IPOG Research Needs

Contract Number PS18233

Date: 17th August 2020

Revision	Description	Prepared	Reviewed	Date
1.2	Final	Mark Calverley	Gus Jeans	17th August 2020
1.1	For OGTC/OGUK review	Mark Calverley	Gus Jeans	27th July 2020
1.0	For NERC review	Mark Calverley	Gus Jeans	27th July 2020

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1. Introduction

The Natural Environment Research Council (NERC)'s £5million 5-year Innovation Programme in Oil and Gas (IPOG) is drawing to a close. The programme funded research into a number of industry challenges and cross-cutting themes, see Figure 1.

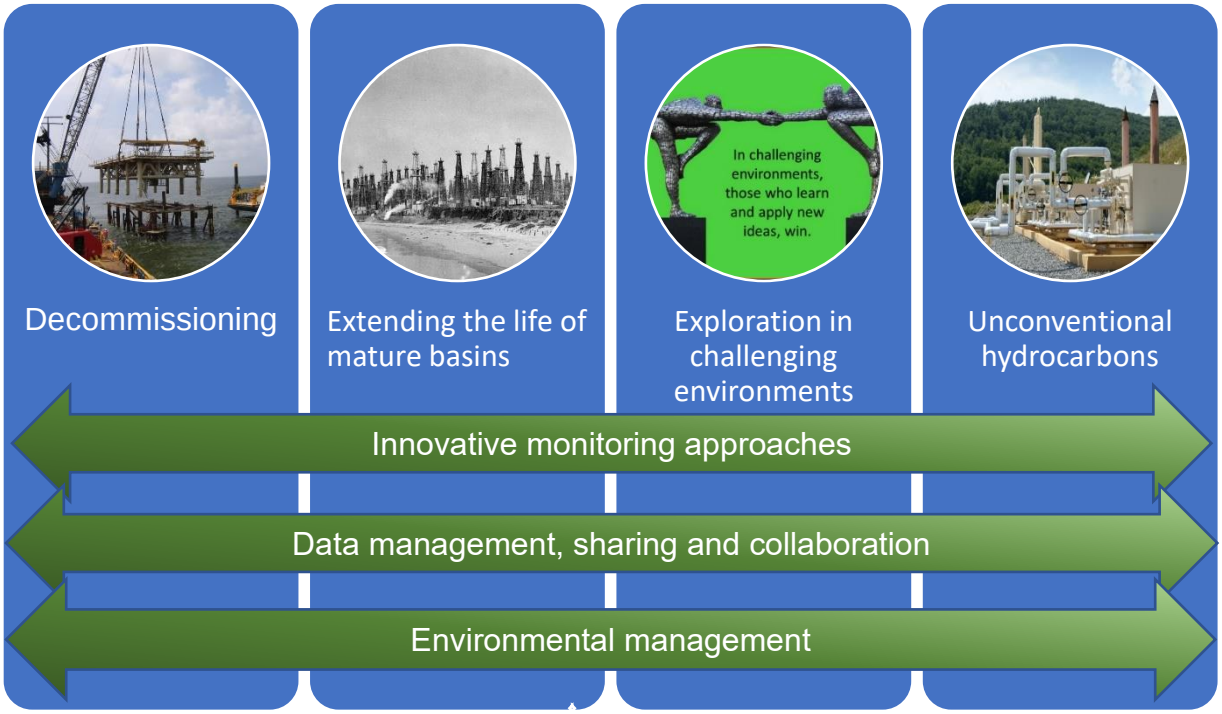

Figure 1 IPOG Challenges and Themes (2017)

In the period since the challenges and themes were agreed, there have been notable changes to the operating environment, notably the energy transition and the commitment to net zero production on the UKCS (United Kingdom Continental Shelf).

