Battery Electric and Hybrid Vessels in Norway and Denmark: Ampere, Vision, and HH Ferries

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Marine Hi-Power Battery Workshop
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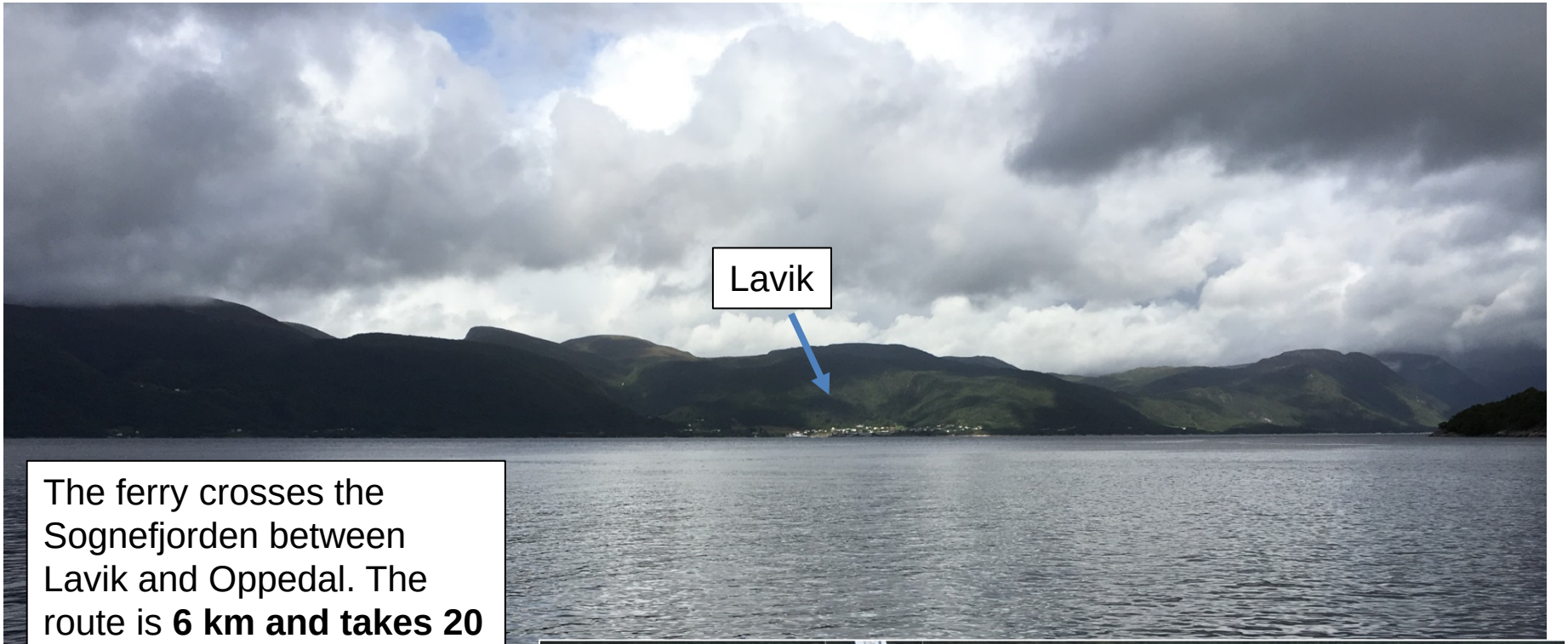
Ampere
Vision of the Fjords
HH Ferries
Sweden
Norway
Denmark
Molde
Ålesund
Sundsvall
Hudiksvall
Bergen
Oslo
Drammen
Fredrikstad
Haugesund
Stavanger
Kristiansand
Karlstad
Örebro
Stockholm
Uppsala
Västerås
Gävle
Falun
Borlänge
Mora
Norrköping
Linköping
Jönköping
Gothenburg
Vendsyssel
Aalborg
Aarhus
Odense
Sjælland
Malmö
Gotland

