Green Offshore Tech

TURN GOOD IDEAS INTO BUSINESS

Making Offshore production and transport green, clean and sustainable

D1.1
Challenges, needs and trends of four industrial Offshore sectors

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Disclaimer

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EU	European Union
R&D	Research and Development
SDG	Sustainable Development Goals
SME	Small and Medium-sized Enterprises
WP	Work Package

1. Executive Summary

This document is deliverable **D1.1 Challenges, needs and trends of four offshore sectors** of the GreenOffshoreTech project. It provides an overview of common, sectoral specific, and SME specific sustainability challenges, needs and trends of four offshore industry sectors with strong synergies: offshore wind energy, offshore aquaculture, offshore oil and gas, waterborne transport. It also includes the definition of environmental and sustainability requirements for the envisaged new products, processes, or services to be developed within GreenOffshoreTech's Call for Proposals.

Common sustainability challenges are environmental requirements and sustainability goals (SDG, EU Green Deal), renewable energy supply, scarcity of materials and resources, lack of qualified workforce, increased demand, and production. Common challenges identified are the transition of EU's Blue Economy from 'Blue Growth' to a 'Sustainable Blue Economy' and the achievement of the European Green Deal's objectives. GreenOffshoreTech will contribute to the sustainability goals SGD#14, SDG#7, SDG#12, SDG#13, and SDG#9.

Sectoral sustainability challenges identified are in line with the preliminary analysis of sectoral sustainability challenges undertaken at proposal stage and have been validated through an updated desk-based review and a workshop with all GreenOffshoreTech consortium partners.

These offshore challenges include operation in deeper wates and harsher environments, meaning higher costs and carbon impact of inspection, operation and maintenance. Environmental impact of materials use, including waste management and a need for reuse and recycle of materials was another common challenge across the sectors.

All the sectors highlighted the need to develop routing and storage of energy from its production to support other offshore sectors. In considering the challenges, there are a range of opportunities to develop solutions and these solutions will have applications across these specific sectors and more widely in a Sustainable Blue Economy.

SMEs specific challenges are mapped based on a survey among SMEs that are members of the GreenOffshoreTech participating clusters. The survey is a questionnaire for analysing challenges and needs of SMEs with focus on innovation, technology transfer and sustainability management in business practice. This includes identification of factors that facilitate or hinder technology transfer as well as the current and preferred forms and procedures for technology transfer. New challenge identified is offshore hydrogen to be used as a feedstock, a fuel or an energy carrier and storage to meet carbon neutrality.

2. Introduction

2.1 GreenOffshoreTech project

The GreenOffshoreTech project aims at supporting innovation in Small and Medium-sized Enterprises (SMEs) and fostering the development of the emerging Blue Economy industries by enabling new cross-sectorial and cross-border value chains based on shared challenges and the deployment of key enabling technologies (KET).

Therefore, the GreenOffshoreTech consortium will provide EUR 3 million in funding for innovative SME projects in form of a competitive "Call for Proposals".

GreenOffshoreTech will facilitate the creation of new products, processes or services with the ambition to turn good ideas into business, making offshore production and transport green, clean and sustainable.

2.3 Aim of this deliverable

In order to select the most relevant topics for the planned GreenOffshoreTech Call for Proposals, this deliverable aims to analyse and identify the challenges, needs and trends of the four targeted industrial offshore sectors with strong synergies:

offshore wind energy, offshore aquaculture, offshore oil and gas, maritime transport.

This analysis will be cognisant of emerging economic opportunities for SMEs and the urgent needs for industrial value chains to contribute to the global effort to tackle climate change.

This document provides the results of:

- A desk-based review on **common sustainability challenges** including the transition of the Blue Economy to a Sustainable Blue Economy and the achievement of the European Green Deal's objectives.
- An analysis of **sectoral sustainability challenges** through a desk-based review of the challenges and validation of the finding trough workshops with leading-edge clusters of the GreenOffshoreTech consortium representing the four offshore sectors across Europe.
- In order to comprehensively analyse and interrogate **SME specific challenges**, a survey was carried out with the SMEs of the GreenOffshoreTech clusters.

In addition, Scaberia (SCA) has done an analysis on **regional challenges** and **regional smart specialisation strategies** to be adressed to enable regional support and synerges with other funding instruments (see **D5.1 Regional challenges and RIS3 priorities to be addressed**).

3. Common sustainability challenges

3.1 Transition of the Blue Economy from 'Blue Growth' towards a 'Sustainable Blue Economy'

The Blue Economy is a driver for Europe's welfare and prosperity economy. According to the latest published EU Blue Economy Report 2021[1] (European Commission, 2021), Europe's Blue Economy provides 4.5 million direct jobs, many in regions where there are few alternatives, and generates around €650 billion in turnover and €176 billion in gross value added and contributed to about 1.5 % of the EU-27 GDP and 2.3% of EU-27 total employment in 2018.

The Blue Economy needs to undergo a transition from 'Blue Growth' towards a 'Sustainable Blue Economy' (European Commission (2021), The EU Blue Economy Report 2021).

This implies transforming the Blue Economy value chains and moving away from linear business models towards circular, less resource- and waste-intensive ones. All Blue Economy sectors have to reduce their climate and environmental impact and contribute to the recovery of marine ecosystems.

Therefore, strict measures against marine pollution, coastal litter and plastics have already been introduced and efforts to replace fossil fuels, invest in biodiversity conservation, ecosystem restoration and protection, promote nature-based solutions, and incubate marine renewable energy and innovative blue biotechnologies will be continued.

The European Union had committed to be at the forefront of the global sustainability agenda. The EU has reaffirmed its resolve to contribute to the UN Sustainable Development Goals (SDG), to protect biodiversity in at least 30% of its land and seas by 2030. The EU has set the ambitious target of achieving climate neutrality by 2050, and to put sustainability at the core of its Blue Economy.

A sustainable Blue Economy shall enable society to obtain value from the oceans and coastal regions, whilst respecting their long-term ability to regenerate and endure such activities through the implementation of sustainable practices.

This implies that human activities must be managed in a way that guarantees the health of the oceans and safeguards economic productivity, so that the potential they offer can be realised and sustained over time.

[1] European Commission (2021), The EU Blue Economy Report 2021.

A sustainable Blue Economy will create tangible opportunities for new jobs and businesses. They will be created by work to mitigate the impacts on oceans and coasts to build a resilient economic model based on innovation, a circular economy, and a respectful attitude to the ocean. This means that businesses that use or generate renewable resources, preserve marine ecosystems, reduce pollution, and increase resilience to climate change will be incentivised, while others will need to reduce their environmental footprint.

3.2 European Green Deal

The rationale behind the transition towards a Sustainable Blue Economy is the European Green Deal[2] (European Commission, COM (2019) 640 final).

The European Green Deal is the European Commission's long-term strategy for sustainable growth, builds on clear ambitions such as carbon neutrality, a circular economy, zero pollution and the restoration of biodiversity.

The European Green Deal aims at implementing the United Nation's 2030 Agenda by putting sustainability and the well-being of citizens at the centre of economic policy and the sustainable development at the heart of the EU's policy making and action.

The EU aims to mobilise at least €1 trillion of investments over the 2021-2027 period to become a global leader in sustainable growth and climate-neutral continent by 2050. Half of the overall €1 trillion budget will come from the EU long-term budget. It is expected that this will trigger national co-financing from the Member States of about €114 billion over this timeframe, and an additional €279 billion of climate and environment related investment from the public sector (e.g., EIB Group) and private sector investors.

All EU actions and policies will have to contribute to the European Green Deal objectives.

Figure 1 below illustrates the various elements of the European Green Deal:

1. Increasing the EU's climate ambition for 2030 and 2050
2. Supplying clean, affordable, and secure energy
3. Mobilising industry for a clean and circular economy

[2] COM (2019) 640 final; The European Green Deal.

4. Building and renovating in an energy and resource efficient way
5. Accelerating the shift to sustainable and smart mobility
6. From 'Farm to Fork': designing a fair, healthy and environmentally-friendly food system
7. Preserving and restoring ecosystems and biodiversity
8. A zero-pollution ambition for toxic-free environment

Figure 1: The European Green Deal (source: European Commission, COM (2019) 640 final)

3.3 Transforming the Blue Economy value chains

The newly published Sustainable Blue Economy communication[3] (European Commission, COM (2021) 240 final) is the agenda towards a Sustainable Blue Economy.

The following is an extract and summary of the most relevant common challenges for transforming the Blue Economy value chains towards a Sustainable Blue Economy while achieving European Green Deal's objectives:

1. Climate neutrality and zero pollution
2. Responsible food systems
3. Circular economy and preventive waste
4. Biodiversity and investing in nature
5. Coastal resilience

1. Climate neutrality and zero pollution - DECARBONISATION

The EU aspires to reduce greenhouse-gas emissions by at least 55% by 2030 (compared to 1990 levels) and to become carbon neutral by 2050.

This means many of the current activities need to reduce their carbon footprint, while new, carbon-neutral activities need to take centre stage.

The Blue Economy can contribute to decarbonisation and carbon neutrality by developing offshore renewable energy and by greening maritime transport and ports.

Offshore renewable energy could help meet these targets and generate a quarter of the EU's electricity in 2050, mainly (though not exclusively) through offshore wind energy. A sustainable ocean energy mix should include (in addition to bottom-fixed offshore wind) floating wind, thermal, wave and tidal energy - emerging technologies that are expected to reach commercial stage within ten years. To speed up their development, in 2020 the Commission published a new EU Offshore Renewable Energy Strategy[4] (European Commission, COM (2020) 741), that aims to multiply five-fold the capacity for offshore renewable energy by 2030 and 30-fold by 2050.

The European Green Deal calls for a 90 % reduction in greenhouse gas emissions from all means of transport, including maritime transport.

To reduce the emissions from maritime transport, the Commission is preparing concrete initiatives such as incorporating the maritime sector into the European

[3] COM (2021) 240 final; EU agenda for Sustainable Blue Economy
[4] COM (2020) 741 final: EU Offshore Renewable Energy strategy.

