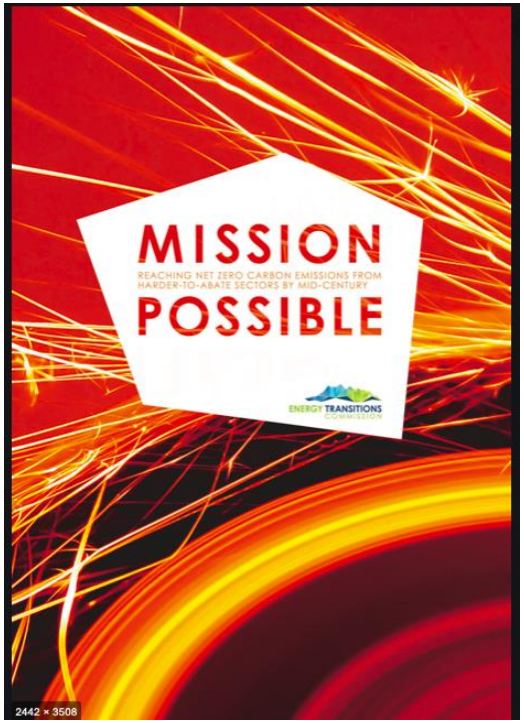
How rapidly do we need to move to decarbonising freight transport?

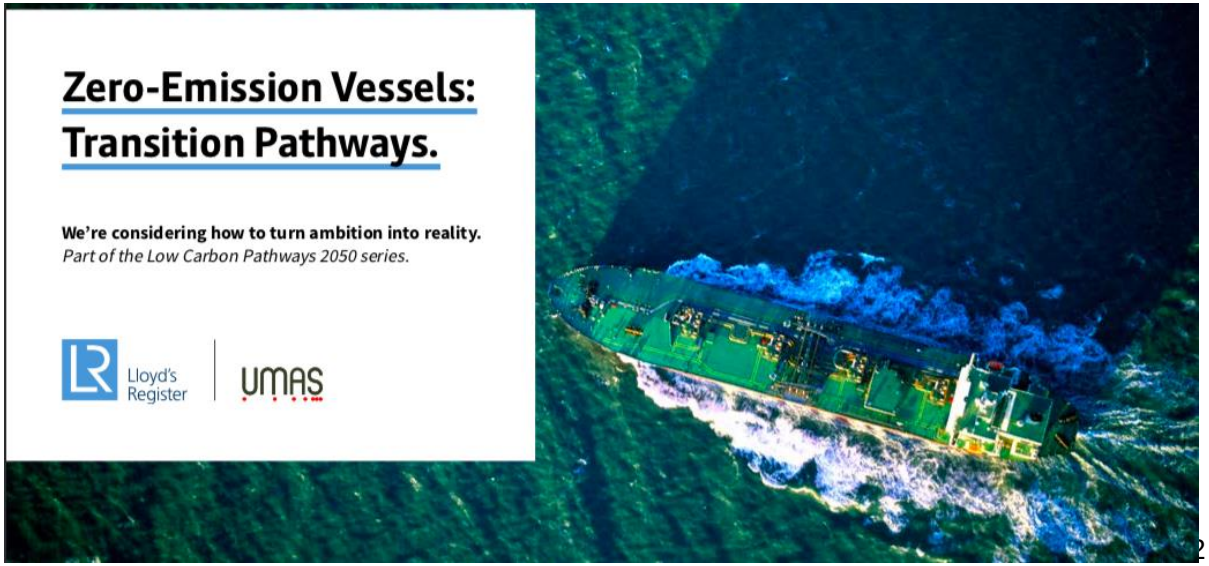
Dr Tristan Smith
Tristan.smith@ucl.ac.uk

