



Hans Fredrik Moe, Zero seminar – Kristiansand 24.8.2016

High power solution for charging of ferries

Landstrøm- og nullutslipshavn



HH Ferries Group

Invests SEK 300 million to reduce emissions and improve Öresund environment

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- The ferries M/F Tycho Brahe and M/F Aurora will be converted to battery operation, as part of the owners long term environmental strategy
 - Before end of 2017 both ferries will be fully battery operated
 - INEA, the EU's executive agency for innovation and network, support the project with approximately SEK 120 million

M/F Tycho Brahe (Built in 1991)

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

M/F Aurora (Built in 1992)

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

Operation profile



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

- Tycho Brahe (DMA)



Approx. 16.000 crossings per year for each ferry

Approx. 1.200kWh per trip

20 minutes sailing time

9 / 5,5 minutes in harbour

- Aurora (STA)



Onboard DC Grid & Energy Storage



ABB's Solution and scope on-board

- Generators: 4 x 2480kW, Remains as back-up
- Energy Storage: 4160kWh
- Propulsion: 4x1,5MW Azimuth thruster
- Automation: Energy Storage Control System
- Advisory: RDS, EMMA
- Class/Notation: Lloyds Register
- Ship yard: Ship yard package in ABB scope

Energy Storage System integration

ABB's Solution and scope on-shore

- Sub Station: Medium Voltage shore connection Switchboard. One in each harbor.
- Energy Transfer: Fully automatic ABB Robotic system, two in each harbor
- Charging time: Helsingør: 5 min 30s
(minimum) Helsingborg: 9 min
- Charging power: Helsingør: 11,2 MW
Helsingborg: 10,35 MW

Main Components in the delivery

Robot

ABB



Onboard DC Grid

ABB



Batteries

"Battery company"



