Assessing the impact of NERC research funding on the development of UK offshore wind

Final Summary Report

23 June 2025

Natural Environment Research Council

Human Economics

To what extent has NERC-funded research supported the development of the UK offshore wind sector? Can we put an economic value on this contribution?

Human Economics

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Report Final Summary Report

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Abbreviations

BCR	Benefit Cost Ratio
BGS	British Geological Survey
CBA	Cost-Benefit Analysis
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CES	Crown Estate Scotland
DEFRA	Department for Environment, Food and Rural Affairs
DESNZ	Department for Energy Security and Net Zero
EIA	Environmental Impact Assessment
EPSRC	Engineering and Physical Sciences Research Council
FEED	Front End Engineering and Design
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GW	Gigawatt
GVA	Gross Value Added
HE	Human Economics
HMC	Howell Marine Consulting
IRO	Independent Research Organisation
MDE	Marine Data Exchange
MNG	Marine Net Gain
MPA	Marine Protected Area
MRE	Marine renewable energy
MW	Megawatt
NERC	Natural Environment Research Council
NC	National Capability
NOC	National Oceanography Centre
NCP	National Capability Provider
OBR	Office of Budget Responsibility
ORE	Offshore Renewable Energy
OW	Offshore Wind
OWDS	Offshore Wind Directorate Scotland
OWF	Offshore Wind Farm
POLCOMS	Proudman Oceanographic Laboratory Coastal Ocean Modelling System
PML	Plymouth Marine Laboratory
SMRU	Sea Mammal Research Unit
SNCB	Statutory Nature Conservation Body
TCE	The Crown Estate
TGN	Tide Gauge Network
UKCEH	UK Centre for Ecology and Hydrology

Executive Summary

Introduction

The UK is a world-leader in offshore wind (OW), ranking second only to China for capacity installed and in the pipeline. The industry has developed rapidly since the UK's first demonstration offshore wind farm (OWF) was installed in 2000. The UK today has over 40 operational OWFs, generating enough electricity to meet the needs of half of all UK households.

Part of this success story has been the research funding provided by the Natural Environment Research Council (NERC), part of UK Research and Innovation (UKRI). NERC is the UK's main funder of environmental science, investing more than £330m annually in research, training and innovation. As part of this, NERC has been funding long-term National Capability (NC) to support world-leading environmental science at national and decadal scales at specialist National Capability Providers (NCPs).

The purpose of this study was to understand how NERC research at specific NCPs has supported the development of the UK's OW industry to date, and to put an economic value on this contribution where possible. Human Economics, in association with Howell Marine Consulting, was commissioned to undertake this study.

Approach

On NERC's direction, the study focused on five NCPs that NERC had identified as impacting the OW industry:

- The British Geological Survey (BGS),
- The Plymouth Marine Laboratory (PML),
- The UK Centre for Ecology and Hydrology (UKCEH),
- The National Oceanography Centre (NOC), and
- The Sea Mammal Research Unit (SMRU).

The study was conducted over a short, four-month timeframe, necessitating a reliance on secondary data sources and stakeholder interviews. The study comprised case study reviews of each of the five NCPs, comprising desk-based research and interviews with key personnel. Routes to impact were identified and tested via interviews with sector stakeholders. Bottom-up and top-down approaches were used to quantify and value the identified impacts where possible, providing confidence in the results. Full details on our approach and calculations can be found in our accompanying Technical Report.

Findings

This study has shown that NERC-funded data, research, monitoring and modelling at the five NCPs have become embedded within the OW industry and are central to the OWF development process:

- **BGS**'s detailed mapping and understanding of the UK's seabed geology is the primary data source used by all stakeholders in the initial stages of wind farm development: from government bodies identifying and prioritising potential areas to be made available for lease, to developers determining which sites to bid for and what to bid for them.

- **UKCEH** and **SMRU**'s long-term seabird and seal population datasets are crucial in modelling the potential adverse environmental impacts from OW developments and determining appropriate mitigations. Their data and models are used by government bodies to guide area selection, by developers when designing their projects and mitigations, and by Statutory Nature Conservation Bodies (SNCBs) to inform their guidance on consent conditions and when inputting into consent decisions.
- **NOC**'s ocean and tidal models enable and underpin almost all OW planning and operational activities: from determining appropriate monopile heights, structures and construction methods; to guiding operation and maintenance windows.

PML's ocean front mapping using satellite data has been used to identify sites of significant ocean biodiversity, informing the creation of Marine Protected Areas (MPAs) and guiding government stakeholders in lease area identification and consent decisions.

The five NCPs produce scientific outputs and expertise that feed into 11 of the 12 stages in the OWF development process. These outputs have enabled the industry to develop faster and at lower levels of cost and risk than would otherwise have been the case. They have enabled industry efficiencies by reducing cost overlaps, de-risking early-stage investment decisions, facilitating OWF design and cable routing, and enabling more efficient maritime activities. At the same time, they have also improved the consideration of environmental receptors within the OW development process and improved mitigations. NERC NC funding has thus supported major policy areas including energy security, net zero, the safeguarding of the UK's marine natural capital assets, as well as economic growth, job creation and the development of the green economy.

Conservative assumptions suggest that:

- Since 2000, in the order of c. £3.3bn of economic value in the OW industry could be attributed to the five NCPs (range: £1bn-£5.5bn) – a 23 times return on investment compared to the £140m of NC funding provided over this period (in present value terms). The actual value generated is likely to be significantly greater. NC funding has also enabled the NCPs to help safeguard the UK's £211bn marine natural capital assets.
- Over the next 25 years, a further c. £3.6bn in economic value in the OW industry could be attributed to the five NCPs (range: £1bn-£6.1bn), based on projected future OWF development.

Discussion

Quantifying and valuing the impacts of the five NCPs within the constraints of this study has been challenging. This is more reflective of the increasing complexity and changing processes within the OW industry than the specifics of the NCPs. Rather than becoming quicker and simpler over time, the OWF development process has instead been getting longer, more expensive and more challenging to navigate, driven by the increasing scale of OWF developments and a lack of regulatory clarity regarding acceptable environmental impacts and site-specific issues. Stakeholders were thus unable to distinguish and separately estimate the potential scale of impacts of each of the NCPs from the wider noise and challenges across the sector.

Valuation of impacts therefore relied on conservative extrapolations and judgement-based attribution, in accordance with Green Book guidance. The resulting estimates should be treated both as indicative and as providing a likely lower bound only. Actual impacts are likely to be significantly greater.

Better tracking at each NCP of the scale and nature of the users of their research outputs, and of how they choose to allocate NC funding across their various research programmes, would nonetheless aid future valuation work. Adopting a site-specific case study approach that considers how a specific NCP might have affected a specific OWF development could be another approach, as could be the use of stated preference techniques, for example contingent valuation, to assess stakeholder willingness to pay for key NCP services.

Acknowledgements

The Human Economics team would like to place on record our gratitude to Fiona Goff, Joseph Moran and colleagues at NERC and UKRI for their support on this study, as well as the staff at the five NCPs who so willingly participated and the industry stakeholders who graciously provided their time.

NERC funding has played a crucial role in the rapid development of the UK offshore wind sector over the last 25 years

Since 2000, NERC has provided c£140m to support offshore wind-related research at five NCPs

These five NCPs have generated

c£3.3bn

in economic value for the sector

x23 ROI

return on investment

Science from five NERC-funded National Capability Providers is embedded in the offshore wind farm development process, enabling them to proceed **faster and at lower levels of cost and risk**

60 YEARS+

NERC has been funding environmental monitoring, modelling, innovation and training, creating national scientific capability and high-value, long-term datasets

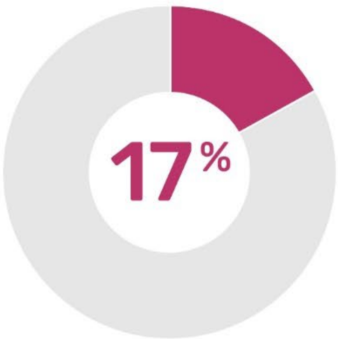
NERC funding has also helped safeguard the UK's marine natural capital assets, worth

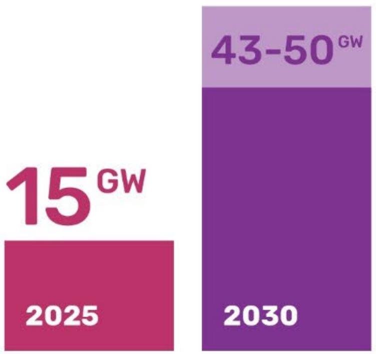
£211bn

Potential future economic value that could arise from the five NCPs by 2050

+£3.6bn

In 2024 offshore wind provided 17% of UK electricity. The government is targeting a trebling in capacity by 2030





