Berliner Hafen- und Lagerhausgesellschaft mbH

ELEKTRA Development and Realisation of the first free emission push boat

Bundesministerium für Digitales und Verkehr

NOW Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie

PtJ Projektträger Jülich Forschungszentrum Jülich

What we do - Operator of two trimodal ports in our capital city

WIR SIND HAFEN!

- Railway company
- Container terminal
- Handling of bulk cargo, general cargo and heavy cargo
- Storage in outdoor storage areas, halls and silos
- Handling of 4.5 million tons a year
- Modal Split: 1.0 million t ship / 1.5 million t rail / 2.0 million t truck
- Projects for the reduction of CO_2 emissions

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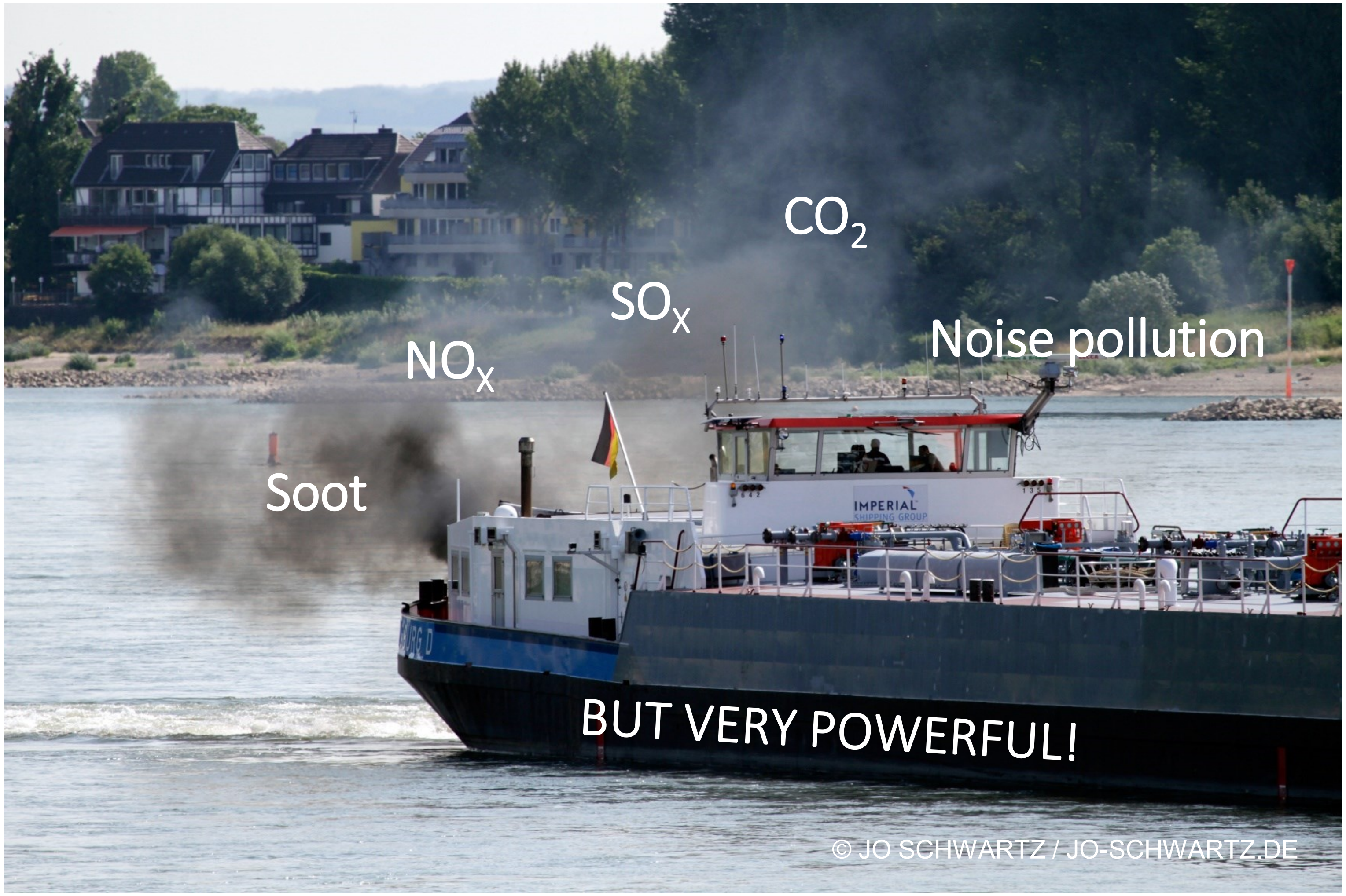
MOTIVATION



