UCL Energy Institute

What is the potential future mix of marine fuels?

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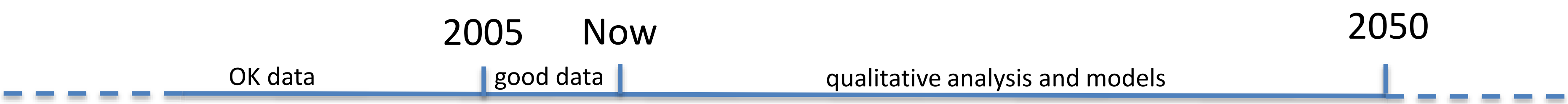
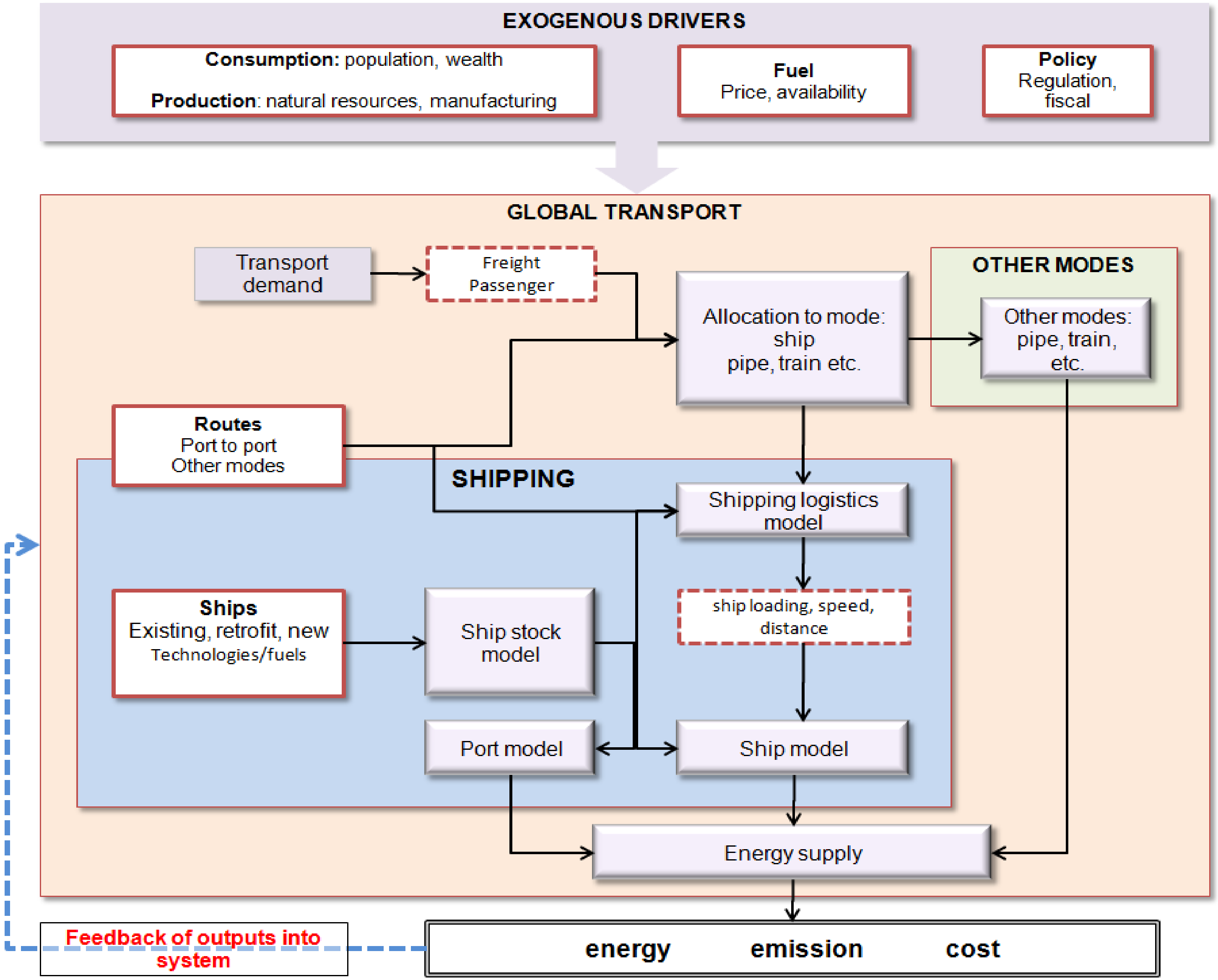
ESPO 2015
European Sea Ports Conference



How does the shipping system work?

