Decarbonisation solutions for the UK fishing sector: a cost-benefit analysis

Stephen Mangi Chai

Introduction

- Transition to a green future requires finding solutions to decarbonise fishing operations by switching to sustainable alternatives.
- Major source of fisheries emissions comes from fuel consumption.
- Switching to carbon-free engines will incur costs but should, in the long-term prove beneficial for all.

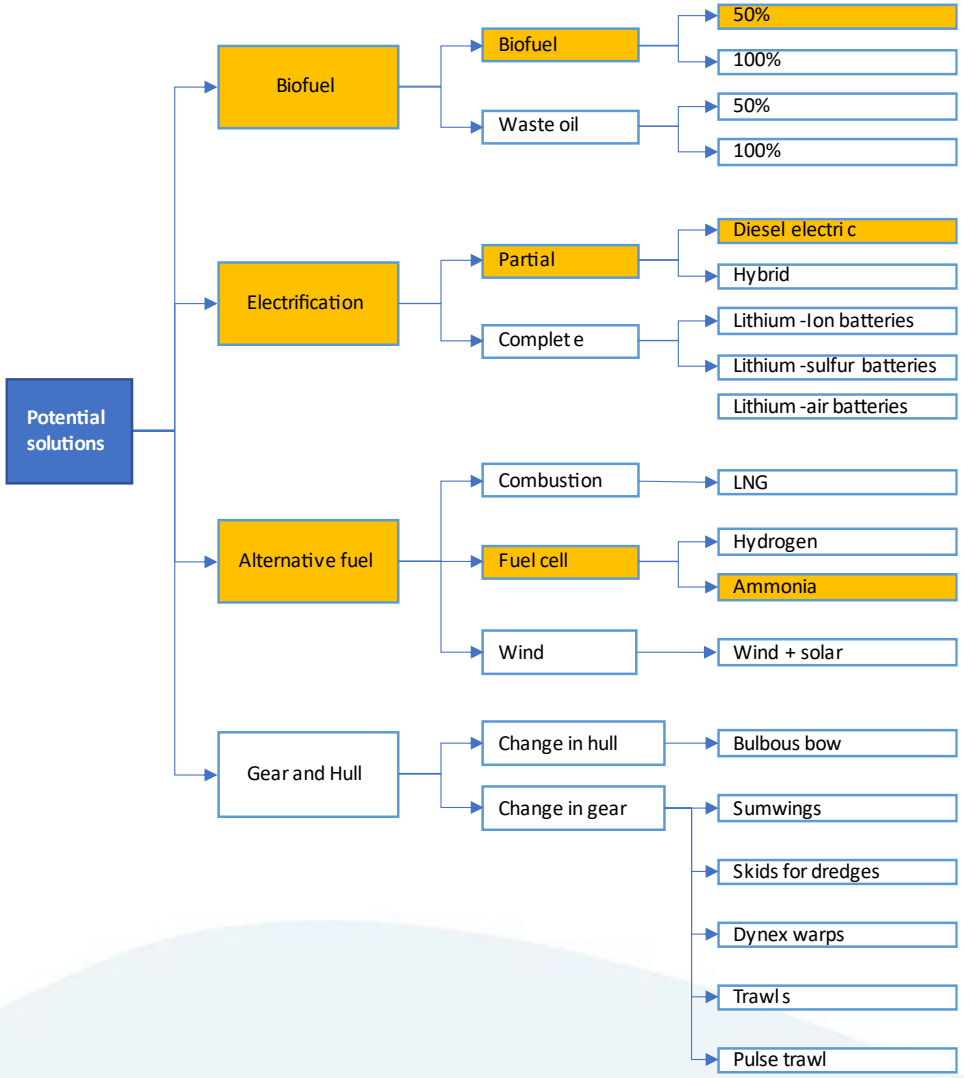
- Link to reports from the study: https://sciencesearch.defra.gov.uk/ProjectDetails?ProjectId=21405

Objectives

- To build upon the Towards Net Zero report by assessing the costs and benefits of various decarbonisation solutions for different UK fleet segments.
- To identify which options best deliver value for money for the different fleets.

- Outputs are expected to inform potential pathways to support decarbonisation across UK fishing sector.

Methods



- Literature review on applicability of decarbonisation solutions and selection of feasible solutions.

- Identified 19 potential solutions that can be grouped into four main families.

Feasibility and applicability of solutions to the UK fishing industry

SOLUTION	STATUS	ASPECTS TO CONSIDER
Biofuel 50% (immediate solution)	Technology has been extensively tested in large fleets by car and truck manufacturers.	Production level of the alternative fuel and the potential adaptation needed for vessels.
Diesel-electric (medium-term solution)	Technology has been deployed extensively in various environments and tested on some new fishing vessels.	Need to increase the uptake by the fishing sector and the availability of batteries.
Ammonia (long-term solution)	Fuel cell technologies are still in development.	One of the best options available to generate a massive change for the industry.

- These solutions were technologically and economically feasible for the fishing industry to adopt on vessels compared to the other technologies.
- Chosen to carry out a full cost-benefit analysis.

Costs

- Assessment period: 25 years = ~lifetime for a conventional marine diesel engine onboard a fishing vessel.
- Annual average cost data from 2015-2019.
- Costs for diesel-electric and ammonia fuel cell options are predominately due to investment in a new engine, new batteries and increased crew costs.
- Biofuel 50% option does not require investment into replacement engines or batteries, the costs are due to increased crew costs and increased maintenance costs.

