Net Zero Vessels Concept Design Project

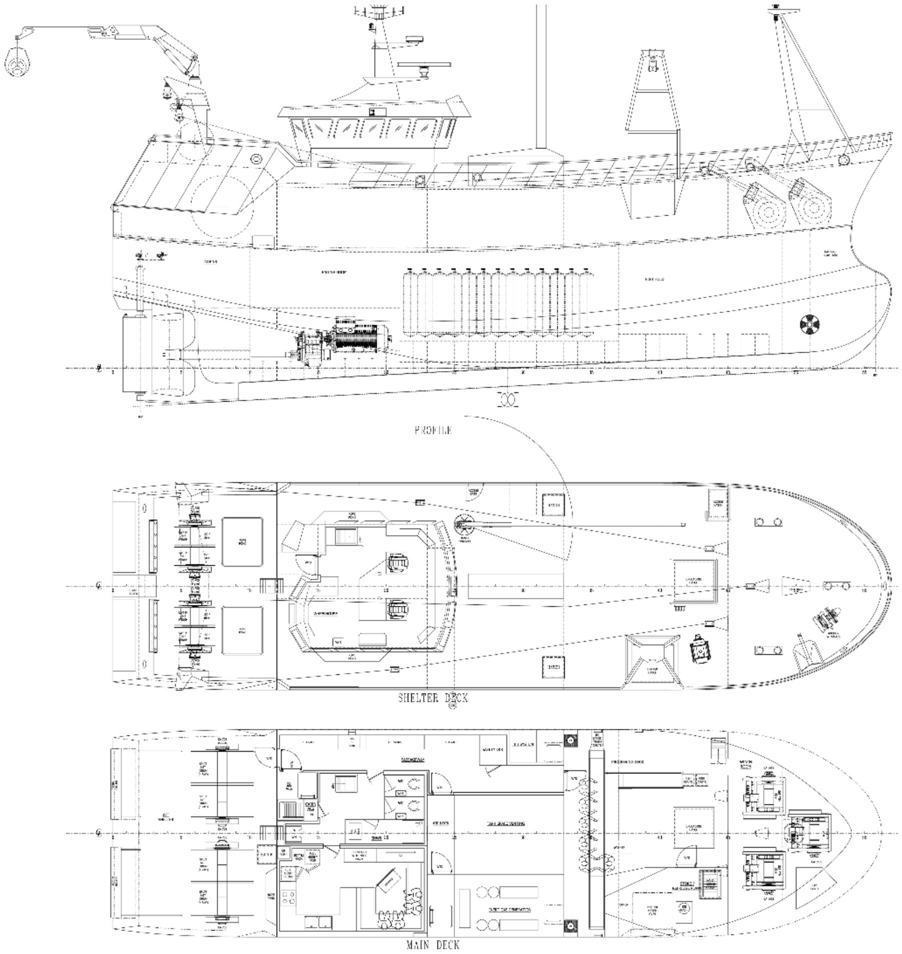
Stage 3

A REPORT COMMISSIONED BY
FIS AND PREPARED BY:

Macduff Ship Design Ltd.

Fisheries
Innovation &
Sustainability

Net Zero Vessels Concept Design Project



May 2024

MACDUFF SHIP DESIGN
Fisheries Innovation & Sustainability
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Riaghaltas na h-Alba

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FISHERIES INNOVATION & SUSTAINABILITY

NET ZERO FISHING VESSEL CONCEPT DESIGN PROJECT

STAGE 3

BY	D BOAG
DATE	01/05/2024
VERSION	Final

RINA
CORPORATE PARTNER

ISO 9001 : 2015
REGISTERED FIRM

ISO 9001:2015 REVISION PAGE

VERSION	DATE	COMMENTS
1	04/03/2024	Initial version sent to FIS for comment
2	22/03/2024	Updated in response to FIS comments
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Contents

OVERVIEW

In April 2022, Fisheries Innovation Scotland, now Fisheries Innovation & Sustainability (FIS), organised the 'Vessels of the Future' workshop in Glasgow, which was attended by stakeholders and industry leaders across the fishing industry. This workshop[1] identified the need for the 'creation of a roadmap' towards a net zero future for the Scottish fishing sector, highlighting both the need for a business case for change and existing regulatory barriers as the key potential obstacles to this transition.

Stage 1[2] of the 'CONCEPT DESIGN PROJECT' was completed in January 2023. The report analysed three different vessel types and highlighted a range of technical, financial, and regulatory barriers associated with a just transition to net zero vessels for the fishing sector.

Stage 2[3] of the 'CONCEPT DESIGN PROJECT' was completed in August 2023, supported by Marine Fund Scotland. This report produced six concept designs[4] for fishing vessels capable of net zero operation. These designs were:

Less than 10m Creel -	Battery Electric Methanol
About 15m Nephrops -	Methanol LNG (Liquified Natural Gas)
Less than 24m Whitefish -	Methanol LNG

One of the key factors highlighted in the Stage 2 report was uncertainty of future alternative fuel availability and pricing. It is widely understood that hydrogen will likely emerge as a cost-effective fuel in comparison to other alternative fuels. Findings from Stage 2 advised future research investigating hydrogen-fuelled vessels to understand the compromises that need to be accepted for hydrogen and evaluate the technical, regulatory, and financial implications associated with transitioning to this fuel.

This Stage 3 report produces three concept designs, all operating with hydrogen fuel as hydrogen/battery hybrid vessels. These are produced using the same vessel sizes as the versions from the Stage 2 report. For this stage, we have fixed dimensions based on the smaller of the two net zero options identified in Stage 2. Adjustments to the number of operational days has been changed as required.

This report is intended to be read in conjunction with the Stage 2 report, as it makes direct comparison to vessels and analysis presented in both reports.

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[1] Report: Vessels of the Future Workshop (fisorg.uk)

[2] Report: FIS Net Zero Vessels Stage 1 (fisorg.uk)

[3] FIS Net Zero Vessels Stage 2 (fisorg.uk)

[4] Net Zero Vessel Designs (fisorg.uk)

EXECUTIVE SUMMARY

This report represents the third stage of a collaboration between Macduff Ship Design Ltd. and Fisheries Innovation & Sustainability (FIS) to support UK fishing vessels owners in meeting government and customer deadlines for decarbonisation.

Focusing on hydrogen as a potential fuel option for UK fishing vessels, this report investigates the technical, regulatory, and financial implications of such a transition. Building on the previous project reports examining battery-electric, methanol, and liquified natural gas (LNG) options, this report presents innovative, first-of their-kind designs for three sizes of fishing vessels fuelled by hydrogen. By comparing these hydrogen designs to traditional 'parent' diesel vessels and net-zero vessels from previous stages of the project, the report provides a clear comparison of opportunities and risks for vessel owners looking to reduce diesel reliance.

Key findings from the report suggest that hydrogen is unlikely to be a suitable option for smaller creel vessels, due to its increased complexity, safety concerns, and additional costs compared to battery electric alternatives. Similarly, for the majority of Nephrops and whitefish trawlers, hydrogen poses challenges due to range and hold space limitations, making methanol a more competitive option for longer-duration operations, unless hydrogen vessel size is significantly larger.

The costs and availability of methanol, LNG, and ammonia, however, are more uncertain. Therefore, the likely lower cost and better supply of net zero hydrogen in the future could position it as a preferred option. However, transitioning to hydrogen would necessitate a significant shift in the type, range, and operational profile of the fleet to align with the constraints associated with hydrogen as a fuel source.

The report highlights the lack of public information on future fuel production and infrastructure, plus associated pricing across the UK, hindering the ability of vessel owners, port authorities, and infrastructure providers to plan ahead, or make informed economic decisions as net zero deadlines approach and diesel access becomes increasingly challenging and costly.

The report underscores the urgency of supporting UK fishing vessel owners in transitioning away from fossil fuel diesel toward net zero solutions. Currently, the lack of vessels operating on net zero solutions poses a significant barrier to the development of best practices in design, operation, and safety systems. Successfully operating demonstrator vessels is critical, to establish a robust evidence base.

Considering that most fishing vessels have a serviceable life exceeding 20 years, and many vessels currently in build are expected to remain operational beyond the net-zero government deadlines of 2045 and 2050 in Scotland and the UK respectively, prompt action is imperative. To support UK fishing vessel owners in transitioning away from fossil fuel diesel, the report introduces a roadmap, identifying essential short-, medium-, and long-term actions. Nevertheless, it cautions that there may be insufficient capacity to complete the fleet transition before net zero deadlines, if action is not taken promptly.

Short Term:

- Conduct a study on future fuel infrastructure plans to understand the cost and availability of net zero fuels.
- Undertake a data collection study to analyse power usage patterns in current vessels across different fisheries.

- Perform an economic analysis of vessels developed in the project's previous stages to assess their total life costs.

Medium Term:

- Develop more concept designs covering a broader range of vessel sizes, fishing methods, and operational cycles, including economic assessments.
- Collaborate with powertrain suppliers to develop suitable options tailored to the fishing industry.
- Initiate projects with owners and shipyards to build demonstrator vessels, including both full net zero options and hybrid vessels.