University College London www.ucl.ac.uk/energy
UMAS www.u-mas.co.uk

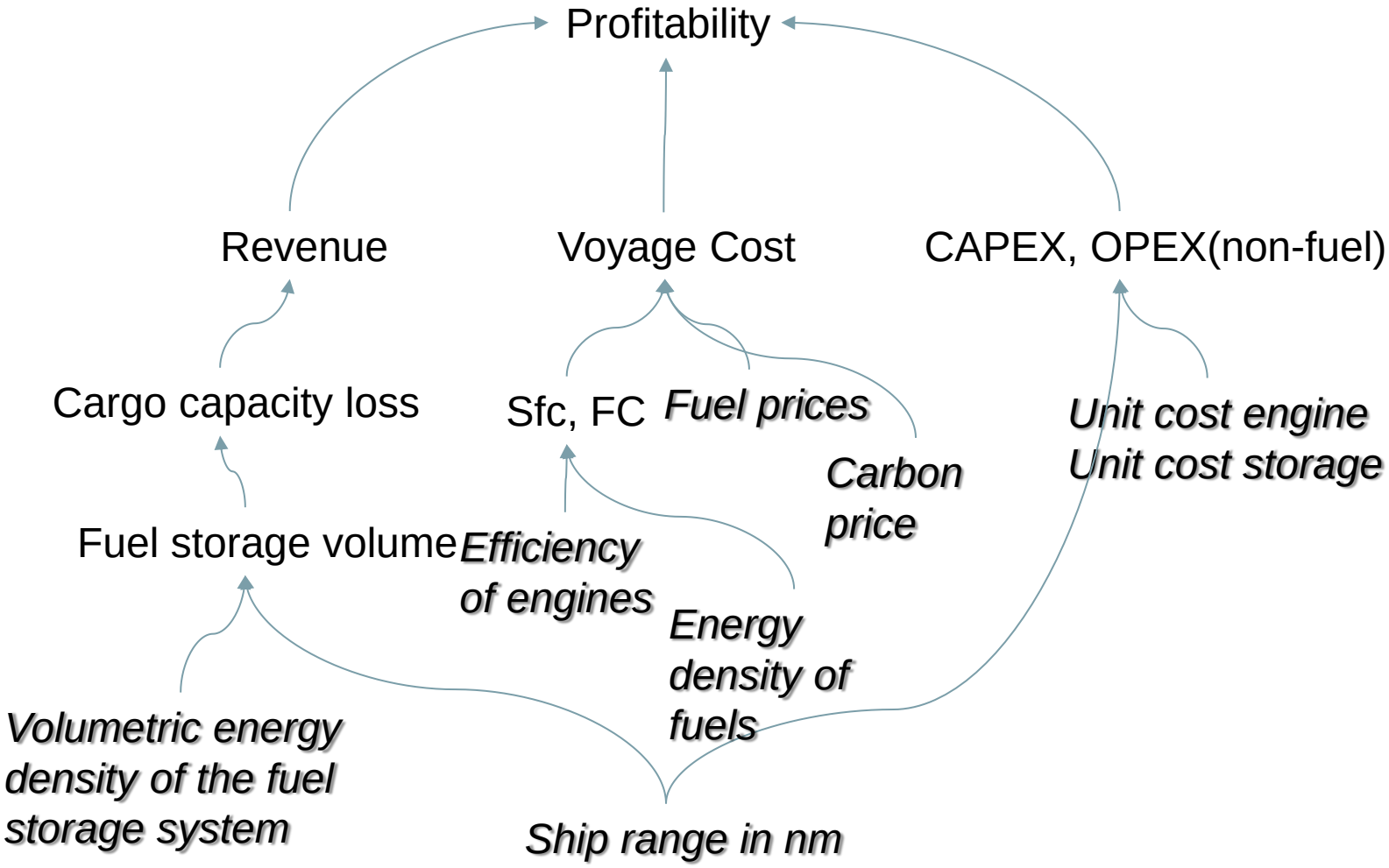


A joint Maersk and LR study has researched the best fuels to develop into net-zero fuels