CO_2
SO_X
NO_X
Noise pollution
Soot
BUT VERY POWERFUL!
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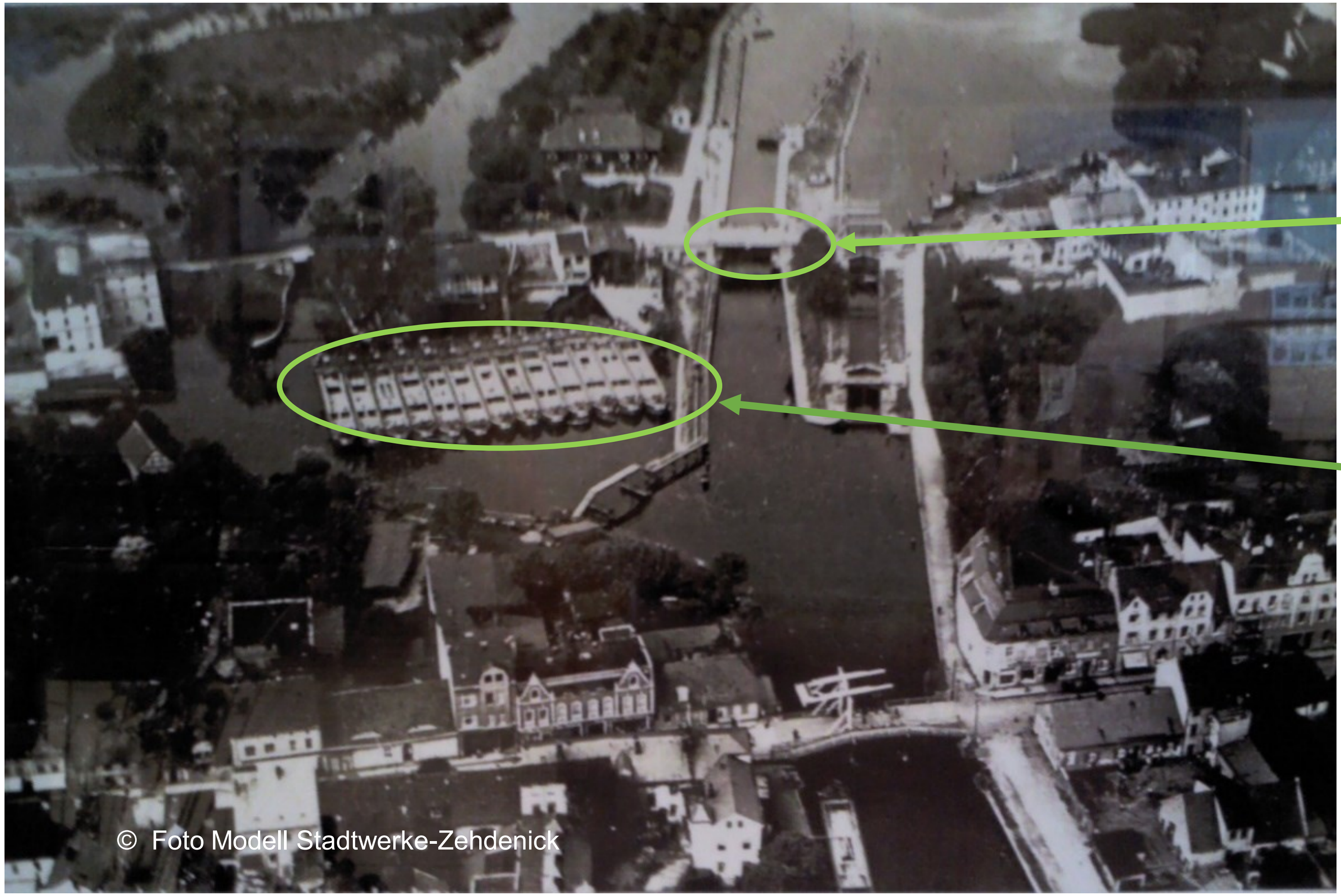
HISTORY OF EMISSIONFREE SHIPPING AT BERLIN

