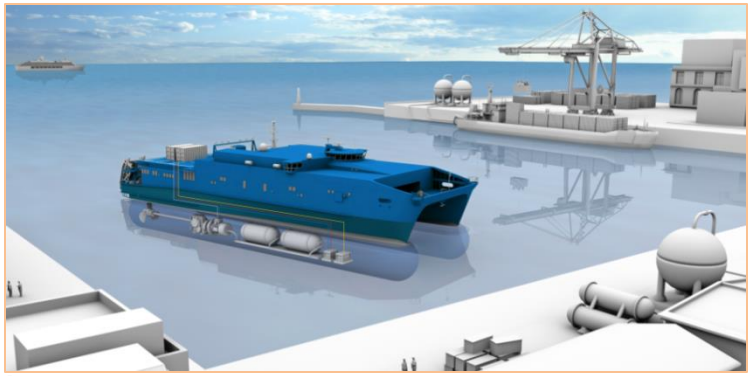
https://www.br.de/nachrichten/wissen/schiffe-emissionen-umweltschutz-lng-windenergie-haie-autonom,RJBY11k

Innovative technologies for shipping without CO_2 emissions

Digital Meeting of the Working Group of the Baltic Sea Parliamentary Conference on Climate Protection and Biodiversity as open stream for 04.10.2021
from Dr. Alexander Dyck

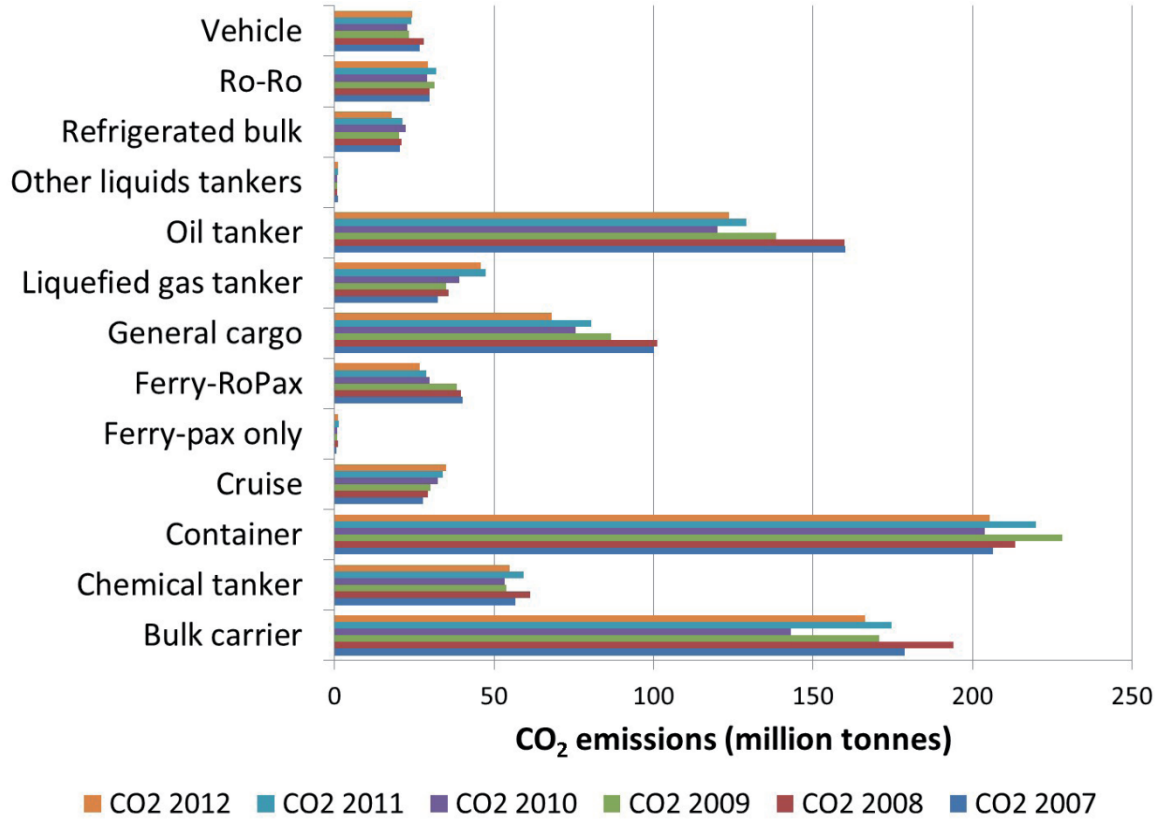
DLR Institute of Maritime Energy Systems



Motivation for Founding the Institute – Decarbonization of Shipping

Achieving a leading role in the technology development of CO_2 reduction

- Recognizing and reducing the impact of shipping on global emissions (3%)
- Maritime economy as an economic factor for Germany as business location
- Strengthening the regional location with scientific research (training + spin-offs)
- Superregional visibility for Germany and Europe as location for innovative technologies
- Lage-scale research infrastructure with test vessel for integrating and testing modular energy concepts
- How will the future supply of sustainable fuels take place?



Emissions by ship type – Smith T., et al. (2015). Third IMO GHG Study 2014. International Maritime Organization (IMO). Micropress Printers, Suffolk, UK.