Energy Storage Control System

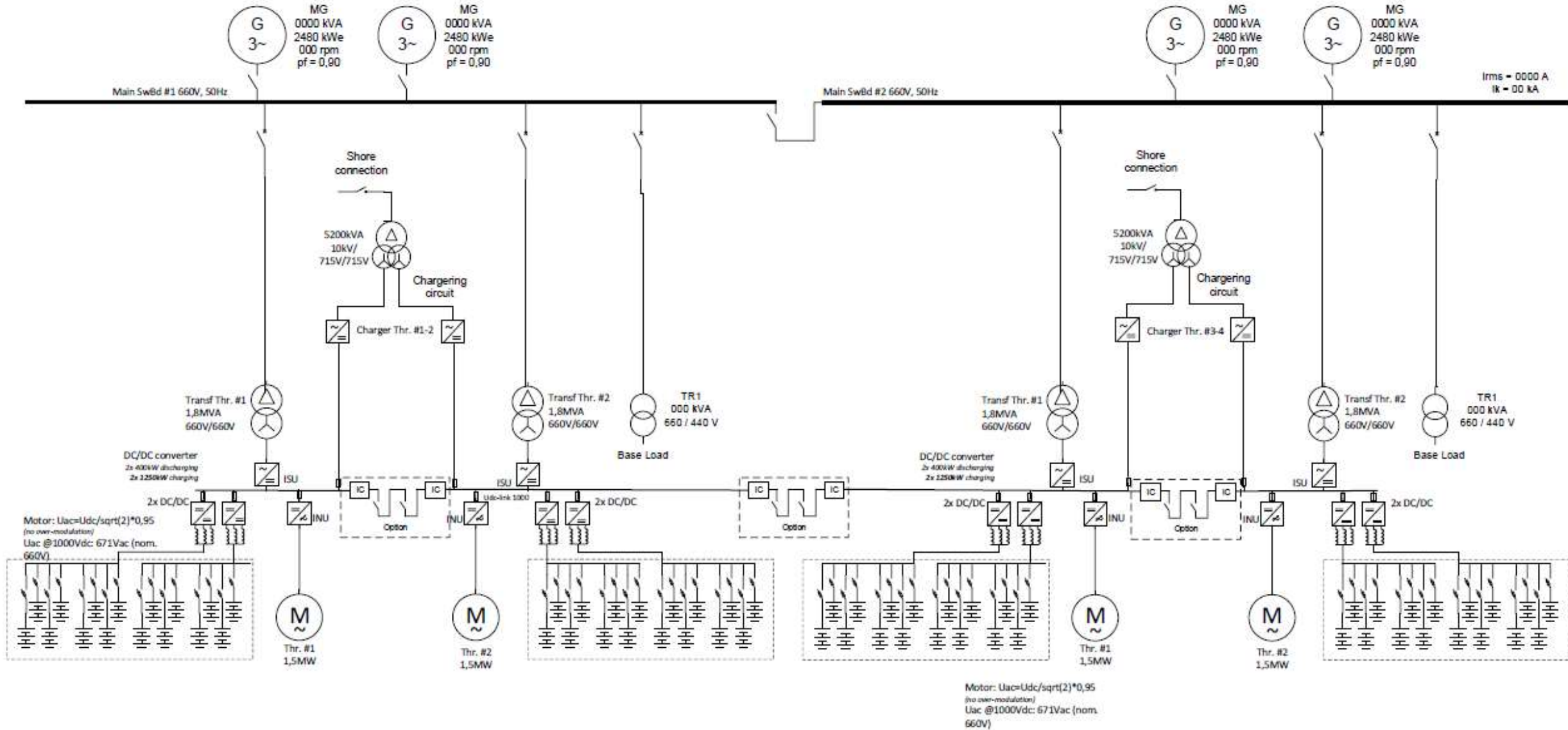
ABB



Overall SLD



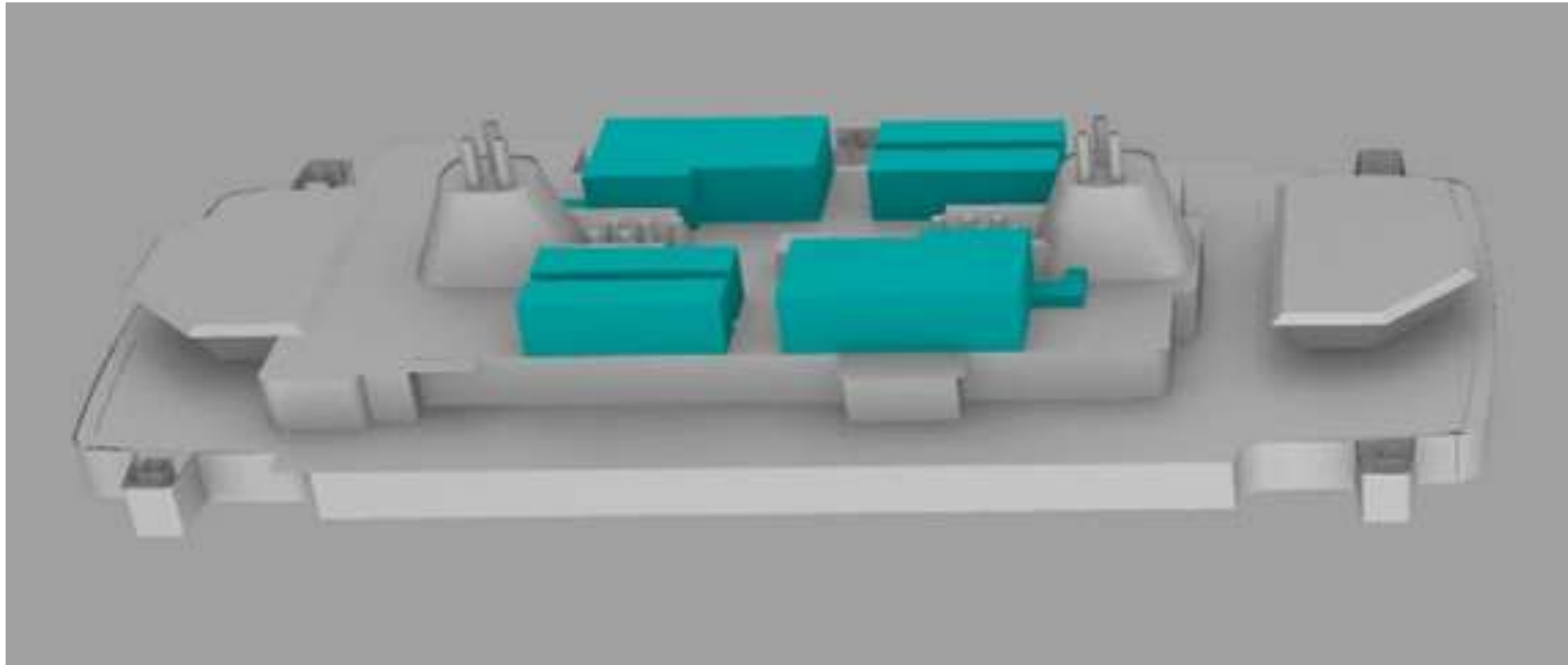
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Equipment location onboard