Emission Trading System (ETS), the inclusion of maritime sector in EU Taxonomy, the Fuel EU Maritime initiative to boost the demand for sustainable alternative fuels as well as the reviews of the directives on energy taxation, alternative fuel infrastructure, and renewable energy.

2. Responsible food production - FARM to FORK Strategy

The current system for food production and consumption is responsible for carbon emissions, pollution and biodiversity loss.

The Blue Economy can help alleviate pressure on climate and on natural resources for food production by using marine resources better and by choosing alternative sources of food and feed.

This includes responsible fishing to bring stocks to sustainable levels, sustainable aquaculture to complement the natural limits of wild captures, and algae production as an alternative to agriculture.

Aquaculture can be a source of sustainable food and has the potential to further become a large source of low-impact food. The sector already complies with the highest quality, safety, and health standards.

By improving its environmental performance, European aquaculture can greatly contribute to the European Green Deal, to the Farm-to-Fork strategy and to a Sustainable Blue Economy.

The new strategic guidelines for EU Aquaculture[5] (European Commission, COM (2021) 236 final) set out the vision and an operational path to achieve this transformation.

In addition to their potential to produce bio-based products and biofuels, algae can provide viable and sustainable alternative food and feed materials.

3. Circular economy and preventing waste

The marine environment is suffering from various kind of waste and pollution, from visible pollution such as plastic litter and oil spills to invisible pollution such as microplastics, underwater noise, chemicals, and nutrients. Reducing the impacts of human activities on the sea is therefore the collective responsibility of all marine sectors.

The Blue Economy can play a vital role in many aspects of the work to combat pollution and can benefit from new opportunities arising from that work.

[5] COM (2021) 236 final: EU Aquaculture strategy.

The EU Action Plan on Zero Pollution offers a unique opportunity to step up action on pollution from nutrients (leading to eutrophication), contaminants, litter (largely made up of plastics) and underwater noise.

Alongside reducing pollution, it will be crucial to develop circular models and solutions. The 2020 EU Circular Economy Action Plan[6] (European Commission, COM (2020), 98 final) sets forth an ambitious agenda for keeping materials and resources in the economy as long as possible and for minimising waste, thus increasing circularity. This also includes recycling of large ships and decommissioning of offshore oil and gas platforms.

Transitioning to a circular economy requires a move from linear to circular material flows through a combination of extended product life cycles, intelligent product design and standardisation, reuse, recycling and remanufacturing. This process starts at the very beginning of a product's lifecycle: sustainable product design and production processes can help save resources, avoid inefficient waste management and create new business opportunities.

4. Biodiversity and investing in nature

Biodiversity conservation and protection should be considered as foundational principles of maritime economic activity. Marine biodiversity is not only the prerequisite for economic activities like fisheries, biotechnology, and tourism. Biodiversity conservation and restoration also present economic opportunities.

Preserving and restoring coastal vegetation systems such as tidal marshes, mangroves and seagrasses – which accumulate 'blue carbon' in their plants, soils and sediments – can contribute considerably to the European Green Deal's decarbonisation targets.

5. Coastal resilience

Protecting our natural and economic assets and infrastructure means adapting to the inevitable consequences of climate change. As an alternative to building yet more 'grey' infrastructure (dams, dikes or concrete barriers), climate adaptation should be based on natural and nature-based solutions – wetlands such as salt marshes, seagrass fields, mangroves and dunes, for instance. In coastal regions, developing green infrastructure will help preserve biodiversity, coastal ecosystems and landscapes, strengthening the sustainable development of tourism and of the coastal regions' economy. These adaptation activities will become a new sector of the blue economy in its own right.

[6] COM (2020): EU Circular Economy Action Plan.

3.4 Common trends in the Blue Economy

According to the latest EU Blue Economy Report 2021[7] (European Commission, 2021), there are trends in both established and emerging sectors.

1. Established sectors

The Blue Economy established sectors include Marine living resources, Marine non-living resources, Marine Renewable energy, Port activities, Shipbuilding and repair, Maritime transport and Coastal tourism.

For the established sectors, two sectors are particularly noteworthy: the living resources, with gross profits valued at €7.3 billion in 2018, saw a 43% rise on 2009 (€5.1 billion). Turnover reached €117.4 billion, 26% more than in 2009. Marine renewable energy (offshore wind) has also seen growing trends, with employment increasing by 15% in 2018 (compared to 2017).

2. Blue Economy - Emerging and Innovative sectors

The Blue Economy emerging and innovative sectors include marine renewable energy (i.e. Ocean energy, floating solar energy and offshore hydrogen generation), Blue bioeconomy and biotechnology, Marine minerals, Desalination, Maritime defence, security and surveillance, Research and Education and Infrastructure and maritime works (submarine cables, robotics). These sectors offer significant potential for economic growth, sustainability transition, as well as employment creation.

Emerging Marine Renewable Energy will be key if the EU is to meet its European Green Deal, the EU Hydrogen Strategy[8] (European Commission, COM (2020) 301 final) and the newly published goals of the Offshore Renewable Energy Strategy[9] (European Commission, COM (2020) 741 final) goals. The latter proposes an increase in offshore wind capacity from 12 GW to 300 GW by 2050, complemented with 40 GW of ocean energy and other emerging technologies by 2050.

The most notable sub-sector in Blue bioeconomy is the algae sector. Although recent socio-economic data are available for only a limited number of Member States (France, Spain and Portugal), turnover for these amounted to €10.7 million.

Desalination, there are currently 2 309 operational desalination plants in the EU producing about 9.2 million cubic meters per day. As climate change may lead to hotter

[7] European Commission (2021), The EU Blue Economy Report 2021.
[8] COM (2020) 301 final: EU Hydrogen strategy.
[9] COM (2020) 741 final: EU Offshore Renewable Energy strategy.

and dryer summers, certain countries must ensure water supply and hence have invested in desalination.

Research and education, developing the right skills in the offshore renewable energy sector seems critical. Currently, 17-32% of companies are experiencing skills gaps, while in technical occupations, 9 to 30% are experiencing skills shortages. In the future, Member States will need to provide more education and training schemes targeting the offshore renewable energy sector in line with their expected development targets, so as to attract young workers and re/upskill workers to offshore renewable energy jobs.

3.5 Sustainability requirements to be addressed by GreenOffshoreTech's Call for Proposals

In order to address the common sustainability challenges of the Blue Economy towards a Sustainable Blue Economy, we have defined the following environmental and sustainability requirements for the envisaged new products, processes or services to be developed within the GreenOffshoreTech Call for Proposals.

All SME-driven innovation projects supported by GreenOffshoreTech within the Call for Proposal shall deliver innovative solutions that contribute (to one or more):

1. to meet EU's targets to reduce CO_2 emissions, for instance through reduction of CO_2 emission, increase of renewable energy sources;
2. to increase resource efficiency, for instance through reduction of total energy usage, increase of energy efficiency, reduction of waste (living and non-living), reduction of raw material usage (e.g. natural resources, water, minerals), circular economy;
3. to reduce the environmental footprint, for instance through reduction of air, soil and water pollution, reduction of hazard substances and their disposal, reduction of noise, reduction of overfishing, reduction of foreign invasive aquatic species;
4. to improve work safety and work conditions in the blue economy.

GreenOffshoreTech will contribute to both the Sustainable Development Goals (SDGs) and the European Green Deal across many areas:

- SDG #14: 'Conserve and sustainably use the oceans, seas and marine resources for sustainable development'
- SDG #7: 'Ensure access to affordable, reliable, sustainable and modern energy for all' (renewable energy)

- SDG #12: 'Ensure sustainable consumption and production patterns' (resource efficiency, pollution, waste)
- SDG #13: 'Take urgent action to combat climate change and its impacts' (CO2 emission)
- SDG #9: 'Build resilient infrastructure, promote inclusive and sustainable industrialization, foster innovation'

and corresponding EU's 2030 climate & energy framework with following key targets:

- at least 55% cuts in greenhouse gas emissions (from 1990 levels)
- at least 27% share for renewable energy
- at least 27% improvement in energy efficiency

Figure 2: The UN Sustainable Development Goals addressed by GreenOffshoreTech

(source: https://www.un.org/sustainabledevelopment/news/communications-material/)

4. Sustainable challenges, needs and trends of four offshore sectors

This section aims to analyse and identify the challenges, needs and trends of four industrial offshore sectors with strong synergies: offshore wind energy, offshore aquaculture, offshore oil and gas, maritime transport. It is important to remember that GreenOffshoreTech aims to support innovation in Small and Medium-sized Enterprises (SMEs) and foster the development of the emerging Blue Economy industries by enabling new cross-sectoral and cross-border value chains, based on shared challenges and the deployment of key enabling technologies. Therefore this analysis will be cognisant of emerging economic opportunities for SMEs and the urgent needs for industrial value chains to contribute to the global effort to tackle climate change. The challenges are defined by the 5 clusters representing the following complementary four offshore industry sectors:

- Offshore Wind: Highlands & Island Enterprise (HIE, UK), FORUM OCEANO (FOC, PT), Maritime Cluster Norddeutschland (MCN, DE)
- Offshore Aquaculture: Iceland Ocean Cluster (IS), FOC (PT), HIE (UK)
- Offshore Oil & Gas: Mosseregionens Næringsutvikling (MNU, NO)
- Waterborne Transport: MCN (DE), MNU (NO)

This section describes how the challenges and potential solutions of all four offshore sectors, which were appraised and presented at proposal stage, were reviewed and refreshed to take account of emerging opportunities and innovative technologies.

4.1 Methodology

A preliminary analysis of sectoral sustainability challenges was undertaken at the proposal stage. This has now been updated with input from the clusters.

Stage 1	A desk-based review of the challenges was undertaken by HIE and presented to the clusters in a workshop.
Stage 2	A 3-hours workshop was held on 24 November 2021 with all consortium members, led by HIE, to validate the findings from the desk-based review. This included 4 focused discussion groups split by offshore sector, facilitated by HIE.

4.2 Sector Definitions

4.2.1 Offshore Wind

Offshore wind energy comprises bottom-fixed and floating wind turbines. It is a dynamic and rapidly expanding sector and is expected to play a significant role in providing energy across the globe and be a cornerstone in green recovery and accelerate the transition to net zero. As part of the wider renewable energy offer, it presents an extremely valuable opportunity for cheaper, cleaner, and faster decarbonisation and has the potential to produce vast amounts of power that can be harnessed by modern technology for example, hydrogen. This is arguably the primary driver for growth and development of windfarms.