Charging point at Zehdenick around 1910

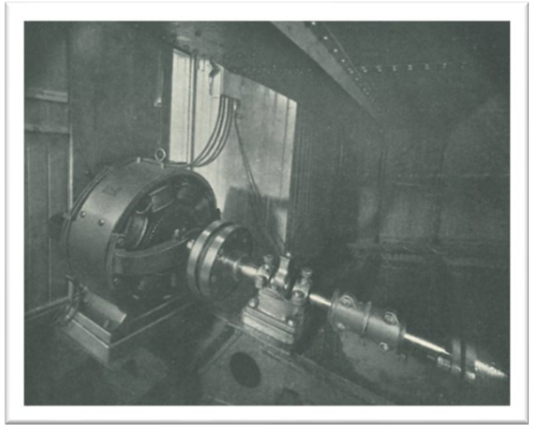


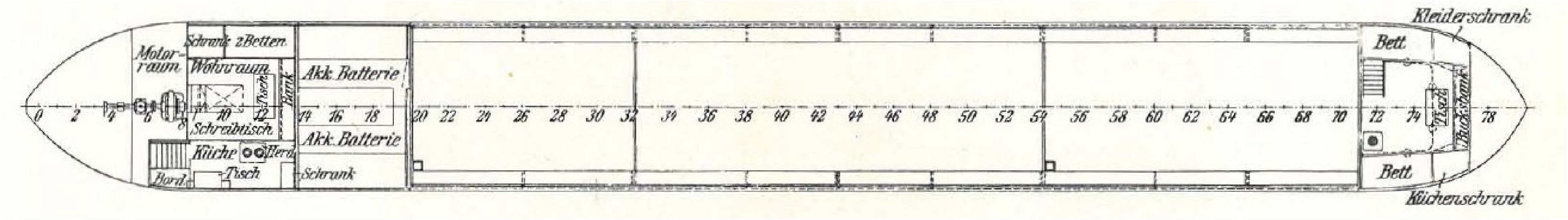
Regenerative power generation through barrages

Brick barges

HISTORY OF EMISSIONFREE SHIPPING AT BERLIN

Purpose:	brick transport from Zehdenick (north of Berlin) to Berlin
Key-Facts:	„Finow-Maßkahn“, 40,0 x 4,6 x 1,3 m, 150 dwt
Propulsion:	DC 7 kW
Battery weight:	9,5 t (lead battery, 6%! of dwt)
Range:	90 km
Quantity:	approx. 120 ships in commercial use (1908)





Source: Jahrbuch der Schiffbautechnischen Gesellschaft 1908

INITIATION

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REQUIREMENTS & CONSTRAINTS

The main task of „ELEKTRA“ in conjunction with „URSUS“:

- RoRo – project loads
- regional / supra-regional transport of heavy duty goods, e.g. gas turbines from the Siemens AG / Berlin plant

Heavy Cargo RoRo-Barge „URSUS“
Length 64.50 m | Width 9.50 m
Displacement 1,400 t | Draught 1.30 m – 3.06 m