The *Ampere*

Vessel

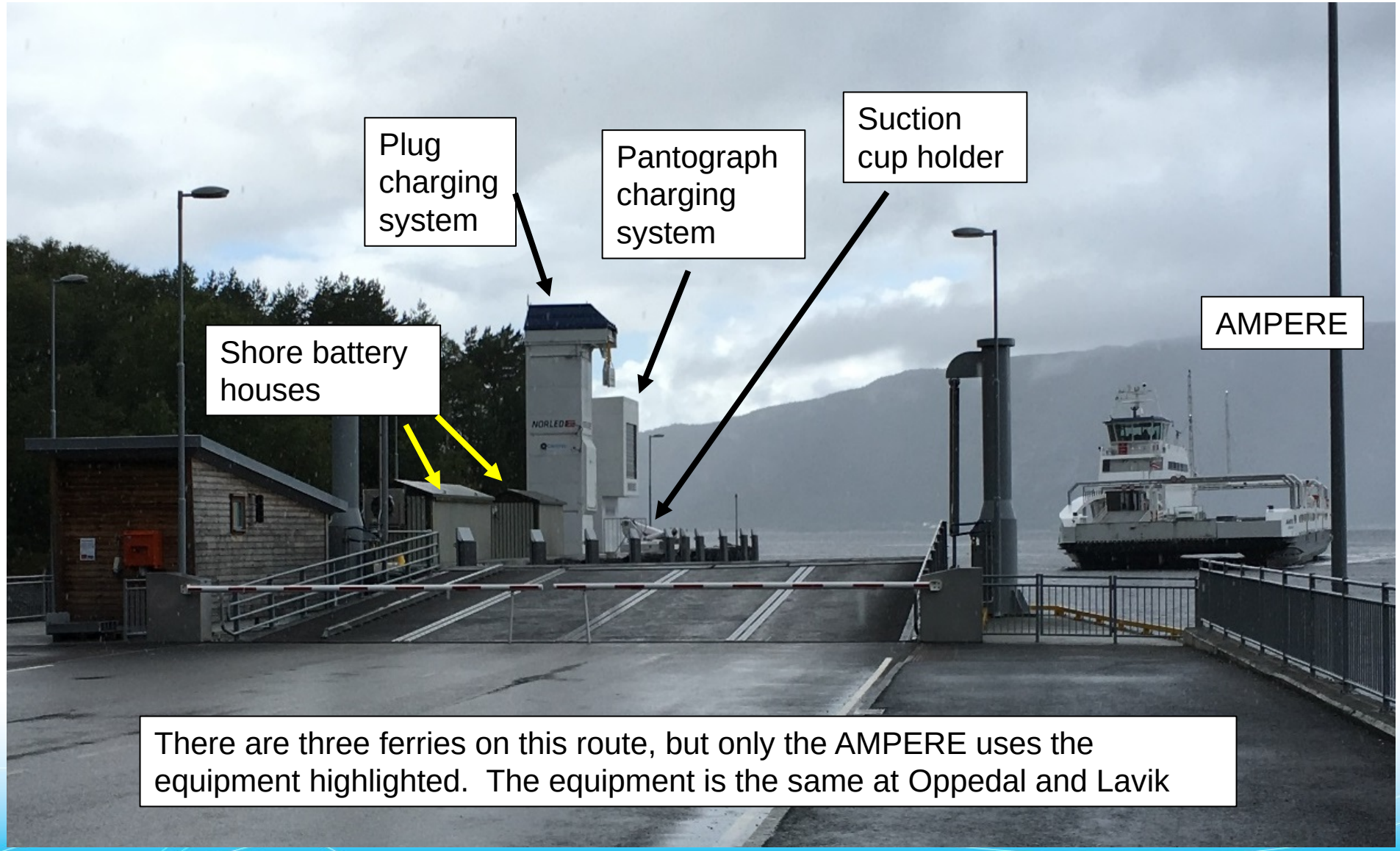
- 120 cars, 350 passengers
- 10-12 knots
- Part of the Norwegian highway system
- Operated by Norled

Route



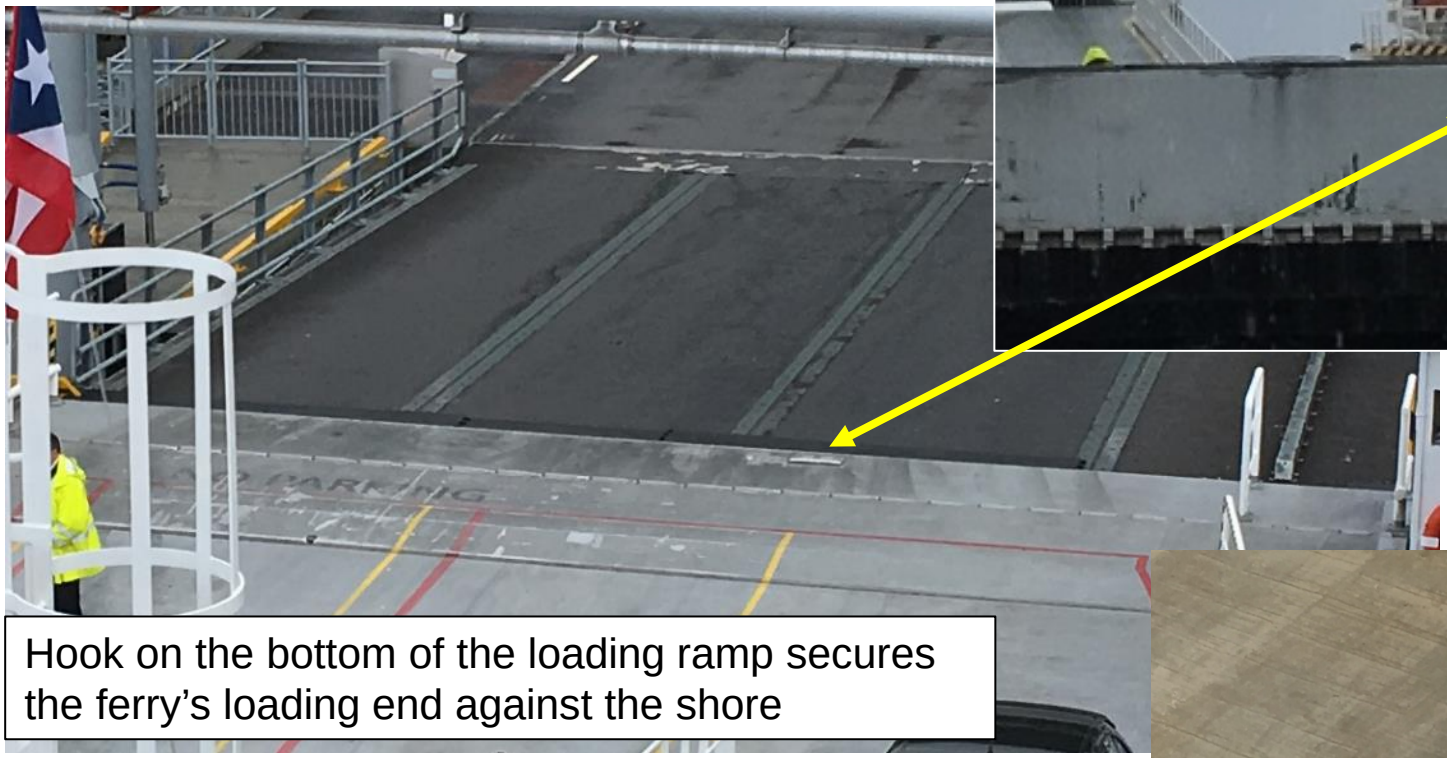
The ferry crosses the Sognefjorden between Lavik and Oppedal. The route is **6 km and takes 20 minutes to cross**. There is a **10 minute turnaround** on each side. It uses about 150 kWhr energy each crossing.