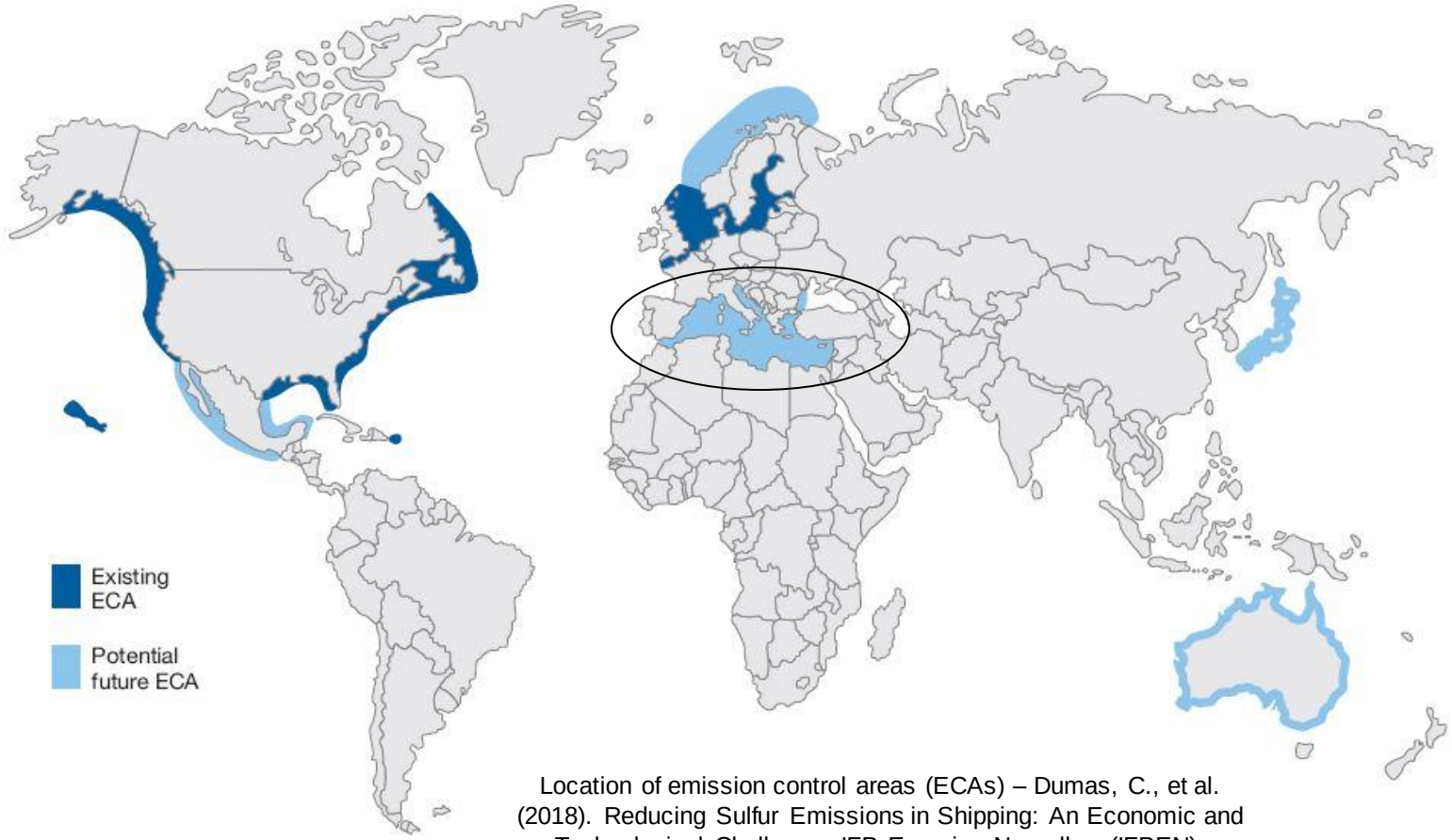
Challenge: Reducing Emissions

Worldwide shipping routes with global emissions of CO2 (3%), SO2 (13%), NOx (15%) and soot

Shipmap.org – Kiln Data Visualisation Studio, London, UK

Challenges: Low Emission Fuels are Needed for Access to Restricted Areas

Application oriented research on LNG supports short term emission goals



Location of emission control areas (ECAs) – Dumas, C., et al. (2018). Reducing Sulfur Emissions in Shipping: An Economic and Technological Challenge. IFP Energies Nouvelles (IFPEN).