Loading ramp
length 265 m

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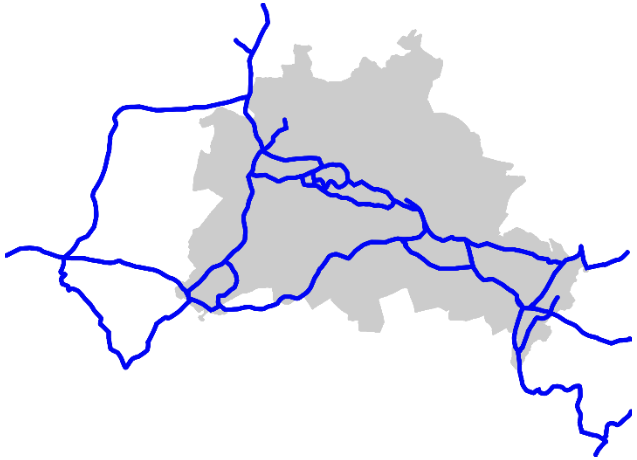
REQUIREMENTS & CONSTRAINTS

REGIONAL OPERATION



- Berlin area
- Approx. range of 65 km / day (8h)
- Service speed: 8 km/h, up to 10 km/h
- Drive: primarily battery-electric

- Berlin ↔ Hamburg
- Operating area: Zone 3+4 (without Rhine)
- Approx. range of 130 km / day (16h)
- Average service speed: 8.5 km/h
- Drive: hybrid-electric

SUPRA-REGIONAL OPERATION

SHIP LAYOUT

Main dimensions

- Length: 20.00 m
- Width: 8.25 m
- Draught: 1.28 m
- Displacement: approx. 130 t