Solution	Fuel costs	Crew costs	Other fishing expenses	Maintenance costs	Investment in new engine / powertrain	Investment in batteries
Biofuel	Increased	Decreased	No change	Increased	Not required	Not required
Diesel-Electric	Decreased	Increased	No change	Decreased	Required	Required
Ammonia	Decreased	Increased	No change	Decreased	Required	Required

Benefits

- Identified numerous benefits to each solution but some were difficult to quantify e.g.
  - Positive impacts that biofuel does not require engine modification and could be used immediately.
  - Reduced maintenance and fuel costs of diesel-electric and ammonia.

- Reduction in CO_2e experienced from switching to the technological solutions was monetised.
  - Used carbon values (representing the monetary value that society places on one tonne of CO_2e) from the Treasury's Green Book.

Stakeholder engagement

Undertaken to discuss potential costs and benefits as well as any issues of feasibility related to the three solutions.

Each of the three solutions were discussed separately.

Stakeholders were offered opportunity to discuss anything else they considered worth discussing.

Issues that would inhibit the ability of fishers to switch to the proposed solutions.

Respondents from:

- Fisheries Innovation & Sustainability (FIS)
- Macduff Ship Design
- National Federation of Fishermen's Organisations (NFFO)
- British Ports
- Two Brothers Ltd
- New Under Ten Fishermen's Association (NUTFA)
- Scottish Fishermen's Organisation (SFO)
- Scottish White Fish Producers Association (SWFPA)

Results: Biofuel

- Identified “as a great and easy alternative that could be switched to tomorrow”, but it was “very expensive” as a fuel.
- Maintenance / operational costs would increase due to need for more routinely clean injectors, joints and filters.
- Geography of biofuel producers and volume produced.
- Some indicated that it may not be feasible on a large scale.

Results: Diesel-electric

Stakeholders were broadly positive about the potential for diesel-electric engines.

Issues regarding the high initial investment costs associated with the solution.

Need for more unique repair skills – while fishers are comfortable with working on diesel engines at sea if needed, that expertise is lost when engines are replaced.

Infrastructure for charging - Small annual fee to dock in harbour, pay more to dock in a marina.

Results: Ammonia

Has the scope to be a truly carbon free fuel, depending on how it is manufactured.

Issues related to how it is stored as a liquid - significant space would be needed to store onboard vessels and for some segments (under 10m especially), this could take all space to store catch.

Requires substantial upfront capital investment by fishers

Training was also raised as an issue – if ammonia is stored incorrectly, it could be released onboard a vessel as a gas, which can be fatal.

If the engine was to break, stakeholders noted that "there won't be someone onboard to fix it like with a diesel engine".

Fuel cells as opposed to diesel tanks that help balance fishing vessels and provide stability.

Feasibility and other issues

Infrastructure, reliability of alternative fuels or engines, and potential regulatory compliance.

Fishers would bear the costs of moving to one of the three proposed solutions but would not necessarily be the beneficiaries.

Any replacement engine, whether using diesel-electric or ammonia fuel-cells, would likely cause issues relating to regulatory compliance with the MCA and MMO.

Extensive port modifications will be needed across the UK

Cost-benefit analysis: Biofuel 50%

Costs and Benefits	Value
Total costs (Maintenance costs, fuel costs)	£430,000,000
Total benefits (CO2e savings (low))	£670,000,000
Total benefits (CO2e savings (central))	£1,300,000,000
Total benefits (CO2e savings (high))	£2,000,000,000
Benefit-cost ratio (low CO2e value)	1.6
Benefit-cost ratio (central CO2e value)	3.1
Benefit-cost ratio (high CO2e value)	4.7
Net present value (low CO2e value)	£240,000,000
Net present value (central CO2e value)	£910,000,000
Net present value (high CO2e value)	£1,600,000,000

Cost-benefit analysis: Diesel-electric

Costs and Benefits	Value
Total costs (Powertrain, batteries, and replacement batteries)	£230,000,000
Total benefits (maintenance savings, fuel savings, CO2e savings (low))	£780,000,000
Total benefits (maintenance savings, fuel savings, CO_2e savings (central))	£930,000,000
Total benefits (maintenance savings, fuel savings, CO2e savings (high))	£1,100,000,000
Benefit-cost ratio (low CO_2e value)	3.3
Benefit-cost ratio (central CO_2e value)	4.0
Benefit-cost ratio (high CO_2e value)	4.6
Net present value (low CO_2e value)	£550,000,000
Net present value (central CO_2e value)	£700,000,000
Net present value (high CO_2e value)	£850,000,000

Cost-benefit analysis: Ammonia fuel cells

Costs and Benefits	Value
Total costs (Powertrain, batteries and replacement batteries)	£1,100,000,000
Total benefits (maintenance savings, fuel savings, carbon savings (low))	£2,900,000,000
Total benefits (maintenance savings, fuel savings, carbon savings (central))	£4,400,000,000
Total benefits (maintenance savings, fuel savings, carbon savings (high))	£6,000,000,000
Benefit-cost ratio (low carbon value)	2.6
Benefit-cost ratio (central carbon value)	4.0
Benefit-cost ratio (high carbon value)	5.3
Net present value (low carbon value)	£1,800,000,000
Net present value (central carbon value)	£3,300,000,000
Net present value (high carbon value)	£4,900,000,000

Conclusions

- The BCRs are variable across the fleet segments.
- Diesel-electric and ammonia showed the highest BCRs for most segments.
- BCRs for biofuels are tightly linked to fuel price of biofuel – if production was to increase within the UK, then there is scope for biofuel pricing to come down and improve the BCRs.
- Qualitative impacts and likely uptake due to upfront costs and other concerns (e.g., safety) need to be considered, which makes biofuel a potentially better option to consider in the short-term.
- In terms of distributional analysis, it is anticipated that the costs are to be borne by the owners of fishing vessels / the fishers, whilst the spread of benefits is more diffused.