



connecting BLUE and green

Evaluating the E-ferry systems and safety measures

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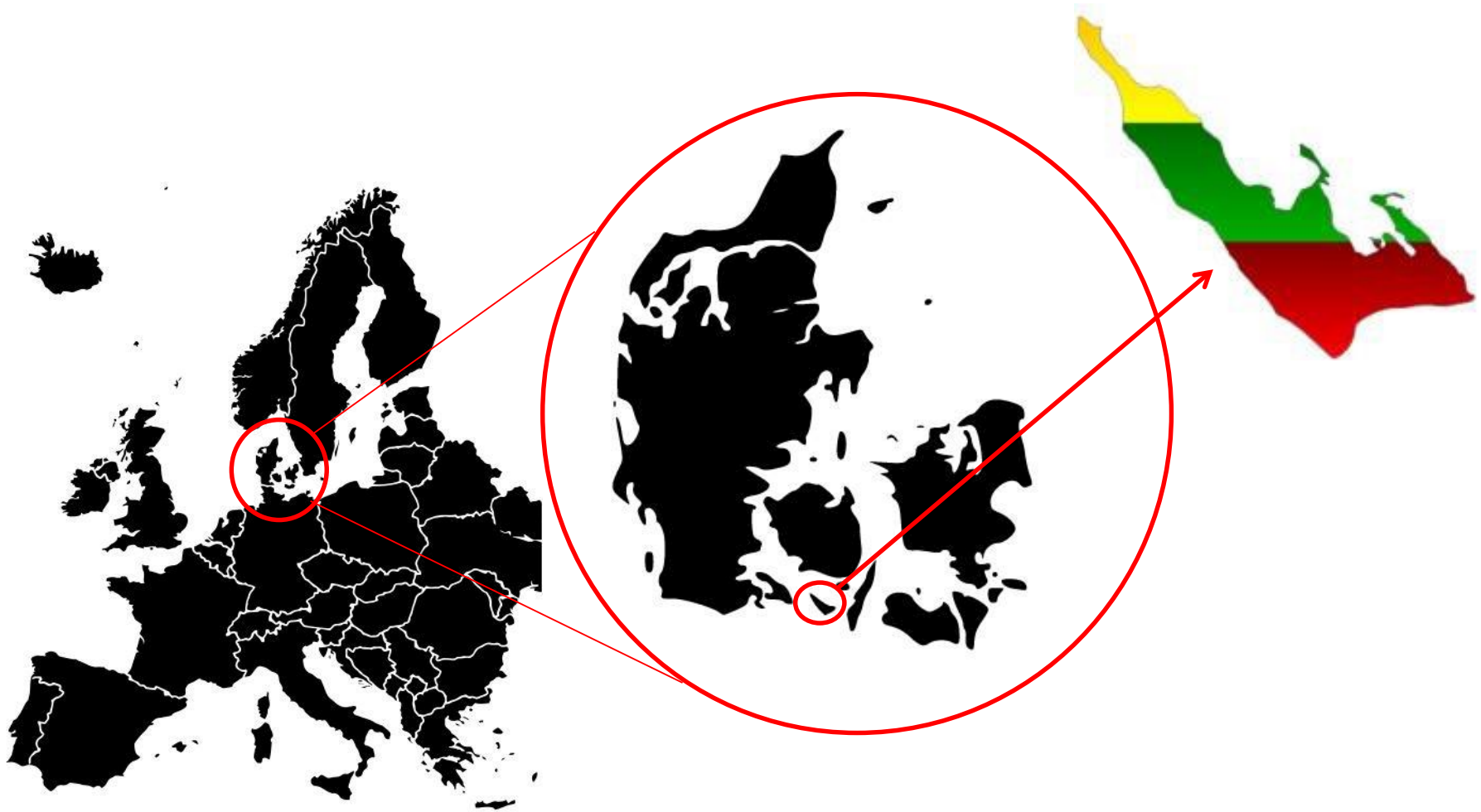
Ensuring efficiency and safety in electric vessels

