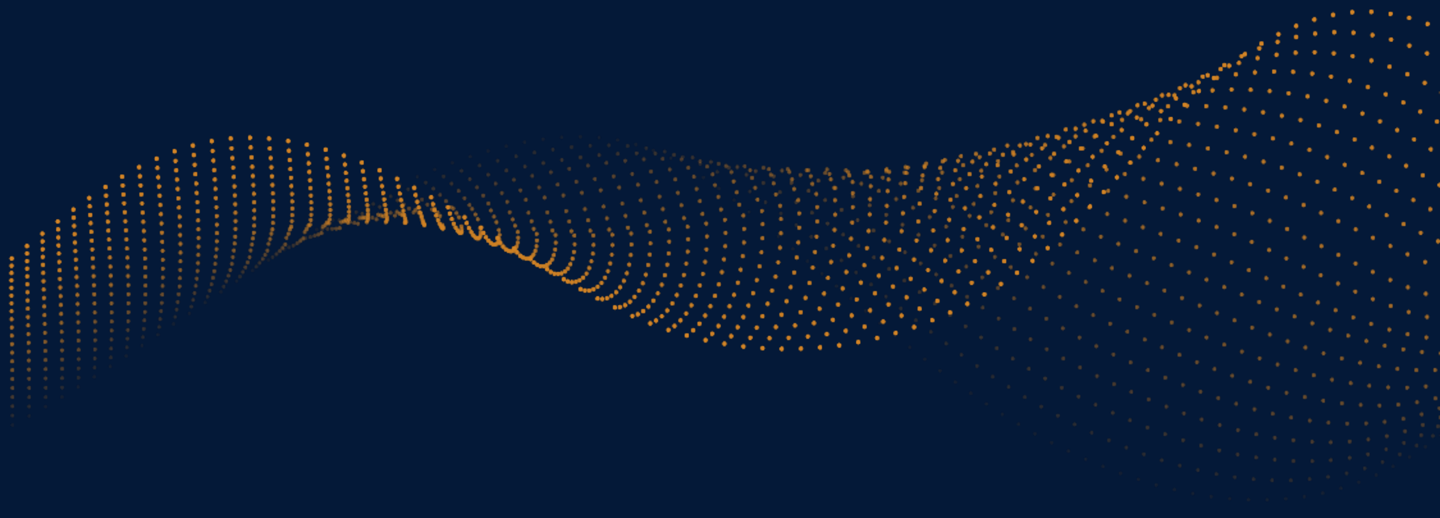
RystadEnergy

UK oil and gas supply chain and opportunities in the energy transition

April 2024



OEUK

Content

Introduction

Rystad Energy has been commissioned by Offshore Energies UK (OEUK) to conduct an independent assessment of the UK's oil and gas supply chain and its opportunities in the energy transition.

To a large extent, there is one UK energy supply chain supporting both traditional and decarbonised energy supply. This supply chain built its skills domestically and used these as a springboard for exports. The energy mix is changing but, whilst renewables are growing, they still only provide 5% of the fuel mix. The energy investment profile shift, from oil and gas to renewables, over the next decade is dependent on our ability to convert potential projects into committed ones. The new energy activity will only maintain the current workforce if we manage the transition in a way that preserves skills and transitions jobs in line with project commitment timelines.

This report aims to serve as a guide for key stakeholders, directing attention towards pivotal opportunities within the energy transition and pinpointing the need for strategic investment in the UK oil and gas supply chain to support and ensure a successful and just energy transition.

Despite its maritime and offshore expertise, the UK has been dependent on international companies for fixed-bottom wind development after being unsuccessful in the establishment of a domestic supply chain. The UK has been one of the leading countries in the development of fixed-bottom wind, driven by substantial government funding and ambitious capacity targets. The UK was an early mover and had until 2023 the largest installed capacity base, followed by mainland China and the Netherlands. Unfortunately, this has not led to a boost in the development of the domestic industry and supply chain, instead contributing to high activity levels for international supply chain companies. To seize opportunities in the development of new energy verticals, the UK must position its supply chain accordingly.

The oil and gas business has much to offer, including offshore expertise, contracting models and financial resources. From a legal efficiency standpoint, if joint venture agreements for wind deployment can achieve the same level of standardisation as joint operating agreements used to manage upstream exploration and production (E&P) activities in oil and gas, significant cost and time savings are likely. However, there are limitations: the level of operator discretion and no-loss strategy common in the oil and gas industry has not made its way into the offshore wind arena.

This report will define and quantify the theoretically addressable market for the UK supply chain within these new energy verticals, domestically and abroad, and the opportunities and challenges this presents for the industry. As such, the report lays the foundation of the future direction of strategic investment and prioritisation of support for the development of carbon capture and storage (CCS), green and blue hydrogen and floating offshore wind (FOW) in the UK.

List of abbreviations

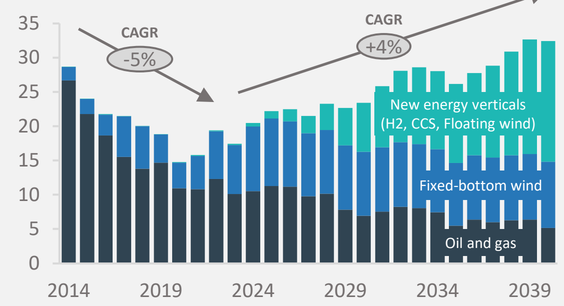
Key term	Definition
AHTS	Anchor handling tug supply vessel
ATR	Autothermal reforming
AUV	Autonomous underwater vehicle
CAGR	Compound annual growth rate
Capex	Capital expenditures
CCS	Carbon capture and storage
CfD	Contracts for difference
CTV	Crew transportation vessel
EERV	Emergency response and rescue vessel
EPC	Engineering, procurement and construction
EPCI	Engineering, procurement, construction and installation
Eqpt	Equipment
ETH	Electrical trace heating
FID	Final investment decision
FIV	Foundation installation vessel
FOW	Floating offshore wind
FPSO	Floating production storage and offloading
FSO	Floating storage and offloading
FTLP	Floating tension leg platform
HVDC	High-voltage direct current
IMR	Inspection, maintenance and repair
LCOE	Levelised cost of electricity
MMO	Maintenance, modification, and operations
O&G	Oil and gas
OCTG	Oil country tubular goods
OCV	Offshore construction vessel
OEM	Original equipment manufacturer
Opex	Operational expenditures
P&A	Plug and abandonment
PSV	Platform supply vessel
ROV	Remotely operated vehicle
SMR	Steam methane reforming
SOV	Service operation vessel
SPS	Subsea production system
SURF	Subsea umbilicals, risers and flowlines
Svcs	Services
T&I	Transport and installation
T&S	Transport and storage
TAR	Turnaround maintenance services
TLP	Tension leg platform
UXO	Unexploded ordnance on seabed
WTIV	Wind turbine installation vessel
XMT	Part of the subsea production system

Content

THE OPPORTUNITY

INCREASING ENERGY SPEND

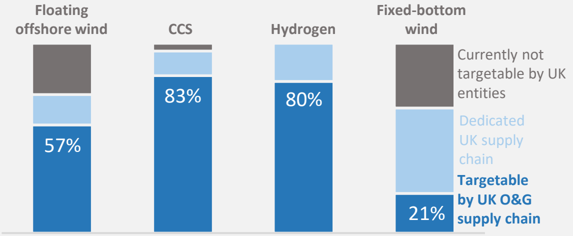
UK energy spending
GBP billion



After years of decline, the UK energy supply chain is set to pivot and scale rapidly

HIGH CAPABILITY OVERLAP

UK O&G supply chain targetable spend by energy vertical
Percentage, 2024-2040



Oil and gas supply chain capabilities will be called on to deliver with 60-80% overlap in coverage*

THE CHALLENGES

SCALE

13x
Fabrication and construction – **onshore processing facilities**

2.6x
Fabrication and construction – **offshore structures**

2/32 → **?/77**

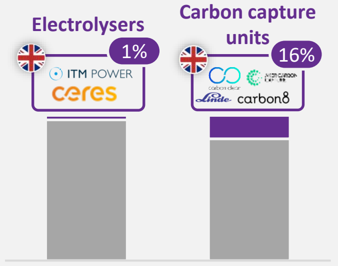
UK AHTS in North Sea fleet

AHTS demand Europe, 2035

Significant scaling needed in segments with long lead times, but lack of project FIDs to build backlog

DEVELOP

Global announced manufacturing capacity**



Develop and commercialise key enabling technologies to secure competitiveness on cost

RETAIN

UK energy spend, GBP million	2023	2040
Subsurface	320	200
Drilling rigs & equipment	1,930	830
Drilling services & tools	1,480	850

Critical segments to retain for the growing CCS industry

Retain segments that will still be in decline, but crucial to enable CCS ambitions

THE REWARD

MEET TARGETS

Government targets

5GW
Floating offshore wind
By 2030

50MTPA
Carbon capture and storage
By 2040

10GW
Hydrogen
By 2030

The oil and gas supply chain is needed to reach government targets

EXPORT CAPABILITIES

Export potential
GBP billion, 2024-2040

100
Floating offshore wind

470
Carbon capture and storage

590
Hydrogen

And significant export opportunities exists if it is successful in building competitive value chains

*For the new energy verticals (hydrogen, CCS and floating wind)
**Electrolysers based on the countries where producers originate. Carbon capture units based on countries where the capture unit producers originate
Source: Rystad Energy research and analysis

O&G supply chain opportunities in new energy verticals – 10 key findings

Key findings

Size of the opportunity

1 After years of decline, the UK energy supply chain is set to pivot, projecting a 4% annual growth in spending from 2023 to 2040 across O&G, fixed-bottom wind and the three new energy verticals; floating wind, CCS and hydrogen. However this pivot is dependent on project certainty improving/project commitments transpiring. The new energy verticals are expected to accumulate £150 billion in combined spending in the UK through 2040. The success of the new energy verticals hinges on the oil and gas supply chain delivering into them - it is essential that capabilities do not erode before demand from new energy verticals takes off.

2 Despite the UK's early move and sizeable investments into fixed-bottom wind, the UK supply chain struggled to gain market share. Low capability and asset overlap (around 20%) and the dominance of turbine original equipment manufacturers (OEM) are identified as key reasons. With the new energy segments, there is an opportunity to utilize and depend on UKs O&G strength in molecule handling (CCS and hydrogen) and deepwater projects (floating wind). These segments have a capability overlap with the O&G sector of between 60% and 80%.

Domestic opportunities and challenges

3 The current UK oil and gas supply chain is heavily weighted towards opex-driven segments, but expansion into new energy verticals requires capex capabilities. Reactivation of capex-heavy sectors requires upfront investment in manufacturing, skilled labour and fabrication sites that comes with significant lead time to scale.

4 Lack of project final investments decisions (FID) is impeding investment and the signal to invest is frequently missing. Only a small portion of the project pipeline has reached FID, the developer landscape is fragmented, technologies are undecided (floating wind), and repeat awards schemes are missing (CCS), all of which impede investment in the supply chain. For companies to invest (domestic or foreign) government support is needed to improve the certainty of supply chain demand.

5 Scale: key segments to secure scale early are engineering, fabrication and construction of offshore structures (ports) and onshore facilities (processing plants, skilled labour), manufacturing expansion of major equipment and materials (compressors, pumps, mooring lines), and offshore assets (anchor-handling vessels and offshore construction vessels). To compete successfully the UK supply chain must be competitive, for example by improving efficiency and productivity through automation and advanced manufacturing.

6 Develop: the UK holds key enabling technology for the new energy verticals, but it is important to commercialise the existing technologies and facilitate for further cost reductions through continued R&D, as selection of providers of major equipment in hydrogen and CCS will be dependent the most cost-efficient solutions.

7 Retain: Some O&G segments are declining, and growth in new energy verticals will not offset this. They remain critical to achieving both industry and government targets. This comprises, seismic and subsurface, drilling rigs and equipment, as well as drilling services. To prevent a downturn in UK spending on drilling, intervention, and P&A, the CCS industry needs to have an estimated capacity of around six times higher than government targets in 2030.

Large export potential if successful

8 Significant export opportunities for all three energy verticals are observed, largest addressable markets for hydrogen and CCS with accumulated spend reaching £590 billion and £470 billion, respectively, between 2024 and 2040, five to six times the floating offshore wind market at £100 billion. Potential export market for design and engineering services, where UK holds significant capabilities, totals £125 billion across the three new energy verticals this period. The subsea market for CCS should also be a very viable opportunity.

9 Despite the smaller international market, floating offshore wind stands out as the most promising opportunity for the UK to win international revenues. With advantages of an early and sizeable position globally together with highly transferable and advanced capabilities from O&G, UK entities will be better positioned to compete.

10 The UK energy supply chain contains several companies that can act as system integrators, specifically engineering, procurement and construction (EPC) and engineering firms, that can use established supplier relationships with UK subcontractors to secure domestic and international wins for multiple UK entities. Government support with promoting the capabilities of the UK's energy supply chain in international markets will further enhance export opportunities.

Material opportunities and significant capability overlap shows promise

1

After years of decline, the UK energy supply chain is set to pivot, projecting a 4% annual growth in spending from 2023 to 2040 across oil and gas, fixed-bottom wind and the three new energy verticals; floating wind, CCS and hydrogen. However, this pivot is dependent on project certainty improving/project commitments transpiring. The new energy verticals are expected to accumulate £150 billion in combined spending in the UK through 2040. The success of the new energy verticals hinges on the oil and gas supply chain delivering into them - it is essential that capabilities do not erode before demand from new energy verticals takes off.

- *Oil and gas spending has declined from £26 billion in 2014 to £10 billion in 2023 (-10% per year) and is set to continue declining at an average of 4% annually from 2023 to 2040.*
- *Spending in fixed-bottom wind has not fully offset this decline, with a spending increase from £2 billion in 2015 to £7 billion in 2023. Spending levels are expected to continue growth in the short term before stabilising at roughly £9 billion in 2025 throughout 2040.*
- *New energy verticals projected to surpass oil and gas spend in early 2031 and fixed-bottom wind in 2032 primarily driven by the FOW sector, which is expected to see 2 gigawatts (GW) of installed capacity, accounting for close to 30% of the global market, despite being 3 GW short of the government's target of 5 GW by 2030.*
- *Significant growth expected for CCS and hydrogen, but relatively lower contributions to UK spend compared to floating wind.*
- *With activities in new energy verticals, the stage is set for an overall spending growth that will challenge multiple supply segments, many of them with a heritage in oil and gas. Overall spending will likely grow 31% annually from £200 million in 2023 to £18 billion in 2040.*

Commercial implications

The forthcoming wave of new energy investments represents a strategic opportunity for the oil and gas supply chain to diversify its revenue streams, enhance its capabilities, and extend its reach into international markets. Supply chain companies should adapt towards theses new energy verticals by both maintaining and renewing in-house competence.

Policy implications

Ensure the UK's oil and gas capabilities do not erode before demand from new energy verticals takes off by facilitating necessary activity levels and support schemes. The success of these new energy verticals hinges on the oil and gas supply chain delivering into these.

2

Despite the UK's early move and sizeable investments into fixed-bottom wind, the UK supply chain struggled to gain market share. Low capability and asset overlap (around 20%) and turbine OEMs' dominance are identified as key reasons. With the new energy segments, there is an opportunity to utilise and depend on UKs oil and gas strength in molecule handling (CCS and hydrogen) and deepwater projects (floating wind). These segments have a capability overlap with the oil and gas sector of between 60% and 80%.

- *Spending distribution by supply chain segments reveals distinct differences in addressability by the oil and gas supply chain in the new energy verticals. Some 84% of CCS spending is addressable by oil and gas supply chain companies through current capabilities, 57% in floating wind and 80% in hydrogen. This compares to 21% addressability of total spending in fixed-bottom wind.*
- *The low addressability in fixed-bottom wind, together with low asset overlap, the dominance of turbine OEMs and low technology components outside the domain of OEMs have been identified as key reasons for the failure in securing a larger share of the investments that have gone into expanding this fixed-wind industry, that has been heavily supported by government incentives.*

Commercial implications

The fundamentals for securing work in the new energy verticals are better than it was for fixed-bottom wind. Key enabling technologies are being developed in the UK and a large share of the work scopes are relevant to oil and gas supply chain companies' current capabilities, early-stage build-out on capabilities will benefit new energy industry sectors.

Policy implications

oil and gas supply chain companies will be critical to ensuring the success of the new energy verticals. The transition of the supply chain will be critical not only to meeting government targets, but also to securing UK jobs where government-supported investments are made. Progressing late-stage technology development and supporting readily transferable oil and gas technology to be adapted to meet the needs of new energy production offers an opportunity to get ahead. As the UK capabilities to serve the demand for new energy verticals is stronger than it was for fixed wind, there is a clearer path to develop a competitive supply chain industry in the UK. Depending on the supply chain segment, scaling, developing and/or retaining UK capabilities will be critical to fulfil future demands.

Source: Rystad Energy research and analysis

Rapid scaling of supply chain is needed, but signal to invest is missing

3

The current UK oil and gas supply chain is heavily weighted towards opex-driven segments, but expansion into new energy verticals requires capex capabilities. Reactivation of capex-heavy sectors requires upfront investment in manufacturing, skilled labour and fabrication sites that comes with significant lead time to scale.

- *UK oil and gas expenditure is heavily weighted towards opex with 50% of spending between 2024 and 2040– the segments supporting this are largely locally or regionally centered.*
- *Capabilities in capex-heavy segments, such as fabrication and construction, have been scaled down and outsourced to low-cost countries partly due to a sustained period with lower levels of greenfield activity and non-competitive labour costs in the UK.*
- *The forthcoming growth phase in the new energy verticals will call for capex-heavy supply chain segments to be reactivated, with capex accounting for 93% in floating wind, 80% in hydrogen and 71% of spending in CCS from 2024 to 2040. Compared to offshore oil and gas and fixed-bottom, a larger share of these will need to be manufactured and/or assembled in the UK. This is dictated by the onshore nature of carbon capture and hydrogen plants and the quay-side assembly and tow-out of floating wind turbines.*
- *In some segments – e.g., subsea construction and survey – the UK supply chain is already stretched due to the large-scale rollout of fixed-wind combined with a short-term oil and gas upcycle in the North Sea.*

Commercial implications

UK oil and gas supply chain companies must reactivate and scale capabilities in capex-intensive segments to support the buildout of new energy verticals. Due to the locality of activities, UK oil and gas supply chain companies should hold an advantage, but capex projects entail higher risk for foreign competition.

Policy implications

Capex-heavy segments often require up-front investments in infrastructure or offshore assets to meet demand. Examples include fabrication capacities for heavy equipment, materials and metals, port infrastructure and offshore asset classes. These build-outs have long lead times and will likely need government support to reach targets.

4

Lack of project FIDs is impeding investment and the signal to invest is frequently missing. Only a small portion of the project pipeline has reached FID, the developer landscape is fragmented, technologies are undecided (floating wind), and repeat awards schemes are missing (CCS), all of which impedes investment in the supply chain. For companies to invest (domestic or foreign), government support is needed to improve the certainty of supply chain demand.

- *The missing signal to invest has similarities to the chicken and the egg causality dilemma. Lack of industry alignment, scale and stable market conditions fail to signal the need for new investments in the supply chain. Without supply chain expansion committing to projects is difficult, and as such, one could be left at a stand-still.*
- *In floating wind, the vast option space in development concept, material and contract set-ups hinders first movers from creating scale. The scattered developer landscape with smaller portfolios, results in a scarcity of sizable contracts with the same concept. Design certainty strengthens supply chain confidence to invest in manufacturing capability and capacity.*
- *Uncertainties related to offtake agreements and end-use demand for low-carbon hydrogen and CCS hinder developers to commit to new projects, this is exemplified by the current imbalance between announced (but not sanctioned) capture and storage capacities. Continuous cost improvement for key enabling technologies also keeps investments on the fence.*

Commercial implications

Developers must provide greater transparency on upcoming work scopes, through communicating concepts and choices to help the supply chain de-risk and invest in capacity build-out, despite project sanctioning risk. Collaboration and strategic engagement both between developers and with the supply chain is needed.

Policy implications

Government intervention is required to accelerate and mitigate the risks associated with investments in new supply chain capacity and capabilities. For example, getting competitive allocation rounds for contracts for difference (CfD) in FOW correct (non-price considerations) and moving on to CCS and hydrogen allocation rounds. Lack of government assistance places the responsibility on private investors, who require volume pledges to progress.

Source: Rystad Energy research and analysis

Key to cater for scale and stimulate R&D to ensure success across new energy verticals

5

Scale: key segments to secure scale early are engineering, fabrication and construction of offshore structures (ports) and onshore facilities (processing plants, skilled labour), manufacturing expansion of major equipment and materials (compressors, pumps, mooring lines), and offshore assets (anchor-handling vessels and offshore construction vessels). To compete successfully the UK supply chain must be competitive, for example, by improving efficiency and productivity through automation and advanced manufacturing.

- *The key segments needed to scale are fabrication and construction of onshore facilities (13x), supply vessels (2.7x), fabrication and construction of offshore structures (2.6x), major equipment (1.7x), engineering (1.7x), material and metals (1.6x), SPS and SURF (1.5x), subsea installation and survey (1.3x, but already tight).*
- *These are large segment aggregations and within these we will find highly constrained subsegments. Some key examples are ports, AHTS, large capacity CO2 compressors, pumps, skilled labour (e.g. welders), offshore engineering, mooring lines, dynamic cables etc.*

Commercial implications

Improve understanding of transferability of capabilities from oil and gas to each new energy vertical. Identify opportunities and invest to build delivery abilities to meet the growing demand. Find business models to secure capacity early to unlock investments and secure capital. The UK boasts world-leading engineering capability, which is not only highly exportable but also provides an opportunity to gain an early foothold.

Policy implications

Across these segments, it will be vital to secure both the required infrastructure and asset investments and labour. Some of these segments have challenging investment signals and contract set-ups and need government support. Access to skilled workers and science, technology, engineering and mathematics (STEM) professionals is already under stress and government must facilitate for the right education programs to secure long-term capacity to meet the scale required.

6

Develop: the UK holds key enabling technology for the new energy verticals, but it is important to commercialise the existing technologies and facilitate for further cost reductions through continued R&D, as selection of providers of major equipment in hydrogen and CCS will be dependent the most cost-efficient solutions.

- *Technology owners play a key role when the supply chain for new emerging industries is being developed, largely due to their ability to drive down the cost of key enabling technologies.*
- *UK holds key enabling technologies such as electrolysers for hydrogen production and carbon capture equipment in CCS through companies like ITM, Linde, Carbon8 and Carbon Clean. Scaling these capabilities will be necessary to meet future demand.*
- *Technology owners have limited experience in bringing complex infrastructure projects together, a role typically served by larger system integrators, for which the UK has several experienced companies, including Subsea7, Wood Plc, Petrofac and TechnipFMC.*

Commercial implications

The presence of technology owners in the UK will improve the UK's opportunities to get a strong foothold in the supply chain. Collaboration between technology owners and system integrators will be important to bring projects together due to the complex nature of these developments, with examples including Technip Energies strategic collaboration with the French low-carbon hydrogen equipment supplier McPhy.

Policy implications

Facilitate the scaling of key enabling technologies in the new energy verticals such as electrolysers and carbon capture equipment, and support UK's technology owners. Invest in R&D programmes to ensure that technologies developed in the UK are at the forefront of the industry. Commercialise this technology development through existing companies, but also seek to bring forward new ventures to build breadth in the supplier landscape to strengthen UK's overall position.

Source: Rystad Energy research and analysis

Preventing legacy O&G segments from tapering off important to unlock CCS

7 **Retain: some oil and gas segments are declining, and growth in new energy verticals will not offset this. They remain critical to achieving both industry and government targets. This comprises seismic and subsurface, drilling rigs and equipment, as well as drilling services. To prevent a downturn in UK spending on drilling, intervention and plugging and abandonment (P&A), the CCS industry needs to have an estimated capacity around six times higher than government targets in 2030.**

- *The segments where the UK holds the highest capabilities are also those that will see the marginal growth and, in some segments, continued decline in demand.*
- *These segments include subsurface, drilling rigs, drilling equipment and drilling services – all particularly important for the CCS industry. Despite a highly material market, drilling intensity does not match current oil and gas activity levels.*
- *However, these robust UK capabilities must be retained to ensure the successful build-out of the CCS industry that hinges on these critical activities to take place.*

Commercial implications

Retain capabilities by looking for international opportunities for oil and gas work scopes and invest in specialised competence within CCS to further scale internationally so that enough demand is crafted to retain and potentially grow these challenged segments.

Policy implications

Create favourable conditions for these companies to operate within, by supporting companies operating in these segments in the face of public opinion and support brownfield work scopes on existing oil and gas fields to maintain supply chain capabilities needed for CCS.

8 **Significant export opportunities for all three energy verticals are observed, with largest addressable markets being for hydrogen and CCS, with accumulated spending reaching £590 billion and £470 billion, respectively, between 2024 and 2040, five to six times the floating offshore wind market at £100 billion. The potential export market for design and engineering services, where the UK holds significant capabilities, totals £125 billion across the three new energy verticals during this period. The subsea market for CCS should also present a very viable opportunity.**

- *There are significant export opportunities for all new energy verticals, also when accounting for segments that are locally and regionally sourced and when the UK's current capabilities have been applied.*
- *The global addressable FOW market is estimated at $195 billion, where the sizeable domestic UK market accounts for 50% of spending in the period 2024 to 2040.*
- *The UK domestic market for CCS and hydrogen is projected to make up £53 billion between 2024 and 2040 combined, where the country has a significant export potential should UK entities be successful.*
- *Vast potential export opportunities for CCS and hydrogen due to large addressable global markets, roughly five to six times the global addressable market for FOW.*

Commercial implications

Seek opportunities abroad and scale high-demand, high-capability segments such as subsea production systems (SPS) and subsea umbilical, riser and flowline (SURF) packages, which hold strong synergies/targetability from oil and gas. If the UK is able to secure a technology advantage on key enabling technologies, this can be used as a lever to win integrated work scopes internationally.

Policy implications

Support the UK's technology owners and make it easier for important supporting technologies, such as electrolysers and carbon capture equipment, to grow and develop in the emerging energy verticals. Champion UK-led public and private R&D to progress late-stage technology development and support proven, readily transferrable oil and gas technology to be adapted to meet the needs of new energy production. Establish R&D regimes that helps push UK investment to the top of the OECD peer group, unlocking the full potential of the UK economy; industry will underpin this by ensuring it delivers 30% or greater locally sourced technology.

Source: Rystad Energy research and analysis

System integrators can help unlock international revenues

9

Despite the smaller international market, floating offshore wind stands out as the most promising opportunity for the UK to win international revenues. With advantages of an early and sizeable position globally together with highly transferable and advanced capabilities from oil and gas, UK entities will be better positioned to compete.

- *FOW rises as the most promising opportunity for the UK to win international revenues due to its current capability, projected materiality and early mover advantage.*
- *The UK holds strong capabilities in some of the key sub-segments within logistics and vessels and equipment and materials such as dynamics cables, mooring solutions, ports (likely first mover) and vessels management.*
- *The domestic UK FOW market expected to reach £4 billion in 2030, equal to 64% of oil and gas spending in that year. The UK is set to be an early mover, accounting for 36% of global average FOW spending between 2030 and 2040.*
- *The sizable addressable export markets for CCS and hydrogen suggests significant opportunities in niche sub-segments.*

Commercial implications

Look to secure capacity outside UK to find enough firm work scopes (sanctioned projects) to build out capacity in floating wind segments. Lean on existing and demonstrated prowess in several floating wind segments to secure work scopes internationally.

Policy implications

Continue to facilitate for development in floating offshore wind to retain the early mover advantage. Support development and buildout of capacity in key supply chain segments such as dynamic cables, mooring solutions and vessels where the UK holds strong capabilities and the potential to win international revenues is high. Ensure and support commercialisation and industrialisation of new technologies that have been developed through UK's extensive R&D programs.

10

The UK energy supply chain contains several companies that can act as system integrators, specifically EPC and engineering firms, that can use established supplier relationships with UK subcontractors to secure domestic and international wins for multiple UK entities. Government support with promoting the capabilities of the UK's energy supply chain in international markets will further enhance export opportunities.

- *System integrator of these complex developments is well positioned to drive down cost through industrialisation and scaling of new sectors will have a significant advantage in the race to control the supply chain.*
- *System integrators traditionally have their own set of preferred sub-suppliers and will therefore likely bring along significant work to the local UK supply chain both domestic and internationally.*
- *The UK houses some of the largest engineering and project management firms and engineering, procurement, construction and installation (EPCI) companies in the oil and gas industry that hold the necessary requirements to take the role of system integrator, including Wood Plc and Worley, as well as EPCI holders such as Petrofac, Subsea7 and TechnipFMC.*

Commercial implications

Larger contract packages awarded to system integrators in the UK will likely bring significant work for smaller UK-based supply chain companies. Improve the standing of these integrators through collaborative efforts with UK providers of key enabling technologies.

Policy implications

Craft and support the role of the system integrators in the UK to secure a key role in the emerging supply chains through UK government advocacy for UK supply chain companies abroad. Government support in promoting the capabilities of the UK's energy supply chain in international markets will further enhance export opportunities.

Source: Rystad Energy research and analysis

Content

Definition of a UK O&G supply chain company and the broader supply chain

UK oil and gas supply chain companies are defined as companies that are either a UK parent company or the UK subsidiary of a foreign parent company.

This report defines the UK oil and gas supply chain as consisting of three types of companies:

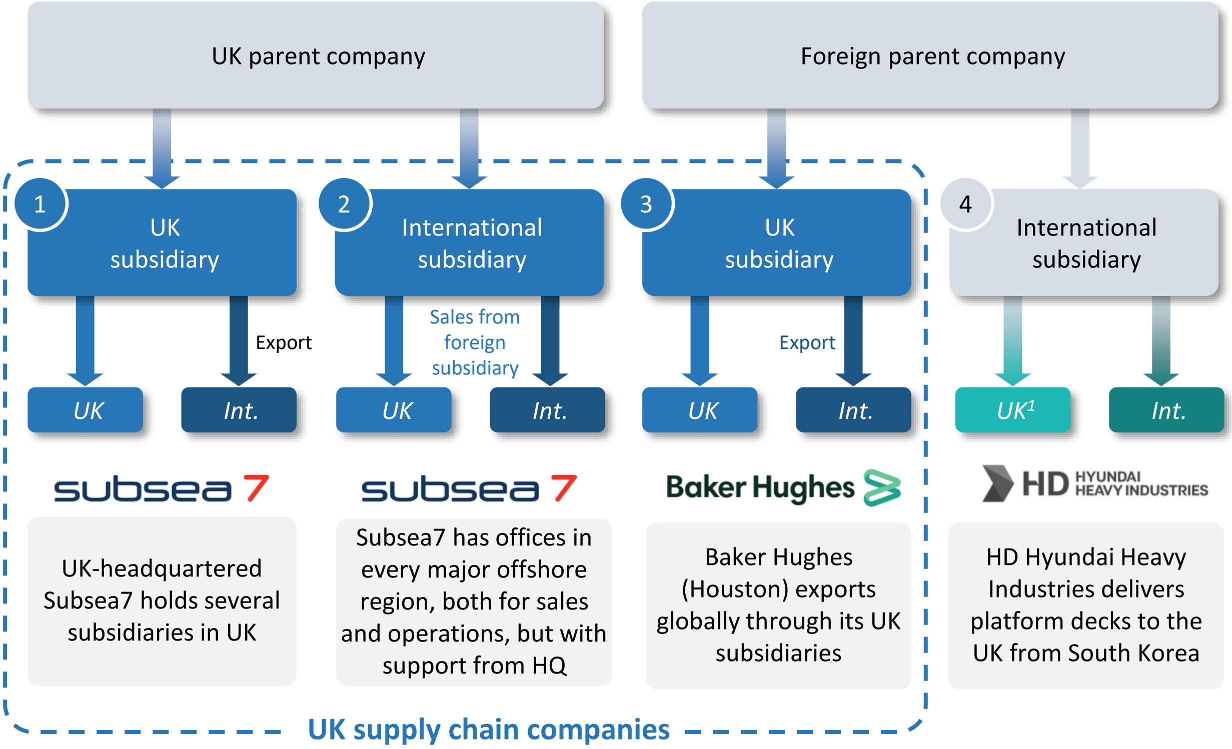
1) The UK subsidiary of a UK parent company that derives its turnover through sales to either the domestic UK market or through exports of products and services to the international market.

2) The international subsidiary of a UK parent company that derives its sales through sales from its foreign subsidiary either to the UK or to the international market.

3) Foreign parent company with a UK subsidiary that derives its turnover through sales either in the UK or through exported products and services to international markets.

4) The UK also imports products and services from foreign parent companies' international subsidiaries. This turnover constitutes a part of the UK offshore market, but the company is not considered to be a UK oil and gas supply chain company in this report.

Together, entity types 1 to 3 form the defined UK supply chain in this report. The capabilities of international companies with a strong local presence (UK subsidiary) are given equal weight to a UK-headquartered business.