The European Commission estimates the total offshore wind installations in Europe (including the UK) will be between 240 and 450 GW by 2050. The Global Offshore Wind Report 2021 estimates that 59 GW of installations will be added to the European market (excluding the UK) between 2020 and 2030, or around 4000-5000 turbines at 13-15MW on average[10].

Floating offshore wind (FOW) is less established than bottom-fixed but is growing rapidly and is arguably approaching commercial maturity[11]. By the end of 2020, there was approximately 80MW of floating offshore wind generating capacity installed globally: c.75% of this is installed in Europe (59MW), with the remainder in Asia[12]. Of the European installed capacity, much of this is accounted for by the Hywind Scotland project, with a capacity of 30MW.

Given that many potential FOW sites are further offshore and may not currently be viable for cable connection to national grids, hydrogen production and storage will be an important part of energy solutions going forward and there are strong examples of research and development in capturing, storing, and using hydrogen, for example in transport. This will be a key component of the future energy mix and is driving the need for higher volumes of renewable energy generation.

Figure 3. Beatrice offshore wind farm, Picture Credit: Gillian Frampton/HIE.

[10] https://www.fao.org/documents/card/en/c/ca9229en/
[11] https://www.hie.co.uk/media/2980/maximarplussiaplus-plusreport.pdf
[12] https://www.fao.org/documents/card/en/c/ca9229en/

4.2.2 Offshore Aquaculture

In this project aquaculture is defined as the production of finfish and shellfish. Seaweed is not within scope but could benefit from the project at a later stage.

Aquaculture is of particular significance to the economic and social health of rural, coastal and island areas where it can act as an anchor industry providing year-round, well-paid jobs in remote areas and contributing to the viability of many communities. It also supports a wider, and more geographically dispersed supply chain including, processing, distribution, feed supply, and exporting.

There is an increased demand globally for protein, of which fish and seafood is a key component. This is being driven by global population growth and rising affluence in developing countries. A key element of meeting this demand is increasing sustainable production through aquaculture[13]. Allied to this is the need to ensure future food security. There is widespread recognition of the role that increasing aquaculture production can play in meeting this food provision requirement[14]. The UN FAO considers that aquaculture has expanded fish availability to regions and countries with otherwise limited or no access to the farmed species, often at more affordable prices, leading to improved nutrition and food security[15].

Figure 4. Loch Duart Salmon, Picture Credit: Gary Doak

There are opportunities to realise significant growth in the aquaculture sector and explore innovations and novel approaches within the industry. With offshore aquaculture development there is significant opportunity to develop offshore cage aquaculture in more exposed sites and semi-containted units, and there are also opportunities to increase non-salmonid farmed fish including halibut and trout, as well as shellfish.

[13] https://gwec.net/wp-content/uploads/2021/03/GWEC-Global-Wind-Report-2021.pdf
[14] https://www.greentechmedia.com/articles/read/so-what-exactly-floating-offshore-wind
[15] https://www.energy.gov/sites/default/files/2021-08/Offshore%20Wind%20Market%20Report%202021%20Edition_Final.pdf

4.2.3 Offshore Oil and Gas

Oil and Gas is a huge sector with a number of large global enterprises. Given that this project is about SMEs, the working assumption is that the focus of Oil and Gas will be on supply chain companies and activities. There is a global shift towards low carbon and reducing dependency on fossil and carbon-based fuels and associated carbon emissions. However, there remains a recognition of the significant role that Oil and Gas has and will continue to play in energy transition and in the future energy mix.

Figure 5. FirScot Ltd, precision engineering service company based in Forres, Moray. Picture Credit: Tim Winterburn / HIE

Consequently, there is now a focus on decarbonising extraction and production as far as possible and 'greening' every stage of the supply chain and decommissioning. This includes managing and minimising environmental impacts.

4.2.4 Waterborne Transport

Marine transport is potentially a huge area, covering freight shipping, barges, dredgers, tugboats, wild capture fishing vessels, passenger transport such as ferries and cruise ships, and a wide range of other vessels and uses. In this project, waterborne transport is focused on passenger ferries and vessels that supply and support other marine-base activities such as oil and gas, aquaculture, and off-shore wind. However, the potential developments and innovations that will flow from this project will have wider applications in marine transport.

Waterborne transport in this project can be viewed as an enabler of the other three sectors that make up the project, and part of their supply chains. In terms of passenger transport, efficient, reliable, and resilient maritime transport links are critical to meet the lifeline needs of coastal and island communities and supports tourism and economic development.

It covers the design and build of vessels, operating waterborne transport, including energy sources, repairs, and maintenance, and decommissioning and waste management of vessels at end of life.

A valuable opportunity lies in the decarbonisation of maritime waterborne transport. This is a key area of focus and there is considerable activity in developing alternative fuels and propulsion methods.

Figure 6. Subsea Viking in Scrabster Harbour, Caithness.
Picture Credit : Mike Brookes Roper /HIE

4.3 Defining Sector Challenges

This section sets out how the consortium identified and agreed the challenges for each sector.

4.3.1 Preliminary Analysis

The preliminary challenges were identified in the formative stage of the project and are set out in **Table 1**, on the next page.

4.3.2 Desk Based Review

The desk-based review tested the validity of the preliminary challenges taking into consideration:

- advances in innovative technologies
- the development of new industrial value chains and clusters across the four key sectors
- macro political drivers, most critically the global commitment to reduce climate change, as committed to in the Glasgow Pact and Paris Agreement.

This desk-based review informed the development of key considerations to be explored by the project partners in an online workshop. These slides are included in **Annex 1**.

Table 1. Preliminary Challenges

Sector	Challenges, Needs and Trends
Offshore Wind	Operation in increased water depths; more remote and distant site locations; corrosion of towers and foundations; larger size of components; resultant increase in logistical challenges for installation; operation; maintenance; decommissioning; safety; and environmental sustainability (including noise pollution, material pollution such as antifouling); work safety and work conditions
Offshore Aquaculture	Increase access to space and water; administrative simplification; guaranteed adequate supply of quality raw material for processing and distribution; high quality; sustainability; consumer protection standards. Production and practice with focus on quality inputs (seed and feed), better fish health (fish welfare, health) instead of high yield per unit area. Reduce fish loss through handling, escape, stress (pathogens, parasites, chemical pollutants, microplastics) and diseases. Improve environmental sustainability through reduction of fish escape and water pollution. Improve work safety and work conditions. Moving commercial aquaculture from the traditional experience-based to a knowledge-based production regime.
Offshore Oil and Gas	Operation in deeper seas; higher pressures, temperatures, and with increased levels of corrosion and erosive materials in the flow; maintaining integrity; reducing operation and maintenance costs; meeting more stringent leakage prevention requirements; safety and environmental sustainability (oil spill, drilling waste, decommissioning). Transfer of technology and expertise to emerging blue economy sectors (e.g., offshore wind, offshore aquaculture).
Waterborne Transport	Stringent environmental and safety requirements, e.g., reduction of air pollution through CO2, SOx, NOx; matter and of water pollution through ship waste and foreign invasive aquatic species. Improve work safety and work conditions; reduce rate of accidents to zero by 2050. Transformation of logistics and supply chains to seize new offshore opportunities and safe offshore operations

4.4 Workshop

In focused working groups, project partners considered the key constraints and challenges inhibiting each sector's development. Particular attention was given to the regional and strategic challenges and considered where SMEs could have a significant role to play through the development and application of innovative technologies, advanced materials, and services.

4.4.1 Process

As a whole group, project partners considered the impact of the challenges and the potential for SMEs as solution providers, to lead a green transition, accelerate digital adoption and to build resilience in supply chains and sectors.

Project partners grouped and prioritised challenges using a three-tier system, with tier one being the challenge of most importance. Some of the issues are applicable to more than one sector and there is likely to be cooperation in developing the solutions. Opportunities will exist in sub-sectors including concept design, advanced materials, energy supply, waste handling, data, and logistics.

4.4.2 Offshore wind

Offshore wind comprises both floating and bottom fixed. Floating turbines tend to be deployed in deeper waters and whilst there are many shared challenges, there may be some that are specific to floating offshore wind and this should be considered in the GreenOffshoreTech project.

- Corrosion, damage, materials fatigue, and risk of equipment failure – potentially very high cost.
- Solutions for cost effective equipment inspection, monitoring and testing integrity (using technology, e.g., autonomous smart systems)
- Waste management and decommissioning. Option for future recycling, circular economy, decommissioning and considering this at design and manufacture stage.
- High cost of materials e.g., composites such as glass fibers and carbon fibers.
- Onshore infrastructure and facilities for lay down, assembly, construction, and repairs and maintenance
- Availability of fit for purpose vessels. Competition from other sectors and a lack of modern vessels.
- Minimising environmental impact of wind farm operations including noise, compromising the seabed and biodiversity.

- Market failure – getting the energy from where it is generated to where it is needed. Harnessing opportunities presented by hydrogen capture, storage, and transportation.

4.4.3 Offshore aquaculture

Offshore aquaculture will require innovative design concepts that are appropriate to the environmental conditions, the scale of the farms, and the distance to production sites as they potentially move further offshore and into more exposed locations. Challenges that have been identified and discussed are as follows:

- Development of new materials that are suitable for high energy locations and are recyclable
- Logistical challenges and cost of production in more exposed locations with longer journey distances and times from shore – managing harvesting and transport to market of fresh produce.
- New cage and equipment designs will be required to minimize cage and equipment failure, stock losses etc.
- Development of new digital solutions including robotics, cobotics and automation.
- Monitoring production and use of real time and time series data
- Increasing sustainability of the sector and circular economy activities – fish, byproducts and assets such as equipment.
- Disease, fish health and biosecurity of stock (in changing climatic and growing conditions)

Decarbonising operations and the supply chain including on farm integration of renewable energy and use of clean waterborne transport.