23 June 2020

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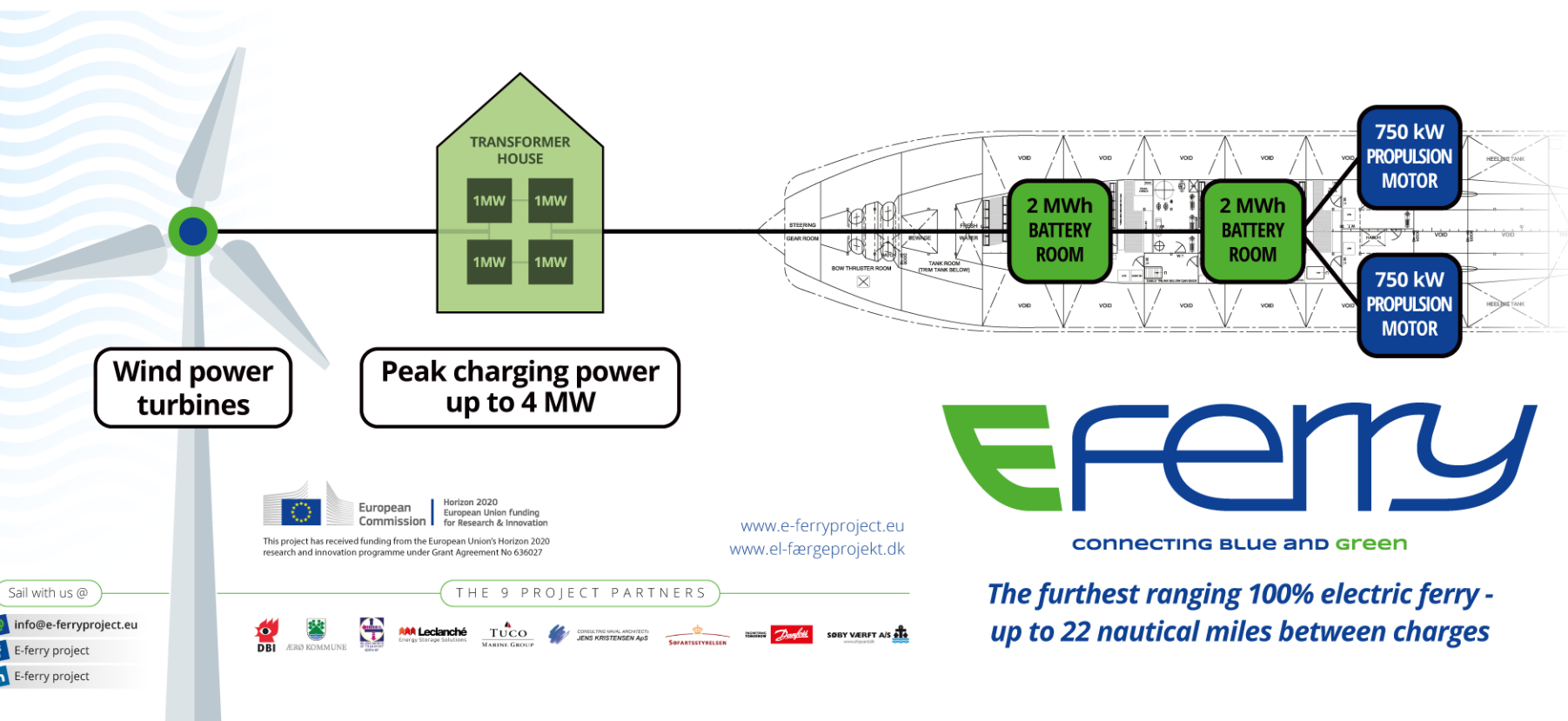
1. The E-ferry sails in southern Denmark



1. The E-ferry sails 22nm during a roundtrip



1. The E-ferry systems, simplified



CONNECTING BLUE and green

The furthest ranging 100% electric ferry - up to 22 nautical miles between charges

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www.e-ferryproject.eu
www.el-faergeprojekt.dk