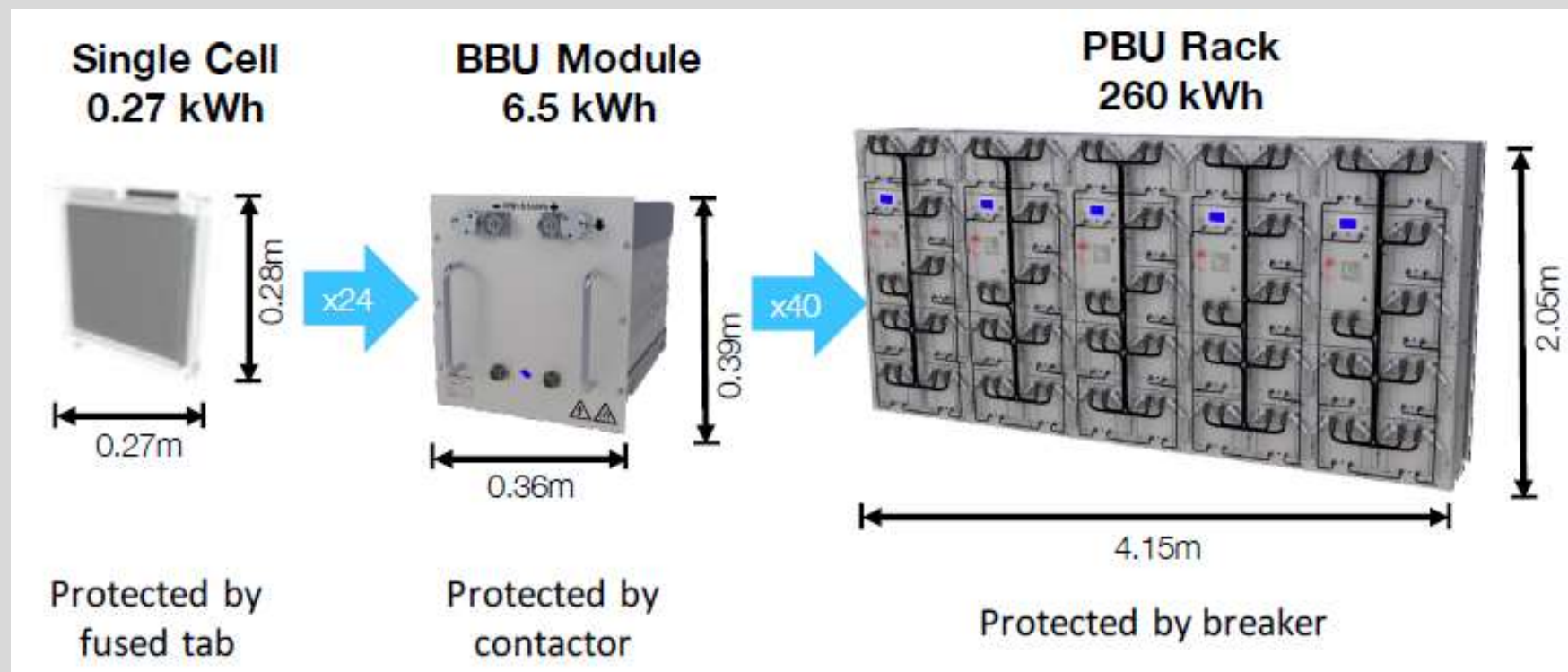
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Cell – Module – Rack - System