UK-headquartered Subsea7 holds several subsidiaries in UK

Subsea7 has offices in every major offshore region, both for sales and operations, but with support from HQ

Baker Hughes (Houston) exports globally through its UK subsidiaries

HD Hyundai Heavy Industries delivers platform decks to the UK from South Korea

🟦 UK turnover from UK oil and gas supply chain companies
▆ International turnover from UK oil and gas supply chain companies
🟩 Turnover in the UK from international company, operations outside UK*
▆ International turnover from international company

*This revenue constitutes a part of the offshore market in the UK but will not be included or addressed in this report. This is revenue stemming from direct imports, i.e., outside of UK established entities

Source: Rystad Energy research and analysis

UK O&G supply chain exposed to both domestic and international markets

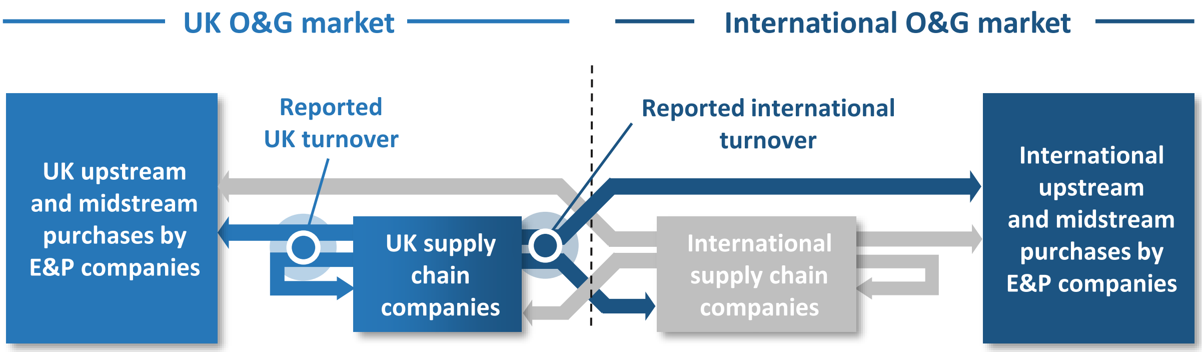
The route to the end market is not always clear for a supply chain company, with several pathways to the end user existing. It can sell its products and services to other service companies, foreign or domestic, or directly to the end users on the UKCS or in other offshore basins. These pathways are not individually quantifiable. What can be quantified is the size and development of the end user markets, the E&P purchases in the UK and other offshore basins. The call on supply chain deliveries out of the UK depends on the development of both of these markets. In this report we have included purchases from both upstream and midstream activities.

The share of exports is highly segment dependent. Engineering, subsea EPCI and well services have historically been key export segments for UK companies. Below we highlight two examples, Subsea7 and Baker Hughes, to illustrate how we define the UK supply chain baseline.

1. Subsea7, a UK headquartered business, gets more than 75% of its revenue from international activities. Renewables also account for a fair portion of its annual turnover, and this highlights an added complexity in quantifying the supply chain size for oil and gas.

2. Baker Hughes, a US-headquartered business, has a significant UK presence. Its UK subsidiary, which is included in the UK supply chain definition, has significant exposure to UK revenues.

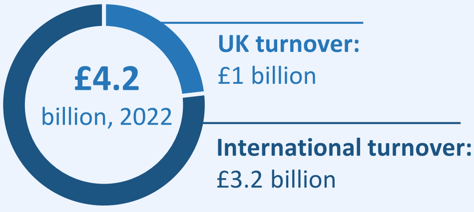
These complexities imply that, when the current baseline is evaluated, we will look to the end user segments, the E&P purchases, to evaluate the current and future outlook for the UK's supply chain within the oil and gas domain.



EXAMPLE: UK oil and gas supply chain companies

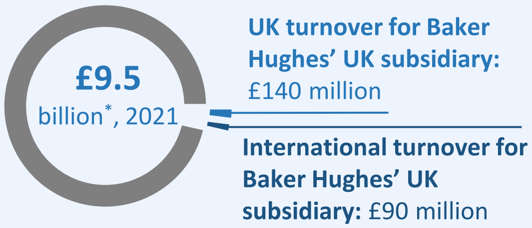
UK-headquartered companies

subsea 7



UK subsidiaries

Baker Hughes



*Baker Hughes Oilfield Services & Equipment division revenue

Source: Rystad Energy research and analysis; Baker Hughes; Subsea7; Companies House

O&G supply chain comprises six key service segments

Three supply chain segments make up roughly 75% of the £11-billion domestic UK oil and gas supply chain.

The UK's domestic oil and gas supply chain is a complex network comprising diverse companies offering a broad spectrum of products and services. This intricate landscape can be broadly categorised into six key service segments: operations and maintenance; logistics and vessels; drilling, intervention and plug and abandonment (P&A); equipment and materials; engineering and construction; and the subsurface segment.

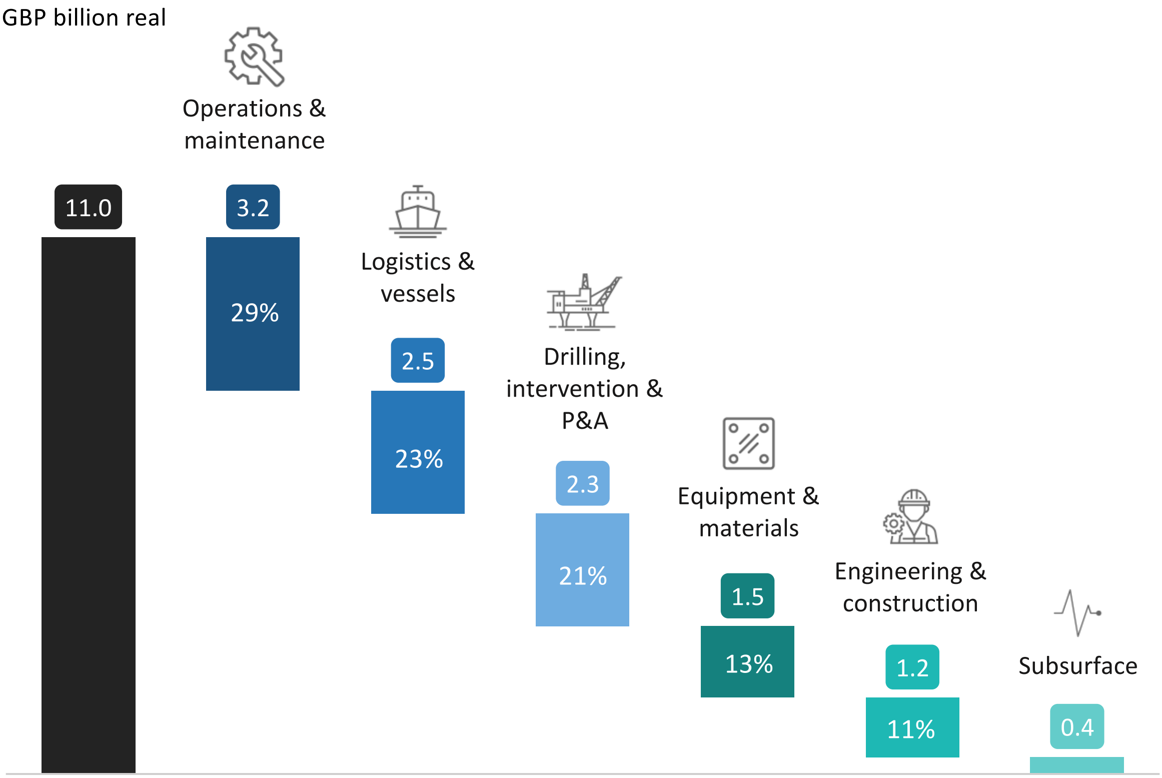
Oil and gas operators' capital and operational expenditure in the UK's upstream and midstream sectors averaged roughly £11 billion between 2020 and 2023. Understanding the distribution of expenditures across various service segments provides insights into the dynamics of the supply chain.

The operations and maintenance segment emerges as the cornerstone of the UK's oil and gas supply chain, commanding approximately 30% of annual expenditure. This significant share can be attributed to the continual supply of products and services needed to keep the mature base of existing oil and gas infrastructure producing.

The logistics and vessels segment as well as the drilling, intervention and P&A segment follow as the second and third largest segments, each with about one-quarter of total expenditure. This significant share can be attributed to the concentration of oil and gas activities in deepwater operations in the North Sea, along with a substantial presence of subsea operations.

Together the three segments of operations and maintenance, logistics and vessels, as well as drilling, intervention and P&A make up about 75% of the domestic UK supply chain.

UK upstream and midstream capex and opex investments by segment, avg 2020-2023



Source: Rystad Energy research and analysis; Rystad Energy ServiceDemandCube

Key supply chain services utilised during several lifecycle stages

Key supply chain products and services are utilised across multiple stages during the oil and gas project lifecycle.

Expenditures in oil and gas appears at different lifecycles of a project, each representing a distinct stage in the exploration, development, production and decommissioning of an oil and gas field.

During the pre-final investment decision (FID) phase, significant expenditures are incurred in activities aimed at identifying potential hydrocarbon reservoirs. This includes conducting seismic surveys, exploratory drilling, and thorough geological and geophysical studies requiring rigs, vessels and subsurface activities.

In the EPC phase, expenditures are directed towards engineering, procurement and construction associated with the establishment of infrastructure for hydrocarbon extraction. This involves drilling production wells and constructing facilities such as platforms and pipelines, and the manufacturing of subsea equipment.

Some of the key supply chain services and products appear across multiple stages during the lifecycle such as the drilling, intervention and P&A segment where 10% to 15% of spending is centred in the pre-FID phase, 15% to 20% in the EPC phase, 50% to 55% in the operations phase and 20% to 25% in the decommissioning phase.

By breaking down the oil and gas supply chain by services and products rather than a lifecycle-oriented segmentation, we can pinpoint the key distinct services and products by aggregating demand across various lifecycles.

UK upstream expenditures by segment and lifecycle, 2020-2023

% expenditures

		Lifecycle →			
		5%	10%	72%	13%
Segment	**Sub-segments**	Pre-FID	EPC	Operations	Decom
Subsurface	Subsurface	30-35%	10-15%	55-60%	<5%
Equipment & materials	Materials & metals SPS + SURF Electrical & instrumentation Major equipment	<5%	20-25%	75-80%	<5%
Engineering & construction	Fabrication & construction Engineering	<5%	15-20%	80-85%	<5%
Drilling, intervention & P&A	Drilling rigs & equipment Drilling services & tools	10-15%	15-20%	50-55%	20-25%
Logistics & vessels	Subsea installation & survey Supply vessels Logistics & supply bases	<5%	5-10%	70-75%	20-25%
Operations & maintenance	Maintenance & integrity Facility leasing Decommissioning & abandonment	<5%	<5%	85-90%	10-15%

Source: Rystad Energy research and analysis; Rystad Energy ServiceDemandCube

Maintenance and integrity constitutes largest sub-segment by expenditure

Maintenance and integrity constitutes the largest expenditure among the 15 sub-segments comprising the domestic UK oil and gas supply chain.

The six key service segments can be divided into 15 sub-segments to provide more details on key services that make up the oil and gas supply chain. For example, the logistics and vessels segment is made up of subsea installation and survey, supply vessels and the logistics and supply bases sub-segments as depicted in the figure below, which breaks down the average domestic UK oil and gas supply chain market size from 2020 to 2023 by sub-segment. Maintenance and integrity is the largest sub-segment, averaging about £2.1 billion per year in the period.

Segment	Sub-segment	UK market size (GBP billion)*	Description
Subsurface	Subsurface	0.4	Reservoir studies, log interpretation, geoscience, reserves evaluation, seisimc acquisitions, processing of seismic, among others.
Equipment & materials	Materials & metals	0.6	Manufacturing of oil country tubular goods (OCTG), part of pipes, valves, and fittings for pipelines and upstream processing facilities.
	SPS & SURF	0.2	Manufacturing and aftermarket services of subsea production systems, separation, compression, boosting, flow meters, control modules and large-diameter, composite flowlines and subsea umbilicals.
	Electrical & instrumentation	0.5	High-voltage transformers, switchgears and other power transmission and distribution equipment. Instrumentation and automations sensors, meters, cable trays and ladders, ETH cables, fiber optic cables.
	Major equipment	0.2	Manufacturing and aftermarket services of major equipment such as compressors, industrial pumps, process equpment, wellheads, trees, gas turbines, combustion engines for power generation.
Engineering & construction	Fabrication & construction	0.7	Costs associated with fabrication of topsides and structural steel including decks, frames, process modules, templates etc. Onshore infrastructure, piping installation, painting and welding.
	Engineering	0.5	Conceptual and feed studies for surface facilities, subsea and marine engineering services. Detailed engineering, procurement and project management for facility fabrication and construction activties.
Drilling, intervention & P&A	Drilling rigs & equipment	1.3	Rigs for drilling, intervention and P&A operations including mobilization, demobilization and fuel. Sales, rental and repair of rig equipment such as top drives, drawworks, mud pumps and more.
	Drilling services & tools	1.0	Rental and sales of drilling tools such as coring bits, torque tools, supply and handling of mud, completion fluids, wireline and cementing services for well plugging and abandonment, and more.
Logistics & vessels	Subsea installation & survey	1.2	Installation of subsea structures and equipment, geotechnical survey, trenching, AUV/ROV support, subsea IMR services.
	Supply vessels	0.6	Cranes, winches and other material handling equipment for offshore vessels, platform supply and mooring operations with PSVs and AHTS vessels, and accomodation vessels, CTVs, ERRVs etc.
	Logistics & supply bases	0.7	Port and shore-based warehousing and supply bases, road, rail sea and air transportation of freight and people, catering, cleaning and accomodation support services.
Operations & maintenance	Maintenance & integrity	2.1	Mechanical and fabric maintenance services as well as MMO frame agreements and shutdown/TAR services. Pipeline inspection, pigging and plugging services and other operational support.
	Facility leasing	0.7	Leasing of floating production, storage and offloading (FPSO) and floating storage and offloading (FSO) vessels.
	Decomissioning & abandonment	0.4	Dismantling, shipbreaking, recycling and disposal of decommissioned offshore vessels and steel structures including topsides, jackets and vessels after being delivered to shore.

*UK market size (GBP billion real), average annual spending 2020-2023
Source: Rystad Energy research and analysis; Rystad Energy ServiceDemandCube

UK capabilities and export potential vary across supply chain segments

Export potential varies across segments due to differences in international competition, value chain dynamics and UK's domestic supply chain capabilities.

Each of the 15 sub-segments is assessed on four key parameters to uncover the UK supply chain's strengths, weaknesses and growth opportunities:

1. **UK capability:** What are the existing capabilities of the UK's oil and gas supply chain? Is domestic demand met by the import of services and goods or supplied by local entities?
2. **Value chain:** What are the underlying value chain dynamics shaping each segment? Is it a local, regional or global value chain?
3. **Global competition:** What is the magnitude of competition from international players?
4. **Export potential:** What is the UK's export potential in each segment? Strong UK capability and regional/global value chains generally offer higher export potential for the UK.

The assessment shows the UK's oil and gas supply chain has robust capabilities within several of the key supply chain segments, including subsea installation and survey, maintenance and integrity, drilling rigs and equipment, subsea production systems (SPS) and subsea umbilicals, risers and flowlines (SURF), as well as engineering, among others. However, different value chain dynamics and global competition impact the export potential of these segments.

The engineering segment is considered a global value chain due to its transferability of exporting services to other markets. The UK holds significant engineering capabilities, with several key engineering, procurement, construction and installation (EPCI) providers and dedicated engineering houses established within the country. The competitive landscape on a global scale is moderate, positioning the UK's export potential within the engineering segment at a high level.

Conversely, the maintenance and integrity segment exhibits a contrasting profile, operating within a local value chain where the majority of services are catered to by locally established companies. While the UK's capability is strong, the export potential within the maintenance and integrity segment is inherently limited, as is global competition due to the requirement of local skilled labour.

Segments with regional or global value chains where the UK holds strong capabilities and limited international competition generally make for high export potential. The UK's capabilities in these segments therefore have a higher probability of surviving despite an expectation of shrinking domestic demand for these services in the future.

The subsea installation and survey, drilling services and tools, SPS and SURF, electrical equipment and instrumentation as well as the engineering sub-segments stand as having the largest export potential out of the 15 sub-segments.

Segments with regional or global value chains and where the UK holds limited capability generally means that more imported products and services are required to meet domestic market demand.

Source: Rystad Energy research and analysis

UK O&G capabilities and export potential vary across sub-segments

Segment category	UK O&G capability	Value chain	Global competition	Export potential	Comments
Subsurface	Medium	Global	High	Medium	Segment dominated by international companies, some with UK presence and others without. No major UK headquartered seismic company.
Materials & metals	Low	Global	High	Low	Segment largely covers OCTG, linepipe and valves, which are mostly sourced internationally.
SPS & SURF	High	Regional	Medium	High	UK holds 10% of global subsea tree manufacturing, 20% of global umbilicals, cables and flexibles manufacturing. Subsea7 has a subsea bundle facility and spool base in the UK.
Electrical & instrumentation	High	Global	Medium	High	Strong UK position with key players such as Rolls-Royce, Proserv, JDR and Siemens.
Major equipment	Medium	Global	Medium	Medium	Moderate capabilities in major equipment manufacturing and services with the likes of Petrofac, Rolls-Royce, Wood and UK subsidiaries of players like Siemens, Alfa Laval and Man.
Fabrication & construction	Low	Global	High	Low	UK value chain capable of delivering on pre-fabrication scope and smaller modules. Larger topside modules typically delivered from international yards, including in Asia.
Engineering	High	Global	Medium	High	Several EPCI providers including TechnipFMC, TechnipEnergies, Subsea7 and Baker Hughes with engineering as a core part of their value proposition. Large dedicated engineering houses such as Wood also play a major role.
Drilling rigs & equipment	High	"Global"	High	Medium	Drilling rig market has consolidated over recent years. The UK has a strong drilling rig position with the likes of Awilco, Valaris and KCA Deutag, together with equipment and service providers such as Expro. Global offshore market, regional onshore markets.
Drilling services & tools	Medium	Regional	High	High	Dominated by large international players with UK subsidiaries, with an undergrowth of local niche suppliers. High export potential for speciality services and tools.
Subsea installation & survey	High	Global	Medium	High	Most international subsea installation and survey companies are either headquartered in the UK or operate through UK subsidiares. Asset-heavy and high-competence segments, which makes it difficult to scale up in new offshore regions.
Supply vessels	Medium	Regional	High	Low	50% of the UK vessel fleet is ERRVs predominantly flagged to the UK. The majority of AHTS vessels and PSVs are owned by foreign entities and fly foreign flags.
Logistics & supply bases	High	Local	Low	Low	Strong established logistics and supply base support. Foreign companies operating in this segment have established local subsidiaries serving the UK market.
Maintenance & integrity	High	Local	Low	Low	As with most maintenance markets, the UK is served by local companies/entities. Given its labor-intensive nature, exporting the business model poses significant challenges.
Facility leasing	Low	Global	High	Low	Segment covers leased FPSOs, a segment characterised by a few large projects. International FPSO operators operate in a global market.
Decomissioning & abandonment	High	Regional	Medium	Medium	Offshore work typically served by companies active in the maintenance segment. Onshore scope covered by decommissioning specialists and dedicated ports. Topside removal is predominantly led by international players.

Source: Rystad Energy research and analysis; Rystad Energy ServiceSupplyCube; industry interviews

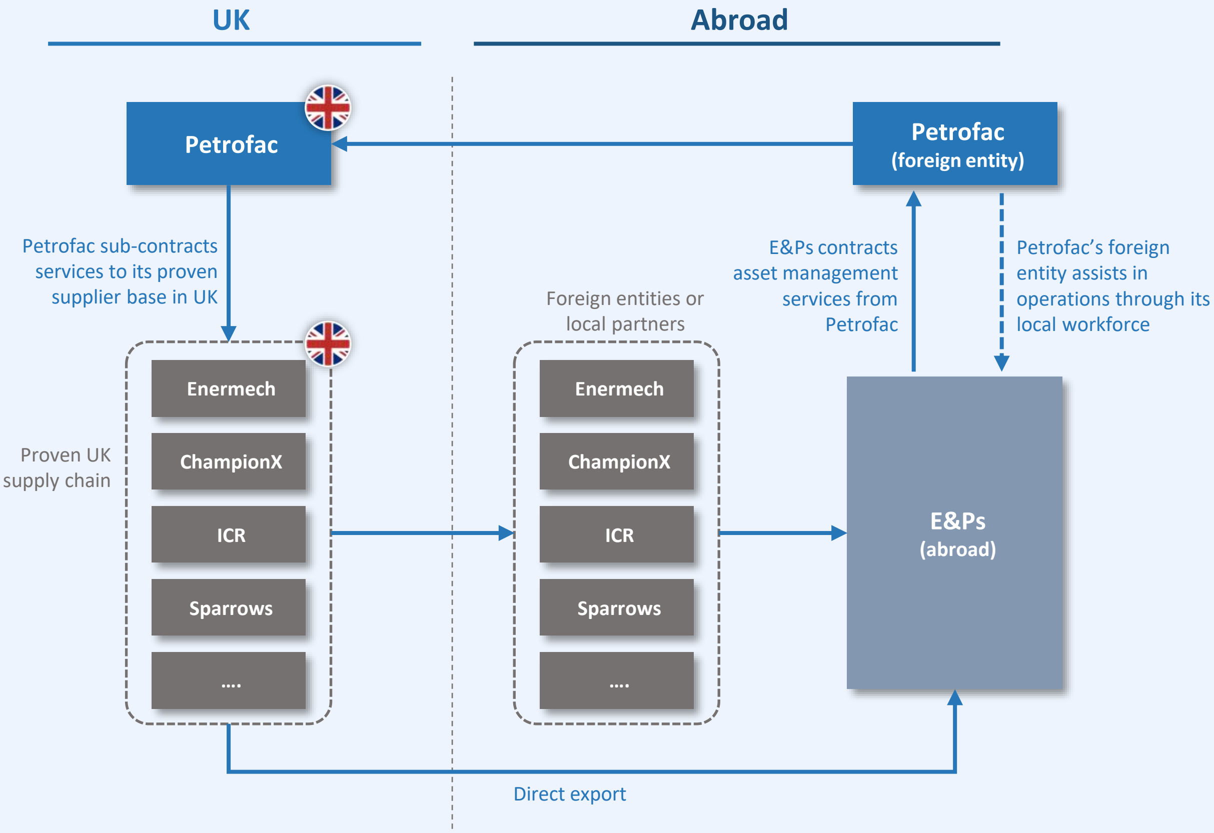
Smaller UK supply chain companies benefit from large international wins

EXAMPLE: UK supply chain exports

Petrofac is one of the UK's leading oilfield services contractors, with more than £2 billion in revenue in 2022 and more than 8,500 employees across the globe. The UK-listed contractor designs, builds, manages and maintains infrastructure in oil and gas, refining, petrochemicals and renewable energy. The contractor relies heavily on smaller subcontractors to deliver its vast range of services for its clients.

With its long-lasting track record and experience in the domestic UK market, Petrofac has established a base of proven local supply chain companies in the UK that delivers products and services to Petrofac's projects, including suppliers such as ChampionX for chemicals, Sparrows for maintenance and certifications of cranes, and other lifting equipment, and Enermech for power tools, plant and equipment and lifting gear services, ICR for specialists repair, inspection and integrity solutions, among others.

UK-based sub-contractors also play a key part in Petrofac's operations abroad. When Petrofac's UK entity is contracted from the foreign Petrofac entity, Petrofac sub-contracts services to its local supplier base in the UK, which then delivers services to the client through direct export or through its own foreign entities or local partners while Petrofac's foreign entity is assisting operations with its local workforce.



Source: Rystad Energy research and analysis; industry interviews

Domestic UK O&G supply chain market to gradually decline towards 2040

UK supply chain capabilities have retracted with the shrinking domestic demand. The trend is likely to continue with a gradual market decline towards 2040 unless alternative market mechanisms step up.

The domestic UK's oil and gas supply chain market experienced a significant downturn following the 2014/2015 oil price collapse, and it has since struggled to regain its former strength.

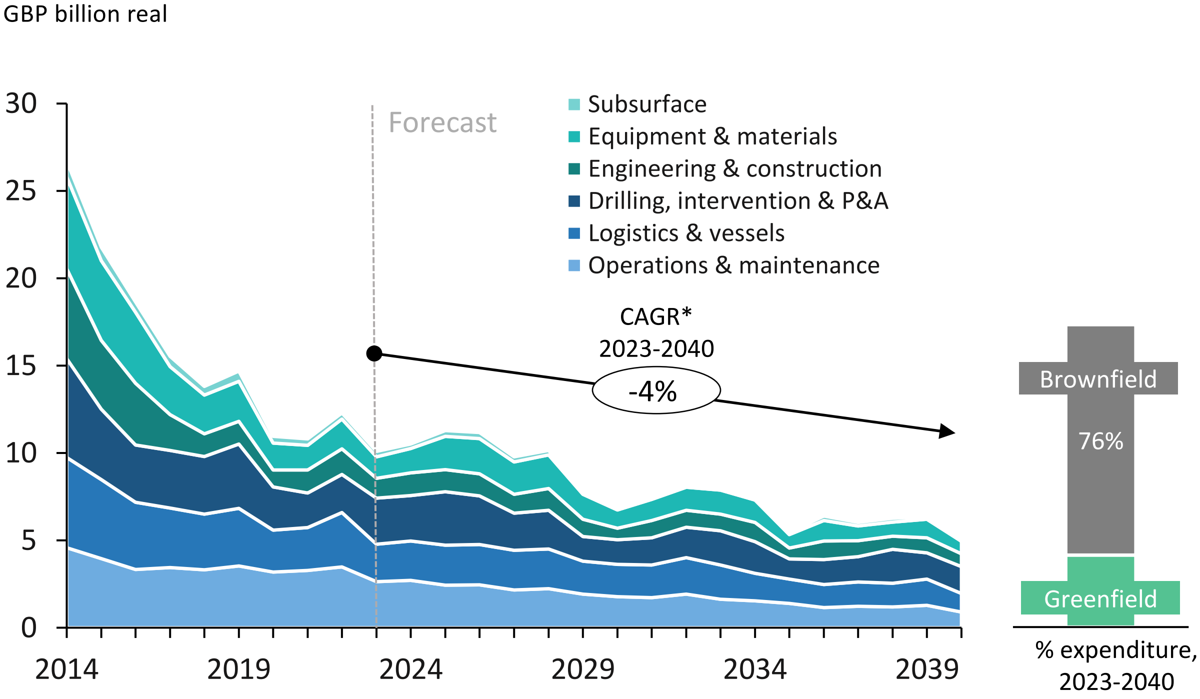
As of this year, the domestic UK supply chain market is valued at approximately £11 billion, which represents a near 60% decline from its peak in 2014 in real terms, driven by deteriorating demand within the equipment and materials as well as the engineering and construction segments, where both segments have been decreasing by more than 70%. The significant decline can be attributed to shrinking investments in new oil and gas projects.

Decreasing domestic demand for services has led to companies scaling down local operations and manufacturing capabilities and outsourcing services to other countries. The fabrication and construction segment is an area where the UK's domestic capability has decreased over the years due to low domestic demand, uncompetitive labour costs, and a global value chain dynamic with substantial competition from international players.

The UK's capability in the subsea installation and survey sub-segment has developed in a different direction with more stable domestic demand and global export opportunities and less international competition.

The domestic UK market is projected to remain stable in the short term before gradually declining towards 2040 at an annual rate of 4% from 2023 levels, making potential export opportunities vital to keeping local capabilities alive in the years to come.

UK upstream and midstream capex and opex expenditures per year by segment



*CAGR: compound annual growth rate

Source: Rystad Energy research and analysis; Rystad Energy ServiceDemandCube

Significant upcycle in global O&G market before gradual decline after 2024

Significant short-term upcycle in the global oil and gas market before the market is expected a gradual decline towards the end of the decade.

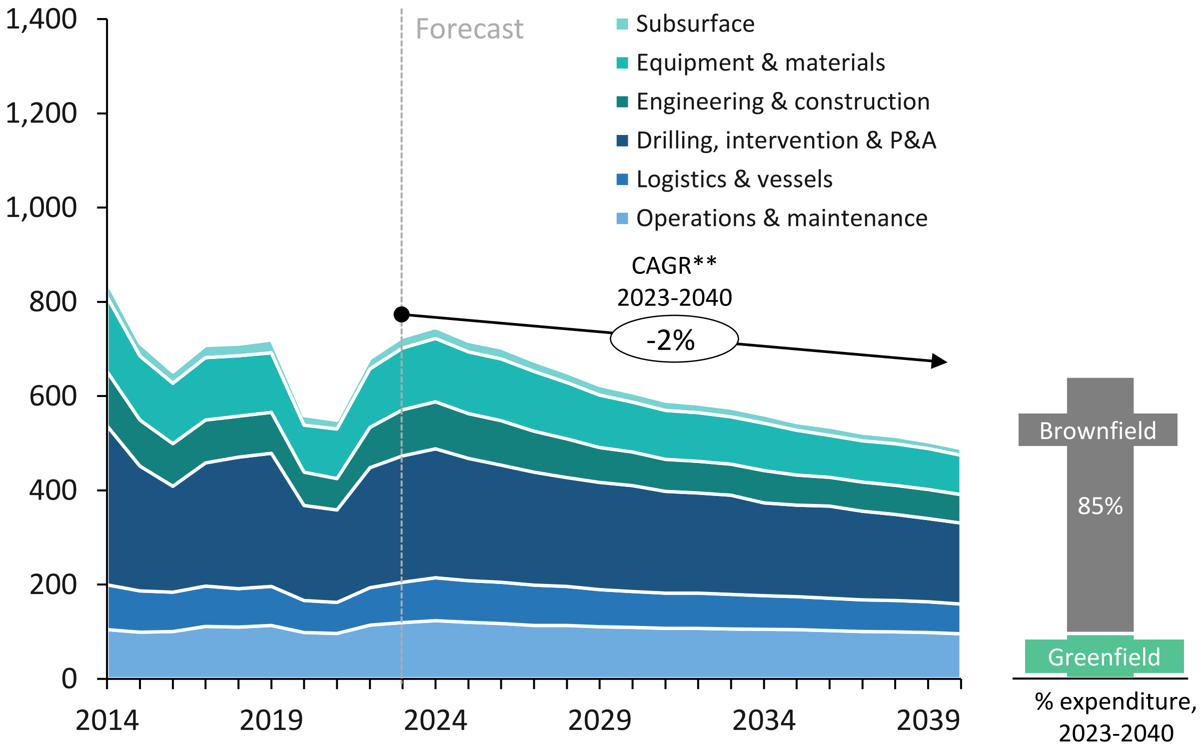
The global oil and gas supply chain market has also experienced a substantial contraction since the 2014 heydays, declining almost 50% from 2014 to 2023 in US dollar terms. However, when measured in pounds sterling, the market has contracted by approximately 15%, mitigated by the strengthening of the pound against the dollar. The global oil and gas supply chain market is estimated at roughly £730 billion in 2023, around 60 times larger than the domestic UK market.

The global market is currently in the midst of a noteworthy upswing, having grown by 30% since the Covid-induced downturn in 2020 and 2021. This growth can be attributed to the resurgence of commodity prices and mounting concerns over the security of supply.

Understanding the magnitude of the export potential for the UK supply chain across each segment becomes crucial for determining the necessary measures and strategies required to preserve the UK's oil and gas supply chain.

Global upstream and midstream capex and opex expenditure per year by segment*

GBP billion real



*Excluding UK domestic market
**CAGR: compound annual growth rate
Source: Rystad Energy research and analysis; Rystad Energy ServiceDemandCube

Addressable domestic and export market set for decline towards 2040

Global exports are unlikely to be adequate to sustain UK supply chain capabilities, given the simultaneous decline in both the domestic UK market and the global addressable export market following the short-term upcycle.