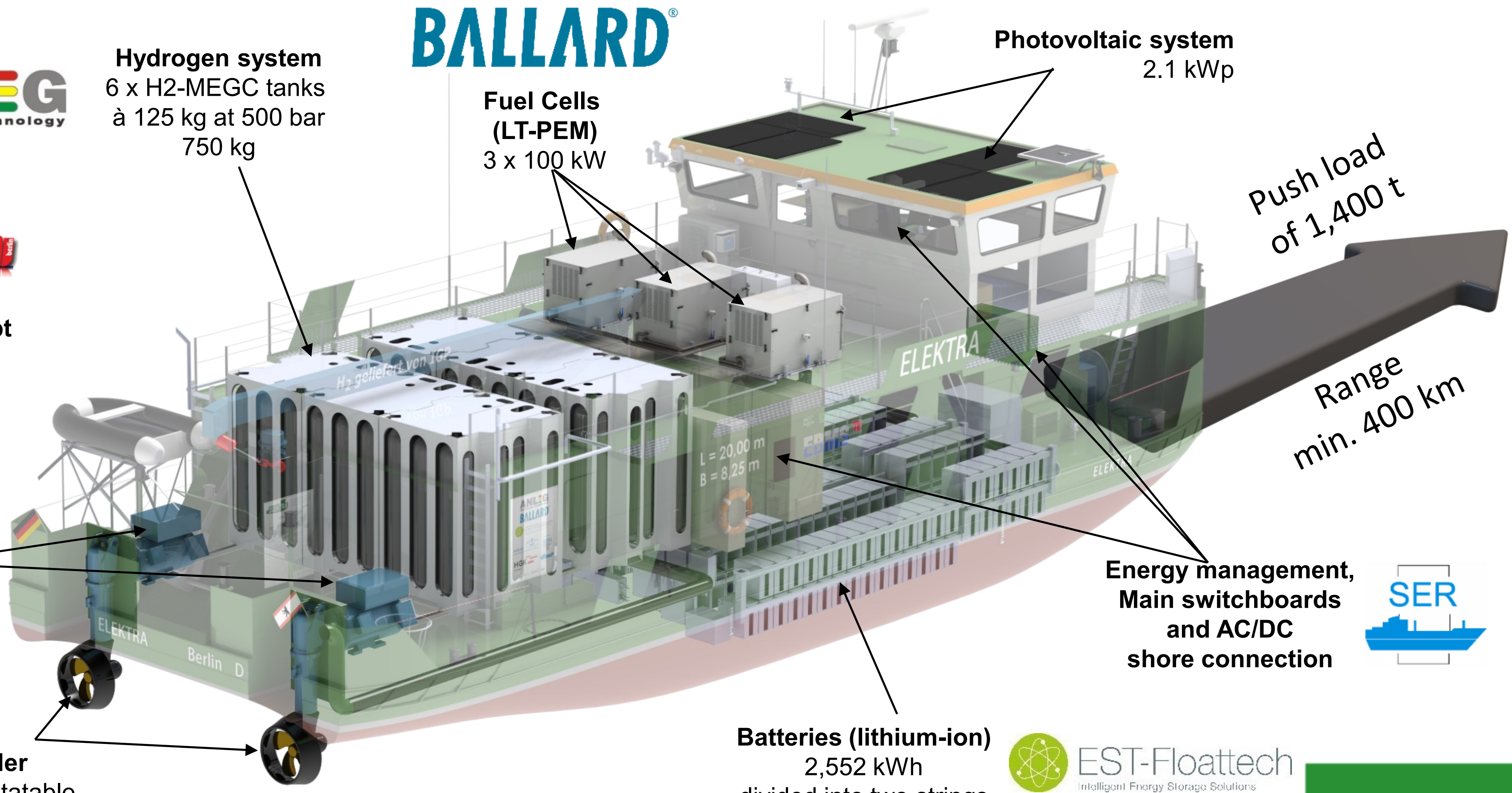
Operational range

- Total range with 1,400 t push load approx. 400 km
- Battery-electric: 8 h / 65 km / day
- Hybrid-electric: 16 h / 130 km / day