By 2030, the number of jobs in the sector is expected to grow from 30,000 to 100,000

As of 2025, the UK has the 2nd largest offshore wind capacity in the world

Science from five NERC-funded National Capability Providers is embedded in the UK offshore wind journey

All site location decisions are underpinned by the maps, models and insight of **BGS**, and informed by the environmental work of **SMRU**, **UKCEH** and **PML**

Almost all consent decisions are informed by the work of **SMRU** and **UKCEH**

Most offshore wind farm operations, servicing and maintenance activities are informed by the tidal and ocean models developed by **NOC**

11/12

11 of the 12 stages of the offshore wind development process are informed by science from five NERC-funded NCPs

	BGS	NOC	SMRU	UKCEH	PML
1. Marine strategy development	✓	✓	✓	✓	✓
2. Identification of wind farm lease areas	✓	✓	✓	✓	
3. Screening and review of potential lease areas	✓	✓	✓	✓	
4. Bidding & lease agree-ments for land use rights	✓	✓			
5. Development proposal and consenting	✓	✓	✓	✓	✓
6. Site design and engineering	✓	✓	✓	✓	
7. Granting of consent			✓	✓	
8. Electricity connections, licenses and CfDs					
9. Pre-construction mitigation			✓	✓	
10. Construction		✓	✓	✓	
11. Operation and maintenance		✓	✓	✓	
12. Decommissioning		✓	✓	✓	

BGS
British Geological Survey

BGS's maps, modelling and understanding provide the **primary data source** used by **all stakeholders** in the initial stages of wind farm development

SMRU
Sea Mammal Research Unit

UKCEH
UK Centre for Ecology & Hydrology

The long-term seal and seabird population datasets of SMRU and UKCEH are **central to understanding the potential adverse impacts from offshore wind** developments on key environmental receptors and determining appropriate mitigations

NOC
National Oceanography Centre

NOC's models **enable almost all offshore wind planning and operational activities**: from determining appropriate monopile heights and construction methods, to guiding operation and maintenance windows

PML
Plymouth Marine Laboratory

PML's ocean front mapping (using satellite data) has been used to identify areas of significant biodiversity, informing the creation of Marine Protection Areas where development is not permitted

1 Introduction, purpose and methodology

1.1 Introduction

The UK has an expansive marine area that is highly suited to OW development, with a large coastline surrounded by a relatively shallow continental shelf - ideal for fixed wind turbines - and with the largest wind resource in Europe.[1] Since the UK's first demonstration wind farm 25 years ago, the UK has been able to harness these natural assets to become a world-leader in OW; today the UK ranks second only to China in terms of capacity installed and in pipeline.[2,3] As of the end of 2024, the UK had 45 operational OWFs, providing 17% of total UK electricity, 50% of the electricity needs of UK households and supporting more than 30,000 jobs.[4,5] Looking ahead, the UK Government is targeting a trebling in current OW capacity to 43-50GW by 2030, potentially creating up to 70,000 additional jobs across the country.[6]

Research funding provided by the Natural Environment Research Council (NERC), part of UK Research and Innovation (UKRI), has been an important factor in the development of this industry. For more than 60 years, NERC has been funding long term National Capability (NC) to support environmental monitoring and modelling programmes at ten National Capability Providers (NCPs), enabling the development of research platforms, science infrastructures, complex data models and high-value, long-term datasets.

NERC-funded research at these NCPs has become increasingly valuable to the OW industry. This report explores the ways in which NERC has impacted the industry via its funding of specific NCPs, and the extent to which value can be attributed to these impacts. This report is accompanied by a more detailed Technical Report.

1.2 Scope

Human Economics (HE), in association with Howell Marine Consulting (HMC), was commissioned by the Natural Environment Research Council (NERC) to review the impact of NERC-funded research on the development of the UK offshore wind sector.

The project was conducted over a short, four-month timeframe, necessitating a reliance on secondary data sources and high-level sector consultation. Given these constraints, the aims of the project were: (1) to identify *how* NERC-funded research might have enabled the sector to develop, and (2) to develop indicative estimates of the potential broad order of magnitude of benefits that these impacts might have generated where possible.

The scope of the project focused on determining the impacts arising from the work of five NCPs NERC thought most likely to have affected sector development: the British Geological Survey (BGS), the Plymouth Marine Laboratory (PML), the UK Centre for Ecology and Hydrology (UKCEH), the National Oceanography Centre (NOC), and the Sea Mammal Research Unit (SMRU). NERC selected these five NCPs following an earlier review of a series of impact case studies prepared by NERC-funded organisations.

1 Harnessing offshore wind – UKRI
2 UK Wind Energy Database, UK Wind energy database (UKWED) | RenewableUK
3 EnergyPulse Insights: Offshore Wind February 2025: PowerPoint Presentation
4 Clean Power 2030 Action Plan,
5 RenewableUK: Offshore wind | RenewableUK
6 Offshore Wind Industry Council Over 100,000 offshore wind jobs by 2030 with decisive action on skills

1.3 Approach and methodology

The study involved a short-timeframe exploration of the impacts of five NERC-funded NCPs on the OW industry. The study comprised case study reviews of each of the five NCPs, comprising desk-based research and interviews with key personnel, leading to the development of logic models setting out how NCP could have affected the OW sector's development. This work was conducted alongside a literature review and secondary data gathering to chart the development of the OW industry, within which impacts would be arising.

Routes to impact were then tested via stakeholder consultation. Different stakeholder groups were included, covering a cross-section of the OW development process, and engaged via semi-structured interviews. Sixteen consultations were completed, with the interviews designed to test developed logic models, to confirm (or reject) our identified routes to impact, and to collect views on the potential scale of benefits where possible. Given the limited sample size the consultations provided indicative views only, rather than more robust, representative evidence. See Annex A for the list of consultees interviewed.

Bottom-up and top-down approaches were then used to quantify and value the identified impacts where possible, in line with accepted Green Book methodologies. Full details on our approach and calculations can be found in our accompanying Technical Report.

1.4 This report

This non-technical summary report sets out the key findings of our work and is structured as follows:

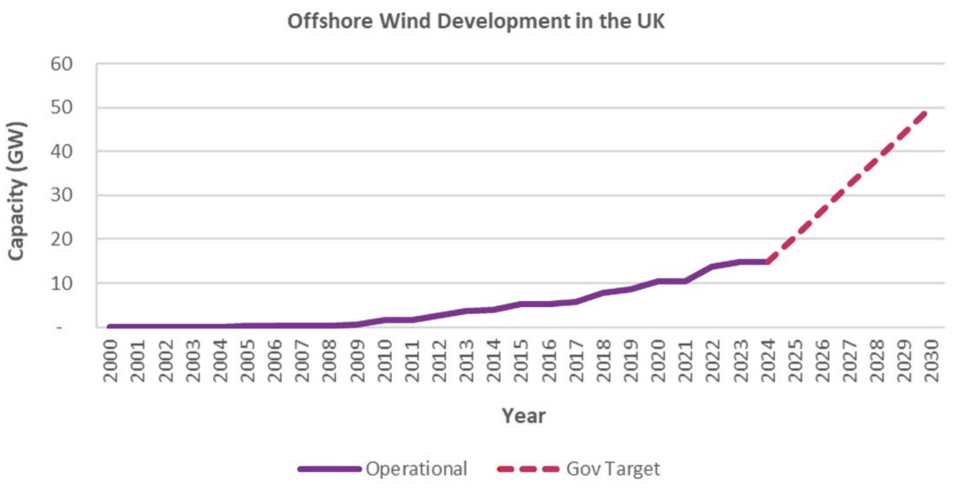
- Chapter 2 summarises the development of the UK offshore wind industry;
- Chapter 3 introduces the five NERC NCPs considered in this study;
- Chapter 4 discusses how these NCPs affect the OW industry;
- Chapter 5 presents our work to quantify and value the impacts of the NCPs on the OW industry;
- Chapter 6 concludes and provides a series of recommendations for how to improve measurement and bolster impact in the future.

