

ELEKTRA

The first emission-free push boat – from vision to realization



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INTERNATIONAL HYDROGEN SYMPOSIUM
Hamburg, den 24. Oktober 2019

Gefördert durch:



Bundesministerium
für Verkehr und
digitale Infrastruktur

Koordiniert durch:



ANLEG
Advanced Technology

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BALLARD[®]


Schiffswerft
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 **EST-Floattech**
Intelligent Energy Storage Solutions

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EDMS 

Agenda



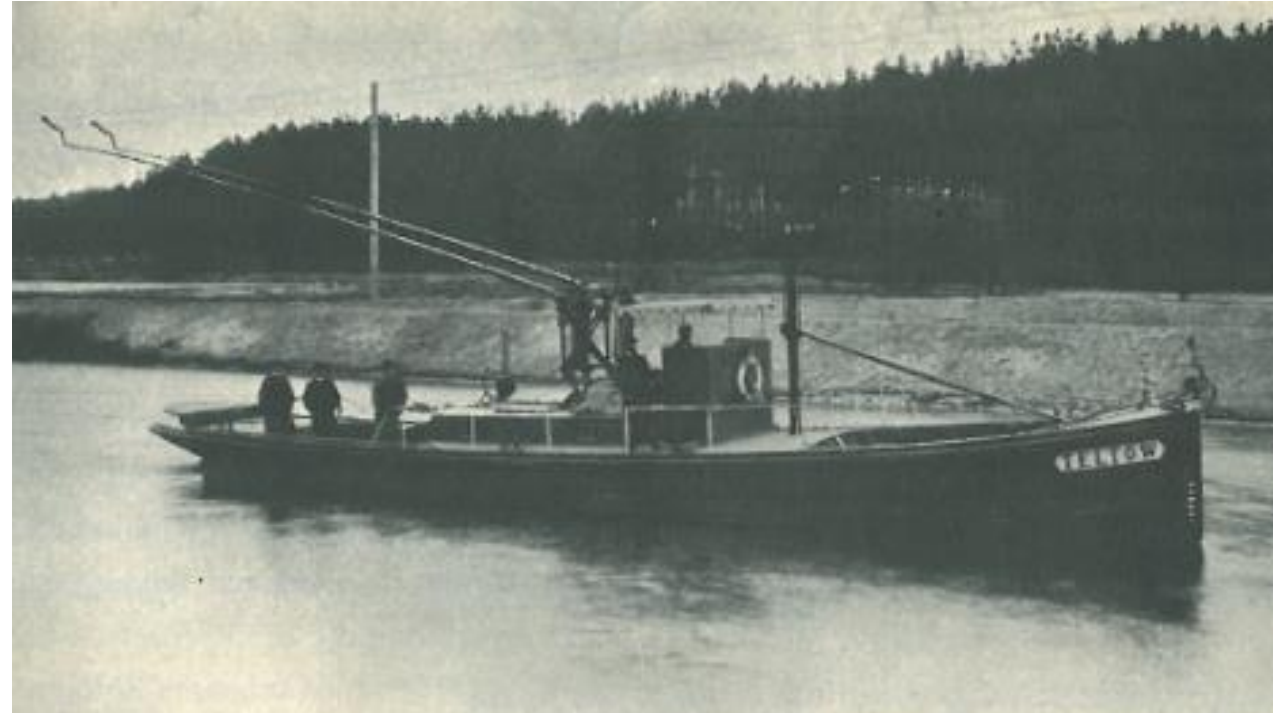
- 1. Local history**
- 2. Requirements and constraints**
- 3. Layout**
- 4. Supply of energy**
- 5. Summary**

1. Local history - nothing is fully new

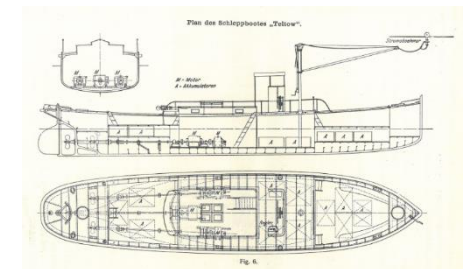


**1886: first electrical ship by Siemens & Halske
at the river at Spree „ELECTRA“ 25 passenger at 14 km/h.**

Quelle: Siemens



Tug boat „ Teltow“ 1906
- Tug convey up to 250 m length
- Trolley wire system
- Experimental vessel (Data lost)

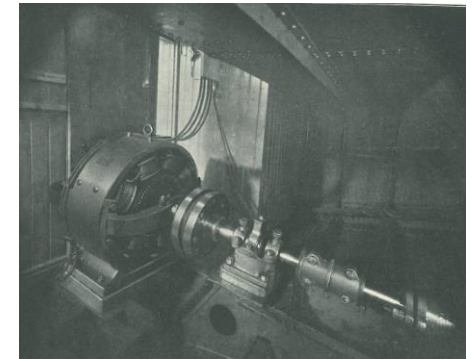


Quelle: Jahrbuch der Schiffbautechnischen Gesellschaft 1908

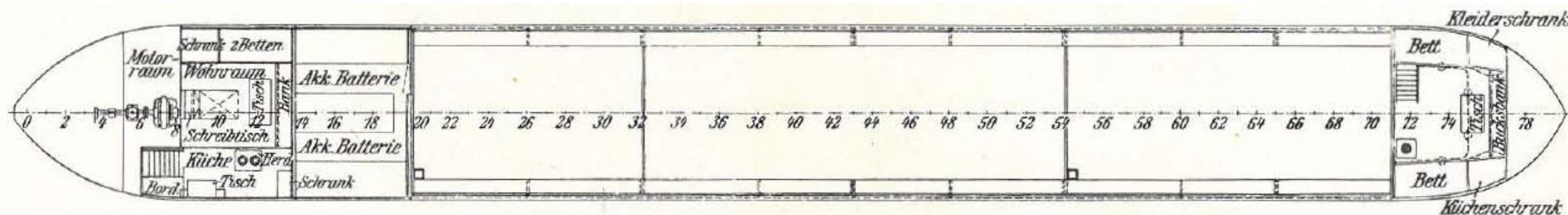
1. Local history - nothing is fully new



- **Transport idea:** brick transport from Zehdenick (*northern of Berlin*) to Berlin
- **Basis:** Finow-Maßkahn 40,0 x 4,6 x 1,3 m, 150 dwt
- **Power unit:** direct current 7 kW
- **Akkuweight:** 9,5 t (**6%!** from dwt, lead battery)
- **Range:** 90 km
- **Quantity:** app. 100 ships 1908