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1. Charging the E-ferry

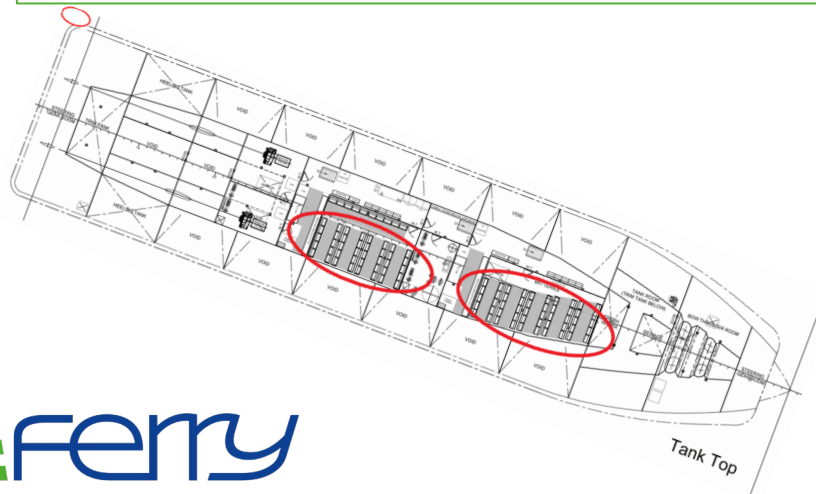


- 4 x 1.2 MW transformers
- 4.4 MW peak charging
- Up to 6,000 amps
- Ramp-based charging arm



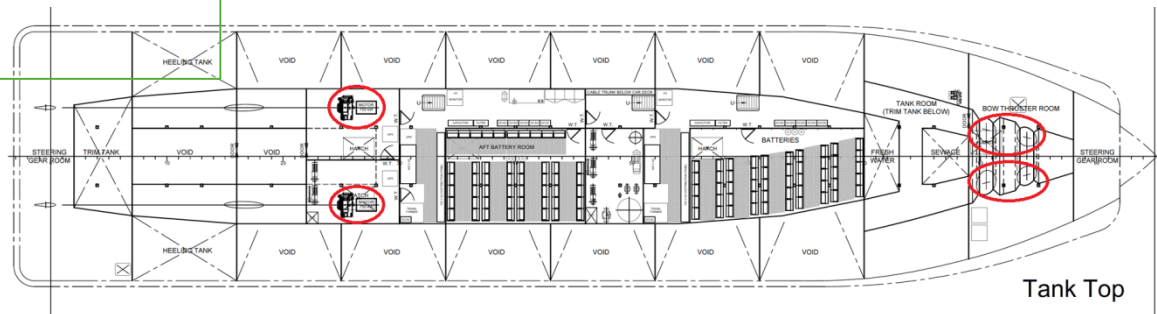
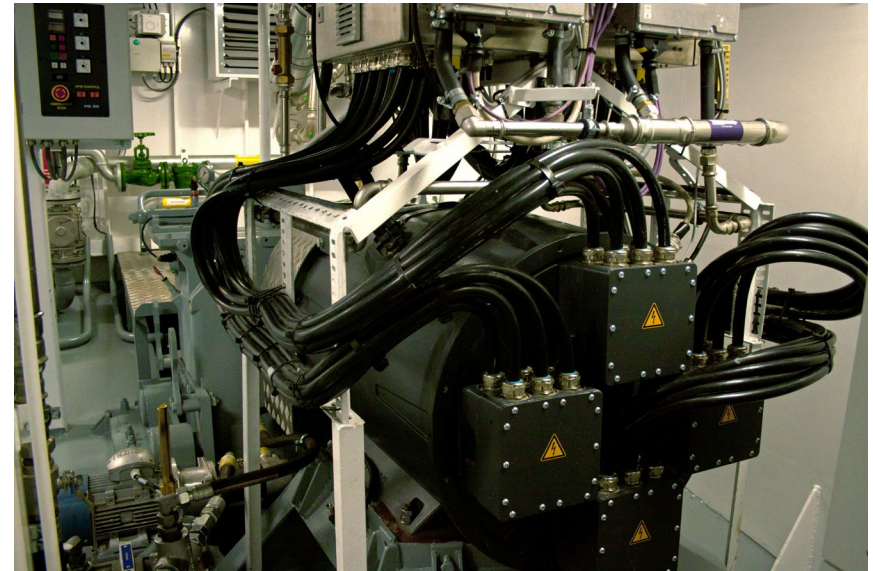
1. The batteries

- Lithium-ion Graphite/NMC
- 4.3 MWh
- 56 tons
- 20 separate strings in two rooms
- Type approved for maritime use
- Leclanché
- Redundancy (seperate systems)