Dock equipment



There are three ferries on this route, but only the AMPERE uses the equipment highlighted. The equipment is the same at Oppedal and Lavik

At the dock



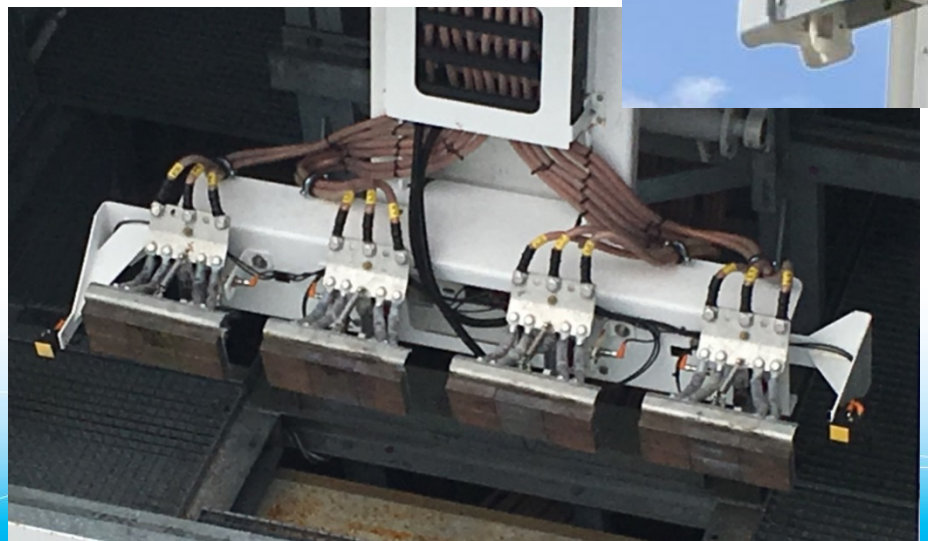
Hook on the bottom of the loading ramp secures the ferry's loading end against the shore

Suction cup along the side secures the ferry's side against the dock

Both measures are needed to ensure the electrical connection remains secure throughout the time at the dock