Germany 1908, Power up to app. 500 PS

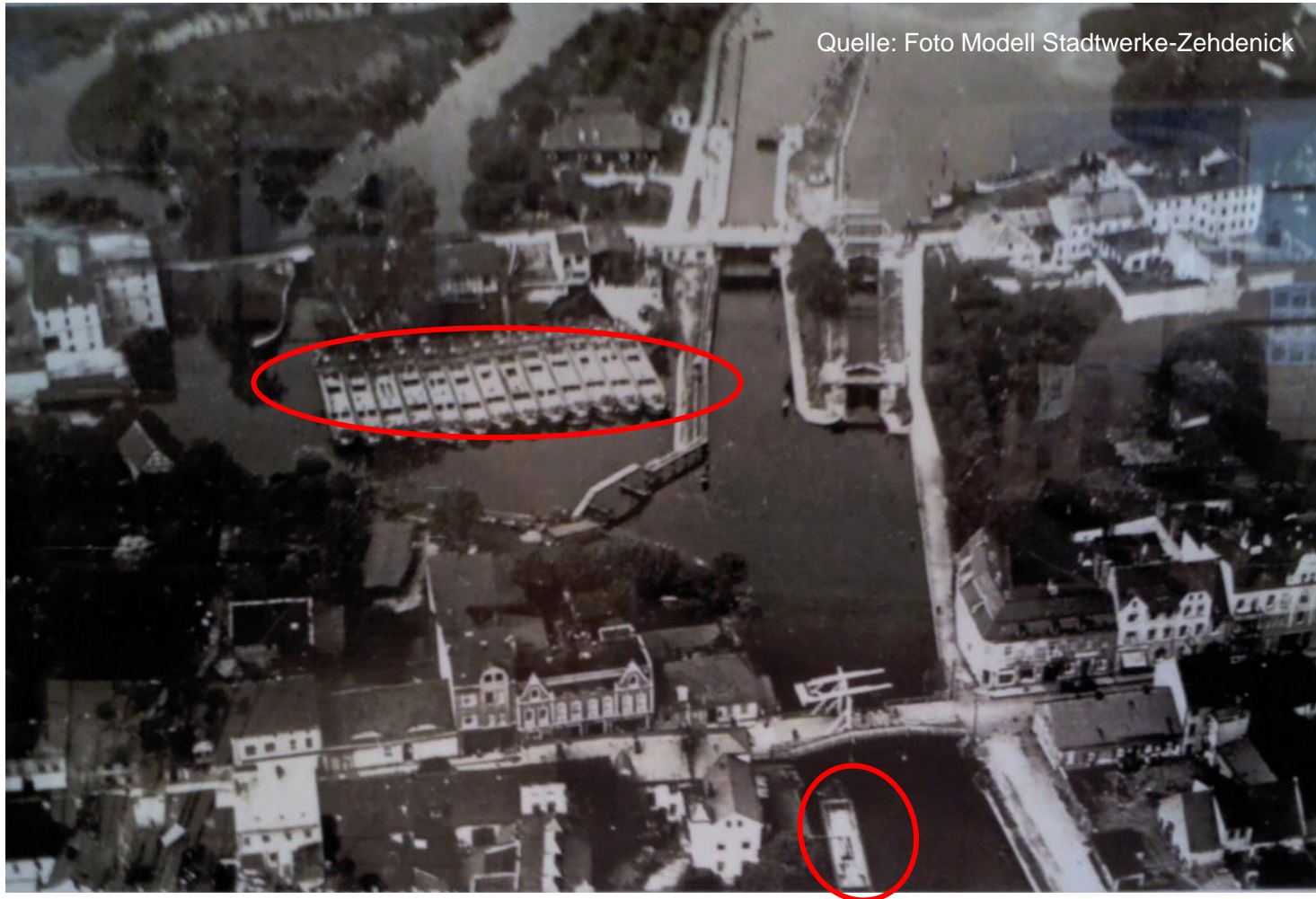


Source: Jahrbuch der Schiffbautechnischen Gesellschaft 1908

1. Local history - nothing is fully new



„Renewable“ electrical charging station at Zehdenick about 1910



Agenda



1. Local history
- 2. Requirements and constraints**
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2. Requirements and constraints – local and global emission-free



Main task „ELEKTRA“ in connection with „URSUS“:

- RoRo – project loads
regional / supra-regional transport of heavy duty 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

Ramp

length 265 m



2. Requirements and constraints – local and global emission-free

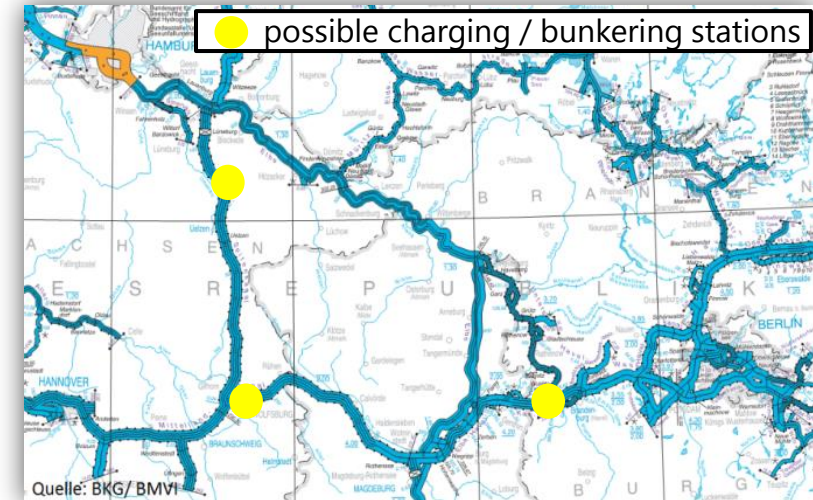


Regional operation



- Max. push load of 1,400 t
- Approx. range of 65 km
- Area of operation: zone 4
- Operational time of 8 h
- Average speed 8 km/h, up to 10 km/h
- Drive: battery or hybrid electric