2 How the UK offshore wind industry has developed

2.1 Scale and growth

Offshore wind as a means of electricity generation has developed rapidly in the UK. Since the first demonstration-scale offshore wind farm (OWF) was developed in 2000 off the Northumberland coast at Blyth, there are now 45 operational OWFs around the UK, providing a total capacity of 14.7GW[7] – equivalent to half the UK's domestic electricity needs and 17% of total UK generation.[8,9] The UK has ambitious targets to continue this growth. A further 16GW of offshore wind capacity have secured a Contract for Difference (CfD) agreement for supply of power but are not yet fully operational, and the UK Government is targeting 43-50GW by 2030.[10]

Figure 2–1: UK offshore wind farm capacity



Source: Human Economics analysis of i) UK Wind Energy Database, and ii) HM Government's Clean Power 2030 Action Plan (2024)

This growth has been driven by increasing scale, output and technical complexity:

- Output per turbine has increased five-fold from 2MW in 2000 to 10MW today, enabled by much larger towers and rotor blades. Overall rotor sizes have more than tripled from diameters of 66m in 2000 to over 220m today.[11]
- The average number of turbines per OWF has grown dramatically – from 30 in the early 2000s to over 150 at the largest operational OWFs today.[12]

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[7] UK Wind energy database (UKWED) | RenewableUK
[8] Clean Power 2030 Action Plan,
[9] RenewableUK: Offshore wind | RenewableUK
[10] Clean Power 2030 Action Plan: assets.publishing.service.gov.uk/media/677bc80399c93b7286a396d6/clean-power-2030-action-plan-main-report.pdf
[11] UK offshore wind history – Guide to an offshore wind farm
[12] Renewable UK, UK Wind Energy Database (link)

- With increases in both the number of turbines and the electricity that each can generate, the overall output per OWF has rocketed, from 30MW at the earliest commercial OWFs, to more than 1GW at recently commissioned sites, to the 4.1GW Berwick Bank wind farm currently working its way through consent.[13]
- Wind farm sites have also extended further offshore with the introduction of floating offshore wind farms becoming viable via anchoring technologies in water depths of more than 60 metres.

2.2 Key stages in the development process

The complexity of modern OWFs is reflected in the processes involved in their development. There are twelve separate stages involved in OWF development, operation and decommissioning, as summarised in Table 2-1.

Table 2-1: Summary of the key stages in OWF development

Source: Human Economics/Howell Marine

	Stage	Stakeholders involved	Process
Site identification	**1. Marine strategy development**	UK Government Marine Directorate Scotland	National governments are responsible for marine strategic planning, which enables the identification of possible lease areas. Sites are chosen to minimise environmental impacts by avoiding Marine Protection Areas and Special Protection Areas.
	2. Identification of wind farm lease areas	The Crown Estate (TCE) Offshore Wind Directorate Scotland (OWDS)	The OWDS in Scotland and TCE for the rest of the UK use their governments' marine strategic plans to identify / consider potential areas where wind farms could be developed. This process has evolved considerably over time, with TCE Rounds 1 and 2 characterised by developer-led site selection, whereas for Round 5 TCE has led on identifying and offering specific areas for development. In Scotland, most offshore wind leases were awarded as part of the SCOTWind lease round in 2022.
Site screening and bidding	**3. Screening and review of potential lease areas**	OW Developers and their consultants	Once announced, offshore wind developers will review and screen potential lease areas to determine their attractiveness for lease. This analysis is predominantly desk-based since all costs are at-risk prior to lease agreements being signed. External consultants will support developers in this process.
	4. Bidding and lease agreements	TCE, Crown Estate Scotland (CES) OW Developers	Following a bidding process, successful developers sign a land use lease from TCE or CES, triggering annual lease payments from the developer.
The consenting process	**5. Development proposal and consenting process**	OW Developers and their consultants SNCBs, TCE, CES	Once leases are signed, developers start to prepare their consent application. A key part of this process is the preparation of detailed Environmental Impact Assessments (EIAs) for each site, which assess how the development might impact key environmental receptors, including seabirds and sea mammals. The process often involves developers undertaking successive rounds of consultation with Statutory Nature Conservation Bodies (SNCBs), regulators, and TCE / CES, prior to submitting their application to maximise their chances of consent being issued.
	6. Site design and engineering	OW Developers and their consultants	As part of the consenting process, Front End Engineering and Design (FEED) studies are produced, setting out turbine size, wind farm layout, foundation type selection, and grid connection method. FEED studies are continually refined through the development process, ultimately supporting engineering and procurement decisions.

[13] Berwick Bank

	7. Granting of consent	UK Secretary of State Scottish Government's Energy Consents Unit	Applications for development consent are reviewed and granted (or denied) by the Scottish Government's Energy Consents Unit in Scotland and by the Secretary of State for the rest of the UK. Marine licenses may need to be granted.
Licensing	**8. Electricity Generation License, Grid Connection and Contracts for Difference**	OW Developers Gas & Electricity Markets Authority, Low Carbon Contracts Company, National Grid Electricity Transmission	An electricity generation license is required, and a grid connection must be secured. In addition, developers will usually seek to secure a guaranteed minimum price for the electricity they generate (i.e. a contract for difference, CfD) via public auction. Securing this CfD is typically required for the developer to achieve financial close.
Development	**9. Pre-construction mitigation measures**	OW Developers, their consultants and contractors	Environmental impact mitigation measures are put in place, such as bubble curtains and noise mitigation screens to reduce noise impacts on marine mammals.
	10. Construction	OW Developers, their consultants and contractors	The physical construction of the OWF begins, both on land and at sea, including foundations, turbines, array cables to the offshore substation, and export cables to the onshore substation for connection to the grid.
Oper ation	**11. Operation and maintenance**	OW Developers, their consultants and contractors	The OWF becomes operational, supported by planned maintenance and unplanned servicing in response to faults. Ongoing environmental monitoring is also undertaken.
Decommi ssioning	**12. Decommissioning**	OW Developers, their consultants and contractors	Sites are decommissioned at the end of their useful lives, involving the removal or making safe of the offshore infrastructure, pre- and post-decommissioning environmental surveys, and post-decommissioning site management.

2.3 Key changes in this process over time

2.3.1 Greater TCE involvement in site selection

The approach that TCE has adopted to successive leasing rounds has evolved over time.[14] Whereas rounds 1 and 2 were characterised by developer-led site selection, with developers approaching TCE with their suggested areas for development, TCE took a greater spatial planning role for rounds 3 and 4. For the current round 5, TCE has taken the lead in identifying suitable sites, utilising a range of geological, environmental and social data to identify sites, and offering these to market with baseline geological and environmental receptor data in place, reducing the need for developers to collect costly data of their own.

2.3.2 Increasingly complex consenting processes

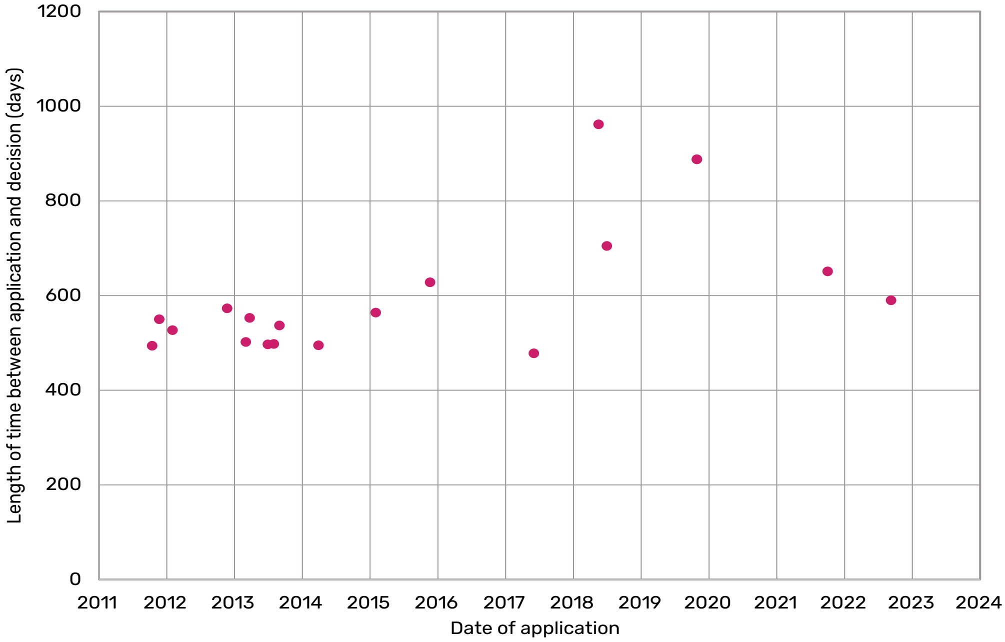
The process for obtaining consent has changed considerably over the last two decades. However, rather than becoming quicker, simpler and more efficient over time, the process has instead been getting longer, more expensive and more challenging to navigate, driven by a lack of consensus and clarity regarding how environmental impacts are considered, and the increasing size of OWF developments.