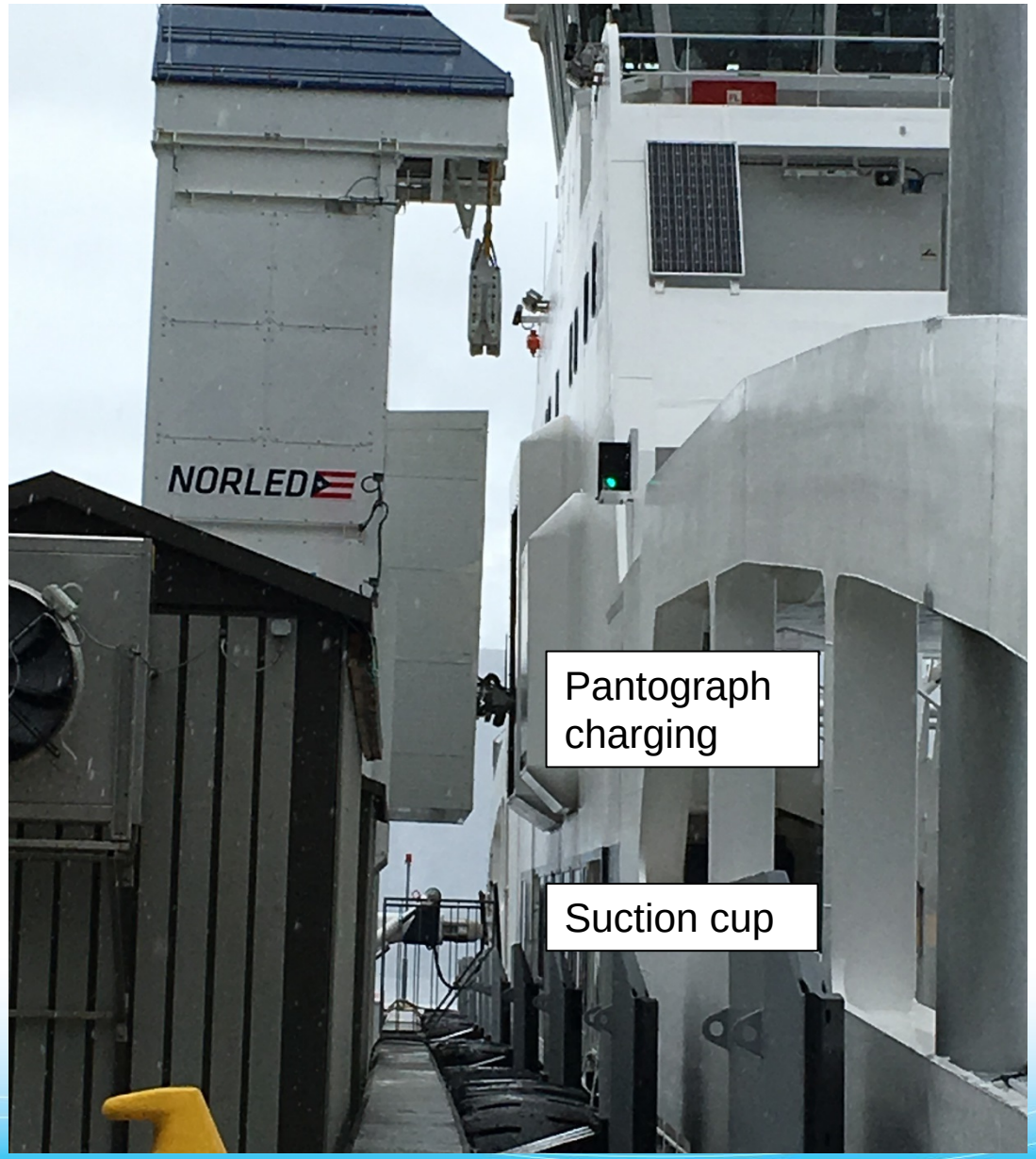
Charging

The pantograph system is preferred because it is faster to connect and allows for more motion of the ferry when docked. On the plug system the operator has to wait for the arm to extend and lower the plug. Also the plug does not have much flexibility so if the vessel rocks the plug can come loose, interrupting the charge and damaging the contacts



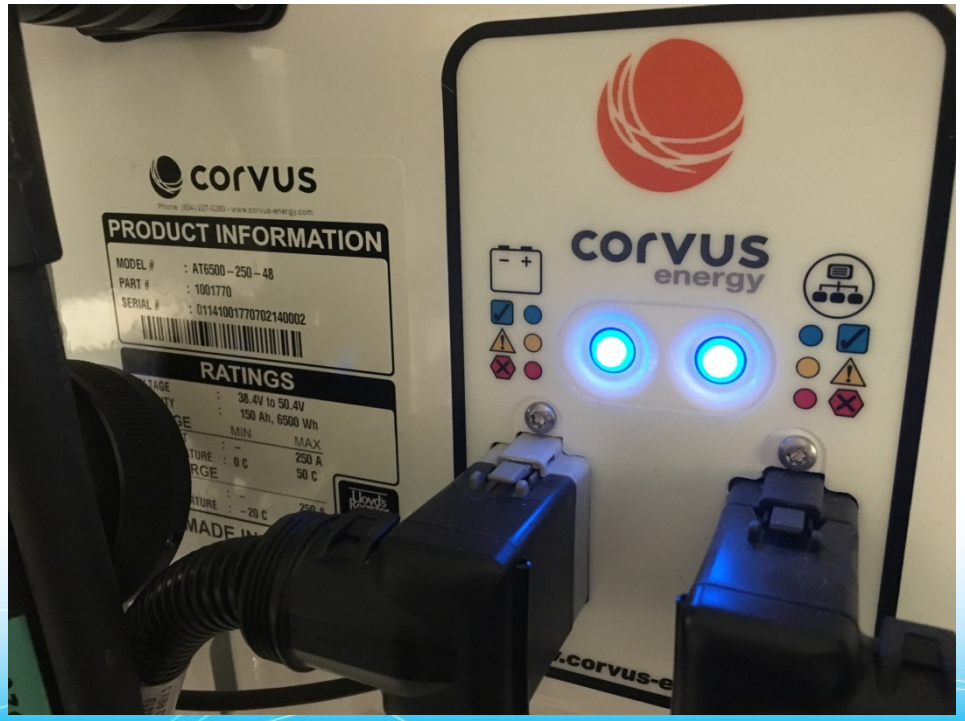
Charging

Charge about 10 minutes each time it docks, receiving up to 200 kWhr (~1.2 MW rate). Electricity comes from the batteries on shore because the local grid cannot support this much power.