Supra-regional operation



- Berlin ↔ Hamburg
- Max. push load of 1,400 t
- Approx. range of 100 km/d
- Area of operation: zone 3+4 (exc. Rhine)
- Operation time of 16 h
- Average Speed 8.5 km/h, min. 10 km/h
- Drive: hybrid electric (FC/accumulator)

Agenda



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3. Layout



Main dimensions

- length 20.00 m
- width 8.20 m
- draught 1.25 m
- displacement appr. 140 t

Operation

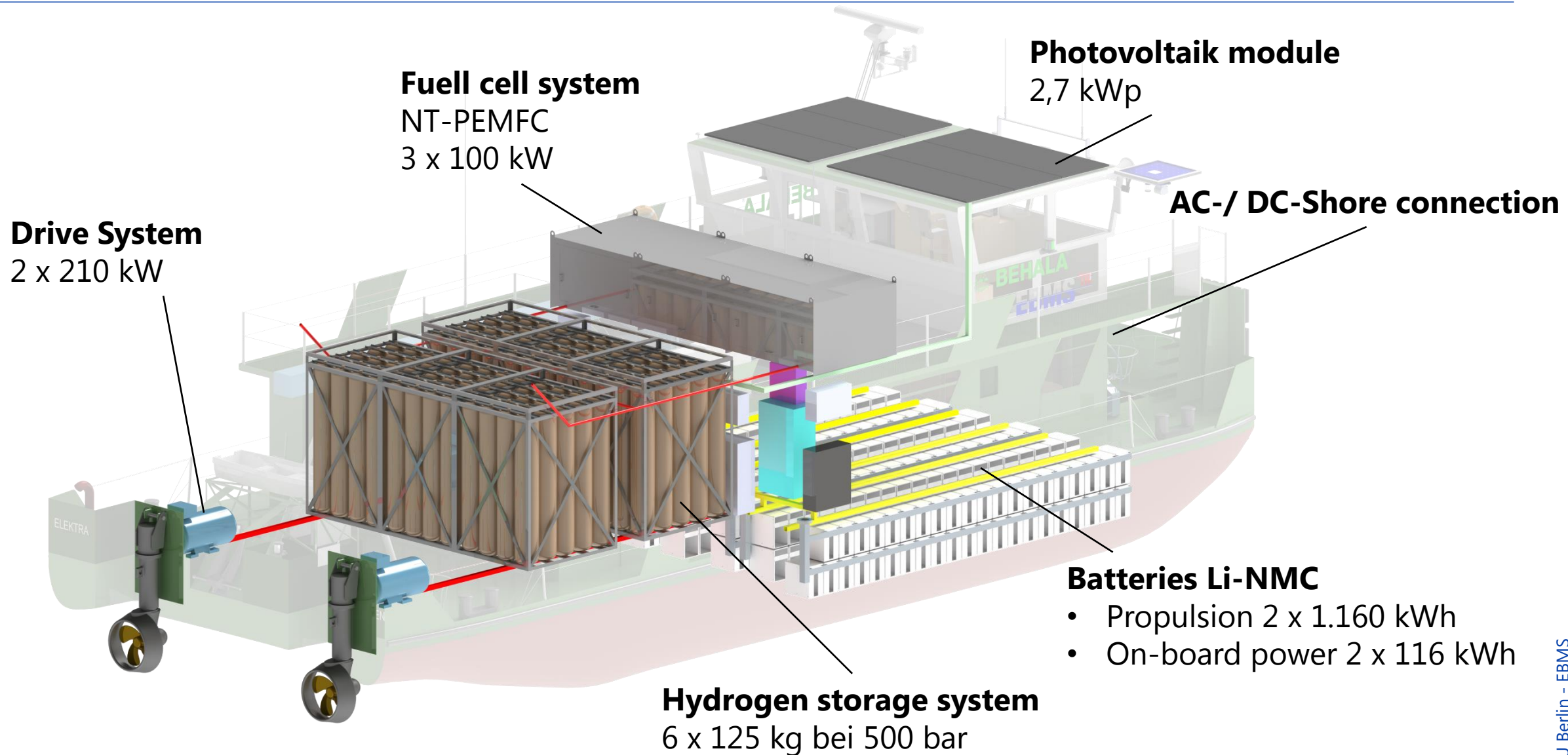
- Batterie-elektrisch 8 h / 65 km
- Hybrid-elektrisch 16 h / 100 km

Powertrain

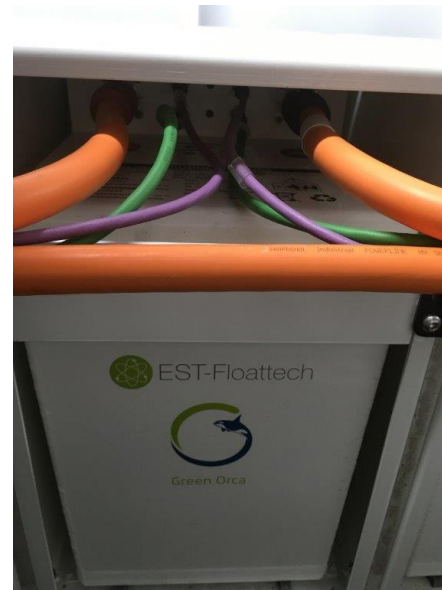
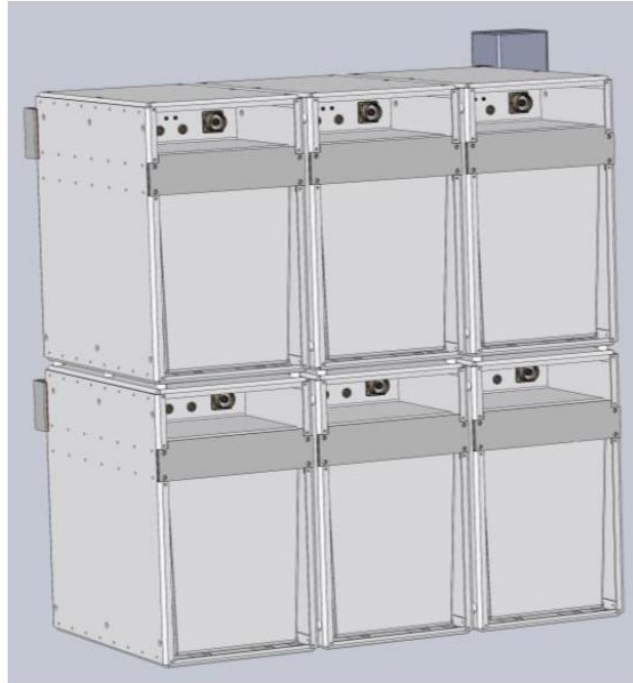
- power 2 x 210 kW



