Alternative Fuels: Shoreside storage & vessel design

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Introduction

- Maritime facilitates 80+% global trade.
- Accounts for ~2-3% global GHG emissions [1,2].
- IMO strategy
  - 20 – 40% reduction by 2030 (2008 baseline)
  - 5 – 10% alternative fuels by 2030
  - 70 – 80% reduction by 2040 (2008 baseline)
  - Net Zero by ~2050
- UK Govt mandate Net Zero by 2050
- Scottish Govt mandate Net Zero by 2045

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[1] Sector by sector: where do global greenhouse gas emissions come from? - Our World in Data
[2] REVIEW OF MARITIME TRANSPORT 2023 - Chapter 3: Decarbonizing shipping

Introduction

- The marine energy transition is in a quandary.
- ESTs reduce emissions but ONLY changing fuel will meet Net Zero.
- Which comes first - infrastructure or vessels?
- How do we manage a future with a variety of fuels?

Fuel Options

Nuclear possible for some vessels.

Electric possible for some vessels.

	Hydrogen, H_2	Liquified Natural Gas (LNG), CH4	Ammonia, NH_3	Methanol, CH_3OH	REFERENCE (MGO)
With Tank (Gross) Volumetric Energy Density (MJ/L)	2.7 – 7.9	13.2	11.5	14.2 – 15.1	27.3 – 31.0
General Storage Conditions	Cryogenic (or Pressurised)	Cryogenic	Cryogenic (or Pressurised)	Ambient	Ambient
Space Requirement	7.7 – 15.7	3.2	3.4 – 6.4	2.3	1.0
Flash Point	-253°C	-162°C	-33°C	+12°C	+61.5
Flammability Limits in air (vol%)	4.0 – 75.0	5.3 – 15.0	15.0 – 28.0	7.3 – 36.0	0.7 – 5.0
Minimum Ignition Energy in air (mJ)	0.02	0.29	8.0	0.14	20.0
Explosion Risk	Large flammability range with low ignition energy	Medium flammability range with reasonable ignition energy	Medium flammability range with high ignition energy	Medium flammability range with reasonable ignition energy	Small flammability range with high ignition energy
Toxicity	None	None	Highly toxic to humans and aquatic life	Toxic to humans, but very low-toxicity to aquatic life	
Combustion Emissions	**NOx**	**NOx & lower COx**	**NOx**	**NOx & lower COx**	**COx, NOx, SOx & PM**

