Addressing the Challenges and Business Opportunities in Implementing Maritime 2050

Meeting the Environmental Challenge

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Maritime 2050 values and ambitions

Maritime 2050 Strategic Ambitions

The UK will...

- Maximise our strength in maritime professional services, retaining and enhancing our UK competitive advantage in the provision of maritime law, finance, insurance, management and brokering, and developing our green finance offer.
- Lead the way in taking action on clean maritime growth, enjoying economic benefits from being an early adopter or fast mover.
- Strengthen our reputation for maritime innovation, maximising benefits to the UK from new maritime technology through our world leading universities, maritime small and medium enterprises (SMEs) and global companies.
- Continue to be recognised as the global leader in maritime safety and security standards and expertise worldwide.

7 themes:

- UK competitive advantage
- technology
- people
- environment
- infrastructure
- trade
- security

CLEAN MARITIME PLAN
Environment Route Map for Maritime 2050

“The plan reflects the need to respond to the challenges of climate change and air pollution’s threat to public health, and identifies the clean growth opportunities associated with a transition to zero emission shipping.”

MARITIME AIR POLLUTION
Scale – taking CO$_2$ as example

- Global CO$_2$ emissions = 37 Gt/an
- 8 – 10 Gt increase in CO$_2$/an
- 15 Gt/an from stationary sources
- Global shipping emits 940 Mt CO$_2$/an = 2.5% of global emissions

If global shipping were a country it would be 6$^{th}$ largest emitter in the world

http://worldpopulationreview.com/countries/co2-emissions-by-country/
MARITIME AIR POLLUTION

International imperative

• Forecast increase in global shipping
• Business as usual not an option
• 2018 IMO commitment to:

  “reduce the total annual GHG emissions by at least 50% by 2050 compared to 2008, while, at the same time, pursuing efforts towards phasing them out entirely.”

http://www.imo.org/en/MediaCentre/PressBriefings/Pages/06GHGinitialstrategy.aspx
Variety of pollution - CO\textsubscript{2}, other GHGs, SO\textsubscript{x}, NO\textsubscript{x}, particulates ...
MARITIME AIR POLLUTION

Sources

Ports of the future

Vessels of the future

Figure 14 - Sources of maritime air pollution

Key Pathways

Low emission fuels and Fuel efficiency

Future Fuels
- Biofuels
- Hydrogen
- Ammonia
- Methanol
- LNG
- Electrification

Vessel Efficiency
- Hull shape/form
- Propulsion
- System Efficiency
- Automation
- Digitisation
- Optimization
Future fuel capability – Low emission port ops – Low emission connections

Infrastructure
Fueling
Storage

System Efficiency
Automation
Digitisation
Optimization
Electrification
Tugboats
Work vessels
Port machinery

Transport links
Rail vs Road
Electric Vehicle support
Access away from urban centres
HGV waiting places
EMISSIONS REDUCTION

Selected solutions – Maritime 2050

Selected Solutions for Reducing Emissions

- Use fuel alternatives
  - Biofuels
  - Electrofuels
  - Electricity (batteries)
  - Lower carbon fossil fuels
    - Hydrogen
    - Ammonia
    - Methanol
    - Liquefied Natural Gas

- Emissions treatment
  - Scrubbers
    - Addition of propulsion aides e.g. sails, kites
    - Improved hull form
    - Reduce waiting time at port
    - More frequent hull cleaning

- Increase fuel efficiency
  - Design efficiency
  - Operational efficiency

Figure 15 - Selected solutions to reducing emissions
FUTURE FUELS
Challenges to uptake

• Biofuels
  • Capacity – requires significant land use and bioresources for production
  • Expensive – likely to be more accessible to airlines and road vehicles before maritime transport
    • Look elsewhere ...

• Electrofuels - Hydrogen/Ammonia/Methanol
  • Highly toxic, combustible, cryogenic
  • Uncertainty of material integrity of storage and transmission equipment on board
    • Research to better understand FF and develop necessary infrastructure

• LNG
  • Transition fuel towards zero emission fuels, cleanest of fossil fuels
  • Change in infrastructure in vessel and portside infrastructure
    • Existing knowledge and exemplars – further research for scale and optimization
• Massive renewable energy generation capacity required to make future fuels ‘clean’
• Net emissions not reduced by making future fuels with low emissions at point of consumption from burning fossil fuels.
• Research to address technology gaps across the lifecycle of renewable energy facilities to make economically competitive.
ELECTRIFICATION
Storage and transmission