Following discussions with IPOG members, the Oil & Gas Technology Centre (OGTC) and Oil & Gas UK (OGUK) it was evident that a roadmap of environmental research needs would be useful to both UKRI-NERC and stakeholders within the industry. NERC, OGTC and OGUK invited interested parties to contribute their thoughts on environmental research needs across Net Zero Production, Energy Transition and Decommissioning.

The request was framed within the following context

- Putting sustainability at the core of the industry in reshaping to Net Zero (UK target under Paris agreement)
- Assessing business and economic models to determine benefits to the environment and economy and understand trade-offs, tipping points and unintended consequences to inform decision making.
- Gaps in knowledge and needs for environmental research and innovation.

The needs will also be considered in the context of the Research and Innovation priorities outlined in NERC's delivery plan:

- Environmental solutions
- Pushing the frontiers of understanding
- Productive environment
- Healthy environment
- Resilient environment
- Digital environment
- Global environment
- Best environment for research and innovation

Although the roadmap was initiated by NERC, respondents were invited to consider the full breadth of UKRI skills, including engineering and physical science research, economic and social research, biotechnology and biological sciences research.

2. Overview of survey interactions

2.1 Number of Respondents

The survey closed on 10 July 2020. Invitations were sent to IPOG members on 17th June and a reminder on 26th June. The survey was distributed by OGTC and OGUK on 31 June 2020. The total number of respondents to the survey was 23. This represented a very low percentage of those invited which comprised 18 invitations to existing IPOG members, 300 invitations to OGUK members and invitations delivered by OGTC. The low response may have resulted from targets being furloughed or COVID may have impacted the response in other ways. The survey was also live during the Scottish school holidays which may have impacted the number of responses.

Of those responding only 7 identified needs, the remainder submitted contact information to be kept informed of the outcomes. The total number of on-line needs submitted was 17. A further 12 needs were submitted during telephone interviews with 4 people. The number of needs submitted by responder is illustrated in Figure 2.

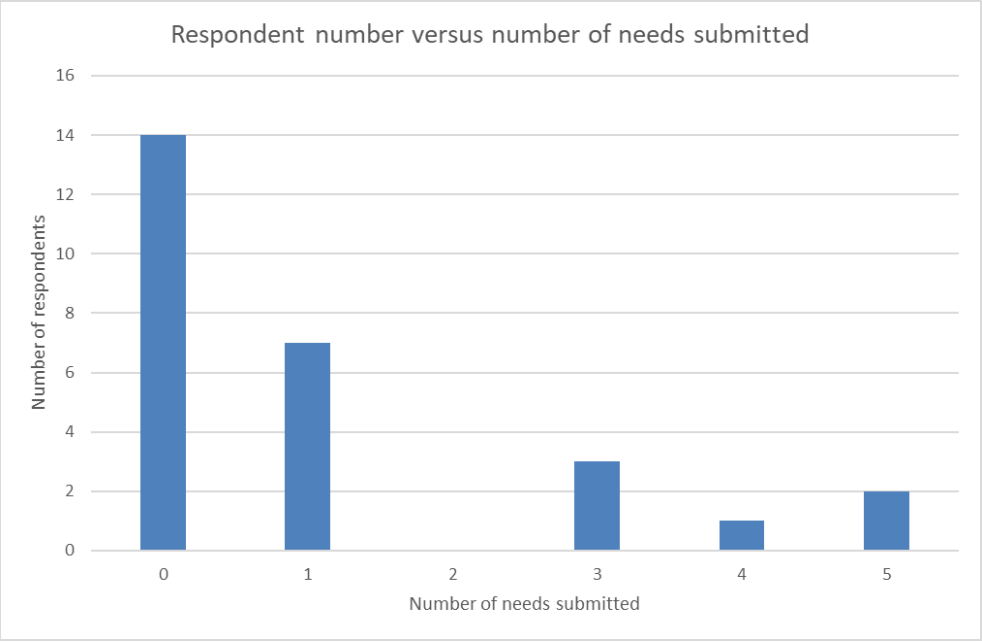

Figure 2 Distribution of respondents submitting needs

2.2 Focus Areas

Net Zero production generated the greatest number of needs (13) with decommissioning and the energy transition generating number (8 and 9 respectively)