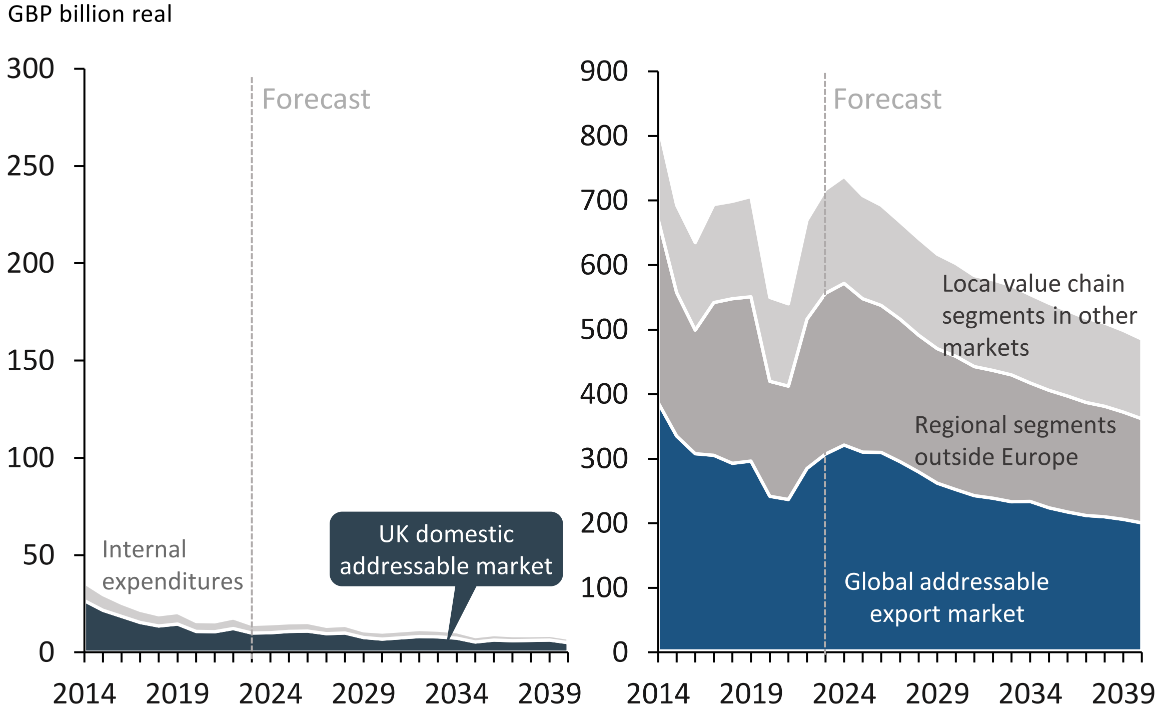
UK supply chain companies' addressable market is made up of the domestic UK market as well as the global export market.

The global addressable export market is derived by starting with the global oil and gas supply chain market (excluding the UK domestic market). The next step is to exclude local value chain segments, such as maintenance and integrity or logistics and supply bases, as these have limited export potential for UK entities. This means that only regional and global supply chain segments are considered for export potential.

The final step is to exclude the regional segments outside Europe such as onshore drilling rigs and equipment, supply vessels, among other. The global addressable export market for the UK supply chain then includes the regional and global segments in Europe as well as global value chain segments in the global market, and amounts to roughly £300 billion in 2023, which is around 30 times the domestic addressable market excluding internal expenditures. The global addressable export market is currently in a significant upcycle before a gradual decline is expected towards 2040, with an average annual growth rate of -2% from 2023 to 2040.

While the export of products and services has played a crucial role in preserving the capabilities of the UK supply chain, the diminishing global addressable export market suggests that preserving domestic capabilities may pose increasing challenges. Consequently, additional support mechanisms will likely be necessary to meet the supply chain demand arising from emerging energy verticals.

UK domestic and global addressable export O&G supply chain market*, 2014-2040



*Excluding UK domestic market

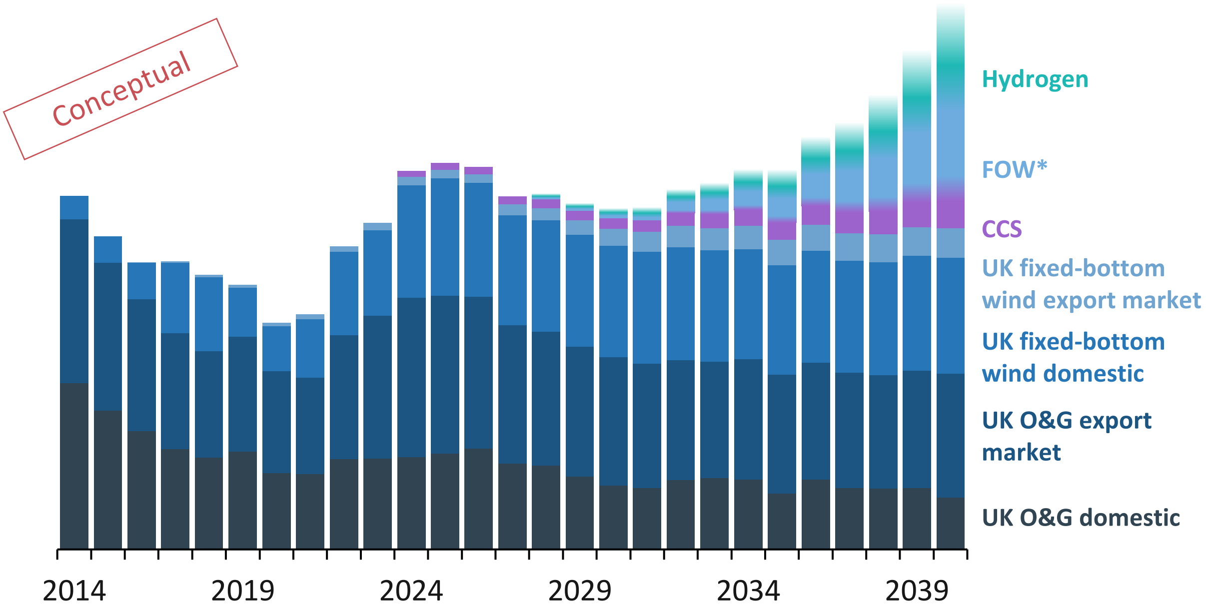
Source: Rystad Energy research and analysis; Rystad Energy ServiceDemandCube

Support likely needed to offset shrinking UK O&G supply chain

The UK oil and gas supply chain will likely need support mechanisms to preserve its capabilities before demand from new energy verticals is expected to take off.

Supply chain demand from new energy verticals will likely take a significant time to materialise. Meanwhile, both the UK oil and gas supply chain export and domestic markets are foreseen contracting, underscoring the need for supplementary support mechanisms to maintain critical capabilities and ensure an equitable energy transition. UK's fixed bottom wind industry have already offered a new avenue for oil and gas players to pivot into. The industry is expected to continue its growth going forward and pull-on certain segments in the domestic UK supply chain.

Conceptual - UK supply chain market



Key questions to be addressed in the report

Addressability	Which supply chain segments in the new energy verticals can UK oil and gas supply chain effectively target and capture?
Materiality	Is domestic market demand from new energy verticals sufficient to keep the supply chains alive?
Capability	What segments in the UK oil and gas supply chain will be of key importance to scale?
Timing	How to ensure that the supply chain will be there to meet the required scale from new energy verticals?

*FOW: floating offshore wind
Source: Rystad Energy research and analysis

Content

Content

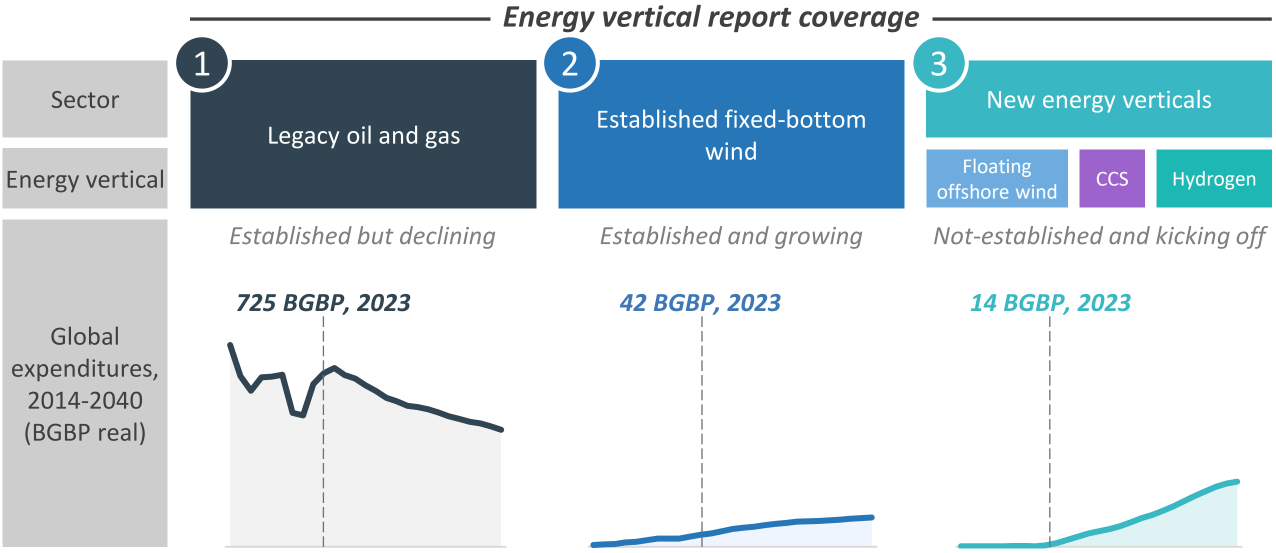
New energy verticals and growing fixed-bottom wind to drive supply chain demand

The ability to deliver on new energy verticals depends on the ongoing dynamics in the legacy oil and gas industry and the growing fixed-bottom wind market.

This report defines three core sectors based on the current and projected market dynamics within each energy vertical:

1. **Legacy oil and gas:** Includes the global upstream and midstream oil and gas market as covered in the previous section of the report. This is a well-established industry with significant market size but is projected to gradually decline towards 2040.
2. **Established fixed-bottom wind:** Includes the already well-established fixed-bottom wind industry. Industry expenditure is estimated at £42 billion in 2023 and projected for an impressive growth of 6% per annum in real terms towards 2040, putting additional pressures on the oil and gas supply chain, which has been pivoting into the emerging fixed-bottom sector in recent years to diversify revenue streams.
3. **New energy verticals:** Includes floating offshore wind, CCS as well as green and blue hydrogen production. The three industries are yet to be established but are expected to be kicking off over the next decade as the energy system is expected to transition away from fossil fuels.

Government targets, project pipelines and economics of supply then lay the foundation for the capacity outlook, which is used to project the capex and opex for each energy vertical. Spending is further broken down into granular cost segments and mapped towards a unified supply chain segmentation. The cost segments are further assessed on targetability by the oil and gas supply chain via current offering/capabilities, together with an assessment of the UK oil and gas supply chain's capabilities within each segment. The capabilities and spending development determines the gap to potential which is used to identify opportunities and challenges for the UK oil and gas supply chain.



Energy vertical assessment

1. Capacity targets and outlooks
2. Projections on capex and opex
3. Cost segment breakdown and mapping
4. Oil and gas supply chain targetability
5. UK O&G supply chain capability
6. Addressable export market
7. Gap to potential analysis

Source: Rystad Energy research and analysis

New energy verticals are needed to offset declining spending in O&G market

Global expenditures in the new and established energy verticals covered in this report will be needed to offset declining expenditure in upstream and midstream oil and gas developments.

Global expenditure in upstream and midstream oil and gas is expected to see a gradual decline towards 2040 after the current upcycle that is expected to roll over 2026-2027, as the world is turning to new and cleaner energy sources to meet energy demand and reduce emissions.

The deployment of the new energy verticals calls for supply chain services. New products and services will need to be developed to meet the challenges these new energy industries will face, but existing supply chain capabilities in the oil and gas industry is expected to play an important role due to overlapping capabilities between the industries.

Additionally, we expect to see the growing demand in the already established fixed-bottom wind industry to pull further on the oil and gas supply chain and further tighten the supply of certain high overlapping segments such as vessels, survey, engineering and subsea installation.

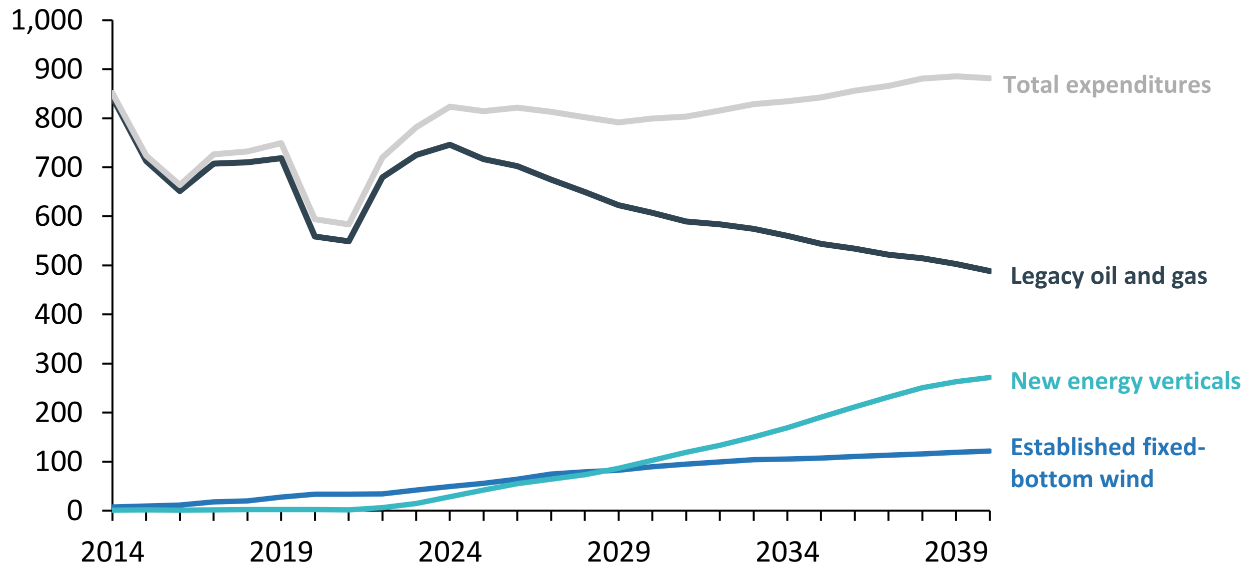
Fuelled by ambitious government and operator targets, investment in new energy verticals such as floating offshore wind (FOW), green and blue hydrogen and carbon capture and storage (CCS) is forecast to grow at an impressive annual rate of 19% from 2023, reaching roughly £270 billion in real terms by 2040. The new energy verticals are projected to surpass investments in fixed-bottom wind by around 2030.

Total energy spending, including oil and gas, fixed-bottom wind, floating offshore wind, green and blue hydrogen and CCS, is expected to reach close to £900 billion in 2040, driven by healthy growth in the CCS segment, which is expected to account for 13% of the market in that year.

Total energy spending are expected a peak at just above £800 billion in 2024 before the market sees a contraction towards the late 2020s, after which spending in new energy verticals will turn the tide and bring growth back to the market. It is crucial to sustain supply chain capabilities during this period, recognising the potential erosion of capabilities over an extended period of steady market contraction in the oil and gas sector.

Global energy capex and opex by sector

GBP billion real



Source: Rystad Energy research and analysis

UK positioned as key player in global FOW and in European CCS developments

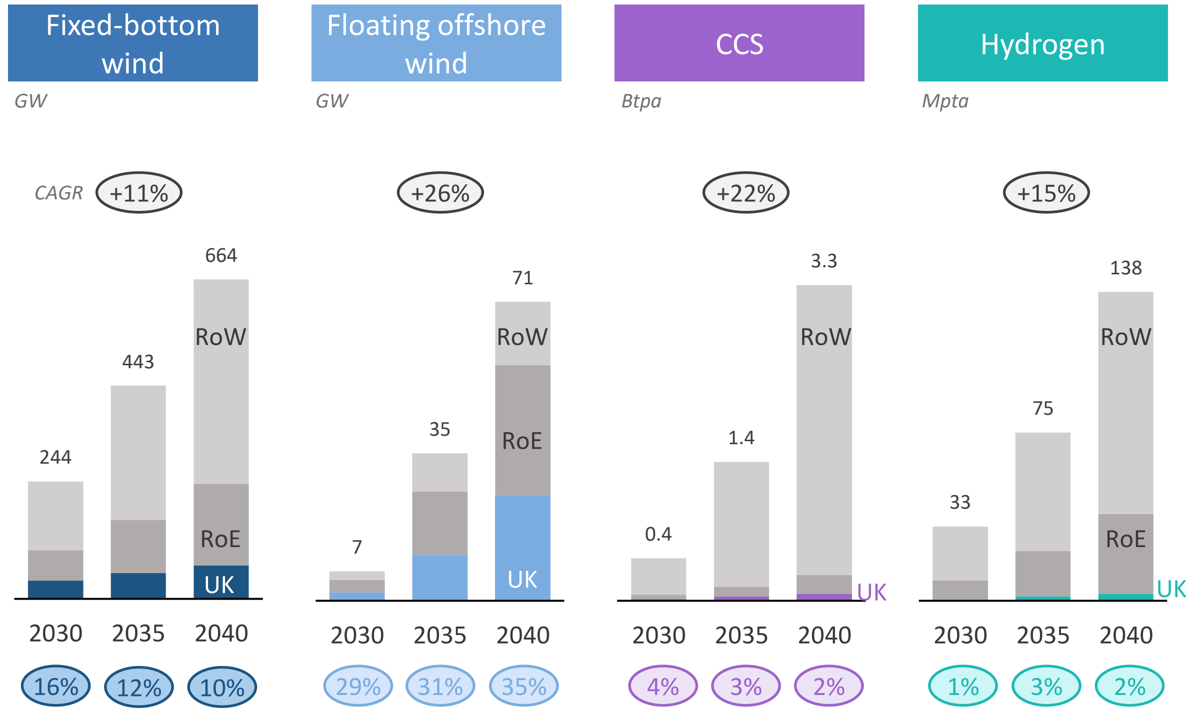
Aggressive government targets will make the UK an early mover and key player in the global floating offshore wind market, while current CCS outlook are ambitious in European perspective.

The UK is set to drive global FOW deployments towards 2040, with its market share set to reach 35% of installed capacity in 2040. The UK will be at the forefront of FOW deployment already in 2030, with an expected installed capacity of 2 gigawatts (GW) accounting for close to 30% of the global market, despite being 3 GW short of the government's target of 5 GW by 2030.

The UK has also set ambitious targets for its CCS capacity with a goal of 20 million to 30 million tonnes (Mt) of CO2 in annual capture and storage capacity by 2030. The UK's current unrisked carbon capture project pipeline holds a cumulative capacity of more than 90 Mt of CO2 per year. By risking the current pipeline based on parameters including project maturity, infrastructure, distance to storage and funding, we estimate the UK to reach a capture capacity of just below 20 Mt of CO2 in 2030. Some 400 Mt of CO2 capacity is projected to be online globally by 2030, which is aligned with the required capacity to achieve the 1.8 degrees Celsius scenario of global warming according to the IPCC's carbon budgets. The limited share of cumulative capacity of only 4% in 2030 may pose challenges for the UK in gaining a first-mover advantage in the CCS sector. However, in the context of Europe, UK is expected to play an important role, and is projected to account for roughly 30% of the CCS capacity in the region towards 2040.

The UK's hydrogen production outlook follows a similar story where the government has set a target of achieving 10 GW of low-carbon hydrogen production by 2030, with at least half coming from electrolytic hydrogen, translating to approximately 0.5 Mt of annual green hydrogen production. Rystad Energy's risked assessment of the UK's green and blue hydrogen pipeline projects an annual production of 0.5 Mt in 2030, constituting about 1% of global production.

Global and UK capacity outlook by energy vertical



RoW = Rest of the world; RoE = Rest of Europe
Source: Rystad Energy research and analysis

Content

New energy verticals to fuel growth in UK energy spending towards 2040

Expenditure in new energy verticals will surpass expenditure in oil and gas and fixed-bottom wind already in the early 2030s, predominantly driven by expansion in floating offshore wind.

During the 2012 to 2014 upcycle, the oil and gas industry in the UK saw roughly £25 billion of annual spending. After the oil price collapsed in 2014/2015, the oilfield service industry faced some tough years, with spending activity within the country plummeting. Spending reached roughly £10 billion in 2023, down more than 60% from £27 billion in 2014. A boost in oil and gas spend is projected towards 2026 driven by Equinor's newly sanctioned Rosebank FPSO development, and the third phase of BP's Clair development. The majority of this capex will be delivered from abroad with the upgrading of Altera's Petrojarl Knarr FPSO in Dubai.

This significant drop in spending levels is primarily driven by a lack of sanctioning and availability of large-scale projects in recent years and has been compounded by cost optimisation measures undertaken by companies since the 2014 oil price crash.

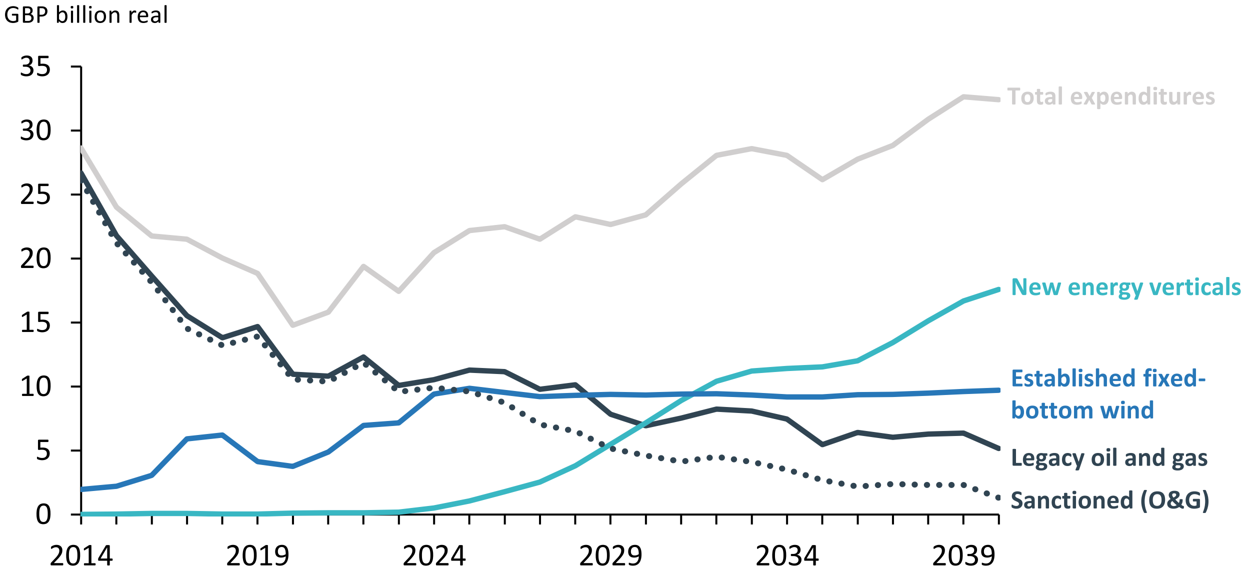
The UK's oil and gas supply chain has eroded with the shrinking domestic activity. Certain segments, however, have been preserved through the industry's capability to export services and products to global markets and pivot to the fixed-bottom wind industry.

The forthcoming wave of new energy investments presents a strategic opportunity for the oil and gas supply chain to further diversify its revenue streams, enhance its capabilities, and extend its reach into international markets.

Projections indicate that spending in new energy verticals will soar to £17 billion by 2040, triple the size of the oil and gas market. New energy spending are anticipated to surpass traditional oil and gas as early as the 2030s, driven by ambitious expansion plans for floating offshore wind, with additional growth facilitated by CCS and green hydrogen initiatives.

The UK has been in the front seat of fixed bottom-wind development globally driven by ambitious government initiatives. Spending in the sector has already surpassed oil and gas spend and is estimated at more than £7 billion in 2023. Spending will remain strong going forward but the growth levels is expected to taper off due cost reductions and lower capacity additions due to constraints on availability of new development areas calling for floating foundations to drive growth further.

UK energy capex and opex by energy vertical



Source: Rystad Energy research and analysis

UK energy expenditure growth driven by capex-intensive energy verticals

The UK's energy expenditure is set to grow, primarily driven by capex. The legacy oil and gas industry has traditionally been opex oriented, but the new energy verticals are shifting the financial landscape.

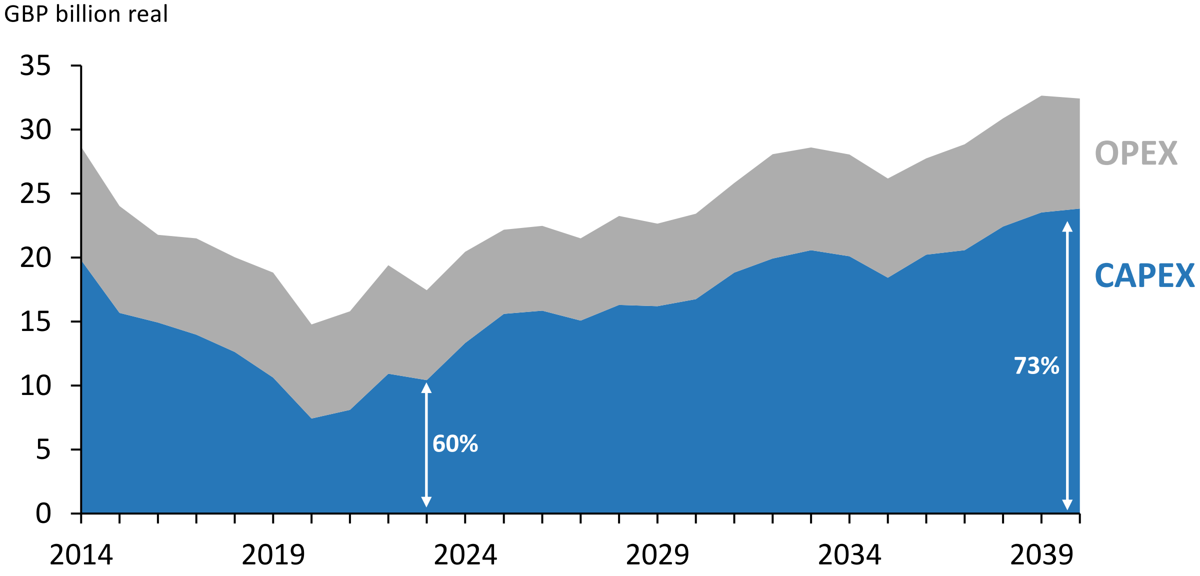
Historically, capital expenditure has been the dominant form of spending. This trend is projected to continue, with capex exceeding £20 billions by the late 2030s. By 2040, capex is expected to comprise over 70% of UK energy expenditure, rising from 60% in 2023.

Until 2022, the oil and gas sector was the primary capex driver. However, fixed-bottom wind investments surpassed oil and gas capex, exceeding £6 billion. Looking towards 2040, fixed-bottom wind, with significant investments in turbines and foundations, is expected to be more capex-intensive than oil and gas. Floating offshore wind is the most capex-intensive energy vertical and is projected to outpace fixed-bottom wind by the early 2030s, with an expected capex of £11 billion by 2040. This shift is attributed to the fixed-bottom wind industry maturing and the subsequent redirection of investments into floating offshore wind. While UK capital expenditure in hydrogen and CCS will be relatively modest compared to fixed and floating wind, these segments are expected to contribute more to UK capex than the oil and gas industry towards 2040.

With a mature UK Continental Shelf (UKCS), operations and maintenance-related expenditure has represented a significant share of total spending, oscillating around £7 billion from 2014 to 2023. UK oil and gas opex is expected to decline to roughly £2 billion by 2040. After 2030, fixed-bottom wind opex is expected to reach more than £2 billion as wind farms age. In contrast, opex for floating offshore wind, which has a younger installed base, is projected to remain below £1 billion until 2040. Opex related to hydrogen and CCS-related opex is expected to account for a larger share of UK opex from 2024 to 2040 compared to floating offshore wind opex.

The transition from an opex-centric oil and gas industry to the development of capex-heavy energy verticals can pose challenges for the UK oil and gas supply chain. This shift requires a transformation in capabilities, moving from primarily brownfield work to engaging in new, complex and technologically advanced design, fabrication and installation.

UK energy expenditure by capex and opex



Source: Rystad Energy research and analysis

Demand from new energy verticals will be more capex heavy than O&G

The forthcoming wave of capacity additions in the UK's new energy verticals boosts demand for capex-intensive segments as compared the current opex-exposed oil and gas industry in the UK.

The UK's oil and gas sector is characterised by its mature base of producing assets driving demand for brownfield spend to maintain production. As its opex is expected to make up roughly 50% of total expenditure in the UK from 2024 to 2040 as limited greenfield development is expected in the country during the timeframe. New developments on the UKCS adds both capex and opex, e.g., the capex and opex profile for Rosebank represents a typical oil and gas project with substantial demand for operational expenditure - around 50% - over its lifetime.

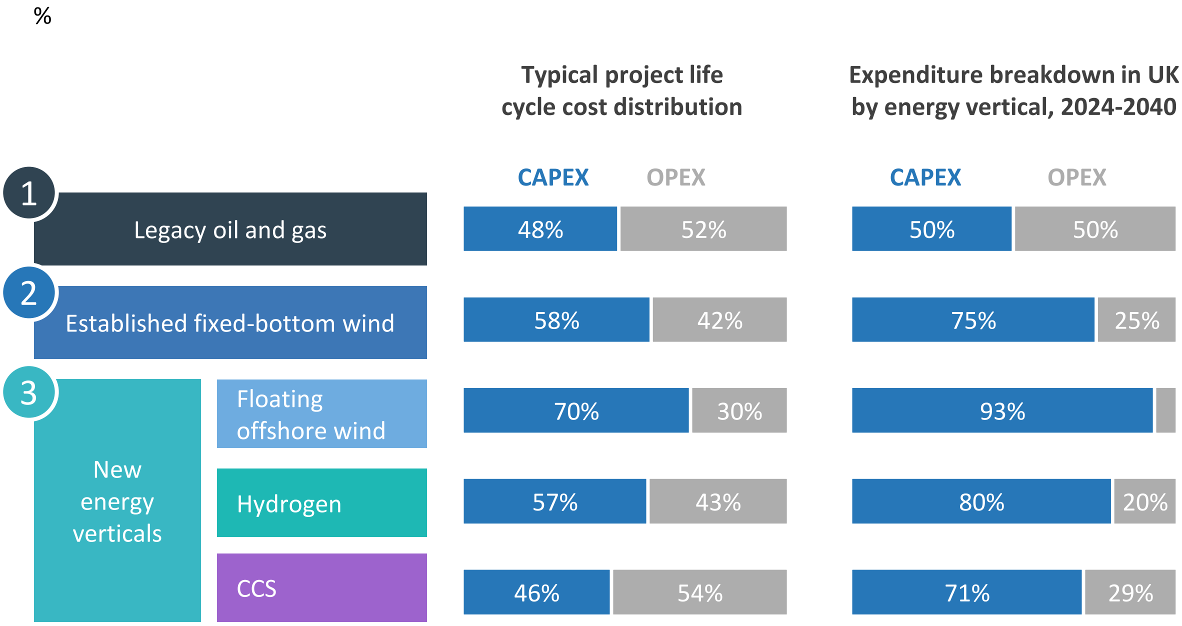
A typical FOW project, on the contrary, has a larger share of capital expenditure, constituting around 70% of project cost, depending on the foundation concept. Total capex is expected to accumulate more than 90% of FOW spending towards 2040 since the opex element of the latest projects included does not contribute with opex before the 2040s. The capex spend will be fuelled by growth in annual capacity additions outpacing the active base of turbines, which is the primary driver for operational expenditure.

The spending profile for hydrogen and CCS is more opex intensive, where opex accounts for roughly 40% of the lifetime cost of a typical hydrogen project with pipeline transportation and underground storage, and 55% for a typical CCS project with onshore capture as well as offshore pipeline transport and storage.

Despite being more opex heavy, CCS and hydrogen spending will be largely driven by capital expenditure towards 2040, propelled by the buildout of new capacity.

This transition from current opex-driven services supporting the oil and gas industry to capex-intensive segments such as fabrication and construction to support the buildout of new energy verticals represents a fundamental shift in capability requirements. This shift poses a potential challenge for the UK's oil and gas supply chain, necessitating strategic adaptation to meet the demands of the growing new energy verticals.