Scientific understanding of how OWFs might affect key environmental receptors (e.g. marine mammals, seabirds etc.) was relatively limited 25 years ago. Scientific understanding has since progressed rapidly, but consensus has not yet been achieved for all receptors – for example seabirds. This means regulatory clarity regarding what type or scale of seabird impacts might be acceptable does not exist, leaving developers to consult with SNCBs, regulators and other stakeholders on a site-by-site basis, to achieve a consensus view of impacts and appropriate mitigations. As developments have become ever larger and more complex, this has

[14] TCE manages the seabed and coastline of England, Wales and Northern Island. In 2017, responsibility for managing the Scottish seabed and coastline was devolved to the Crown Estate Scotland.

become a bigger issue, with developers needing to go through repeated rounds of consultation, often without reaching agreement. The impacts of this can be seen below in the variation, and the overall lengthening, of consenting timelines for OWFs submitted over time.[15]

Figure 2-2: Length of consenting process for OWFs in England & Wales



Source:
Human Economics' analysis of data from the National Infrastructure Planning Inspectorate

2.3.3 Marine net gain

The growth in the OW industry to date has occurred alongside an emerging and increasing awareness of the need to avoid and mitigate environmental impacts on natural capital assets. In June 2022 DEFRA launched a consultation on the Principles of Marine Net Gain (MNG), which would require marine environments to be left in a better condition post-development (though interventions to compensate for losses where necessary).[16] While this concept has not yet been taken forward into policy, it reflects the increasing shift towards stronger mitigation and compensatory requirements than was the case 15-20 years ago.

[15] National Infrastructure Planning Inspectorate database (link)
[16] Summary of responses - GOV.UK

3 The five NERC research organisations

3.1 Introduction

NERC is the UK's main funder of environmental science, investing more than £330m annually in research, training and innovation.[17] A central plank of this funding is NERC's provision of 'National Capability' (NC) funding, which has been designed to allow the UK to deliver world-leading environmental science at national and decadal scales via specialist research services and activities. Previous NERC analysis found that this funding at five NCPs in particular has supported the development of the UK OW sector. These are discussed in turn below.

3.2 The British Geological Survey

BGS's work focuses on understanding the UK's geology (i.e. its substructure, properties and processes) through systematic surveying, long-term monitoring, data management, and academic and applied research. Founded in 1835, the NERC research centre is the oldest national geological survey in the world.

BGS has an annual budget of around £55 million; roughly half of which comes from NERC NC funding. BGS's Marine Geoscience division is relatively small by comparison, receiving between £0.3 million and £0.6 million per year in NC funding over the past 7 years.

BGS supports the OW industry through its detailed mapping and understanding of the UK's seabed geology. Their maps, models and data products are often publicly available and provided free of charge. BGS also has a consulting arm that provides site-specific advice and insight as required.

3.3 The National Oceanography Centre

NOC is a world-leading oceanographic institution, performing research in large-scale oceanography and ocean measurement, from coast to deep ocean. NOC was formed in 1948 as the National Institute of Oceanography. It became part of NERC in 1965, before being spun-out to become a self-governed independent research organisation (IRO) in 2019. It is one of the largest oceanographic research institutions in the world.

NOC received total income of £86m in 2023/24, of which NERC NC funding came to about £34m. This funding supports a broad array of oceanographic models, data and research activities, NOC supports the OW industry through its understanding of tidal and ocean flows and systems. It makes most of its datasets and models freely available, many of which have been incorporated into portals hosted on other sites or run by other organisations.

[17] Who NERC is – UKRI

3.4 Sea Mammal Research Unit

SMRU was established by NERC in 1978 to fulfil the UK Government's obligations under the Conservation of Seals Act of 1970. The Act requires NERC to provide the UK Government with data and advice on the management and conservation of UK seal populations. SMRU receives about £0.7m in NC funding per year to discharge these obligations and support its long-term monitoring and research activities.

Under the 1970 Act (and the Marine (Scotland) Act 2010 in Scotland), it is an offence to intentionally or recklessly kill, injure or take a seal. As the UK's leading authority on seals, SMRU supports the OW industry by helping to ensure the industry conforms with the requirements of these Acts and supports developers to predict and quantify the potential impacts of their projects on seals.

SMRU's data and models are freely available but access to some data is controlled given the sensitive nature of the data. SMRU also has a consulting arm that works on specific projects.

3.5 The UK Centre for Ecology and Hydrology

UKCEH is an IRO focusing on environmental monitoring and modelling. It was created in 2000 through the merger of four NERC terrestrial and freshwater research organisations that had been monitoring and modelling environmental change for over 60 years. In 2019, the Centre became independent and was re-named the UK Centre for Ecology & Hydrology.

Although UKCEH's income totalled £60.5m in 2023, of which £20.4m was NERC NC funding, only its relatively small ornithological research group is of relevance to the OW sector, accounting for approximately £160,000 per year of this NC funding. This research group runs UKCEH's long-term seabird monitoring programme, centred on the Isle of May in the Firth of Forth in Scotland.[18] The programme has accumulated over 50 years of continuous monitoring data, making it one of the most thorough and comprehensive seabird monitoring programmes in the world.

UKCEH supports the UK OW industry by providing research, baseline data and advice on the impacts of OWFs on seabirds and advising on appropriate mitigations. Seabirds are important because Great Britain and Ireland host a quarter of Europe's breeding seabirds – almost eight million individuals across 25 species.[19] Legislation requires that marine developments must demonstrate consideration of their impacts on seabirds from Special Protection Areas (SPAs) to obtain consent.

As per BGS and NOC, the majority of UKCEH's NERC-funded research outputs are freely available without the need for users to register. UKCEH has a consulting arm that advises on specific projects.

3.6 The Plymouth Marine Laboratory

PML is a world-leading marine research institute focused on supporting a healthy and sustainable ocean. Formerly a NERC research centre, PML became an IRO in 2002.

PML receives about £3.3m per annum in NC funding from NERC, although relatively little of this funding supports research directly relevant to OW.

An area of PML work that has been of relevance to the UK OW industry has been through its work on ocean fronts. These are areas where coastal and deep-water ocean masses meet and mix, meaning they are often areas of increased biodiversity. Stakeholders have used this work to designate Marine Protected Areas (MPAs), protecting them from development.

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[18] The Isle of May Long-Term Study (IMLOTS).
[19] [Understanding the impacts of climate change on seabirds | BTO - British Trust for Ornithology]

4 How the research organisations affect the UK offshore wind industry

4.1 Impacts across the development cycle

Over the past quarter century, the five NERC NC-funded NCPs have played important roles in the UK's OW industry. Our analysis has also shown that **their work now feeds into eleven of the twelve stages in the OWF development process**, as shown below in Figure 4-1. Each NCP affects these stages differently:

- **BGS's detailed mapping and understanding of the UK's seabed geology is the primary data source used by all stakeholders in the initial stages of wind farm development**: from government bodies identifying and prioritising potential areas to be made available for lease; to developers determining which sites to bid for and what to bid for them, and deciding where to focus the fine-scale geological surveying that enables detailed site design and cable routing.
- **The long-term seal and seabird population datasets of SMRU and UKCEH are central to understanding the potential adverse environmental impacts from OW developments and determining appropriate mitigations**. The two NCPs are amongst the UK's primary environmental authorities on seals and seabirds – key receptors for OWFs – meaning their data and models are used by government bodies to guide area selection, by developers when designing their windfarms and considering potential mitigations, and by SNCBs and regulators to inform their guidance on consent conditions and when inputting into consent decisions. SMRU and UKCEH's data and advice further feeds into decisions around environmental monitoring and mitigations during construction, operation and decommissioning.
- **NOC's ocean and tidal models inform a broad variety of OW planning and operational activities**: from determining appropriate monopile heights, structures and construction methods; to guiding operation and maintenance windows.

PML's ocean front mapping from satellite data is used by government stakeholders to inform the creation of Marine Protected Areas (MPAs), feeding into lease area identification and consent decisions.

The extent of impacts across each stage of development reflects the extent to which key industry stakeholders rely on the work of the NCPs to inform and underpin key decisions:

- All site location decisions are underpinned by the work of BGS and informed to varying degrees by the environmental work of SMRU, UKCEH and PML, with operational considerations related to water depths and tide / wave heights based on the work of NOC.
- Almost all consent decisions are informed by the work of SMRU and UKCEH.
- Most seal monitoring and impact mitigation work is informed (and often undertaken) by SMRU.
- Most OWF operations, servicing and maintenance activities that are affected by water-depth are informed by the tidal and ocean models developed by NOC.