Long Term:

- Continue developing projects to build more challenging net-zero demonstrator vessels for various fishing types and vessel sizes.
- Organise engagement events for stakeholders to interact with demonstrator vessels and understand the transition to net zero.
- Provide support to vessel owners in developing plans for vessel replacement or retrofitting to net zero solutions.

MAIN REPORT

This report is designed to follow on from Stage 2, and produces net zero concept designs utilising hydrogen as the primary fuel source. This report is intended to be read in conjunction with the Stage 2 report, as it directly references and compares information from Stage 2.

The analysis from Stage 1 advised that significant modifications would likely be necessary for hydrogen integration across all three designs. For Stage 3, it was decided to utilise the same hull as the closest option to a diesel vessel developed in Stage 2. The goal was to identify the required changes to the operational cycle to accommodate hydrogen as the primary fuel source.

The report explores hydrogen as a fuel for three types of vessels:

- Less than 10m Creel
- Approx. 15m Nephrops
- Less than 24m Whitefish

In the case of the <10m creel vessel, this was adapted from the hull of the battery electric version from Stage 2. Given that the battery option is less efficient in terms of space than other fuel alternatives, hydrogen was added to increase the range and number of operational cycles between refuelling/recharging. The final version was also compared to the methanol version developed in Stage 2.

For both the Nephrops and whitefish trawlers, these designs were developed using the hulls of the methanol versions from Stage 2. Methanol is more space-efficient than hydrogen, and therefore to maintain the same hull form we compromised on the range of the vessel and the operational cycle of the vessel. We maintained the same fishing gear, method, and power delivery and used range, fish hold volume, and processing space as variables. The primary comparison is with the methanol versions which share the same hull, but secondary comparisons were made with the LNG version where applicable.

All the hydrogen systems reviewed in this report are based on compressed gas. At this time, there are no suppliers offering off the shelf liquid hydrogen systems, which could potentially improve the weight of hydrogen stored within the vessel. However, liquid hydrogen poses other notable safety and operational concerns related to the cryogenic system and boil-off risks. Due to this complexity, liquid hydrogen systems are beyond the scope of this report.

<10m creel boat – Hydrogen

Specification

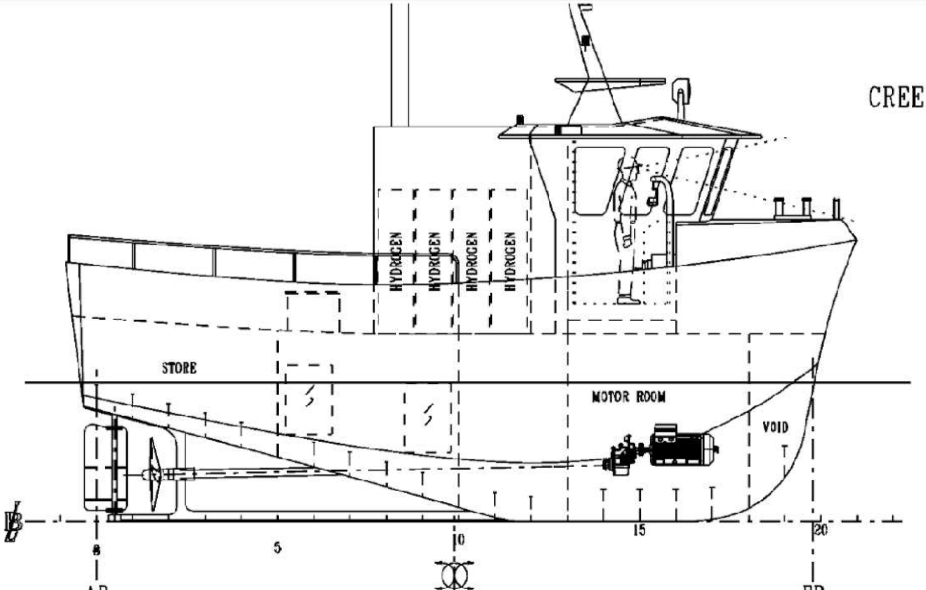
This vessel is a creel boat with hauler and block to starboard. Catch is assumed to be stowed on deck.

	Details	Comparison to	
	Hydrogen Design	Stage 2 – Battery Electric	Diesel parent vessel
Length Overall	9.950m	No change	No change
Beam	3.500m	No change	No change
Prime mover	40kW Electric Motor	100kW Electric Motor	100 kW Diesel Motor
Gross Tonnage	13GT	No change	No change
Number of operations between refuelling	7 days	4 day increase, 133% more (3 days range)	3 day reduction, 30% less (10+ days range)

Fuel Capacity	29.6kg @ 700Bar	
Battery Capacity	80kW.h	
Regulations	MGN 628 (construction)	[No Change]
	MSN 1871 (Safe Working Practice)	[No Change]
	MGN664 (Hydrogen Fuel/fuel cell)	[to use BV Hydrogen rules]
	BV NR678 (Hydrogen Fuel)	[for hydrogen system]
	BV NR 547(Fuel Cell)	[for hydrogen system]

FIS CONCEPT DESIGN PROJECT

CREEL BOAT - HYDROGEN / BATTERY HYBRID



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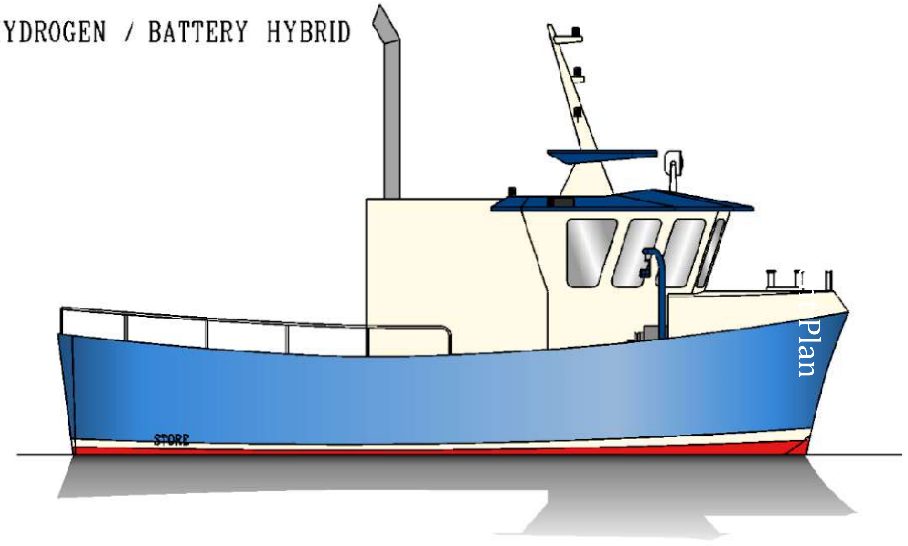
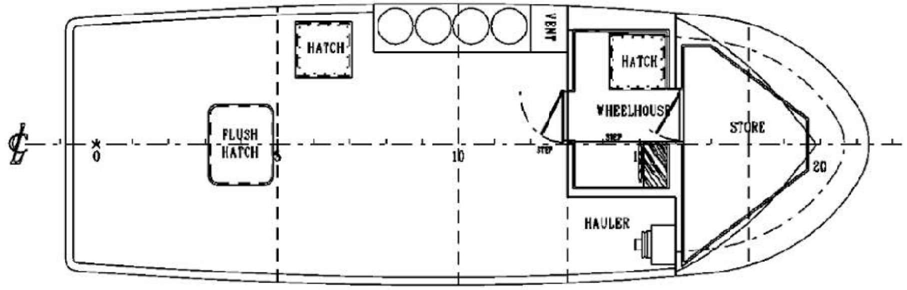
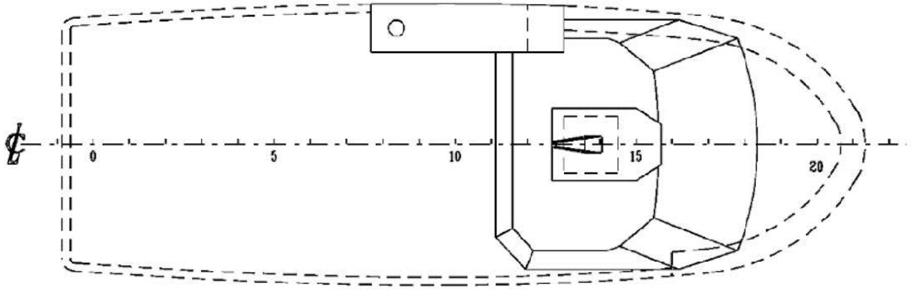
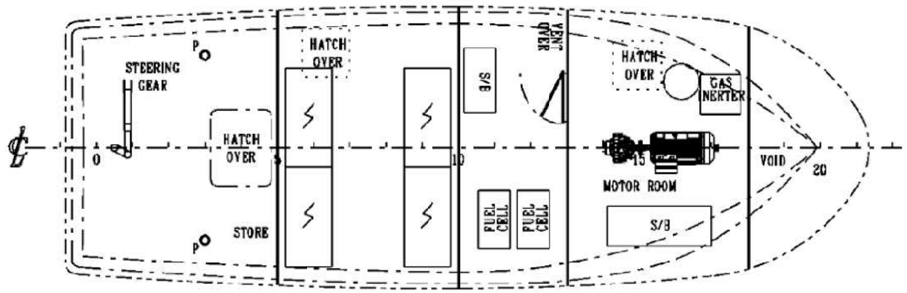




MAIN DECK



WH TOP



BELOW DECKS

PRINCIPAL DIMENSIONS

LENGTH OVERALL	9.950 m
LENGTH B.P.	8.900 m
BREADTH MLD.	3.500 m
DEPTH MLD.	2.325 m

A	TITLES UPDATED	DB	22/03/24	IAN	22/03/24
REV.	MODIFICATION	BY	DATE	CHKD.	DATE

APPROVED BY:-
DATE:-

TITLE:-	FIS CONCEPT DESIGN CREEL BOAT HYDROGEN/BATTERY HYBRID GENERAL ARRANGEMENT		REF:- -
DRAWN BY:- JV		CHECKED BY:- DB	DRAWING NO :- 001
DATE:- 01-03-24		DATE:- 01-03-24	REVISION :- -
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Report

The vessel was developed to emulate the operation of a Cygnus GM32 set up for creel fishing. Unfortunately, exact design details for the GM32 were unavailable, as these vessels are typically outfitted to meet individual owner requirements. To compensate for this lack of specific information, we used the extensive design database held by Macduff Ship Design Ltd., supplemented by additional open-source data.