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Shoreside Storage

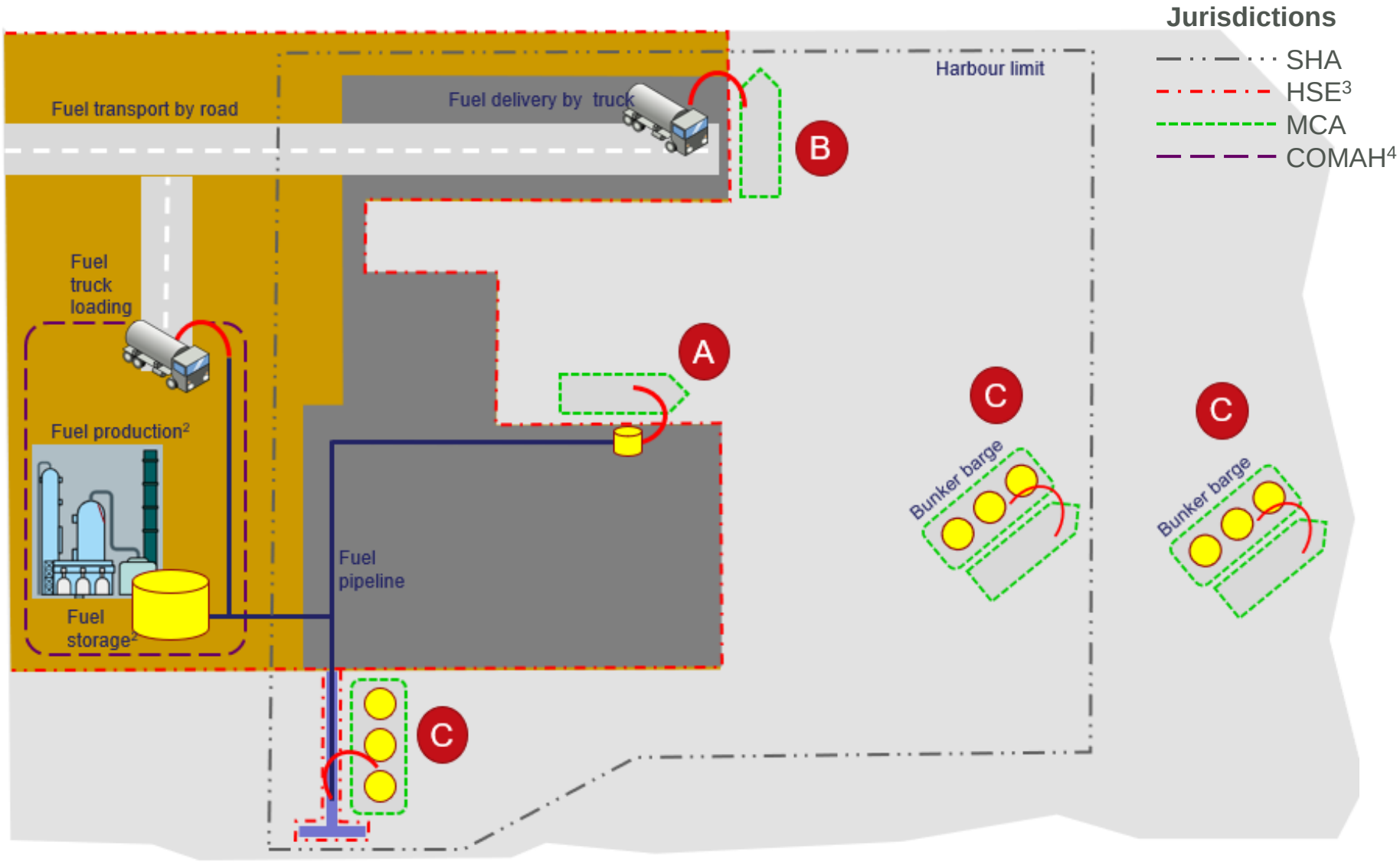
- COMAH Regulations – apply when above lower limits.
- DSEAR Regulations – apply for all aspects of the pipeline and transfer.
- Harbour Master has final say on vessel inside jurisdiction.

Fuel	Additional Quantity Required	Lower Tier (tonnes)	Upper Tier (tonnes)	% Energy Stored
Hydrogen	3.7 – 10.9	5	50	0.02 – 0.05
LNG	2.2	50	200	0.91 – 0.36
Ammonia	2.5	50	200	0.8 – 0.32
Methanol	2.0	500	5,000	10
Diesel	1.0	2,500	25,000	100

Authorities

Fuelling Scenarios

- A Shore - ship
- B Truck - ship
- C Ship – ship[1]



1. Shown within harbour. When outside port limit this falls within MCA jurisdiction. Fuel barge loaded at jetty and unloaded on water. Barge may fill at another port or terminal outside of harbour limit.
2. Shown outside harbour. This may be located within SHA jurisdiction.
3. HSE has a limited role on vessels – covering onshore staff working on a vessel
4. COMAH applies where fuel quantities exceed minimum limits