Maersk: ammonia, alcohol, biomethane best fuels to reach net-zero emissions



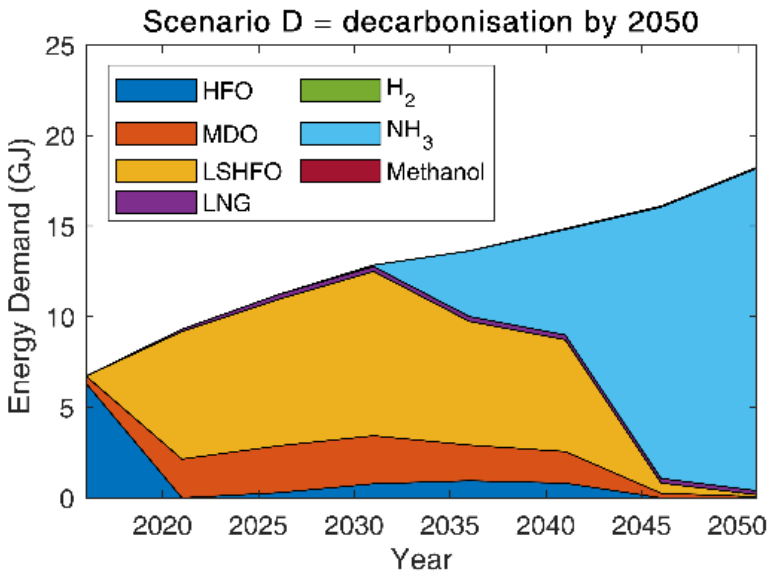
Assessing the profitability of ZEVs



A hydrogen carrier (e.g. ammonia) will have a 75-99% market share by 2050

2050 decarbonization (1.5ºC aligned)

GJ



2070 decarbonization (IMO aligned)

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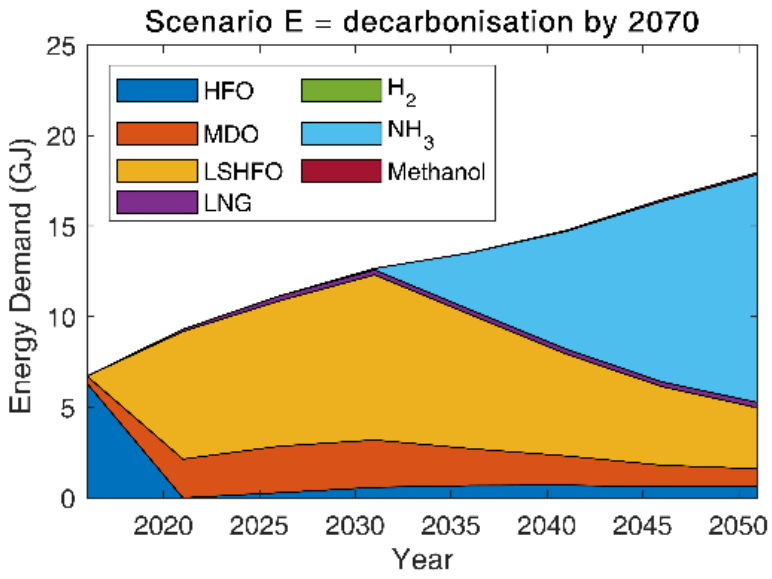
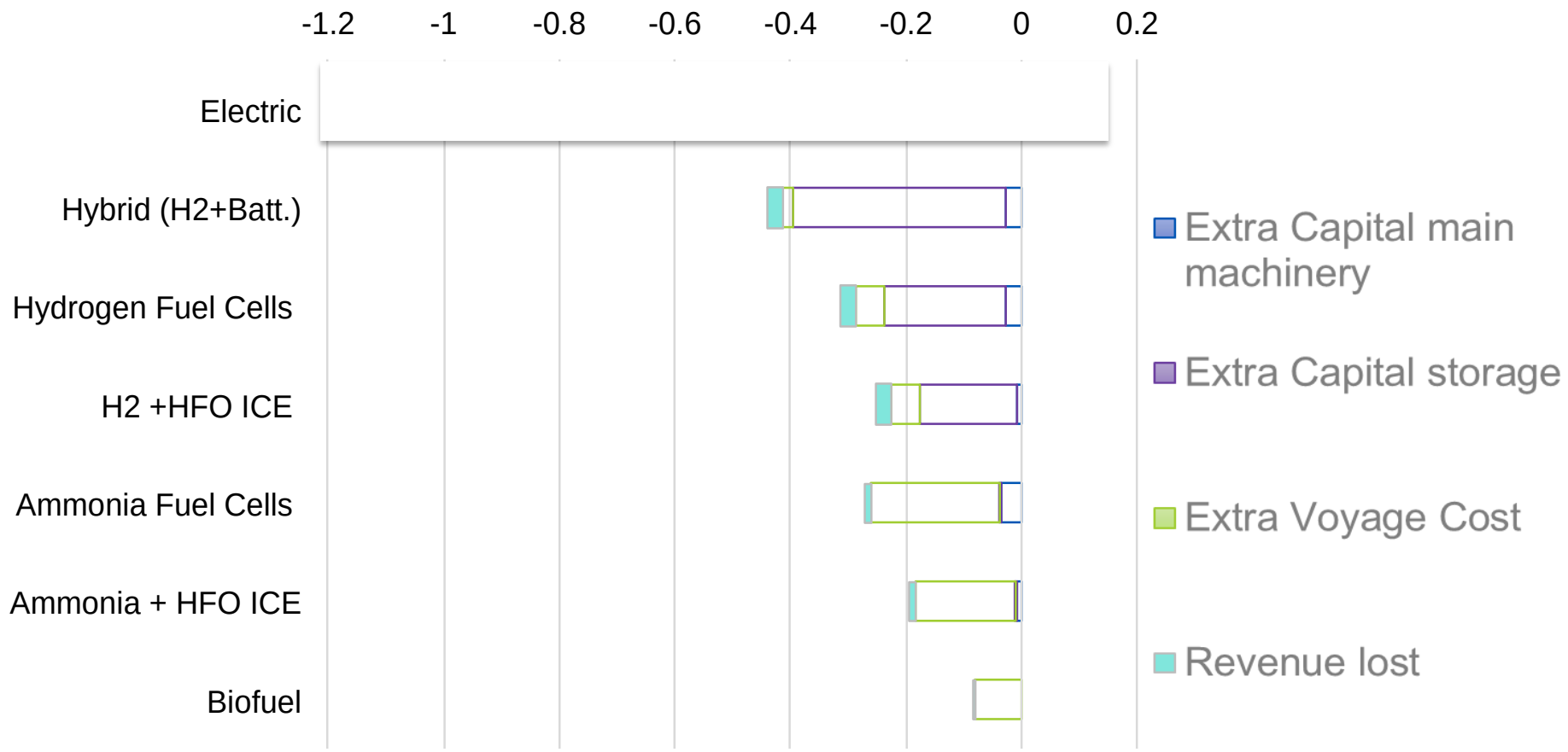