Additionally, information from a MIT power collection report for a Cygnus GM32 owned by Douglas Chirnside was incorporated, along with comments from Chirnside regarding test conditions and skipper perception. A key finding was that the 100Kw engines typically fitted to vessels such as this are excessive, with a 40Kw motor sufficient for maximum operations. This suggests that these vessels are less fuel efficient than previously believed, and that the battery electric version developed in Stage 2 would have better range than initially thought. This is corrected in the comparison table on page 8.

The vessel utilises a hybrid system for propulsion, combining hydrogen as the primary fuel source, with batteries as a secondary source to power the electric motor. This configuration ensures the fuel cells can operate at their most efficient rating, while the batteries cover the excess or deficit in required power for propulsion and ship systems.

As the vessel is equipped with a hydrogen fuel cell and additional batteries, there are significant differences to the diesel parent vessel. Due to the explosive nature of hydrogen, the vessel will require a storage space with an inert gas system. To mitigate potential leaks into confined spaces, this storage area has been placed above the main deck, and includes space to support venting the fuel cell space. However, given this vessel has the same overall dimensions as the parent vessel, the storage area has reduced the available deck space. Furthermore, due to size constraints, this has been placed at the side of the vessel, which currently falls outside the NR678 rules without specific exemption.

The time between refuelling of the parent vessel and the range of the hydrogen vessel are comparable with the hydrogen vessel having a supply of hydrogen that will last six days before needing to be replenished and then battery capacity that will allow an additional day of service to give seven total days.

Analysis showed that in order for the Cygnus GM32 to be viable, the total weight of the hydrogen equipment and batteries needed to remain below 3 tonnes. While there are some unknowns remaining over exact fitout, the weight of the major items totals just under 2 tonnes therefore leaving a significant margin.

The selected cylinders operate at 700bar to maximise the weight of hydrogen that can be fitted to the vessel, for its impact on the vessel layout. However, 700bar systems pose greater challenges than 350bar systems in terms of system safety and refuelling complexity, resulting in higher costs. A 350bar system of the same footprint would allow four days of operation. Adding four additional cylinders on the inboard side would allow the same weight of hydrogen and cylinders as for the 700bar system, which would be manageable in terms of allowable weight, although there would be a noticeable impact on the deck space available.

It is important to note that the tank position is outside the regulations (as noted in table above). This could potentially be granted exemption by providing sufficient safety systems and gas analysis, but at this stage of design there is significant uncertainty as to whether the final vessel would pass tests to ensure the vessel was safe and acceptable. At this point, we are unable to identify a suitable tank placement that aligns with the regulations and is feasible for a vessel of this size and operation. These rules have been developed for large ships, typically over 100m in length, making their application to a vessel of this scale challenging.

Analysis

The key potential technical, regulatory, and financial issues associated with this modified design are summarised below.

Technical

- Prior to development, the hydrogen storage area and vent design require detailed analysis from specialists to confirm suitability.
- Analysis of structure and materials around the hydrogen storage is essential to ensure it can withstand potential hydrogen leaks.
- Most hydrogen currently available is not net zero. Whilst use of fossil-fuel based hydrogen currently available on the market incurs no operational issues, the critical point is that the vessel will not achieve net zero until it can operate on a net zero source hydrogen.
- The control systems to manage the fuel cell and battery charging will be significantly more complex than control systems fitted to the parent vessel.
- A lack of experience in UK shipyards to fit or maintaining hydrogen fuel cell systems of this size presents a capability gap. Similarly, crew members lack experience in maintaining and operating hydrogen systems.
- Spaces containing hydrogen tanks are required to be gas tight and equipped with inert gas systems, which are uncommon on vessels of this size.
- The hybrid system needed for operation of hydrogen fuel cells adds significant complexity to the vessel's electric system.
- There are limited hydrogen vessels currently operating, and insufficient evidence to prove safety systems effectiveness. This raises concerns about the effectiveness of safety systems, potentially leading to significant vessel modifications in the future.

Regulatory

- This modified vessel cannot be certified using standard regulations; therefore, MGN664 should be used to show equivalence for the hydrogen sections of design, with BV NR678 used as the equivalency regulation. Uncertainty remains over whether the Maritime and Coastguard Agency (MCA) would need any additional mitigation to what is advised in NR678, and this would not be clarified until a contract for project approval is signed with the MCA.
- Certain elements of NR678 regulations are impractical for vessels of this size, such as the requirement for hydrogen tanks to be more than 0.7m (Beam/5) from the side.
- It is unclear whether the MCA would have any additional requirements for skipper/ engineer qualification due to hydrogen use.
- Tank placement within current regulation-accepted locations is not possible on this vessel.

Financial

There are a range of anticipated costs associated with this vessel, relating to:

- Design costs due to;
    - the need for a vapour/explosive analysis, and
    - the need for a hazard identification and mitigation (HAZID) table and associated uncertainties of a one-off approval procedure.

- Shipyard costs to train staff in hydrogen systems and ensure staff retention.
- Contingency costs for the designer/shipyard to cover uncertainties and changes during both the approval and build processes.
- Staff costs to the owner for crew training and skilled staff retention.
- Increased cost of hydrogen, batteries and electrical system compared to a diesel engine or a battery electric drive.
- Additional uncertainties on both the cost and availability of hydrogen as a fuel.
- Potential additional maintenance and through life costs.

Comparison to Stage 2

The key difference between the hydrogen vessel and the battery vessel lies in the vessel's increased range. Operational requirements, based on the data gathered by MIT, indicate that the battery capacity fitted to the electric boat would allow three days of operation before recharging was required, whereas the hydrogen vessel can operate for seven days. This is a significant factor when vessels may not have a harbour with suitable facilities near their working grounds, and the extended vessel range would reduce the time spent travelling between fishing grounds and a harbour with suitable facilities.

Whilst space requirements for the hydrogen system are less onerous than the battery electric vessel, the placement of the hydrogen tanks poses an issue, and is not currently permitted in the regulations. Additionally, managing potential hydrogen leaks, and adding venting capabilities to the space, adds complexity, plus the requirement of HAZID tables to be produced. Overall, the weight of the hydrogen system should be less than the battery system.

It should be noted that although the hydrogen version can achieve seven days operation, the methanol version from Stage 2 could likely undertake 10+ days operation between refuelling, and could more plausibly be re-fuelled in locations with low infrastructure.

While the hydrogen version extends the range of possible operations compared to the battery electric version, if better infrastructure was available to allow quick charging of battery vessels in all harbours, this need for additional range would be removed. Without the need for additional range the battery vessel is advantageous in safety, technical challenges, regulatory compliance, and financial viability.

In conclusion, while hydrogen presents a plausible fuel source for this type of vessel, the number of cases where it would be the best option may be limited, especially if there is investment in suitable charging infrastructure in harbours. If the length of operation is a key deciding factor, then there is then a difficult comparison between methanol and hydrogen vessels. While the methanol vessel may be cheaper in terms of capital expenditure, operational costs would be higher. Given the difficulty in assessing future fuel costs – especially of methanol – this comparison is inconclusive at this time.

~15m Nephrops trawler – Hydrogen

Specification

This vessel is a Nephrops trawler, implementing the same Twin Rig Trawl system as the parent vessel 'Antares BF27' and methanol vessel from the Stage 2 report. Equipment, fishing gear spaces, fishing gear, shaft, propeller, and nozzle are also assumed to remain the same as the parent vessel/methanol vessel from Stage 2. Fish hold volume, fish processing space and operational duration are variables in the design. The hull form remains the same as the methanol vessel from Stage 2.