Contribution to Global Emissions by Shipping

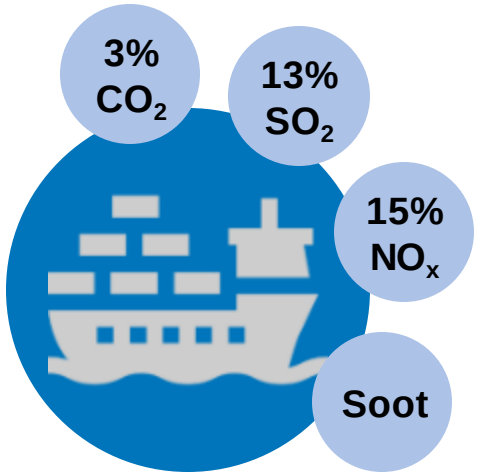


Image done using resources from flaticon.com

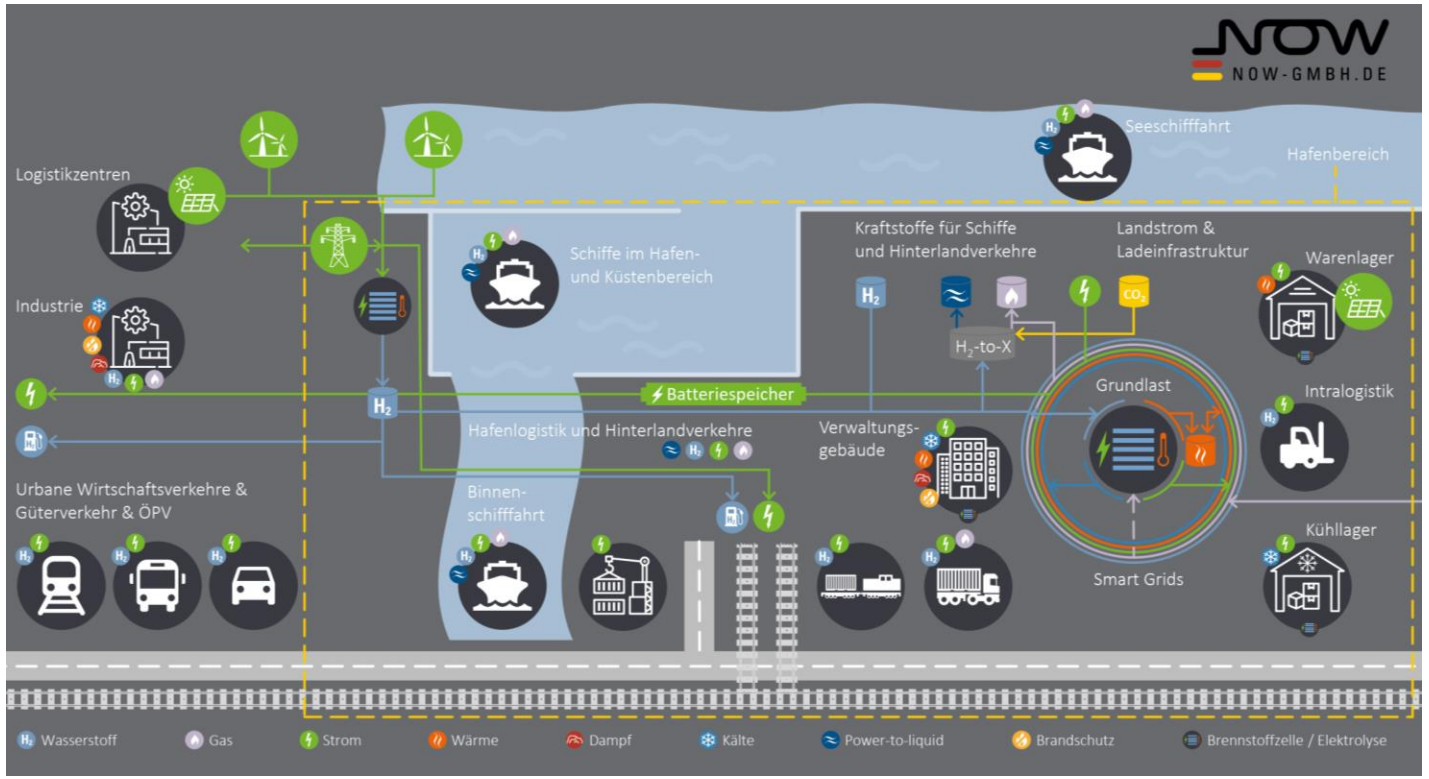
Emissions Impact

- Climate
- Health
- Environment

DLR Institute of Maritime Energy Systems

Scientific targets & main research

- CO_2 free energy systems in shipping
  - Store and loading fuels on board
  - Use of converters
  - Developing energy grids on board
  - Provision of electricity, heat & cooling
  - Grant of maneuverability
- Alternative fuels (supply and import)
- Synergies in port operations
- Onshore energy supply infrastructure

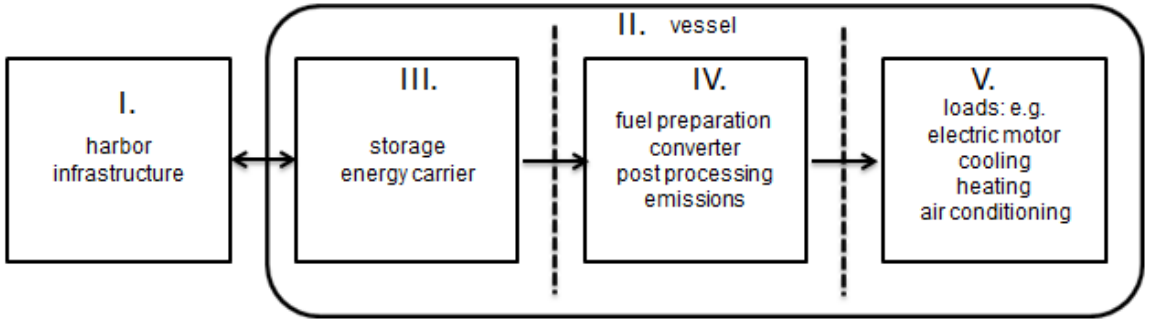


Integrated Port Energy System – Schumacher, E. (2020). Informationsveranstaltung HyStarter-Region. Organisation, Hyland, Maritime Anwendungen. NOW GmbH.

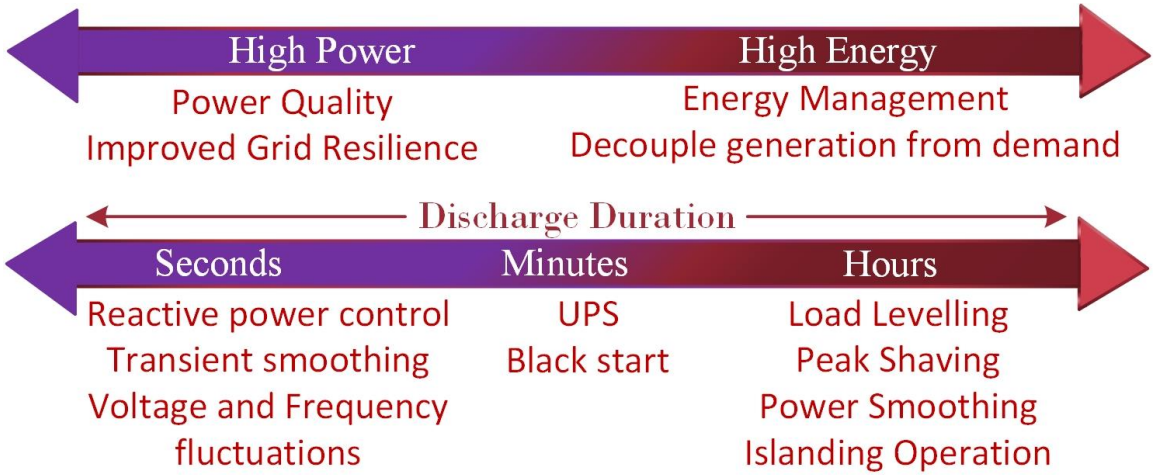
Industrial Cooperation

Partners over the whole value chain will be adressed

- Shipyards (mainly cruise & special ships)
- Technology manufacturer (e.g. dual-fuel engines)
- Ship equipment supplier
- Shipping companies
- Port operators



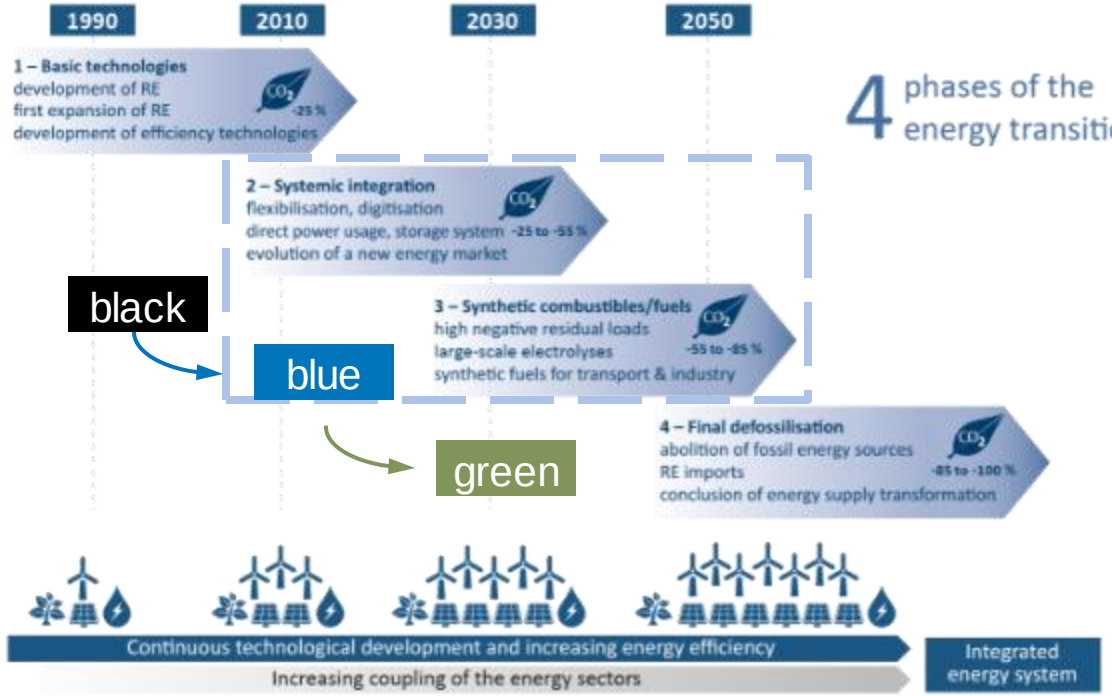
Topics of the institute – Dyck, A. et al. (2020). Institute of Maritime Energy Systems. Description of the new DLR research institute in Geesthacht, Schleswig-Holstein. German Aerospace Center DLR. Cologne, Germany.