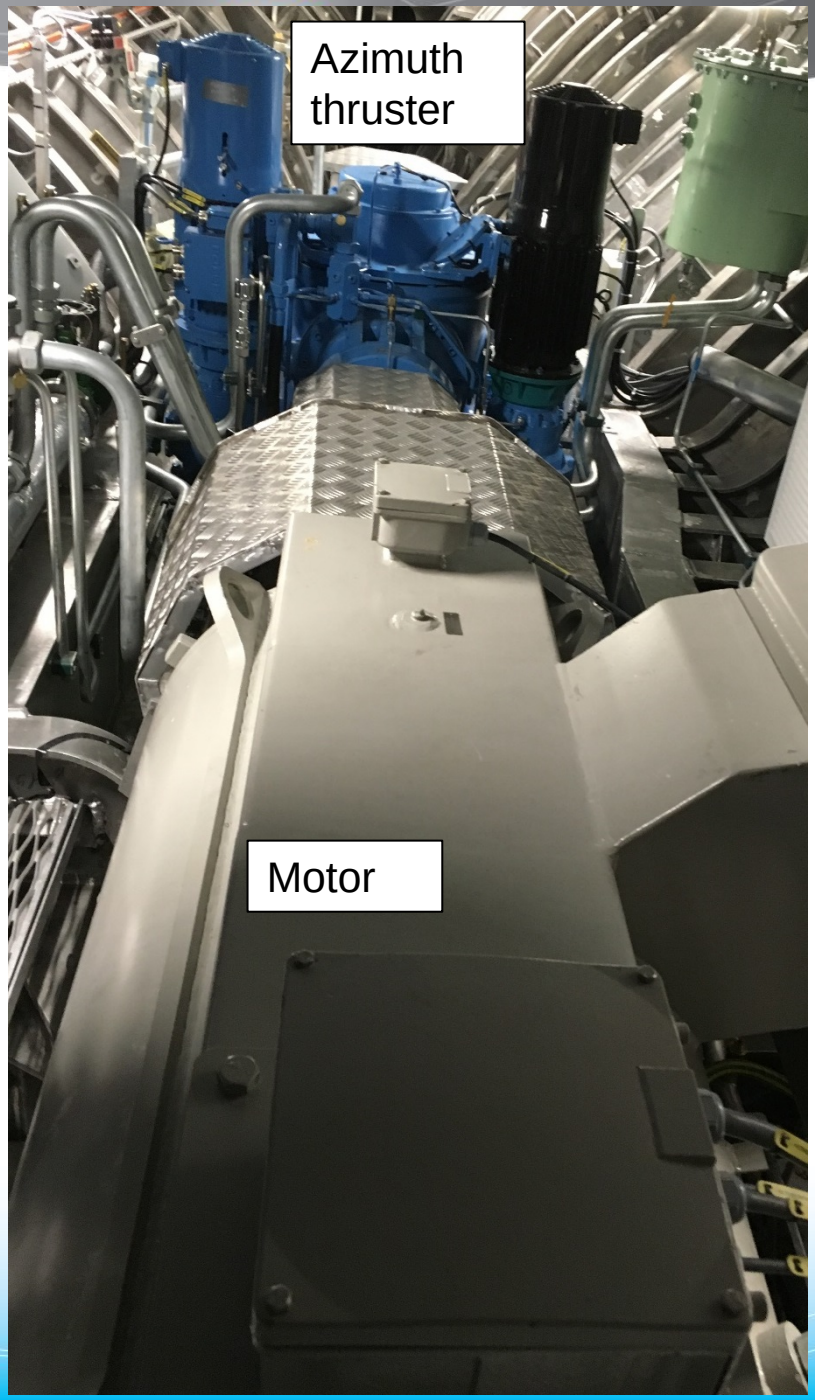
Batteries

- 2 independent battery rooms
- 4 banks in each room
- 15 batteries in each bank
- Corvus model AT6500-250-48, 6500 Wh rated capacity
- 10 year life



Drivetrain

- 2 independent engine rooms
- 1 x 450 kW motor in each room
  - 620 VAC
  - 520 A
  - Siemens
  - 2,700 kg
  - Regular grease/oil checks
  - 50,000 maintenance interval (bearings)
- 1 azimuth thruster



Thank you Norled and DNV-GL

- Frank Kristiansen, Chief Engineer, Norled
- Arne Hopland, Principal Surveyor, DNV-GL

Arne Hopland and Tom Escher

The *Vision of the Fjords*

Vessel

- Carbon fiber catamaran
- Diesel electric hybrid
- 400 passengers
- Panoramic windows
- Full disabled access
- Owned/operated by The Fjords

