Visions of Tomorrow

Engineered Today

Marine & Offshore / Products & Services

Marine

Technical consulting

Feasibility studies

Concept development

Basic & Detail Design

Project Management

Offshore Energy

Offshore, Renewables

Hydrogen, Power to X

Development, Pre-FEED

FEED & Detail Design

EPCM

Float Foundations

Pat. pending innovations:

- Mono pile
- Multi pile
- Artificial Island
- Windmill foundation

Performance Upgrades

ELOGRID

Hull & Hydro upgrade

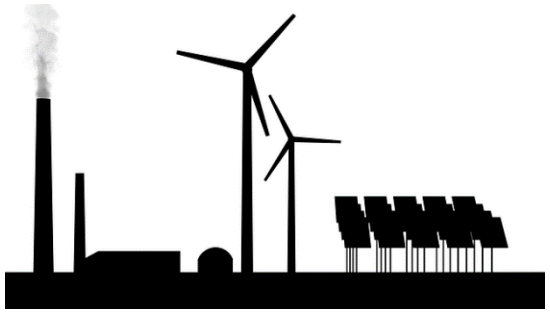
Systems upgrade

Operations efficiency

Digital Transformation

Power-to-X

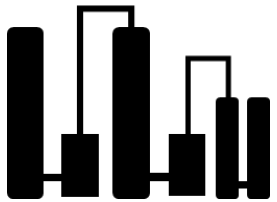
Electricity from grid
100%



Electrolysis
η: 60 – 70%

H_2

H_2

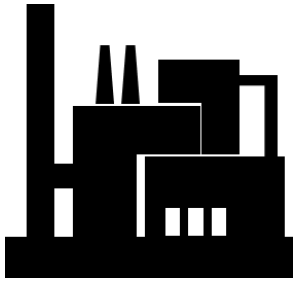


Compression/liquefaction

Finished fuel

Liquid H_2
Compressed H_2

"Shipping energy demand"
2 times current wind installations worldwide



N_2/CO_2

Fuel synthesis
(+ High temperature heat)

Methane
Ammonia
(longer C-chains)