Energy storage applications & their discharge timings – Mutarraf, M.U., et al. (2018). Energy Storage Systems for Shipboard Microgrids – A Review. In: Energies, vol. 11, no. 12.

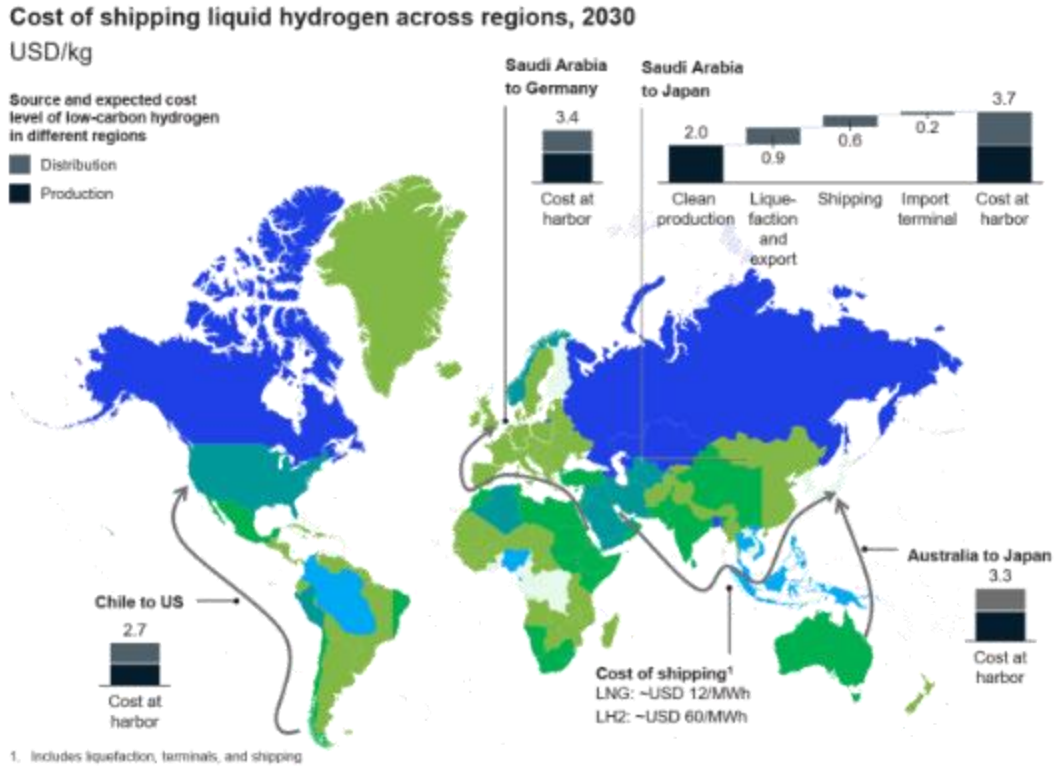
Future Development in Shipping

The four phases of the energy transition



Hacker, J. et al. (2018). Coupling the Different Energy Sectors – Options for the Next phase of the Energy Transition. Series on Science-Based Policy Advice. Leopoldina, acatech, Akademieunion. Available at: www.energiesysteme-zukunft.de