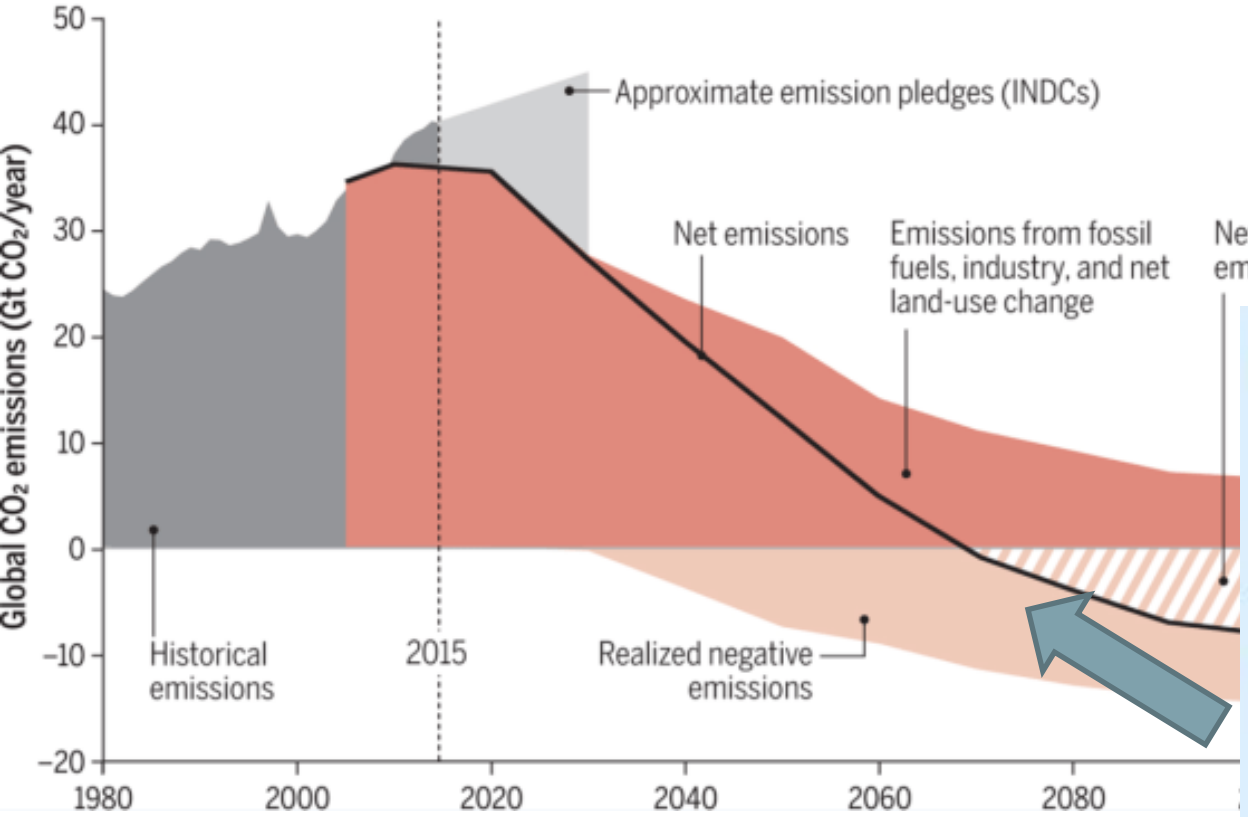
Source: UMAS GloTraM (2019), UK Clean Maritime Plan