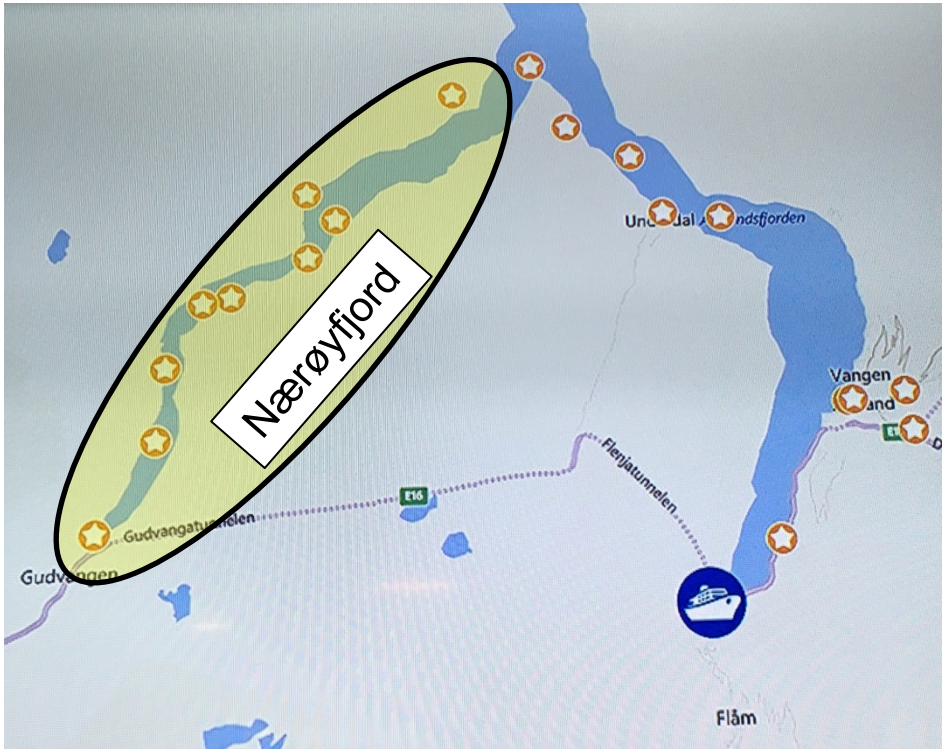
More vessel design info: http://www.seasight.braa.no/

Route

The boat cruises between Flam and Gudvangen, Norway. The main point of the trip is the part through the Nærøyfjord, a UNESCO World Heritage site.

One-way route profile:

- Flam to entry of Nærøyfjord
  - Diesel engine
  - 30-40 minutes
  - 18-19 knots
- **Through Nærøyfjord to Gudvangen**
  - **Battery only**
  - **50 minutes**
  - **8-11 knots**



Dock equipment

Flam

Gudvangen

see video

Procedure

Only dockside equipment is the cable reel/crane

Charging

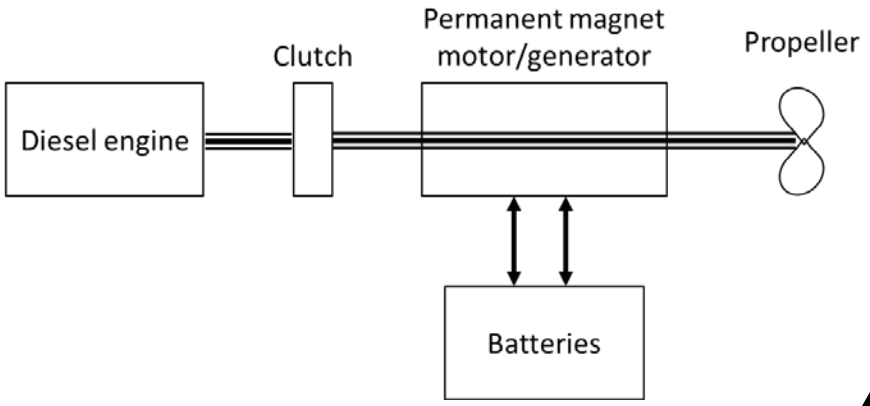
- The cables weight about 3 kg/m and the connectors about 10 kg each.
- The cables are not very flexible and do not have play in them – because of tides they do not charge overnight.
- Operator would prefer fully automated system with a single plug requiring only one crew and one connection.
- Each cable is 440 VAC / 600 A, total 528 kW
- Charge time is dictated by schedule, not optimized for the electricity needed. Sometimes do not get necessary charge.
- Shore-side voltage limits charging to 77% maximum. Installation of a converter could increase this to 100%.