3. Layout – technical specifications



3. Layout – accumulators



Battery energy storage system

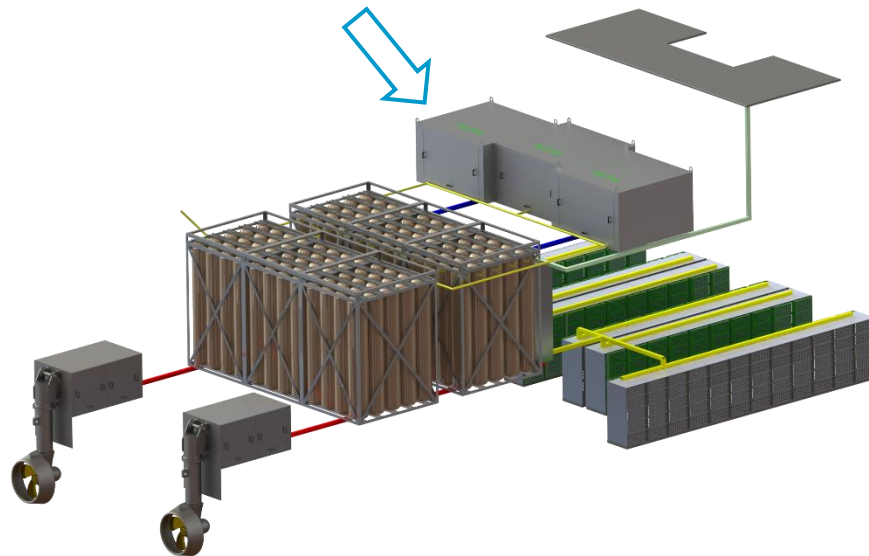
- **cell chemistry:** NMC (nickel manganese cobalt oxide)
- **total capacity:**
 - approximately 2,250 kWh (usable)
 - approximately 1,800 kWh @EOL (theoretically ~15-20 years)
- **total system weight:** about 25 tonnes (15 % of the ELEKTRA overall weight)
- incl. **thermo management**
- **integrated fire protection** system
- fully **charged** via shore connection in 7 to 8 hours

3. Layout – fuel cell system



Fuel cell system

- approximately **200 kW base load**
 - ~ stationary behaviour
- Small window of operation
 - ~16 h continuous operation



BALLARD®

FCveloCity®-HD 100

- NT-PEM incl. cooling and compression system
- **3 x 100 kW** units installed
- individually operable
- „freezable“
- remote diagnostics
- H₂-sensor integrated
- Durability approximately 15 years

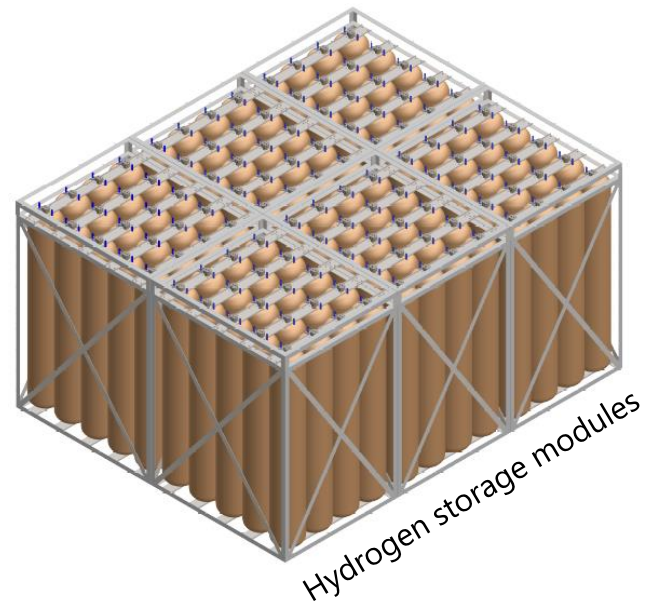
Arrangement of fuel cells system and hydrogen storage on board of ELEKTRA

3. Layout – hydrogen storage system



Hydrogen storage (exchangeable)

- Type IV high-pressure vessels, GH₂ 500
- 6 modules, individually crenable
 - transport by truck and trailer
 - Total weight: about 20 tonnes
- 750 kg GH₂ useable



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4. Supply of energy – examination of the route



Examination of

- Distances
- Operating ground speeds
- Optional minimum speed of 10 km/h
- Operating times
- Influence of the flow velocities
- Field measured energy demands (in locks)