4.4.4 Offshore Oil and Gas

Offshore oil and gas will continue to be a key part of the world's energy mix, even as we transition to net zero. The key themes of the challenges facing the sector are around greening the industry, managing and minimising environmental impact and waste management. The challenges for the sector are as follows.

- Decarbonisation of exploration and extraction operations.
- Meeting more stringent leakage prevention requirements.
- Sustainable management waste resulting from extraction

- Diversification and repurposing of platforms, infrastructure and equipment and components as part of decommissioning. This includes salvaging, handling and reusing materials.
- Operating in extreme and harsh environmental conditions and the increased incidence of severe weather. This includes higher pressures and temperatures and has implications for:
    - Increased erosion and corrosion
    - Structure and equipment design
    - Materials that perform in harsher conditions
    - Monitoring equipment integrity and undertaking maintenance and repairs in high-risk locations.
    - Worker safety
- Impact of biofouling on equipment, operations, and the environment.
- Achieving systems change through procurement and monitoring of the supply chain

4.4.5 Waterborne Transport

Waterborne transport is part of the supply chain for the other three sectors and so the challenges and solutions are likely to also have an impact on them, for example decarbonising supply vessels will contribute to the decarbonisation of oil and gas extraction. The challenges that have been identified for waterborne transport within the scope of the GreenOffshoreTech project are set out below.

- Decarbonisation of waterborne transport through using clean energy sources
- Reduction of air and water pollution including clean propulsion systems and managing waste from vessels
- Climate change leading to more frequent extreme weather events and linked to this, ensuring resilience and continuity of passenger transport routes and supply and servicing routes for essential and lifeline services.
- Modernising and fit for purpose fleets
- Achieving efficiencies and synergies, potentially deploying vessels cross-sectorally and cross-sector planning and implementation of logistics (implications for design).
- Shoreside infrastructure including requirements for clean energy waterborne transport, and fabrication, repairs, and maintenance.

4.4.6 Workshop Findings – Sector Contraints

All the sectors highlighted the need to develop routing and storage of energy from wind turbine farms to support other offshore sectors. In considering the challenges, there are a range of opportunities to develop solutions and these solutions will have applications across these sectors and more widely in a Sustainable Blue Economy.

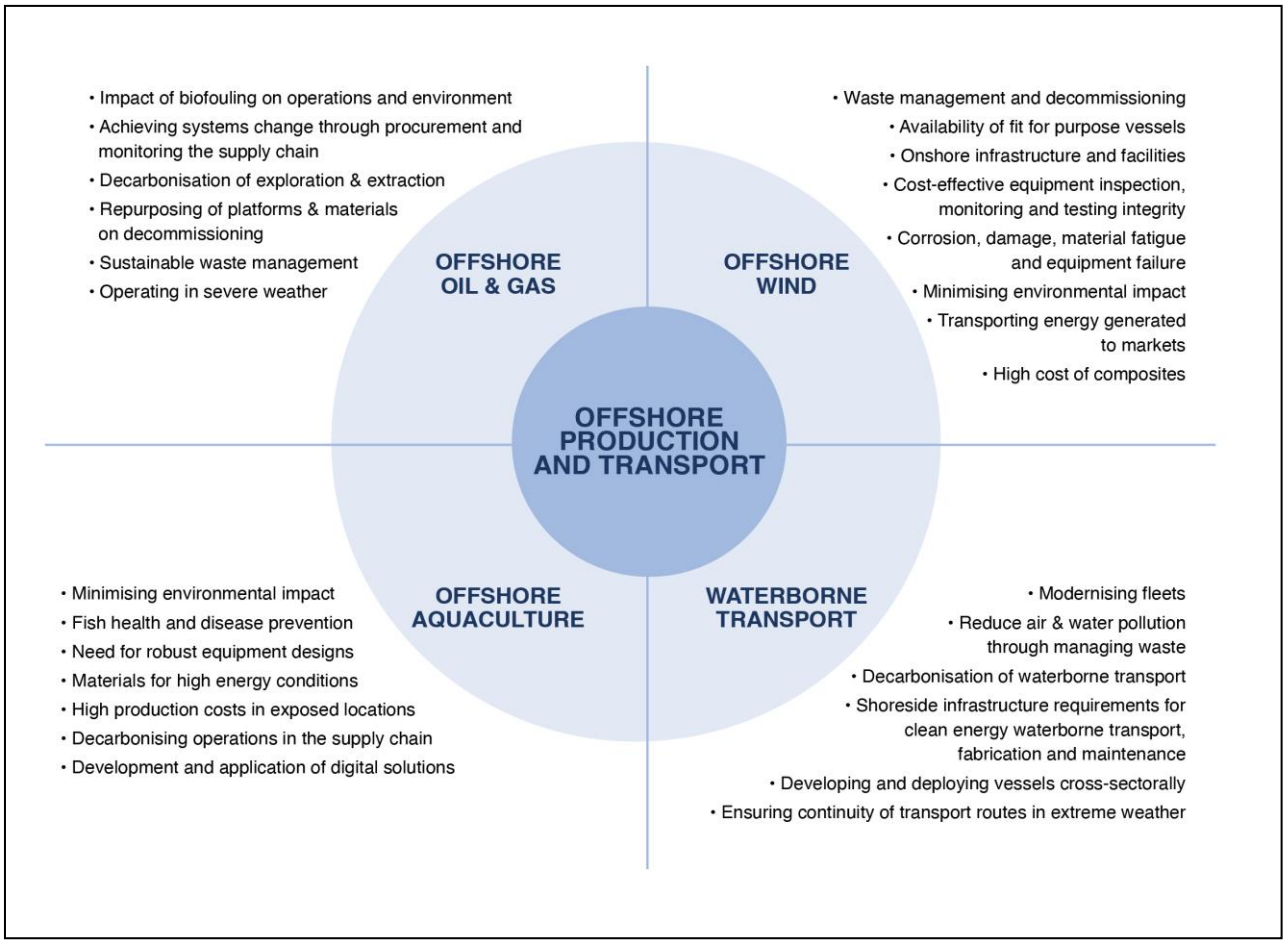


Figure 7. Workshop findings on sector constraints

5 SME Specific Challenges

It order to comprehensively analyse and interogate SME specific challenges, a survey was carried out with the SMEs of the GreenOffshoreTech clusters.

The survey sought to better understand the challenges and needs experienced by SMEs with a focus on innovation, technology transfer and sustainablitly management.

5.1 Survey Structure

The survey tool and questionnaire has been developed in WP2 and is presented in deliverable **D2.2 Survey tool and form for analysing challenges/needs/offers of companies and clusters (public).**

The survey questionnaire was divided in four sections:

A. Information about business and SMEs situation

B. Innovation in SMEs - challenges and barriers

C. Technology transfer - challenges and needs

D. Diagnosis of Sustainability in business practice - challenges and needs

The survey was conducted electronically in the four weeks between 14 December 2021 and 11 January 2022 using a software tool provided by our GreenOffshoreTech project partner HIE at no cost. Responses were gathered from both individual businesses and those representing clusters.

HIE undertook the analysis and synthesis of the SME survey results and the following sections provide an overview of the findings.

5.2 Sample Profile

In total, 87 valid responses were received from a range of organisations, 77% from individual businesses (66 busineses), 17% from clusters (15 cluster respondents) and the remainder were primarily research and education institutions. Not all questions were answered by or relevant to all respondents, so for some questions non-response was evident.

Responses were received from every region in the consortium although the level varied depending on the approach taken in each region, and also the size in terms of population and business base. The achieved sample included the four offshore industry sectors that are the focus of GreenOffshoreTech: Offshore Wind; Offshore Oil and Gas; Offshore Aquaculture; and Waterborne Transport.

There was also representation from related sectors such as: Greentech; Advanced Manufacturing; Advanced Materials; and Greentech. Three respondents indicated they operated in the hydrogen sector.

The sample also includes small and micro organisations (employing less than 10), medium (50-249) and large organisations employing in excess of 249 people. The majority (85%) of respondents are SMEs.

5.3 Sustainability

On average, the 84 respondents who provided an answer rated their organisation's commitment to achieving sustainability to be eight out of ten which is very positive (with ten being very committed). Of these 69% reported having a strategy or action plan for becoming more sustainable and 31% said that they may develop one going forward. Only one organisation said that they do not have a strategy or action plan and do not intend to deveop one. In summary, this demonstrates that the commitment to achieving sustainability has and is likely to continue to translate in to actions. Respondents were asked what actons they were takin now, or intended to take in the next five years to be more sustainable and reduce emission and carbon footprint.

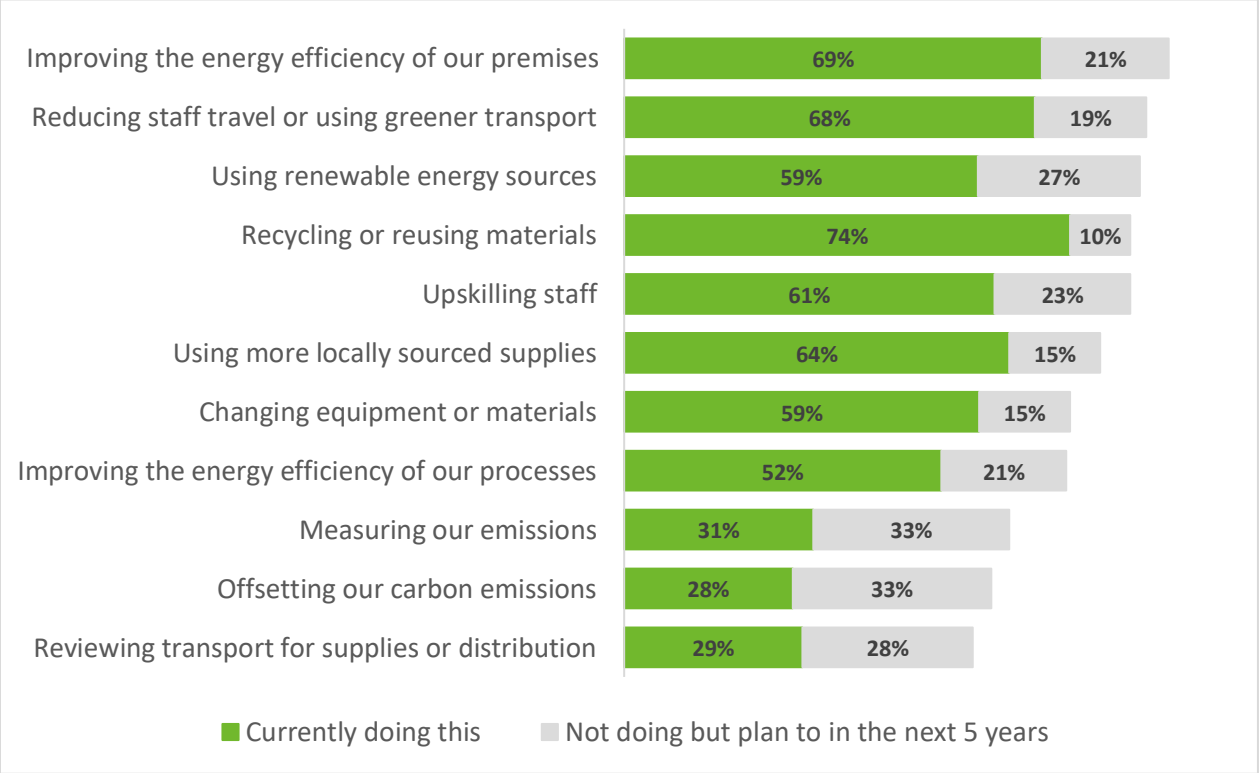


Figure 8. Actions taken or planned to be more sustainable (n=84)