Figure 4-1: Summary of NERC Impacts across the OW Development Process

Source:
Human Economics/Howell Marine

	BGS	NOC	SMRU	UKCEH	PML
1 Marine strategy development	Seabed geology informs where OWFs could potentially be developed	Wind resource mapping informs areas suitable for development	Seal population data informs identification of MPAs	Seabird research informs identification of STAs	Ocean front modelling informs identification of MPAs
2 Identification of wind farm lease areas	Seabed geology enables suitable areas to be identified in detail	Tidal models inform water depth at possible sites	Seal data informs identification of potentially suitable areas	Seabird data informs identification of potentially suitable areas	
3 Screening and review of potential lease areas	Seabed geology enables developers to appraise potential sites	Tidal models enables developers to appraise water depth at potential sites	Seal data informs potential mitigation costs during construction and operation	Seabird data informs potential mitigation costs during construction and operation	
4 Bidding and lease agreements for land use rights	Seabed geology informs developer bids based on potential development costs	Tidal models enables informed developer bids based on potential development costs			
5 Development proposal and consenting	Seabed geology informs design and scope of fine-scale surveying for towers and cable routes	Data supports EIAs for assessing impacts on tidal currents and surrounding environment	Seal data and models inform EIAs, HRAs and Environmental Statements	Developed standard approach to test overlap of seabirds and OWFs. Informs EIAs and HRAs	Ocean front models inform predictions of seabird foraging used for EIAs
6 Site design and engineering	Seabed geology informs optimal OWF design, layout and anchoring	Tidal models inform engineering designs for sites, towers and turbines	Seal data informs potential mitigations needed for design and construction	Population tools allow testing of different OWF designs	
7 Granting of consent			Consent dependent on seal monitoring and impact mitigation plans	Consent dependent on seabird monitoring and impact mitigation plans	
8 Electricity connections, licenses and CfDs					
9 Pre-construction mitigation			Advice & data informs preconstruction monitoring and mitigation measures	Advice & data informs preconstruction monitoring and mitigation measures	
10 Construction		Tidal, wave & water depth data informs construction activity	Advice & data informs construction monitoring and mitigation measure	Advice & data informs preconstruction monitoring and mitigation measures	
11 Operation and maintenance		Tidal, wave and water depth data informs operation and maintenance windows	Advice and data informs ongoing monitoring and mitigation measures	Advice and data informs ongoing monitoring and mitigation measures	
12 Decommissioning		Tidal, wave & water depth data informs decommissioining activity	Seal monitoring pre, during & post decommissioning	Seabird monitoring pre, during & post decommissioning	

4.2 Routes to impact

The NCPs affect the industry via three main routes:

1. **Via their data and scientific research**: each NCP makes most of their data and models freely available for users, usually without requiring users to set up an account or sign-in.[20] NCP staff also produce research outputs, articles and conference papers that are published in journals or via other sources.
2. **Via paid consulting work**: BGS, SMRU and UKCEH all have consulting arms that advise on projects.
3. **Via third-party platforms**: Much of NOC's work on tides and water depths has become embedded into commonly utilised and freely available ocean tools, hosted on other sites or run by other organisations. Examples include the National Oceanographic Database (NODB) provided by the British Oceanographic Data Centre (part of NOC), and a wide range of ocean model datasets provided by the Met Office.

A common feature of the NCPs is that none are OWF-focused. Rather, each are specialists in their own geological and environmental fields – and have been for decades – and it is their accumulated knowledge, mapping and long-term datasets that the OW industry has been able to leverage to support its development.

Each NCP's historical research was developed separately from the OW industry, and without this new industry in mind. Nevertheless, their knowledge and understanding has been readily absorbed by the industry, often several years, if not decades, after the original research was funded. This is particularly the case for PML, whose work on ocean fronts is only tangentially relevant to the OW industry but nonetheless informs the creation of MPAs which feeds into TCE's work to identify potential sites for lease.

4.3 Impacts arising

The various impacts across the OWF development process were reviewed and prioritised with stakeholders, arriving at a final list of 18 impacts summarised in Table 4-1 on the next page. The majority of these were found to be economic impacts – for example resulting in reduced risks and costs for industry stakeholders – with the other four being environmental. The following section discusses our approach to valuing these impacts.

[20] The exception here is SMRU, given the sensitive nature of seal location data.

Table 4-1: Most important impacts of NERC NC funded research on OW industry

Source: Human Economics' analysis

NCP	Impact	Type of Impact	
		Economic	**Environmental**
BGS	Faster & better identification of site areas to be offered for lease	X	
BGS	Faster & better review and selection of site areas by developers	X	
BGS	Avoided developer costs through more targeted fine-scale surveying	X	
BGS	Faster & better-informed OWF design	X	
NOC	Avoided costs for developers not needing to model wave diffraction	X	
NOC	Better-informed OWF design	X	
NOC	Better-informed construction, operation and maintenance activities	X	
SMRU	Reduced costs for public & private sector to gather seal data	X	
SMRU	Faster & better-informed seal impact consultations and consent applications	X	
SMRU	Faster & better-informed consent decisions where seals are a factor	X	
SMRU	Reduced OWF impacts on sea mammals		X
UKCEH	Better-informed seabird impact consultations and consent applications	X	
UKCEH	Better-informed consent decisions where seabirds are a factor	X	
UKCEH	Reduced OWF impacts on seabirds		X
PML	More environmentally-aware identification of site areas to be offered for lease		X
PML	Better-informed OWF consent applications	X	
PML	Better-informed consent decisions	X	
PML	Reduced OWF impacts on marine ecosystems		X

5 Quantification and valuation of impacts

5.1 Introduction

One of the central aims of this study was to explore the extent to which the impacts of NERC's NC funding on the OW industry could be quantified and valued. The following analysis presents the results of this work from two perspectives:

1. A bottom-up analysis that looked at quantifying the individual impacts identified in Table 4-1,
2. A top-down analysis that considered the overall potential magnitude of impacts across the industry.

Where possible, the analysis considered impacts over two time periods:

- Realised impacts to date over the period 2000/01 – 2024/25, on the basis that the first offshore wind farm in the UK became operational in 2000, and
- Potential future impacts over the period from 2025/26 - 2049/50, to align with the UK Government's 2050 net zero ambition, for which offshore wind is a key enabler.

The assessments drew on publicly available reports and evaluations, supported by consultations with 19 industry stakeholders.

5.2 Bottom-up assessment of individual impacts

The bottom-up analysis revealed limited usable data. Data exists on the average costs of OWF development on a per MW basis, but little aggregate data exists on how long it takes an OWF to progress through the various development stages. Moreover, stakeholders were unwilling to provide quantitative estimates of the extent to which projects on average might have saved time or costs as a result of the work of the NCPs. This was due to:

- The long time-lags between research funding being provided, research outputs being generated, and those outputs being used by the industry,
- The lack of an 'average' OWF given the extent to which site-specific issues drive so many of the big decisions, as well as scale and technological issues, differing developer strategies etc., that left stakeholders unable to provide estimates of average impacts on an average OWF,
- The way in which the OWF development process has changed over time, making it hard to disentangle and separately identify the impacts of the NCPs, particularly within the context of ever-increasing technical complexity on the one hand and environmental awareness and scrutiny on the other.

As a result, while stakeholders generally agreed that the NCPs had mostly enabled the OWF development process either to proceed quicker or at lower cost, stakeholders emphasised that any such gains were occurring within a process that overall was getting longer, more expensive and much more complex.

5.2.1 Published analyses

The quantification and valuation of impacts therefore had to rely upon published analyses. Two such analyses were found:

1. An impact case study published by the University of St Andrews which identified how SMRU research enabled developers to avoid collecting their own data as part of the OWF EIA process.[21]
2. An impact case study from the NOC, identifying how their research had enabled developers to avoid conducting their own wave monitoring surveys.[22]

Cost savings arising from SMRU research

SMRU undertakes annual surveys of seal populations around the UK as part of its obligations to provide advice on UK seals. This data is made available to all stakeholders on request, enabling developers to avoid the cost of having to undertake their own baseline surveys. By avoiding the need for multiple developers to perform duplicated surveys, this provides an efficiency gain to the sector overall. An impact case study prepared by SMRU noted that SMRU's research had underpinned 16 EIAs of OWF and tidal marine projects between 2013-2020, representing 76% of UK OW capacity at the time, and estimated that this had saved developers £4.8m in avoided costs over the seven-year period.