Shipping today:
12 EJ
Ave 380GW

2020
Wind power
743GW
PF 45%? ->
330GW

Eg. district heating

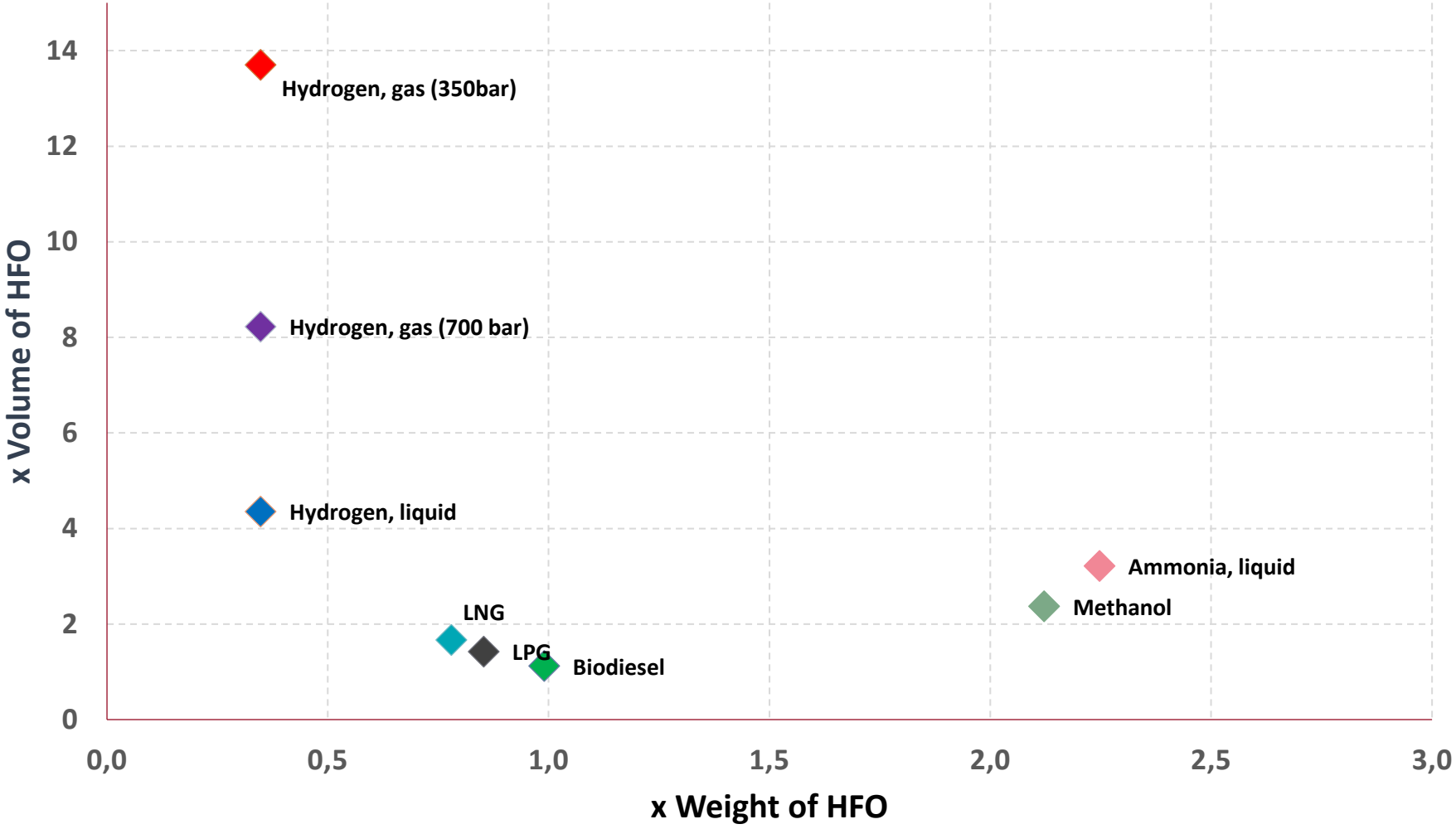
Chemical properties compared to HFO

Ammonia – toxic gas cloud

Hydrogen – light and flammable. Diffusion leakage considerable

LNG - can be made as electro fuel

Methanol – toxic
Can be both bio based, and e-fuel based. Could be mixed with lignin.



Case Flexens P2AX

Elomatic supported Flexens in their Power2AX project with a study for the production of hydrogen aimed to be used in new ferries in the Åland archipelago.

The project Power2AX has a unique and comprehensive approach that includes harvesting wind energy, creating the hydrogen fuel of the generated wind, and finally using the renewable fuel in ferries operating in Åland.

Some Offtakes

- Hydrogen promising as business case
- Subsidiaries are today needed but also highly available
- The land-based production and the ferry systems need to be integrated into one entity to lower the overall costs of both production capacity and operation scheme as well as the cost for storages.

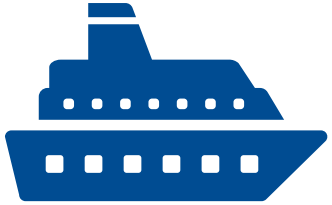
Which fuel to select?

ELECTRICITY

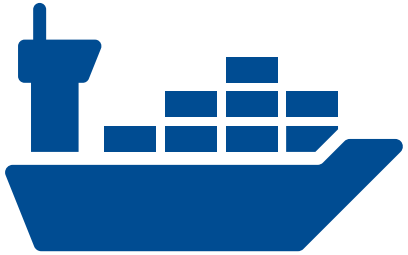
HYDROGEN

AMMONIA

TUGS,
ROAD FERRIES,
LOCAL TRANSPORT



FERRIES,
SHORT VOYAGES,
SHEDULED TRAFFIC



DEEP SEA
SHIPPING

	Volumetric density [MJ/L]		LHV [MJ/kg]	
	w. storage	net	w. storage	net
BATTERY	*2*		*0,3*	
CH_2 (700 bar) **LH_2** (-253 °C)	est. 4 est. 6	4,8 8,5	est. 7 est. 14	120
AMMONIA	10	11,4	11	18,6
MGO	36	41	41	43

Hydrogen as marine fuel

Storage:
- Compressed or/and insulated container
- LH_2 -253 °C;
  CH_2 up to 700 bar
- LHV [MJ/kg]: 2,8x MGO (excl. container)
- Leakage about 1 % per day (pressurized)
- Combustion engines
- PEM fuel cells