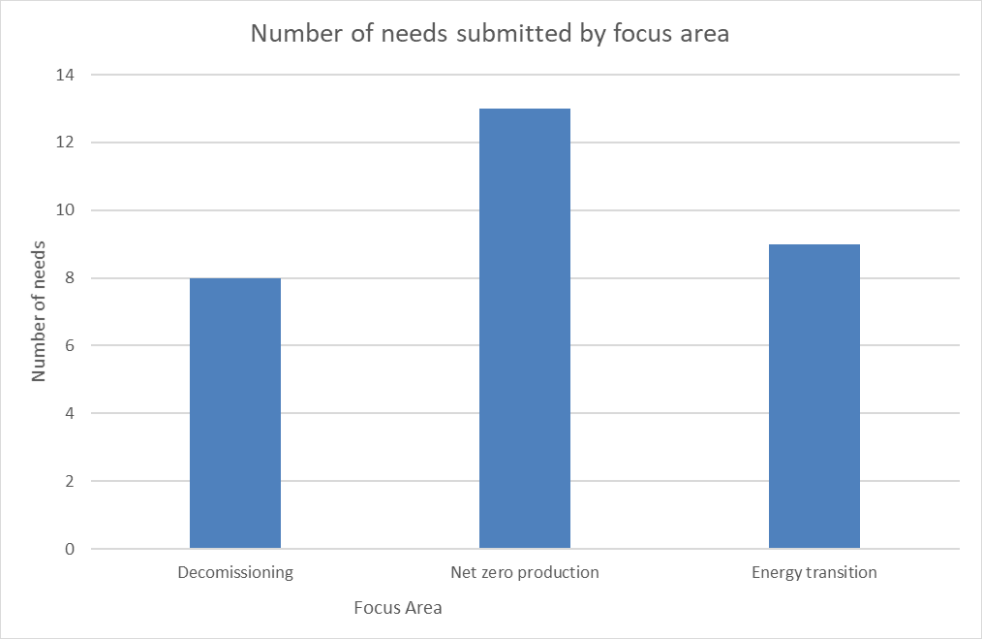

Figure 3 Distribution of needs by focus area

2.3 Research Need Horizon

The research needs were fairly evenly distributed across short, medium- and long-term horizons.