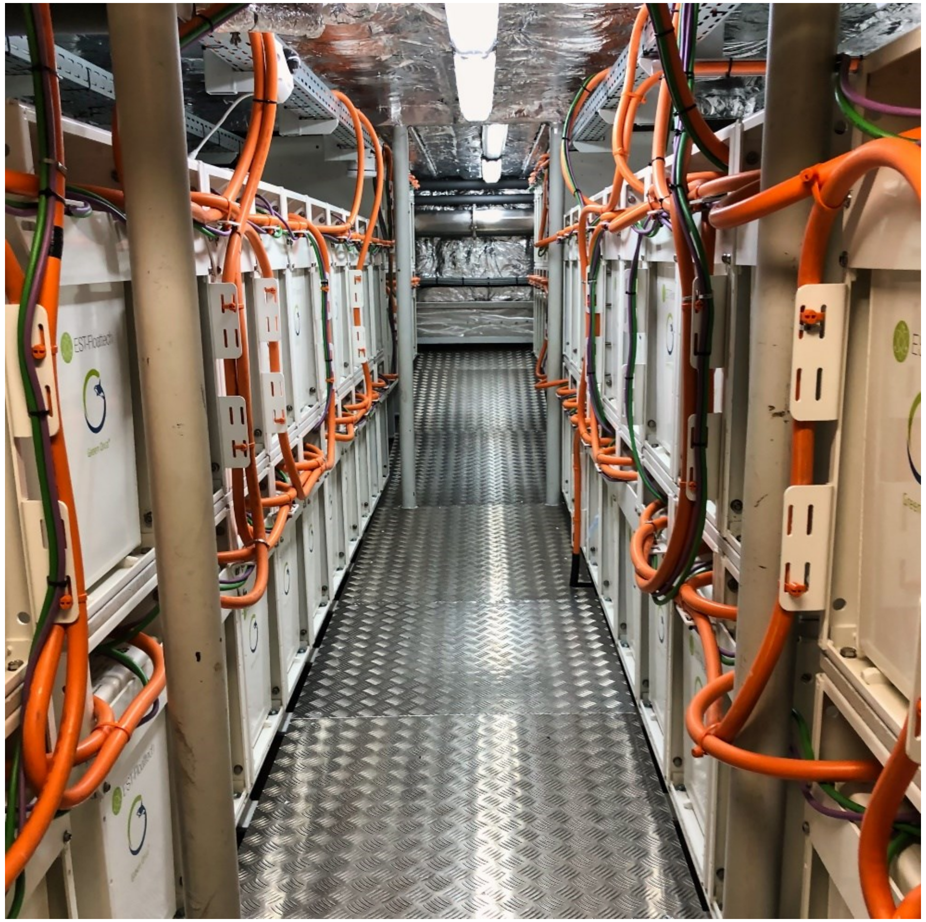
Propulsion

- Water-cooled electric motors: 2 x 210 kW
- Rudder propeller

ENERGY SYSTEM LAYOUT



ENERGY SYSTEM LAYOUT – BATTERY SYSTEM



EST-Floattech
Intelligent Energy Storage Solutions

- cell chemistry: NMC (nickel manganese cobalt oxide)
- total capacity:
    - 2,552 kWh (installed) (~ 2,160 kWh usable)
    - approximately 1,800 kWh @EOL (theoretically ~15-20 years)
- total system weight: approx. 25 tonnes (15 % of the ELEKTRA overall weight)
- incl. temperature management and integrated fire protection system
- no active fire protection in the room
- fully charged via shore connection in 7 to 8 hours (SER)

SER

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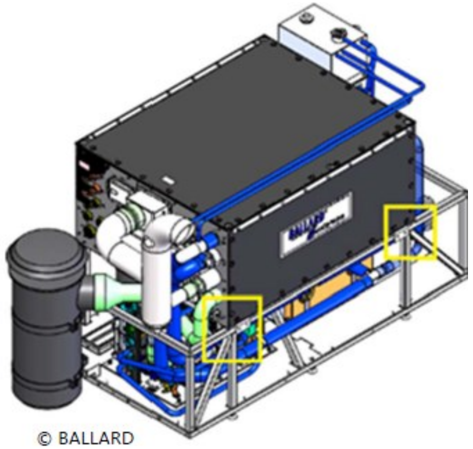
ENERGY SYSTEM LAYOUT – FUEL CELL SYSTEM



© BALLARD

© BALLARD

BALLARD®

- **LT-PEM-FC** incl. cooling (water) and compression system
- **3 x 100 kW** units installed on board
- **Individually independent operation**
- Goal: stationary operating behavior - approx. **200 kW base load**

  ~16 h continuous operation window
- Frost-proof
- Remote diagnostic capability
- Integrated H_2-sensor monitoring
- Service life up to 15 years, then refit if necessary

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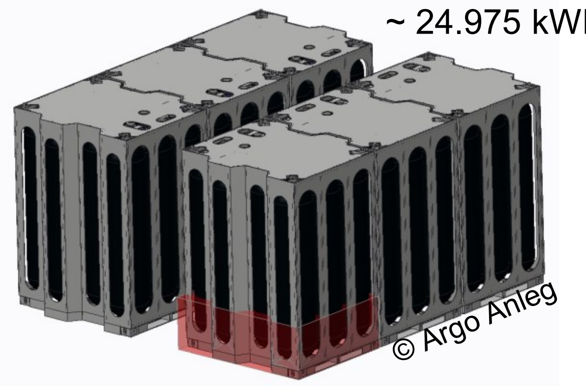
ENERGY SYSTEM LAYOUT – HYDROGEN STORAGE SYSTEM

ANLEG

- MEGCs (Multiple-Element Gas Containers)
- Type IV (carbon) high pressure cylinders, GH_2 500 bar
- 6 modules on board, 6 in circulation
- individually craneable and fork-lift truck capable
- Transport by truck trailer or ship
- Total mass: approx. 18 t
- 750 kg GH_2 usable on board