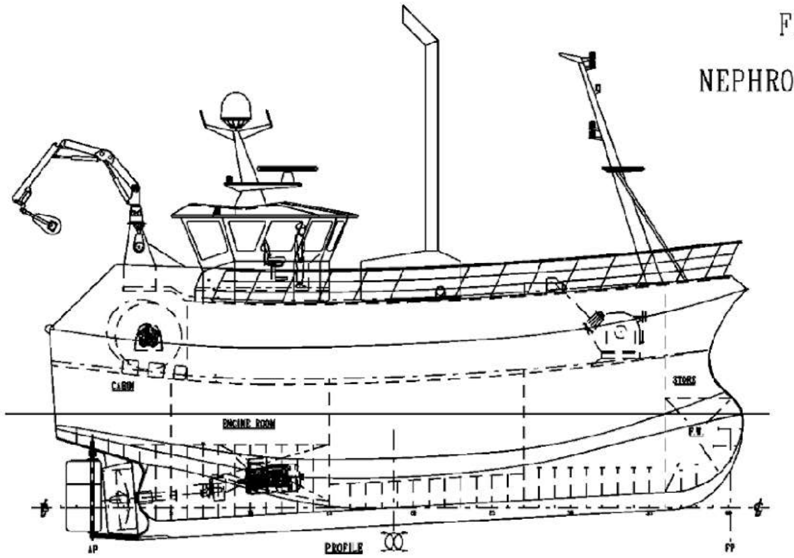
	Details	Comparison to	
	Hydrogen Design	Stage 2 – Methanol	Diesel parent
Length Overall	19.950m	No change	3.250m longer (parent 16.700m)
Length Registered	18.200m	No change	3.850m longer (parent 14.350m)
Beam	6.400m	No change	No change
Depth	3.600m (to main deck)	No change	No change
Fresh water capacity	1,500L	No change	No change
Ballast weight	37.5 Tonnes	7.5 Tonnes more (methanol 30T)	7.5 Tonnes more (parent 30T)
Gross Tonnage	135GT	No change	29GT more (parent 106GT)
Number of operations between refuelling	2.75 days	3.25 day reduction (Methanol 6 days)	3.25 day reduction (parent 6 days)
Fish hold capacity	100 boxes	200 boxes less (methanol 300 boxes)	200 boxes less (parent 300 boxes)

Fuel (Hydrogen) Capacity	36 x 796 Litre 350bar hydrogen cylinders – total 687kg
Propulsion	350kW electric motor
Fuel Cells	3 x 150kW hydrogen fuel cells
Batteries	550 kW Hrs Lithium batteries

Regulations	MGN 629 (construction)	[No Change]
	MSN 1872 (Safe Working Practice)	[No Change]
	MGN664 (Hydrogen Fuel)	[to use BV H2 rules]
	BV NR678 (Hydrogen Fuel)	[for H2 system]
	BV NR 547(Fuel Cell)	[for H2 system]

FIS CONCEPT DESIGN

NEPHROPS TRAWLER - HYDROGEN



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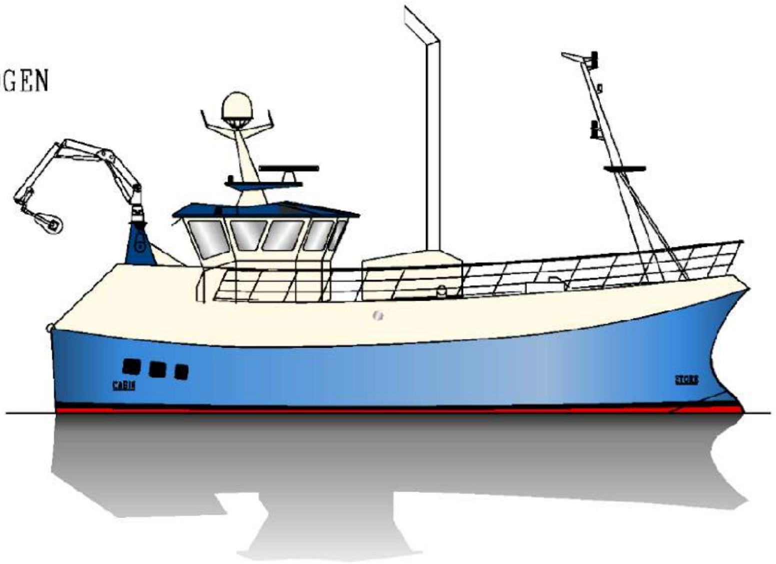

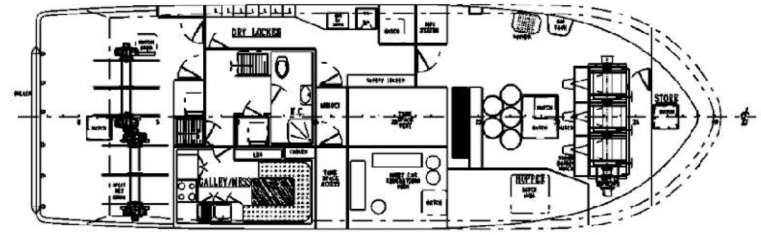

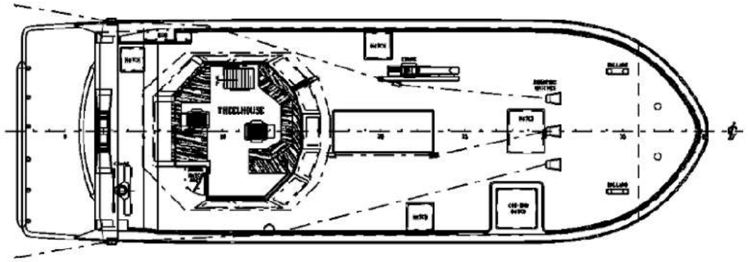

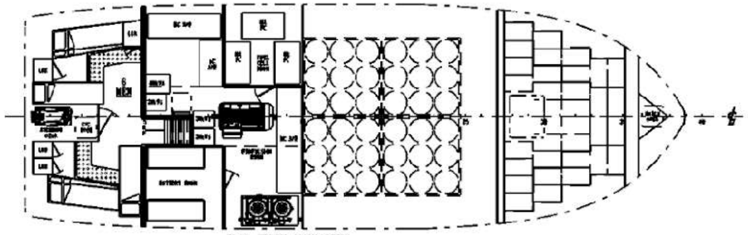

PLAN BELOW MAIN DECK

PRINCIPAL PARTICULARS

Length O.A.	19.95 m
Length B.P.	18.20 m
Breadth Mld.	6.40 m
Depth Mld.	3.60 m

REV.	MODIFICATION	BY	DATE	CHKD.	DATE

APPROVED BY:-
DATE:-

TITLE:- FIS CONCEPT DESIGN - NEPROPS HYDROGEN GENERAL ARRANGEMENT

REF:-
DRAWING NO :- 001
REVISION :-
SCALE:- 1:25 @ A1

DRAWN BY:- -
DATE:- -
CHECKED BY:- -
DATE:- -

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Report

This hydrogen Nephrops vessel was developed from the parent vessel the Antares BF27, utilising the hull model, design drawings, and stability data from this vessel, as well as designs and calculations from Stage 2, and supplemented by the extensive database of information held by Macduff Ship Design Ltd.

The key differences between either a diesel or methanol vessel, and a hydrogen vessel, is the fuel storage and power generation method. Hydrogen requires containment in high-pressure containers, which if kept inside the hull, requires a space filled with inert gas and a clear vent path to atmosphere. Similar to methanol, the hydrogen tanks must be positioned away from the side of the vessel to mitigate collision risks. While hydrogen engines are likely to become available in the future, this vessel utilises a group of fuel cells, which at this time have a higher efficiency and yield more usable energy to maximise operational range. This configuration also allows easier integration to an electrical drive system, increasing efficiency.

The layout of the vessel is similar to the methanol version from Stage 2. Below deck, the cabin remains in the same place, while the engine room is replaced by a propulsion room with two separate sealed spaces for batteries and fuel cells. This is the same size as the engine room on the methanol version. The fuel tanks are positioned in the same location as the methanol tanks were, however this space is lengthened by 2.7m to accommodate 36 hydrogen bottles. Each is a 796L bottle, at 350bar – capable of holding 19.1Kg of hydrogen. The 2.7m of length has been removed from the fish hold which now has a capacity of 100 boxes, a reduction from 300 boxes on the methanol or parent diesel versions.

On the main deck, the aft working deck and accommodation remain consistent with the original diesel version, with a significant space between these and the processing space dedicated to venting and inerting of the tank space. The processing space has been reduced in size but has a similar processing layout, minimising operational differences. In comparison to the original diesel parent vessel, the methanol version gained an additional cabin on main deck plus more processing space, but both of these gains have been lost in the hydrogen version.

The hydrogen onboard enables 2.75 days of operation. A three-day operation is achievable, but the vessel falls short of the six-day cycle. With the now 100-box hold limit in place, a three-day cycle aligns well with the new days of operation limit.

The design uses350bar cylinders to better manage safety requirements and reduce refuelling complexity. Technically, analysis shows that 700bar cylinders are viable, despite the significant increase in weight. Using the 700bar cylinders would increase the range to 5.25 days, which would correspond to the six-day cycle. However, with only 100 boxes, this is significantly less than the 300 boxes needed for this duration of fishing. Additional vessel length of 2.7m would need to be added to achieve this hold capacity.