1. The engines

- 2 x propulsion engines
 - ✓ 750 kW/motor (1000 HP)
 - ✓ 950 kg/motor
- 2 x thruster engines
 - ✓ 250 kW/motor
 - ✓ 465 kg/motor
- Fixed magnet
- Danfoss Editron



1. Safety: Redundancy

- Redundancy: Backup if main system fails

- Redundancy on the Ellen:
- 2 separate battery rooms
- 2 separate electrical systems
- 1 battery room = 1 propulsion sys.
- 1 battery room enough to sail
- Ample reserve power



1. Safety: Fire prevention/fighting

- Fire prevention
 - ✓ Electronic probes (heat/gas)
 - ✓ Physical probe (wire)
 - ✓ Water cooling
- Fire fighting equipment
 - ✓ Full automation
 - ✓ Special foam for battery fire
 - ✓ Sprinklers for regular fire
- Gas ventilation
 - ✓ Vents from batteries to deck
- Training
 - ✓ All crew are trained



1. Safety: Passenger safety

MOB system: Hoist and sling

Life rafts: Double capacity, complete capacity on either side (200 pax)

Life vests: Stored in seats



1. Efficiency: Weight and resistance

Hull: Hydrodynamic hull design

Deck: Open car deck

Salon: Almost at water level

Spoiler: Composite not implemented



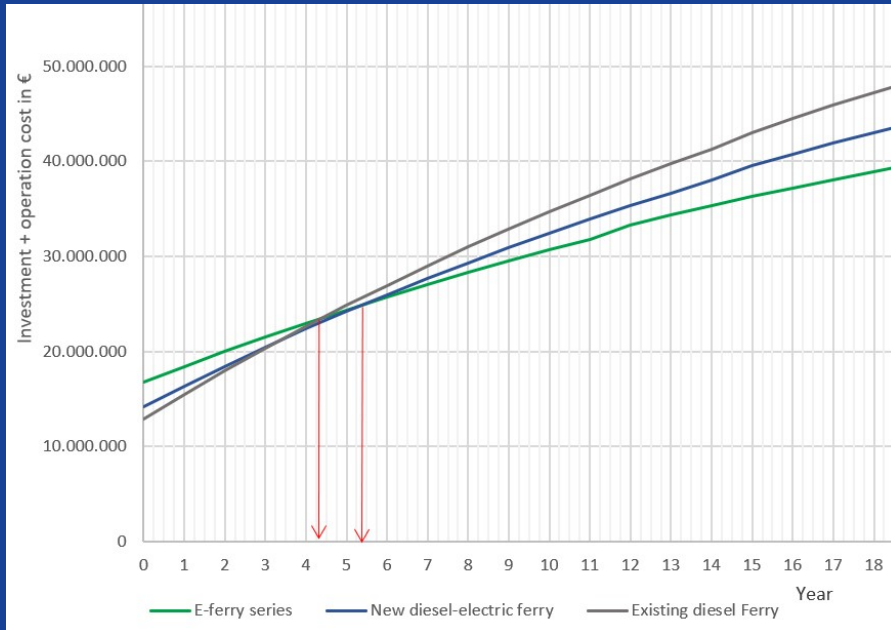
2. Benefits from electric operation

- Reduced pollution and GHG emissions
 - 2000 tons CO₂, 41 tons NO_x, 1.3 tons SO₂, 2.5 tons particulates annually (conservative estimate based on Danish grid mix)
- High energy efficiency
 - 85 % energy efficiency (more than double of a diesel)
 - Hydrodynamic hull design
 - Weight reduction