Figure 8 shows that there is a great deal of current and intended activity around the key sustainability areas and interest in reviewing processes, ways of working, materials, energy, emissions and of course, recycling and repurposing materials. It also demonstrates that where there may be more limited activity currently, e.g. measuring emmissions, there is a commitment to addressing this going forward which highlights some key areas that could benefit from innovation and support.

5.4 Challenge to Sustainability

Organisations were asked to indicate factors that prevent them from becoming more sustainable. A quarter of respondents (26%) reported that this is not applicable or that they already operate in a sustainable way and a further 8% did not report any barriers. Of those who reported barriers (52 respondents), lack of financial resources was most commonly cited at 71%. Following that, the most common barriers are: lack of awareness on how to integrate sustainability in to the business model (35%); a perception that 'it would not be profitable (31%); lack of skills, including managerial (31%); lack of consumer demand (29%); and a pereception that 'it is not compatible with current business model' (19%).

Along with finance, these finding shows the importance of knowledge, understanding and skills on sustainability within business, and that a lack of these can impact on the pereceptions and so the drive within businesses, for example where leaders do not understand how sustainability can sit alongside and contribute to delivering profit.

5.5 Knowledge Acquisition

In the sample, 74 respondents indicated the key mechanisms by which knowledge is acquired in the company and the most commonly cited source is through academia (70%). Expertise from local clusters; professional and industry associations including Chambers of Commerce; trade fairs and exhibitions; and large firms and collaborations were each reported by around half of respondents (54%, 50% and 50% and 47% respectively).

Other sources to note are external consultants (cited by 36%), online databases (35%), government laboratories/institutes (34%), technology transfer institutions (31%) and agencies supporting organisational R&D (31%). Interestingly, at 41%, friends and acquaintances was sixth most common answer provided and this shows the importance of informal networks and contacts as well as more formal means of knowledge transfer.

5.6 Innovation and Technology Transfer

Seventy-three respondents answered the question about whether the organisation develops new and innovative solutions for the business and 88% said yes which shows an appetite for innovation. In total, 74% reported having staff dedicated to innovation and the remaining 26% do not.

Whilst organisations may have staff dedicated to innovation, they may not necessarily have an R&D department. In the survey sample, 53% reported having a specific R&D department and the remainder do not. The number of people employed in R&D divisions (where employers have them and provided a figure) ranges from one to 50.

Fifty-seven repondents reported that they have cooperations with R&D institutions and/or other companies which accounts for 80% of those who answered this question. This shows that even where companies may not have their own R&D department, they may draw on external R&D expertise and reources.

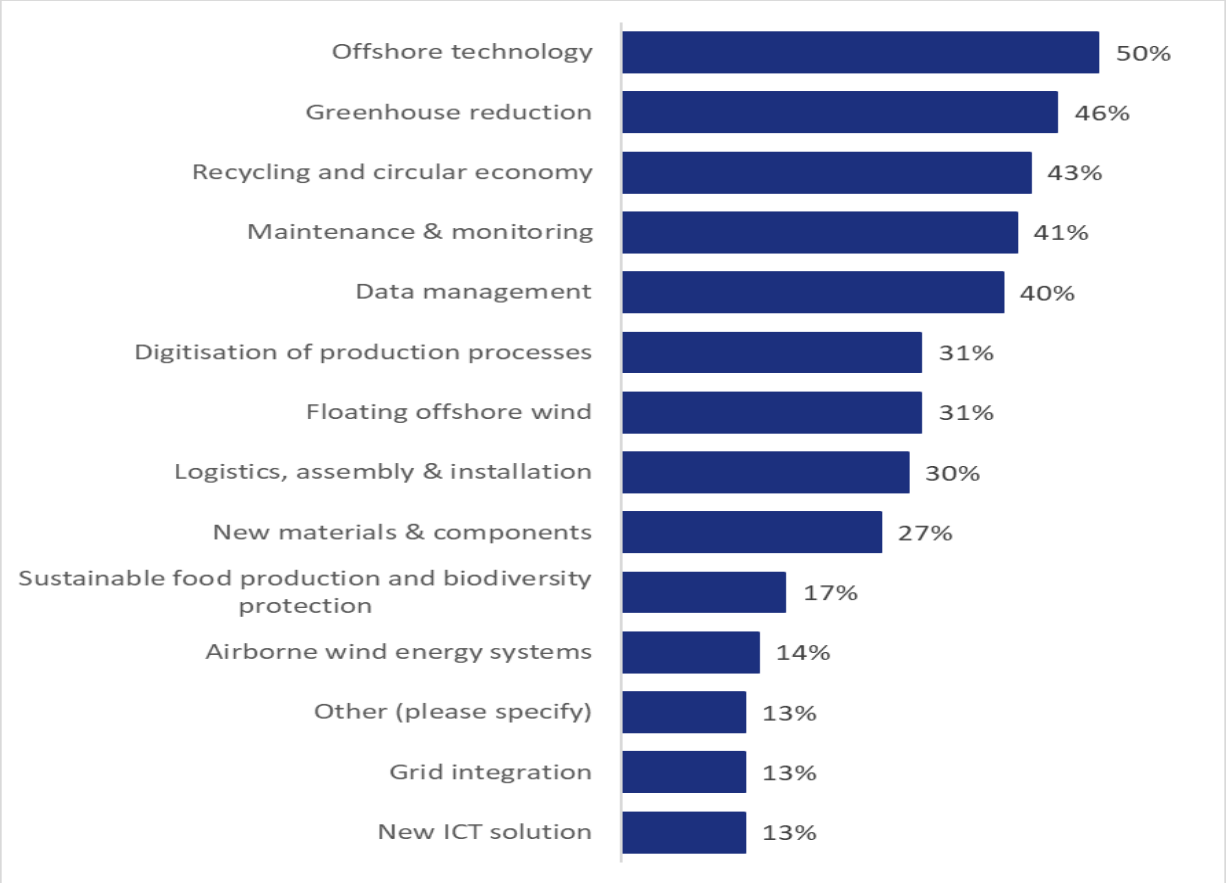


Figure 9. Research and innovation priorities (n=70)

In terms of priorities, Figure 9 shows that the priority areas for research and innovation amongst survey respondents are: Offshore technology; greenhouse reduction; recycling and circular economy; maintenance and monitoring; data mangement; floating offshore wind; digitisation of producion; and new solutions such as new materials and components, logitics, assembly and installation, and new ICT solutions. Hydrogen was also mentioned as an 'other'priority by four respondents. These closely reflect the challenges identified earlier in the report through the desk research and workshops.

Respondents were asked how many innovative projects the organisation had implemented in the last five years and the findings are set out in Figure 10. It shows that 11% had implemented one, 41% had implemented between two and five and 36% had implemented more than five. This means that 56 of the 73 respondents to this question have implemented at least two innovations in R&D, products, services or processes and shows a strong level of engagement in innovative activity that can be built on.

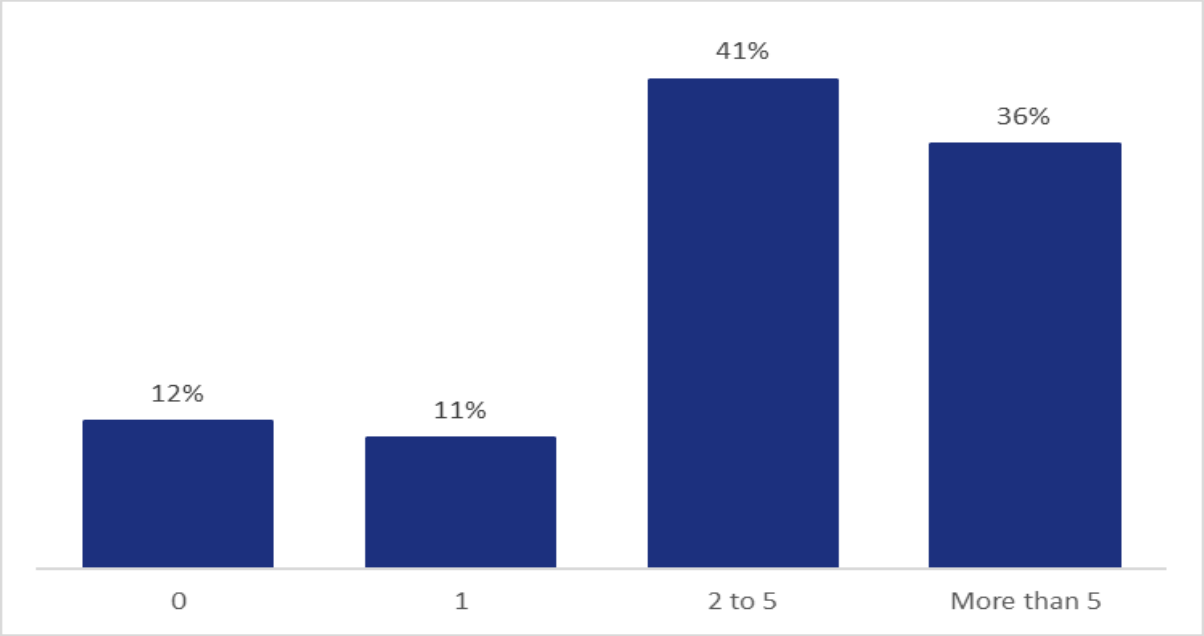


Figure 10. Number of innovative projects implemented in last 5 years (n=73)

The sample includes:

- 24 respondents from offshore oil and gas and of these, 21 had implemented at least one innovative project, nine of these had implemented between two and five projects and 10 had implemented more than five.