Preliminary analysis shows the new design has good stability characteristics, requiring an additional 7.5 tonnes ballast compared to the parent diesel vessel and methanol version from Stage 2 to meet statutory stability criteria. This additional ballast can be accommodated within the existing box keel without impacting vessel production. The vessel is seen to float and operate at an acceptable waterline. There was scope in the Stage 2 methanol vessel to reduce the volume of the hull to improve the lines and efficiency, but this is not possible with the hydrogen version.

While the vessel meets with the general guidelines of the regulations, a full system design, HAZID assessment, and gas/vapour analysis has not been completed. This may require significant modifications from the initial layout to ensure safety and adequate risk mitigation.

Analysis

The key potential technical, regulatory, and financial issues associated with this modified design are summarised below.

Technical

- Prior to development, the vent design would need detailed analysis from specialists to confirm suitability.
- Hydrogen system suppliers would need to work with designers and regulators prior to construction, to produce a detailed gas analysis to gain an approval in principle.
- Many of the systems needed for fuel and safety are not available off the shelf and would require custom-made systems.
- At present, there are no suitable tank inerting systems available off the shelf. As such, custom made options would need to be purchased.
- There are no agreed international standards on bunkering hydrogen and associated connections, which may lead to complications if the vessel was built and alternative procedures and fittings become adopted as international standard.
- Currently, there is no port infrastructure for hydrogen bunkering in the UK.
- Limited experience in UK shipyards for the fitting or maintaining of hydrogen and electric drive systems of this size presents a capability gap. Similarly, once installed, there is currently a lack of crews experienced in maintaining and operating hydrogen systems.
- Most hydrogen currently available is not net zero. Whilst use of fossil-fuel based hydrogen currently available on the market incurs no operational issues, the critical point is that the vessel will not achieve net zero until it can operate on a net zero source hydrogen.
- Reduction in range may prevent this being a suitable solution for some fisheries.
- While 700bar cylinders could increase range, it has associated technical issues around safety management and refuelling.
- Uncertainty remains over the best safety procedures for using hydrogen, and until vessels are operating on hydrogen these will not be developed and refined.
- There are limited hydrogen vessels currently operating, and insufficient evidence to prove safety systems' effectiveness. This raises concerns about the effectiveness of safety systems, potentially leading to significant vessel modifications in the future.

Regulatory

- Due to the increase in this vessel's registered length above 16.5m, the skipper would need additional certification compared to the parent vessel.
- This modified vessel cannot be certified using standard regulations; therefore, MGN664 should be used to show equivalence for the methanol sections of design, with BV NR678 and NR547 used as the equivalency regulation. Uncertainty remains over whether the MCA would need any additional mitigation to what is advised in NR678, and this would not be clarified until a contract for project approval is signed with the MCA.
- NR678 is designed for larger vessels, and sizes and clearances are potentially overly large for this vessel type.
- The tonnage of this vessel has necessarily increased, without a corresponding increase in fishing capacity. As tonnage for fishing vessels is limited for the UK fleet, this may reduce the overall fishing capacity of the UK fleet if similar changes are made fleet-wide.

- Uncertainty remains regarding whether the MCA will have any additional requirements for skipper/engineer qualifications due to use of hydrogen as a fuel.
- Rules for hydrogen vessel require significant gas analysis and HAZID assessment to prove the safety of the vessel, in addition to meeting the written regulations. Until these are completed, it is uncertain whether further safety systems or design modifications would be required.

Financial

There are a range of anticipated costs associated with this vessel, relating to:

- Design costs due to
    - the increased size of the vessel in comparison to the parent vessel,
    - the need for a vapour/explosive analysis, and
    - the need for a HAZID table and associated uncertainties of a one-off approval procedure.
- Additional vessel costs due to
    - increased size and associated heavier steel weight,
    - the need for premium cost hydrogen tanks, systems, and fuel cells which are more expensive than those of diesel engines, and
    - the need for additional safety systems onboard due to the use of hydrogen.
- Approval costs for utilising MGN664.
- Shipyard costs to train staff in hydrogen and electrical drive systems and ensure staff retention.
- Contingency costs for the designer/shipyard to cover uncertainties and changes during both the approval and build processes, due to the new technology.
- Additional costs to the owner for;
    - licence and tonnage on a larger vessel,
    - crew training and skilled staff retention, and
    - the increased skipper qualification required for a vessel of this size.
- Additional uncertainties on both the cost and availability of hydrogen as a fuel.
- Additional maintenance and through life costs associated both with the larger vessel and the hydrogen system in comparison to the diesel systems on the smaller parent vessel.

Whilst some financial costs may fall to the shipyard, designer, or other suppliers, it is assumed that the majority of additional costs will ultimately be passed onto the vessel owner as part of the purchase price of the vessel or through life service costs.

Comparison to Stage 2

If 350bar cylinders is determined as the only suitable pressure for hydrogen, there is a significant reduction in range of operation compared to the Stage 2 methanol vessel. However, the 2.75 days of operation aligns closely with the three-day operation cycle. If the vessel owner planned to operate a three-day cycle, this hydrogen vessel closely matches the methanol vessel from Stage 2. Despite the higher capital expenditure the hydrogen vessel, its operational costs are expected to be lower. Given the uncertainty in future cost and supply of both fuels, it is challenging to identify the balance in costs or the payback period.

If 700bar is deemed safe and feasible, then an operation much closer to the six-day cycle is possible, with a 5.25 days trip achievable with shown fuel tank sizes. However, the current fish hold capacity is insufficient for this duration, necessitating additional length and resulting in a larger vessel than demonstrated in this report.

The resultant vessel would have similar dimensions to the LNG version from Stage 2. Nonetheless, the added complexity of 700bar and the increased vessel length would raise capital expenditure in comparison to the 350bar version included in this report. Coupled with the increased cost of refuelling at 700bar, the balance of costs or payback time compared to the methanol version may not be achieved.

If pressures above 350bar are deemed not suitable, then this vessel would not be suitable for operations over three-day cycles, and would need such a significant increase in size that it would no longer be comparable to the parent vessel or versions produced in Stage 2.

<24m registered whitefish trawler – Hydrogen

Specification

The vessel is a whitefish trawler, implementing the same Twin Rig Trawl system as its parent vessel 'Crystal Sea SS118'. Fish hold volume, fish processing space and equipment, fishing gear spaces, and fishing gear remain identical to the parent vessel. The shaft, propeller, and nozzle are also assumed to be the same as the parent vessel.

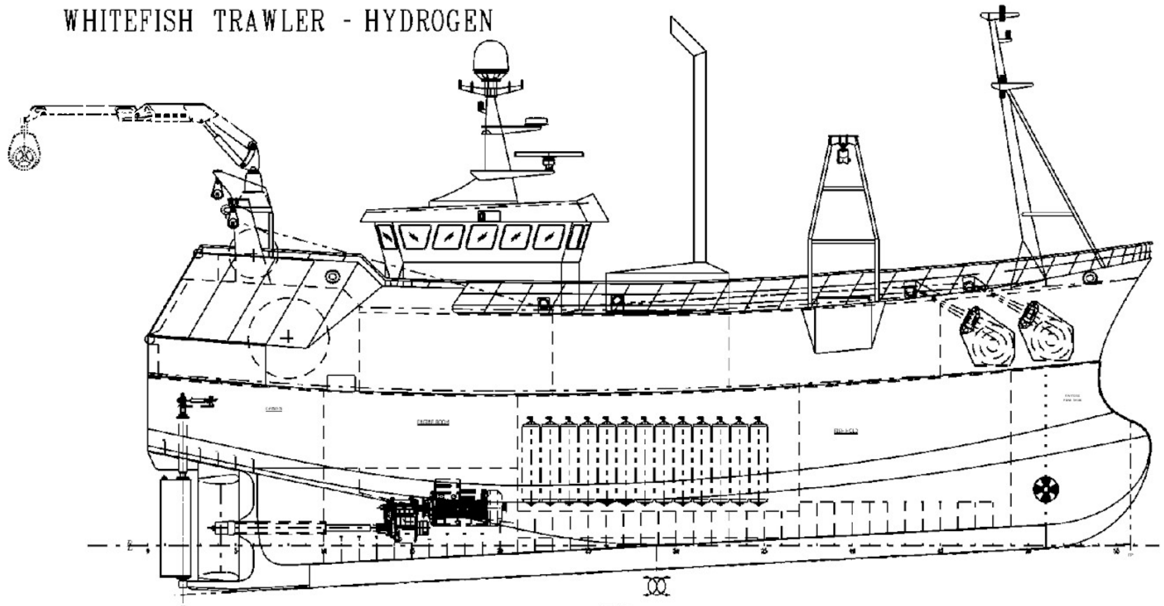
	Details	Comparison to	
	Hydrogen Design	Stage 2 – Methanol	Diesel parent
Length Overall	28.500m	No change	4.000m longer (parent 24.500m)
Length Registered	26.900m	No change	3.850m longer (parent 23.050m)
Beam	7.600m	No change	No change
Depth	4.300m (to main deck)	No change	No change
Fresh water capacity	24,000L	No change	No change
Ballast weight	65.5 Tonnes	7.5 Tonnes more (methanol 58T)	15 Tonnes more (parent 50.5T)
Gross Tonnage	295GT	No change	48GT more (parent 247GT)
Number of operations between refuelling	2.75 days	8 day reduction (Methanol 10+ days)	8 day reduction (parent 10+ days)
Fish hold capacity	260 boxes	440 boxes less (methanol 700 boxes)	440 boxes less (parent 700 boxes)