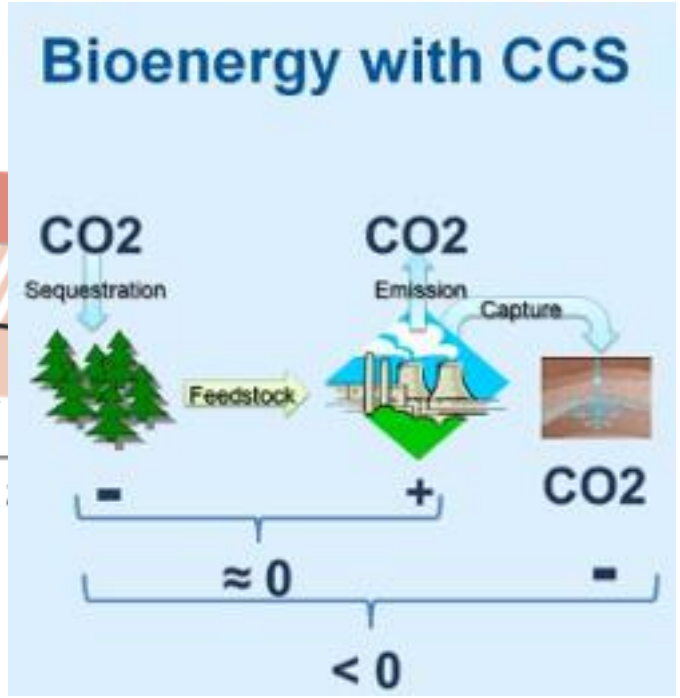
How do costs change relative to a conventional ship (9000TEU container) ?



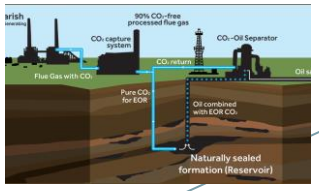
LR UMAS (2017). Zero-Emission Vessels 2030. How do we get there?

Why isn't bioenergy the long-run solution?