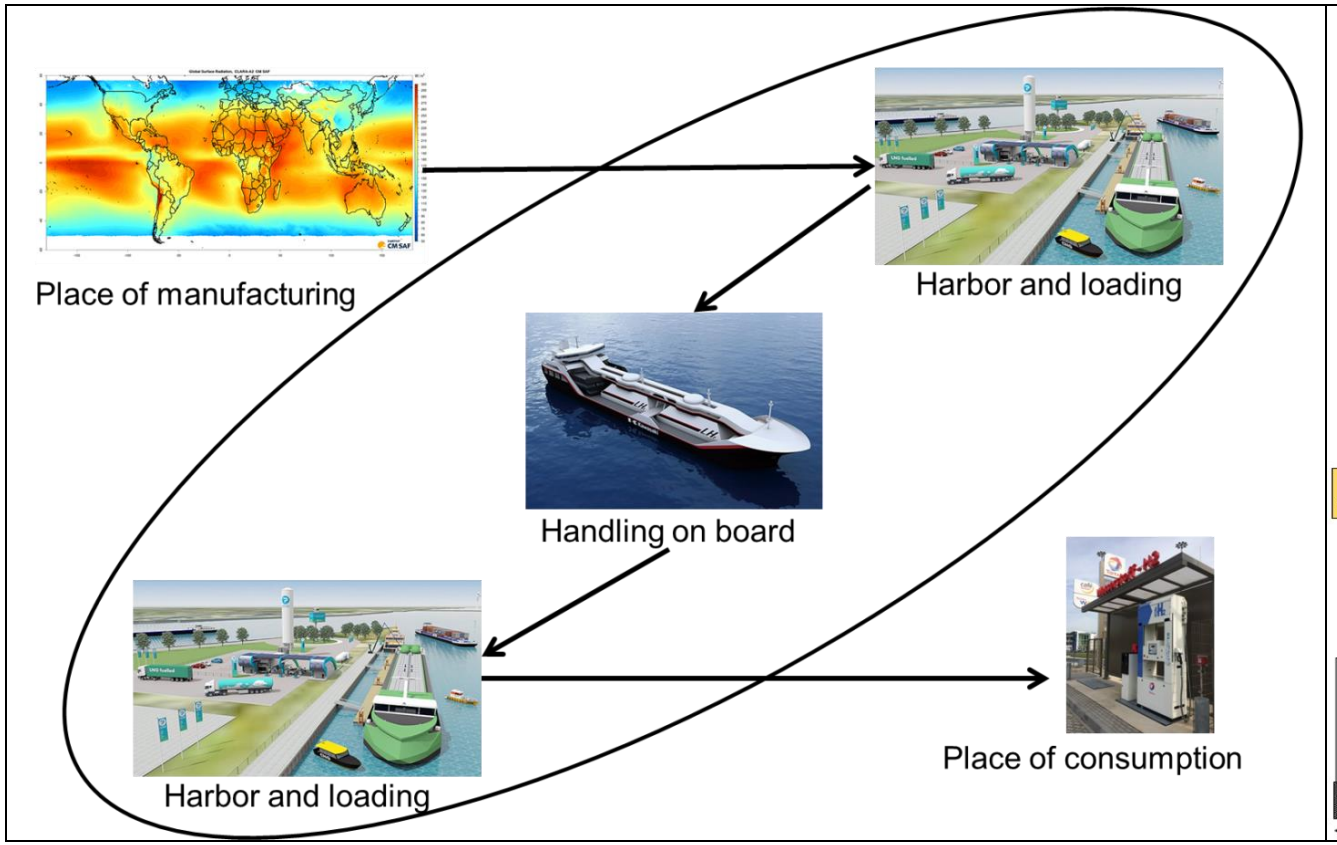
Hydrogen pathways

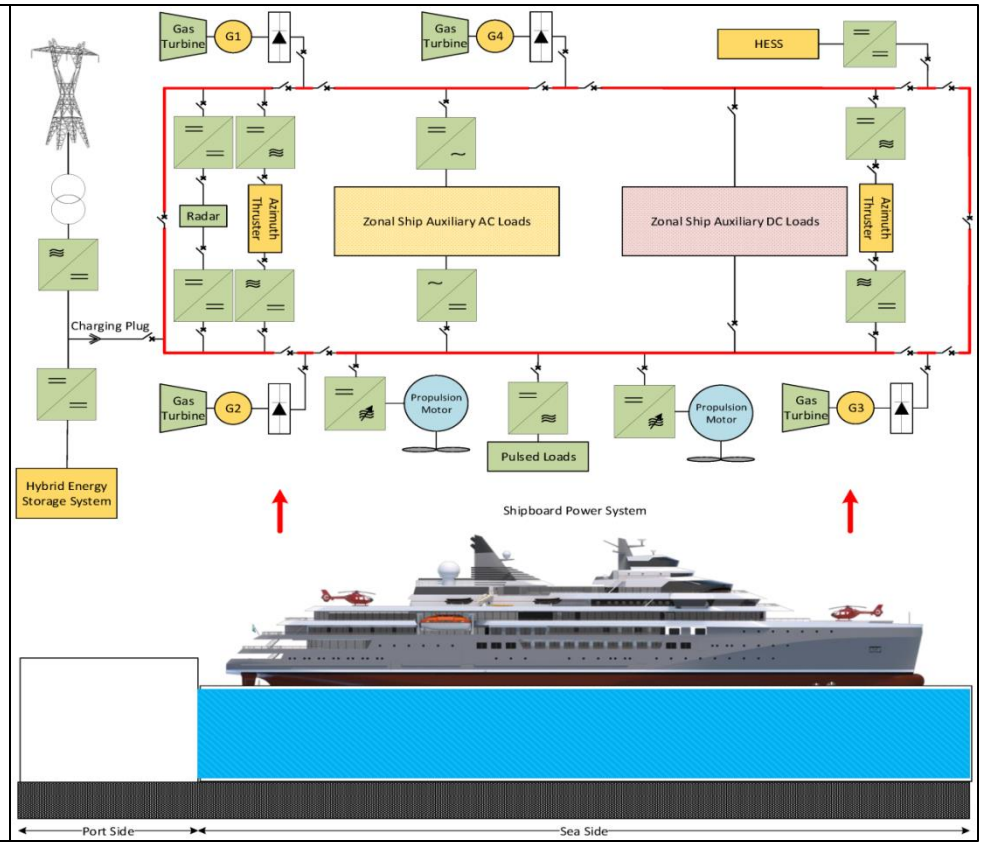


Hydrogen Council (2020). Path to Hydrogen Competitiveness. A Cost Perspective. Available at: www.hydrogencounsil.com

Tank infrastructure and electrical structure on board as main item

- Import from renewable fuels from the areas of the sunbelt and efficient DC grids on board of ships





M. U. Mutarraf, Y. Terriche, K. A. K. Kamran Ali Khan Niazi und J. C. Vasquez, Energy Storage Systems for Shipboard Microgrids—A Review, *Energies,* Bd. 11, 2018.

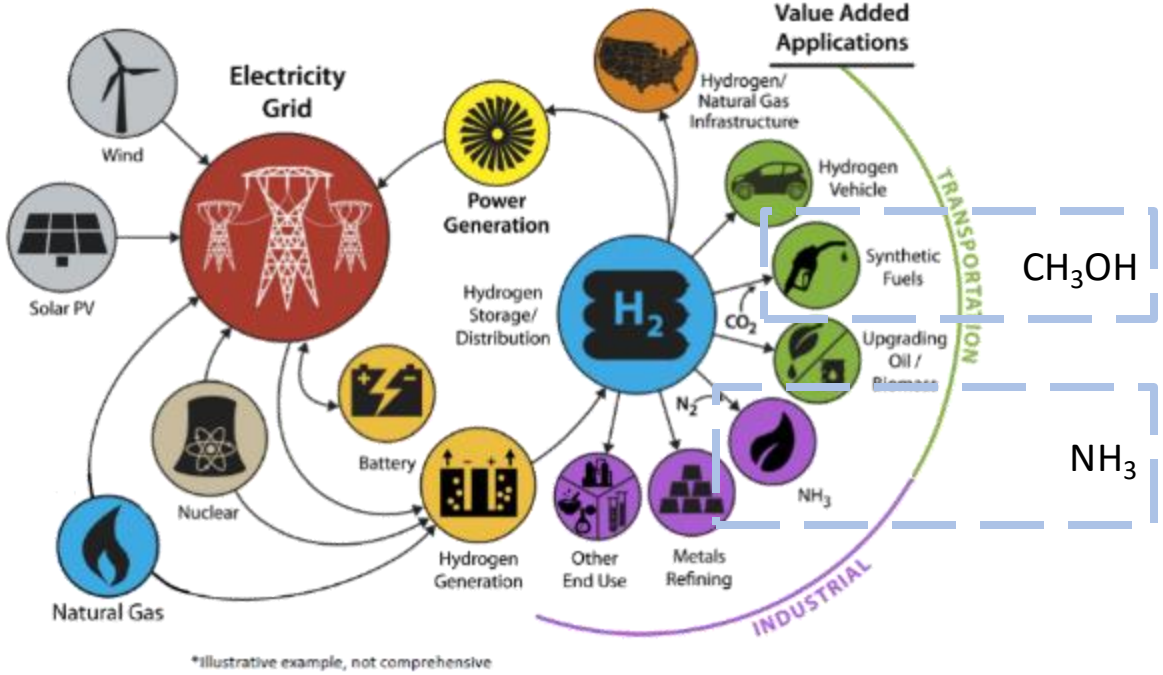
Which Renewable Energy Based Fuel is Suitable?

