Overview of technologies for electric propulsion

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Definition

CHAPTER 11
SPECIAL PROVISIONS APPLICABLE TO ELECTRIC VESSEL PROPULSION

Article 11.00
Definitions

For the purposes of this Chapter, the following definitions shall apply

…

2. ‘electric vessel propulsion’ either a purely electric or diesel-electric or gas-electric propulsion installation of a craft, which is operated either by its own power supply or by the on-board network and comprising at least one electric propulsion motor. In the case of a diesel-electric or

Outline

- Motivation for electric propulsion
- Transfer from other modes
- Regulatory requirements
- Components

Motivation

- Less investment costs?
- Less energy costs?
- Less maintenance?
- More payload?
- More cargo space?
- Shippers pay higher freight rates?

- → Need for other drivers

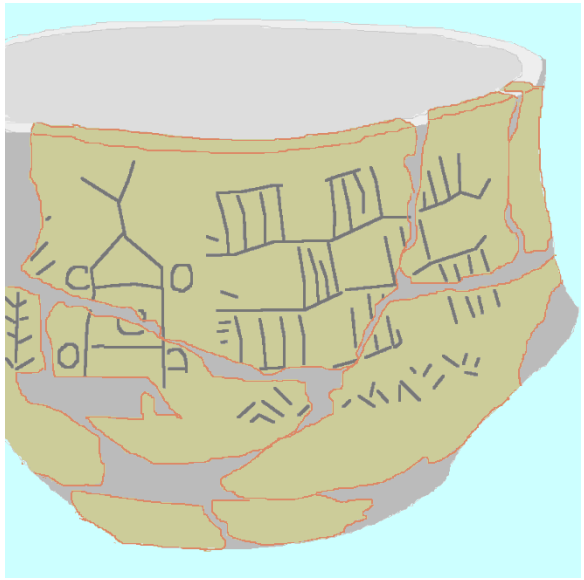
Motivation

- Global and societal challenge to mitigate climate change
- Awareness of health risks caused by air pollution
- Congested roads but reserve capacity on the inland waterways
- Long lifecycles may risk modal shift

- Air quality
- Noise and vibration
- Manoeuvrability
- Cargo attracting image
- Future proof
- Freedom in ship design
- Incentive schemes
- Funding where no business case

Other modes

- A great invention 5500 years ago
- Archimedes' principle even better at low speeds



Source: Wikimedia.org

Source: dpa

Source: www.geo.de/Reisen

- Environmental performance of rail and road improving at high pace

Other modes

- Rail
  - 50% of lines electrified
  - 80% of traffic with electric traction
  - Overhead Line or conductor rail
  - Electricity from the grid
  - Diversity of systems (1.5 kV DC to 25 kV AC)
  - Kinetic Energy Recovery

Other modes

- Road
  - Overhead Line
  - Electricity from the grid
  - Lithium-Ion Batteries
  - Kinetic Energy Recovery
  - Charging at home
  - E-Scooters, Pedelecs, Cars
  - Urban Transport
  - Long haulage and FC drives in development

Source: PINTSCH BAMAG

And IWT?

- Long lifecycles
- Inefficient propulsion
- No access to energy from the grid
- Almost no charging infrastructure
- No recuperation