750 kg hydrogen
~ 24.975 kWh



2.550 l Diesel ~ 24.990 kWh

The „hydrogen dilemma“

- Energy content of hydrogen: 33.3 kWh/kg
- Energy content of diesel: 11.95 kWh/kg
- Density of gaseous hydrogen at a pressure of 500 bar: 0.031 kg/l
- Density of diesel: 0.82 kg/l

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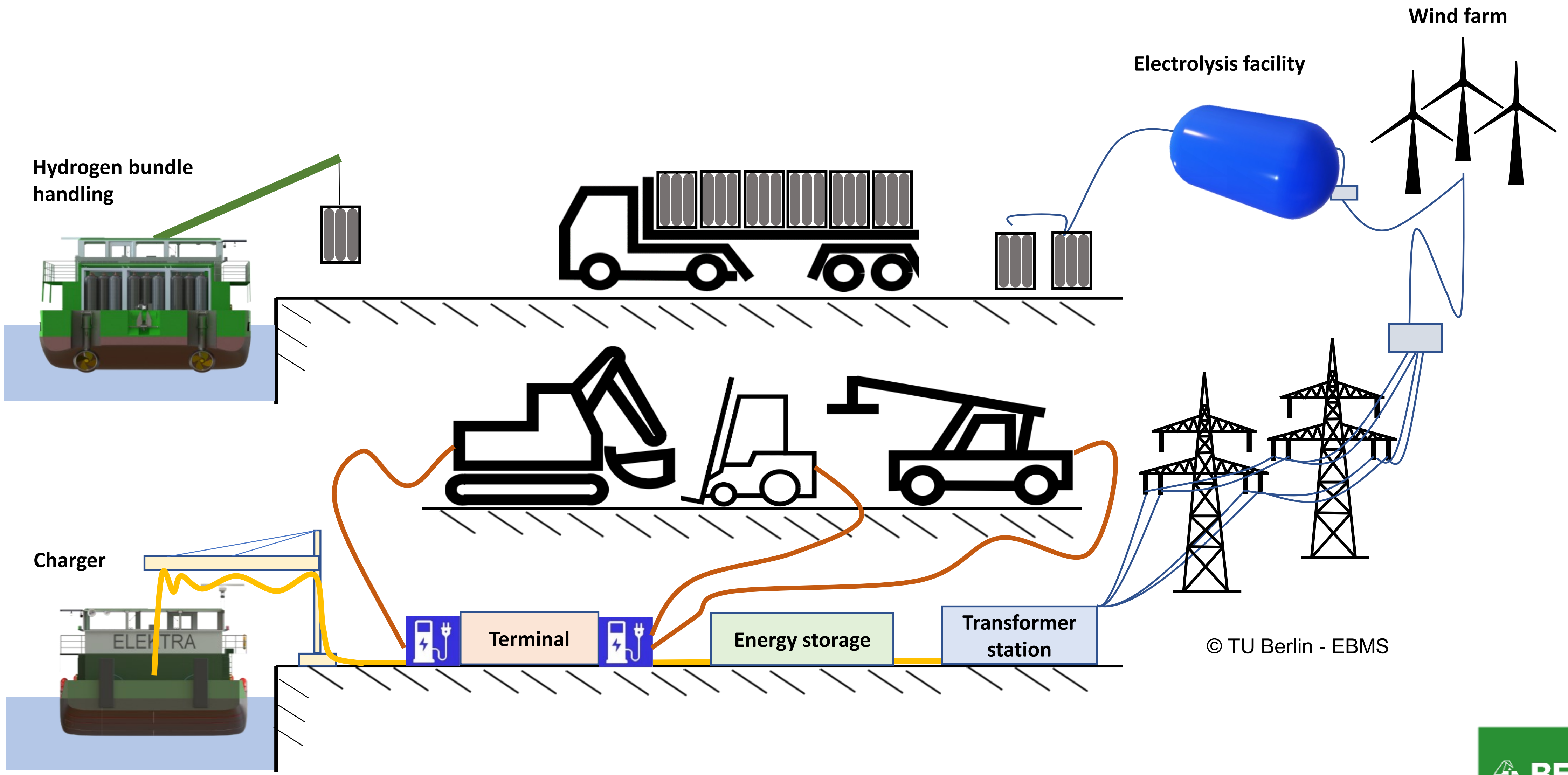
ENERGY SUPPLY INFRASTRUCTURE

- **Shore power** connections with **16 A CEE** plugs are **currently available** at some berths -> primarily used to **supply the on-board power supply**.