2. Benefits from electric operation

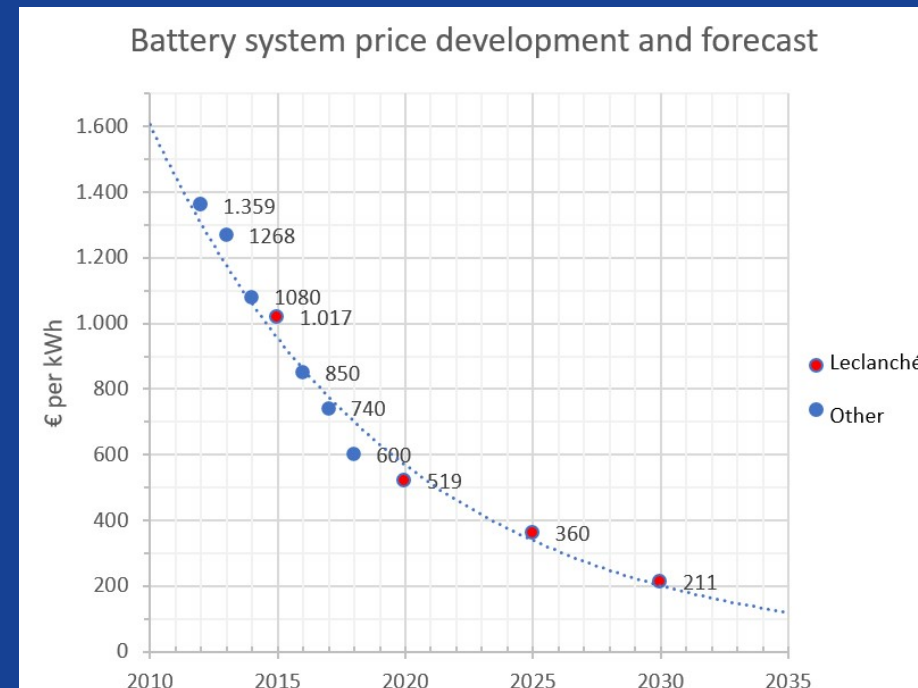
- Reduced costs
 - Larger up-front investment
 - Lower operating costs due to
 - Lower fuel prices
 - Less maintenance
 - Smaller crew
- Life-cycle economy
 - Fully electric is cheaper than diesel or diesel-electric
 - Operator saves 24 % - 36 % over 30 year life
- Reduced noise and vibration
 - Improved comfort for crew, passengers and neighbors

2. Fully electric systems are cheaper



<- Life-cycle costs of an Ellen II versus diesel and diesel-electric ferries

Battery prices have dropped drastically in recent years ->



3. Potential for electric operation

What do we know?

- **Green Ferry Vision (2015):** 65-80% of Nordic ferry routes are suitable
- **Siemens Danmark (2016):** 7 in 10 Danish ferry routes would be more profitable
- **E-ferry Business Study (2018):** Fully electric operation is feasible on 900 ferry routes in Europe

4. Next steps for a transition

1) Standardization

- Charging systems
 - Communication between systems and providers
-
- Type approvals
 - Sharing experiences
 - European/global standards?



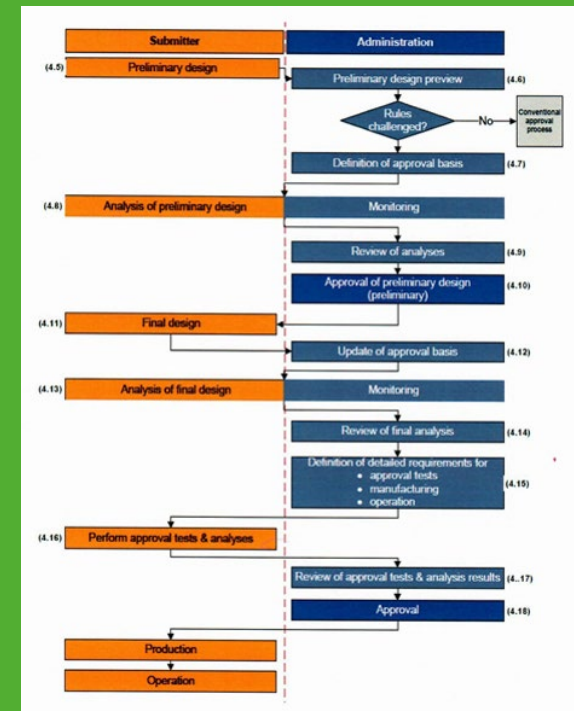
4. Next steps for a transition

2) Battery life cycle

- Optimizing weight and energy density
- Reducing pollution from battery production
- Recycling procedures
- Second life

3) Regulatory framework

- Battery specific regulations
- Authorities familiar w. process
- Flag state/regional strategy
- Parameters in tenders
- Education (STCW)



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Eferryproject
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[e-ferry-project](https://www.linkedin.com/company/e-ferry-project)

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E-ferry evaluation report:
[E-ferry homepage](#)