Co-financed by the European Union
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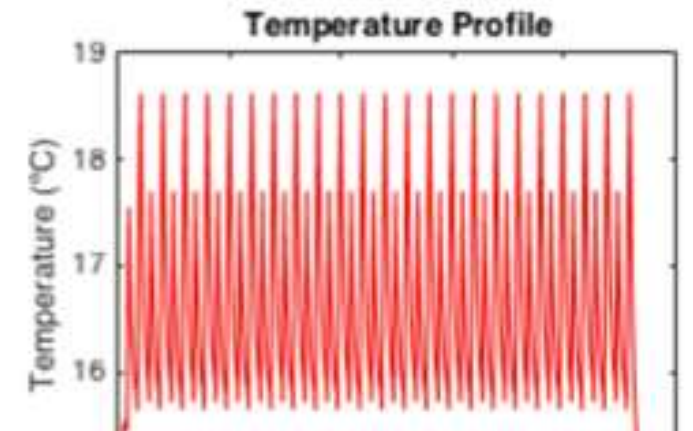
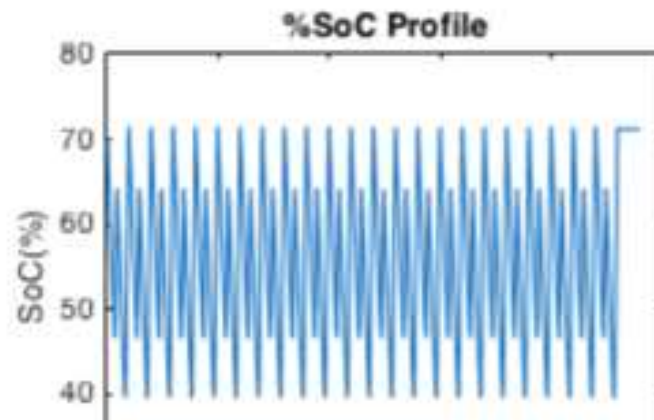
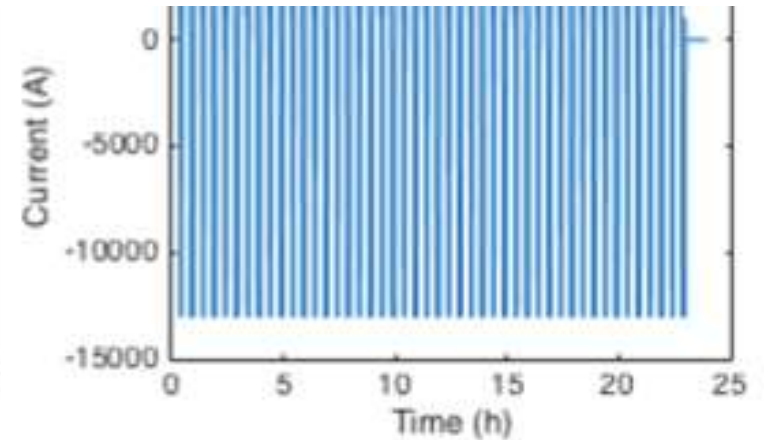
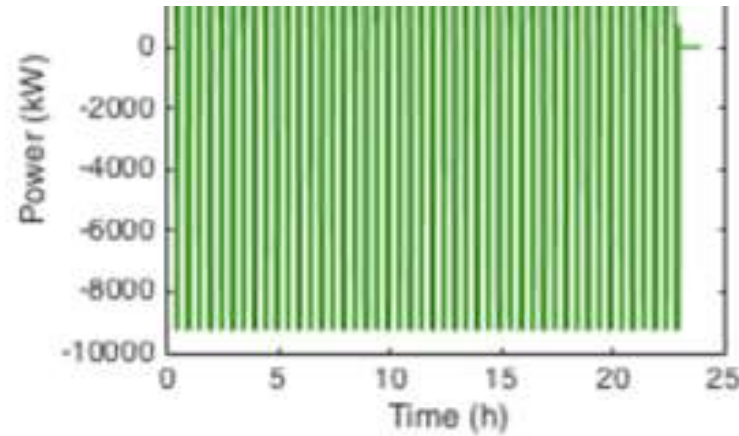