- **Medium-term expansion** of electrification of waterways **up to 32 A CEE system** -> ensure shore-side on-board power supply and avoid operation of ship's engines to generate electricity in port, **still not sufficient for charging!**

- Transmission of larger amounts of energy for storage in short periods of time, as is the case with electric vehicles, is **not covered by the described infrastructure. 63 A CEE** would be **sufficient, 125 A CEE even better** (both possible with the ELEKTRA AC-/DC shore connection).

CONCEPT FOR HYDROGEN AND ELECTRIC SUPPLY



SUMMARY

I. **Local and global low-emission** (= CO_2 and pollution-free) waterborne transport in metropolitan regions and supra-regional **is feasible today** (**zero-emission transport**, locally and globally, achieved through the further use of green hydrogen and green electrical power).

II. Further **development of** the **charging and H_2-infrastructure** is **necessary.**

III. **Cost** for green hydrogen and green electricity **must come down.**

IV. **Efficient inland waterway vessels** with H_2 fuel cells and battery energy storage systems **are feasible.**

V. **Rules and Regulations** enabling economic use of the technology **need to be created** and are **necessary** for reliable **investments** today.

VI. The energy system of the ELEKTRA is a **blueprint for inland and coastal shipping.**

<u>Thank you for your attention!</u>

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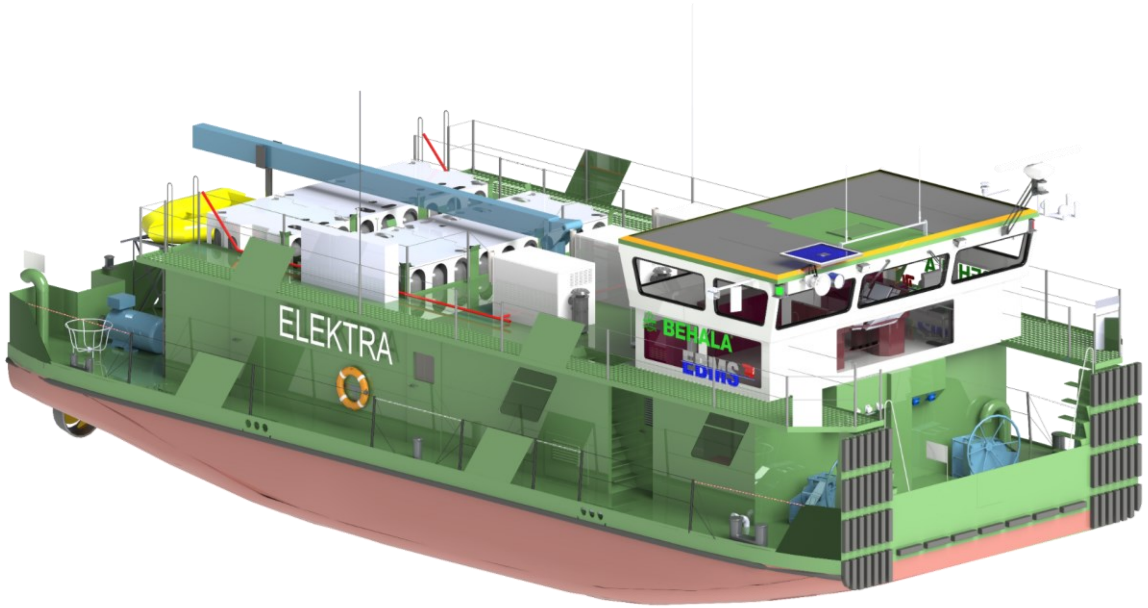

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