How do shipping markets work, what is slow steaming, what happened in the recession, how can we model investment and ship operation?

What can we learn from analysis and models for:
a) shipping regulation to control GHG
b) Assistance to shipping's stakeholders to lead transitions to a low carbon shipping system


EXOGENOUS DRIVERS
Consumption: population, wealth
Production: natural resources, manufacturing
Fuel
Price, availability
Policy
Regulation, fiscal
GLOBAL TRANSPORT
Transport demand
Freight
Passenger
Allocation to mode: ship
pipe, train etc.
OTHER MODES
Other modes: pipe, train, etc.
Routes
Port to port
Other modes
SHIPPING
Shipping logistics model
Ships
Existing, retrofit, new
Technologies/fuels
Ship stock model
ship loading, speed, distance
Port model
Ship model
Energy supply
energy
emission
cost
Feedback of outputs into system

We try to simulate the ship owner's perspective

f(speed)

f(technology)

f(technology)

$$p_{pa} = R_{pa} - C_{s\_pa} - C_{v\_pa}$$

f(speed)

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Lloyd's Register Marine

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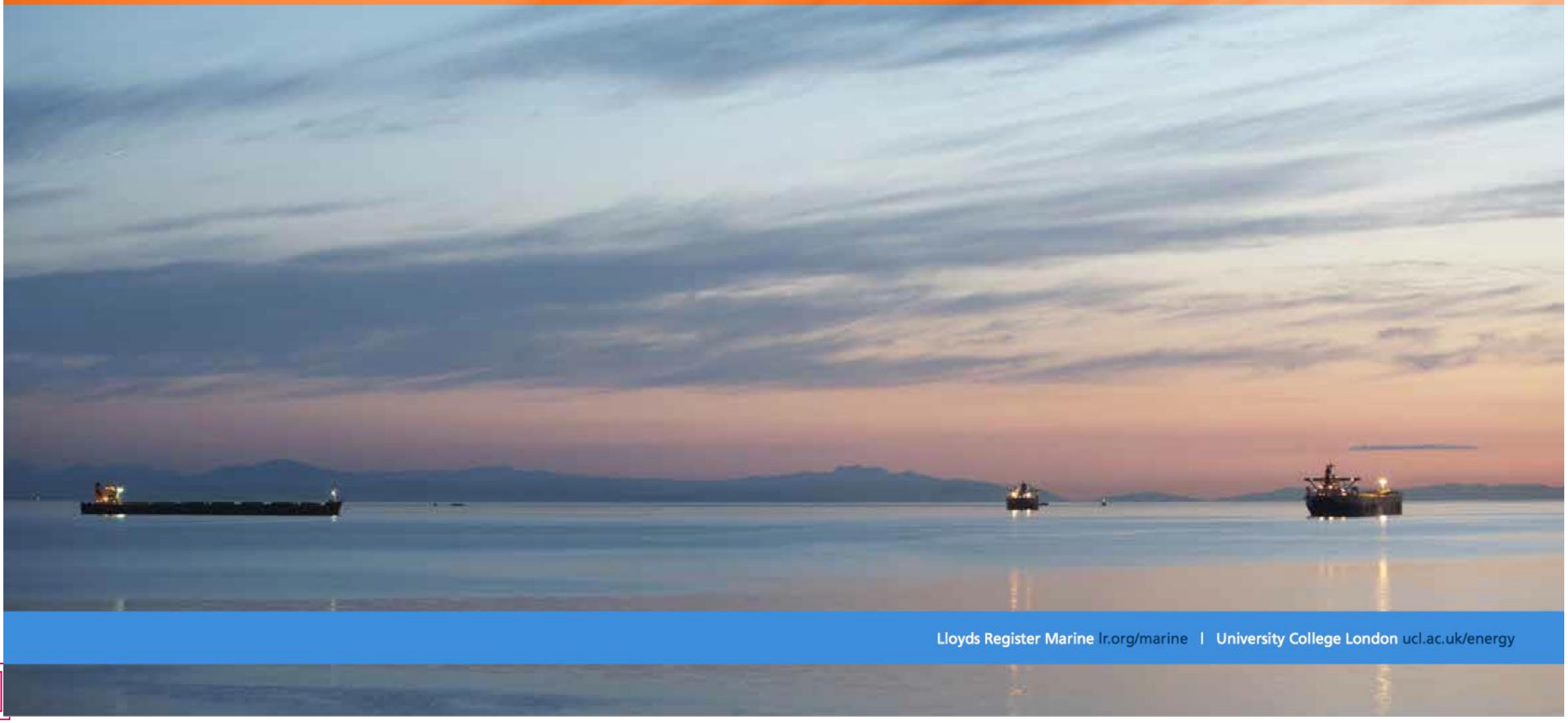
Global Marine Fuel Trends 2030