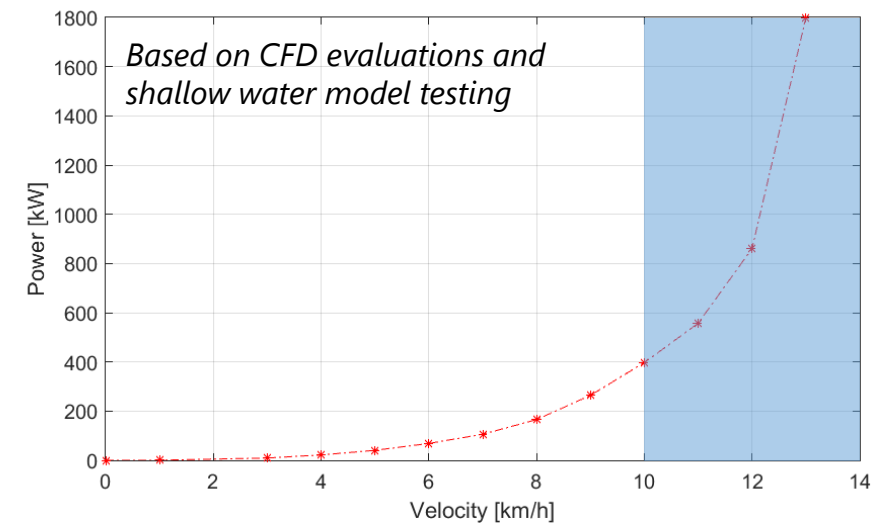
Hamburg

~ 395 km
one-way

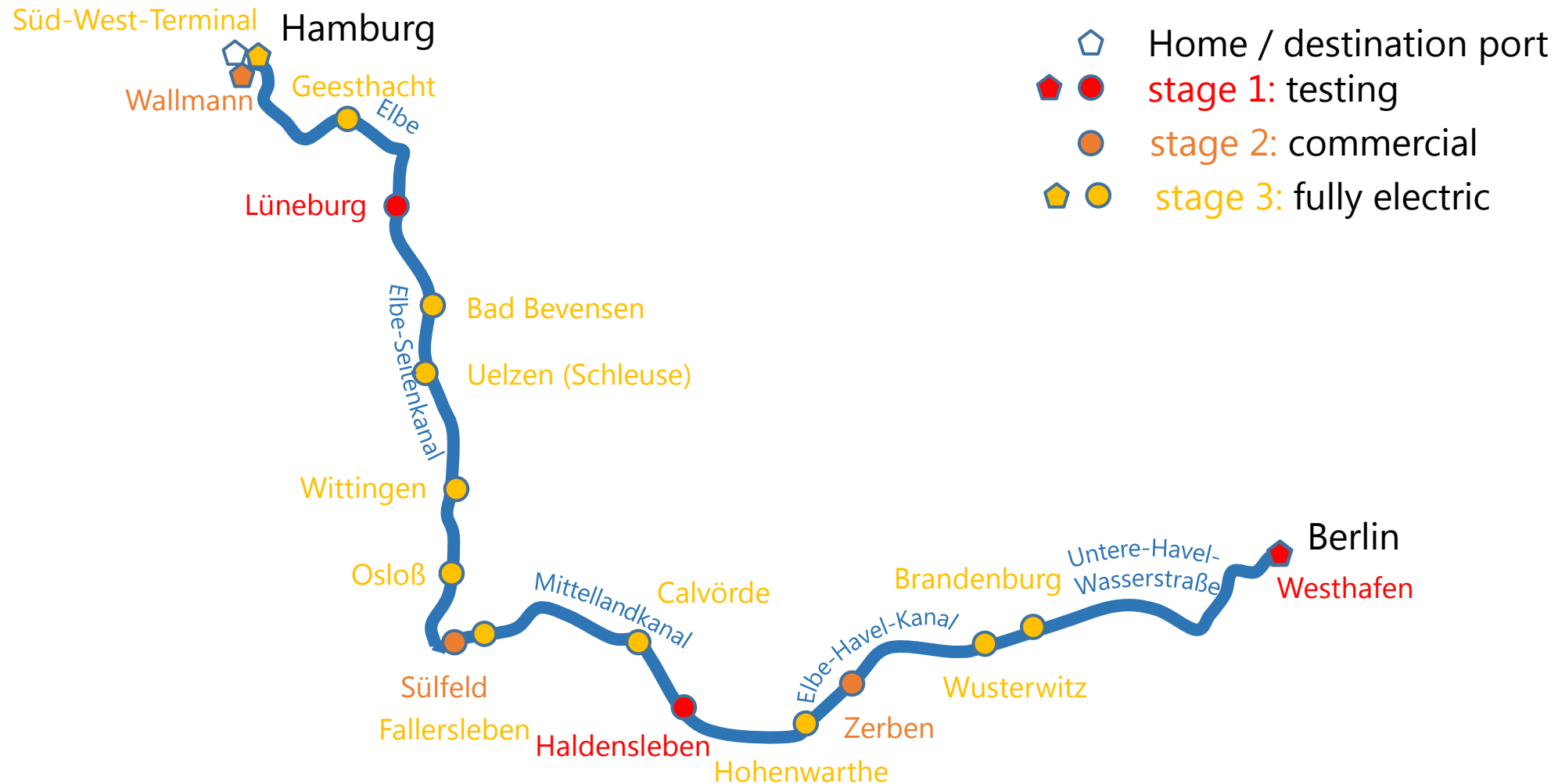
Berlin

Energy demand round trip

Demand driving energy (round trip)	~ 21.200 kWh
Demand driving energy (one-way)	~ 10.600 kWh