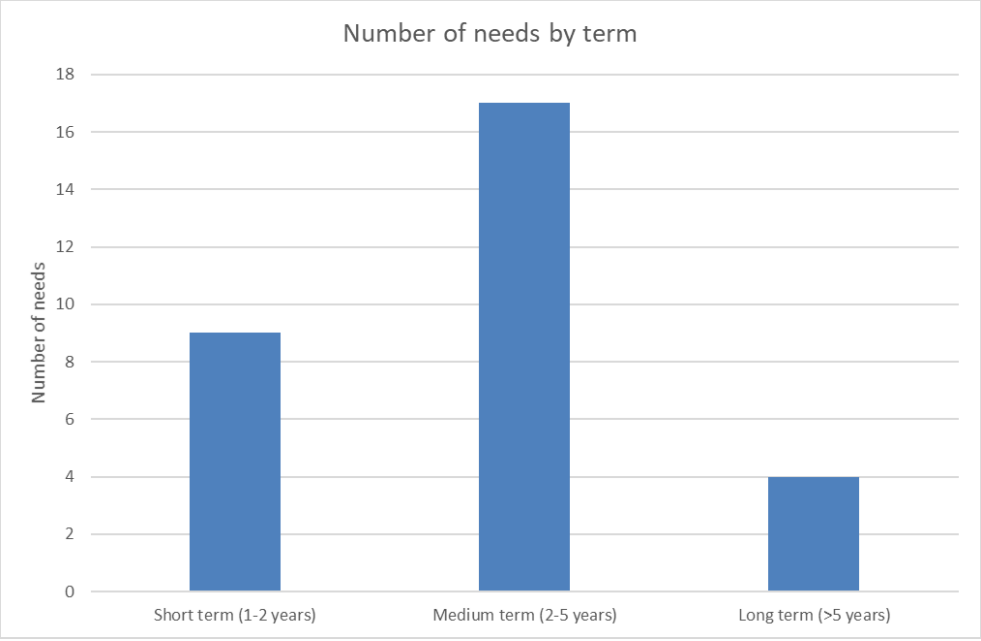

Figure 4 Distribution of needs by horizon

2.4 Drivers of Needs

The drivers of the needs were only reported in the on-line survey, and they appear fairly evenly distributed. Most responders noted multiple drivers for each need.