1908 Battery

Source: virtuellesbrueckenhofmuseum.de

1967 Overhead Line

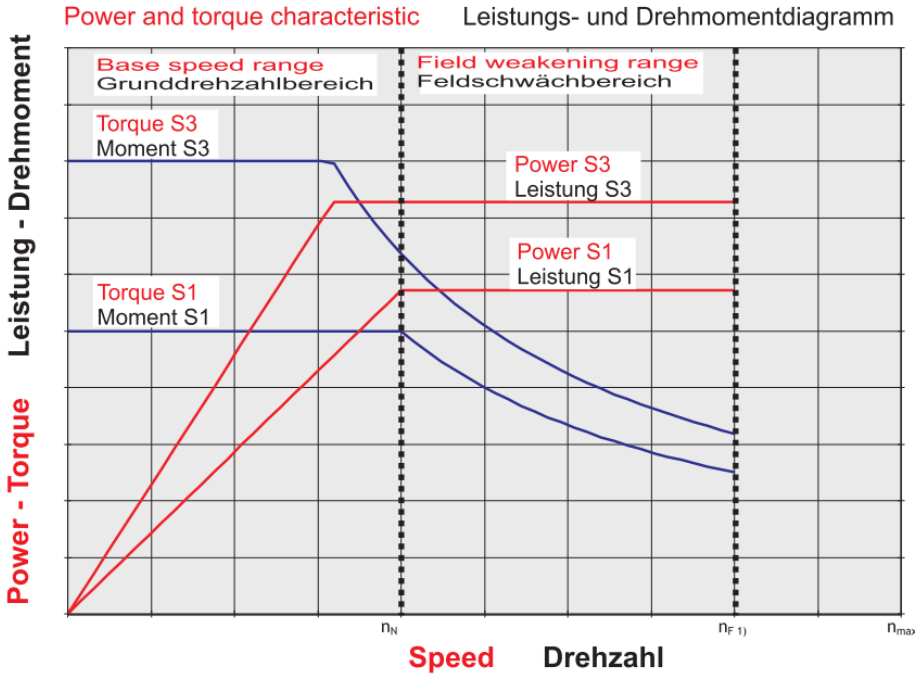
Source: strausbergereisenbahn.de

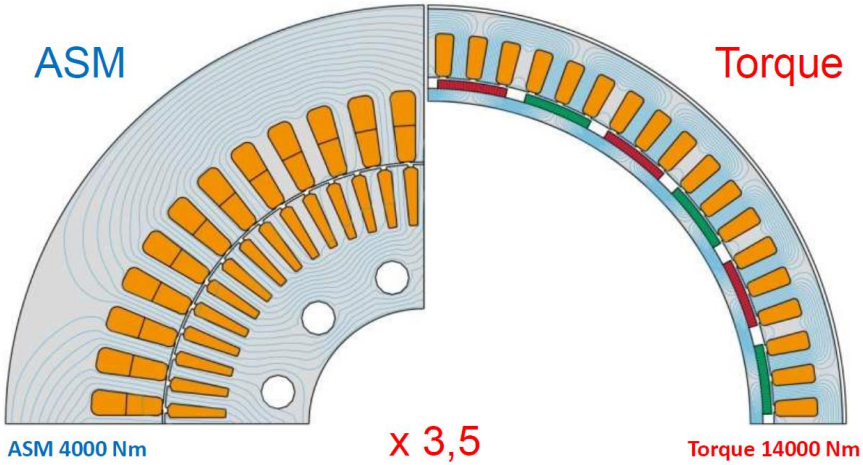
Regulatory Requirements

- ES-TRIN 2021 – Chapter 11
- Article 11.01 – General Provisions
  - At least two electrical power sources, switchgear, motor, …
  - One electric motor: Capability of making steerageway in case of a fault in the power electronics and/or control system