- 34 respondents from offshore wind and of these 29 (85%) had implemented at least one innovative project, 19 of these had implemented between two and five, and 9 had implemented more than five.
- 17 respondents from offshore aquaculture and of these 16 (94%) had implemented at least one innovative projects, eight had implemented between two and five, and seven had implemented more than five.
- 21 respondents from waterborne transport and of these 18 (89%) had implemented at least one innovative project, eight between two and five, and nine had implemented more than five.

This shows a strong level of engagement in innovation in organisations in the four sectors that are the focus of this project.

Projects do not always translate to commercialistion and this was explored in the survey. Of those organisations reporting that they had implemented at least one innovation project, 32% reported that one had succeeded to a transfer, 44% reported that between two and five had succeeded and a further 16% reported that more than five had succeeded to a transfer. Only 8% reported no project transfers.

In terms of technology transfer, respondents were asked how often the organisation had been involved in technology transfer and whether that transfer was from their organisation to another, or acquired from another organisation.

The findings set out in Figure 11 illustrates that there is strong transfer in both directions amongst participating organisations although there are more instances of organisations.

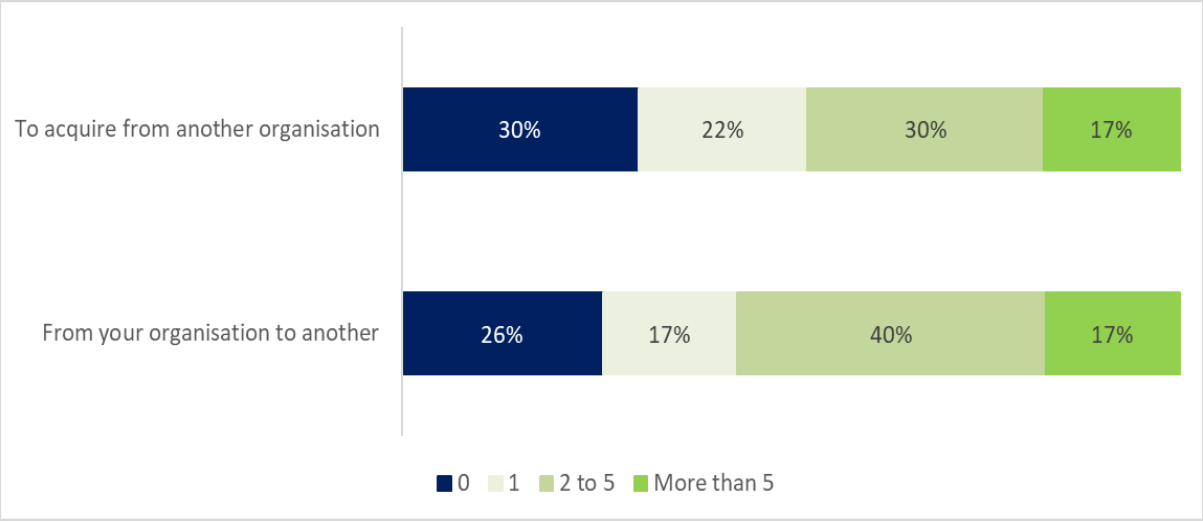


Figure 11: Technology transfer activity in the last 5 years (n=62)

NB. Base: To acquire from another organisation n=46; From your organisation to another n=58

The most commonly reported methods for technology transfrer reported in the survey are: cross industry collaboration (67%); events, seminars and conferences (60%); network meetings (55%); trade shows (45%); technical assistance from source; customer /supplier needs; informal exchange (all 32%); and site visits/training (28%).

The measures considered by respondents to be important for innovation technology transfer are illustrated in Figure 12. It illustrates the importance of strategic planning and the value placed on external support e.g. from mentors, advisers and experts. Some respondents (29%) report that they incentivise innovation and technology transfer by rewarding people in the workforce who are involved.

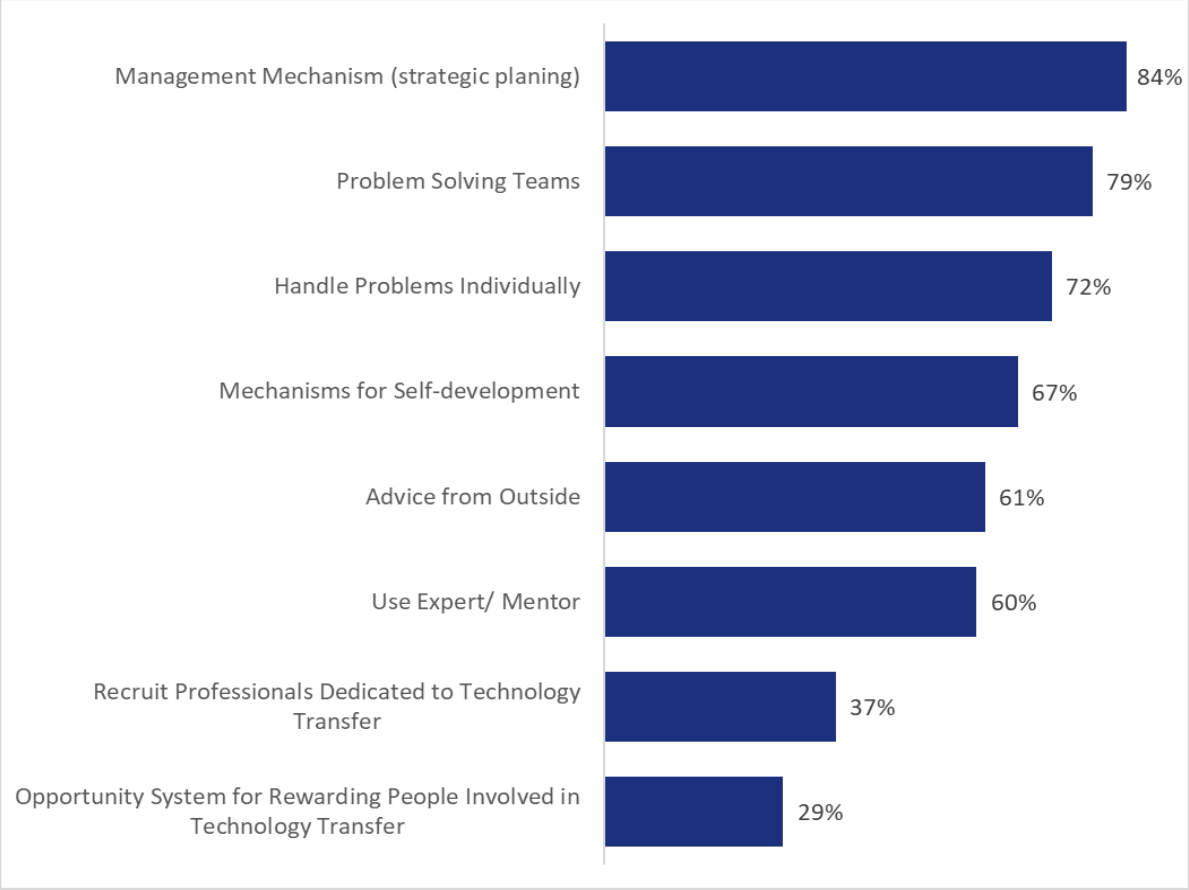


Figure 12. Measures important to innovation and technology transfer (% citing each as very or fairly important) (n=64)

5.7 Challenges for Innovation and Technology Transfer

As with barriers to sustainability, the main barrier to innovation reported in the survey is lack of financial resources at 57%. This was follow by difficulties in predicting market

responses (33%), athe legal or administrative environment (29%) and lack of skills was also a barrier to innovation (25%).

This again shows the importance of skills, including managerial skills to driving and achieveing innovation. Importantly, lack of technology infrastructure and lack collaboration with enterprises and research institutions was also a barrier for a number of companies (cited by 19% and 13% of respondents respectively). Just over one in 10 cited difficulties with protecting intellectual property as a barrier (13%).

The main barrier to technology selection reported in the survey is the high investment cost with 73% reporting it. Time pressure was a barrier for around two-fifths (42%) of respondents and lack of accepted standards for a third. Again, staff skills and knowledge is highlighted as a barrier – either in terms of an inadequate number of trained staff, lack of skills amongst staff, and opposition from employees. Pace of technological changes can also be an issue which may reflect difficulties in keeping abreast of changes as well as understanding which technology an organisation should adopt, bearing in mind that this can be a significant expense. This was cited by 27% of respondents.

The extent to which repondents consider certain factors present a barrier to technology transfer and some factors that assist it are set out in Figure 13. It shows that there are a range of barriers and overall the challenge will be an interplay between these.