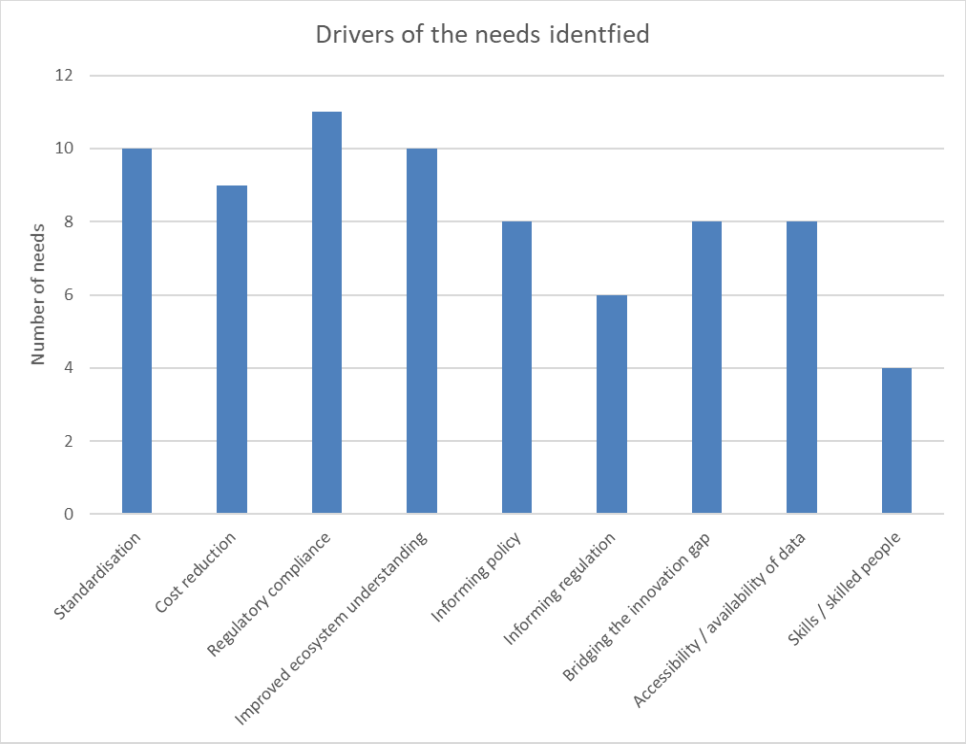

Figure 5 Distribution of the drivers of needs

3. Research Needs

3.1 Decommissioning

Title (Horizon)	Description
Standardised OSPAR 98/3 Characterisation (medium)	As an operator of one of several North Sea Gravity Based concrete Structures (GBS), the substructure is an OSPAR 98/3 derogation candidate. There is currently no standardised approach to Environmental Characterisation required under OSPAR 98/3, e.g. for the derogation application. The level of structure contents mapping, survey and sampling is not consistent across operators, or across the OSPAR membership. The level of characterisation required will be based on what the structure contains, however, not all operators are starting with the same data or information. The research could review what accuracy is needed, what are specimens vs. samples and how is characterisation representative under Best Available Techniques (BAT). A clearer definition of BAT under OSPAR 98/3, primarily addressing how full/complete/representative characterisation can be achieved would be a key aim.
Decommissioning (short)	Allowing for smoother decommissioning.
Drill cuttings management (short)	Studies into drill cuttings pile management in recent years have concluded that leaving the piles in situ to degrade naturally is generally the best option. However, disturbance during decommissioning may be unavoidable and there is therefore a need to better understand the options available to manage drill cuttings during decommissioning and how they could impact the environment.
eDNA Sampling (short)	Development of Best Available Techniques for eDNA sampling – there are presently a number of different ways to sample eDNA and the results from the different sampling techniques can be quite different. The sampling may be from sediment, water column or structures so all three need consideration. BAT for analysis of data would also be helpful.
eDNA database (medium)	Gap analysis to identify any UKCS or invasive species not presently represented in the eDNA database. This may also help other marine space users.
eDNA ecosystem management (medium)	Can eDNA be adopted to inform planning in a holistic ecosystem management process that addresses multiple users of the marine space.
Produced Water (medium)	The present models utilised in produced water ecotoxicity assessments have not been properly validated against in-situ data. Developing a cost-effective sampling technique for this may also help with assessments of ecotoxicity impacts if drill cuttings are disturbed.
Pipeline monitoring (medium)	Need a tool that allows assessment of metals in pipes to manage risk post decommissioning. This relates to the contents of the pipes, and residual metal content from treatments.

3.2 Net Zero Production

As may be expected the needs identified in net zero production support the pathways identified by the OGUK Pathway to a Net-Zero Basin: Production Emissions Targets Report 2020. It is noted that some respondents categorised CCS activities as net zero production rather than energy transition.

Title (horizon)	Description
UKCS Basin & Field Carbon Footprint Assessment (short)	A UKCS Basin & Field Carbon Footprint Assessment could be conducted to review and quantify hot spots for CO2 emissions (including Methane CO2e). A similar approach the Strategic Environmental Assessment (SEAs) could be taken to scope cumulative and in combination emissions. The results could then be filtered by field and operator to development consistent KPIs and measures for reduced emissions. This would align to the OGUK Net Zero UKCS basis by 2050
Distributed Electrical Systems (short)	Develop the technology and operating methods for integrating the electrical supply and demand between offshore installations which have differing electrical specifications and operating modes (voltage, frequency, loads, etc.).
UKCS Ornithological Survey (short)	Offshore wind permitting relies upon long duration ornithological surveys which hamper the permitting process. Survey of the whole basin would significantly reduce the duration from project sanction to first power from offshore wind assets.
Offshore wind for net zero (medium)	Is there a way to expedite the licensing of wind farms through the adoption of innovative survey techniques?
Achieving net zero for aging assets in production (medium)	aging assets producing in the North Sea may potentially have limited scope due to age, space, economics and infrastructure limitations to move towards more energy efficient equipment, or end of pipe technologies. Research into how this impasse can be resolved in consideration of the life cycle element of production, COP to decom.
Decarbonising Production & Processing Operations (medium)	Identification of BAT options available for reducing emissions produced during existing oil and gas processing plant and production operations. Cost/benefit analysis information for implementation and retrospective implementation.
Quantification of Methane emissions (short)	There needs to be a better understanding and quantification of methane emissions arising from oil and gas operations. Currently general calculated assumptions are used relating to flare efficiency, venting and fugitives. This is highly inaccurate and does not provide the baseline required to allow operators to target methane reduction opportunities.
Fugitive Emissions (short)	Fugitive emissions remain a challenge. Can research provide an environmental emission monitoring solution at national scale.
Nature-based solutions (long)	Carbon storage in nature-based solutions and climate smart agriculture could play a significant role in achieving the Paris COP objectives of limiting global warming to <1.5°. Significant uncertainty in the data and analysis of these potentials must be addressed for their successful deployment.