  - General plans including the propulsion components
  - Monitoring of battery capacity, always sufficient to reach a berth, alarm at critical capacity
  - … and many more to guarantee safety for cargo, crew and navigation

Electric engine

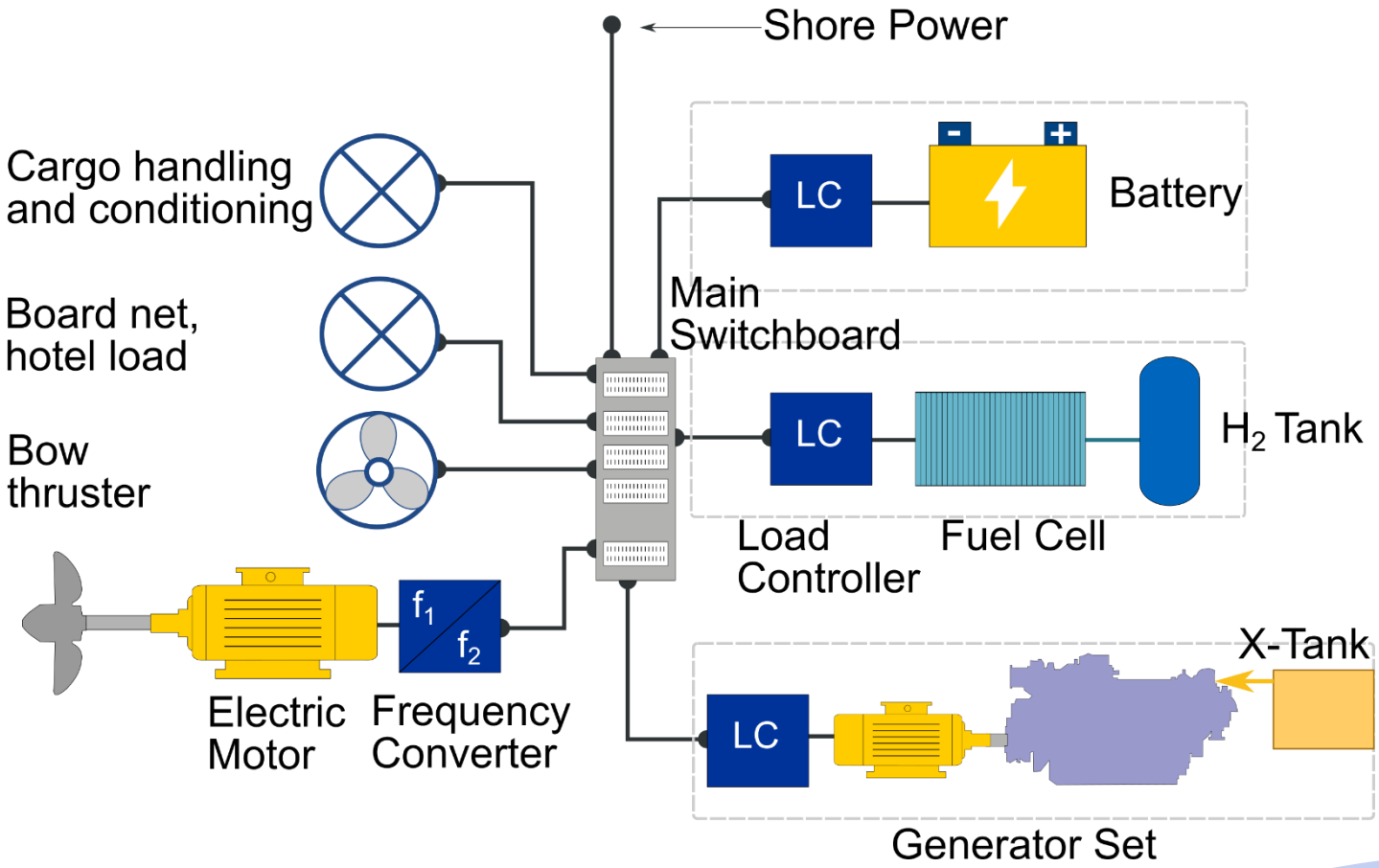
- Permanent-magnet synchronous motors can drive the propeller without a gearbox
- The same torque requires ~20-30% of weight and volume of asynchronous motors (ASM)