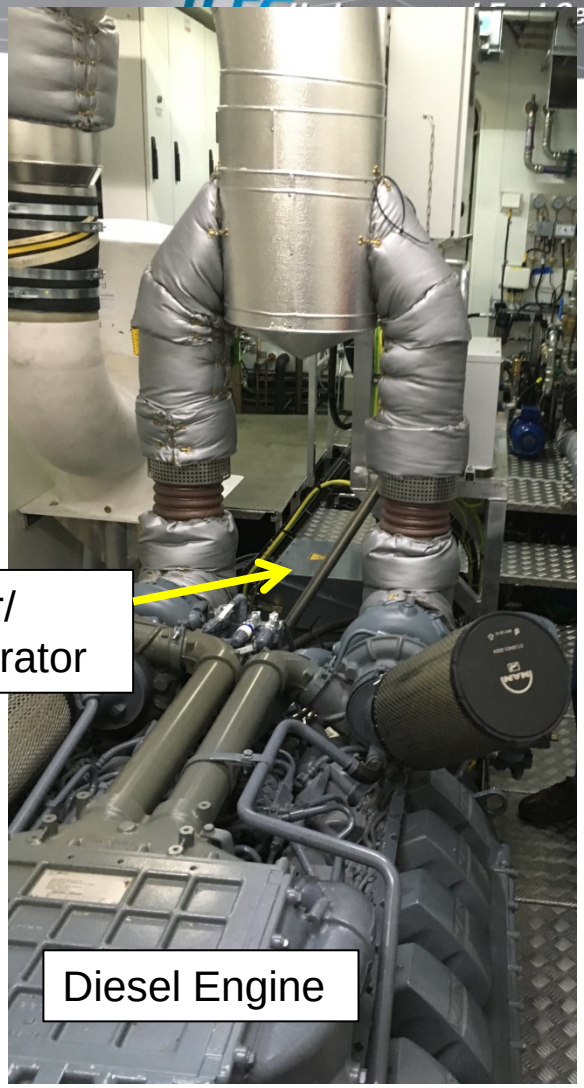
Batteries

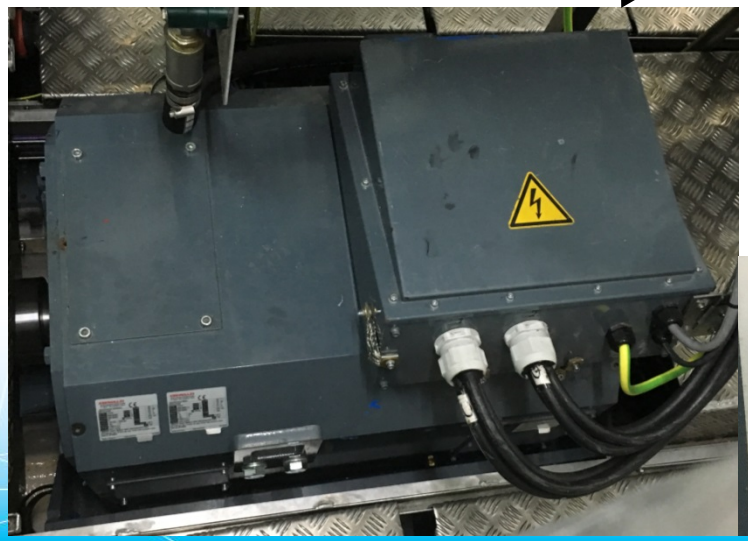
- Battery system by ZEM
- Batteries from LG Chem
- 15 batteries per rack
- 7 racks per bank
- 288 kWhr per bank
- 1 bank each hull

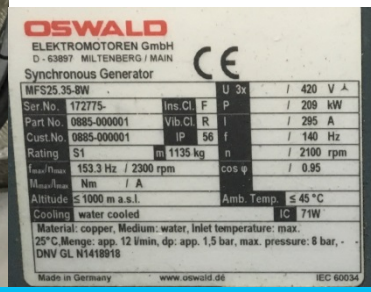
Drivetrain

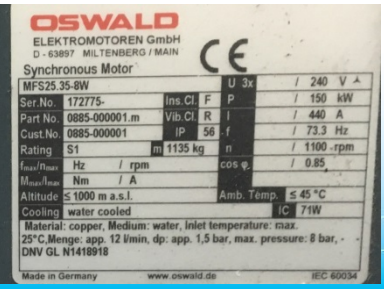
2 independent engine rooms











Thank you The Fjords crew and DNV-GL

The Fjords
- David Westgård Jansson
  Chief Engineer
- Arvid Langteig, Captain
- Anu Pietiläinen, Chief Mate

DNV-GL
- Arne Hopland, Surveyor

David Jansson, Captain Langteig, and Tom Escher

HH Ferries

Information and graphics from ABB: http://new.abb.com/marine/references/hh-ferries

Vessels

- Vessel conversion project from diesel powered to 100% battery electric
- Diesel generators remain on-board as backup

M/F Tycho Brahe

- Built 1991
- Length 111 m
- Breadth 28 m
- Draft 5,3 m
- Cars 238
- Passengers 1 100
- Lanemeters 539 m

M/F Aurora

- Built 1992
- Length 111 m
- Breadth 28 m
- Draft 5,5 m
- Cars 240
- Passengers 1 250
- Lanemeters 528 m

http://new.abb.com/marine/references/hh-ferries

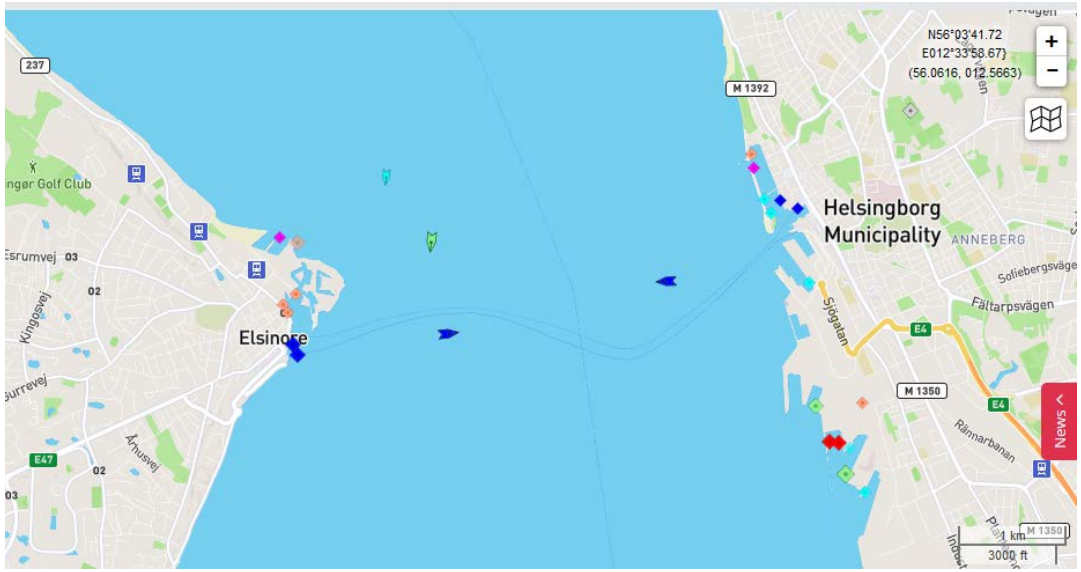
http://hhferriesgroup.com/about-hh-ferries-group/ferries/