Future fuel



Blue – NG+SMR+CCS

Green – Elec+H2O+Electrolyser

Make some hydrogen

Nitrogen-base (ammonia)
80% of air

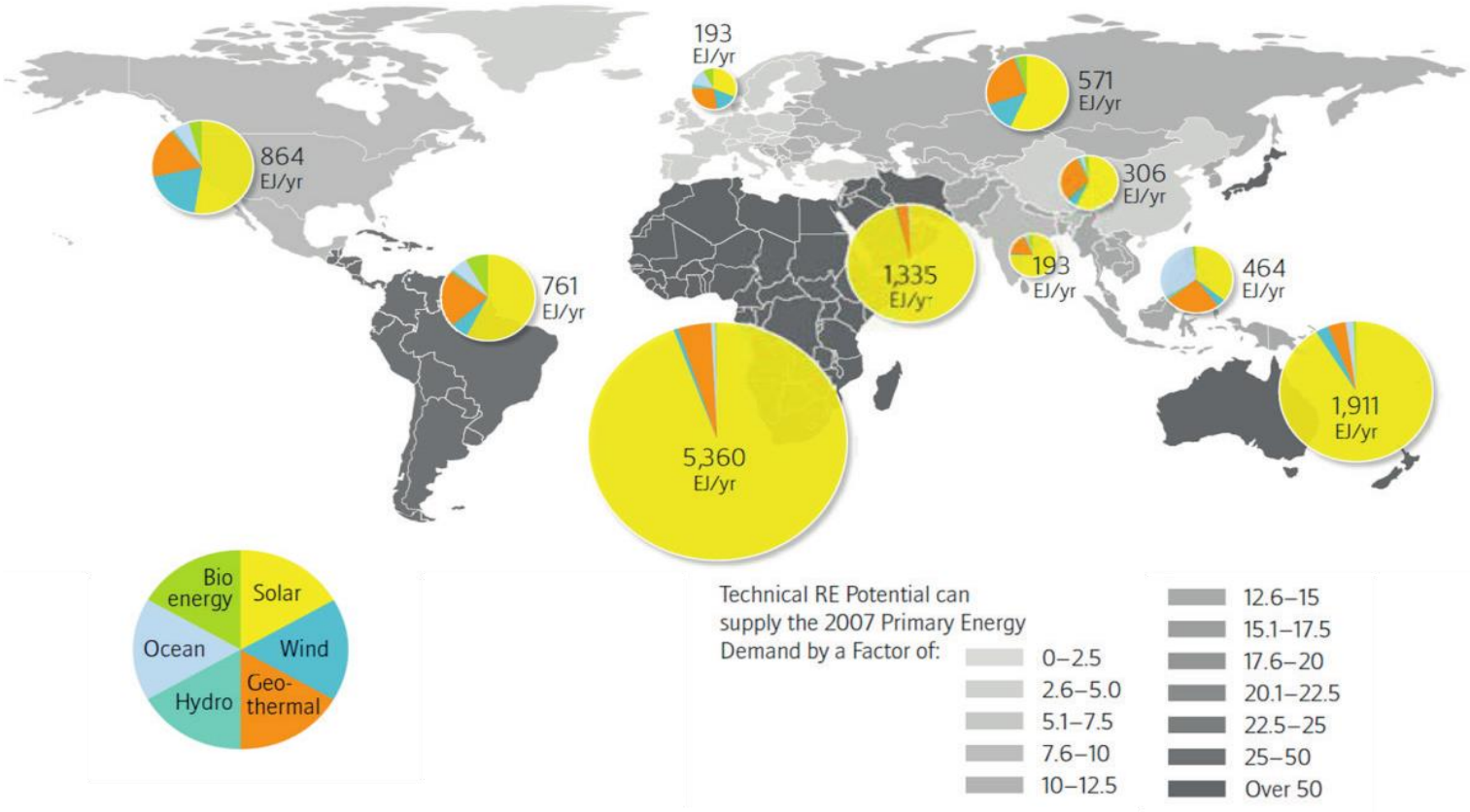
Carbon-base (synth hydrocarbon)
0.04% of air

Pure (liquefaction)

Manipulate the hydrogen

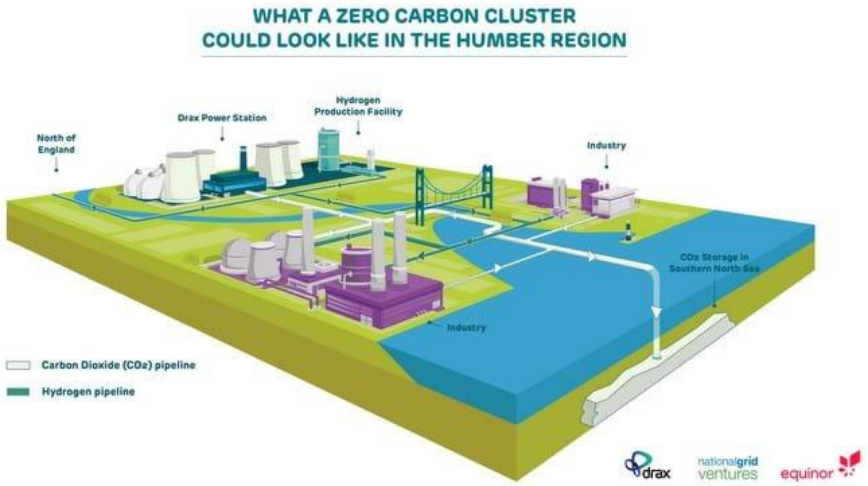
Many countries have the potential for renewable fuel provision

Shipping – 20-40EJ/yr



IEA Renewable Fuels

UK freight fuels: UK fuel producer or fuel importer?