Capex and opex distribution by energy vertical



Source: Rystad Energy research and analysis

New energy vertical segments are mapped against O&G supply chain for comparison

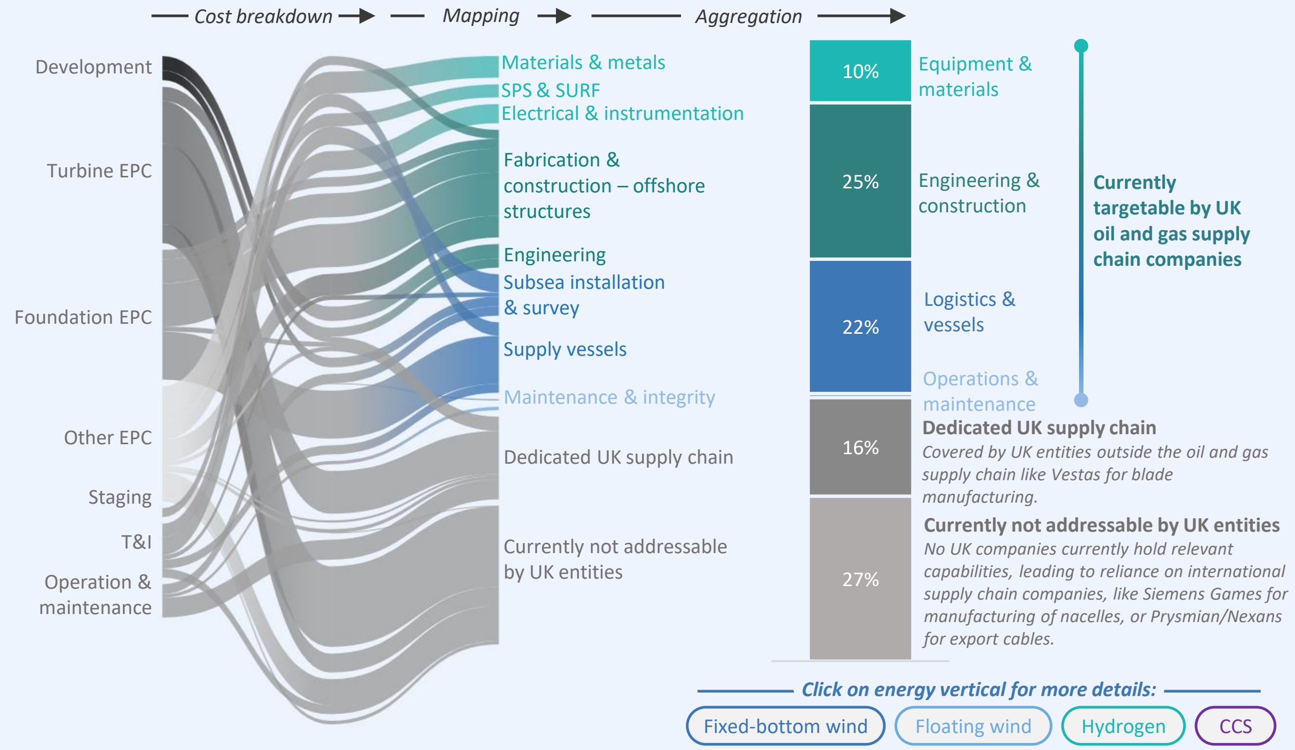
Each energy vertical generally employs its own cost segmentation, typically based on distinct lifecycle phases. For example, the traditional FOW cost breakdown is made up of costs associated with the development stage, EPC of turbines and foundation, while other minor EPC items such as cables and mooring systems are grouped into a third EPC category. After the development and EPC stage, the turbine needs to be integrated with the foundation in the staging phase before T&I at the wind farm location. Subsequently, operations and maintenance costs are incurred after production commences.

Each cost segment is made up of more granular sub-segments such as EPC of nacelles, towers, rotors in the turbine EPC segment, and installation of dynamic array cables, export cables, substations, etc., in the T&I segment.

Mapping these segments to a unified supply chain segmentation, comparable across various energy verticals such as oil and gas, CCS and hydrogen, enables the projection of aggregated demand for each individual segment. The unified segmentation is broadly categorised into six key segments: subsurface; equipment and materials; engineering and construction; drilling, intervention and P&A; logistics and vessels; and operations and maintenance.

Most new energy segments, like dynamic array cable installation and fabrication of foundations in FOW, are deemed addressable by the UK oil and gas supply chain through the subsea installation and survey supply chain and fabrication and construction, respectively. However, certain new energy segments, like nacelle EPC, are beyond reach of the UK's oil and gas supply chain. These segments are either served by dedicated UK supply chain companies or, if no UK companies hold relevant capabilities, are served by supply chain companies outside the UK. See dedicated sections for each energy vertical for more details.*

EXAMPLE: From floating offshore wind cost distributions to a unified supply chain definition



Dedicated UK supply chain
Covered by UK entities outside the oil and gas supply chain like Vestas for blade manufacturing.

Currently not addressable by UK entities
No UK companies currently hold relevant capabilities, leading to reliance on international supply chain companies, like Siemens Games for manufacturing of nacelles, or Prysmian/Nexans for export cables.

Click on energy vertical for more details:

Fixed-bottom wind | Floating wind | Hydrogen | CCS

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*See page 73, 90, 106, and 123, for fixed-bottom wind, floating offshore wind, hydrogen and CCS, respectively

Source: Rystad Energy research and analysis

Targetable spending in new verticals at 60% to 80% against 20% for fixed-bottom wind

Unified supply chain segmentation reveals distinct differences between supply chain sectors, where CCS holds most segments targetable and most similar segment composition as the oil and gas supply chain.

The UK's oil and gas market is largely driven by three segments: the drilling, intervention and plug and abandonment (P&A) segment; logistics and vessels; and operation and maintenance. Together they account for three-quarters of the market.

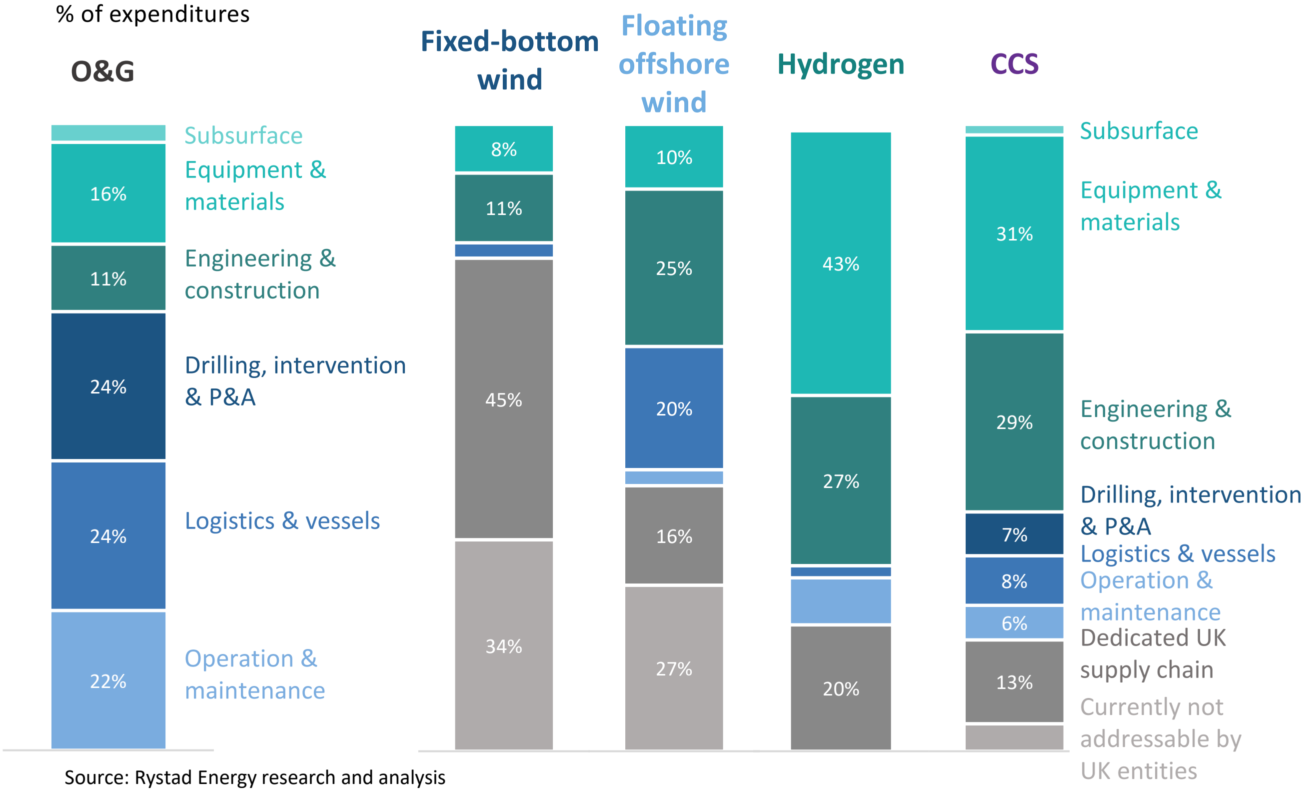
The supply chain segment mapping exercise reveals that just above 20% of the fixed-bottom industry is currently targetable by the oil and gas industry as the sector is largely covered by dedicated supply chain companies with limited presence of oil and gas supply chain companies.

Some 43% of the FOW supply chain is deemed not targetable by the oil and gas supply chain due to the existence of a dedicated wind supply chain, either in UK or in other parts of the world. The rest of the targetable FOW supply chain is largely made up of fabrication and construction of foundations, logistics and vessels used in the tow-out and installation phase. Furthermore, the FOW market requires no drilling, intervention or P&A operations and limited subsurface services.

Roughly 70% of the targetable hydrogen supply chain is made up of capex-intensive segments such as equipment and materials, and engineering and construction. Like hydrogen, the carbon capture and storage supply chain is heavily dominated by two segments. However, here we also see substantial demand for similar products and services found in the drilling, intervention and P&A segment as well as logistics and vessels driven by demand for offshore transportation and storage of CO2. Two segments dominate the CCS market with minor contributions from drilling, intervention and P&A, subsurface and the logistics and vessels segments, driven by offshore well drilling and support for carbon storage.

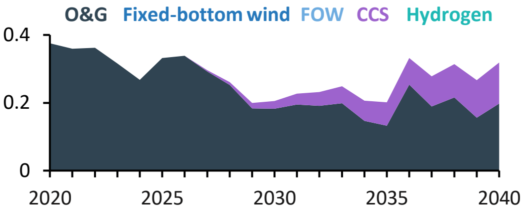
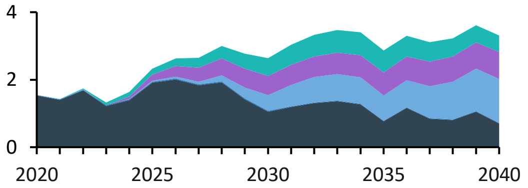
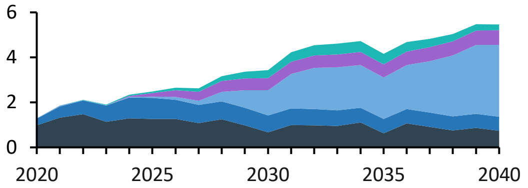
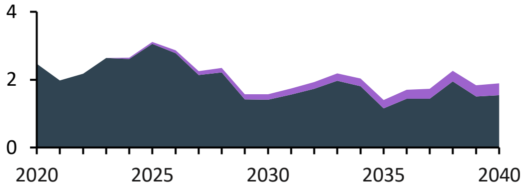
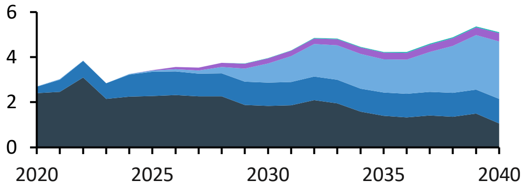
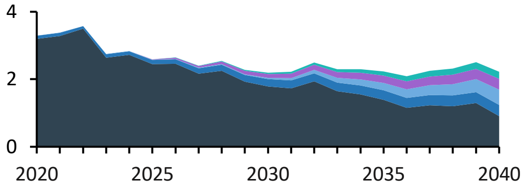
Hydrogen projects also requires very little subsurface services and limited drilling, intervention and P&A.

UK expenditure by unified supply chain segment for each energy vertical, 2024-2040



Source: Rystad Energy research and analysis

UK supply chain growth largely centered in three segments

Segment	Targetable UK spend by vertical (GBP billion real)	Comment
Subsurface		• The UK's subsurface market is set for a gradual decline towards 2040 with limited greenfield developments and exploration expected. • Subsurface demand from offshore storage of carbon will not be able to offset the decline in the oil and gas sector but will key to limit the impact of the shirking oil and gas sector.
Equipment & materials		• Demand for equipment and materials is expected to grow at 4% annual growth rate from 2024-2040, reaching £3.3 billion in 2040 driven by dynamic cables and mooring lines required to meet the aggressive deployment in annual FOW capacity additions. • Growth is further elevated with moderate deployment in CCS and hydrogen creating substantial demand for materials and metals, major equipment as well as electrical and instrumentation.
Engineering & construction		• The targetable engineering and construction services market is expected to be fuelled by the expanding FOW market driven by demand for turbine foundations. • This sector is poised for robust growth, with an expected annual growth of 6% from approximately £1.9 billion in 2023 to £5.5 billion by 2040.
Drilling, intervention & P&A		• The drilling and intervention market is expected a short upcycle towards 2026. The market is then expected to stabilise in the late 2020s with a stable demand for intervention and P&A activities. • Drilling demand from offshore carbon storage will not be able to offset the decline in the oil and gas sector.
Logistics & vessels		• Demand for logistics and vessels is projected a healthy 3% CAGR towards 2040 driven by extensive demand for supply vessels such as AHTS's, and subsea installation vessels used in the T&I phase in FOW. • CCS and hydrogen will have limited contributions to demand for logistics and vessels with demand largely driven by vessel support required in the construction and installation of offshore carbon storage and pipelines.
Operations & maintenance		• The targetable operations and maintenance market will gradually decline towards 2040 ticking in at roughly £2.2 billion, down roughly 19% from 2023 levels. • New energy verticals will have substantial contribution to operations and maintenance spend as the active base of installed infrastructure develops towards the end of the 2030s.

Source: Rystad Energy research and analysis

UK O&G capability and future market growth determines the gap to potential

Low-capability segments with a significant scale gap, such as onshore and offshore fabrication and construction and supply vessels, have a higher gap to potential, than subsurface and drilling segments.

For each category across the new energy verticals, the gap to potential is calculated as a function of the UK oil and gas supply chain's capability within each supply chain segments, and the gap between the current and future market size.

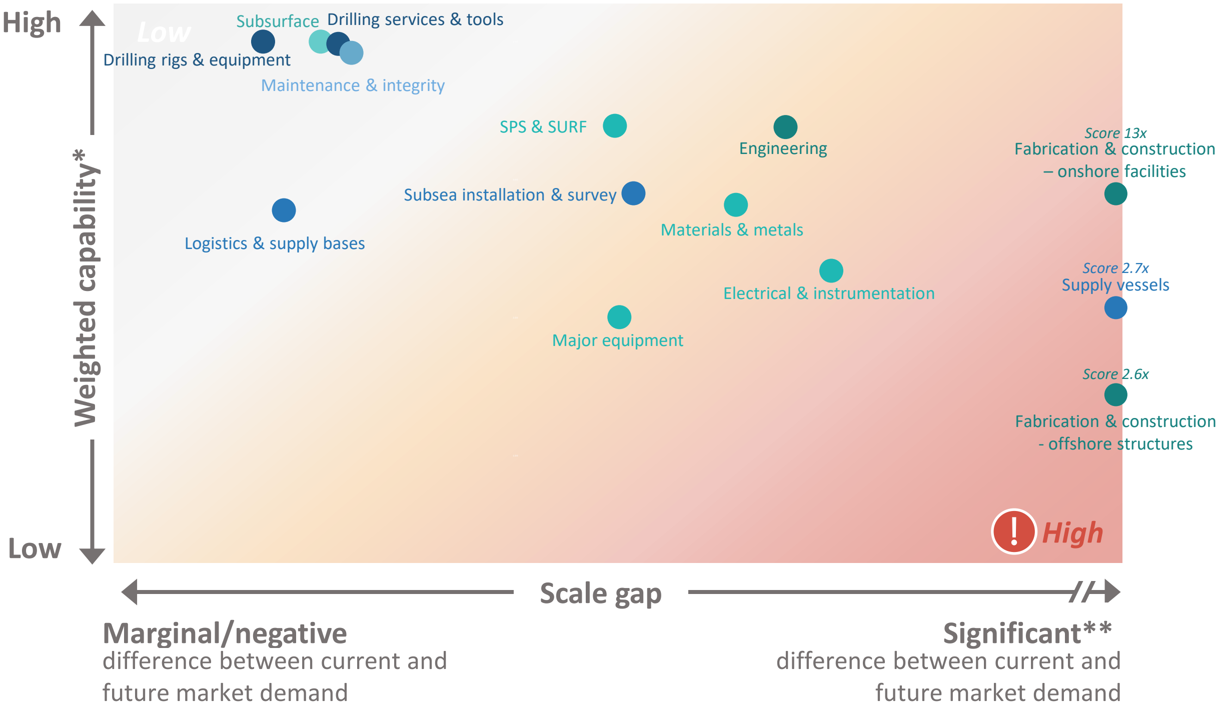
Weighted capability: The UK oil and gas supply chain's capability in each supply chain segment. Capabilities are weighted across each new energy vertical based on the market size and capability of each segment within each energy vertical. The capability assessment of each segment within the new energy verticals is based on OEUK's capability assessment in the report 'Harnessing the potential'. A more detailed breakdown of the capability assessment for each energy vertical is available in the floating offshore wind, hydrogen and CCS section of the report.

Scale gap: The development in demand for each supply chain segment. The scale gap is determined by the difference in current size (peak expenditure between 2019 and 2023) and future size (peak expenditure between 2023 to 2040). A significant scale gap will call for substantial scaling of the supply chain segment to meet future demand, whereas a marginal/negative scale gap requires limited actions.

Supply chain segments with significant scale gap and low capability, such as offshore fabrication and construction, have a high gap to potential and will require significant actions to deliver future demand.

For other segments such as subsurface and drilling services and tools, where capability is high and the scale gap is marginal/negative, we expect the UK to hold the necessary capabilities and scale to meet future demand.

Gap to potential



*Capability based on OEUK assessment. For more details see the floating offshore wind, hydrogen and CCS section of the report, respectively. **X-axis cut at scale gap equal to 150% to illustrate spreads. Accurate score is added for segments with score above 100%
Source: Rystad Energy research and analysis; OEUK

Fabrication and construction segment and supply vessels identified as critical paths

Segment category	FOW capability*	CCS capability*	Hydrogen capability*	Energy vertical relevance	Weighted capability	Scale gap**	Gap to potential
Subsurface	*Not relevant*	🟪🟪🟪🟪	*Not relevant*	🟪	🟦🟦🟦🟦	0.6x	○
Materials & metals	🟦🟦🟦⬜	🟪🟪⬜⬜	🟩🟩🟩⬜	🟦🟪🟩	🟦🟦🟦⬜	1.6x	🟠 !
SPS & SURF	🟦🟦🟦⬜	🟪🟪🟪🟪	*Not relevant*	🟦🟪	🟦🟦🟦⬜	1.5x	🟠 !
Electrical & instrumentation	🟦🟦🟦⬜	🟪🟪🟪⬜	🟩⬜⬜⬜	🟦🟪🟩	🟦🟦⬜⬜	1.7x	🟠 !
Major equipment	*Not relevant*	🟪🟪🟪⬜	🟩🟩🟩⬜	🟪🟩	🟦🟦🟦⬜	1.7x	🟠 !
Fabrication & construction - offshore structures	🟦⬜⬜⬜	*Not relevant*	*Not relevant*	🟦	🟦⬜⬜⬜	2.8x	🔴 !
Fabrication & construction - onshore facilities	*Not relevant*	🟪🟪🟪⬜	🟩🟩🟩⬜	🟪🟩	🟦🟦🟦⬜	13x	🔴 !
Engineering	🟦🟦🟦⬜	🟪🟪🟪🟪	🟩🟩🟩🟩	🟦🟪🟩	🟦🟦🟦⬜	1.7x	🟠 !
Drilling rigs & equipment	*Not relevant*	🟪🟪🟪🟪	*Not relevant*	🟪	🟦🟦🟦🟦	0.9x	○
Drilling services & tools	*Not relevant*	🟪🟪🟪🟪	*Not relevant*	🟪	🟦🟦🟦🟦	0.9x	○
Subsea installation & survey	🟦🟦🟦⬜	🟪🟪⬜⬜	🟩🟩⬜⬜	🟦🟪	🟦🟦🟦⬜	1.3x	🟠 !
Supply vessels	🟦🟦⬜⬜	🟪🟪🟪⬜	*Not relevant*	🟦🟪	🟦🟦⬜⬜	2.7x	🔴 !
Logistics & supply bases	🟦⬜⬜⬜	🟪🟪⬜⬜	🟩🟩🟩⬜	🟦🟪🟩	🟦🟦⬜⬜	0.8x	○
Maintenance & integrity	🟦🟦⬜⬜	🟪🟪🟪🟪	🟩🟩🟩🟩	🟦🟪🟩	🟦🟦🟦⬜	0.9x	○
Facility leasing				*Not relevant*			
Decomissioning & abandonment				*Not relevant*			

Medium to high capabilities across the equipment and materials supply chain segment and strong growth yields a **moderate gap to potential**

UK oil and gas supply chain holds low capability in fabrication and construction of offshore structures required for floating offshore wind projects. Demand projected to grow by 2.8x towards 2040. Low capability, high scale gap yields a **high gap to potential**

Despite a medium-high capability in fabrication and construction of onshore facilities required for hydrogen and CCS plants, the 13x demand increase yields a **high gap to potential**

Moderate capability in supply vessels and 2.7x demand increase yields a **high gap to potential**

*Capability based on OEUK assessment. For more details see the floating offshore wind, hydrogen and CCS section of the report, respectively. **Scale gap calculated as peak expenditure 2023 – 2040 / peak expenditure 2019-2023
Source: Rystad Energy research and analysis; industry interviews; OEUK

FOW ports will be critical in solving UK's fabrication and construction demand

Fabrication & construction – offshore structures

FOW capability*	CCS capability*	Hydrogen capability*	Energy vertical relevance	Weighted capability	Scale gap**	Gap to potential
🟦⬜⬜⬜	*Not relevant*	*Not relevant*	▬	🟦⬜⬜⬜	2.8x	!

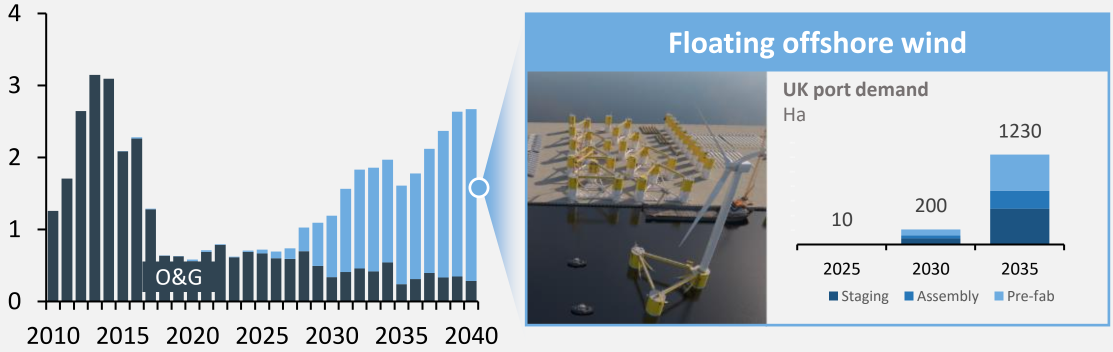
The surge in demand for floating offshore wind from the early 2030s onwards results in a critical need to address bottlenecks in offshore fabrication and construction, particularly in port infrastructure.

Port infrastructure requirements depend on the structure of the foundation EPC supply chain. The staging process, involving turbine and foundation integration, should ideally occur locally or close to the wind farm, while substructure assembly can take place at more distant ports. Pre-fabrication of foundation elements is expected to be location-independent, with activities potentially outsourced to countries outside the UK, depending on foundation material and concept design. Regardless of the supply chain structure, port infrastructure requirements are anticipated to increase significantly, reaching approximately 15 ports in 2035 covering 50 hectares in an assembly and staging in-country scenario.

Various stakeholders have highlighted and addressed this significant challenge in the industry, with current efforts supported by a £160 billion government grant from FLOWMIS.

UK targetable offshore fabrication and construction expenditure

GBP billion real



Key pain points

① **Under-supply**

Demand for ports far exceed current availability in the UK.

② **Investments/support**

Difficult to secure volumes required to attract private investors, underscoring the need for the already committed UK government support

③ **Design/material/EPC**

The vast option space of design-, material- and contract set-ups hinders first movers of creating scale.

*Capability based on OEUK assessment. For more details see the floating offshore wind, hydrogen and CCS section of the report, respectively. **Scale gap calculated as peak expenditure 2023 – 2040 / peak expenditure 2019-2023

Source: Rystad Energy research and analysis; industry interviews; OEUK

Hydrogen and CCS will boost onshore fabrication and construction demand

Fabrication & construction – onshore facilities

FOW capability*	CCS capability*	Hydrogen capability*	Energy vertical relevance	Weighted capability	Scale gap**	Gap to potential
Not relevant	🟪🟪🟪⬜	🟩🟩🟩⬜	🟪🟪🟪🟪🟩	🟦🟦🟦⬜	13x	!

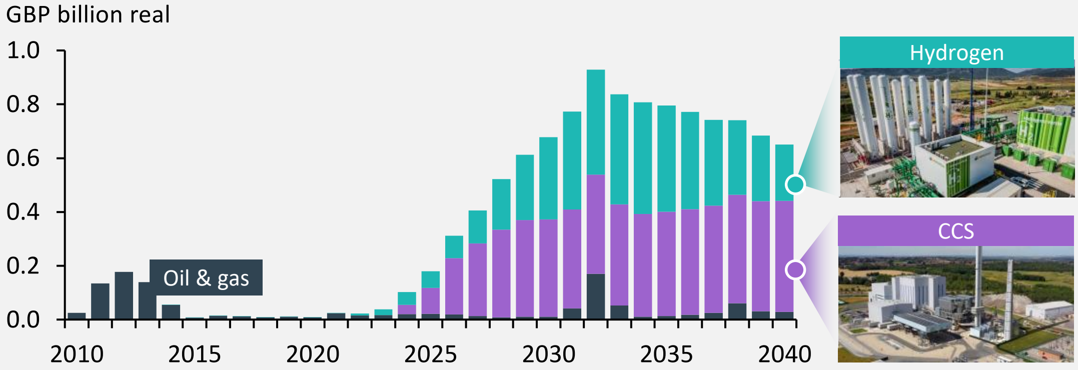
The buildout of CCS and hydrogen production facilities in UK is expected to bring unprecedented demand for onshore fabrication and construction services for energy-related facilities.

Since the UK oil and gas industry is dominated by offshore production the onshore fabrication and construction segment have traditionally seen limited activity except for minor onshore midstream and downstream infrastructure investments. Where oil and gas as well as offshore wind are independent facilities, CCS and hydrogen have multiple complex interaction points with other industries that can create challenges in obtaining the necessary scaling of the industry.

CCS can be installed not only on existing industrial plants but also on newbuild plants, for example in cases where there are no alternatives for decarbonisation, such as in cement or waste plants. This installation, along with gathering infrastructure, needs to be completed prior to onshore compression, requiring collaboration between a multitude of entities in the UK's industrial clusters.

Green hydrogen value chains often require close integration with grid and energy generation sources, as well as new business models.

UK targetable onshore fabrication and construction expenditure



Key pain points

1. **System and location integration**
   Complex integration of carbon capture equipment into existing industrial processes. Co-location of capture equipment and emission source required with remote storage.
2. **Technology development**
   Technology development required to enhance efficiency and drive down cost of electrolysers, SMR/ATR and carbon capture units.
3. **Commercial structures**
   Immature business models and high risk associated with input cost (power and gas prices).
4. **Skilled workers**
   Shortage of skilled workers such as welders, engineers and concrete workers together with high labor costs.

*Capability based on OEUK assessment. For more details see the floating offshore wind, hydrogen and CCS section of the report, respectively.**Scale gap calculated as peak expenditure 2023 – 2040 / peak expenditure 2019-2023
Source: Rystad Energy research and analysis; industry interviews; OEUK

Significant number of newbuild AHTS vessels needed to meet FOW demand

Supply vessels

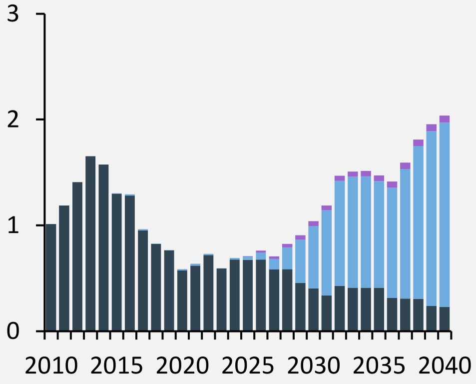
FOW capability*	CCS capability*	Hydrogen capability*	Energy vertical relevance	Weighted capability	Scale gap**	Gap to potential
■■□□	■■■□	*Not relevant*	▬	■■□□	2.7x	!

The UK supply vessel demand is expected to skyrocket throughout 2040, largely driven by AHTS demand in the expanding floating offshore wind market. AHTS demand will be substantial during various stages, including the tow-out of floating substructures from shore to the wind farm site, the hook-up and installation of mooring and anchors, and potentially during the transportation of structures between countries. Fixed-bottom wind will, on the other hand, see limited demand for supply vessels used in the oil and gas industry as the transportation and installation of the turbines and foundations rely on purpose-build installation vessels, heavy transport vessels, larger offshore OCVs, and SOVs and CTVs for maintenance. This calls for a significant scaling up of the UK's AHTS fleet, which is currently largely made up of vessels owned by foreign entities and flying foreign flags.

Some 50% of the UK vessel fleet is ERRVs, predominantly flagged to the UK. The majority of AHTS vessels and PSVs are owned by foreign entities and fly foreign flags.

UK targetable supply vessels expenditure

GBP billion real



	AHTS	PSV	ERRV
CCS	✓	✓	○
FOW	✓	○	○
Fixed-bottom	○	○	○
O&G	✓	✓	✓

Key pain points

1. **UK already out of market**
   Exited from a flag owner and owner view. Of the 22 AHTS in North Sea only three have UK flag and two are owned by UK entities.
2. **Newbuilds needed**
   Supply will struggle to meet demand already by 2030 and AHTS newbuilds will be needed.
3. **Commercial interest misaligned**
   Vessel owners need receipts - long-term firm commitments needed to get financing in place.
4. **Seasonality**
   Highly weather sensitive operations in FOW makes it difficult to take on continuous long-term scopes.

*Capability based on OEUK assessment. For more details see the floating offshore wind, hydrogen and CCS section of the report
**Scale gap calculated as peak expenditure 2023 – 2040 / peak expenditure 2019-2023
Source: Rystad Energy research and analysis; industry interviews; OEUK

Several pain points to be addressed in segments with strong growth

Segment category					Description	Pain points
	Energy vertical relevance	Weighted capability	Scale gap**	Gap to potential		
Materials and metals	🟦🟪🟩	■■■□	1.6x	!	• Diverse set of goods and products including casing, tubing, pipes, valves, actuators, chains, fiber, jewelry, etc. • Large dimensions in FOW • CCS/hydrogen new material requirements (cracking and sour service).	• Manufacturing capacity for specific material and dimension requirements (valves, fiber ropes, jewelry). • Some manufacturing capacity have significant lead times.
SPS and SURF	🟦🟪	■■■□	1.5x	!	• CCS subsea injection infrastructure systems with related subsea trees, manifolds, SURF and monitoring systems. • Dynamic cables for FOW.	• Build fit for purpose SPS & SURF (existing track record from Snohvit and Sleipner). • Flow assurance modelling, leakage monitoring are some of many development needs. • Technology maturity for dynamic cables. • Alignment on kV (22) to scale efficiently. • Few suppliers with dynamic experience from oil and gas.
Electrical and instrumentation	🟦🟪🟩	■■□□	1.7x	!	• +65% onshore work for CCS and hydrogen. • +35% floating wind work, most relates to offshore substation and some onshore transformer.	• For the onshore work scaling challenge is potentially overstated as companies provide services across industries (broader challenge from energy transition with electrification of industries). • Bottlenecks in the OSS segment driven by HVDC is already a bottleneck in fixed-bottom wind and could also impact FLOW. • Technology development in subsea substations for FOW to reduce cost.

Major equipment	🟪🟩	■■□□	1.7x	!	• Electrolyser, SMT/ATR not considered targetable.
					• These are the major equipment that are targetable given the oil and gas experience with handling gases i.e., compressors, thermal exchangers, turbines, etc.
						• Expanding capacity on current equipment such as hydrogen and CO2 compressors.
						• New gases management and material issues (thicker walls, contingencies, steel grades).
						  • Hydrogen: Manage the balance of pressure (cracking) and material cost.
						  • CCS: Purity and material consideration.

Engineering	🟦🟪🟩	■■■□	1.7x	!	• STEM talents are highly versatile and can be deployed broadly from offshore to onshore. • Specific offshore capabilities are highly relevant for CCS and FOW.	• A lot of talent already working on fixed-bottom wind. Engineering spend in UK fixed wind at £240 million in 2023 compared to £430 million in oil and gas. • Energy transition puts significant strain on STEM talents to be deployed and the industry cannot scale without it.
Subsea installation and survey	🟦🟪	■■■□	1.3x	!	• Key segment of floating and fixed bottom wind, CCS and oil and gas for the OCV segment with offshore crane capacity. • FIV, WTIV, cable layers, SOVs, CTVs not considered part of this segment.	• Vessels already constrained by fixed-bottom • Vessel sharing initiatives in the UK. • Stable demand from oil and gas and growing from fixed wind and accelerating from FOW and CCS puts strain on vessels. • Remobilisation or newbuilds likely needed.