Route and Logistics

- Departure every 15 minutes
- Travel time of 20 minutes.
- ~ 3 nm one-way
- ~ 12 knots top speed

Planned Charging:

- 5.5 minutes charge at Helsingor
- 9 minute charge at Helsingborg



marinetraffic.com

http://new.abb.com/marine/references/hh-ferries

Equipment

Main Components in the delivery

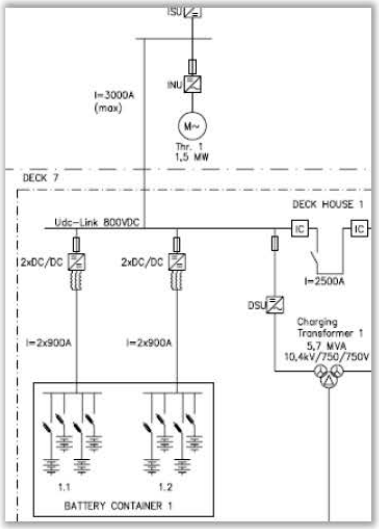
Co-financed by the European Union
Trans-European Transport Network (TEN-T)

Robot

ABB

Onboard DC Grid

ABB



Batteries

PlanB e Storage Ltd

Energy Storage Control System

ABB

This project has received funding from the Innovation and Networks Executive Agency (INEA), Connecting Europe Facility, under grant agreement No. INEA/CEF/TRAN/M2014/1040935."

ABB

http://new.abb.com/marine/references/hh-ferries

Charging

Robot in action: https://youtu.be/krJTdCFxupo
Search: "ABB's shore connection robot"

Automated shore-side charging station

Co-financed by the European Union
Trans-European Transport Network (TEN-T)

Highlights

- Connecting cable whilst the ferry is still making the final approach to the ramp → optimize the connection time and therefore maximize charging period
- Physical cable connection → minimum energy transfer losses
- Long life time for robot and cable reel.
- The tower moves vertically based on tidal water

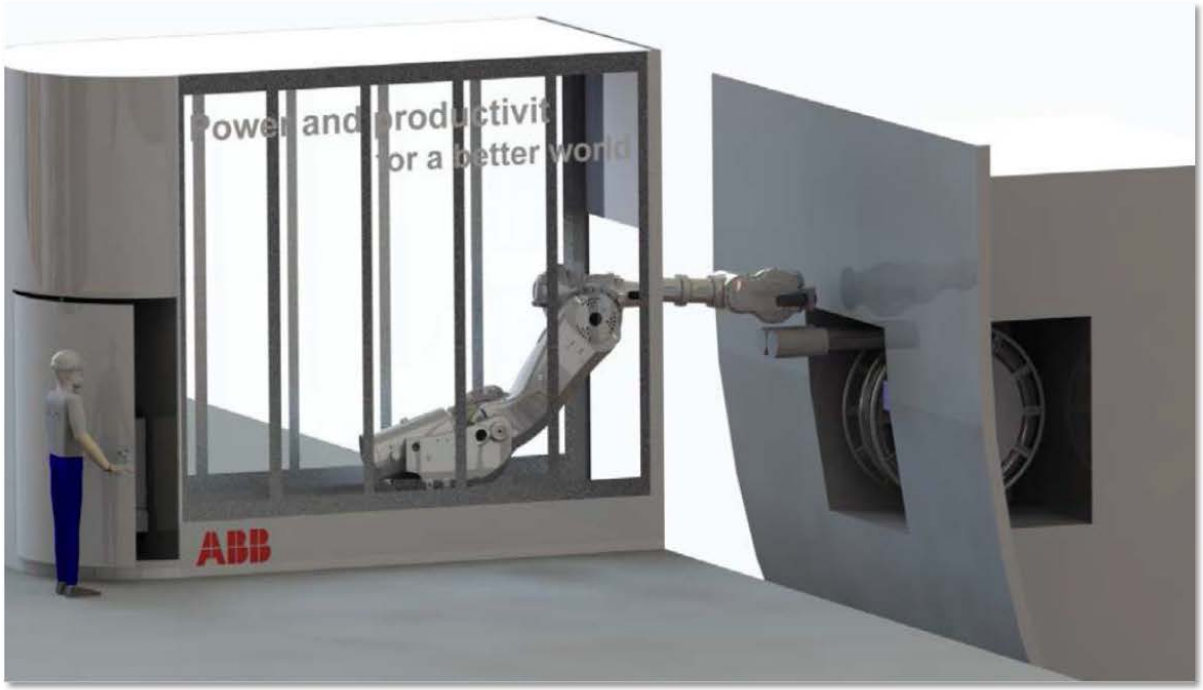


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ABB

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What is the best type of zero emission ferry to build today?