Extrapolating from this data, we have estimated that SMRU research to date has enabled (and could continue to enable) an average saving of c.£275 in EIA costs per MW of capacity installed, equivalent to 3.4% of EIA costs. In present value terms this equates to:

- Total cost savings of £19.4m over the period 2000-2025, based on the development of OWFs to date,
- Potential future cost savings of £8.5m over the period 2025-2050, based on future OWF development.

Detail on how these estimates have been generated can be found in the accompanying Technical Report. However, the estimates should be treated with caution as the case study is based on a small sample size of OW projects over a limited period, and we have not been able to independently verify and validate the original calculation.

Cost savings arising from NOC research

The NOC case study focused on the NOC's work investigating the impact of offshore wind monopiles on constructive/destructive patterns of waves. By deploying its marine radar system, NOC found no evidence that monopile installation at the Scroby Sands OWF was affecting constructive/destructive wave patterns at Great Yarmouth beach. As a result, the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) advised that such monitoring would not be required for future OWFs. NOC estimated that removing this requirement saved developers a minimum of £100,000 per project (in 2020 prices)[23], assuming that similar radar technology would be used. This estimate is based on the cost of installing radar systems before, during and after wind farm construction to assess the impact on wave diffraction.

Extrapolating from this data by applying this cost saving to all UK OW projects since Scroby Sands was developed in 2005, we have estimated:

- Total cost savings of £18.3m in present value terms over the period 2000-2025,
- Potential future cost savings of £7.2m in present value terms over the period 2025-2050, based on projected future OWF development.

[21] University of St Andrews (2021). Enabling environmentally sustainable growth of the marine renewable energy industry.
[22] Evaluation of NERC Centres 2020, Impact Case Studies: National Oceanography Centre
[23] Paul Bell, NOC

However, as with the SMRU impact estimates, the resulting NOC impact estimates should be treated with caution, as it has not been possible to independently assess and verify the robustness of the cost savings reported in the case study.

5.2.2 Wider impacts

Combined, the above examples yield savings of £37.6m to date, with a further £15.7m of savings to come over the next 25 years (both in present value terms). These count for just two of the 18 impacts identified in Table 4-1. Following HM Treasury guidance that "every reasonable attempt should be made to quantify benefits,"[24] we developed this analysis further by considering the remaining impacts – initially on a qualitative basis. This involved a value-based judgement of the potential relative size of the impacts, based on:

- The extent of the impact, i.e. the proportion of OWF developments that might use this data or research;
- The scale of the impact, i.e. the potential importance of the impact in the development of an OWF.

Each impact was assigned a level – high, medium or low – for both their extent and their scale, based on qualitative feedback obtained through stakeholder consultations (see the accompanying technical report for further details). By combining the two we arrived at a view as to the overall magnitude of the impact in economic terms (level of costs saved / value created) and environmental terms (impact on natural capital outcomes), as shown in Table 5-1 on the following page.

As this table shows, the two quantified impacts above are both considered to be of medium economic magnitude. Of the other economic impacts:

- Three are rated high, so are likely to be of significantly greater magnitude than those quantified,
- Seven are rated medium, so are likely to be of comparable magnitude to those quantified.
- Two are rated low, so are likely to be of lower magnitude than those quantified.

As a lower bound, even if all 10 other 'medium' or 'high'-rated economic impacts were to be of similar scale to those quantified, this would suggest:

- **NERC-funded research generates benefits for the OW industry in excess of £320m in present value terms over the period 2000-2050**.
- **Compared against prudent estimates of £141m for the value of NERC NC-funding to the NCPs that has been of relevance to OW, this yields a benefit-cost ratio (BCR) of around 7.2.**

Such estimates should be treated both as indicative and as providing a lower bound estimate only. The calculation assumes that all medium and high impacts are of broadly similar values, whereas the high impacts arising from the work of BGS are likely to be many times greater.

5.3 Top-down assessment of overall industry impacts

Given the challenges faced in bottom-up estimation, we have also sought to assess the economic and environmental importance of each NCP at an industry-wide level. We did this by 1) considering the overall economic importance of the OW industry, and 2) using stakeholder feedback and desk-based research to estimate the extent to which overall economic value could reasonably be attributed to the work of each NCP. The assessment considered both economic impacts and impacts on the UK's marine natural capital accounts.

[24] Guide 6.to developing the Project Business Case: "Every reasonable attempt should be made to quantify benefits… Where quantification is particularly challenging…it may be acceptable to express a benefit in qualitative terms"

Table 5-1: Qualitative Review of Identified Impacts

NCP	Impact	Extent of Impact	Scale of Impact	Overall Economic Impact	Overall Environmental Impact
BGS	Faster & better identification of site areas to be offered for lease	High	High	High	
BGS	Faster & better review and selection of site areas by developers	High	High	High	
BGS	Avoided developer costs through more targeted fine-scale surveying	High	High	High	
BGS	Faster & better-informed OWF design	Low	Medium	Medium	
NOC	**Avoided costs for developers not needing to model wave diffraction**	**High**	**Low**	**Medium**	
NOC	Better-informed OWF design	Medium	Medium	Medium	
NOC	Better-informed construction, operation and maintenance activities	High	Medium	Medium	
SMRU	**Reduced costs for public & private sector to gather seal data**	**High**	**Low**	**Medium**	
SMRU	Faster & better-informed seal impact consultations and consent applications	High	Low	Medium	
SMRU	Faster & better-informed consent decisions where seals are a factor	High	Low	Medium	
SMRU	Reduced OWF impacts on sea mammals	High	Medium		High
UKCEH	Better-informed seabird impact consultations and consent applications	Medium	Medium	Medium	
UKCEH	Better-informed consent decisions where seabirds are a factor	Medium	Medium	Medium	
UKCEH	Reduced OWF impacts on seabirds	High	High		High
PML	More environmentally-aware identification of site areas to be offered for lease	High	High		High
PML	Better-informed OWF consent applications	Low	Low	Low	
PML	Better-informed consent decisions	Low	Low	Low	
PML	Reduced OWF impacts on marine ecosystems	High	Low		Medium

*Note: The two impacts that we have been able to quantify are shown in **Bold.***

5.3.1 Economic importance of the UK offshore wind industry

The OW industry has become an important source of economic growth for the UK over the last 20 years. The industry now employs over 32,000 workers and is estimated to contribute about £2-3bn in gross value added (GVA) per GW of offshore wind energy installed.[25,26] This GVA contribution is driven by the extent of UK content (i.e. the proportion of project expenditure being sourced through the domestic supply chain), which has increased substantially from c.32%[27] in 2017 to c.50%[28] today, and the UK now exports between £1-2bn a year in OW components and services.[29]

Based on work by the ORE Catapult, which estimated the potential GVA of OWFs per GW installed and made assumptions about the expected percentage of UK content that could be achieved over time, we developed both annual and cumulative profiles of potential industry GVA over the period from 2000-2050. This suggests:

- The development and operation of OWFs are currently generating around £10bn GVA per annum for the UK economy,
- The development and operation of OWFs to date has generated around £78bn for the UK economy, with a further £85bn expected to be generated over the period through to 2050 (in present value terms).

Since the vast majority of lifetime project expenditure typically occurs during the development and construction phases, most of the economic value created to date has occurred since the mid-2010s, since when there has been a marked increase in the number and scale of projects being developed.

5.3.2 Industry impact of BGS

BGS's understanding of seabed geology provides foundational data for the early to mid-stages of OWF development. Their datasets and models mean planners and developers start from a well-informed position, which not only reduces cost but crucially reduces risk – especially during the leasing stage when developers do not yet have development rights in place and all costs are at-risk. Suitable areas can be identified and appraised quicker, speeding up the process and reducing the need for detailed, costly offshore surveys. At the design stage, BGS's data enables fine-scale geotechnical surveys to be better targeted, which some interviewees thought could save developers in the order of £100,000 per day.

The availability and quality of BGS's data enables all parties to proceed with greater confidence, increasing competition and driving growth. Stakeholders noted the ubiquitous use of BGS data across the OW development process, describing the data as the "**best available source of data and evidence**" in relation to seabed geology, and that BGS provides the "**best available aggregation of geotechnical data in the UK**". In the case of Dogger Bank, some stakeholders thought BGS made the difference in the project going ahead.