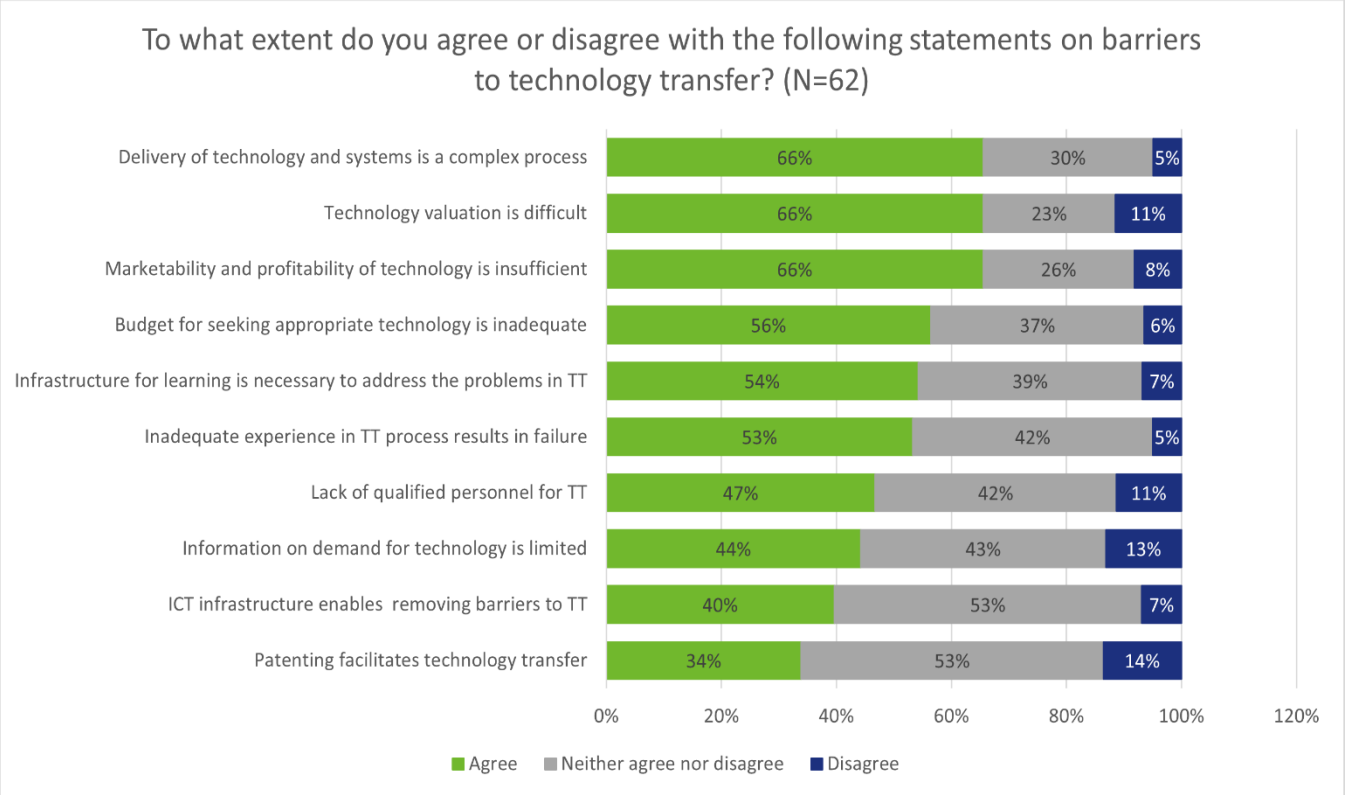


Figure 13: Barriers to technology transfer (n=62)

Around two-thirds of respondents agreed that the delivery of technology and systems is complex, valuation of technology is difficult and the marketability and profitability of technology is insufficient. This suggests a need for collaboration, support and intervention – and this is reflected in the fact that just over half (54%) of respondents believe that infrastructure for learning is necessary to address issues of technology transfer.

The perception of complexity is likely to make innovation and technology transfer seem high risk and costly and reflecting this, inadequate budget and inadequate organisational and staff experience are also cited as barriers. Patenting can de-risk innovation and 34% of respondents noted that patenting facilitates are important for technology transfer. Two-fifths of respondents agreed that ICT infratructure is important in removing barriers.

The survey explored the extent to which there is a lack of information on technology transfer. Just over half of respondents did not feel that there is a lack of information. Of the 37 who indicated that there is:

- 51% reported a lack of resources to obtain information;
- 32% reported a lack of resources to explore technology transfer opportunities; and
- 16% reported a lack of resources for up to date information on technology target markets for SMEs.

5.8 Digital Technologies

The survey findings clearly show that digital technologies have a significant impact on business productivity, innovation and low carbon working. Just over two-thirds (67%) reported that implementing digital technologies had helped make processes more efficient and just over half that it had helped create new or significantly improved products or services, increasesd their skills, and enhanced their competitive advantage (all 51%). Interestingly, almost a quarter (24%) said that it had supported them to shift to low carbon working which shows the contribution that developing and applying technology can make to sustainability.

6. Next Steps

This research has focussed on the analysis of sustainability challenges of the four offshore sectors in the GreenOffshoreTech project – offshore wind energy, offshore aquaculture, offshore oil and gas and maritime/waterborne transport.

The work has summarised some common challenges around achieving a Sustainable Blue Economy in Europe; it has analysed and validated the specific sectoral challenges of the offshore sectors in cosultations with the consortia clusters and finally, it has drilled down to specific SME-level challenges related to sustainability and innovation across the blue economy.

This analysis has confirmed the need for cross-cutting and emerging technologies (advanced materials, advanced manufacturing, Industry 4.0, environmental technologies) to provide solutions for the offshore industries and develop new industrial value chains – to make the offshore production greener, cleaner and more sustainable.

This work will inform the next stage of the GreenOffshoreTech project which will define the Topics of the competitive GreenOffshoreTech Call for Proposals to support innovation in SMEs.

Annex 1 – Slides from workshop

Purpose of the discussion sessions

- To consider common sustainability challenges for the four offshore sectors
  - Offshore wind energy
  - Offshore aquaculture
  - Offshore oil and gas
  - Waterborne transport

Challenges identified in the project proposal

	Challenges	Potential solutions
Offshore Wind	Operation in increased water depths, more remote and distant site locations, corrosion of towers and foundations, and larger size of components, with a resultant increase in logistical challenges for installation, operation, maintenance and decommissioning, safety and environmental sustainability (e.g. noise, antifouling), work safety and work conditions.	New durable materials (lightweight), remote maintenance, predictive modelling and maintenance, new drivetrain solutions, heavy lift crane operations, human protection, noise reduction, circular economy solution. New concepts of floating installations
Offshore Aquaculture	Increase access to space and water, administrative simplification, guarantee adequate supply of quality raw material for processing and distribution, meet high quality, sustainability and consumer protection standards. Production and practice with focus on quality inputs (seed and feed), better fish health (fish welfare, health) instead of high yield per unit area. Reduce fish loss through handling, escape, stress (pathogens, parasites, chemical pollutants, microplastics) and diseases. Improve environmental sustainability through reduction of fish escape and water pollution. Improve work safety and work conditions. Moving commercial aquaculture from the traditional experience-based to a knowledge-based production regime	New concepts/designs/materials for sea-based aqua-culture constructions in exposed environments (waves, currents; e.g. floating, flexible, open cage, closed cage aquaculture structures) and new concepts/designs/ technologies for precision fish farming (e.g. intelligent sensors, autonomous and continues biomass/fish monitoring, tracking of nutrients, fish escapes and pollution monitoring, decision support systems automated monitoring of e.g. sea-lice levels in salmon farms), biofouling cleaning of cage nets, IT solutions for traceability of fish from seed to consumer, circular economy concepts.
Offshore Oil and Gas	Operation in deeper seas, higher pressures, temperatures, and with increased levels of corrosion and erosive materials in the flow, whilst maintaining integrity, reducing operation and maintenance costs and meeting more stringent leakage prevention requirements as well as safety and environmental sustainability (oil spill, drilling waste, decommissioning). Transfer of technology and expertise to emerging blue economy sectors (e.g. offshore wind, offshore aquaculture)	New durable materials, standardization and modular production processes, remote maintenance, predictive modelling/maintenance, 3D-printing for complex machinery & tooling for new maintenance concepts, composite riser, automation and ICT technologies across data acquisition, data quality, data integration, human protection, environmental monitoring/modelling, artificial intelligence for environment and circular economy solution
Waterborne Transport	To meet stringent environmental and safety requirements, e.g.: reduction of air pollution through CO2, SOx, NOx, and particular matter and of water pollution through ship waste and foreign invasive aquatic species. Improve work safety and work conditions, reduce rate of accidents to zero by 2050. Transformation of logistics and supply chains in order to seize new offshore opportunities and safe offshore operations	Emission free, energy-efficient and clean shipping e.g. advanced scrubber systems, innovative propulsion systems and alternative fuels (e.g. battery, LNG, methanol), ballast water management systems, waste heat recovery systems, systems for waste water and solid waste treatment and recycling, antifouling solutions. New designs of service/assistance vessels for the emerging offshore sectors (wind, aquaculture).

Key considerations

- What are the constraints and challenges to each sector's development?
  - Facing SMEs at the individual business level?
  - At the sector level?
  - Regional or strategic challenges that SMEs can directly contribute to addressing?
- Impact of the challenges - making offshore production and transport **greener**, **cleaner** and **modern**?
  - What does this mean for ambitions for a **Sustainable Blue Economy**?
- Are the challenges identified the right *ones for the Project*?
- Significance of each – and priorities to address challenges?

Slide 5 has on 'Breakout Groups' has been omitted re data protection.