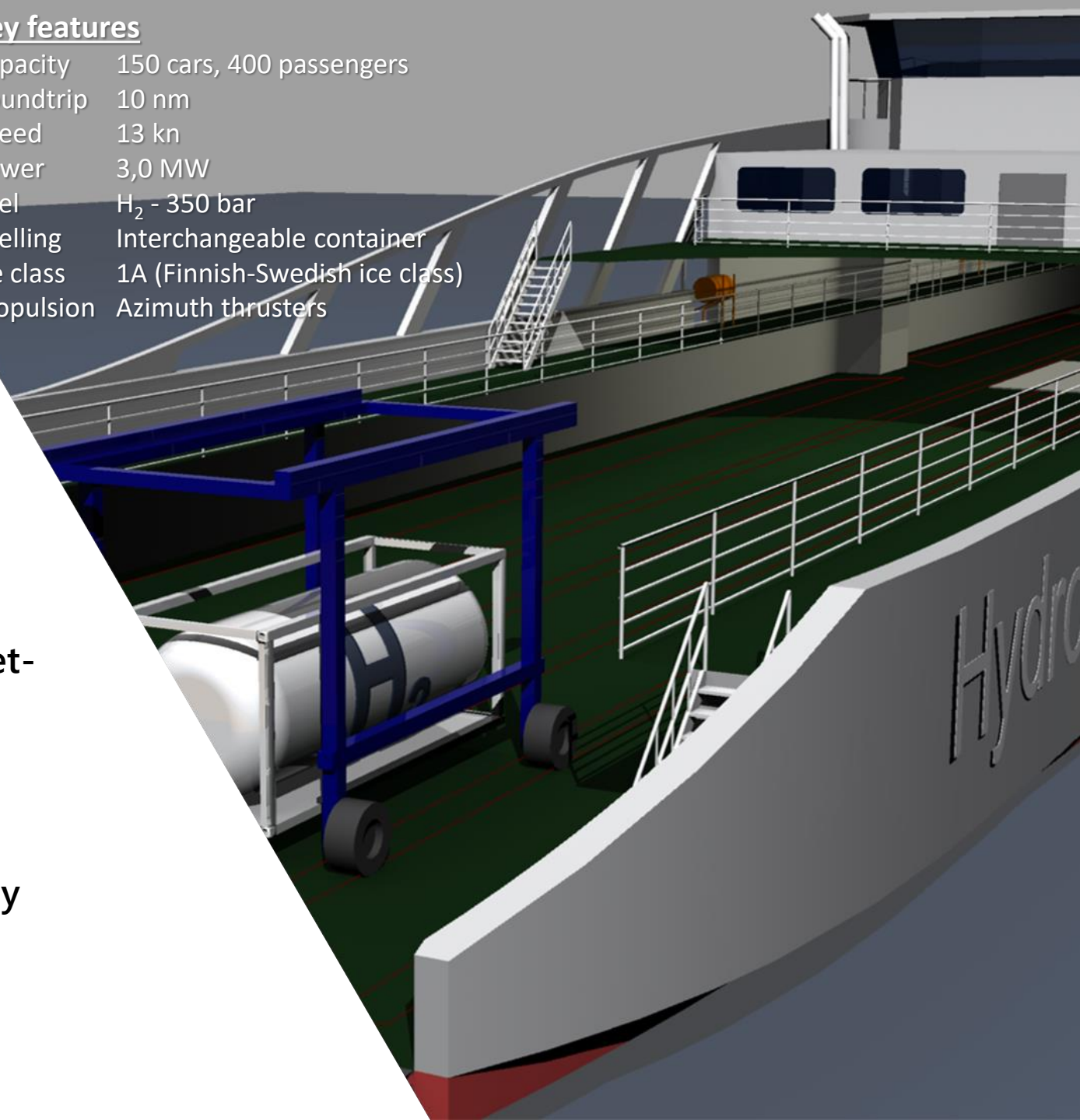
Safety aspects:
- Ventilation
- Gas detection
- Hazardous areas
- Risks, HAZID process
- Proof of concept (AiP)

Fuel supply system (FSS):
- Complex
- Optimal for:
  Low endurance,
  frequent bunkering

Hydrogen solution for a road ferry

Key features

Capacity	150 cars, 400 passengers
Roundtrip	10 nm
Speed	13 kn
Power	3,0 MW
Fuel	H_2 - 350 bar
Fuelling	Interchangeable container
Ice class	1A (Finnish-Swedish ice class)
Propulsion	Azimuth thrusters

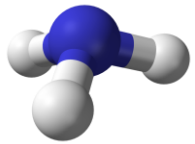


Capex to consider holistic view for both on-shore and ship design concept

Hose connection requires on-shore storage which dependent of pressure / compressor set-up may become overly expensive.

Interchangeable container lowers combined on-shore and ship storage CAPEX. Gives independency of fuelling port. Total costs may be very attractive compared to hosing.

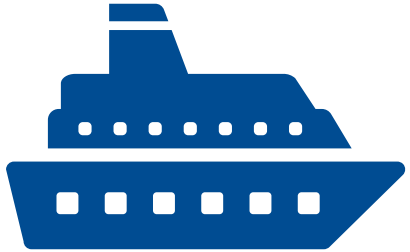
Hydrogen for Deep Sea Shipping in form of ammonia



Shipping industry is familiar with ammonia as cargo, but not as a fuel.

Considerations:

- Extra space required for weighty fuel
- Volume and weight reduces cargo carrying capacity
- Very toxic, safety aspects in bunkering and at operations
- Highly corrosive
- Difficult to combust, pilot fuel required
- NO_X emission > SCR to be considered
- N_2O emission, strong GHG



Ferry: 40t MGO/day; 1 week 280 t / 250m^3
Ammonia for 1 week voyage: 800t / 550m^3 (liquid)

BC 35 000 Dwt, 14 kn, 25t HFO/day, 2 weeks >350t
Ammonia for 2 weeks voyage: 1000t

Hydrogen is key component in P2X

When we stop using fossil fuels the remaining options are bio based and hydrogen based

Emissions

- With pure hydrogen emissions are minimal
- Other P2X fuels may emit COx and NOx
- Traditional emission abatement needs

Infrastructure & technologies

- New infrastructure on land / offshore
- Optimize production and bunkering solutions at same time as ship design

Act now

- Retrofit conversions to be considered in early stage of ship design