A recent study commissioned by the UK Hydrographic Office (UKHO) suggested that 20-40% of the economic value arising from offshore energy could be attributable to fine-scale seabed mapping – the private sector mapping that is performed after leases have been signed.[30] Stakeholders interviewed as part of our study reported that BGS services were also of critical importance to the industry's economic value, but were unwilling or unable to estimate a broad percentage attribution. In the absence of better data, we have adopted a conservative but fair range estimate of 1%-5% of total OW industry value is attributable to the role, data and services of BGS.

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[25] OWIC - Offshore Wind Skills Intelligence Report (2023)
[26] ORE Catapult - The Economic Value of Offshore Wind (2017)
[27] ORE Catapult - The Economic Value of Offshore Wind (2017)
[28] Offshore Wind Industry Council & Offshore Wind Growth Partnership - UK Supply Chain Capability Analysis (2023)
[29] Office for National Statistics - Low Carbon and Renewable Energy Economy estimates
[30] UK_Seabed_Mapping_CBA_Final_Report_V5.1.pdf

Case Study Examples:

Dogger Bank

Dogger Bank is one of the world's largest OWFs, capable of generating up to 3.6GW of electricity for up to 6m homes. It is being developed in three phases, at a cost of £9bn.[31] More than 2,000 jobs are being created in the construction and operation of the project

BGS data and research has been instrumental in the development of Dogger Bank to date. Stakeholders noted that developers had invested significantly in initial site survey data, but the data was not showing the geological characteristics expected – putting turbine design, and fundamentally the economic viability of the project, at risk. BGS's services were engaged, reinterpreting the geophysical data and creating a geological ground model that allowed developers to proceed with design, secure financing and ultimately move forward with construction.

Dogger Bank A, the first of the wind farm's three phases, is now partially operational, with its first turbines generating electricity since October 2023 and commercial operations expected to follow in the second half of 2025. Commercial operations for Dogger Bank B are due to commence in 2026, followed by Dogger Bank C in 2027 and marking completion of the overall wind farm.

Offshore Wind Estate Leasing Round 5

The Crown Estate has recently evolved its OW site leasing process from the developer-led site selection process in early rounds to a TCE-led site selection basis using extensive modelling of geological, environmental and ecological data. In the current Round 5, sites for development of floating wind farms in the Celtic Seas were selected by TCE using a multi-stage design process whereby information regarding site conditions, including geological data from BGS, was used to identify the most suitable areas for development; rather than site identification occurring prior to site conditions being examined. This was performed to reduce 'wasted' and overlapping private sector investment, de-risking the site leasing process for developers by lowering barriers to entry for companies and resulting in increased competition for the sector. This is also intended to reduce site selection times and costs and speed up the overall development and consenting process for the sites; once again, improving competition in the sector and making domestic and foreign investors more likely to fund UK offshore wind.

This process has also been evolved to try and reduce the likelihood of failed site developments, making the UK a more attractive destination for investment. As part of Round 3, Centrica was awarded a lease to develop a 4.2GW site in the Irish Sea known as the Rhiannon Wind Farm. However, in 2014, the site was abandoned due to the discovery of unfavourable geological conditions on the seabed. This resulted in a write-off of £40m in Centrica's 2014 interim results[23]. For Round 5, a stakeholder noted that having BGS data available "is a great (and significant) first step in understanding the potential ground conditions that may be encountered on site and feed into early assumptions on foundation design and therefore potential installation costs".

[31] Our Energy Future is Switched on | SSE Renewables

5.3.3 Industry impact of SMRU

SMRU's seal population data, distribution maps, trend analysis and commissioned expertise is used at several stages across the OW development process including:

- At site identification and screening stage by marine planners and lessors;
- During the planning and consent stage, when SMRU data is often used by all parties: by developers to inform their applications, by SNCBs to consult on these applications, and by the UK Secretary of State and the Scottish Government's Energy Consents Unit when deciding whether to grant consent;
- And during construction, operation and decommissioning, when monitoring and mitigation activities are required.

SMRU thus enables industry efficiencies by avoiding the need for repeated seal surveys by developers, SNCBs and regulators. Their work reduces consenting risks for developers via the provision of clear and credible advice to both sides during consent decisions, improves outcomes for seals, and helps ensure conformity with the law.

Stakeholders were uniformly positive about the work of SMRU. It is seen as a centre of scientific excellence, producing "**world-leading research**". "**Independent, capable and well-regarded**," SMRU has a strong reputation for providing robust data, credible insights, and practical advice regarding consent conditions and seal impact mitigation measures and is "**very solutions-focused**".

However, although highly regarded by the industry, SMRU's contribution is likely to be less than BGS's. This is because seals are rarely a significant consenting risk. This means that whilst SMRU's work is clearly of significant value to the sector, it is rarely a determining factor. As a result, we have assumed a lower range of 0.1-0.5% of the economic value of the OW industry is attributable to the role, data and services of SMRU.

5.3.4 Industry impact of UKCEH

UKCEH's data and research on seabird population and behaviour informs baseline analysis, impact assessments, consent applications, monitoring and mitigation. The NCP has transformed how seabirds are tracked, developed models that test wind farm placement and size, and has recently completed the development of a Cumulative Effects Framework tool which will support the review and analysis of consent applications for OWF expansions and developments near existing sites. As per SMRU, UKCEH's data, models and advice are used across the same stages of the OWF development process and by all parties involved. Stakeholders noted that UKCEH's work is "**world class and world-leading**", and that UKCEH tracking data has been "**fundamental to decision making**". Stakeholders also noted their "**scientific credibility**" and "**independence versus other consultants**".

UKCEH's work is especially impactful for OW, given that ornithological issues account for six of the ten largest evidence gaps contributing to consenting delays; [32] seabird populations are protected through designated areas, including Special Protection Areas (SPAs) and Marine Protected Areas (MPAs), which restrict access to their habitats and require prospective developers to evidence the potential impact of their activities on the species. In Scotland, seabird related concerns have resulted in Judicial Reviews on several OWFs, resulting in consenting delays of upwards of two years. Unlike seals, and despite improvements in the science, consensus has not yet been achieved as to how seabirds are affected by OW, which is causing issues.

Stakeholders thus presented a more mixed view of the impact of UKCEH on industry development. Whilst UKCEH's work will have improved environmental outcomes – via an improving understanding of the impact of OWFs on seabirds, and how to mitigate these impacts, which is now central to securing consent – some stakeholders suggested that UKCEH's work may have increased consenting timelines, owing to the complexity of their models and their perceived precautionary approach.

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[32] Use of evidence and data in decision-making in offshore wind farm consenting, Offshore Wind Industry Council

As a result, we have assumed the same attribution range as for SMRU of 0.1-0.5%. This similar range seems reasonable since it balances the trade-off between UKCEH's work being more consequential for whether consent is secured, but this can both speed-up development time and reduce costs.

5.3.5 Industry impact of NOC

NOC is one of the foremost oceanographic research organisations in the world. However, its research is often one step removed from the OW sector; its data and models have been often incorporated into other platforms and portals prior to industry use, and there are significant time lags between research and industrial application. Nevertheless, its work underpins most maritime operations in the UK, and whether via water-depths, ocean current data or tidal models, it is likely that NOC's work underpins and enables many of the maritime operations associated with OW.

Interviews with the Scottish Government noted in our consultation that **'the work of NOC to help understand [ocean] stratification is crucial'**, and the current ECOWind-Accelerate programme highlighted that NERC's £7m of programme funding to NOC is being supported by more than £21m of in-kind data and support from OW industry partners who are keen to utilise the outputs of NOC's research. Stakeholders also pointed out that private consultancies often do not have the depth of modelling expertise, knowledge and computing power built up over years of research to generate the same **complexity of analysis** and that NOC research is therefore often preferred.

As a result, we have conservatively assumed that at least 0.1% of the economic value of the offshore wind industry could be attributed to NOC, with the true value likely to be significantly higher.

5.3.6 Industry impact of PML

PML's work inputs into site selection work impacts the creation of MPAs and thus helps protect marine natural capital. However, like NOC, this work is less visible to stakeholders – since their outputs have been incorporated into other tools before use by the sector – and their research has a more theoretical focus which is less applicable to OWF development. As a result, PML's impact is more likely to be environmental rather than economic. We have not attributed a proportion of the OW industry's economic value to PML.