Credit: Keith Johnstone, MCA

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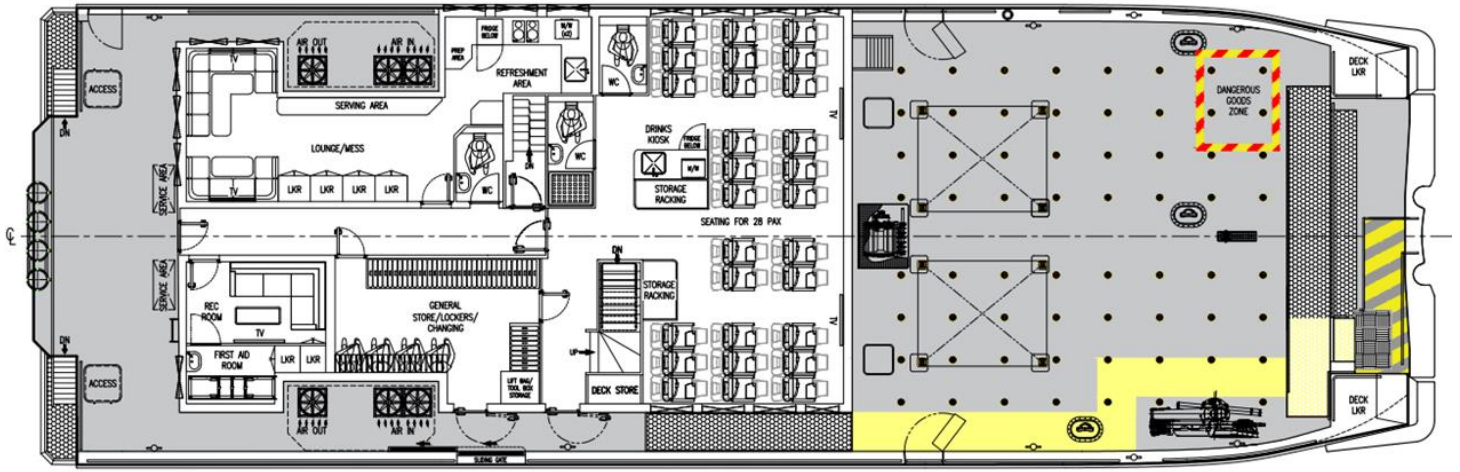
Design Considerations

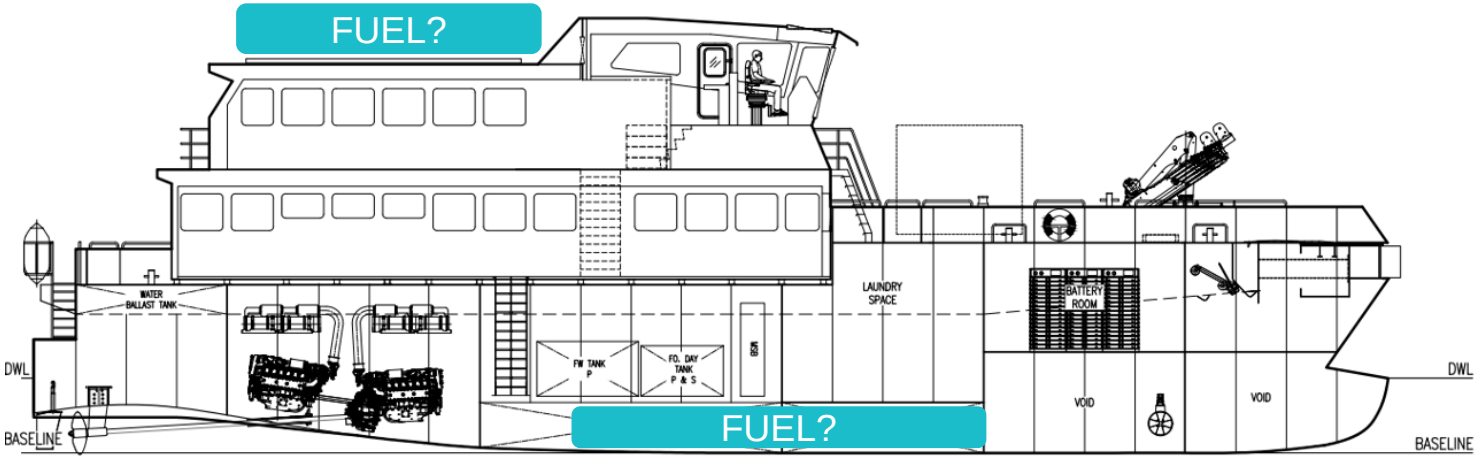
- Gas tight boundaries
- Airlocks – with alarms outside
- Safety stations
- ‘Double walled’ pipes
- Redundancy
- Explosive & Toxic Atmospheres
- Ventilation
  - Dedicated ducts – alarms near open decks
  - Continuously operating fans
  - Blast Proof
  - Scrubbers