Fuel (hydrogen) Capacity	104 x 350 Litre 350bar hydrogen cylinders – total 936 kg
Propulsion	500kW electric motor
Fuel Cells	3 x 200kW hydrogen fuel cells
Batteries	750 kW Hrs Lithium batteries

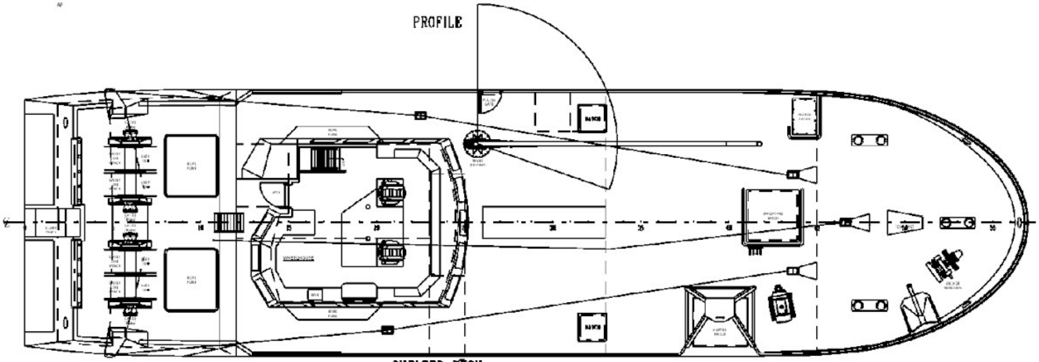
Regulations	BV NR600 (Construction)	[as vessel >24m registered]
	BV NR467 (Outfitting & Stability)	[as vessel >24m registered]
	MSN 1872 (Safe Working Practice)	[No Change]
	MGN664 (Hydrogen Fuel)	[to use BV hydrogen rules]
	BV NR678 (Hydrogen Fuel)	[for hydrogen system]
	BV NR 547(Fuel Cell)	[for hydrogen system]

FIS CONCEPT DESIGN

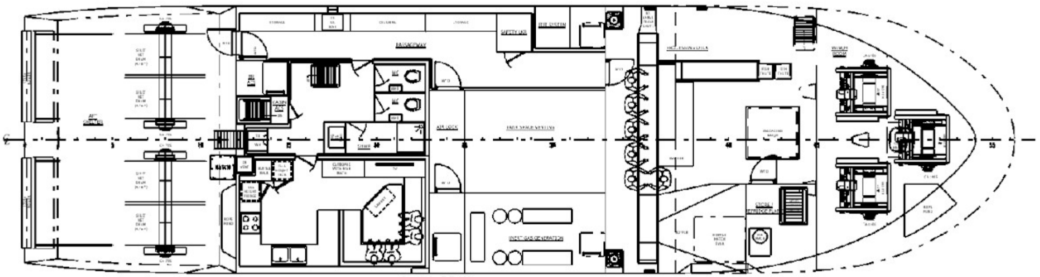
WHITEFISH TRAWLER - HYDROGEN



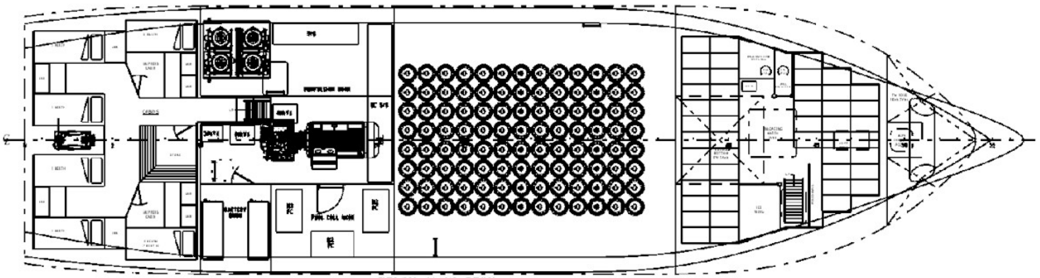
PROFILE



SHELTER DECK



MAIN DECK



BELOW MAIN DECK

PRINCIPAL PARTICULARS

Length O.A.	28.50 m
Length B.P.	26.90 m
Breadth Mld.	7.60 m
Depth Mld.	4.30 m

REV.	MODIFICATION	BY	DATE	CHKD.	DATE

APPROVED BY:-

DATE:-

TITLE: FIS CONCEPT DESIGN - WHITEFISH HYDROGEN
GENERAL ARRANGEMENT

REF:-

DRAWING NO :- 001

DRAWN BY:- -

CHECKED BY:- -

REVISION :-

DATE:- -

DATE:- -

SCALE:- 1:75 @ A1

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Report

This whitefish trawler vessel was developed from the parent vessel, the Crystal Sea SS118, utilising the hull model, design drawings, and stability data from this vessel, alongside designs and calculations from Stage 2, supplemented by the extensive database of information held by Macduff Ship Design Ltd.

The key differences between either a diesel or methanol vessel, and a hydrogen vessel, is the fuel storage and power generation method. Hydrogen requires containment in high pressure containers, which if stored inside the hull need to be in a space filled with inert gas and a clear vent path to atmosphere. As with methanol, the hydrogen tanks must be positioned away from the side of the vessel to mitigate collision risks. While hydrogen engines are likely to become available in the future, this vessel utilises a group of fuel cells, which at this time have a higher efficiency and yield more usable energy to maximise operational range. This configuration also allows easier integration to an electrical drive system, increasing efficiency.

The layout of the vessel is similar to the methanol version from Stage 2. Below deck, the cabin remains in the same place, while the engine room is replaced by a propulsion room with two separate sealed spaces for batteries and fuel cells. This is 0.5m shorter than the engine room on the methanol version. The fuel tanks are positioned in the same location as the methanol tanks were, however this space is lengthened by 4m to accommodate 104 hydrogen bottles. Each is a 350L bottle, at 350bar – capable of holding 9.0Kg of hydrogen. 3.5m has been removed from the fish hold, which now has a capacity of 260 boxes, a reduction from 700 boxes on the methanol or parent diesel versions.

On the main deck, the aft working deck and accommodation remain consistent with the original diesel version, with a significant space between these and the processing space dedicated to venting and inerting the tank space. The processing space has been reduced in size but has a similar layout, minimising operational differences. The methanol version had additional space for processing versus the original diesel parent vessel, but this has been lost in the hydrogen version.

The hydrogen onboard enables 2.25 days of operation, which corresponds well to the 260 box hold. This is significantly below the 10+ days achievable with the methanol version and the diesel parent, resulting in a significant change in operational profile. This may not be suitable for some of the fisheries that the diesel parent vessel currently operates in.

It was decided to use 350bar cylinders to easier manage the safety requirements and reduce the refuelling complexity. Analysis shows it would be technically possible to use the 700bar bottles; this would be significantly heavier, but would increase the range to 4.25 days. While this is a notable increase, it is still significantly below the 10 days needed to achieve the same operation as the methanol version. The 260 box capacity may also be low for 4 .25 days of operation, and additional size may potentially be needed to increase the hold.

Preliminary analysis shows the new design has good stability characteristics. and needs an additional 7.5 tonnes ballast compared to the methanol version from Stage 2 to meet statutory stability criteria. This additional ballast can be accommodated within the existing box keel without impacting vessel production. The vessel is seen to float and operate at an acceptable waterline. There was scope in the Stage 2 methanol vessel to reduce the volume of the hull to improve the lines and efficiency, but this is not possible on the hydrogen version.

While the vessel meets with the general guidelines of the rules, a full system design, HAZID assessment and gas/vapour analysis has not been completed. This may lead to significant modifications from this initial layout in the future, to ensure the appropriate level of safety required to mitigate risks.

Analysis

The key potential technical, regulatory, and financial issues associated with this modified design are summarised below. As with other methanol modified vessels, this vessel anticipates the same issues, with some additional issues associated specifically with the increased registered length above 24m.

Technical

- Prior to development, the vent design would need detailed analysis from specialists to confirm suitability.
- Hydrogen system suppliers would need to work with designers and regulators prior to construction, to produce a detailed gas analysis to gain an approval in principle.
- Many of the systems needed for fuel and safety are not available off the shelf and would require custom made systems.
- At present, there are no suitable tank inerting systems available off the shelf, requiring purchase of custom-made options.
- There are no agreed international standards on bunkering hydrogen and associated connections, which may lead to complications if alternative procedures and fittings become adopted as international standard.
- Currently, there is no port infrastructure for hydrogen bunkering in the UK.
- Limited experience in UK shipyards with regards to fitting or maintaining hydrogen and electric drive systems of this size presents a capability gap. Similarly, once installed, there is currently a lack of crews experienced in maintaining and operating hydrogen systems.
- Most hydrogen currently available is not net zero. Whilst use of fossil-fuel based hydrogen currently available on the market incurs no operational issues, the critical point is that the vessel will not achieve net zero until it can operate on a net zero source hydrogen.
- Reduction in range may prevent this being a suitable solution for some fisheries.
- While 700bar cylinders could increase range, it has associated technical issues around safety management and refuelling.
- Uncertainty remains over the best safety procedures for using hydrogen and until vessels are operating on hydrogen these will not be developed and refined.
- There are limited hydrogen vessels currently operating, and insufficient evidence to prove safety systems effectiveness. This raises concerns about the effectiveness of safety systems, potentially leading to significant vessel modifications in the future.