Totally 16 x 260kWh batteries onboard each ferry (4160kWh)

Parameters for selecting correct battery size

Parameters

- Power
- Current
- State of Charge (SoC)
- Temperature Profile



Batteries

Things to consider

Chemistry and life time

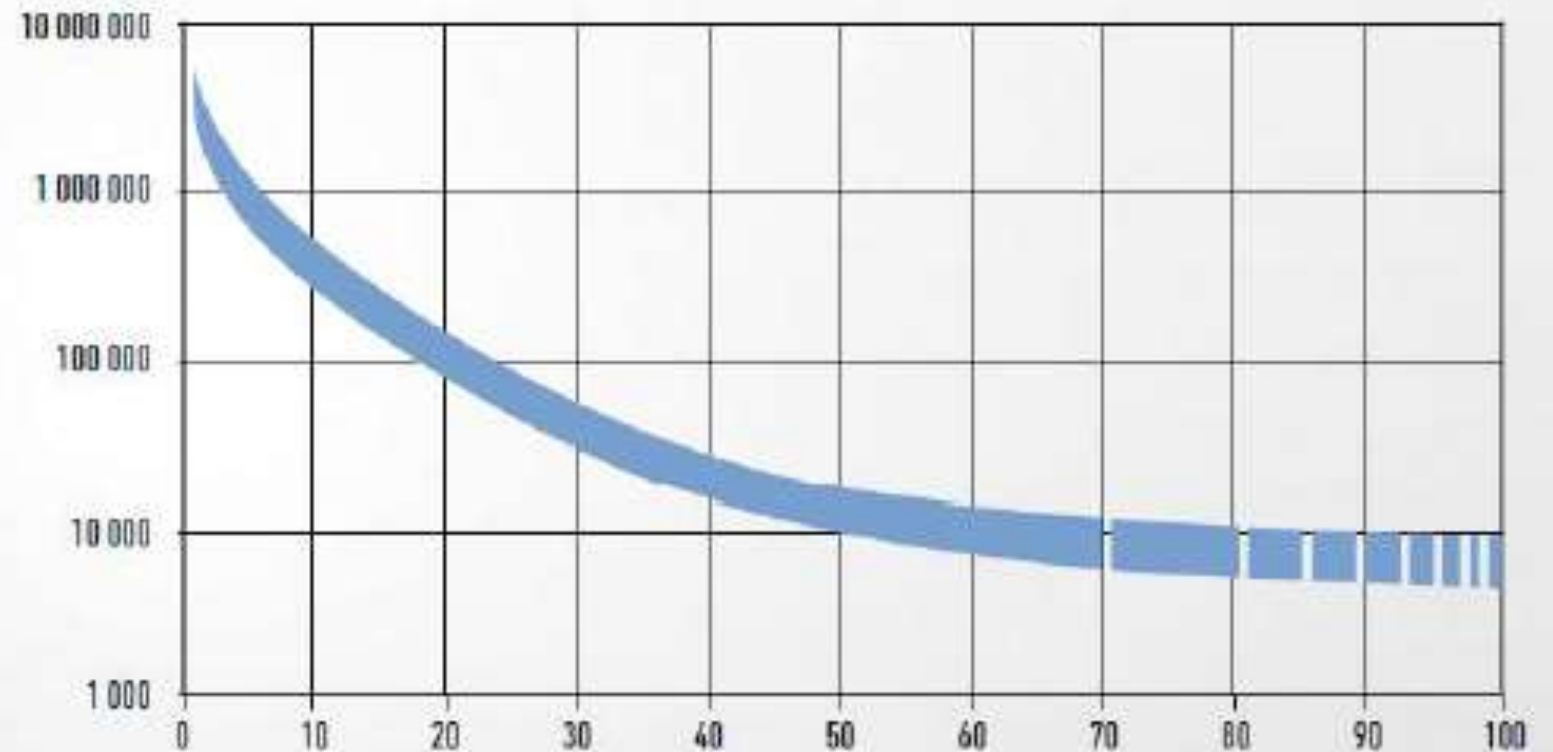
Industrial batteries have 3 vital attributes:

- Energy Density
- Power Density
- Number of Cycles (charges and discharges)

Different type of chemistry are best in different applications

- LI-NMC; Lithium-nickel-manganese-cobalt → energy and power
- LI-LTO; Lithium Titanate → power
- LI-LFP; Lithium-iron-phosphate → energy (and power in liquid cooled)

Number of cycles



Automated shore-side charging station

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 shore connection can be High Voltage, Low Voltage, AC or DC.

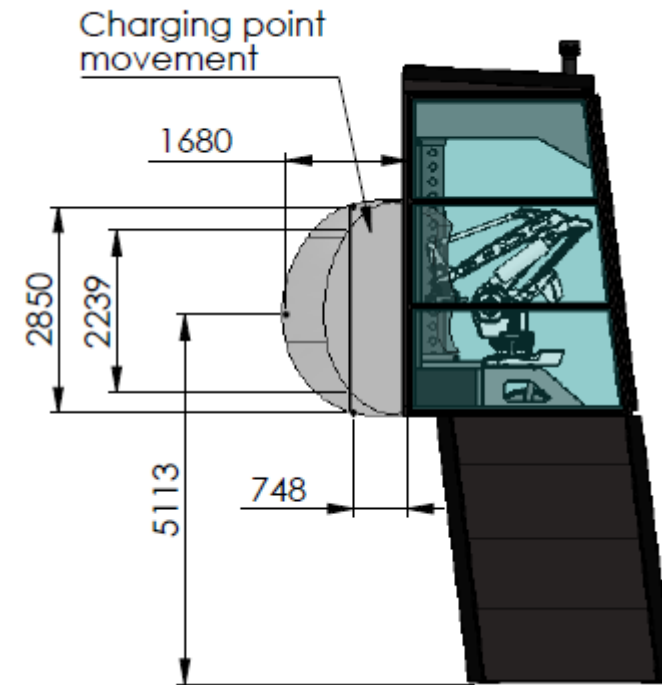


Functionality

Shore-side tower

Shore side tower

- The tower and robot room is protected against weather conditions and the robot stays inside when not in use. The robot door opens up only for the time period of connection.
- The communication between the vessel and shore side is via radio control
- The identification of the vessels when approaching is with 3-D laser scanner



Functionality

Energy Transfer – plug and cable

Energy transfer – plug and cable

- Plugs and cables based on high voltage shore connection standard, approved according to IEC.
- The connection is established by use of the ABB robot, who grasp the plugs from the cable reel at the ship or from the shore side tower.
- The connection speed is fast, due to connection during vessel final movement to berth.
- The plug is connected at shore side or at ship side, depending on the infrastructure demand