🟦 Floating offshore wind 🟪 CSC 🟩 Hydrogen

*Capability based on OEUK assessment. For more details see the floating offshore wind, hydrogen and CCS section of the report, respectively. **Scale gap calculated as peak expenditure 2023 – 2040 / peak expenditure 2019-2023

Source: Rystad Energy research and analysis; Rystad Energy ServiceSupplyCube; industry interviews; OEUK

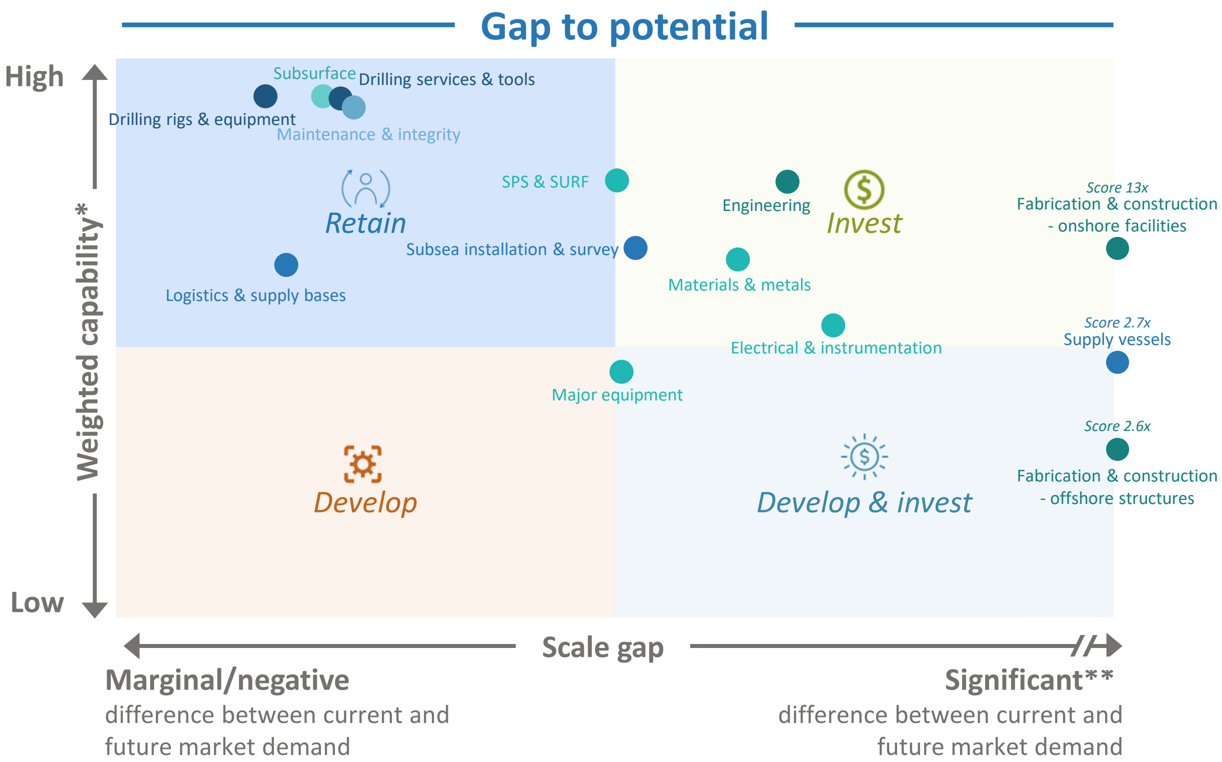
Segments with high capability and significant scale gap call for investments

The gap to potential within each segment can be used to determine the overarching actions recommended to meet the future demand: ‘develop’, ‘retain’, ‘develop & invest’ or ‘invest’. The recommended action for each segment category lays the foundation for further critical pathway assessments.

The most attractive segments lie within the invest category. This category represents segments where the UK oil and gas supply chain can leverage its existing capabilities and will only require investments to build the scale required to meet forthcoming demand. These segments should be prioritised, as the existing capabilities increase the chance of success for UK players to capitalise on the considerable growth potential. Several supply chain segments falls within the invest category, such as onshore fabrication and construction, SPS and SURF and engineering, among others.

Segments with significant scale gap and low capability, however, fall within the develop and invest category as they will require both extensive efforts to develop capabilities in the UK and investments to meet the scale required to meet future demand. Offshore fabrication and construction presents itself as an obvious segment to develop and invest in due to low UK oil and gas capability and a significant scale gap from the current and future market demand. The supply vessels segments also sees a significant scale gap, but the more moderate capabilities places it on the border between invest and develop and invest categories.

Another important category, ‘retain’, includes segments with strong UK supply chain capabilities but limited/negative growth. UK supply chain must hold on to its capabilities in this segment to keep delivering these services in the future, as several of them represent high-volume expenditures that are critical for existing and new energy verticals.



*Capability based on OEUK assessment. For more details see the floating offshore wind, hydrogen and CCS section of the report, respectively.**X-axis cut at scale gap equal to 150% to illustrate spreads. Accurate score is added for segments with score above 100%
Source: Rystad Energy research and analysis

Limited FIDs creates supply chain uncertainty and impede investments

Only a small portion of the project pipeline across floating offshore wind, CCS and hydrogen has a reached final investments decision, creating uncertainty among the supply chain companies and challenge investments in new supply chain capacity.

The UK outlined a very ambitious goal to capture 20-30 million tonnes per annum (Mtpa) of CO2 through industrial carbon capture and storage clusters by 2030. While the UK offers significant funding and incentives, these ambitions may not be realised. The current announced commercial project capacity stands at more than 90 Mtpa – and although this sounds promising – there are no commercial projects in operation or under development so far.

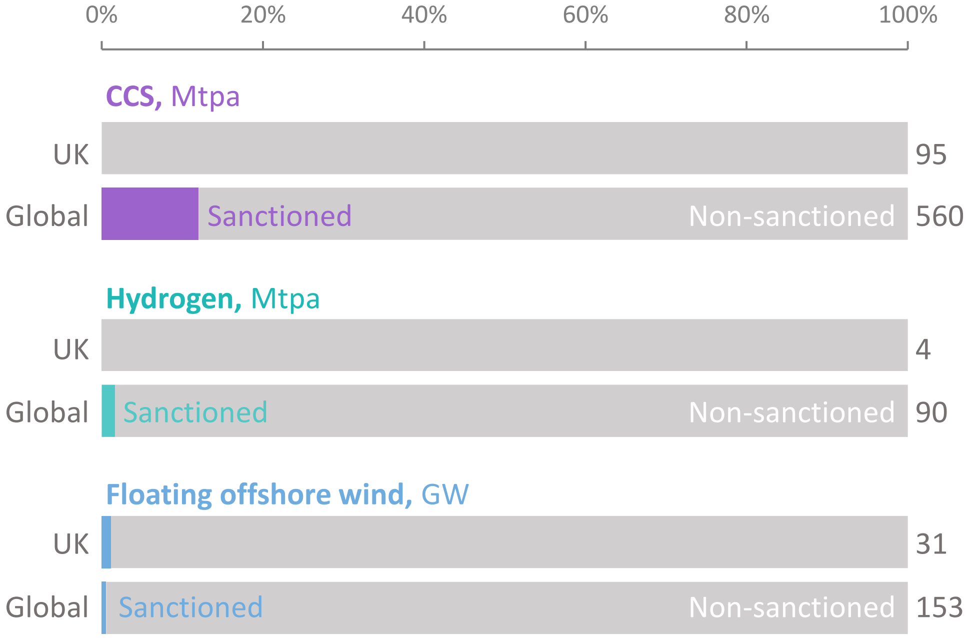
Similarly, only a handful of hydrogen projects have reached final investment decision in the UK, with total production capacity representing less than 0.1% of the current identified project pipeline of 4.4 million tonnes of annual capacity. Several projects are expected to reach FID after the UK government awarded funding to 11 electrolytic hydrogen projects under its first hydrogen allocation round (HAR1) late last year.

The UK's floating offshore wind market is also experiencing limited FID, with less than 500 megawatts (MW) of floating wind capacity being in operation or under development.

The lack of FIDs in sends mixed signals to investors and manufacturers, creating uncertainty and make it challenging to commit to expanding or establishing new facilities. While ambitious government targets provide a roadmap, they alone are insufficient to instill the confidence needed in the supply chain to take on the associated risks of required investments.

Project pipeline to 2040 by sanctioning status

%, announced capacity



Source: Rystad Energy research and analysis

Scattered developer landscape and wide solution space challenges FOW deployment

For FOW to reach full industrialisation the industry must overcome two key challenges. A fragmented developer landscape prevents a full FOW supply chain scale-up. In terms of FOW foundations, the industry must agree on a concept and the material of choice.

The 2035 capacity outlook reveals a highly fragmented developer landscape, characterised by numerous players, each holding modest volumes, as evident from the lower left chart. The 10 largest developers account for around 14 GW out of the global 34GW 2035 Rystad Energy estimate. Another 17% of the capacity outlook is yet to be awarded, and another 14 GW is split between 30-plus developers.

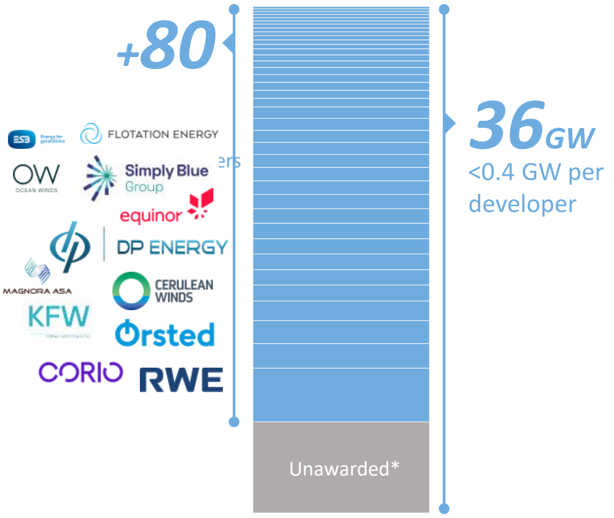
This fragmented nature of the developer landscape constitutes a significant hurdle, likely slowing down the development of the FOW value chain. The prevalence of many developers with small contract sizes hinders the necessary industrialisation pace, as suppliers require larger contracts to scale up their supply chain capacities.

The fragmented developer landscape has contributed to a lack of consensus on the industry standard foundation type. The most suited foundation will vary between projects due to factors such as water depth, seabed conditions, weather conditions, etc. While we broadly categorise various foundations into four categories, over 90 different FOW foundations are still in contention. Most of these still need to be tested and many accommodate both steel and concrete structures. As such, there is significant uncertainty about which design will emerge as the industry standard.

Of the projected wind energy installations set for completion by 2030, over half have not yet disclosed their choice of foundation design, as can be seen from the lower right chart. Currently, semisubmersible foundations are in active use within operational wind farms, having been adapted from established oil and gas industry technologies. This positions them as one of the more advanced and reliable options available.

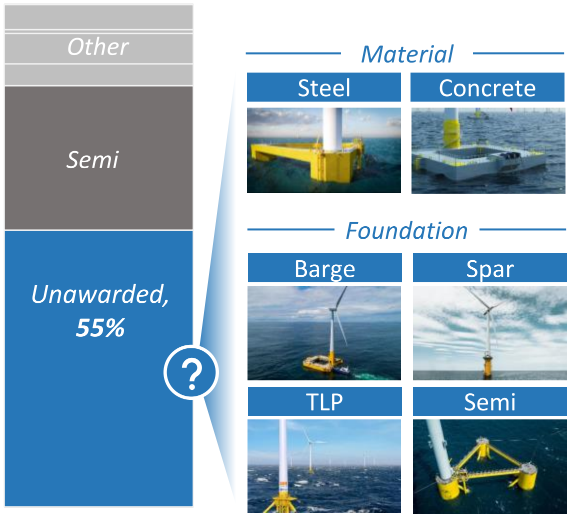
FOW project pipeline to 2035 by developer

%



FOW foundation distribution, 2035

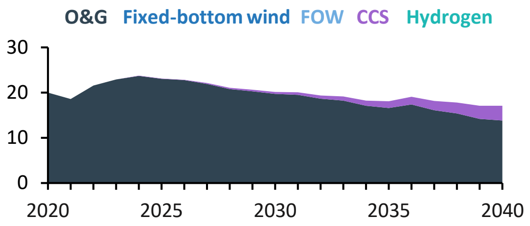
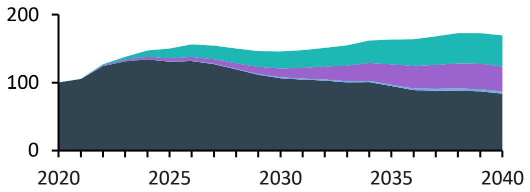
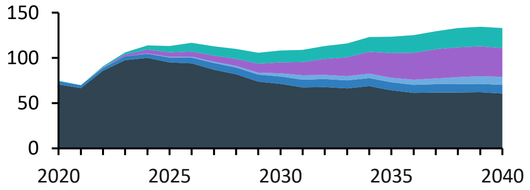
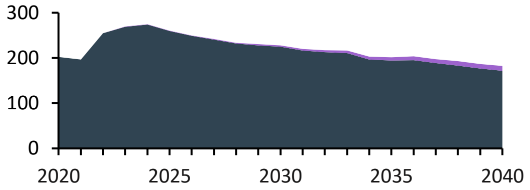
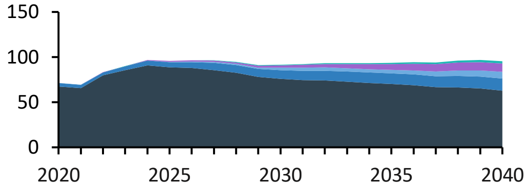
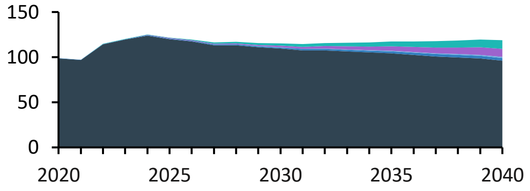
%



*Unawarded refers to announced projects where developer has not yet been appointed, such as Utsira Nord
Source: Rystad Energy research and analysis

Content

Hydrogen and CCS with largest impact on O&G supply chain segments globally

Segment	Targetable global spend by vertical (GBP billion real)	Comment
Subsurface		• Global targetable subsurface market is set for a gradual decline towards 2040 with limited greenfield developments expected. • Subsurface demand from offshore storage of carbon will help offset the decline in the oil and gas sector, with total subsurface market size decreasing by 2% annually, compared to a 3% annual reduction in the oil and gas market.
Equipment & materials		• Global targetable equipment and materials market is expected to grow at a modest 1% annually towards 2040 propelled by capacity additions in CCS and hydrogen which is driven by substantial demand for materials and metals, major equipment as well as electrical and instrumentation. • Limited contribution from fixed-bottom wind towards equipment and materials due to low targetability for oil and gas companies.
Engineering & construction		• Declining demand for engineering and construction services is expected to offset by the expanding market for CCS and hydrogen. • This sector is set for a stable growth projection, with an expected annual growth of 1% from approximately £106 billion in 2023 to £133 billion by 2040.
Drilling, intervention & P&A		• The drilling and intervention market is expected a short upcycle before a gradual decline towards 2040 is expected. • Drilling demand from offshore carbon storage will have limited impact on the global drilling, intervention and P&A market towards 2040 and will not be able to offset the decline in the oil and gas sector.
Logistics & vessels		• Demand for logistics and vessels is projected a flat development towards 2040 where oil and gas decline is offset by demand for supply vessels such as AHTSs and subsea installation vessels used in the T&I phase in FOW. • CCS and hydrogen will have limited contributions to demand for logistics and vessels with demand largely driven by vessel support required in the construction and installation of offshore carbon storage and pipeline.
Operations & maintenance		• Operations and maintenance market is expected to remain stable towards 2040. • New energy verticals will have limited contribution to operations and maintenance spend towards 2040 during the forthcoming growth phase.

Source: Rystad Energy research and analysis

Global addressable market for both CCS and hydrogen far larger than FOW

The potential export opportunity for UK's oil and gas supply chain in new energy segments can be gauged by assessing the global addressable export market for each new energy vertical.

This global addressable market is derived by starting with the global projected market spend from 2024 to 2040 (excluding the UK domestic market). The next step is to exclude currently not addressable segments for oil and gas supply chain companies as some segments are currently covered by dedicated supply chains.

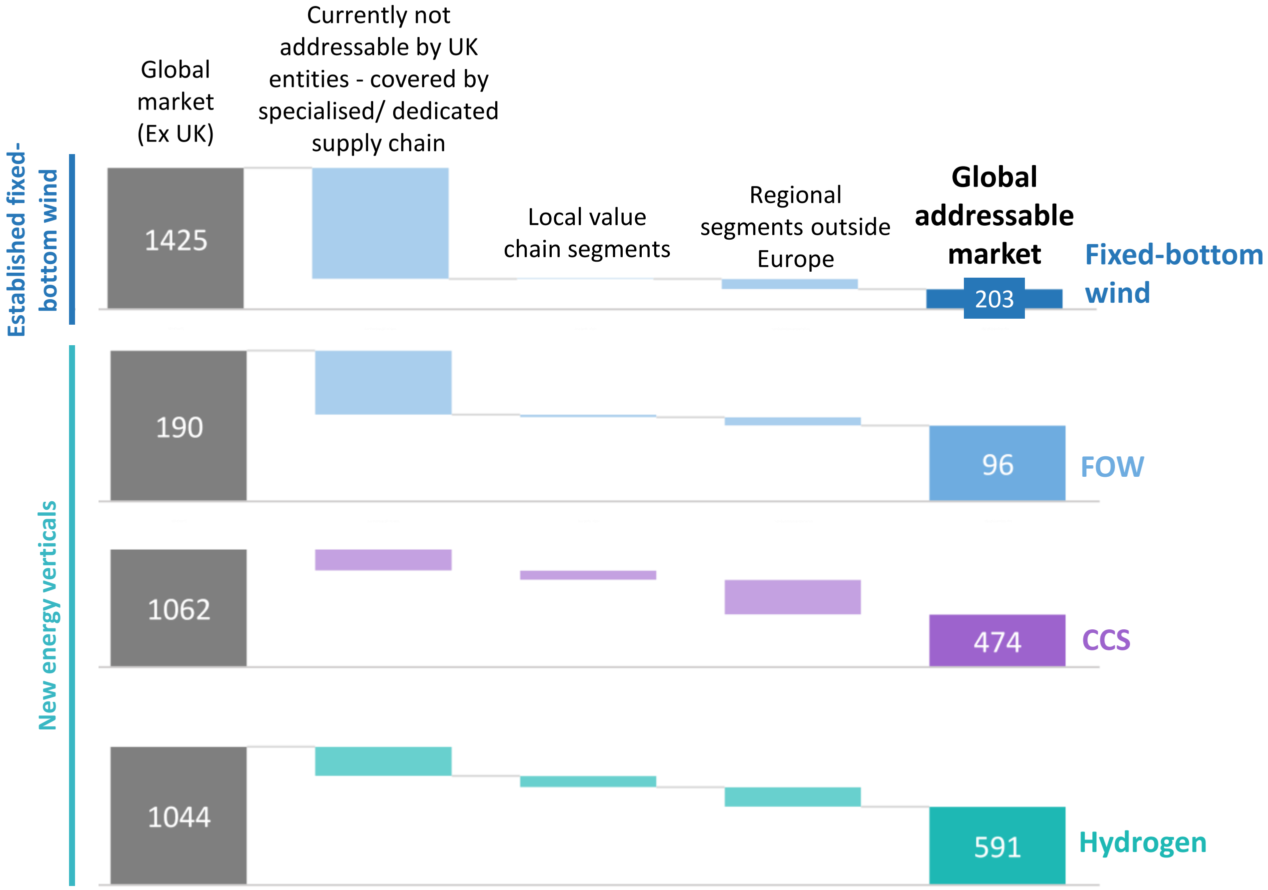
Then we exclude local value chain segments, such as maintenance and integrity or logistics and supply bases, as these have limited export potential for UK entities. This means that only regional and global supply chain segments are considered for export potential. The final step is to exclude the regional segments outside Europe such as drilling tools and services, supply vessels among other. The global addressable export market for the UK supply chain then includes the regional and global segments in Europe as well as global value chain segments in the global market.

The exercise suggests a global addressable FOW market of £96 billion between 2024 and 2040, roughly 40% of the global FOW market (excluding UK).

The global addressable CCS market amounts to approximately £470 billion in the same timeframe, five times larger than FOW, whereas this figure is estimated at close to £590 billion for hydrogen. The size of these two new energy verticals suggests that there will be significant opportunities for UK to deliver in a variety of smaller niche segments.

Global addressable market by energy vertical (excluding UK)

GBP billion real, cumulative 2024-2040



Source: Rystad Energy research and analysis

Denmark's early entry in fixed-bottom wind paved the way for continental supply chains

Despite its maritime history and being one of the early movers, the UK has relied on non-UK players for fixed-bottom wind development, due to its lack of success in establishing a strong domestic supply chain. This can be attributed to a capability mismatch and other European countries utilising the early mover advantage and taking strong positions in their local supply chain.

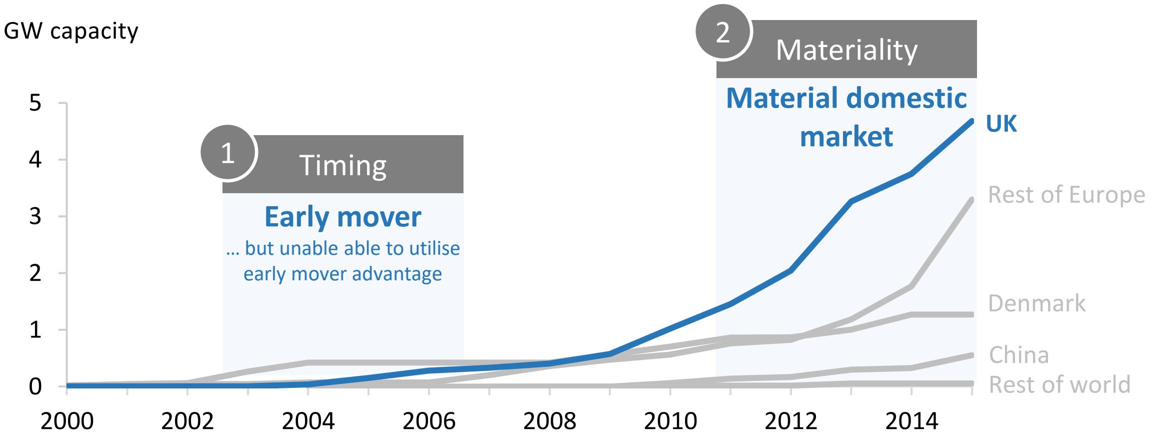
The UK has been one of the leading countries in the development of fixed-bottom wind, only beaten by Denmark prior to 2009. The UK expansion has been driven by governmental funding and ambitious targets. However, this support did not translate into domestic supply chain growth, instead strengthening the position of international supply chain companies in the UK.

The UK supply chain's limited presence in manufacturing and installation of key wind equipment can be attributed to lack of success in being an early mover and a mismatch between existing capabilities and new requirements. Onshore wind experience and Denmark's early entry into fixed-bottom wind bolstered establishment of local supply chain across continental Europe. Non-UK OEMs with decades of experience from onshore wind dominated the fixed-bottom wind supply chain early on, further impeding UK competition. The cost-focused procurement process and the low call for new technology, given the applicability of existing oil and gas technology, also hindered the UK oil and gas supply chain from entry through innovation.

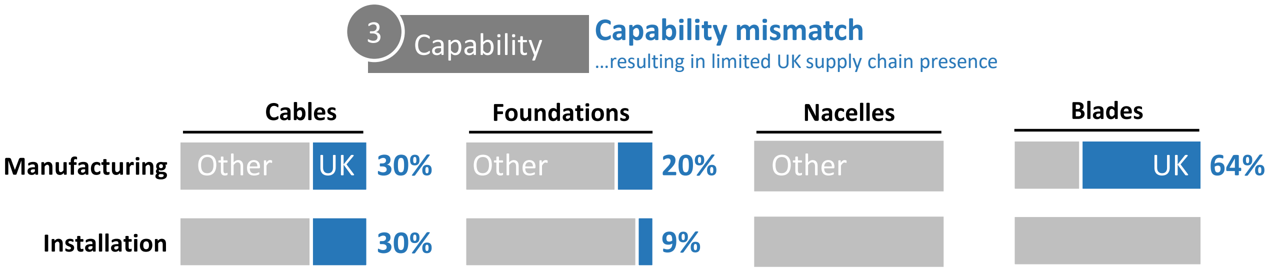
Existing UK offshore supply chain capabilities had limited overlap with fixed-bottom wind, and the offshore wind asset base differed from the oil and gas industry, which prevented a seamless transition to offshore wind. Consequently, non-UK offshore wind supply chain players filled the gap, solidifying their position in the UK fixed-bottom wind supply chain.

This demonstrates that having a material domestic market alone is insufficient to ensure domestic supply chain growth. Seizing the first-mover advantage and leveraging existing expertise are key to develop robust domestic supply chains for new energy verticals.

Cumulative offshore wind capacity 2000-2015



UK-based supply chain companies share of deliveries to the UK in 2000-2023



Source: Rystad Energy research and analysis

Timing, materiality and capabilities are key for success in winning international revenues

The UK's success in winning international revenues is determined by three key parameters. The first is market timing – when will the domestic market materialise compared to markets in other regions? The second is domestic market materiality – is the domestic demand for products and services sufficient to stimulate investment and foster the buildout of new capabilities? The third is the UK oil and gas supply chain's capabilities – does the UK have the required experience to deliver the products and services in demand?

In floating offshore wind, the UK is rated high on the timing element due to the significant 36% projected share of global FOW spend between 2030 and 2040. Furthermore, FOW materiality is considered as high with the domestic FOW market expected to reach £4 billion in 2030, equal to 64% of the oil and gas spending in that year. The UK oil and gas supply chain's FOW capability is considered to be moderate driven by a material targetable project cost of roughly 60% and strong capabilities in certain key supply chain segments.

The assessment of each new energy vertical suggests that the significant materiality and early timing of FOW expansion, coupled with sufficient UK capabilities, mean that the UK can have success in winning international revenues in certain FOW segments.

UK's success in winning international revenues depends on…	***New energy verticals***		
	FOW	**Hydrogen**	**CCS**
1 Timing	**High**	**Moderate**	**Moderate**
Early/late mover in new energy vertical	- UK set to be an early mover, accounting for 25% of global average FOW spending between 2025 and 2030.	- UK will account for 2% of global spending between 2025 and 2030 but is leading the race in Europe on blue hydrogen.	- UK set to be a moderately early mover, accounting for 30% of the European spending between 2025 and 2030.
2 Materiality	**High**	**Moderate**	**Moderate**
Materiality of domestic demand	- Domestic UK FOW market expected to reach £4.2 billion in 2030, equal to 64% of oil and gas spending in that year.	- Domestic UK hydrogen market expected to reach £1.1 billion in 2030, equal to 17% of oil and gas spending in that year.	- Domestic UK CCS market expected to reach £1.9 billion in 2030, equal to 29% of oil and gas spending in that year.
3 Capability	**Moderate**	**Moderate**	**High**
UK O&G supply chain capability	- 57% of cost is targetable by oil and gas supply chain. - UK holds strong capabilities in some of the key sub-segments within logistics and vessels and equipment and materials such as dynamics cables, mooring solutions.	- 80% of project cost is targetable by oil and gas supply chain, mainly driven by two segments engineering and construction and equipment and materials where UK holds moderate capabilities.	- More than 80% of project cost is targetable by oil and gas supply chain, driven by two segments (engineering & construction and equipment & materials) where the UK holds relatively high capabilities.

Source: Rystad Energy research and analysis

Largest potential in FOW but addressable markets are larger in CCS and hydrogen

FOW

- The UK's domestic FOW market is set to gain substantial materiality with average annual spending of £8.2 billion between 2030 and 2040 driven by the country's early commitments and aggressive capacity targets of 5 GW by 2030.
- The UK's share of global FOW spending will reach 36%, and 45% of European FOW spending between 2030 and 2040, respectively. These compelling figures suggests that UK will have a significant headstart against its peers in the race to win international revenues.
- Domestic market materiality coupled with an early mover advantage suggests for an attractive investment opportunity for UK to win European revenues primarily in segments where the UK holds its key strengths, such as mooring solutions, dynamics cables, ports and logistics, and vessels.

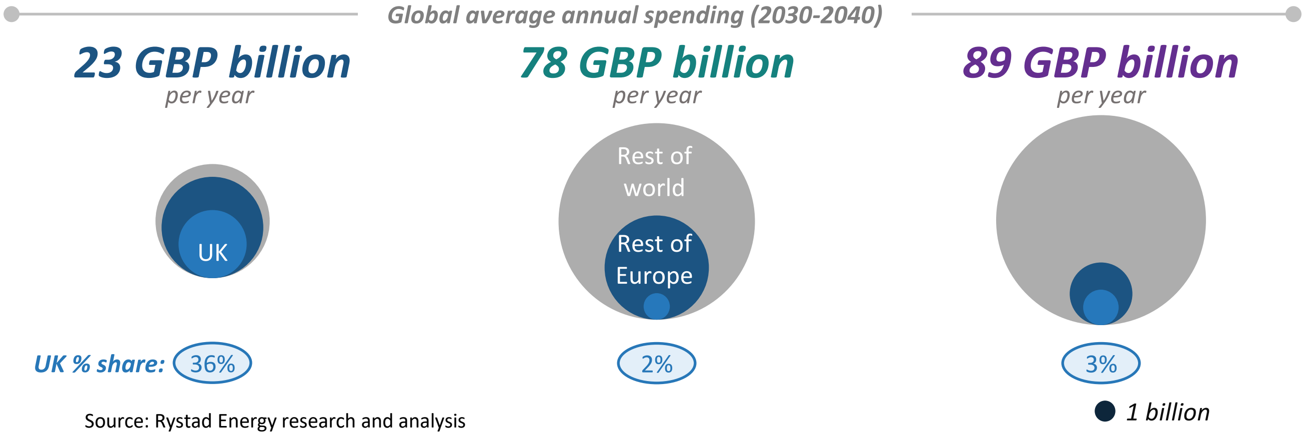
Hydrogen

- Assessment of the hydrogen opportunity is based on the UK as a green and blue hydrogen hub, but leading the race on intermittent renewables share of the power mix, with 33% in 2023 and 67% in 2030, the UK could be a test bed for using hydrogen for balancing the grid either with domestically produced or imported blue or green hydrogen.
- Based on the UK's prominent position in Europe, entities could seek to develop their European hydrogen value chains with the UK as a key hub, particularly within blue hydrogen.
- Engineering, and onshore fabrication and construction rise as the UK's most promising segments due to its strong capabilities and high transferability.
- Storage and midstream infrastructure, hydrogen-ready gas power plants or fuel cells are downstream opportunities that this report has not covered.

CCS

- The integrated nature of CCS projects makes it more difficult to take a large international position.
- Roughly 75% of spend is located onshore and integrated as part of the point source-emission facility it seeks to decarbonise.
- Both the engineering and construction and operation and maintenance scopes at these facilities would be difficult to target as integration with local suppliers in the targeted markets internationally will be necessary.
- Offshore-specific segments could be a possible export value. The UK accounts for 31% of the European market between 2030 and 2040, that historically has been a key competency base for delivering subsea technology globally.
- Well construction and related tools and services, subsea EPCI, subsurface and flow assurance are segments where UK entities should be well positioned to deliver international scopes.

Holding the key enabling technology is key to unlock the potential in the new energy verticals. For CCS, the unlocking technology is the capture unit, for green hydrogen the electrolyser, for blue hydrogen the SMR or ATR, and for floating wind, large turbine size and lean foundation designs will be key to bring LCOE down. The UK oil and gas supply chain currently lacks capabilities related to manufacturing some of these components, which undermines its potential to earn international revenues. For greater success, focusing on key strengths and can offer innovative technology is essential for gaining a competitive advantage in the global market.



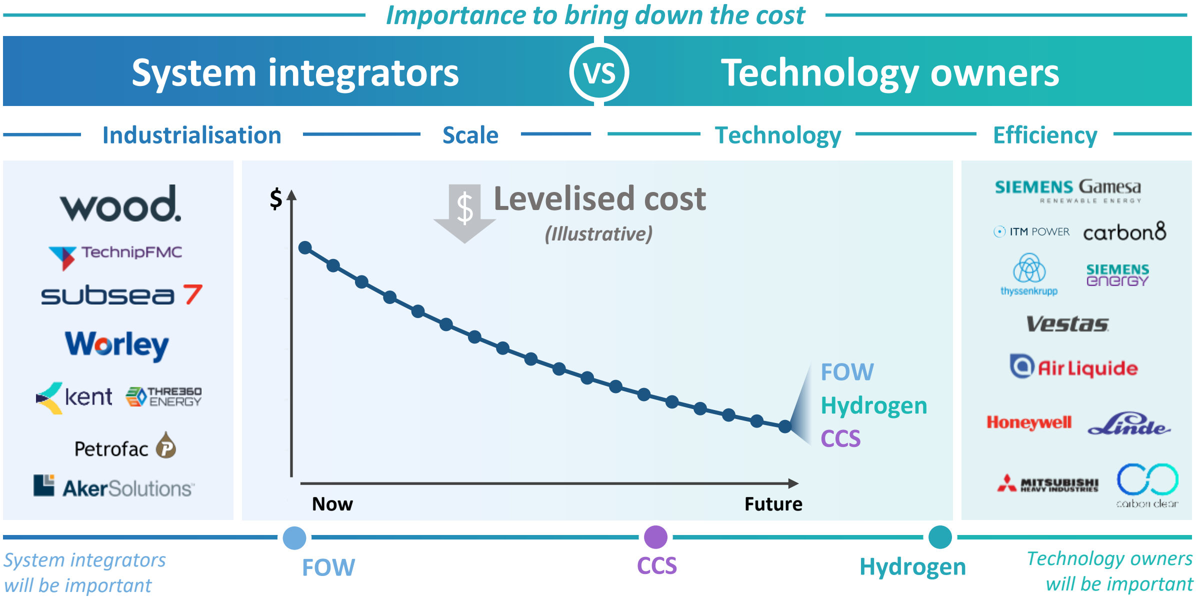
Source: Rystad Energy research and analysis

System integrators and technology owners play key role in forming the supply chain

System integrators and technology owners play key roles when the supply chain for new emerging industries is developed, largely due to their ability to drive down the project cost.