4. Supply of energy – infrastructure – charging stations



4. Supply of energy – scenarios for charging and bunkering



Scenario A



~ 10 %



~ 90 %

Scenario B



~ 25 %



~ 75 %

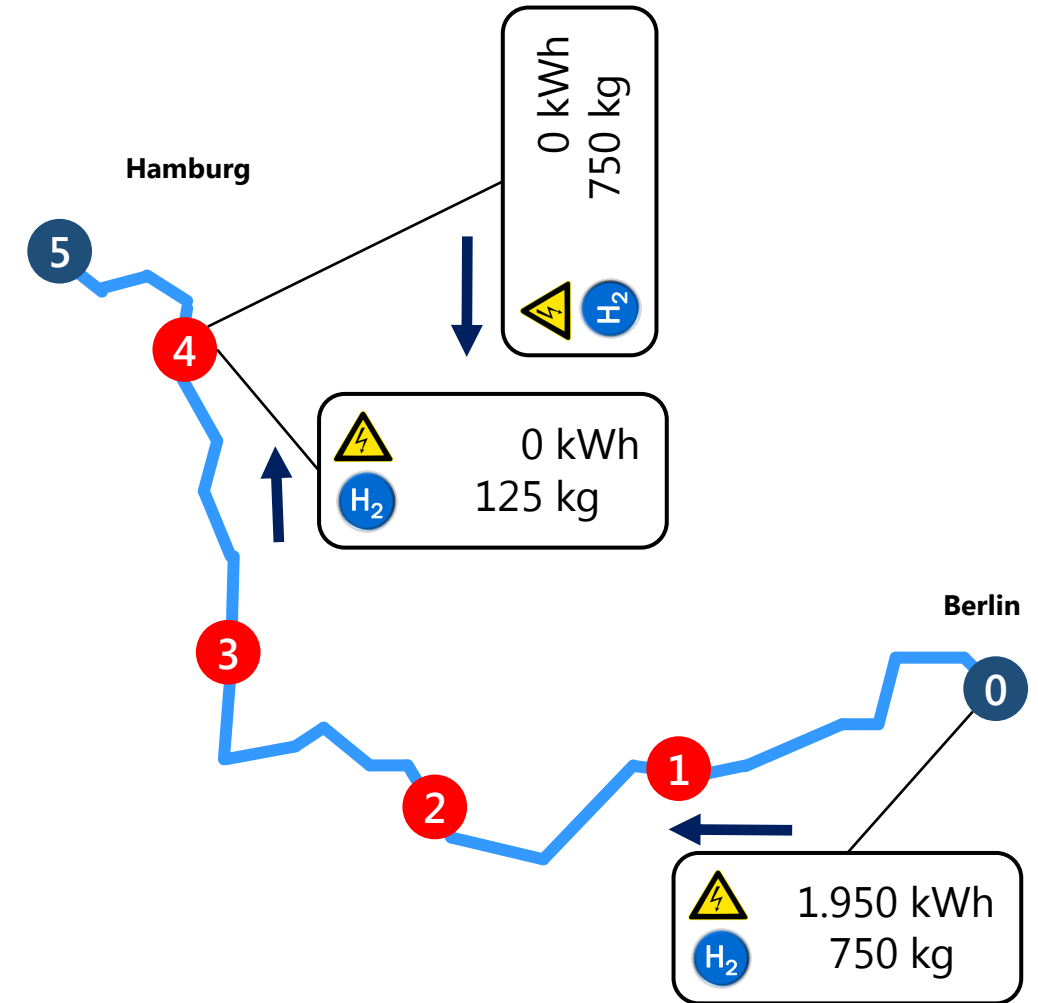
Scenario C