• Research Challenges
  • Amount of storage & rate of transfer
    • Tailor battery for application
    • Cost, power, capacity, service life, degradation, environmental impact...
  • 3D printed cells
  • Sustainability
    • Non-lithium chemistries
    • Readily recyclable
  • Integration of Energy Storage
EMISSIONS REDUCTION

Selected solutions – Maritime 2050

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Figure 15 - Selected solutions to reducing emissions
VESSEL EFFICIENCY

Reducing drag

- Air lubrication systems. Layer of micro-bubbles lubricates underside of hull - reducing drag and reducing emissions by 5 – 10%.
- UoS projects to model systems and determine feasibility of using Machine Learning to optimise the operation

https://www.silverstream-tech.com/silverstream_images-3/

NPV $156M, 6.8M tonnes CO₂

Adam Sobey, Dominic Hudson Amy Parkes, University of Southampton
VESSEL EFFICIENCY

Wind-assist technology

• CFD of Flettner rotors for oil and LNG carriers
• NPV $6.2M, 0.5M tonnes CO₂

Dominic Hudson & Wolfson Unit, University of Southampton
VESSEL EFFICIENCY

Improved propulsion

- Bio inspired propulsion – resonant robot
- Most efficient accelerator underwater – officially!

Gabe Weymouth, University of Southampton
SYSTEM EFFICIENCY
Physics-based ML for real time management

• Sparse Data Surrogate Models using Physics-Based ML

Gabe Weymouth, University of Southampton
VESSELS & PORTS OF THE FUTURE
Barriers and solutions to realizing the vision to meet the environmental challenge

Technology
- Future Fuels
- Electrification
- Generation/Storage
- Vessel efficiency
- System efficiency
- Automation/Digitisation

Infrastructure
- Transforming infrastructure while operating at full capacity

People
- Change in workforce skill requirements.
- Training & re-training

Regulation
- Progressive forward looking regulation to enable uptake of new technologies to meet clean growth demand
THINKING BIGGER

How else can the maritime sector contribute to clean growth?

• Challenge that Maritime has greater role to play in clean growth than just reduction of emissions from shipping.

• Oceans have SPACE for:
  • Renewable energy generation
  • Carbon Capture and Storage
  • Low carbon food production (fish, seaweed)

• Inlets and coastlines are crowded – oceans provide space to generate energy, create food, store CO₂
THINKING BIGGER

How else can the maritime sector contribute to clean growth?

Renewable energy

• Global electricity consumption forecast to continue increase …

THINKING BIGGER

How else can the maritime sector contribute to clean growth?

- Fuel shares in power generation - share of non-fossil fuels for Electricity Generation in 2017 was LOWER than in 1997 (power generation much greater!)

1997

Coal: 38.2%
Oil & gas: 24.8%
Non-fossil: 37.0%

The share of coal used today in the power sector is almost identical to two decades ago.

2017

Coal: 38.1%
Oil & gas: 26.6%
Non-fossil: 35.3%

The share of non-fossil fuels is actually slightly lower than 1997.

Business opportunity for maritime industry in development of offshore renewable energy

THINKING BIGGER
How else can the maritime sector contribute to clean growth?

Carbon capture and storage

• In terms of volume CCS is potentially a larger industry than the oil business.

Capture all 37 Gt/yr CO$_2$ emissions annually
Compress to critical point (73.82 b)
79.2 bn m$^3$ = cube of side 4.3 km.
World oil production is 3.88 Gt/yr
4.52 bn m$^3$ = cube of side 1.7 km.

Business opportunity for maritime industry injecting supercritical CO$_2$ in deep rock reservoirs for storage

After example by Richard Darton, Oxford
Aquaculture

• To feed an additional 2 bn people by 2050 requires 60% increase in food production

THINKING BIGGER
How else can the maritime sector contribute to clean growth?

Monitoring ocean health

Blair Thornton
https://ocean.soton.ac.uk

Business opportunity for maritime industry to create the evidence base to understand how our interventions are affecting the oceans in order to manage interventions responsibly.
‘THE’ ENVIRONMENTAL CHALLENGE

Demand and Limit

• Demand on the planet – Increased demand for resources, food, goods, energy for an increasing and increasingly wealthy global population pushing outwards

• Limit of the planet – Emissions limits and targets set by legislation or sense of environmental responsibility pushing inwards

• How to reconcile competing agendas?

• Rely on technology and innovation in absence of behaviour change.

• BUT …
‘THE’ ECONOMIC MODEL TO MEET ‘THE’ ENVIRONMENTAL CHALLENGE

Doughnuts – Food for thought

• Must integrate consideration of demand and limit

“The world has enough for everyone's need, but not enough for everyone's greed.” Mahatma Gandhi