In industries where the enabling technologies make up the majority of project capex, technology owners have a significant advantage to take a leading role in the supply chain. As seen in the fixed-bottom wind industry, where turbine EPC makes up roughly 40% of total project capex, the supply chain is now largely controlled by turbine original equipment manufacturers (OEM) such as Siemens Gamesa and Vestas. Technology owners are also expected to play a major role in low-carbon hydrogen and CCS supply chains, where the SMR/ATR with carbon capture accounts for around 40% to 55% of blue hydrogen project capex, and the electrolyser package around 30% to 35% of green hydrogen project capex. Technology owners hold the ability to drive down cost through an increase in efficiency of key input factors such increasing the capture performance of CCS plants and enhance the use of input factors such as electricity in green hydrogen production.

In contrast to fixed-bottom wind, project capex distribution in the floating offshore wind industry is more evenly distributed, where turbine EPC and foundation EPC make up roughly equal shares at 25% to 30% each, lowering the OEMs impact on project execution which opens the opportunities for other companies to grab a leading role in the supply chain. Still increasing MW sizes is key to lowering the cost curve. Companies that can take the role of a system integrator of these complex developments is well positioned to drive down levelised cost through industrialisation and scaling of the FOW sector and will have a significant advantage in the race to control the supply chain. The presence of system integrators and technology owners can drive cost reductions through industrialisation and technology development, which is key for the UK to win the supply chain.



- System integrators are well positioned to drive down levelised cost through industrialisation and scaling of emerging industries by having the ability to bring complex infrastructure projects together and take full responsibility of the project scope.
- System integrators that lack the key enabling technology capabilities need to subcontract key components to other external vendors. This introduces a significant level of risk and uncertainty as these components typically make up the lion's share of project cost and exhibit significant technological immaturity.

- Owners of key enabling technologies generally control the major cost components and have the potential to reduce levelised cost through technology development and efficiency improvements.
- Technology owners have its core competency in the enabling technology and does has typically limited experience in bringing complex infrastructure projects together.

Source: Rystad Energy research and analysis

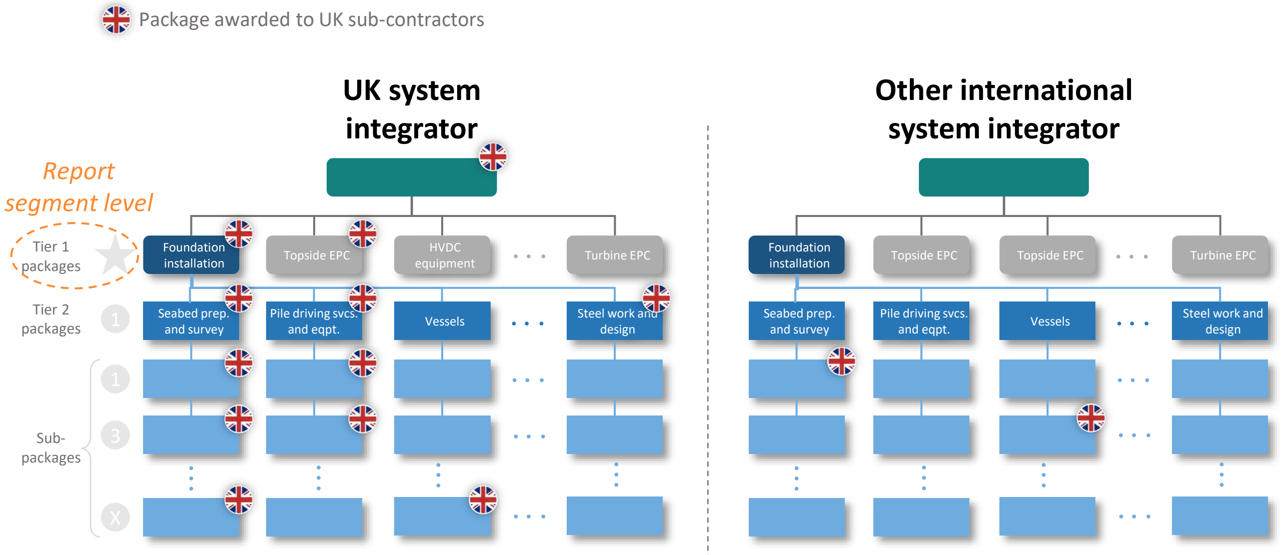
UK-based system integrators will likely bring along local subcontractors

Larger contract packages awarded to system integrators in UK will likely bring significant work for smaller UK based supply chain companies.

Energy infrastructure projects are complex and require a vast range of services and products traditionally delivered by a variety of contractors and sub-contractors. E&Ps and wind farm operators traditionally hand out entire project responsibilities to large system integrators or major project scopes in a few large contract tier 1 packages. These responsibilities are usually awarded to either large engineering houses, construction firms, vessel companies or technology owners. In the fixed-bottom wind sector, we usually see the tier 1 packages, including for example foundation transportation and installation (T&I) traditionally being awarded to larger vessel companies such as Van Oord and Boskalis, turbine engineering, procurement, and construction (EPC) to Vestas or Siemens Gamesa, whereas topside EPC package relevant for oil and gas can be awarded to fabrication yards in Asia. After receiving the tier 1 packages, contractors responsible for foundation installation then traditionally sub-contract the tier 2 packages covering seabed preparation and survey, pile driving services and equipment to other smaller supply chain companies depending on its own in-house capabilities. The tier 2 packages such as seabed preparation and survey requires its own set of tools and services such as ROVs and unexploded ordnance (UXO)-related services, which is likely to be outsourced to other supply chain companies.

The origin of the system integrators have substantial power and will play a critical role in the formation of the supply chain. System integrators traditionally have its own set of preferred sub-suppliers and UK-based system integrators will therefore likely bring along significant work to the local UK supply chain.

Typical contract package setup in fixed-bottom wind and potential impact of system integrators on UK's supply chain



Larger contract packages awarded to system integrators in UK will likely bring significant work for smaller UK based supply chain companies

Fewer packages will likely be awarded to smaller UK based supply chain companies if the system integrator originates outside UK

Source: Rystad Energy research and analysis; industry interviews

UK engineering firms and EPCI holders well positioned for system integrator roles

The UK's diverse landscape of supply chain companies houses some of the largest engineering, project management firms and EPCI companies in the oil and gas industry. The engineering and project management firms include Wood Plc, Kent Plc and Worley, together with EPCI holders Petrofac, and global subsea specialists Subsea7 and TechnipFMC. These industry leaders have played pivotal roles in supporting the burgeoning community of small and medium-sized enterprises (SME) through its role as system integrators, exemplified by the successes of entities like Three60 and Katoni. These large firms hold necessary requirements to take role as a system integrator with full responsibility of project scope in the development of emerging industries, such as floating offshore wind (FOW), CCS and hydrogen. The systems integrators then sub-contract other tier 1 packages where it lack in-house capabilities.

The lack of presence from key enabling technologies and generally low overlap of supply chain scopes in the fixed-bottom wind sector, is likely to have contributed to not being able to secure a strong foothold in the fixed-bottom supply chain.

However, FOW, CCS and hydrogen have the potential to turn out differently with key competence and technology in the country via the current presence of industrial gas giant Linde, together with smaller dedicated CCS and hydrogen companies such as Carbon Clean, Carbon8 and ITM Power and concepts holders within FOW.

It will be particularly important to build scale around the technology owners and craft and support the role of the systems integrator in UK to secure a key role in the emerging supply chains.

Potential UK based system integrators and likley coverage for typical tier 1 contract packages in each energy vertical

✔ High coverage

✓ Some coverage

⊗ Limited coverage

Companies with ability to take on full project scope

Sector	Packages	Engineering & PM Worley kent wood.	EPCI holders Petrofac AkerSolutions subsea 7 THREE60 ENERGY TechnipFMC	Technology owners Linde carbon8 carbon clean ceres ITM POWER
FOW	Development and project engineering	✔	✔	✓
	Turbine EPC	⊗	⊗	⊗
	Other EPC	✓	✔	⊗
	T&I	✓	✔	⊗
CCS	Capture	⊗	⊗	✔
	Transport	✔	✔	⊗
	Storage	✔	✔	⊗
Hydrogen	Production	⊗	⊗	✔
	Transport	✔	✓	⊗
	Storage	✔	✓	⊗

Sub-contracting required where coverage remains limited

Several large engineering and project management firms such as Wood Plc and Worley, and EPCI holders such as Petrofac, Subsea7, TechnipFMC originates or have significant UK presence through local subsidiaries.

No major technology owners in wind, but some CCS and hydrogen companies are located in the UK

Source: Rystad Energy research and analysis; industry interviews

UK with strong position in CCS, but limited tech-owners in floating wind and hydrogen

Electrolysers, carbon capture technology and wind turbines are considered the key enabling technologies in the hydrogen, CCS and offshore wind industries, respectively. The holders of these technologies have a significant advantage to take a leading role in the supply chain during the development of new emerging industries, largely due to their ability to drive down the project cost.

The UK holds a strong position in CCS, housing some world-renowned companies such as industrial gas giant Linde (HQ in Ireland), Aker Carbon Capture, and smaller companies such as Carbon8 and CarbonClean. These UK-based companies hold roughly 16% of the global project backlog by capture capacity from 2023 to 2040.

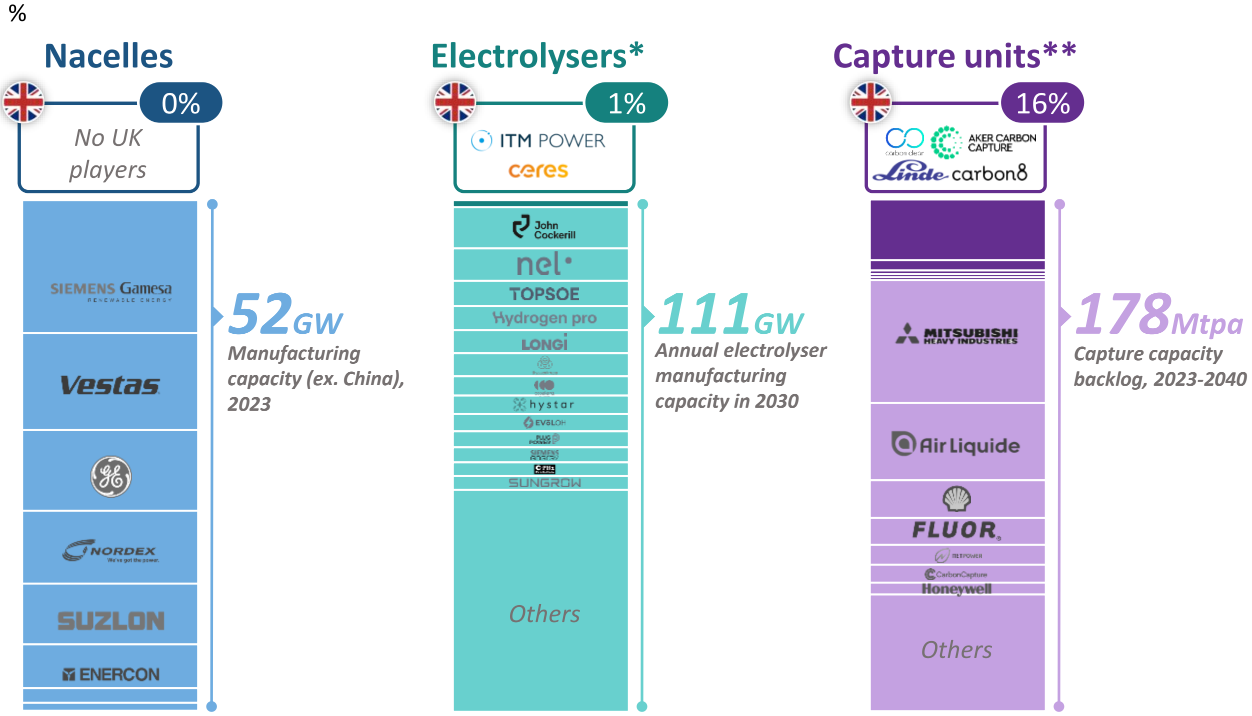
Japan's industrial group Mitsubishi Heavy Industries (MHI) is the largest supplier of carbon capture technologies, largely through chemical absorption, with close to 25% of the global project backlog, followed by French industrial gas company Air Liquide.

The UK hosts several electrolyser companies including ITM Power and Ceres, but the companies only account for around 1% of the global manufacturing capacity from 2023 to 2040. The global electrolyser market is fragmented, with major players such as John Cockerill from Belgium and Norwegian Nel. It is crucial to recognise that electrolyser capacity figures are announced by original equipment manufacturers (OEM) and may not reflect actual production capacity, posing risks due to potential exaggerations in manufacturing expansion plans.

None of the major wind turbine nacelle manufacturers, such as Siemens Gamesa, Vestas and GE, originate from the UK. The UK's failure to gain a significant foothold in the offshore wind supply chain, despite being one of the early movers, can be attributed to the lack of these key technology holders within the country.

To avoid the outcome seen in fixed-bottom wind, the UK must now support the scaling of these key enabling technologies in CCS and hydrogen within the UK to craft domestic supply chains around the technology owners to increase their opportunities to win contracts.

Manufacturing capacity of key enabling technologies per energy sector



*Based on the countries where electrolyser producers originate. **UK suppliers include UK-headquartered companies and UK-subsidiaries

Source: Rystad Energy research and analysis

Four sub-segments identified, each surpassing £100 billion in export potential

The UK's oil and gas supply chain holds substantial export potential, particularly in four key sub-segments that individually surpass the global addressable market for floating offshore wind, valued at £96 billion.

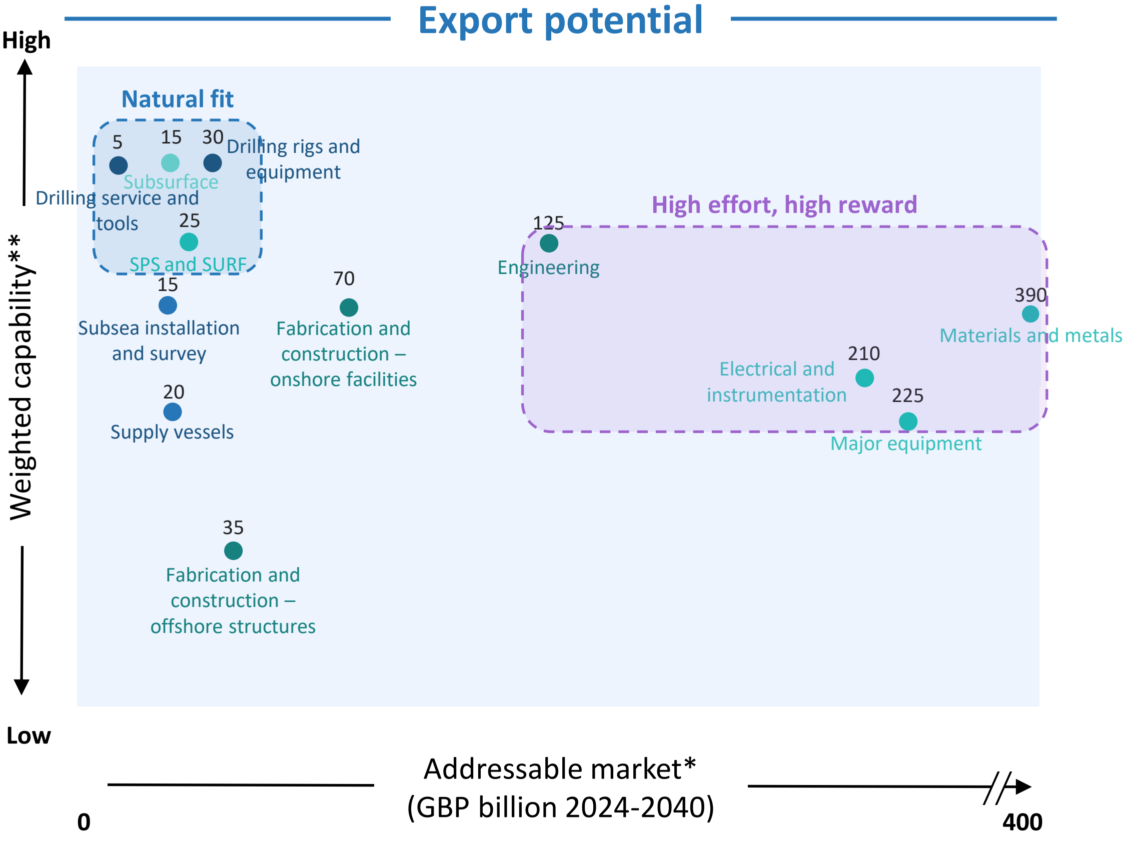
The graph below shows the export potential for UK's oil and gas supply chain. These segments are presented as a function of the weighted capabilities of the current UK oil and gas supply chain along with the respective addressable markets across the new energy verticals.

Highlighted in the graph as 'natural fit' are segments such as subsurface and drilling rigs and equipment, where the UK oil and gas supply chain demonstrates strong capabilities. However, these segments face constraints due to the relatively limited size of their addressable markets, potentially making them less attractive when compared to certain other segments on the graph.

The other category of segments that are highlighted in the graph below as 'high effort, high reward' are the ones with the largest addressable markets. These segments, theoretically, present the most appealing export potentials for the UK oil and gas supply chain.

Nevertheless, in a new and growing market, possessing advanced capabilities is crucial for securing market shares. Therefore, the convergence of high capabilities and a comparatively substantial market size is vital for companies aiming to compete and capture market shares.

Export potential



*Addressable market for each segment is the sum of the spend in the respective segment across three new energy verticals: CCS, FOW and hydrogen. **Capability based on OEUK assessment. For more details see the floating offshore wind, hydrogen and CCS section of the report
Source: Rystad Energy research and analysis

Large, low-capability segments offer export opportunities in niche products and services

The global emergence of the new energy verticals is expected to bring along significant export potential for established UK oil and gas supply chain companies. The potential is present through segments where the UK oil and gas supply chain exhibits strong capabilities, but also extends to specialised niche areas in segments with large addressable markets.

The materials and metals segment makes up the largest addressable market globally throughout 2040, with an estimated market size of almost £400 billion across hydrogen, CCS and floating offshore wind. The segment, which includes pipes, fittings, valves, actuators required largely in the CCS and hydrogen sector, and mooring, anchoring, fibre ropes and jewelry for floating offshore wind is expected to offer significant opportunities for oil and gas players like Hunting, Tata Steel and Acteon.

Major equipment make up the second-largest global addressable market at more than £200 billion from 2023 to 2040, with a crucial role in both hydrogen generation and CO2 capture. Common industrial equipment such as thermal exchangers, compressors, pumps, turbines will be of high demand in the emerging hydrogen and CCS markets throughout 2040.

The natural fit segments, where UK holds the largest probability of success is, made up of drilling related services, SPS and SURF, together with subsurface surfaces. The demand is largely driven by the transportation and storage element of CCS which requires geotechnical and geophysical surveys, drilling rigs and equipment together with subsea equipment such as manifolds, subsea trees and other subsea infrastructure for the subsea CCS injection wells. Dynamic array cables in floating offshore wind also offer opportunities in this segment with an addressable export market of roughly £5 billion. Companies such as TechnipFMC, with its extensive experience within dynamic cables, should be well-positioned to capitalise on this opportunity.

	Sub-segment	Global addressable market, 2023-2040 (BGBP)	Export opportunities in new energy verticals
High effort, high reward *Large addressable markets, lower capability*	Materials and metals	389	• Transferable products such as pipes, fittings, valves and actuators required for CCS and hydrogen. • Mooring, anchoring, fibers and jewlery for FOW.
	Major equipment	223	• Equipment knowledge on turbines, thermal exchangers, compressors and pumps for hydrogen generation and carbon capturing.
	Electrical and intrumentation	211	• Transferable capabilities for flow monitoring, pressure gauging, temprature and composition handling towards CCS and hydrogen.
	Engineering	123	• Transferable expertise within chemical engineering with process simulations, and design expertise for CCS and hydrogen. • Engineering and development in FOW.
Natural fit *High capability and low addressable markets*	Drilling rigs & equipment and drilling service and tools	30	• Drilling rigs and related equipment required for drilling, completions and repurposing og subsea CCS injection wells.
	SPS & SURF	23	• XMTs, manifolds, umbilicals are tranferable segements from the O&G supply chain towards subsea CCS injection infrastructure. • Dynamic array cables are are transferable from the O&G supply chain towards FOW.
	Subsurface	18	• Subsurface understanding and geoscience expertise are highly transferable to T&S in CCS.

Source: Rystad Energy research and analysis

O&G competence proves valuable in technology innovation in new energies

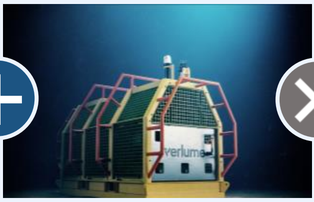
The UK oil and gas industry has decades of experience of working in challenging maritime environments and developing high-tech solutions. UK-based oil and gas supply chain companies can leverage their offshore track record and well-established networks to take strong positions in new energy verticals, such as hydrogen, CCS and floating offshore wind. Several UK-based supply chain companies with an oil and gas legacy have pivoted to create innovative technologies that are highly relevant to new energies. Companies such as Verlume and Oil States, which are highlighted below, exemplify such transitions.

EXAMPLE: Oil and gas competence transitions into new energies

Legacy O&G infrastructure → Pivot towards new energies

verlume

Early mission to stabilise power for subsea wells with predictable low-carbon tidal energy and battery storage.



Verlume pivoted into offshore wind after discovering similar problems with regards to short-term power balancing. The company refocused from tidal power generation to an agnostic stabilisation solution for offshore energy generation subsea.

By developing solutions for energy storage with intelligent power conditioning and management of available energy, Verlume is able stabilise power output within and from offshore windfarms. Verlume facilitates charging at times of low energy demand and maximise revenue from power generation.

Wide opportunity space in other new energy verticals

- Long-term hydrogen storage
- Powering of subsea carbon capture injection systems.
- Integration with subsea substation with storage in floating offshore wind.

OIL STATES

Oil States provides products and services to oil and gas, with a focus on drilling, completion and subsea technologies. Oil States is responsible for 27 out of 28 tension-leg platform (TLP) foundations globally and has over 40 years of UK experience.

Oil States utilised 30 years of oil and gas TLP experience to pivot into offshore wind and develop a novel proprietary hybrid solution, FTLP, for foundations, aimed at 50 to 150 meters water depth.

FTLP has a small bore tubular design that is both economical in use of material and modular where the key technology is how FTLP is assembled using Oil States bespoke range of connectors. Currently Oil States can manufacture 20 units per year and will scale to 100 units. Rystad Energy expects approximately 15% of the global market to be deployed within FTLP target depth and in UK waters all of the current awards fall within the target depth.

Key benefits of FTLP are

- Stability of a fixed foundation.
- Light weight, easy to transport.
- Minimises strain on UK port infrastructure.
- Modular design enables automation and industrialisation and scale.
- Exportable technology meeting local content requirements.

Source: Rystad Energy research and analysis; Verlume; Oil States; industry interviews

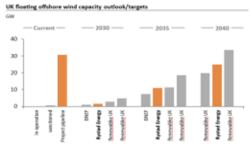
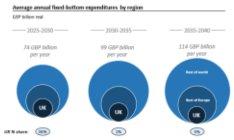
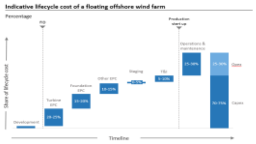
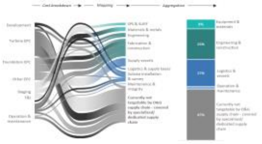
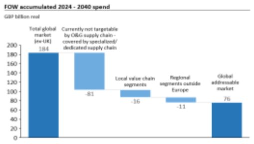
Content

Each energy vertical is assessed with the same methodology

The assessment of each energy vertical follows a consistent process using the steps outlined in the table below.

The goal of the assessments has been to assess the UK's supply chain gap to potential via a thorough analysis of each energy vertical.

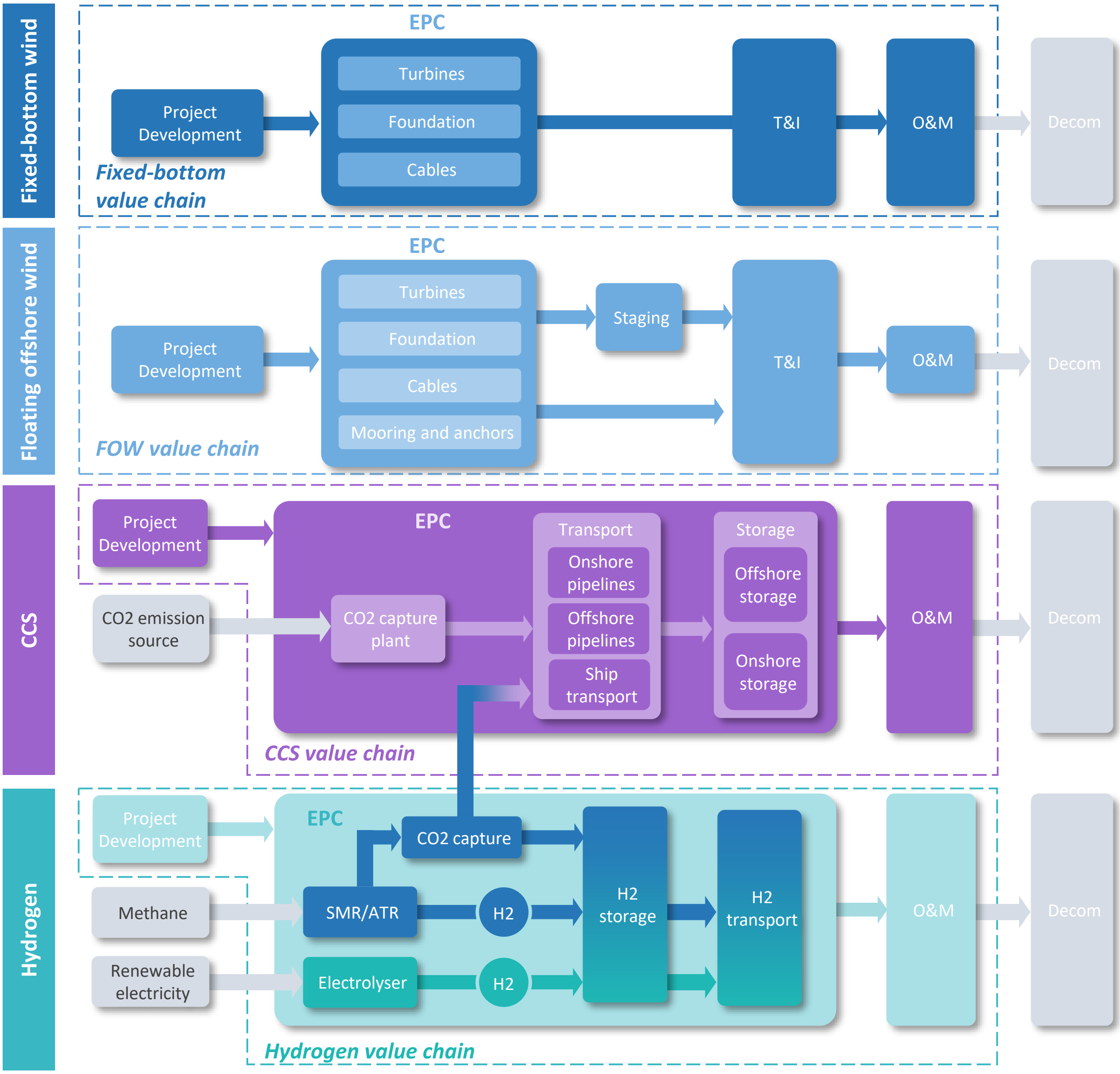
The analysis is focused on identifying the existing strengths and capabilities of the UK oil and gas supply chain. Moreover, the assessments take into account the addressable markets for each new energy vertical and assess the scale gap within each subsegment to determine what is targetable by the oil and gas supply chain.

Step	Description	Exhibit
1 Capacity targets and outlooks	• Capacity outlooks are established for each energy. • Government targets and capacity outlooks from relevant peers are obtained for calibration and benchmarking.	
2 Projections on capex and opex expenditures	• Capex and opex expenditures are calculated for the UK, Europe and globally. Learning curves are considered in the cost estimation. • Capex figures is projected based on new capacity additions while opex is driven by the cumulative capacity base.	
3 Cost segment breakdowns	• Capex and opex figures for each energy vertical broken down into detailed cost segments.	
4 UK O&G supply chain capability assessment and targetability	• The UK oil and gas supply chain's capability within each cost segment are assessed primarily based on research conducted in previous OEUK reports. • Targetable segments for the oil and gas supply chain are identified within each energy vertical.	
5 Supply chain segment mapping	• The traditional supply chain segments within each new energy vertical are mapped to a unified supply chain segmentation that is comparable and aggregatable across all energy vectors.	
6 Addressable domestic and export market	• The resulting is a view of the addressable domestic and export markets by UK oil and gas supply chain. • For international markets the degree of international sourcing is also included as part of the addressability assessment.	
7 Gap to potential analysis	• Finally, the gap to potential for each supply chain segment is assessed based on the weighted capabilities for UK's oil and gas supply chain and the scale gap. • The scale gap is determined by the difference in current and projected spend levels for each supply chain segment.	

Source: Rystad Energy research and analysis

Carbon transport and storage in blue hydrogen covered in CCS supply chain

The four energy verticals cover established fixed-bottom wind, together with the new energy verticals including floating offshore wind, green and blue hydrogen and CCS. Fixed-bottom wind and floating offshore wind share similarities in the value chain from project development to decommissioning, but certain differences in the EPC phase, and unique elements such as staging, which includes the integration of the wind turbines and foundation in shore prior to tow out and installation. A border between the blue hydrogen and CCS value chain must also be established due to the overlapping nature between the two value chains as blue hydrogen production requires capture, storage and transportation of the CO2 emitted in the production process. In the report, we have therefore chosen to define the carbon capture element of blue hydrogen production in the blue hydrogen value chain, whereas the transportation and storage element is covered as a part of the CCS value chain.



Source: Rystad Energy research and analysis

Content

UK fixed-bottom wind set for steady capacity increase towards 2040

The Rystad Energy outlook for installed fixed-bottom wind capacity in the UK aligns well with Catapult's mid- and high-scenario capacity outlooks. Both outlooks suggest steady growth towards 2040.

Rystad Energy's UK fixed-bottom wind capacity outlook suggests a compound annual growth rate (CAGR) of 14% between 2024 and 2030 before the yearly growth declines to 6% between 2030 and 2040. This projected growth culminates in 69 GW of installed capacity by the end of 2040.

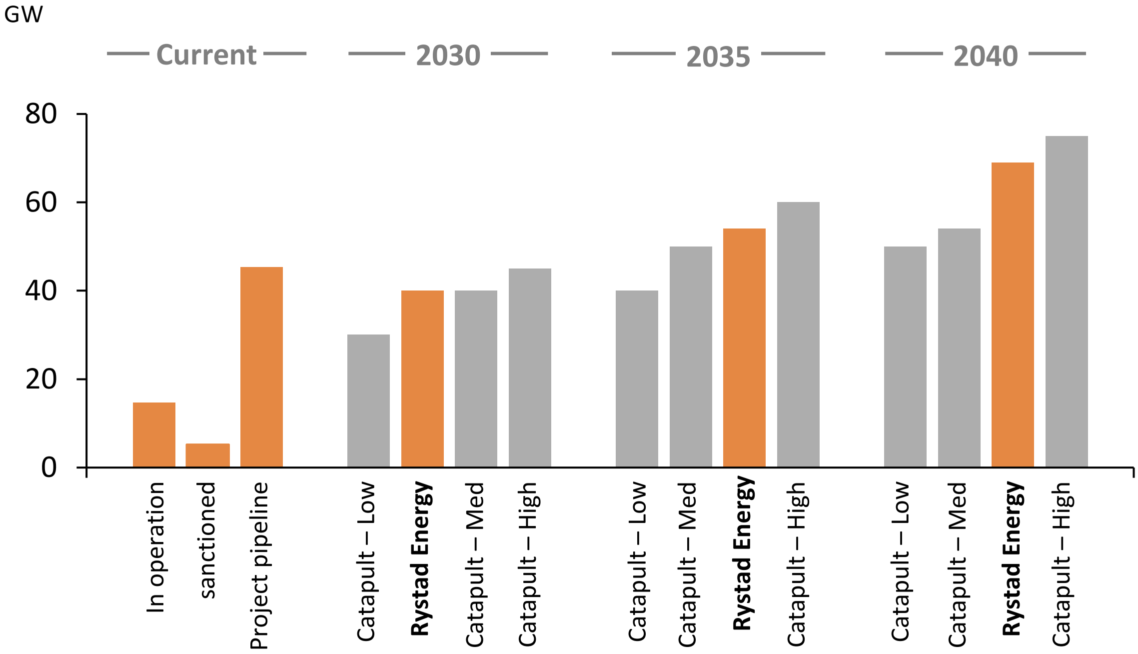
It is important to note that all scenarios presented below are associated with uncertainty. Actual deployment rates will be subject to various factors such as interest rates, cost level, country targets and policies, and the competitiveness of fixed-bottom wind against other energy sources, influencing the pipeline of realised projects.