Offshore wind: challenges

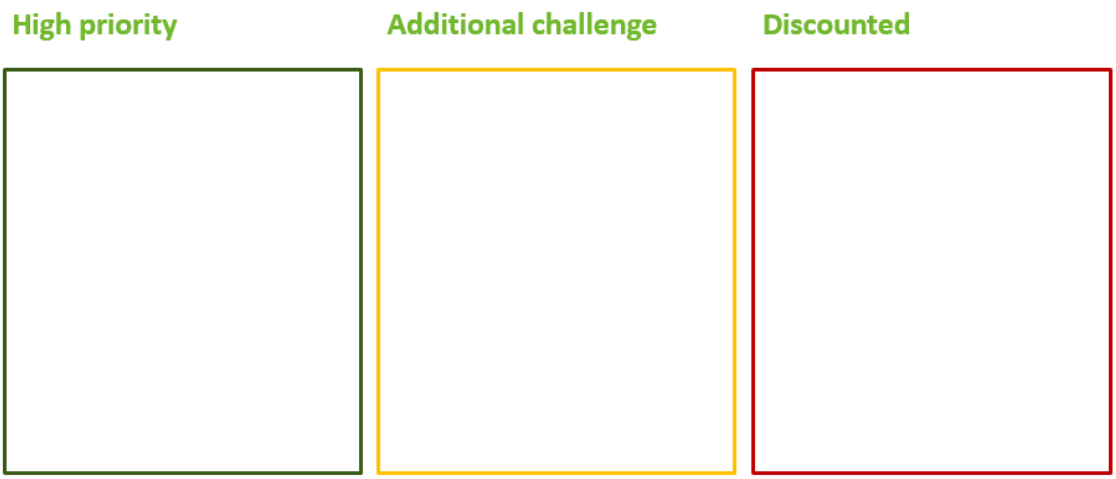
Thinking about solutions development and the supply chain

- Deeper waters and harsher environment – waves, wind – for installation and operation. Implications for:
  - Health and safety – high velocity environment
  - Equipment – damage, corrosion, fatigue
- Larger size of components so increased logistical (and safety) challenges for installation
- Remote and distant site locations (and identifying weather windows) - longer travel times for maintenance and repairs
- Power required for the service vessels. So how to adapt heavy maintenance and service vessels
- Corrosion of towers, foundations, anchorage – and biofouling (barnacles, etc.)
- High installation, safety and maintenance costs
- Tow-to-port – challenges to tow from port to installation, and to disconnect and store connections when bringing the turbine back to port.
- Waste management on decommissioning – can this be designed 'in'
- Impact on the environment – noise, waste

Offshore wind: validating the challenges

- Are these the correct challenges to focus on for offshore wind?
- Are there other challenges that should be considered:
  - For businesses?
  - For the offshore wind sector?
- How significant is each of these challenges?
  - Why is this the case?
- Potential solutions to each challenge
  - Are there any emerging solution propositions?
- Prioritise each of these challenges?

Offshore wind: prioritising the challenges



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Offshore aquaculture: challenges

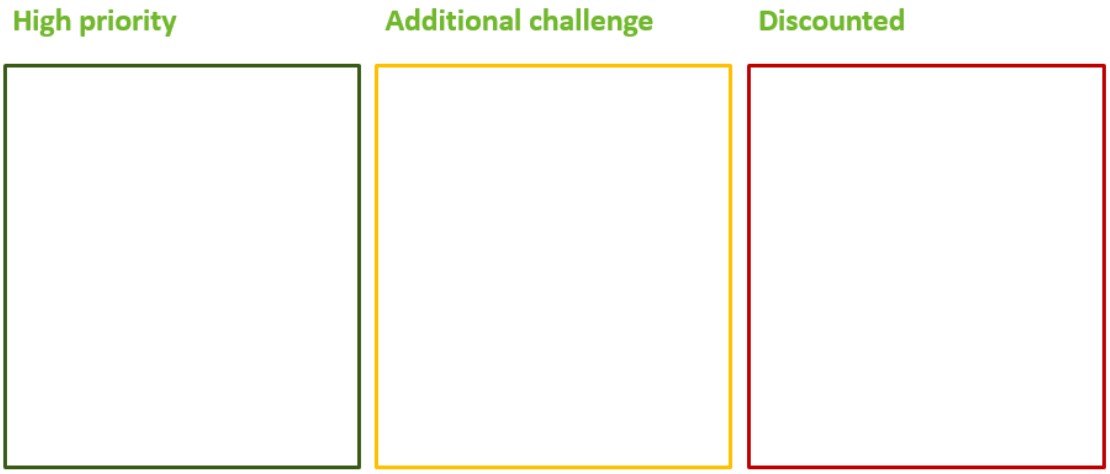
Thinking about solutions development and the supply chain

- Management of disease and biosecurity of fish stock
  - Productivity, fish health and quality/size of harvested fish due to pathogens, and specifically sea lice
  - Impact of chemical pollutants, microplastics
- Movement from inshore/near-shore to offshore farming due to limited availability of suitable inshore sites
  - Drive towards more exposed, high-energy sites and extreme marine conditions
  - Cost implications of more exposed sites
  - Requirement for different cage designs and materials to withstand harsher conditions
  - More complex logistics chains and maintenance systems – time taken to get to sites for maintenance, harvesting, etc.
  - Species that will thrive in off-shore locations
- Reducing fish loss through escape, cage failure
- Impact of climate change on aquaculture production
  - Changing physical and chemical characteristics of marine environment
  - Species diversification

Offshore aquaculture: validating the challenges

- Are these the correct challenges to focus on for offshore aquaculture?
- Are there other challenges that should be considered:
  - For businesses?
  - For the offshore aquaculture sector?
- How significant is each of these challenges?
  - Why is this the case?
- Potential solutions to each challenge
  - Are there any emerging solution propositions?
- Prioritise each of these challenges?

Offshore aquaculture: prioritising the challenges



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Offshore oil and gas: challenges

Thinking about solutions development and the supply chain

- Decarbonisation of oil and gas extraction operations
- Meeting more stringent leakage prevention and other environmental requirements
  - e.g. drilling waste, decommissioning waste, spillage
- Operation in more extreme environments/conditions
  - Withstanding harsher environments
  - Operating in deeper waters and at higher pressures, temperatures
  - Equipment infrastructure integrity and worker safety
- Reducing the impact of platforms and exploration on marine environment
- Biofouling – barnacles, etc. on structures
- Diversification and repurposing of platforms, infrastructure and equipment as part of decommissioning
- Integration with other marine economy sectors, and managing energy transition

Offshore oil and gas: validating the challenges

- Are these the correct challenges to focus on for offshore oil and gas?
- Are there other challenges that should be considered:
  - For businesses?
  - For the offshore oil and gas sector?
- How significant is each of these challenges?
  - Why is this the case?
- Potential solutions to each challenge
  - Are there any emerging solution propositions?
- Prioritise each of these challenges?

Offshore oil and gas: prioritising the challenges

15

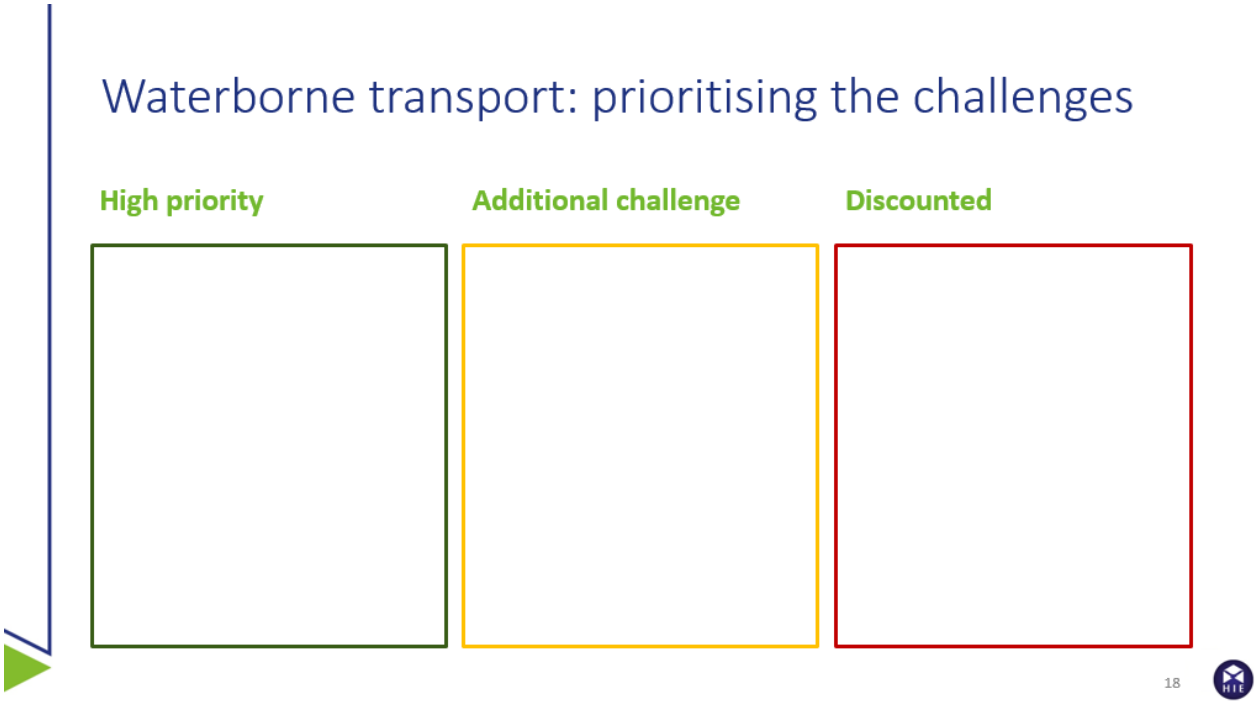
Waterborne transport: challenges

Thinking about solutions development and the supply chain

- Ensuring resilience of maritime transport services – and in context of climate change
  - Risk management and mitigation for extreme weather events
  - Ensuring resilience of key transport routes and essential/lifeline services
- Decarbonisation of maritime transport
  - Reduction of air and water pollution from exhaust particulates and vessel waste
  - Lighter more fuel efficient vessels
  - Clean propulsion systems
  - Land-side infrastructure for fuels
- Modernisation and capacity in the fleet and in vessel building
- Port infrastructure to support marine industries
  - Modernisation and diversification of facilities and infrastructure
  - Refuelling/charging
  - Availability of space for fabrication, construction, maintenance, etc.

Waterborne transport: validating the challenges

- Are these the correct challenges to focus on for waterborne transport?
- Are there other challenges that should be considered:
  - For businesses?
  - For the waterborne transport sector?
- How significant is each of these challenges?
  - Why is this the case?
- Potential solutions to each challenge
  - Are there any emerging solution propositions?
- Prioritise each of these challenges?


Waterborne transport: prioritising the challenges
High priority
Additional challenge
Discounted
18


Feedback and prioritisation
19

Feedback from breakout sessions

Discussion

- Key points of discussion
- Challenges identified
  - Validation
  - Any discounted?
- Important considerations with regard to prioritisation

Prioritisation

- Main challenges to address
  - At the business or sector level
  - Up to 10 challenges
- Ranked by importance

Agreeing the priorities

- For each sector, which of the priorities are most important?
- Do any of the priorities address cross-cutting issues, or challenges common to more than one sector?
- What collaborative priorities are there?

END.