Regulatory

- Due to the increase in this vessel’s registered length above 24m, the skipper would need additional certification compared to the parent vessel. In addition, due to this increased registered length above 24m, the vessel would need to be in a different class surveyed by the MCA ,needing either a rescue boat or exemption granted from this requirement.
- This modified vessel cannot be certified using standard regulations; therefore, MGN664 should be used to show equivalence for the methanol sections of design, with BV NR678 and NR547 used as the equivalency regulation. Uncertainty remains over whether the MCA would need any additional mitigation to what is advised in the BV regulations, and this would not be clarified until a contract for approval is signed with the MCA.

- NR678 is designed for larger vessels, and sizes and clearances are potentially overly large for this type of vessel.
- The tonnage of this vessel has necessarily increased, without a corresponding increase in fishing capacity. As tonnage for fishing vessels is limited for the UK fleet, this may reduce the overall fishing capacity of the UK fleet if similar changes are made fleet-wide.
- Uncertainty remains regarding whether the MCA will have any additional requirements for skipper/engineer qualifications due to use of hydrogen as a fuel.
- Rules for hydrogen vessel require significant gas analysis and HAZID assessment to prove the safety of the vessel in addition to meeting the written regulations. Until these are completed, it is uncertain whether further safety systems or design modifications needed would be required.

Financial

There are a range of anticipated costs associated with this vessel, relating to:

- Design costs due to;
    - the increased size of the vessel in comparison to the parent vessel,
    - the need for a vapour/explosive analysis, and
    - the need for a HAZID table and associated uncertainties of a one-off approval procedure.
- Additional vessel costs due to;
    - increased size and associated heavier steel weight,
    - the need for premium cost hydrogen tanks, systems and fuel cells which are more expensive than those of diesel engines, and
    - the need for additional safety systems onboard due to the use of hydrogen.
- Approval costs for utilising MGN664.
- Shipyard costs to train staff in hydrogen and electrical drive systems and to ensure staff retention.
- Contingency costs for the designer/shipyard to cover uncertainties and changes during both the approval and build processes due to the new technology.
- Additional costs to the owner for;
    - licence and tonnage on a larger vessel
    - crew training and skilled staff retention, and
    - increased skipper qualification required for a vessel of this size.
- Uncertainties on both the cost and availability of hydrogen as a fuel.
- Additional maintenance and through life costs associated both with the larger vessel and the hydrogen system in comparison to the diesel systems on the smaller parent vessel.

Whilst some financial costs may fall to the shipyard, designer, or other suppliers, it is assumed that the majority of additional costs will ultimately be passed onto the vessel owner as part of the purchase price of the vessel or through life service cost.

Comparison to Stage 2

If 350bar is deemed the only suitable pressure for hydrogen, there will be a significant reduction in range of operation when compared to the Stage 2 methanol vessel. With only 2.25 days of operation, this vessel is unlikely to match the operational capacity of the parent vessel. However, it may be suitable for some fisheries, particularly if hydrogen becomes available at a lower cost than methanol.

If 700bar becomes both feasible and safe, the vessel's number of operational days could be extended to 4.25 days. While still a significant reduction compared to the methanol version, this may be suitable for some fisheries. The increased cost of refuelling at 700bar, alongside the cost of safety systems, would reduce the benefit of the cost advantage over methanol, but it could still present a competitive option.

If achieving 10 days of operation were a requirement, the vessel would need to be increased in size to a point that it is no longer comparable to the parent vessel and methanol version.

Analysis to identify best options for specific vessel types

The designs from Stage 2 and Stage 3, coupled with our understanding gained through their development, has enabled us to produce Table 1.0 on page 29. This table extrapolates our findings across a wide range of fishing vessels, demonstrating the general trend in fuel suitability.

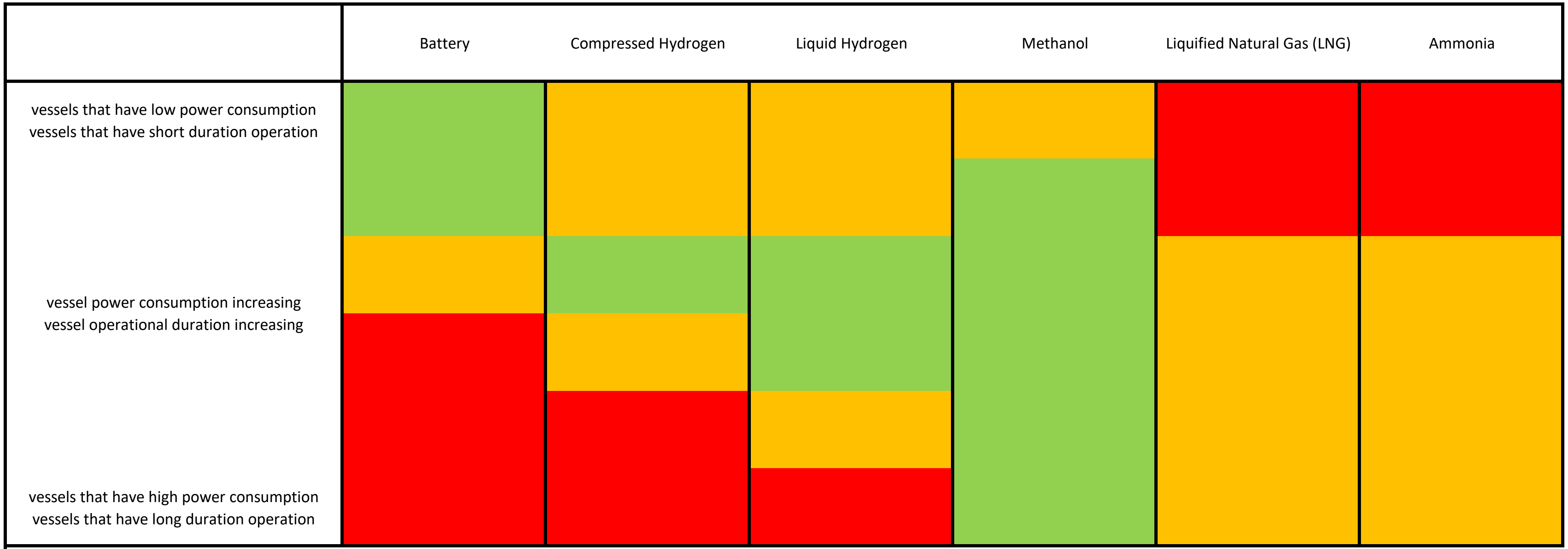
Highlighted in GREEN are selected designs that closely match the dimensions of the parent diesel vessel. ORANGE options are plausible alternatives although likely to be larger in dimensions than the GREEN option. RED options are unlikely to be suitable without a very significant change in vessel dimensions and operation.

When aiming to identify the best option to replace a vessel, we would suggest that all GREEN and ORANGE vessels are suitable candidates, and a cost/benefit analysis would be essential to pinpoint the most economically viable option. For this, it is critical to understand the future availability and likely costings of all the fuels. In some cases, the cost of opting for a larger vessel with more expensive systems may be offset by long-term savings in reduced fuel costs, making the larger alternative the most economic option.

A significant proportion of the UK's fishing vessels fall within either the top two rows or the bottom row of this table. The top two rows are representative of most day boats that utilise potting. For these vessels, battery-power is a good option, with methanol or hydrogen as potential alternatives if greater range is needed.

The bottom row is representative of a large proportion of the trawler fleet engaged in multi-day fishing trips. For these vessels, methanol, LNG, and ammonia are the only suitable alternatives at this time. If future analysis reveals that none of these fuels are economically viable, vessels would need to review their operation to identify their best path forward. Shortening trip duration, using lower-resistance trawl equipment or methods, and/or embracing precision trawling to improve quality of catch could all help to move the vessel up 1-2 rows, making hydrogen a realistic option. Alternatively, opting for a significantly larger vessel, unlike anything currently in the fleet, would present a different set of design and layout options that may be economically feasible.

For vessels in the middle rows – such as the three-day operation version of the Nephrops trawler in this report – almost all options may be suitable. Without a comprehensive understanding of future fuel costs and availability, it is difficult to decide the best way forward.



	Battery	Compressed Hydrogen	Liquid Hydrogen	Methanol	Liquified Natural Gas (LNG)	Ammonia
vessels that have low power consumption vessels that have short duration operation	🟩	🟨	🟨	🟨	🟥	🟥
	🟩	🟨	🟨	🟩	🟥	🟥
vessel power consumption increasing vessel operational duration increasing	🟨	🟩	🟩	🟩	🟨	🟨
	🟥	🟨	🟩	🟩	🟨	🟨
	🟥	🟥	🟨	🟩	🟨	🟨
vessels that have high power consumption vessels that have long duration operation	🟥	🟥	🟥	🟩	🟨	🟨

KEY

🟩	Vessel will be closest dimensionally to the vessel it is replacing. Where two or more vessels are in this category, the designs would be comparable dimensionally.
🟨	Vessel will be larger than the closest version, but still sufficiently dimensionally similar to the diesel vessel that they are suitable to consider as options. While the vessel may be larger, fuel cost and availability may make this the most economically suitable vessel to build and operate.
🟥	This would not be a suitable fuel for this type of vessel without significant alteration to the design and operation of the vessel, which would need special consideration in the regulations.