~ 40 %

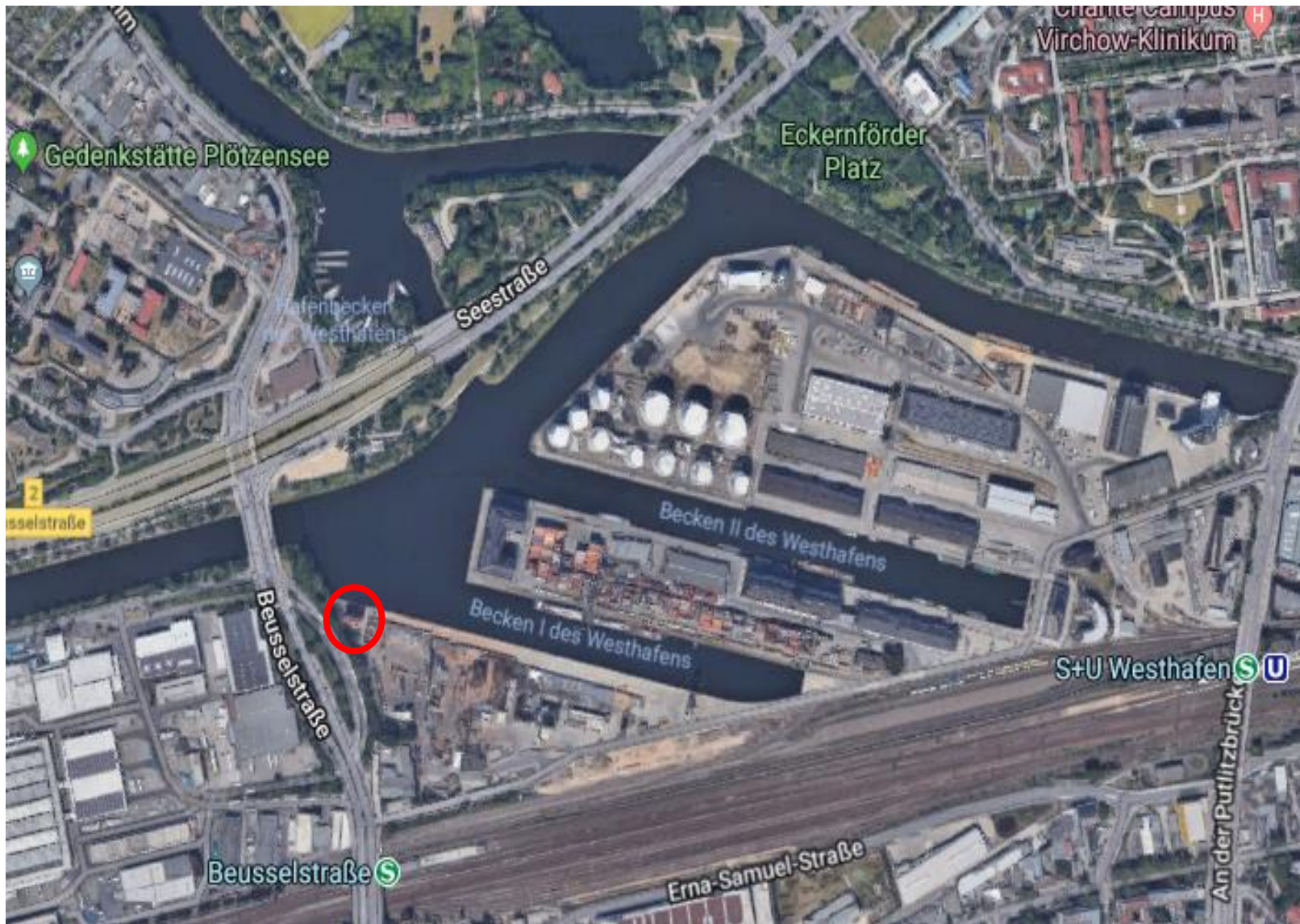


~ 60 %

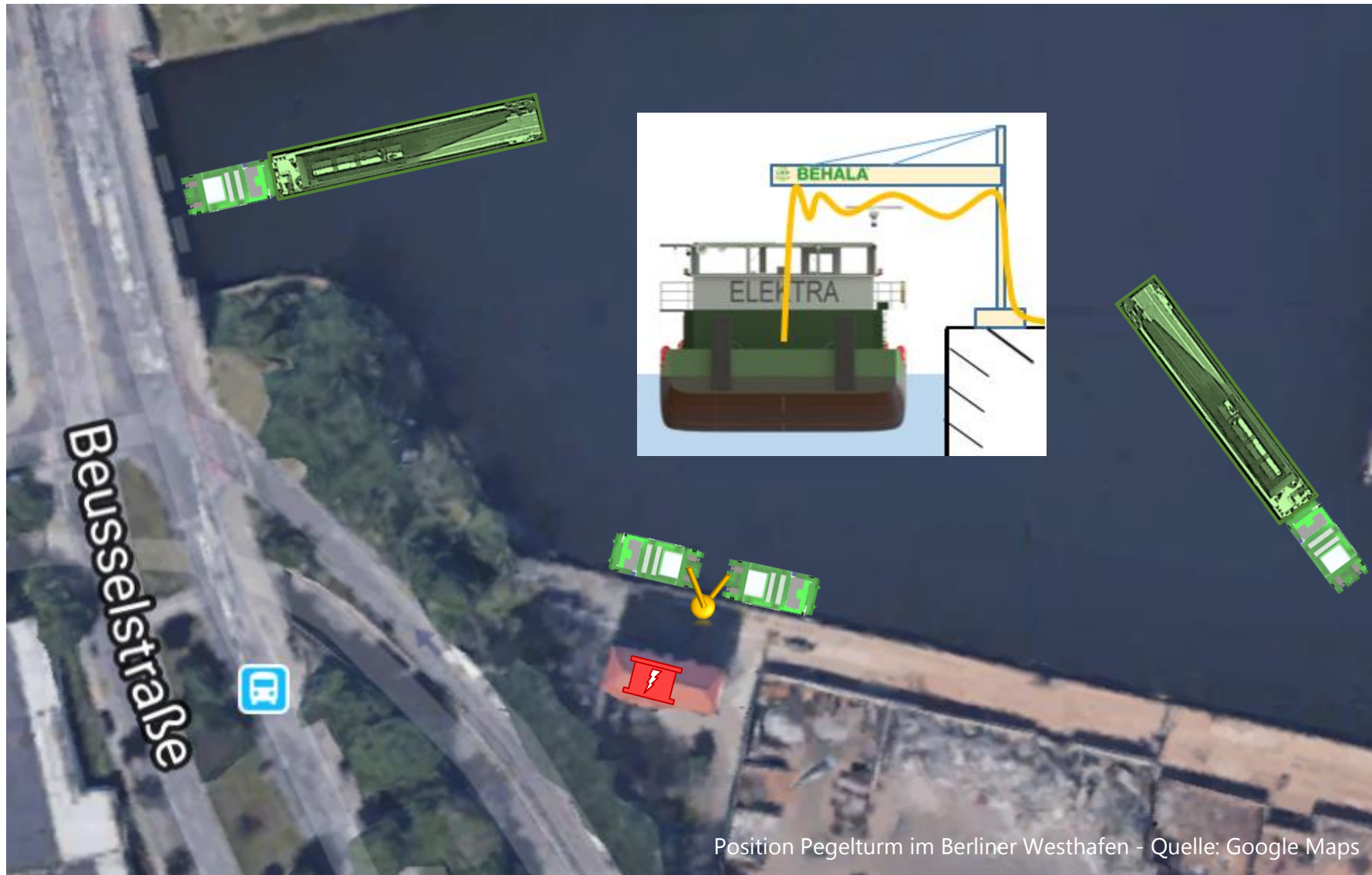


The flexibility to react on prices and availability of the resources (electric current and hydrogen) rises with the expansion stages.