e.g. Saudi Arabia

e.g. Isle of Grain

Green ammonia production

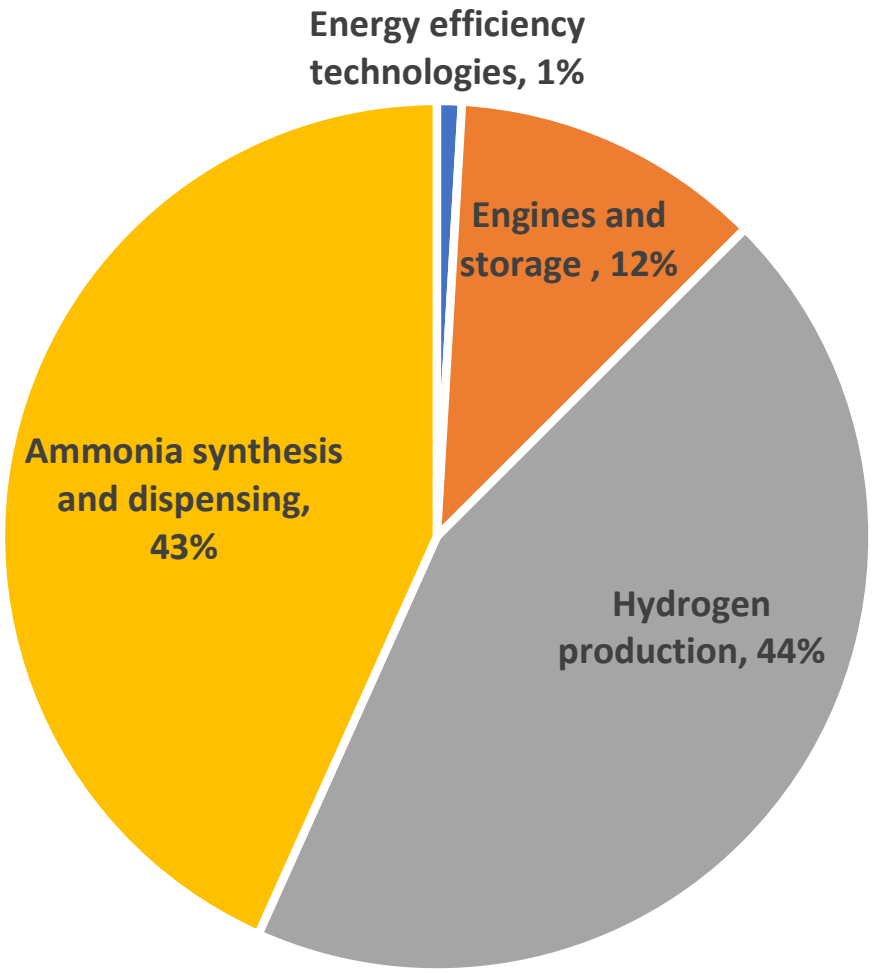
Renewable electricity + electrolyser + haber bosch = green ammonia

$340/t ammonia (~$800/t) by 2030?