Lloyds Register Marine lr.org/marine | University College London ucl.ac.uk/energy

3 scenarios

Scenario	Oil/gas price	Bioenergy	Investment	Regulation
Status quo	Central estimate	Low availability	BAU	0.5% Sulphur in 2025, low carbon price
Global commons	Central estimate (low cost hydrogen)	Low availability	Better than BAU (more long-term)	0.5% Sulphur in 2025, high carbon price
Competing nations	High	High availability	Worse than BAU	0.5% Sulphur in 2030, no carbon price

Fuel/machinery considered

- MDO
- HFO
- LSHFO (0.5%)
- LNG
- Methanol
- Hydrogen

Bio feedstock blends/variants

2 stroke
4 stroke
Dual fuel / Gas engine
Fuel cell

Storage technology

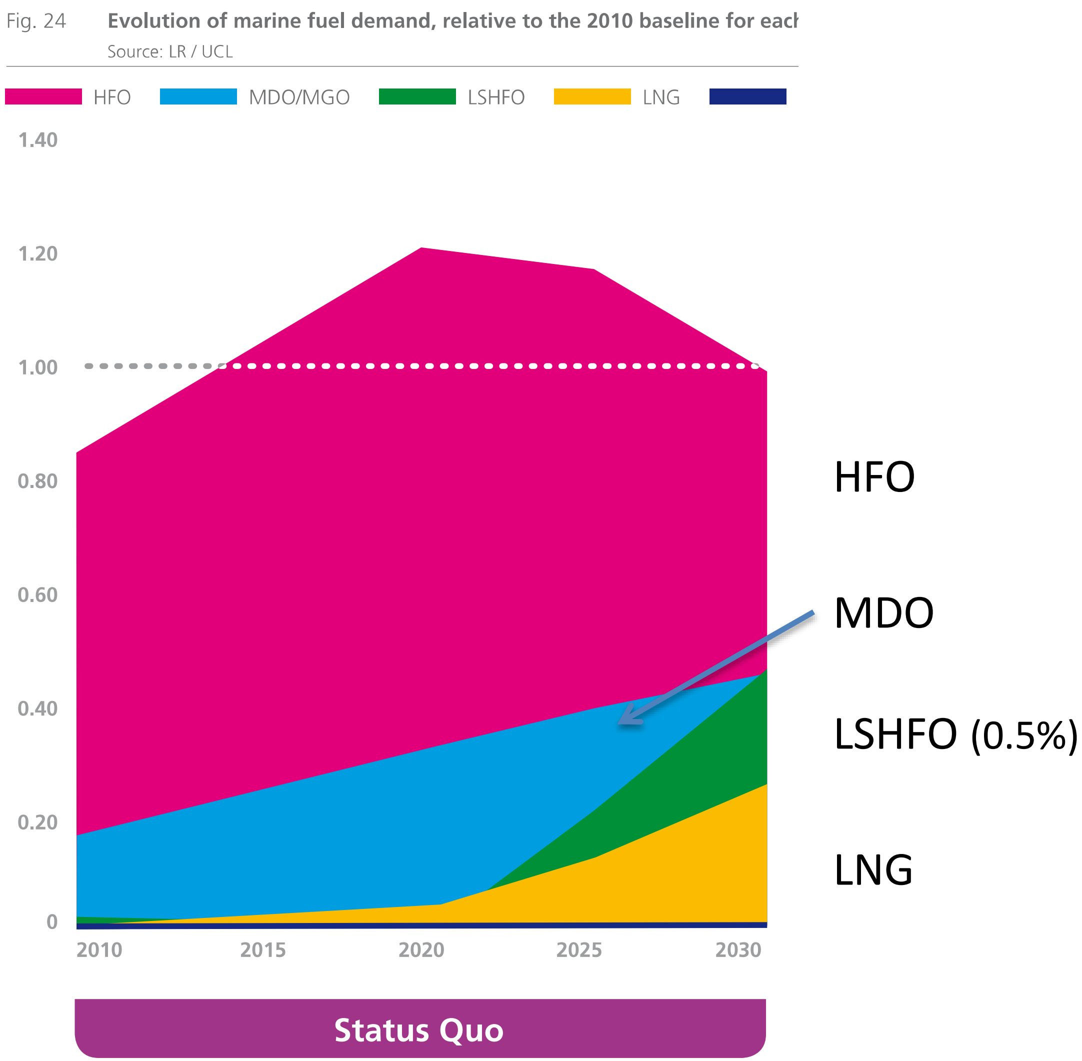
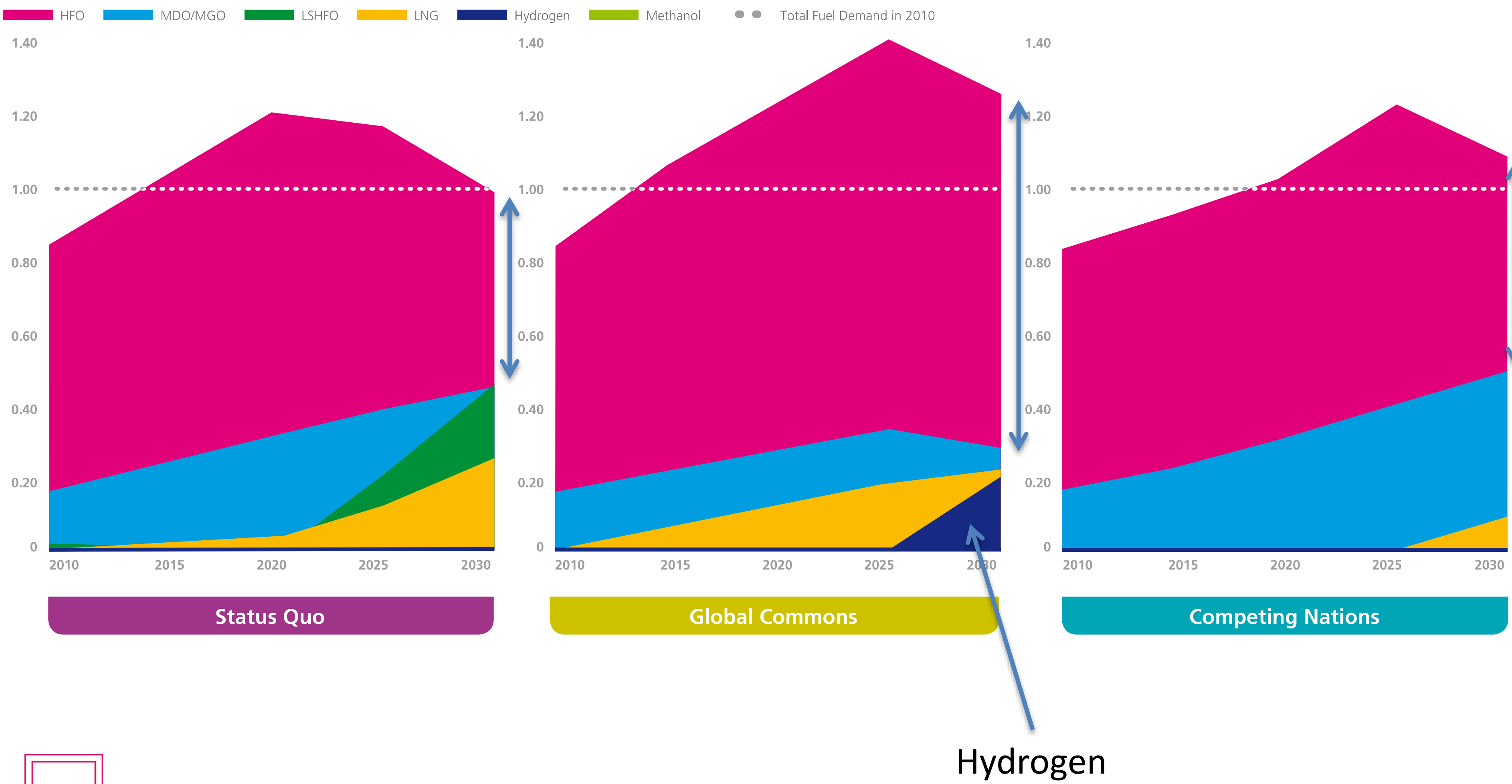


Fig. 24
Evolution of marine fuel demand, relative to the 2010 baseline for eacl
Source: LR / UCL
HFO
MDO/MGO
LSHFO
LNG
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0
2010
2015
2020
2025
2030
HFO
MDO
LSHFO (0.5%)
LNG
Status Quo

Fig. 24 **Evolution of marine fuel demand, relative to the 2010 baseline for each fuel**