Photo: Amogy

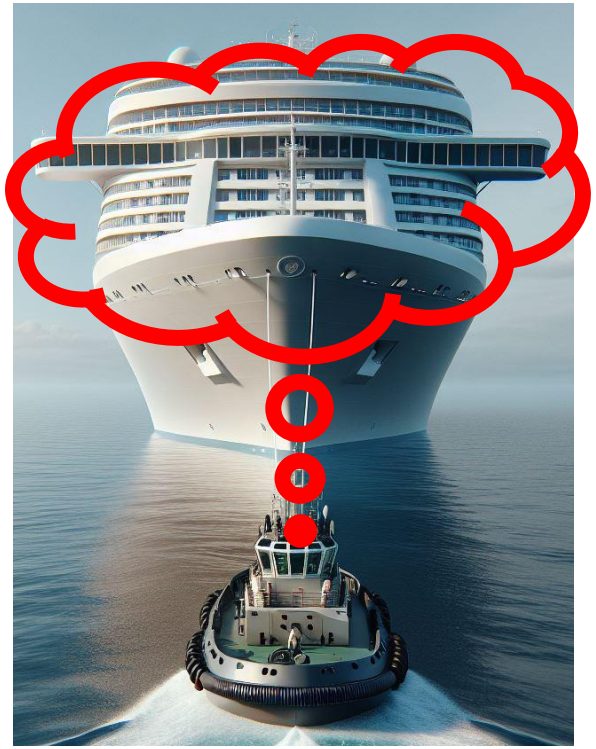
Challenges

- New build or retro-fit?
- How do we keep people safe?
- Where do we store the fuel?





Challenges



- Need to be cognisant of atmospheric conditions in case of fuel venting

Possible Solutions

- Location of fuel requires agreement with Class & Flag.
- New build is easier to prepare for alternative fuels.
- Need to ensure appropriate gas tight superstructure.
- Possibly use localised gas masks, similar to aviation and defence.

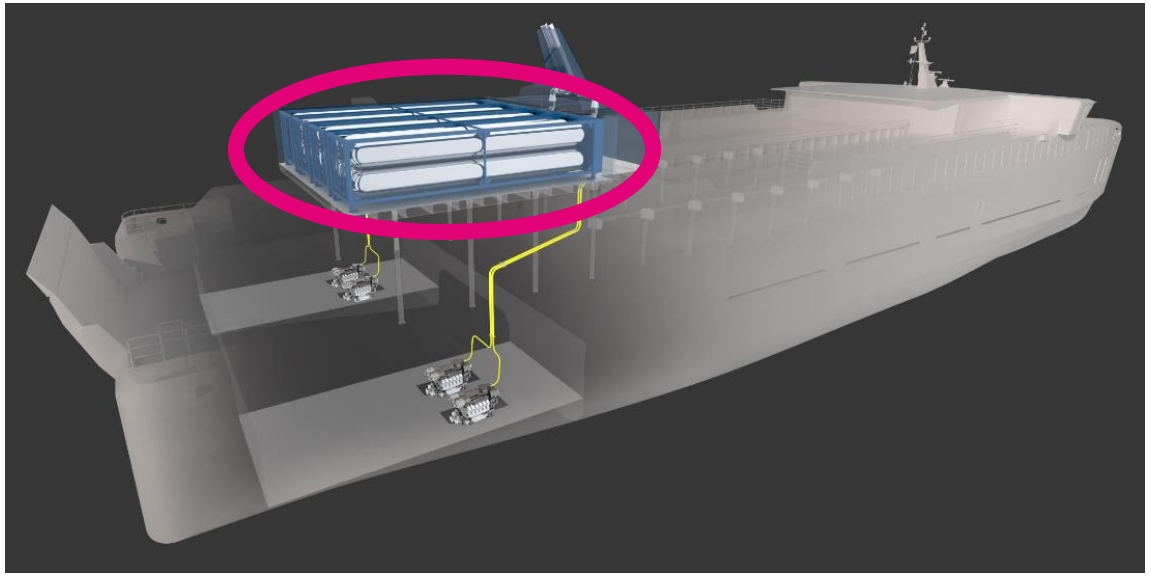


Photo: Flickr – Mike Szczesny

Conclusions

- Fuel choice has several variables to contend with.
- There is a mix of regulators that need to be involved.
- Storage quantities and locations need to be considered carefully in line with regulation – shoreside and onboard.
- **COLLABORATION** is **FUNDAMENTAL**.
- We must NOT put people in harms way.

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Thank you for listening

Any questions or queries please email me at:
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