Legacy well bores for CCS (long)	Legacy well risks lead to the exclusion of many CCS candidates. Improved methods are needed for diagnosis of plug/isolation status using remote geophysics and early identification of CO2 and brine leakage. Cost-effective techniques for resealing legacy wells are also needed.
CO2 behaviour in depleted gas fields (medium)	CO2 injection into depleted gas reservoirs creates an evaporation front within the reservoir which is challenging to simulate. Further modelling work is needed in this area to understand the underlying physics which also requires validation from laboratory measurements on core samples.
Subsea venting of CO2 (long)	In order to conduct integrity testing of subsea tree valves, it would be desirable to vent small volumes of CO2 locally. To inform the design of such a vent, understanding of the environmental impact of venting such volumes of CO2 at the seabed and potential fouling of the vent by biological/chemical means is needed.
Deeper understanding of North Sea storage capacity (medium)	While some research has already been undertaken with the objective of quantifying the carbon storage capacity of the North Sea, next level screening including geology, well-plumbing, etc. is needed to further appraise potential storage locations.

3.3 Energy Transition

Title (horizon)	Description
Assessment of Reuse Options for Offshore Platforms (medium)	Environmental engineering assessment of each live / current UKCS installation which by using a Best Available Techniques and Waste Hierarchy approach assess re-use options for each offshore platform (using a risk based or EIA approach for each option). This standardised assessment could be used by each operator during the DP and EA generation. Further it could form a valuable source of data for a Comparative Assessment or from the opposite side of the process, repurposing of old assets to become hydrogen generators, CCU sequestration hubs or locations for wind turbines etc.
Decarbonising Fuel Gas (medium)	Decarbonising fuel gas by generating green hydrogen using renewable energy generated local to offshore installations can be the first step towards repurposing offshore installations for green hydrogen generation.
Ambient Air Quality Monitoring (long)	Deploy low cost instruments offshore which can continuously gather ambient air quality data in the North Sea.
Revisit CO2 stored (medium)	CO2 stored provided a good initial description of the UKCS capacity for CO2 storage. There is potential to extend the study to help inform cost reductions in storage CAPEX by considering the economics of the highlighted storage capacity.
CO2 Storage integrity (medium)	There is a need to improve the understanding of well integrity in relation to CO2 storage. Historic wells are considered high risk and monitoring requirements could be very expensive, therefore an improved understanding is required.

Storage Assessment (medium)	It is suggested that research could be undertaken on individual reservoirs to a pre-competitive space, this would risk to all parties in delivering commercial scale CCS.
Reservoir behaviour (medium)	There is a need to better understand reservoir behaviour. This is of particular importance to understand CO2 behaviour with multiple injection points. Smart sensors for reservoir monitoring and management are needed.
System approach to CCS (medium)	Little work has been undertaken to look at variable streams from carbon capture, the phase behaviour in pipelines and the injection characteristics. Connecting production, transport and storage could be critical to an efficient system.
Green hydrogen (short)	Improve electrolysis capability to allow UK to become world leader in green hydrogen.

4. Industry Themes

An analysis of the needs submitted revealed a number of themes and these are discussed below. In addition to the technical themes identified, there also seems to be some degree of uncertainty in the regulatory framework and interpretation of Best Available Technique (BAT).

4.1 Quantification of Emissions

Three needs were identified that suggested a greater understanding of offshore emissions would help to inform actions to achieve Net Zero production. The efficacy of the Environmental and Emissions Monitoring System is being considered in an IPOG project led by Leeds University. The project utilised a National Centre for Atmospheric Science aircraft to measure emissions around a number of installations (to gain a holistic view of a platforms emissions) and is comparing these top down estimates to the bottom up estimates derived from the EEMS methodology. BEIS is a partner in this project, and one of the objectives is to determine whether the aircraft approach could offer a cost-effective way of monitoring emissions on the UKCS. Leeds University will prepare a report for OGUK by the end of 2020 to disseminate the findings of the project.