Source: OSWALD

Hybrid systems



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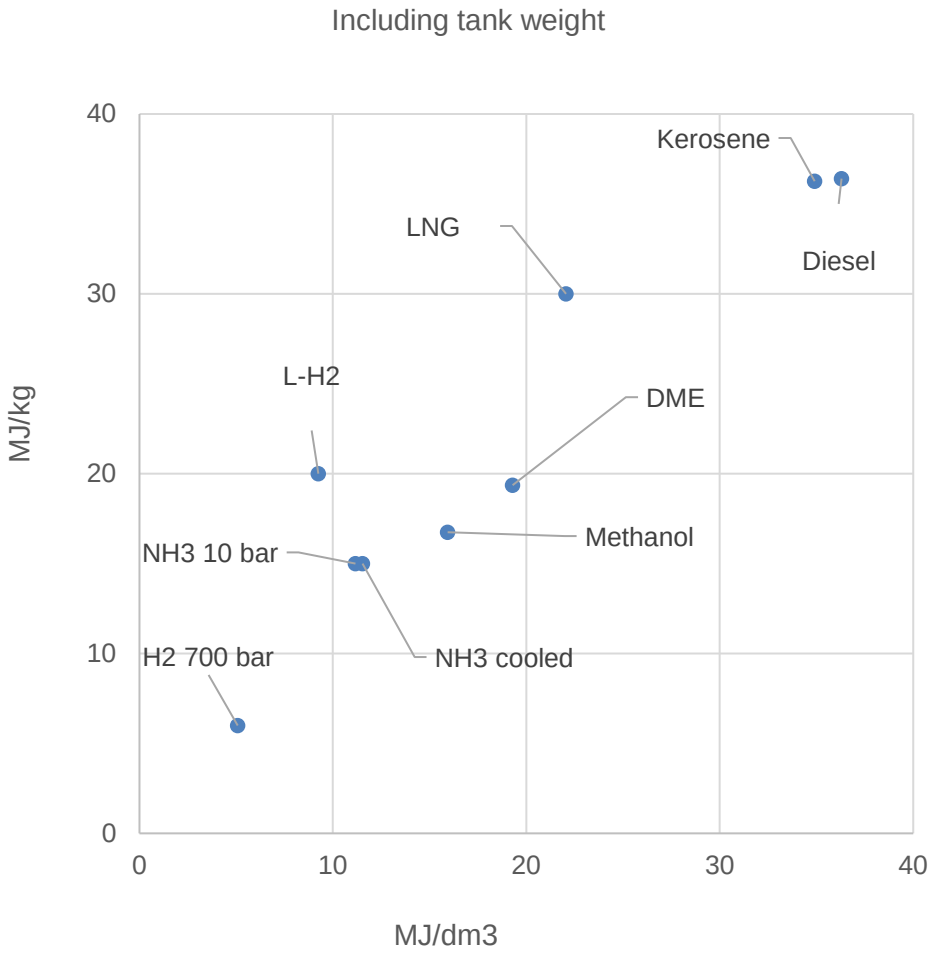
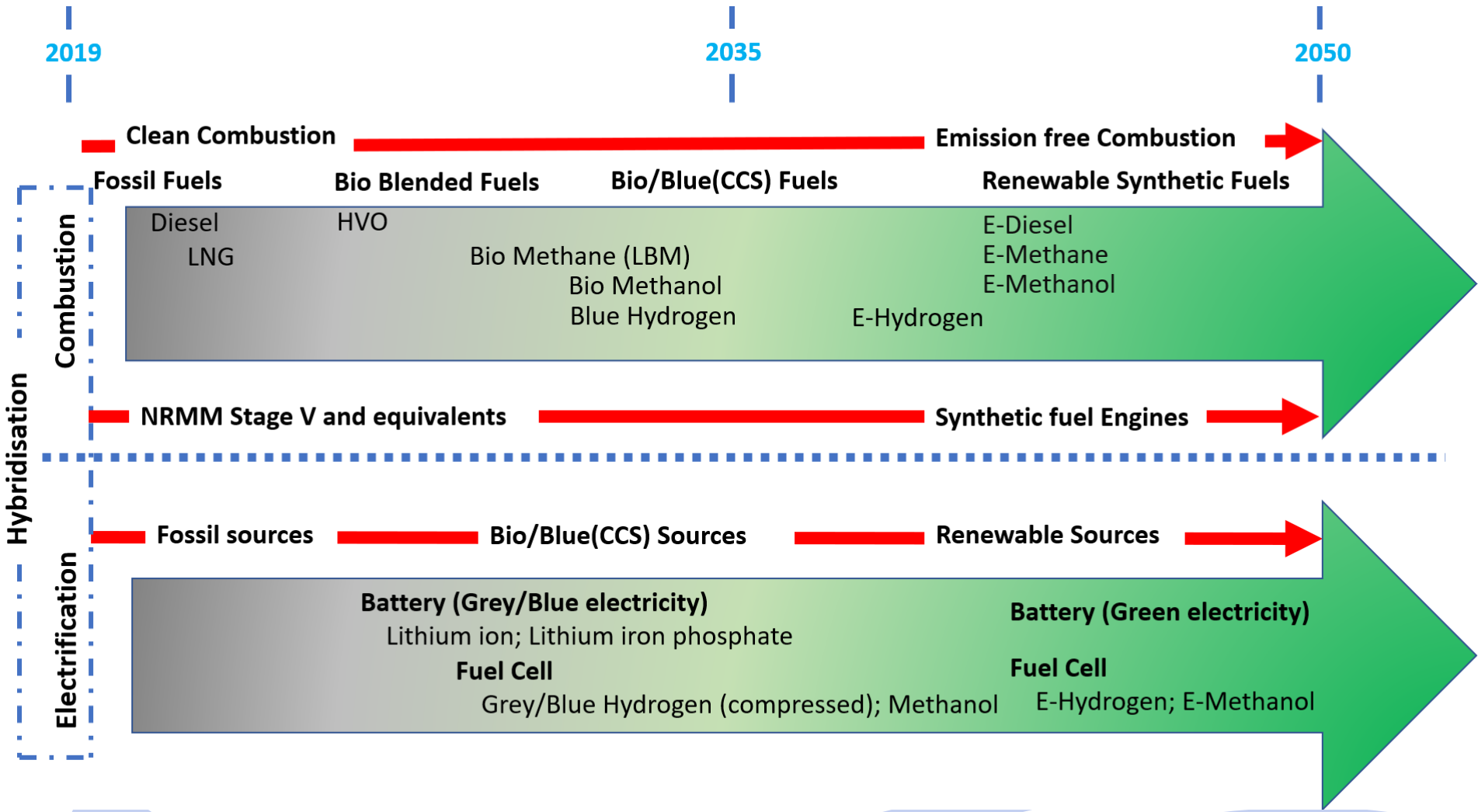
Energy density of fuels



Factor compared to diesel fuel	Volume factor based	Packaging factor ship	Volume incl. space factor
Methanol	2,3	1	2,3
LNG	1,6	2	3,2
NH3 cooled	3,1	1.1	3,1
NH3 10 bar	3,1	2	6,3
cryogenic H2	6,3	2	12,5
comp. H2 700 bar	7,1	2,5	17,7
comp. H2 350 bar	12,5	2,5	31
Battery	50	2	100

Transition Pathways



Questions?

Thank you for your attention!

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