First selection energy carriers

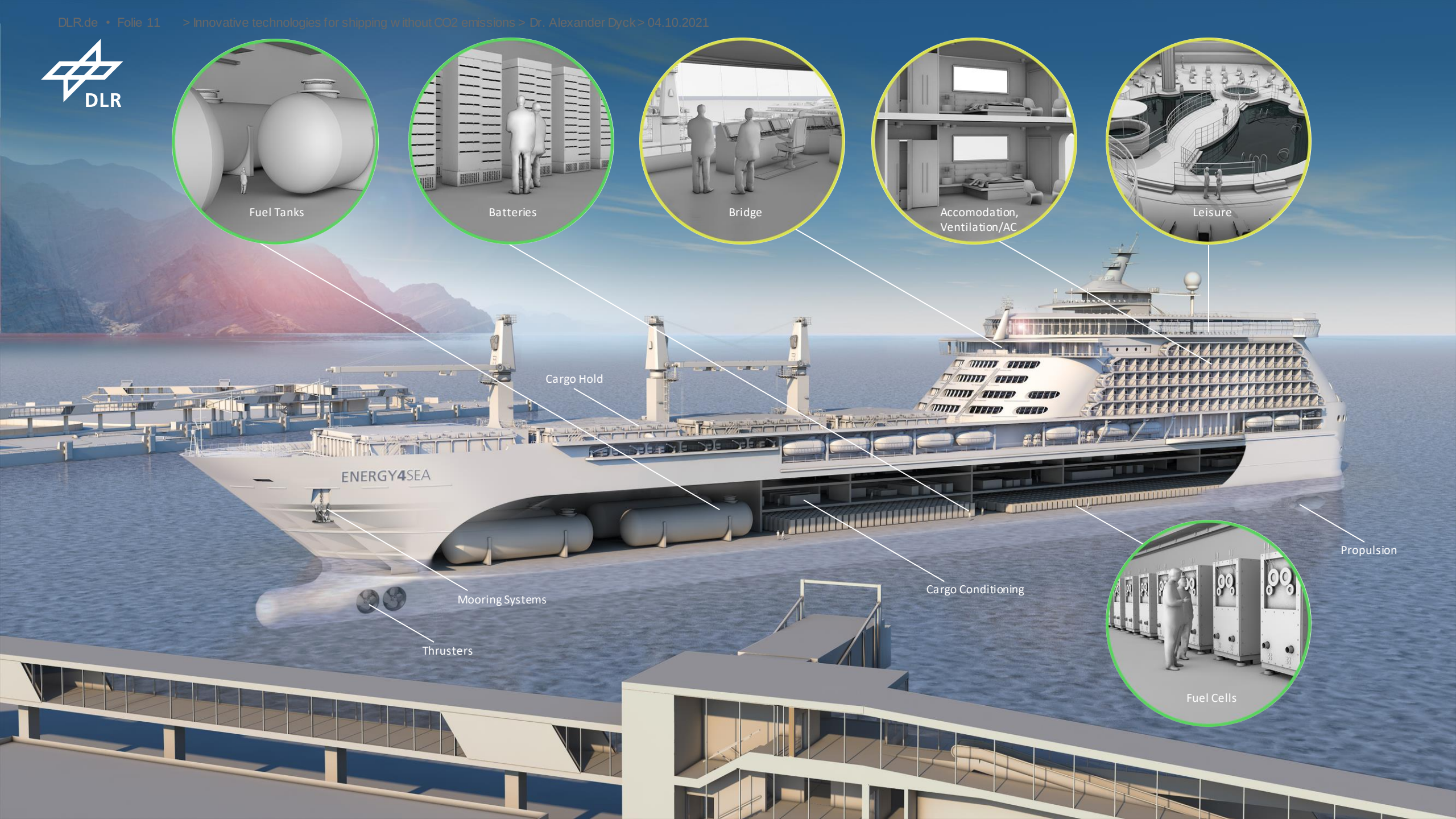
- Liquified Natural Gas (LNG)
- Methanol (CH_3OH)
- Ammonia (NH_3)
- Hydrogen (Liquid or compressed H_2)
- Metal Hydrides (MH)
- Liquid Organic Hydrogen Carrier (LOHC)
- Batteries (for CO_2 emission reduction)

Important criteria & optimization areas

- Storage & energy density
- Greenhouse Gas (GHG) emission & risk potential
- Regulation of new fuels (IMO)
- Endurance in maritime environment