In addition to atmospheric emissions, fugitive subsea emissions also need consideration. IPOG funded a project to develop a methane sensor that is deployable on a micro-AUV (EcoSub). This type of sensor/platform combination offers a low solution to identify subsea emissions and potentially pin point leaks. The sensor was developed to a low TRL but during the course of the project an additional methodology was developed, which offers significant promise in detecting multiple gases and overcoming a number of challenges. This sensor is being funded via a Royal Academy of Engineering Fellowship. The original sensor will be deployed dockside at Southampton to demonstrate is capability, and further research funding is being sought.

Given the interest in emissions it would be useful to have a view of how many installations have quantitative sensors. This information could then be utilised to plan a network of IoT enabled sensors to allow emissions data to be effectively gathered and analysis to be efficiently undertaken.

Approaches to methane management, including measurement are included in United Nations Economic Commission For Europe (UNECE) Best Practice Guidance for Effective Methane Management in the Oil and Gas Sector Monitoring, Reporting and Verification (MRV) and Mitigation. This document refers to a number of initiatives to address methane which could be used to inform a UKCS strategy. It discusses the use of drones to provide top down estimates from individual assets and satellite basin scale estimates, which are particularly useful in identifying “super emitters”. Although these approaches do not directly identify specific sources of emissions, analytical tools are being developed that allow backtracking or mapping the distribution of emissions.

4.2 Best Available Techniques for emissions reduction

The needs submitted suggested a lack of evidence-based approaches to efficiently achieving reduction in emissions. The first theme of greater understanding of the emissions will be needed inform the BAT. A

range of approaches are offered in the marketplace, but an objective cost benefit analysis for implementation and retrospective implementation within the life cycle of production, COP to decommissioning is needed.

Given some of the constraints on historical infrastructure there may also be a need to undertake carbon offsetting. A greater understanding of the benefits of nature-based solutions is required prior to successful deployment.

4.3 Platform / Regional Electrification

To enable interconnection of platforms research is required to overcome challenges associated with differing electrical specifications (voltage, frequency, loads, etc). There is potential for cross sector learning, with knowledge of how to create resilient local grids being developed to support local grid infrastructure. Identification of candidate platforms and associated electrical specifications is recommended to undertake a pilot study.

The use of offshore wind to provide clean energy to platforms was highlighted. Long lead times to permit offshore wind have been identified as a potential block to its adoption to support decarbonisation. Bird surveys have been the subject of considerable research by the offshore wind farm community. The Carbon Trust has supported a number of projects in this area including a bird collision avoidance study which demonstrated that impacts on birds was less than originally expected. NERC recently funded a project under their innovative monitoring call to improve bird collision modelling.

The Carbon Trust presently has an open tender entitled Offshore Renewables Joint Industry Programme (ORJIP): Further development of Marine Scotland's seabird sensitivity mapping tool aimed at better informing the relative importance of a location for individual seabird species and species groups; the likelihood that the birds are from a special protection area and their sensitivity to offshore wind farm developments. Given the ambitions to scale offshore wind it is likely that this tool will help to expedite ornithological surveys to reduce lead time for offshore wind consenting. It may be possible to use existing infrastructure to help expedite bird surveys through the use of radar technologies.

More broadly innovative survey techniques to expedite environmental impact assessments should also be considered. This would also be beneficial to decommissioning and the offshore wind farm community and help them reach their UKCS 40GW target and ensure the pipeline of projects is delivered expediently.

4.4 Decommissioning

NERC is supporting the InSite programme through the provision of £5M funding. The needs identified in this exercise are not being addressed by InSite but will be communicated to the InSite programme team. The main need relates to interpretation of OSPAR98/3 and Best Available Techniques; therefore, involvement of the regulator would be essential.