Source: LR / UCL



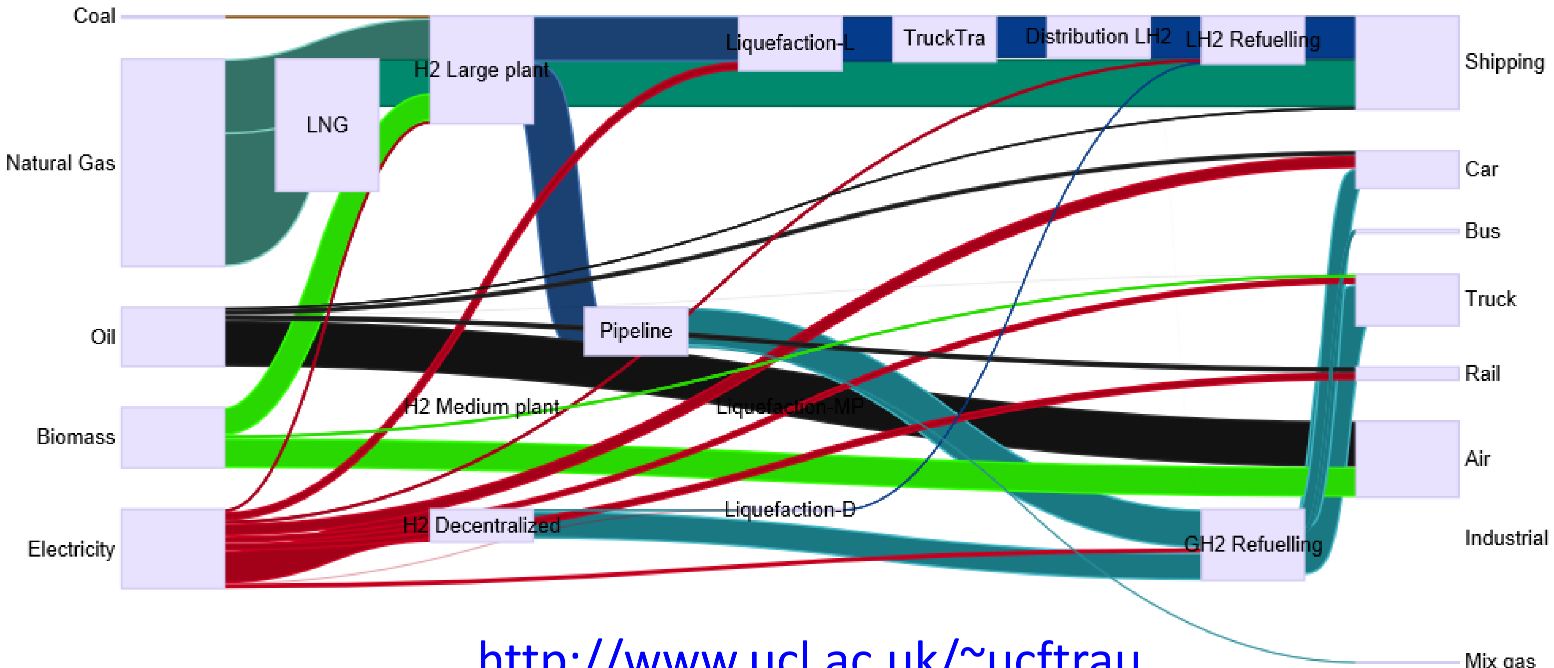
Key takeaways

- The state of the shipping market drives the total demand for fuel, and can influence the fuel mix
- Achieving 30% EEDI reduction (2025) is not a significant driver of fuel switching
- HFO (with a scrubber) remains viable, but its share of the fuel mix is highly sensitive to key assumptions
- In just 15 years, with only moderate deviations from current BAU, significant disruption can occur (e.g. hydrogen)
- Fuel prices are key assumption and the dynamics with the rest of the energy system need addressing

Next step

- Link a bottom-up energy system model to the shipping model
- Initial results from TIAM-GloTraM link :

Transport fuels supply 2050 under 2°C scenario



http://www.ucl.ac.uk/~ucftrau

- Global Marine Fuel Trends 2030 (UCL Energy Institute and Lloyd's Register)
- IMO 3rd GHG Study (UN agency, the International Maritime Organisation)
- Low Carbon Shipping Final Report (RCUK final report)
- On the Attitudes and opportunities of fuel consumption monitoring and measurement (UCL Energy Institute and International Paint/Akzo Nobel)
- Hidden Treasure – Financial Models for Retrofits (UCL Energy Institute, Carbon War Room)
- Bridging the Shipping Gap (WWF, UCL)
- Transport Research Part A: Energy Efficiency and Time Charter Rates (Agnolucci, Rehmatulla, Smith)
- LCS and other conferences

www.lowcarbonshipping.co.uk