The chart below shows that the Rystad Energy outlook aligns well with Catapult's outlook for installed fixed-bottom wind. Catapult presents three scenarios titled by the expected combined floating and fixed-bottom offshore wind capacity by 2050 in each scenario.

Comparing the Rystad Energy outlook with Catapult's scenarios, we observe that the Rystad Energy outlook places itself between Catapult's mid- and high scenarios in 2035 and 2040, with higher growth over the same period. However, with 5% annual growth, the implied growth in the Rystad Energy outlook appears modest. In 2030, both the Rystad Energy outlook and Catapult's mid-range scenario depict 40 GW. In comparison, the UK government's 2030 target is 50 GW (of which 5 GW is floating)

Both the Rystad Energy outlook and all Catapult scenarios depict growth after 2035, but it is worth mentioning that various constraints become more significant as the most geographically cost-efficient sites will have been utilised.

UK fixed-bottom wind capacity outlook/targets*



*Catapult scenarios: High = 150 GW, Med = 100 GW, Low = 75 GW
Source: Rystad Energy research and analysis; Catapult – Strategic infrastructure and supply chain development summary report

Global fixed-bottom wind capacity to close in on 700 GW by 2040

Fixed-bottom wind has been successfully deployed in various regions globally. Significant growth is expected towards 2040, reaching approximately 700 GW up from 71 GW in 2023.

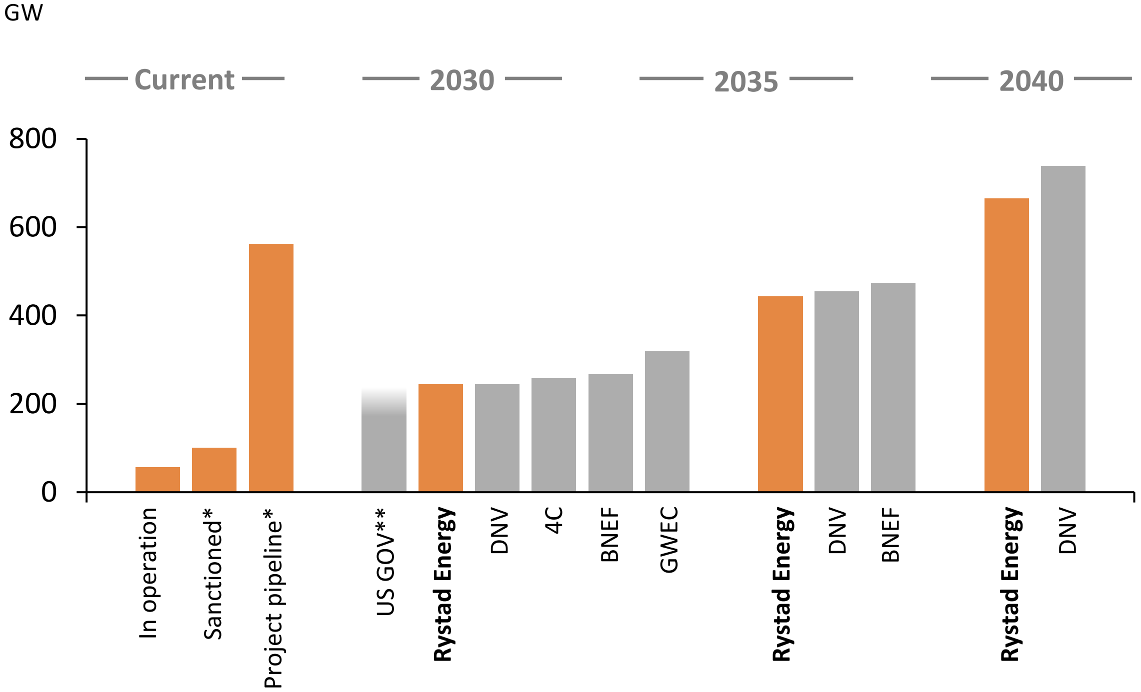
Rystad Energy estimates that almost 71 GW of fixed-bottom wind capacity is currently operational globally, while approximately 100 GW of the capacity is sanctioned (approved or under construction). The project pipeline towards 2040 is significant, with close to 600 GW of identified projects. However, not every project in the pipeline may be realised.

Among various industry sources' 2030 outlooks, Rystad Energy's estimate of roughly 260 GW stands out as modest, taking the current economic sentiment with high inflation, high interest rates and supply chain bottlenecks into account. The Global Wind Energy Council (GWEC) is in the more ambitious end of the scale, suggesting more than 300 GW of fixed-bottom wind by 2030. DNV, 4C and BloombergNEF (BNEF) have slightly higher estimates than Rystad Energy, yet more modest than GWEC.

Fewer industry sources have announced estimates for fixed-bottom wind for 2035 and 2040. In 2035, DNV and BNEF expect global fixed-bottom wind capacity to reach 450 GW and 470 GW, respectively. Rystad Energy projects about 465 GW of fixed bottom-wind by 2030, which is close to BNEF's estimate. The three 2035 estimates suggest significant leaps of growth from 2030 to 2035.

From 2035 to 2040, Rystad Energy forecasts almost 200 GW of capacity to be added, totalling close to 700 GW. DNV has even more ambitious projections and expects global capacity to reach about 740 GW by 2040, which is almost 300 GW more than their 2035 estimate.

Global fixed-bottom wind capacity outlook/targets



*2040 estimates. **174 GW in 2028

Source: Rystad Energy research and analysis; DNV Energy Transition Outlook October 2023; Global Wind Energy Council offshore wind report 2023; 4C; BNEF

UK continues to play a vital role, but other markets are rapidly emerging

Global fixed-bottom wind capacity is set for continued growth. The UK's capacity is anticipated to show a steady increase, with other European nations and China playing pivotal roles in driving global growth.

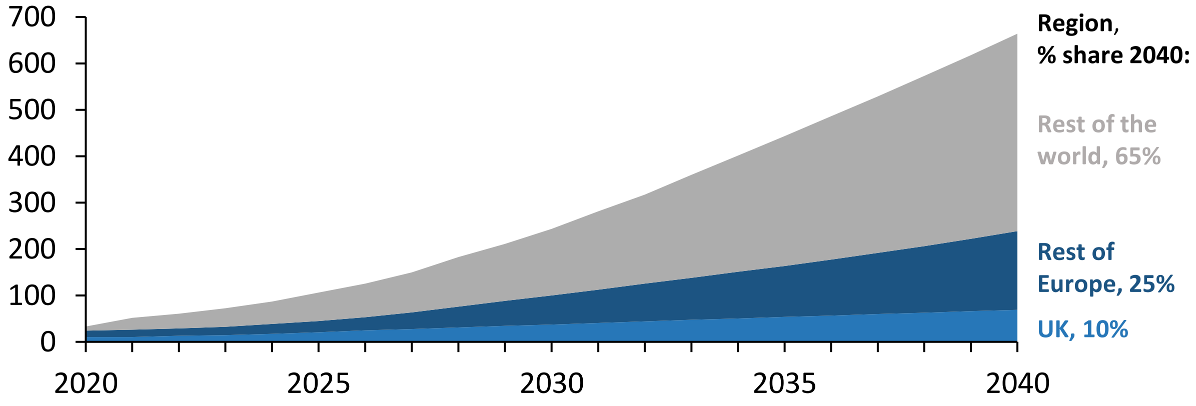
The UK's fixed-bottom wind capacity is projected to increase from the current capacity of 14.7 GW as of 2023 to approximately 70 GW by 2040. Nations outside of Europe are key growth engines in the global expansion of fixed-bottom wind, with China clearly at the forefront. However, the UK, Germany and the Netherlands are expected to be key drivers of fixed-bottom wind deployment.

The UK exhibits an 8% CAGR from 2025 to 2040, while both the rest of Europe and the world show a robust 14% CAGR in the same period. As other countries intensify their efforts, the gap to the UK’s capacity is closing. Since the mid 2010s, the UK has been the leading nation in terms of fixed-bottom wind development, but China is taking over. This shift is driven by aggressive growth targets fuelled by subsidies and development of local supply chain. Looking ahead, the US is not expected to be a significant driver until after 2030 despite its ambitious target of 30 GW by that year.

Analysing the annual addition chart shows a steady global capacity increase at a 23% CAGR until 2028. After 2028, annual installations may fluctuate but remain high, signifying the industry's stability and sustained focus on cost improvement. This points to the industry's maturation and an accelerated development pace in floating offshore wind.

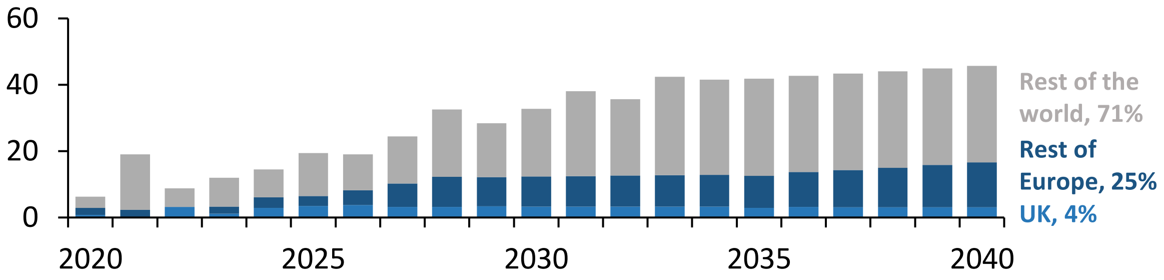
Global fixed-bottom wind capacity outlook

Cumulative capacity, GW



Global fixed-bottom wind capacity outlook

Annual additions, GW



Source: Rystad Energy research and analysis

UK no longer a dominant player in global fixed-bottom wind market

Annual fixed-bottom expenditure is predicted to continue growing at a steady pace over the coming decades. China will continue to drive the growth, the UK is expected to experience a decline in its contribution to global expenditures.

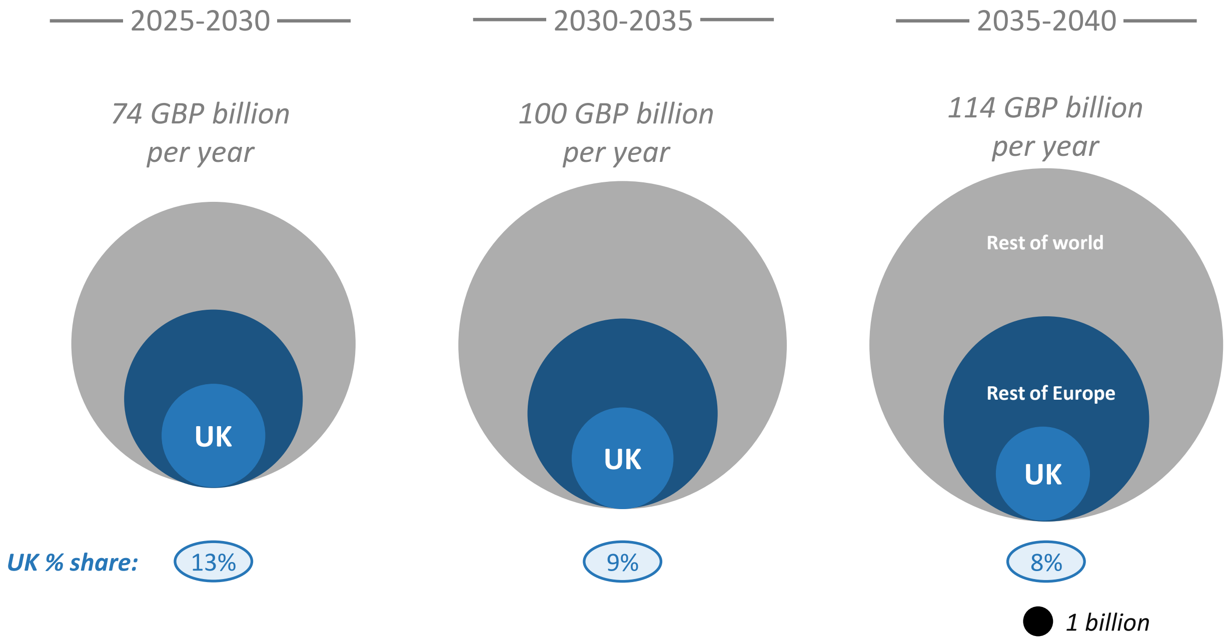
Annual fixed-bottom wind expenditure is anticipated to continue increasing at a steady pace with a CAGR of 6% from 2024 to 2040. Fixed-bottom wind has been established as a pivotal source of renewable electricity over the past three decades, witnessing progressive and heightened investments in technology that continually enhance its competitiveness. From 2035 to 2040, Rystad Energy forecasts a global expenditure of £114 billion per year.

On a global scale, annual spending is projected to increase by a CAGR of 10% from 2030 to 2035 and by 9% from 2035 to 2040. A significant portion of the spending in fixed-bottom wind projects is allocated to engineering, procurement and construction (EPC), reflecting substantial upfront investments before the wind farms become operational. Considering the capex intensive nature, the modest reduction in CAGR for expenditures suggests fewer projects in the pipeline. This moderation in growth can be attributed to intensified focus on new energy segments and technologies, with floating offshore wind being an example of this strategic direction in addition to the most geographically cost-efficient sites for fixed-bottom technologies will have been utilised.

Countries outside of Europe predominantly drive the growth in annual fixed-bottom expenditure, with China leading this expansion. The UK is expected to witness a reduction in its relative share of global expenditures, decreasing from 13% of global annual expenditure in the period of 2025 to 2030, to 9% in 2030 to 2035. Before experiencing a further reduction to a relative share of 8% in 2035 to 2040, equivalent to £9.12 billion per year.

Average annual fixed-bottom wind expenditures by region

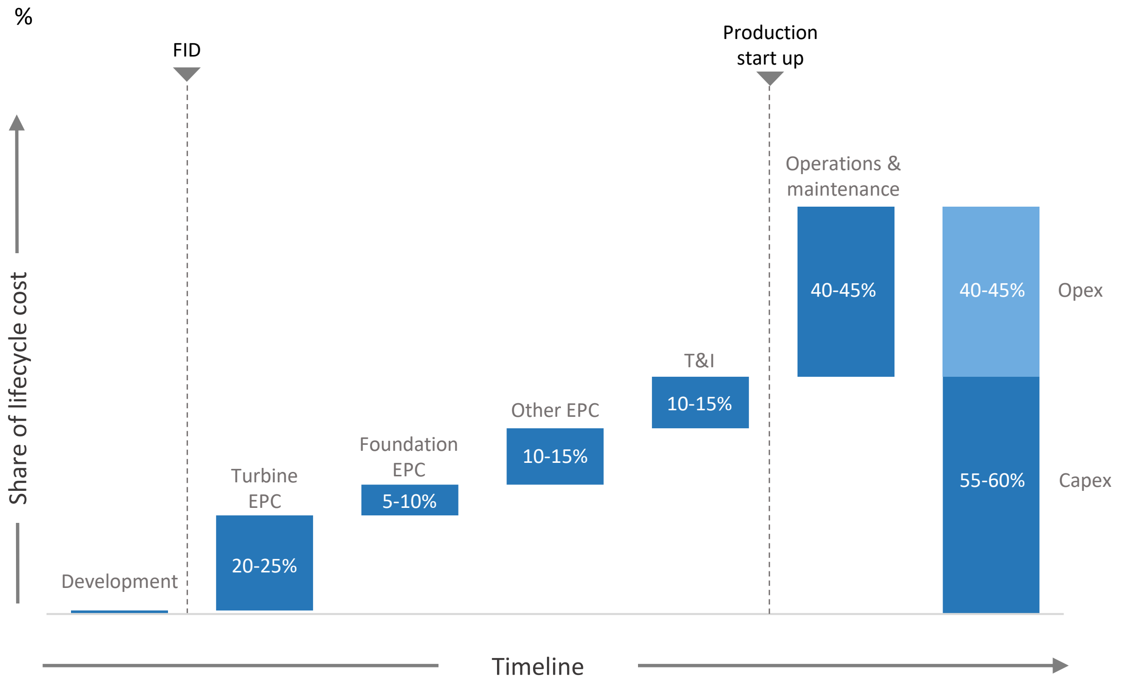
GBP billion real



Source: Rystad Energy research and analysis

Fixed-bottom wind is capex heavy – EPCI makes up more than 55% of lifecycle cost

Indicative lifecycle cost of a fixed-bottom wind farm



Over the life of a fixed-bottom wind farm, 55% to 60% of total spending is capital expenditure. Capital expenditures related to EPC, particularly turbine EPC, are key cost drivers.

Development of fixed-bottom wind is capital-intensive compared to oil and gas assets, with 55% to 60% of the overall lifetime expenditure incurring prior to first power. These costs involve manufacturing and installation of wind turbines, as well as fixed foundations, and infrastructure such as subsea cables and offshore substations required for power exchange.

Costs related to pre-FID activity include project management and development such as surveys, administrative and services, accounting for a minor share of roughly 1% of total expenditure.

Fixed-bottom wind capex is primarily related to the engineering, procurement and construction (EPC) phase, with turbine EPC, involving nacelle, rotor and tower being the main driver. Foundation EPC, typically jacket or monopile, make up a smaller share of the total cost of about 5% to 10%. Other EPC, covering the supply of export and array cables and substations, is another of the key cost elements. The cost of replacing major equipment is included in the EPC expenditure. transport and installation (T&I) spending includes the cost of using dedicated vessels and equipment to bring equipment from marshalling yards and fixing them to the seabed utilising a set of specialised services and equipment.

Operations and maintenance costs accrue after the wind farm starts generating power and make up 40% to 45% of total lifecycle costs. These costs are related to day-to-day operations, including logistics and monitoring, in addition to repair and replacement of equipment. Turbine maintenance makes up the largest share of the operational expenditure with a share of around 70%.

Decommissioning make up a minor share of the total lifecycle cost and is included in opex.

Source: Rystad Energy research and analysis

Several segments targetable, but material segments out of reach for O&G supply chain

Segment (% of lifecycle cost)*	**Sub-segments**		**Targetable by O&G supply chain**	**UK O&G supply chain capability assessment****	
Development 1%	Development & project management	✅	The UK has has a strong track record in offshore development that is transferable to fixed-bottom wind.	🟦🟦🟦⬜	The UK O&G industry has plenty of experience in project development in harsh maritime environments.
	Survey	✅			
Turbine EPC 20-25%	Nacelle	⊗	The UK currently lacks manufacturing capacity for nacelles and towers, while the turbine rotor is supplied by dedicated offshore wind supply chain. However, the Port of Nigg facility manufacturing towers is set to start up in 2024.	⬜⬜⬜⬜	Limited growth opportunities exist in Turbine EPC due to the UK's uncompetitive capability in manufacturing, partly due to high labour costs.
	Rotor	✔		⬜⬜⬜⬜	
	Tower	£ ⊗		⬜⬜⬜⬜	
Foundation EPC 5-10%	Jackets	✅	The UK O&G supply chain has experince in developing offshore structures, that is transferable to jacket manufacturing.	🟦⬜⬜⬜	The UK O&G supply chain companies have transitioned to make jackets for offshore wind.
	Monopiles	£ ⊗		⬜⬜⬜⬜	The UK has limited capabilities and monopiles are likely transported from other countries.
Other EPC 10-15%	Offshore substations	✅	Most segments in Other EPC are targetable for UK O&G supply chain players, except for cables. Offshore substations are delivered by the same suppliers as for O&G, and array cables are covered by UK offshore wind dedicated supply chain.	🟦🟦🟦⬜	The UK O&G supply chain positioned to target supply of modules for offshore substations.
	Array cables	✔		⬜⬜⬜⬜	Critical subsector for the UK. Ambitions to expand and establish new UK OEM facilities.
	Export cables	£ ⊗		⬜⬜⬜⬜	Manufacturing export cables is beyond the current capabilities of the UK.
	Engineering	✅		🟦🟦🟦⬜	Strong UK offshore engineering credentials.
	Electrical & instrumentation	✅			
T&I 10-15%	Jackets	✅	Transportation and installation of jackets possible with larger vessels used in O&G. Monopile is handeled by UK offshore wind dedicated supply chains.	🟦🟦⬜⬜	Within UK O&G supply chain scope.
	Monopile	✔		⬜⬜⬜⬜	Carried out by UK offshore wind dedicated supply chain.
	Turbine	✔	UK O&G players can target various T&I services related to fixed-bottom wind, except for the installation of export cables and turbines, as these segments are traditionally served by other European entities.	⬜⬜⬜⬜	Limited UK position.
	Offshore substation	✅		🟦⬜⬜⬜	Likely to be produced overseas and transported to location for offshore hook up.
	Array cables	✅		🟦🟦🟦⬜	Strong UK capability with proven UK track record.
	Export cables	✔		⬜⬜⬜⬜	Export cable installation differ from O&G activity and is carried out by offshore wind supply chain.
Operation & Maintenance 40-45%	Wet BOP	✅	Wet BOP and dry BOP are targetable by subsea service vessels, while turbine maintenance is covered by UK offshore wind dedicated supply chain.	🟦🟦🟦⬜	Existing UK O&G capabilities.
	Dry BOP	✅		🟦🟦⬜⬜	
	Turbine maintenance	✔		⬜⬜⬜⬜	Carried out by dedicated offshore wind supply chain.

✅	Targetable by O&G supply chain
✔	UK offshore wind dedicated supply chain
⊗	No UK supply chain capability
£	UK investment made

🟦🟦🟦🟦	The UK O&G supply chain has full coverage of the required capability
🟦🟦🟦⬜	The UK O&G supply chain has majority coverage of the required capability
🟦🟦⬜⬜	The UK O&G supply chain has moderate coverage of the required capability
🟦⬜⬜⬜	The UK O&G supply chain has limited coverage of the required capability
⬜⬜⬜⬜	The UK O&G supply chain has minimal coverage of the required capability

*Percentage of total lifecycle cost of a fixed-bottom offshore wind farm. **Capability assessment based on BVG Associates' Offshore Wind report as OEUK Report 'Harnessing the potential' does not include capability assessment of fixed bottom wind

Source: Rystad Energy research and analysis; OEUK; BVG Associates; industry interviews

O&G project management, foundation and cable expertise apply to fixed-bottom wind

The UK's oil and gas supply chain can leverage its expertise in the fixed-bottom wind industry. Although the UK may lack expertise in manufacturing and installing key equipment, UK oil and gas players have valuable experience in other areas.

The supply chain for a fixed-bottom wind farm is complex and customised, but several segments are targetable with the current skillset in the oil and gas supply chain. For fixed-bottom wind, developers tend to prefer contracting multiple companies, opening more opportunities for the oil and gas supply chain.

Oil and gas supply chain capabilities within project development are transferrable to the development of fixed-bottom wind, as project management and work related to survey in the marine environment are similar as in oil and gas. Several companies with oil and gas background have carried out work in offshore wind, including DNV and Fugro. In addition, oil and gas players have high competence related to working in harsh environments, which is highly relevant for offshore wind development.

Engineering, procurement and construction (EPC) related to turbine is the largest contract awarded by the offshore wind developer, constituting close to 80% of greenfield capex. However, Turbine EPC is not targetable by the oil and gas supply chain. The work is carried out by dedicated turbine manufacturers – the OEMs – and oil and gas players are struggling to compete as the manufacturers have decades of experience.

UK oil and gas supply chain companies have decades of experience in offshore support structures, which is relevant for supplying jackets for fixed-bottom wind development. However, monopiles are expected to dominate the fixed foundation space, supported by an upcoming SeAH facility in the UK. Advancements in monopile structures continue to push water depth boundaries, making them relevant in increasingly deeper waters. Furthermore, monopile manufacturing tends to be simpler compared and more cost efficient than jackets.

Other EPC costs cover cables and substations, areas in which the oil and gas industry has capabilities and track record. The UK oil and gas industry has experience in manufacturing array cables used. However, for fixed-bottom wind, this work is carried out by dedicated offshore wind supply chain. Oil and gas supply chain players' opportunities related to export cables are considered limited as large cable producers supplying several industries are already established in the market. Offshore wind developers tend to give substations contracts to suppliers such as GE and Siemens, but the oil and gas industry has a solid track record in offshore platform and accommodation construction that is transferable to supplying offshore substations to the fixed-bottom wind industry. As there is no industry standard for substation design, oil and gas supply chain companies can utilise its expertise in constructing customised solutions.

Transport and installation (T&I) of fixed-bottom wind equipment is to some extent targetable by the oil and gas supply chain. Oil and gas supply chain companies' experience in turbine and foundation installation is limited, and the T&I vessels used for this type of work are often highly specialised. However, installation of jackets is targetable for the oil and gas supply chain, and the same goes for installation of array cables, in which oil and gas companies have relevant experience. The cable installation market is highly specialised and competitive, and oil and gas supply chain companies have already entered with their expertise related to operating in challenging environments.

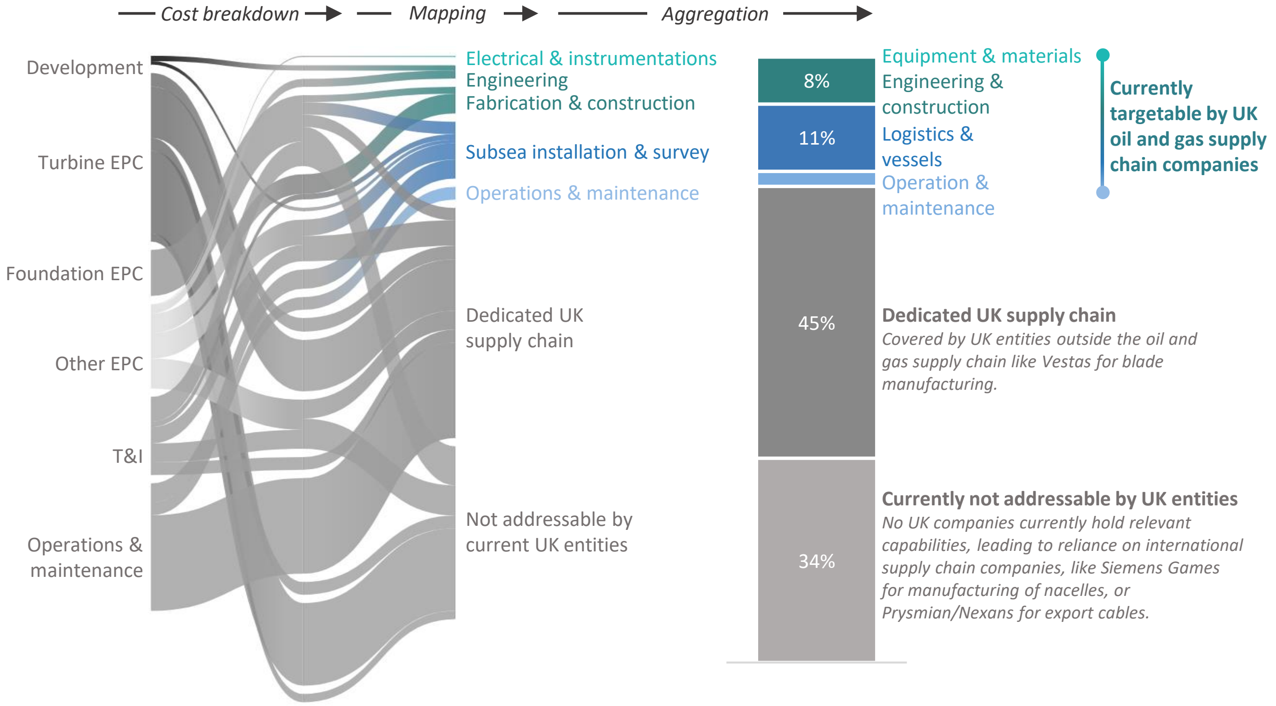
Operation and maintenance work related to day-to-day operations and logistics is an opportunity to oil and gas supply chain players. Moreover, the UK's extensive oil and gas supply chain capabilities, cultivated over decades, are especially relevant for the wet balance of plant in offshore wind, including crucial tasks such as subsea inspection and maintenance. Dry balance of plant and turbine maintenance are not considered targetable by the oil and gas supply chain as these activities require specialised equipment and expertise possessed by dedicated offshore wind players.

Source: Rystad Energy research and analysis

Over 20% of fixed-bottom wind cost is targetable by current O&G supply chain

Fixed-bottom wind cost by traditional segment breakdown

Fixed-bottom wind cost by unified supply chain segmentation



Dedicated UK supply chain
Covered by UK entities outside the oil and gas supply chain like Vestas for blade manufacturing.

Currently not addressable by UK entities
No UK companies currently hold relevant capabilities, leading to reliance on international supply chain companies, like Siemens Games for manufacturing of nacelles, or Prysmian/Nexans for export cables.

> **About 20% of a fixed-bottom wind project's total cost is targetable by the UK oil and gas supply chain through current skillset. Most cost items are handled by other specialised supply chains – traditional turbine OEMs and a supply chain tailored for offshore wind.**

By breaking down the traditional cost components of a typical fixed-bottom wind project, encompassing development, engineering procurement and construction (EPC), transport and installation (T&I), and operations and maintenance, identifying targetable segments for the UK oil and gas industry is possible.

UK oil and gas players can leverage their capabilities by utilising their strengths in engineering, deploying larger vessels, and day-to-day operations and parts of the maintenance scope. Despite several segments being targetable, expenditures in these segments are relatively modest. Therefore, only 21% of total expenditures between 2024 and 2040 are considered within the targetable scope of the UK oil and gas industry.

Currently not addressable segments, including manufacturing of turbine equipment like nacelles, towers, and monopolies, involve substantial costs and are typically carried out by dedicated fixed-bottom wind supply chain companies.

Source: Rystad Energy research and analysis; Rystad Energy Wind Solution; Rystad Energy ServiceDemandCube

UK targetable fixed-bottom wind spending will stabilise at £2 billion after 2025

The UK fixed-bottom wind market has seen high activity and is forecast to close in on £10 billion in 2025, followed by the market stabilising at about £9 billion from 2027 onwards. Most of the fixed-bottom expenditure is considered not targetable for the UK oil and gas supply chain.

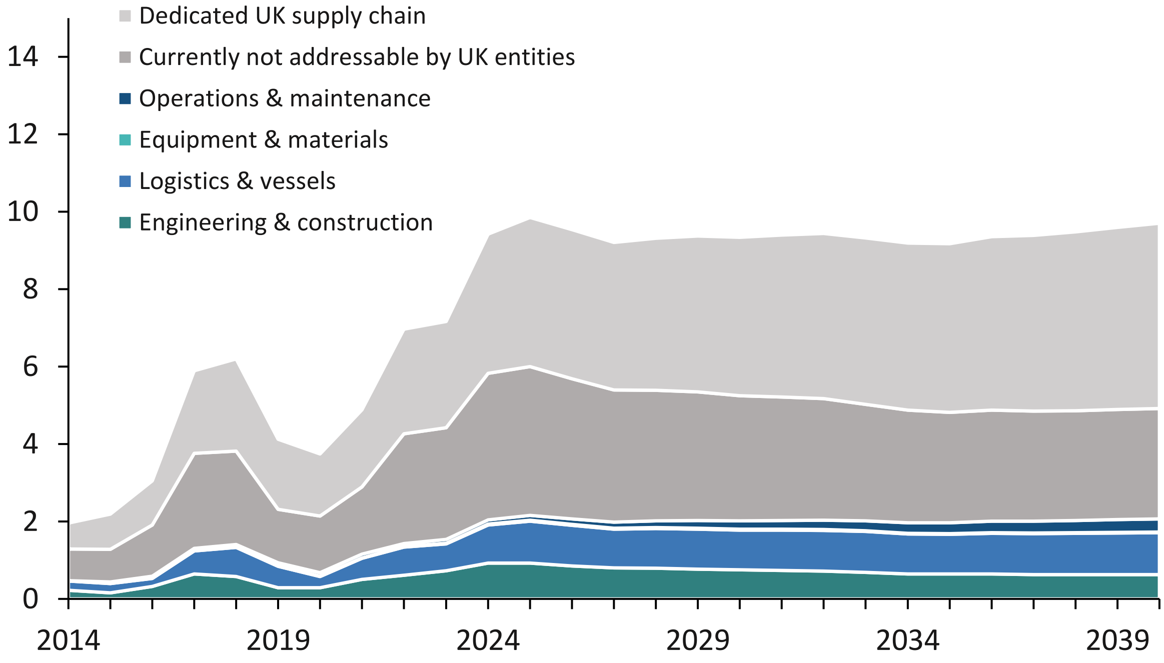
Total expenditure in the UK's fixed-bottom wind sector is expected to increase towards 2025, reaching £10 billion. After 2025, the market is forecast to see a small decline and stabilise at £9 billion from 2027 towards 2040. As the fixed-bottom wind market matures, it is likely that there will be stable annual capacity additions with a greater emphasis on technology and cost optimisation. Investments are likely to shift towards CCS, low-hydrogen and other renewable energy verticals, such as floating offshore wind, rather than further enhancing the matured fixed-bottom wind sector.