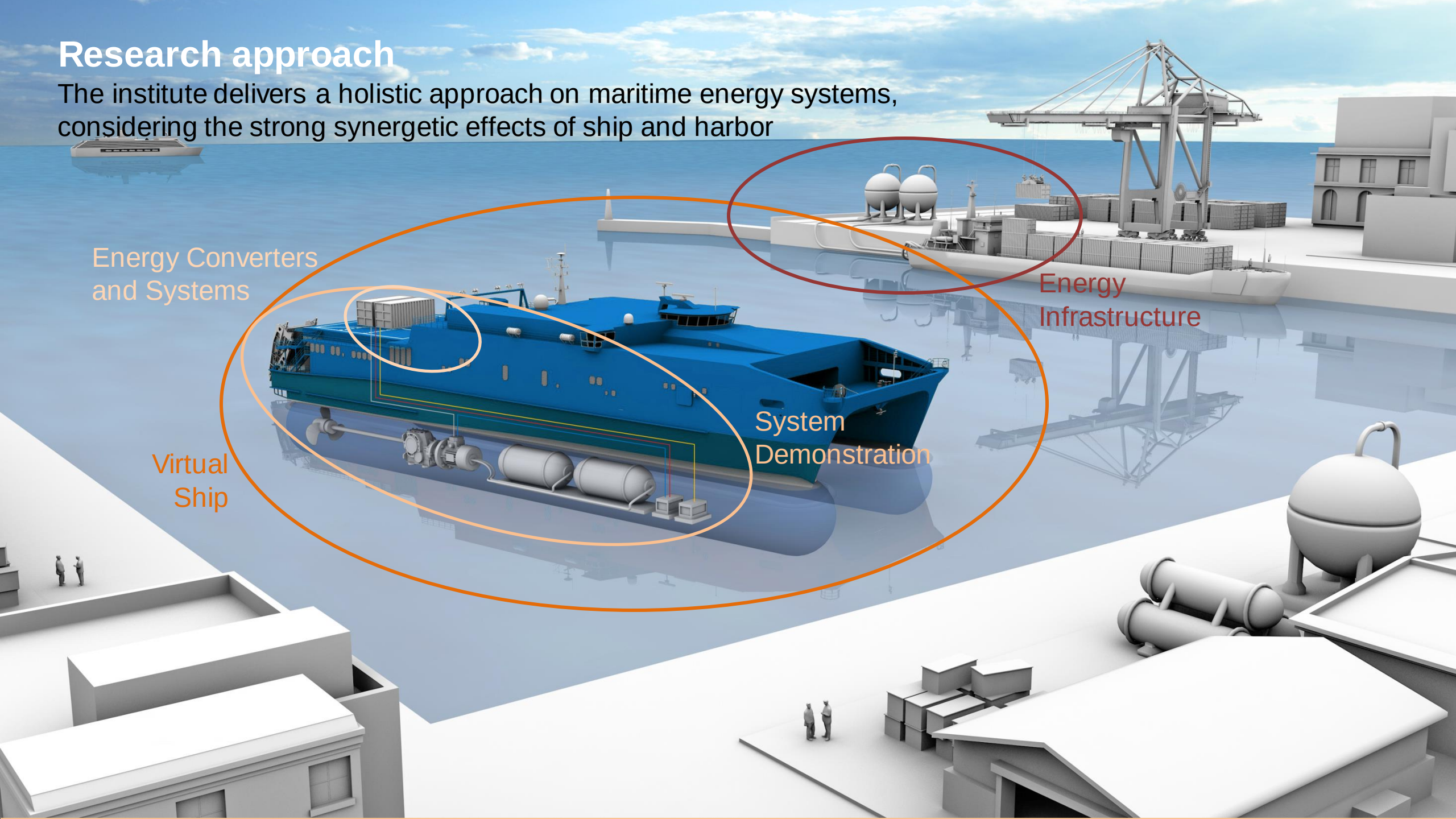


Pivovar, B., et al. (2017). Status of AMFC Technology and Advances in NREL's Perfluorinated Anion Exchange Membranes (PFAEM). Workshop on Ion Exchange Membranes for Energy Application (EMEA). 26th-28th of June, Bad Zwischenhahn, Germany.


Fuel Tanks
Batteries
Bridge
Accomodation, Ventilation/AC
Leisure
Cargo Hold
ENERGY4SEA
Mooring Systems
Thrusters
Cargo Conditioning
Propulsion
Fuel Cells

Research approach

The institute delivers a holistic approach on maritime energy systems, considering the strong synergetic effects of ship and harbor

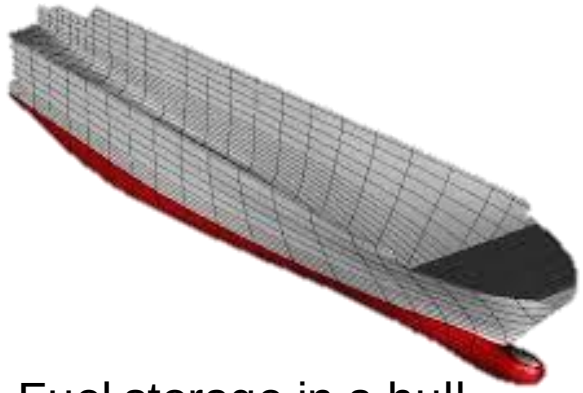


Infrastructure

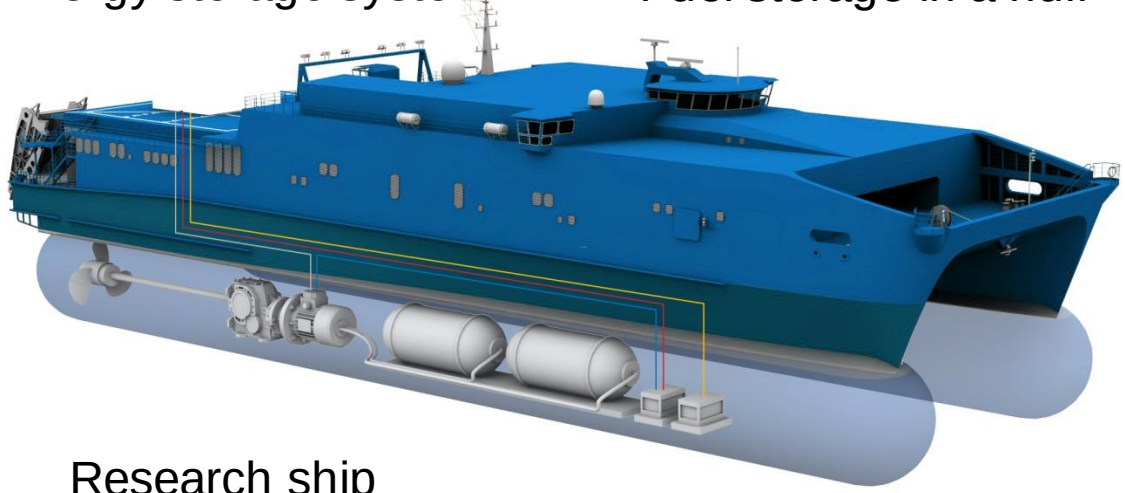
Operating test facilities to facilitate the transfer to the market by valid results

- Procurement and operation of
  - Test equipment for components
    - Energy converters
    - Fuel storage
  - Research ship
    will be build up as testing environment