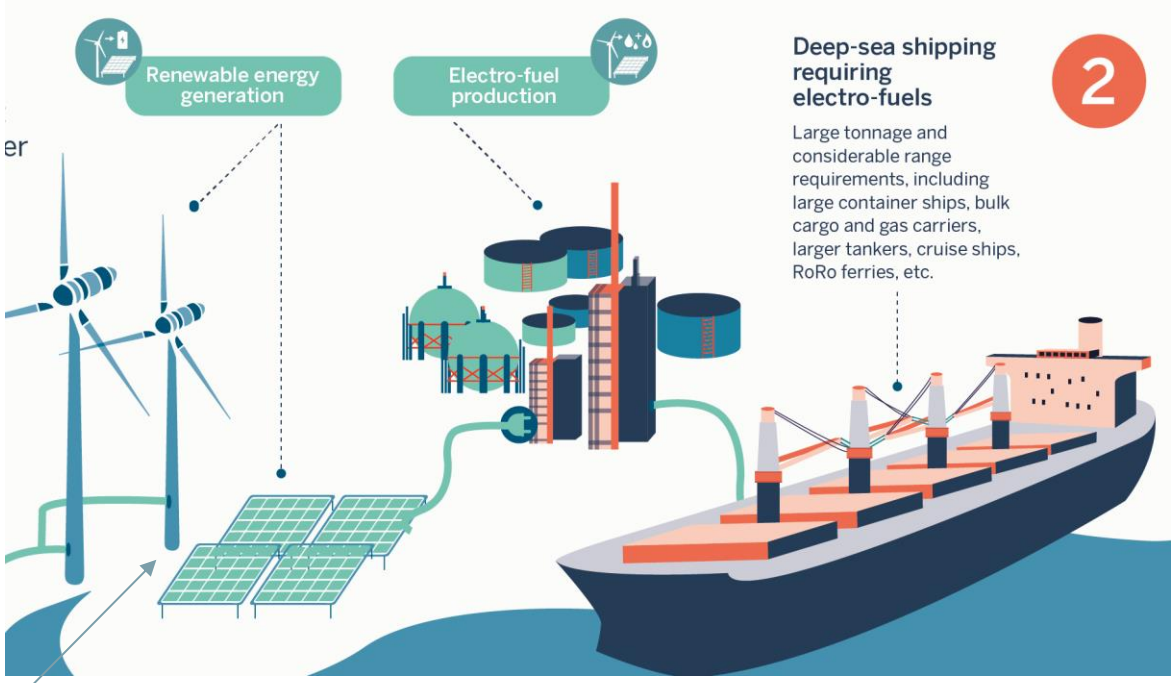
Direct air capture

~1000 to 100 $/t of CO_2 captured

Overall capital costs for 50% GHG reduction of global shipping by 2050 are ~$1trillion broken down as:



The need to join up energy/fuel decarb and fleet decarb



Energy policy

Transport policy

- UK should be able to join up transport and energy policy, this is crucial to manage transition risks
- Traceability/certification of fuels (nationally and internationally) remains a key missing part of the puzzle

Public		Private
Govt. provide risk capital/guarantee for pilots	2020	R&D, trials and pilot projects
UK sends very clear signal on future energy demands/mix in freight	2023	Very shortlist of long-run solutions
UK policy drivers of shift from fossil clarified, early adoption business case investment	2025	Solid investment cases formed on expected UK policy
Clarification on incentivization of fuel production decarbonisation	2028	Fleet and infrastructure investment flowing
Strong policy driver in place	2030	Zero roll-out

Concluding remarks

- Electrification is a clear winner
  - Electrification of local freight machinery (cranes, last mile vehicles)
  - Access to grid when vehicles/vessels stationary
  - Charging for full BEVs/PH
  - Potential for local production of hydrogen
- But electrification alone is not sufficient
  - Hydrogen (+) still in contention for long-haul road freight
  - Hydrogen (+) key for sea freight
- UK role in supply chain of hydrogen-derived fuels not clear for now
- Finance is increasingly ready, but market and policy is not
- We need public/private collaboration in a way we've never had before
- We need inter and intra-sector collaboration in a way we've never had before
- Stakeholders need to be flexible, access reliable information, and use scenario planning to guide strategy

Thank you very much

Tristan.smith@ucl.ac.uk

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Fuel costs/prices are derived from estimates of their production pathways and specific assumptions for each component/process

E-H2	E-NH3	E-METHANOL	E-DME	E-GASOIL	E-LNG	ELECTRICITY	NG-H2	NG-NH3
Water Treatment	Water Treatment	Water Treatment	Water Treatment	Water Treatment	Water Treatment	Battery storage	Steam methane reforming	Steam methane reforming
Electrolysis	Electrolysis	Electrolysis	Electrolysis	Electrolysis	Electrolysis	Transmission	CCS	CCS
Compression	Air Separation	Carbon Capture (DAC)	Carbon Capture (DAC)	Carbon Capture (DAC)	Carbon Capture (DAC)	Converters	Compression	Air Separation
Storage	Haber-Bosch	MeOH Synthesis	DME Synthesis	Hydrocarbons Synthesis	Methanation		Storage	Compression
Liquefaction	Refrigeration and storage	Storage	Storage	Storage	Liquefaction		Liquefaction	Storage
Liquid storage at port / dispensing					Storage		Liquid storage at port / dispensing	Haber-Bosch
								Refrigeration and storage

Machinery further work needed and areas to reduce costs

- Optimising use of hydrogen in main engines
- Optimising use of ammonia in main engines
- Efficiently controlling NOx in hydrogen/ammonia combustion
- Capture of ammonia slip from ammonia combustion
- Onboard cracking of ammonia for hydrogen
- Cost and life improvement for PEM FC
- Cost improvement and ammonia use for SOFC
- Safety