4. Supply of energy – scenarios for charging and bunkering

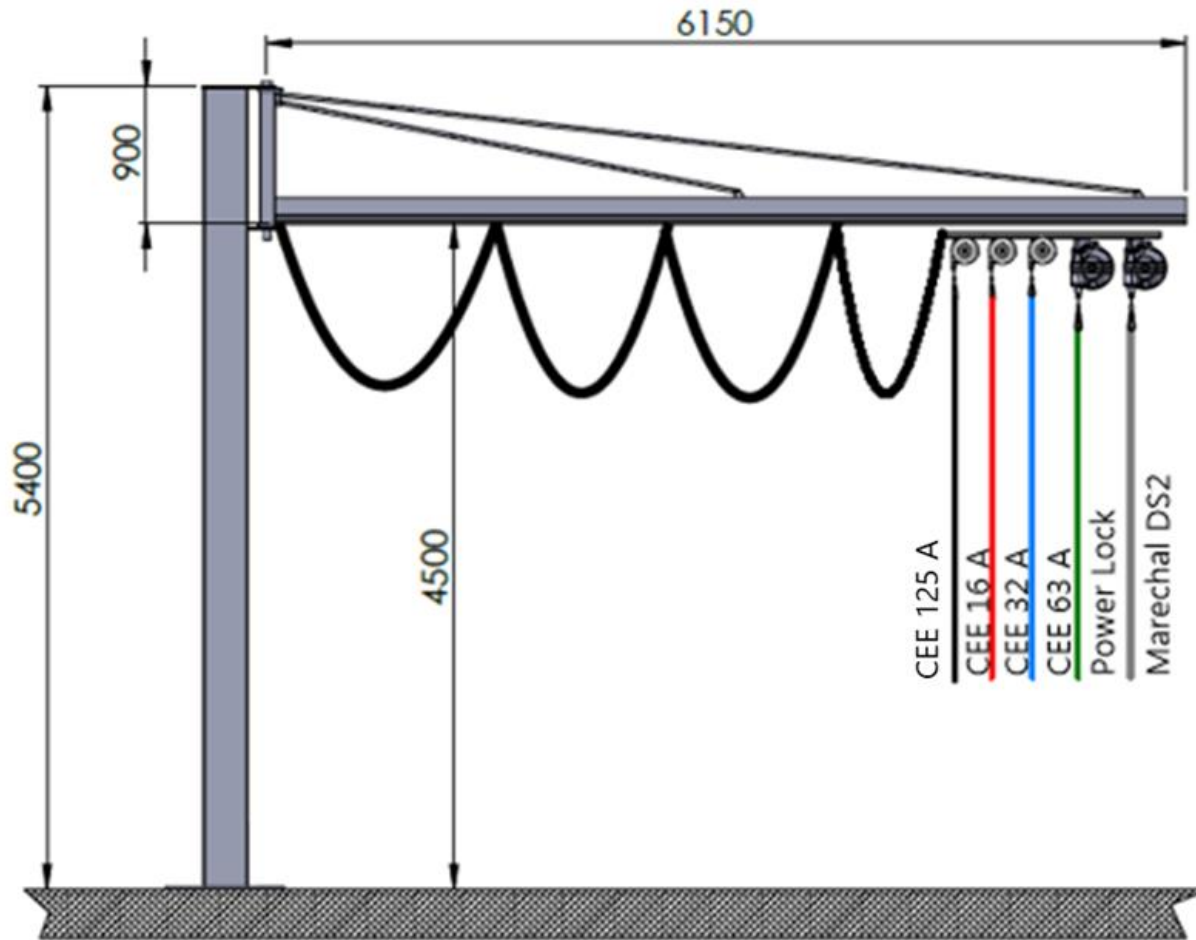


4. Supply of energy – scenarios for charging and bunkering



Position Pegelturm im Berliner Westhafen - Quelle: Google Maps

4. Supply of energy – scenarios for charging and bunkering



Charging gallows

With following connections

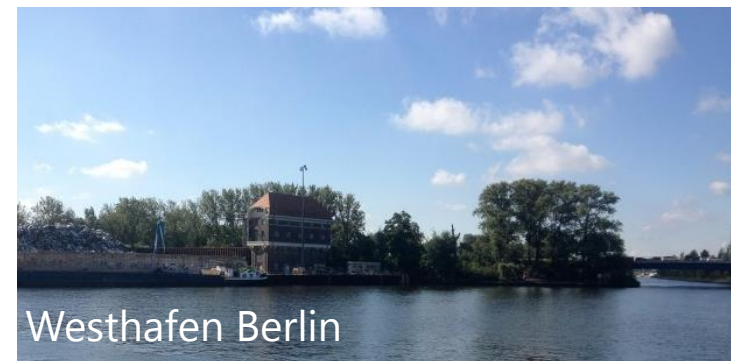
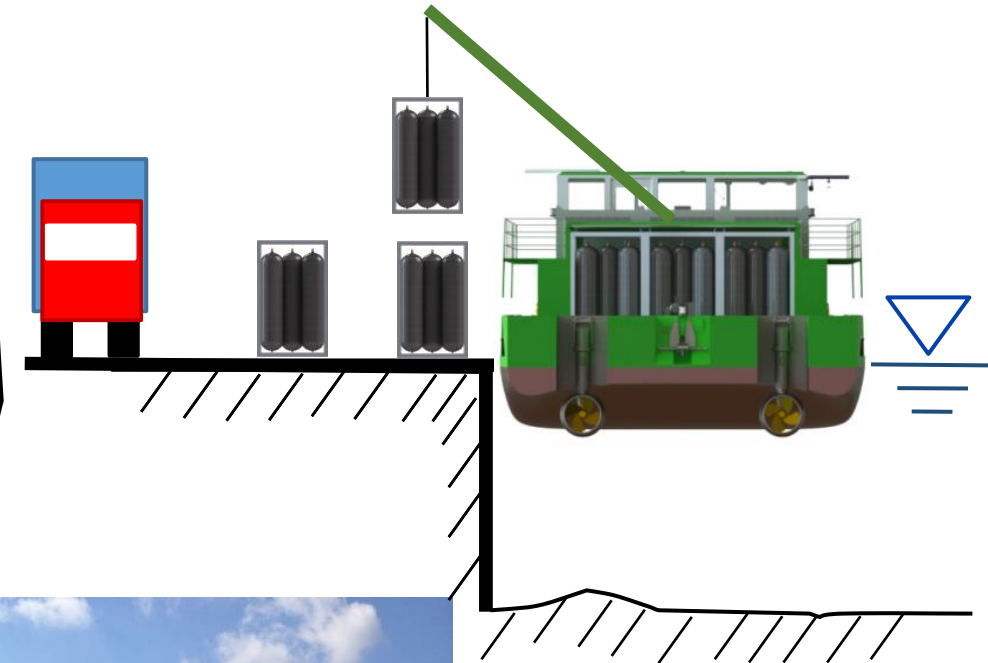
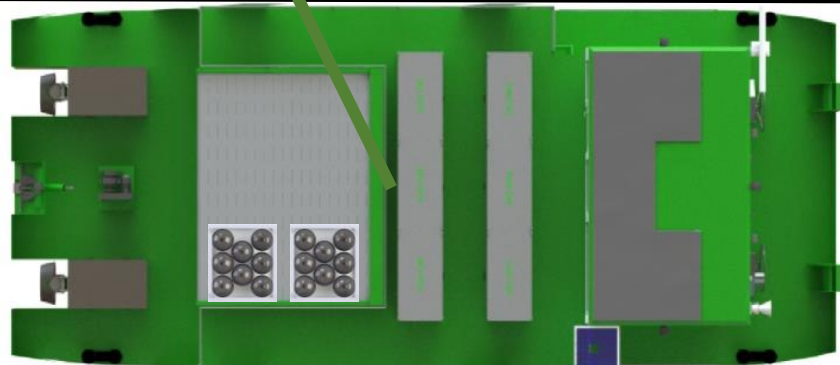
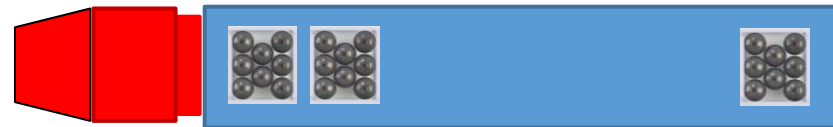
- a) CEE 16 A
- b) CEE 32 A
- c) CEE 63 A
- d) CEE 125 A
- e) Powerlock-System (400 V_{AC})
- f) Marechal DS2 (700 V_{DC})

Charging up to two shipunits



Exchangeable H₂-Tanks

- H₂-delivery by truck or train from the local area



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- **Local zero-emission transport in metropolitan areas is today possible**
- **Global zero-emission transport intended (green hydrogen, green electrical power) is possible**
- **Further development of the charging and H₂-infrastructure is necessary**
- **Cost for green hydrogen and green electricity must decrease**
- **Rules and regulations for reliable investments are necessary**



The ELEKTRA with the heavy cargo barge URSUS in front of the Berlin Westhafen port in 2021

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Outlook:	10/2019	Beginn of construction
	2020	Delivery at Berlin
	2021	Trail period