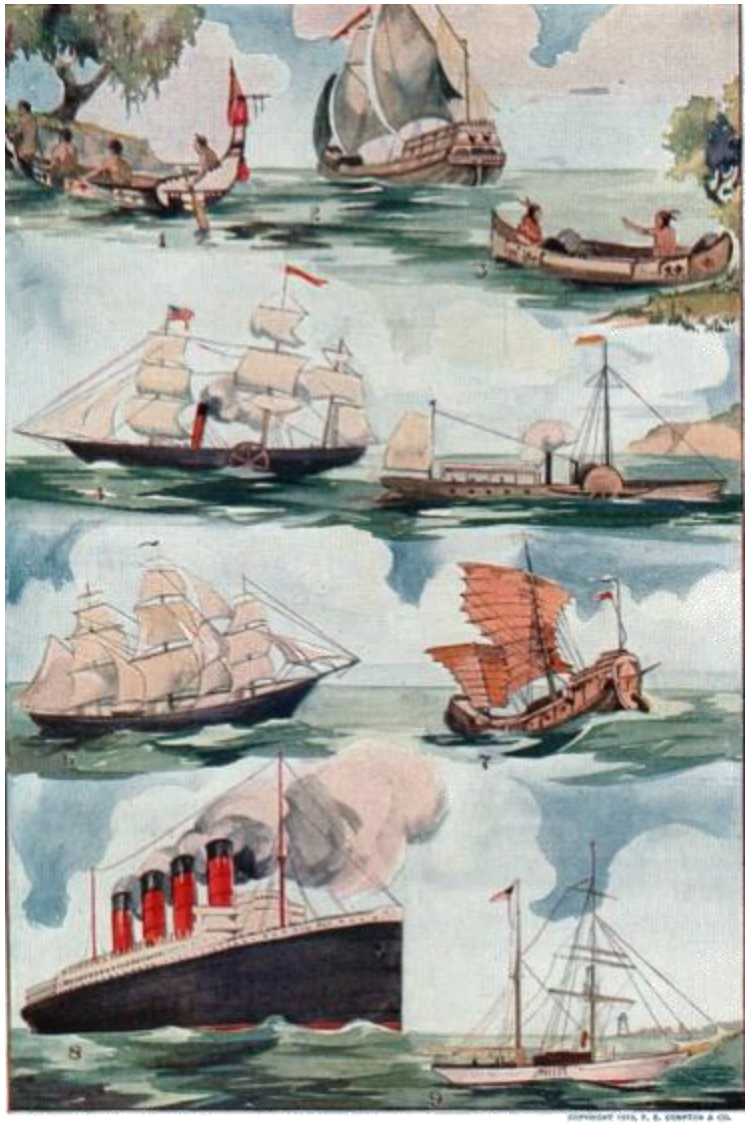
Energy storage system



Fuel storage in a hull



Research ship
Investigating new energy systems under real conditions



WATER TRANSPORTATION—DEVELOPMENT OF MERCANTILE MARINE

1—Fijian Boat. 2—Spanish Caravel Santa Maria: Flag Ship of Christopher Columbus. 3—Indian Canoe. 4—"Savannah," the First Steamship to Cross the Atlantic, 1819. The paddle-wheels could be unshipped when the wind was fair. 5—The Clermont, the First Steamboat, invention of Robert Fulton, 1807. 6—Ship in Full Sail. 7—Chinese Junk. 8—Cunard Liner "Mauretania." 9—A Modern Yacht.

https://de.m.wikipedia.org/wiki/Schiff

Shaping the future!

What will vessels look like in 2040?

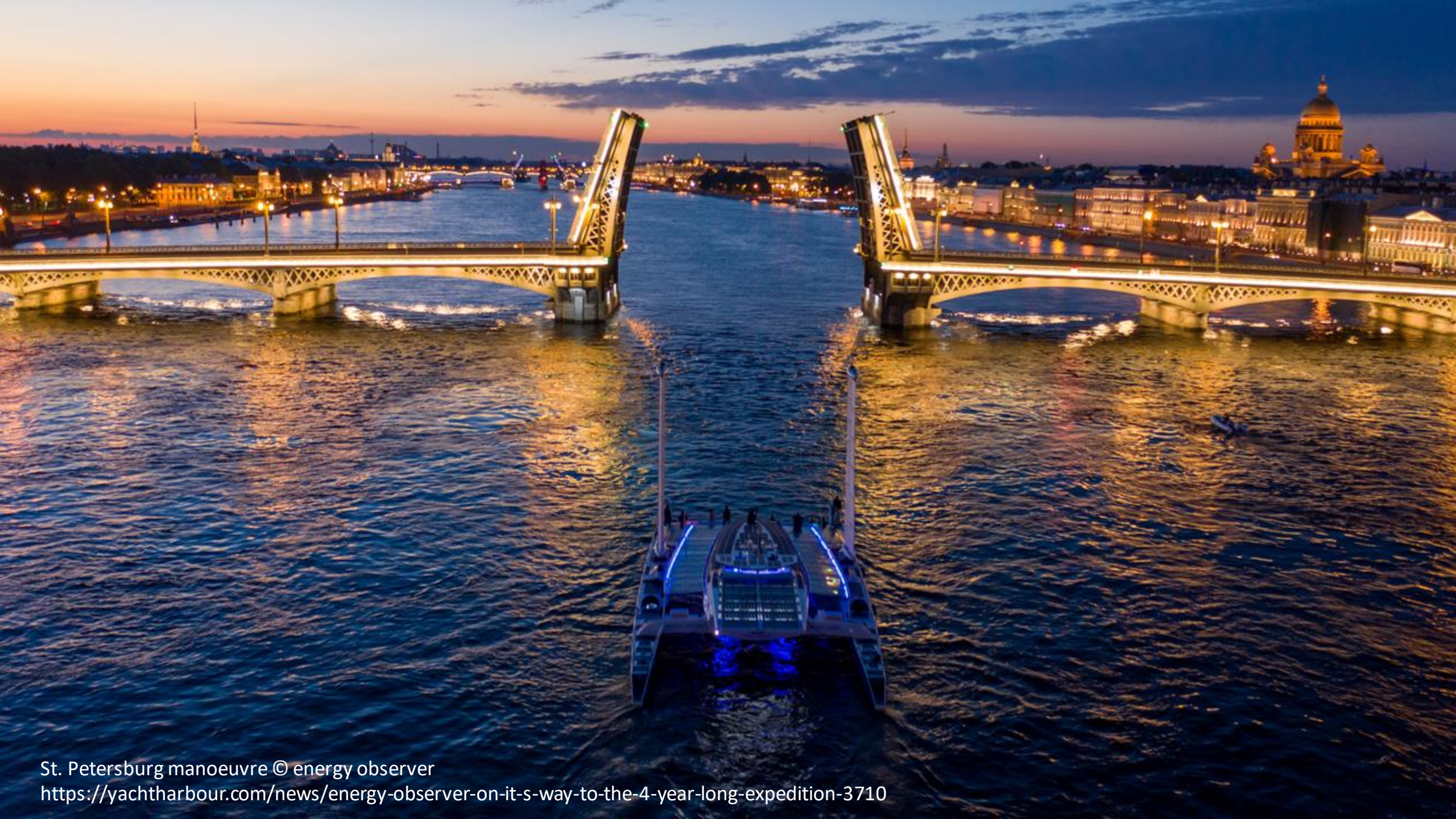
Oars, sails and steam engines determined how vessels were built. Applications changed it. Energy carriers influence the future!

https://www.dvz.de/rubriken/see/detail/news/hyundai-merchant-marine-will-22000-teu-schiffe-ordern.html

https://www.golem.de/news/autonome-schiffe-und-abends-geht-der-kapitaen-nach-hause-1812-137986.html

https://schiffsradar.org/msc-cruises-neue-schiffe-erhalten-wartsila-motoren/

https://www.dvz.de/rubriken/see/detail/news/wilhelmsen-und-kongsberg-gruenden-erste-reederei-fuer-autonome-schiffe.html



St. Petersburg manoeuvre © energy observer
https://yachtharbour.com/news/energy-observer-on-it-s-way-to-the-4-year-long-expedition-3710

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