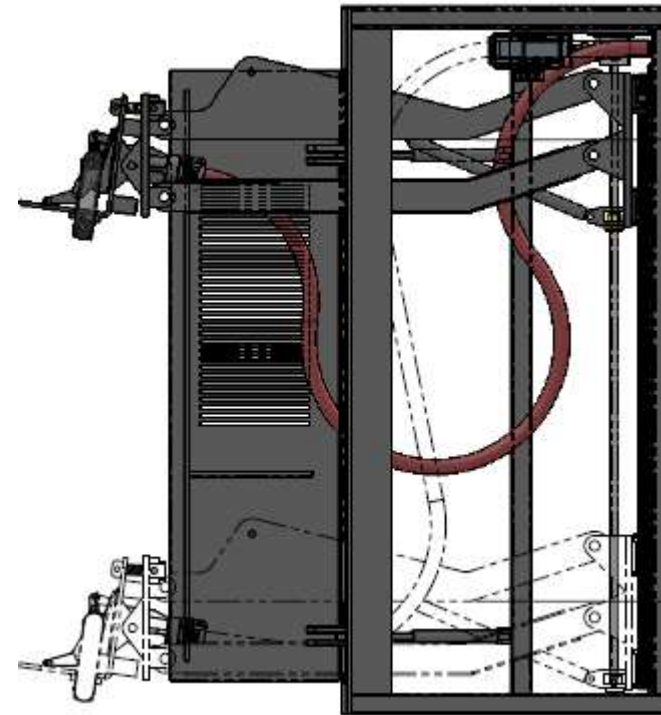
Functionality

Ship side – Hatch and plugs

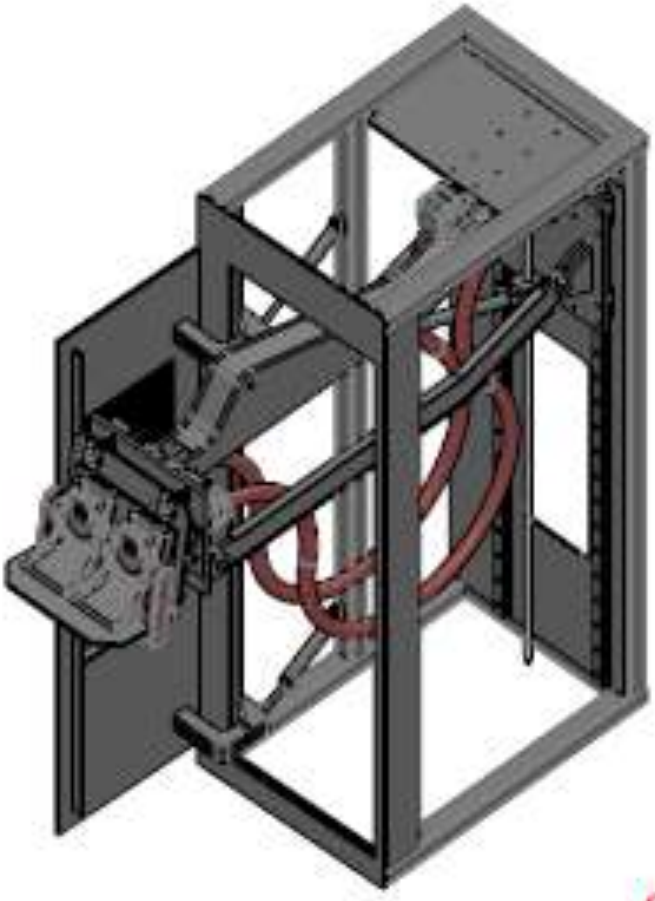
Ship side – Hatch and plugs

- Hatch is opened and remains close to the ship structure. The plug arm is hydraulically and electrically driven and will automatically go to rest position upon signal.
- The design of the mechanism will be water tight and ensure the level of flooding height
- Entrance to the service area is through a separate service hatch
- Plugs according to high voltage shore connection IEC standard.

Hatch open (arm top and down)



Ship side – Hatch and plugs



Two robots in each harbour. (Two quays in each harbour)
Each robot handles two plugs that are fixed to each other



Connection/Connectors/Emergency Stop

-
- The Cavotec PC6 plugs and connectors are IP67.
 - The plug is mechanically locked to the connector.
 - If the vessel is drifting, and reach an outer position (measured by tension sensor), the shore side CB will open, and the locking device of the plug will be opened by the linear actuator. Allowing disconnect without use of the robot.

Shore Connection Robot

ABB Robot – Main advantages

Fast connect and disconnect

Less exposed to whether-conditions

Meets the HV shore-connection standard (IEC 80005-1)

Can combine use of different plugs for different ships

Cable reel can be onshore or onboard

Suitable for HV / LV / AC and DC



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