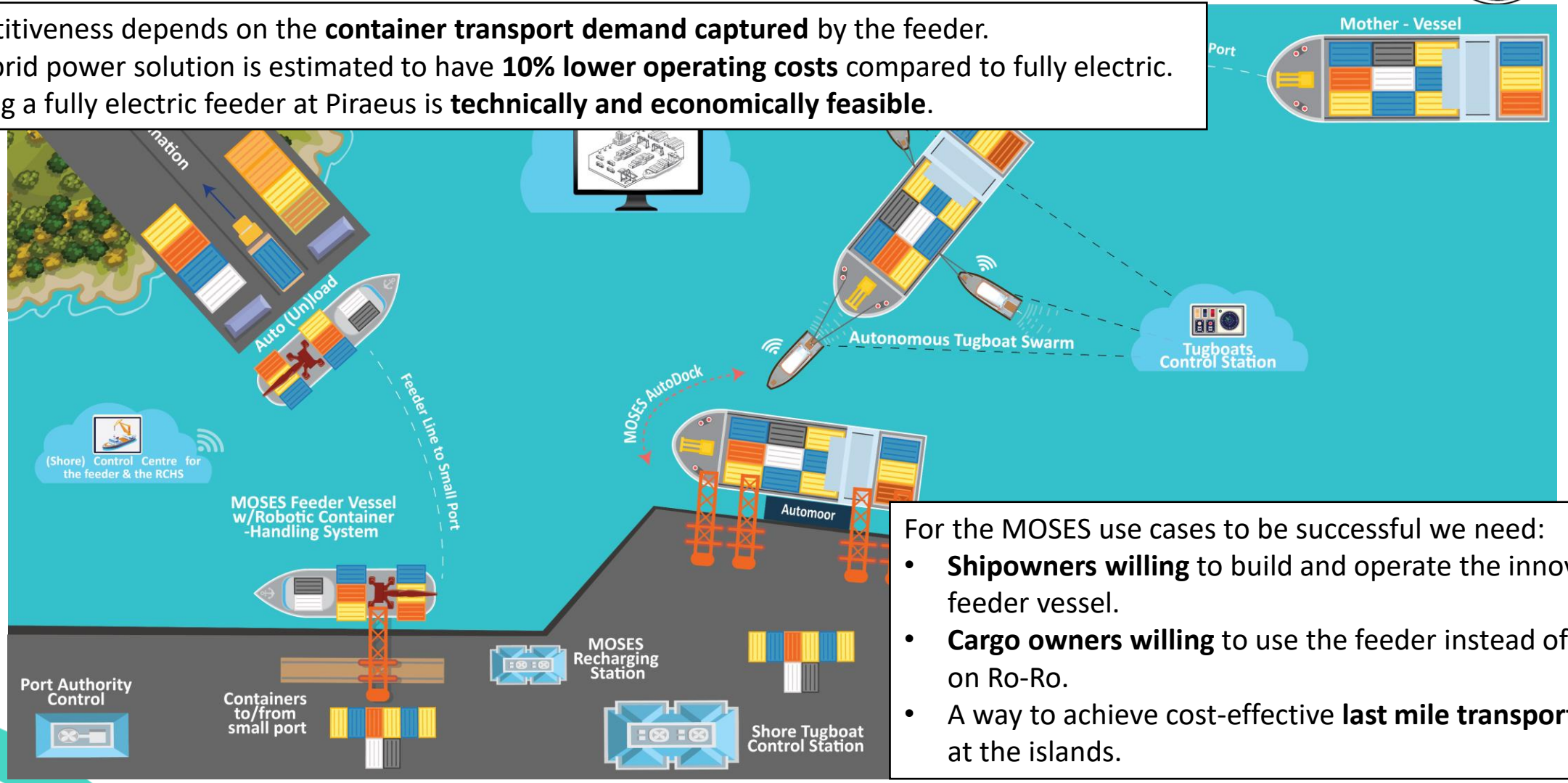
Preliminary Scenario:
Feeder recharges at Piraeus and Mykonos to avoid draining the batteries below 20%

- Need to install batteries buffer to allow constant supply without the risk of port black-out
- Recharging at Mykonos does not seem promising given the current state of the grid and the recharging technology

Final scenario:
Feeder recharges only at Piraeus

MOSES experience and key take-aways

- Competitiveness depends on the **container transport demand captured** by the feeder.
- The hybrid power solution is estimated to have **10% lower operating costs** compared to fully electric.
- Charging a fully electric feeder at Piraeus is **technically and economically feasible**.



For the MOSES use cases to be successful we need:

- **Shipowners willing** to build and operate the innovative feeder vessel.
- **Cargo owners willing** to use the feeder instead of trucks on Ro-Ro.
- A way to achieve cost-effective **last mile transportation** at the islands.

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MOSES Project

Thank you for your attention!

Konstantinos Louzis, NTUA

klouzis@mail.ntua.gr

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