5.3.7 Total top-down economic impact

Table 5-2 below shows the combined results of the top-down assessment. As noted in Section 5.3.1, the OW industry is estimated to have generated around £78bn for the UK economy to date. Based on our assessment of the industry impact of each NCP, we have further estimated that between £1.0bn - £5.5bn of industry GVA could be attributed to the value created by NERC NC-funding, equivalent to a BCR of between 7.2-1 and 39-1. The mid-point value from this range is considered to be a reasonable impact estimate, which suggests NERC NC funding has yielded in the order of £3.3bn of economic value for the UK OW industry compared to £140m in funding costs – i.e. a 23 times return on investment.

Each of the four NCPs to which we have attributed a value has yielded benefits in excess of their costs, with the overall results driven by the contribution of BGS.

Table 5-2: Summary of attribution of industry GVA to date

Source:
Human Economics analysis

NCP	PV of NERC NC Costs 2000-2025	Low Estimate Attribution of Industry GVA	Low estimate Attributed Value (£m)	Low Estimate Benefit Cost Ratio	High Estimate Attribution of Industry GVA	High Estimate Attributed Value (£m)	High Estimate Benefit Cost Ratio
BGS	19.0	1.0%	778	41.0	5.0%	3,889	205.2
SMRU	45.2	0.1%	78	1.7	1.0%	778	17.2
UKCEH	9.3	0.1%	78	8.4	1.0%	778	84.0
NOC	52.5	0.1%	78	1.5	0.1%	78	1.5
PML	15.5	0.0%[33]	-	-	0.0%	-	-
Total	**141.4**		**1,011**	**7.2**		**5,522**	**39.1**

Based on our assessment that the industry could potentially generate a further £85bn in economic value over the period through to 2050 (in present value terms), our analysis also suggests that a further £1.1bn – £6.1bn in industry GVA, over the next 25 years, could be attributed to the value created by NERC NC-funding, as summarised in Table 5-3 below. However, as this study has not considered the potential future NERC-NC funding that might enable these additional impacts, it has not been possible to calculate equivalent BCRs for this time horizon. Rather, the future impact estimates presented below broadly assume that historic NERC-NC funding is sustained over the long-term.

Table 5-3: Summary of attribution of potential future industry GVA

Source:
Human Economics analysis

RO	Low Estimate Attribution of Industry GVA	Low estimate Attributed Value (£m)	High Estimate Attribution of Industry GVA	High Estimate Attributed Value (£m)
BGS	1.0%	855	5.0%	4,273
SMRU	0.1%	85	1.0%	855
UKCEH	0.1%	85	1.0%	855
NOC	0.1%	85	0.1%	85
PML	0.0%[34]	-	0.0%	-
Total		**1,111**		**6,068**

5.3.8 Top-down environmental impact

This study has shown that NERC NC funding has improved not just economic outcomes, but environmental ones too. The UK Government's latest Marine Natural Capital Asset Assessment valued the UK's marine natural capital at £211bn.[35] While it is not possible to attribute a proportion of this value to the NCPs as has been done above for economic value, it can be argued that NERC NC-funded research in relation to the OW industry will have served to avoid or lessen the erosion of some of these assets over the last 25 years.

Given the size differential between the magnitude of NERC funding when compared against the value of the UK's marine natural capital, only very small amounts of value erosion would need to have been avoided on account of the NERC-funded research for NERC costs to achieve breakeven in impact. Stakeholders agreed that NERC research will have contributed to the safeguarding of the UK's marine natural assets and their service flows for current and future generations.

[33] Our analysis has highlighted the value delivered through PML's work. However, it has not been possible to estimate the impact of this work within this study. See Section 4 for further details on the impact of this work.

[34] Our analysis has highlighted the value delivered through PML's work. However, it has not been possible to reliably the impact of this work within this study.

[35] Marine accounts, natural capital, UK - Office for National Statistics

6 Conclusions and recommendations

6.1 Conclusions

This study has shown that NERC NC-funded data, monitoring and science has become embedded within the OW industry. The five NCPs analysed as part of this study produce scientific outputs and expertise that feed into 11 of the identified 12 stages in the OWF development process, enabling developments to proceed faster and at lower levels of cost and risk than would otherwise be the case.

However, valuing these impacts within the constraints of this study has proven challenging. This is because of the combined effects of the rapid technological and engineering development of the industry, which means OWF developments today are of an entirely different scale to those in development even a decade ago, and the changes in the OWF development process, which has been getting longer, more expensive and more complex to navigate. These changes make it hard for stakeholders to disentangle the specific impacts of the NCPs from the increasingly complex wider picture. OWF size and site-specific considerations are such that there is no such thing as an average OWF, making average impacts impossible for stakeholders to estimate.

As a result, we have resorted to alternative means of estimating the value of NERC NC funding on the OW industry. Two alternative means have been used: a bottom-up approach drawing on published research where possible, and a top-down approach using judgement-based attribution. Both approaches have demonstrated that the value generated by NERC NC funding is likely to have far exceeded the costs of the funding provided, with BCRs ranging between 7.2-1 and 39-1.

Conservative assumptions suggest that:

- In the order of £3.3bn of economic value in the OW industry could be attributed to the five NCPs (range: £1bn-£5.5bn) – a 23 times return on investment compared to the £140m of NC funding provided since 2000 (in present value terms).
- Over the next 25 years, a further c. £3.6bn in economic value in the OW industry could be attributed to the five NCPs (range: £1bn-£6.1bn), based on projected future OWF development.

6.2 Possible areas for improving measurement in the future

This study has shown the challenges in quantifying and monetising impacts of NERC-funded research on a sector as complex and changeable as offshore wind. Nevertheless, actions could be taken that would enable better estimation of these impacts in the future, including:

- Better tracking of costs: Requiring NCPs to provide a breakdown of how they allocate NC funding would enable better attribution of costs by theme and sector.
- Better tracking of users: Requiring users of NCP research outputs, models and data products to register to access the data, providing insight into the volume, nature, range and frequency of users. This could also include improved tracking and reporting on the volume and value of NCP consultancy work for industry stakeholders.

- Alternative approaches to tracking benefits, including:
  - Adopting an OWF site-specific case study approach that focuses on how each NCP had affected specific OWF developments;
  - Use of stated preference techniques, for example contingent valuation, to assess stakeholder willingness to pay for key NCP services;
  - Investigating the downstream uses of NCP work, such as the use of NOC's POLCOMS model in the UK Atlas of Marine Renewable Energy.
- Incorporating considerations of industry impact into the evaluations of NERC's ECOWind and ECOFlow programmes.

6.3 Recommendations for additional measures to increase impact

This study has also identified means by which impacts could potentially be increased, for example:

- Supporting the NCPs to undertake user experience analysis, to ensure that NERC-funded datasets are known, accessible and understood by the sector. A recent stakeholder consultation undertaken by BGS has identified areas where additional data and services would be beneficial to users, and a similar approach could be considered by the other NCPs.
- Supporting the NCPs to ensure their outputs meet both industry and researcher needs. For example, some stakeholders noted the example of UKCEH's SeaBORD model, which they thought could be streamlined to facilitate industry use.
- Jointly agreeing key research priorities with industry stakeholders to address unresolved questions.
- Convening scientific stakeholders to align industry views about key impacts.
- Supporting the NCPs to issue research and data as soon as practical after collection or completion – balancing the need for scientific rigour and peer review with the need for up-to-date data for current planning and development purposes.

Annexes

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Annex A List of stakeholders consulted

Sector/Role	Organisation	Stakeholder
NERC research organisation	BGS	Andrew Finlayson Nicola Dakin
NERC research organisation	NOC	Christine Sams Paul Bell Jill Burgess Lucy Bricheno Michela De Demonicis Jo Thompson
NERC research organisation	UKCEH	Francis Daunt Kate Searle
NERC research organisation	SMRU	Carol Sparling
NERC research organisation	PML	Jennifer Lockett Peter Miller
Government	Offshore Wind Directorate	Alexander Gilliland
Government	The Crown Estate	Mike Blair John Mitchell Harry Richardson
Government	Crown Estate Scotland	Annie Breadon
Statutory Nature Conservation Bodies	NatureScot	Erica Knott
Statutory Nature Conservation Bodies	Natural England	Victoria Copley
Developers	EDF	Polly Tarrant
Developers	SSE	Roger Birchall Jonathan Abbatt
Developers	RWE	Paul Catterall Helen Elphick
Developers	BP	Gayle Holland Madeline Hodge
Consultancies	CEA Consultants	Dan Bates
Consultancies	MacArthur Green	Sue O'Brian
Other	Offshore Wind Industry Council	Kat Route-Stevens
Other	ORE Catapult	Tom Quinn
Other	Independent – Chair ECOWind, Former Chief Science Officer Marine for Scottish Government	Colin Moffat

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