Low power consumtion fishing operations include potting and rod fishing.
Increasing power consumption includes fishing operations such as seining and long lining.
High power consumption includes fishing operations such as trawling.

Short duration is 2-3 hours, from a harbour with suitable infrastructure for the selected energy storage.
Long duration is a week, from a harbour with suitable infrastructure for the selected energy storage.

Table 1.0: Comparison table to identify the best fuel option for different vessel types.

Conclusions

The evaluation of hydrogen-fuelled vessels across different fishing vessel types reveals nuanced considerations regarding their suitability and competitiveness.

For the smaller creel vessel, while hydrogen may be a possible method to increase the range of operation from the battery electric version from Stage 2, it falls short of achieving the range of the methanol version from Stage 2 or the diesel parent vessel. the hydrogen version's increased complexity, safety concerns and added costs compared to the battery electric version, suggest that hydrogen would only be a more suitable option where the additional range of operation is required. In such cases, the methanol version from Stage 2 would also be a suitable alternative, and would offer reduced safety concerns and complexity in comparison to the hydrogen vessel.

Similarly, both the Nephrops and whitefish hydrogen vessels have a significant reduction in range when compared to the parent vessels and methanol versions produced in Stage 2. The Nephrops vessel aligns more closely with identified suitable operational cycles, especially if 700bar storage is utilised. Where there is an operational cycle that could be undertaken by the range of the hydrogen vessels, especially at 350bar, the likely low cost and good future supply of net zero hydrogen could make these a competitive option compared to methanol.

It is clear that for the longer-duration operations of Nephrops and whitefish trawlers, hydrogen vessels are unlikely to be suitable without substantial design modifications, resulting in significantly larger vessels.

The primary driver for considering hydrogen as a fuel option is its anticipated low relative cost and widespread availability, particularly when compared to the uncertain cost and availability of methanol, LNG, and ammonias. In most cases, the hydrogen version entails higher capital cost and reduced operational range compared to methanol, only emerging as a favourable alternative to methanol if there is significant savings in fuel cost. This highlights the need for a clear understanding of planned production and uses of these alternative fuels, to inform decision-making in the fishing industry's transition toward sustainable fuel options and net zero.

Roadmap to Net Zero

This section gives an overview of the key steps needed to support the transition of UK fishing vessels away from fossil fuel diesel, including short, medium, and long-term actions to support the transition to net zero. This is not intended to be a comprehensive list and should be used in conjunction with other resources as applicable.

Short Term

These projects should be prioritised, as they directly inform further work required for the safe and practicable decarbonisation of UK fishing vessels.

- Future Fuel Infrastructure Study: An examination of plans for future fuel infrastructure is urgently required to understand the likely cost and availability of net zero fuel options, including 350bar compressed hydrogen, 700bar compressed hydrogen, liquid hydrogen, methanol, ammonia, plug in electricity @ 15, 50 and 100kw, bio diesel, synthetic diesel, and hydrogenated vegetable oil (HVO).

  The three stages of this concept design project have highlighted that multiple options may be plausible for different fisheries. While it is possible to estimate the costs to purchase these vessels or retrofit a currently operating vessel, variations in fuel price and availability will significantly impact the economic viability of alternative fuel options for vessel owners. In some cases spending significantly more on a vessel may be cheaper in the long run due to the reduced cost of the fuel selected.

- Data Collection Study: Conduct a comprehensive data collection study of current vessels across all sizes and fisheries. This study should measure the torque and power output from main engines during a complete operation to understand peaks and troughs in power usage, therefore identifying the best solution for each vessel.

  Having a complete set of data would allow vessels to be produced more specifically to their planned operation, thereby potentially reducing the changes in size shown in the designs developed in this report.

- Economic Analysis: Perform a detailed economic analysis of the vessels developed in stages 2 and 3 of this project to evaluate total life costs. This analysis should consider future fuel availability and pricing to support vessel owners in making informed choices on alternative fuels and operational cycles.

Medium Term

These actions are needed to give the industry a clear picture of the best options for various sectors:

- Concept Design Development: Expand the concept design development to cover a wider range of vessel sizes, fishing methods, and operational cycles. This should include an economic assessment and through-life costing to support vessel owners in selecting the most economic options. The designs should be developed collaboratively with vessel owners to populate economic assessments with data from their existing operation, enhancing the confidence and validity of the resultant designs.

- Engage with Powertrain Suppliers: Engage with powertrain suppliers to develop suitable options tailored for the fishing industry. This should utilise the data collected from vessels on their torque and power usage, to encourage suppliers to develop suitable, efficient solutions for the various loading cycles.

- Demonstrator Vessel Projects (Medium-term): Collaborate with owners, designers, and shipyards to build demonstrator vessels. In the medium term, this involves full net zero options for fishing methods and operational cycles that have attainable solutions at the time, and hybrid vessels (i.e. vessels which use more than one type of energy storage) that use diesel alongside a future fuel, for methods and cycles that are more challenging to resolve.

  Funding for demonstrator vessels could be sought from initiatives such as the CMDC (Clean Maritime Demonstrator Competition), ZEVI (Zero Emissions Vessels and Infrastructure), governmental schemes, or private investment.

- Infrastructure Capacity Review: Review the capacity of infrastructure, including shipyards, ship fitters, and marine engineers, to transition the fishing fleet to net zero by either replacement or retrofit of vessels. This should advise on a likely timeframe to complete the fleet transition.

Long Term

These works are needed to prove net zero vessels are both safe and economic to operate, to encourage investment from owners in full scale fleet renewal to net zero options.

- Demonstrator Vessel Projects (Long-term): Collaborate with owners, designers, and shipyards to build net zero demonstrator vessels covering all types of fishing methods and vessel sizes.

  Funding for demonstrator vessels could be sought from initiatives such as CMDC (Clean Maritime Demonstrator Competition), ZEVI (Zero Emissions Vessels and Infrastructure), similar governmental scheme or by private investment.

- Engagement Events: Organise engagement events for owners, skippers, crew, regulators, and other interested parties, to visit demonstrator vessels or attend workshops. This will provide opportunity to engage with and hear experiences from designers, builders, skippers, and crew of the demonstrator vessels, building industry understanding and confidence in the transition to net zero.

- Owner Support Programmes: Provide support to vessel owners who are developing plans to either replace or retrofit their vessel with net zero solutions. Having a specialist in alternative fuels available to advise on solutions, including guidance on regulations and economic models, could simplify and expedite the process for owners, helping overcome potential barriers to adoption.

Limited timeframe to decarbonise the fishing fleet

The urgency to decarbonise the fishing fleet is underscored by net-zero targets enshrined in law in Scotland and the UK, with deadlines for fossil fuel use set for 2045 and 2050 respectively. However, the majority of fishing vessels have a serviceable life exceeding 20 years, often extending to 35 years with proper maintenance. A number of boats in the current UK fleet are still operating successfully at 50+ years old. Almost all vessels currently in operation or under construction use diesel, and many will still be in their serviceable life when we reach net-zero target dates.

The lack of vessels operating on net zero solutions presents a significant challenge in developing best practice for design and operation, as well as establishing the robustness of safety systems. Until demonstrator vessels are successfully operating, we will not develop this evidence base needed to convince owners and investors that these solutions are suitable and economic when replacing their existing vessel, and build a burden of proof for regulators to make further vessel approval simpler, cheaper, and more certain at an early stage of the project.

Demonstrator projects and first-of-class vessels can take a significant period of time for design, construction, approval, and commissioning. While a typical diesel fishing vessel would take one to four years to build, a future fuel vessel demonstrator project may take two to three times as long, depending on supplier availability and system/regulation maturity.

Owners’ preference for diesel is unlikely to change until there is sufficient evidence from successful demonstrator projects. Consequently, the longer it takes to successfully operate demonstrator vessels and establish confidence in net zero solutions, the less time owners will have to replace or refit their vessels in line with net zero deadlines and reduced diesel availability.

There is a risk of insufficient capacity to complete the transition of the fishing fleet before the net zero deadline. The steps outlined in this roadmap should be implemented without delay to empower vessel owners to plan and undertake the transition to net zero operation by the government-implemented deadlines, in an organised and practical manner.

FiS Fisheries Innovation & Sustainability

Fisheries Innovation & Sustainability is a coalition of experts driving strategic innovation for a prosperous and sustainable UK seafood industry. Our remit is to facilitate, coordinate and leverage investment for innovation in UK seafood.

Our Member Organisations include:

The FISHMONGERS' Company's FISHERIES CHARITABLE TRUST

Sainsbury's

M&S EST. 1884

seafish

SOFINA

Young's Est. 1805

Scottish Charity No: SC045119 | Company No: SC477579