Other needs related to innovative monitoring or sampling techniques, with respect to species utilising structures (eDNA), drill cuttings management and pipeline contents.

4.5 Carbon Capture and Storage

Although broad scale assessments of UKCS CO2 storage capacity has been undertaken, it is apparent that further work is needed to identify the most cost-effective solutions, and to confirm the broad scale assessments agree with reservoir scale assessments. It would appear some research is needed to inform policy:

- A clearer view of the CCS market that would enable a pipeline of CCS projects to be developed would provide confidence to the market.
- One potential solution that would need to be policy led is working reservoir data to pre-commercial levels to allow industry to take forward reservoirs with confidence. This would involve commissioning reservoir analysis, and potentially data acquisition, to provide a more detailed characterisation of the reservoir for CCS purposes.

Technical challenges remain which include: an improved understanding of the storage capacity characteristics of candidate reservoirs; legacy well integrity, systems engineering from capture, transport to injection; and reservoir behaviour including geomechanics.

IPOG funded a project that applied analysis of micro-seismic monitoring from fibre optic data acquisition systems to consider reservoir behaviour during hydraulic fracturing. This technology is now being applied to CCS with research support from the Accelerating CCS Technologies[1] (ACT) ERANET Cofund within the DigiMon project, which aims to develop and demonstrate an affordable, flexible, and intelligent digital monitoring early-warning system, for monitoring any CO2 storage reservoir and subsurface barrier system receiving captured CO2.

4.6 Renewable Energy

The development of green hydrogen using offshore wind was identified as a means to remove fuel gas from platforms and also as a stepping stone towards commercialisation of green hydrogen through repurposing platforms.

The Oil and Gas Authority has been considering the UKCS as an energy source using a mixture of carbon-based fuels, hydrogen, offshore wind and marine renewables. Consideration of all existing platforms and their potential reuse for renewable energy could help companies with respect to decommissioning options, and moving carbon intense platforms with low production towards decommissioning.

[1] **About ACT**
The ambition of ACT is to facilitate the emergence of CCUS via transnational funding aimed at accelerating and maturing CCUS technology through targeted innovation and research activities. ACT is an international initiative to facilitate RD&D and innovation within CO2 capture, transport, utilisation and storage (CCUS). Sixteen countries, regions and provinces are working together in ACT with the ambition to fund world class RD&D innovation that can lead to safe and cost effective CCUS technology. ACT is an ERA NET Cofund, which is a tool established by the European Commission under the Horizon 2020 programme for research and innovation. The UK member of ACTI is BEIS

5. Placing Industry Themes in a NERC Context

The diagram below seeks to highlight how the industry themes fit within the NERC context outlined in Section 1. It is worth noting that several needs are common to users of the marine space, and benefits could be derived for other users.

Table 1 Industry themes mapped to NERC context

Industry Theme	**NERC Context**		
	Sustainability	Application of economic models to determine benefits to the environment and economy	Environmental Research and Innovation
Quantification of emissions	■		■
BAT for emission reduction		■	
Platform / regional electrification	■	■	
Decommissioning		■	■
Carbon Capture and Storage	■	■	■
Renewable Energy	■		

Table 2 Industry themes mapped to NERC delivery plan

Industry Theme	**NERC Delivery Plan**			
	Productive environment	Healthy environment	Resilient environment	Digital environment
Quantification of emissions		■	■	■
BAT for emission reduction		■		■
Platform / regional electrification	■	■		
Decommissioning	■	■	■	■
Carbon Capture and Storage	■	■	■	■
Renewable Energy	■	■		

Notes

1. The digital environment in this context may relate to a real time monitoring network, use of machine learning and analytics, combining environmental data with economic data, etc.
2. NERC also has a goal to deliver the best environment for research and innovation through engagement with business, NGOs and policy makers.