Slightly above 20% of total UK fixed-bottom wind spending – around £2 billion – is considered targetable by the UK oil and gas supply chain. The modest addressable market can be attributed to the limited overlap between UK oil and gas supply chain capabilities and manufacturing in key fixed-bottom wind cost components.

The logistics and vessels segment is set to be the largest targetable segment towards 2040, followed by engineering and construction. These segments include major cost components such as transportation and installation of array cables, jackets and substations, in addition to the manufacturing of substations and engineering. Operations and maintenance is expected to be the highest growing segment with a projected annual growth of 8% from 2024 to 2040. This is a result of the fixed-bottom wind farms maturing and requiring increased maintenance and repairs.

UK fixed-bottom wind capex and opex expenditures per year by segment

GBP billion real



Source: Rystad Energy research and analysis

Some 14% of global fixed-bottom wind market addressable for UK O&G players

The global addressable fixed-bottom wind market outside the UK available to traditional UK oil and gas supply chain players is estimated at £203 billion. Other parts of the market are deemed inaccessible for traditional UK oil and gas supply chain companies due to geographic location or current capability constraints.

Rystad Energy forecasts a global fixed-bottom wind market of around £1.4 trillion accumulated between 2024 and 2040. However, certain segments within the fixed-bottom wind supply chain are deemed inaccessible for traditional UK oil and gas supply chain players due to inherent capabilities and geographical limitations.

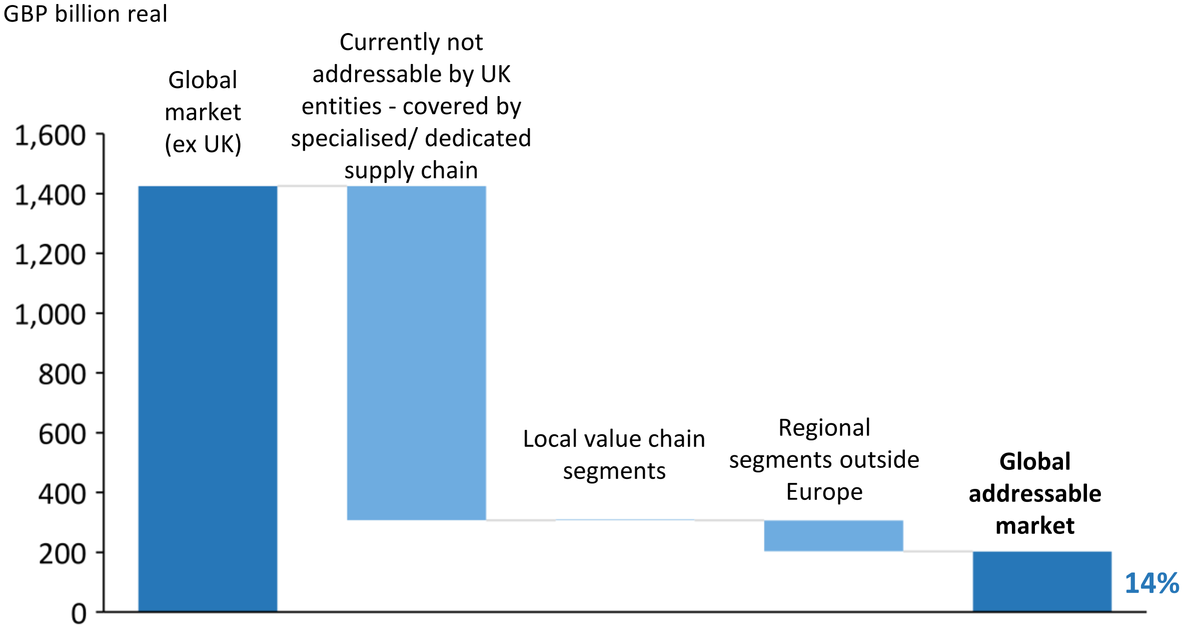
Today's UK oil and gas supply chain capabilities are highly opex oriented, with a focus on reparation and maintenance of mature infrastructure. These capabilities tend to be incompatible with some of the more capex-intensive segments in fixed-bottom wind projects, such as manufacturing and installation of new and complex equipment, which require investments in infrastructure and new technologies.

Segments not considered targetable by the scope of the UK oil and gas supply chain, totalling around £1.1 trillion in spending, require specialised supply chain capabilities. Examples include the manufacturing of nacelle and tower components. High labour costs, coupled with the dominance of legacy original equipment manufacturers (OEM) based overseas, render UK domestic production of these components less competitive. Thus, turbine component manufacturing is considered non-competitive for the UK oil and gas supply chain.

In the fixed-bottom wind industry, all targetable segments are considered to have either regional or global value chains and are thus not exclusively targetable by national value chain segments (non-UK). However, specific expenditures related to regional segments outside of Europe fall beyond the UK scope, totalling £11 billion. Consequently, around 68% of the total fixed bottom wind market is considered not targetable by UK players.

As a result, the estimated addressable market for traditional UK oil and gas players is approximately £203 billion.

Fixed-bottom wind accumulated 2024 - 2040 spend



Source: Rystad Energy research and analysis

OEM dominance, low call for new tech and asset mismatch hindered UK O&G supply chain

CASE: Exploring reasons why the UK failed to take a position in the fixed-bottom wind supply chain

The UK oil and gas supply chain's success in transitioning to new energy sources relies on capabilities, materiality and timing. While there is potential in floating offshore wind, the supply chain has faced hurdles in fixed-bottom wind, including limited asset overlap, low call for new tech and challenges from established OEMs.

While the UK was one of the early movers and the global leader in fixed-bottom wind installations, seen from a capacity point of view, its oil and gas supply chain companies struggled to gain a strong domestic foothold. Limited overlapping capabilities, assets and a low call for new tech prevented them from leveraging early mover advantages, allowing international original equipment manufacturers (OEM) to dominate the market. However, the UK's oil and gas supply chain possesses capabilities more relevant for floating offshore wind. This primes them for a significant share in the global market, unlike the more challenging fixed-bottom wind sector.

The unique requirements of fixed-bottom wind meant that the UK's existing oil and gas assets were not readily applicable. This led to a reliance on vessels from other countries, inadvertently strengthening the position of international supply chain players in the UK market.

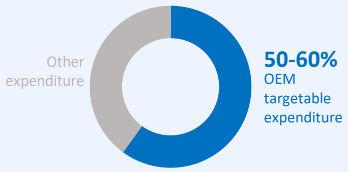
Non-UK based OEMs, with their longstanding experience in turbine manufacturing from onshore wind, quickly established a strong position in the offshore wind supply chain. The OEMs' control over turbine manufacturing and maintenance created entry barriers for UK oil and gas supply chain companies in the fixed-bottom wind sector.

Unlike floating offshore wind, which requires new and advanced technological solutions for foundations and cables, fixed-bottom wind relies on established technologies across key segments like foundation types (jackets and monopiles) and array cables and export cables. Therefore, the opportunity for the UK's oil and gas supply chain companies to gain foothold in the fixed-bottom wind industry through new innovations was never really on the table.

Challenges facing UK oil and gas supply chain companies entering the fixed-bottom wind market

OEM dominance in the UK fixed-bottom wind supply chain

Fixed-bottom wind lifecycle cost



OEMs retain a significant stake, up to 60%, of the fixed-bottom wind farm lifecycle cost

Limited asset overlap between oil and gas and fixed-bottom wind

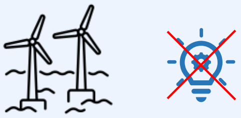
Oil and gas asset base – tailored vessels and rigs

≠

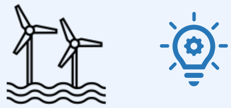
Fixed-bottom wind asset base – pure-play installation vessels

The asset base required in offshore wind compared to legacy oil and gas differ

Low tech need in fixed-bottom wind compared to floating wind



Limited innovation need in fixed-bottom wind



High demand for innovation in floating wind

Source: Rystad Energy research and analysis

Asset mismatch between O&G and offshore wind led to foreign supply chain dominance

CASE: Limited asset base overlap between fixed-bottom wind and the oil and gas industry

The asset base required for fixed-bottom wind is distinct from that of the UK oil and gas industry, hindering UK oil and gas supply chain companies from seamlessly transitioning to offshore wind by utilising their existing assets.

Turbine installation vessels and foundation installation vessels are purpose built for offshore wind equipment installation and were thus not readily available in the UK oil and gas industry. This space has been dominated by non-UK players, such as DEME and Jan De Nul, and were sourced from outside the UK. Certain heavy-lift vessels used for foundation installation can also find applications in specific oil and gas operations.

Cable-laying vessels also differ between the two industries due to the distinct types of cables used. While helicopters are used in both industries for personnel transport, those used in offshore wind are typically smaller, limiting their transferability to oil and gas. While helicopter is standard mode for transporting personnel in oil and gas, it is rare in offshore wind. However, some vessels, such as OCVs, CTVs and more lately C/SOVs purpose built for offshore wind, show more compatibility across both industries.

The mismatch between the UK's existing asset base and the one fit to serve the demands for offshore wind is a key reason to why the UK failed to take a position in the fixed-bottom wind supply chain. As a result, vessels were supplied from other nations, such as Denmark and the Netherlands, to serve the segment. Supply chain companies in these countries managed to establish robust positions in the UK offshore wind supply chain, creating further challenges for the UK's oil and gas supply chain companies to enter.

Asset type		Application in fixed-bottom wind		Application in O&G	
Wind Turbine installation vessel (WTIV)		*Turbine and foundation installation, and some maintenance work (turbine overhaul).*	✅	*Not used in oil and gas.*	❌
Foundation installation vessel (FIV)		*Foundation installation (both tower and substation). Latest vintages are purpose-build for offshore wind.*	✅	*Not commonly used but older assets cand be used for foundation and sub-structure installation.*	☑
Cable laying vessel (CLV)		*Lays underwater cables on the seabed to establish communication and networking between offshore structures.*	✅	*Not commonly used, but possible to be used for development of communication.*	☑
Service operation vessels (C/SOV)		*Lifetime maintenance & operations support (routine maintenance, regular checks and repair work).*	✅	*Walk-to-work vessels used for maintenance & operation support at oil and gas installations, but purpose-build C/SOVs are mainly used in offshore wind.*	☑
Offshore construction vessel (OCV)		*Development, installation, maintenance, and decommissioning of offshore structures.*	✅	*Commonly used in oil and gas to support various activities related to exploration, production, and maintenance of offshore installations.*	✅
Helicopter		*Providing efficient transportation of personnel and equipment to and from the offshore installations.*	✅	*Commonly used in oil and gas. Larger helicopters are used in oil and gas than in Offshore wind.*	☑
Crew transfer vessel (CTV)		*Specialised boats designed for the transportation of personnel to and from offshore installations.*	✅	*Commonly used in oil and gas, to transport personal to offshore platforms.*	✅

✅ Asset commonly used ☑ Asset not commonly used ❌ Asset not used

Source: Rystad Energy research and analysis

OEMs' dominance challenged UK O&G supply chain entry in fixed-bottom wind

CASE: OEMs have a strong position in the UK fixed-bottom wind supply chain

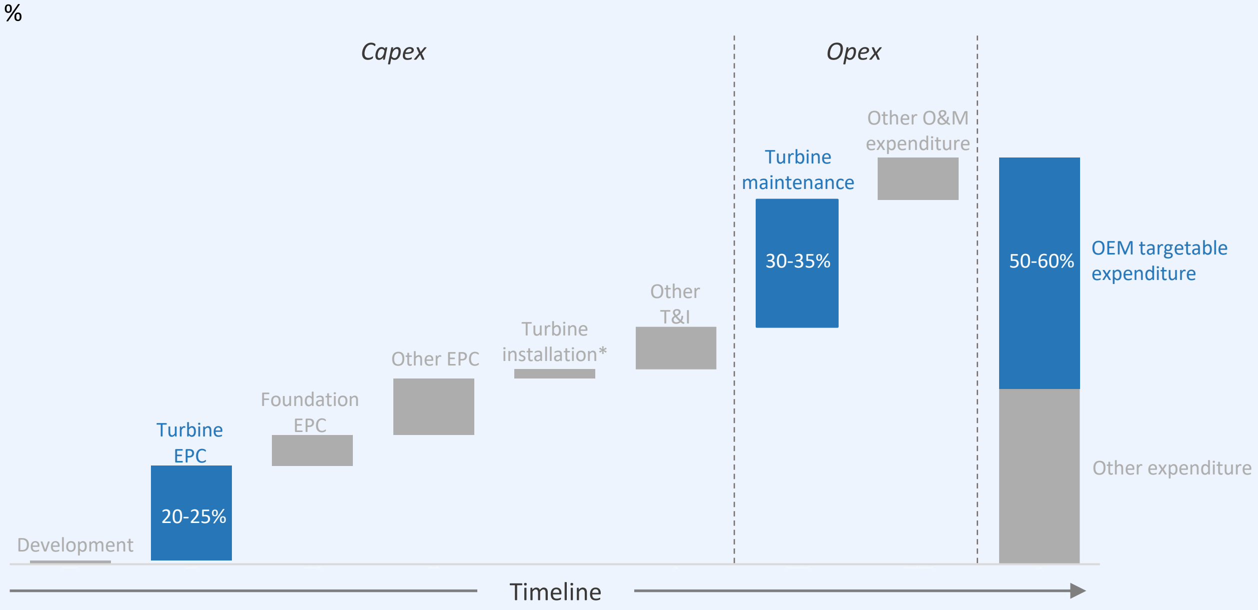
OEMs have a strong position in the offshore wind supply chain as they are responsible for the key technological development piece – the turbine. This dominance posed challenges for UK oil and gas supply chain companies aiming to establish themselves in the sector.

Original equipment manufacturers (OEM) have decades of experience in the onshore and offshore wind sector, and robust local supply chains have emerged abroad since the inception of offshore wind. The OEMs' dominant position in the supply chain is a result of them holding a large share of the contracts placed by the wind developer. This is because the OEMs hold the key technological development piece – the turbine. Turbine EPC represents a significant portion, typically 20% to25%, of the lifecycle cost of a fixed-bottom wind farm. In addition, the OEMs have representatives during the installation process.

The turbines usually come with service agreements ranging from five to 15 years, which effectively locks up the majority of the operations and maintenance expenditure with the OEM. In the contract, the OEM has service agreements with the wind developer including turbine maintenance. Turbine maintenance account for roughly 30% to 35% of the lifecycle cost of a fixed-bottom wind farm. The OEM often take charge of setting up the service operation vessel (SOV) and providing the maintenance crew, thus maintaining control over the assets used to service the dry parts of the turbine.

As a result, OEMs retain a significant stake, up to 60%, of the fixed-bottom wind farm lifecycle cost. This early dominance of non-UK based OEMs created challenges for the UK oil and gas supply chain companies seeking to establish presence in the market.

Fixed-bottom wind farm lifecycle cost distribution by OEM targetable segments



*OEMs with representatives during T&I. Contract typically owned by vessel owner
Source: Rystad Energy research and analysis

Limited call for new tech challenged UK O&G supply chain entry

CASE: Less need for technological advancements in fixed-bottom wind compared to floating wind

> **Fixed-bottom wind requires less advanced technology than floating offshore wind. This posed challenges for UK oil and gas supply chain companies to innovate and secure market position during the early development.**

Key offshore wind equipment such as cables, foundations and turbines compromise a significant share of offshore wind's lifecycle cost. Holding the contract of procuring such equipment is key to gain foothold in the industry. However, turbine manufacturing was early on dominated by original equipment manufacturers (OEM), UK oil and gas supply chain companies did not stand a chance in participating in the turbine development race with the highly experienced and established OEMs.

The offshore cables used in oil and gas are refined through years of innovations, and fixed-bottom wind utilises this oil and gas technology with little modifications. The limited need for advancements in fixed-bottom wind cable technology restricted UK oil and gas supply chain companies from taking a position in the industry. However, floating offshore wind call for flexible cables, requiring the development of new and innovative technologies. This represents a strategic opportunity for the UK oil and gas supply chain to secure a strong position in the market.

Fixed-bottom wind foundations, such as jackets, use established technology based on offshore structures from the oil and gas industry, and monopiles are essentially steel pipes without advanced technology. In contrast, floating foundations such as spars, semisubmersibles or tension-leg platforms still require innovation to reduce costs and find optimal solutions. This highlights significant differences in the need for innovation and advanced technology between fixed-bottom and floating offshore wind systems.

While the UK encountered challenges in establishing dominance within the fixed-bottom wind sector due to limitations in developing key enabling technologies, resulting in a competitive disadvantage, a distinct opportunity emerges within the floating wind sector. Here, technological innovation remains pivotal, as the industry actively seeks optimal solutions to navigate its evolving landscape.

	 Cables	 Foundations	 Turbines
Fixed-bottom	*Cable technology from O&G industry utilised, so no need for new inventions.*	*Existing O&G technology used for jackets, while monopiles are not technologically advanced.*	*Space dominated by strong, non-UK based OEMs, leaving minimal opportunities for inventions from the UK O&G supply chain companies.*
FOW	*Cables must be flexible, so technological advancements are necessary.*	*Continuous technology advancements are highly relevant for floating foundations, lower the costs.*	

Source: Rystad Energy research and analysis

UK’s fixed-bottom wind decom market will not be substantial before the 2040s

CASE: Decommissioning activity in the UK fixed-bottom wind industry will be modest until after 2040

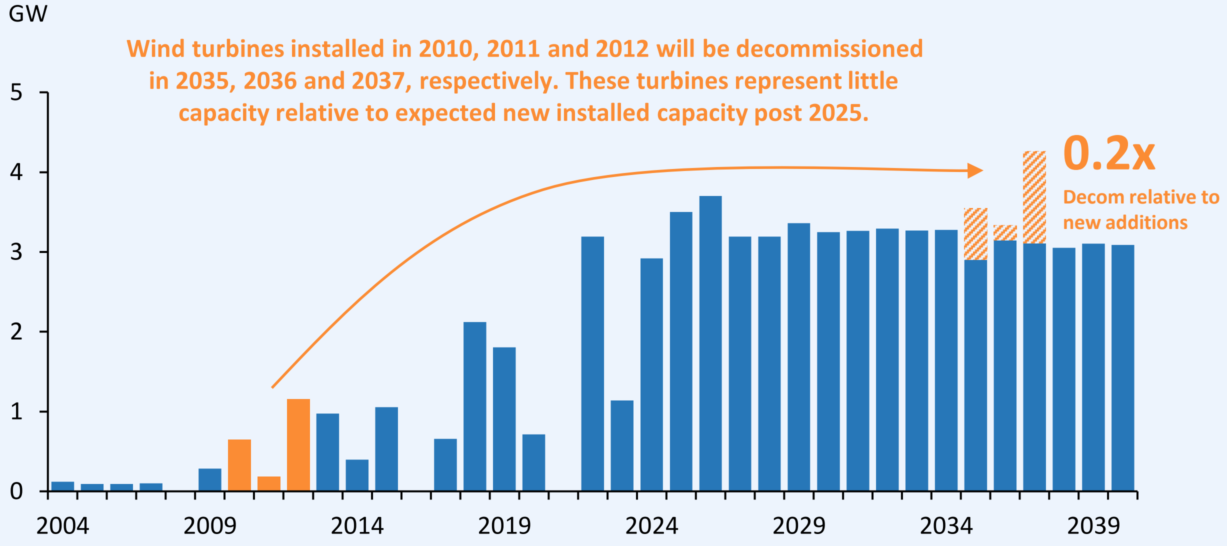
The UK’s first offshore wind turbines were installed some 20 years ago. Wind turbines will likely need to be decommissioned or replaced after 20 to 25 years in service. Although the UK oil and gas supply chain has experience in decommissioning, the early 2000s turbines are considerably smaller than the turbines installed today. This means that the UK decommissioning market will not be substantial for years.

Fixed-bottom wind farms typically have a lifespan of 20 to 25 years before decommissioning becomes a potential reality. As the existing fixed-bottom wind infrastructure in the UK matures, the need for decommissioning these turbines will arise. The UK’s oil and gas supply chain, with its experience in offshore decommissioning and onshore recycling of oil and gas installations, is well positioned to contribute to the decommissioning efforts in offshore wind.

However, it is important to note that this opportunity will not fully materialise for several decades. Wind turbines installed in the early 2000s, which are likely to be decommissioned or replaced after servicing for 20 years or more, are considerably smaller in scale than today’s installations. To illustrate, turbines installed between 2010 and 2012, which have reached 25 years between 2035 and 2037, are only 20% of the size of new additions anticipated for the same period. Consequently, their decommissioning will account for a minor share of the UK total installed base and will be relatively modest compared to annual capacity additions.

Therefore, decommissioning expenditure, compared to other fixed-bottom wind supply chain expenditures, will be very modest for the next decades. However, when the turbines currently being installed reach the end of their operational life in 20 to 25 years, the decommissioning market is expected to grow significantly, becoming a relevant industry in the UK's offshore wind sector.

Annual fixed-bottom wind capacity additions in the UK



Wind turbines installed in 2010, 2011 and 2012 will be decommissioned in 2035, 2036 and 2037, respectively. These turbines represent little capacity relative to expected new installed capacity post 2025.

0.2x

Decom relative to new additions

Source: Rystad Energy research and analysis

Content

Floating offshore wind set for significant expansion in UK towards 2040

The Rystad Energy outlook for installed floating offshore wind (FOW) capacity in the UK is aligned with Renewable UK's scenarios. The Rystad Energy outlook aligns itself in the mid-range between an unlikely, un-ambitious scenario and a scenario aligned with UK public targets.

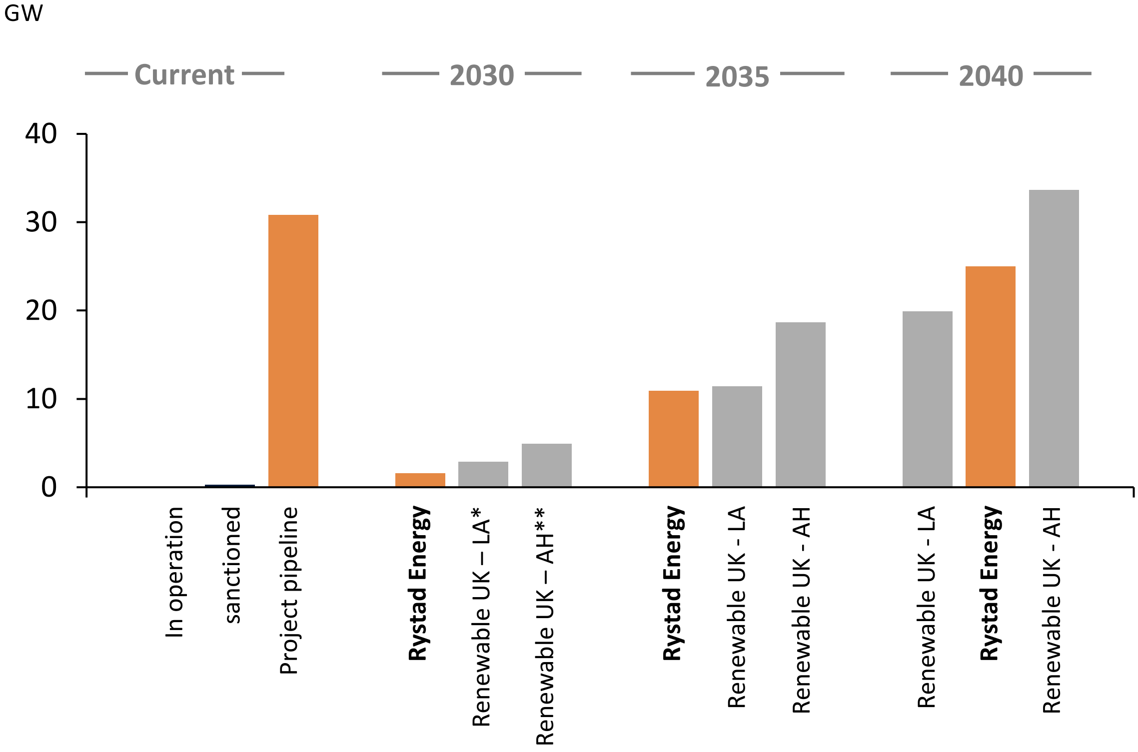
As can be seen from the chart below, Rystad Energy's UK capacity outlook suggests massive growth after 2030. Between 2035 and 2040, we expect a compound annual growth rate (CAGR) of 18%, resulting in 25 GW of installed capacity by 2040.

It is important to note that all scenarios are associated with uncertainty, and factors such as interest levels, country targets driven by policies, supply chain de-bottlenecking and offshore wind's competitiveness against other energy sources will influence the pipeline of realised projects.

The Rystad Energy outlook aligns with Renewable UK and Bloomberg New Energy Finance.

Renewable UK is a British trade organisation representing the interests of the renewable energy industry. In March 2023, it published its 'Floating Offshore Wind Taskforce: Industry Roadmap 2040', where it revealed its capacity outlook for the UK. The graph below shows that Renewable UK publishes two scenarios where the differences between them represent differences in ambitions. Its low-ambition scenario represents a scenario unaligned with government ambitions and, as such, is considered a lower probability scenario.

UK floating offshore wind capacity outlook/targets



*LA = Low ambition scenario. **AH = Aspired high scenario
Source: Rystad Energy research and analysis; Floating Offshore Wind Taskforce: Industry Roadmap 2040

Consensus sees global FOW capacity ramp up, reaching 70 to 100 GW in 2040

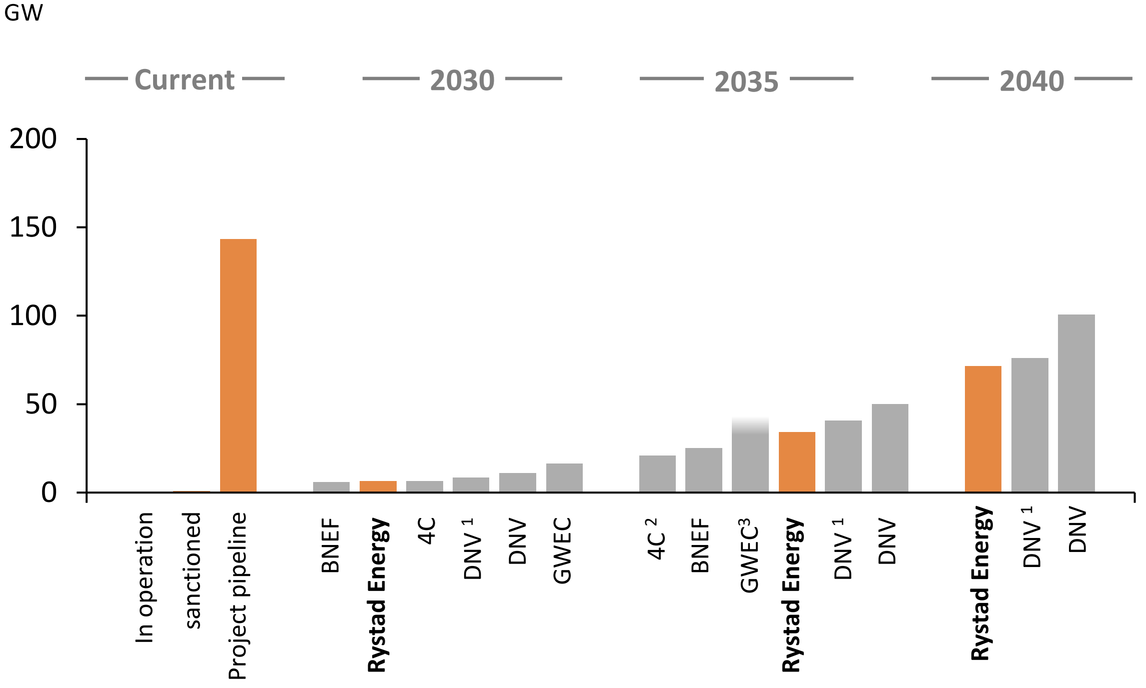
Floating offshore wind is set for significant growth after 2030, as FOW is expected to lower cost and start its path towards industrialisation

The outlook for future installed floating offshore wind capacity varies among different sources. While the pipeline of potential projects is substantial, different opinions on the expected start-up year and the probability of the realisation of the projects drive differences in outlooks of installed capacity. On a global level, we see that Rystad Energy's applied installed FOW capacity outlook places itself in the middle of the observed estimates, being neither overly optimistic nor pessimistic.

Given the current macroeconomic climate with high-interest rates, inflation, cost of capital and expected supply chain bottlenecks, several players have adjusted their capacity outlooks over the last year. The Rystad Energy outlook from 2030 to 2035 suggests strong capacity growth. From 2035 to 2040, the Rystad Energy outlook yields a compound annual growth rate (CAGR) of 18% with a projected installed capacity of 71 GW as of 2040. A strong pipeline of potential projects supports this forecast and could be considered on the conservative side.

Compared to the DNV energy transition outlook, Rystad Energy data suggests modest volumes in China, with less than 1 GW of installed capacity in 2040. Excluding China, the DNV outlook would yield 76 GW of installed FOW capacity globally, and as such, the DNV and Rystad Energy forecasts are quite aligned. Another benchmark, GWEC, suggests 27 GW globally of installed FOW capacity by 2032. The corresponding Rystad Energy's estimate for 2032 is 16 GW of installed capacity, further strengthening the hypothesis that there may be additional upside to the Rystad Energy forecast.

Global floating offshore wind capacity outlook/targets



Note: 1) DNV excluding China; 2) To get 4C's operational 2035 estimate we have applied the 2030 ratio (operational vs under construction) on their 2035 figure. 3) 27 GW in 2032
Source: Rystad Energy research and analysis; DNV Energy Transition outlook October 2023; Global Wind Energy council offshore wind report 2023; BNEF

Floating offshore wind capacity globally to kick off from 2030 and beyond

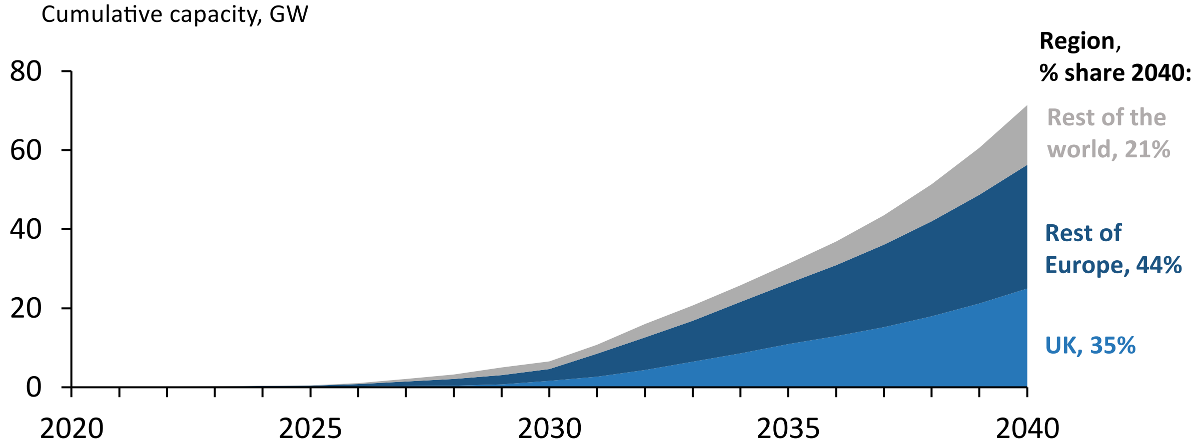
> **Installed global floating offshore wind capacity is driven by Europe with the UK in the driving seat. Europe represents 78% of installed capacity in 2040. As such, the UK's floating offshore wind market will be key for the worldwide ramp-up.**

Looking towards 2040, the UK will lead the European ramp-up of installed floating offshore wind (FOW) capacity, with projected installed capacity of 25 GW. The rest of Europe segment will have more installed capacity than the rest of the world segment, with projected installed capacity of 31 GW and 15 GW, respectively. Other significant players in Europe will be Spain, Ireland, Norway and Portugal. Outside of Europe, we expect South Korea and the US to be major players in terms of installed capacity towards 2040.

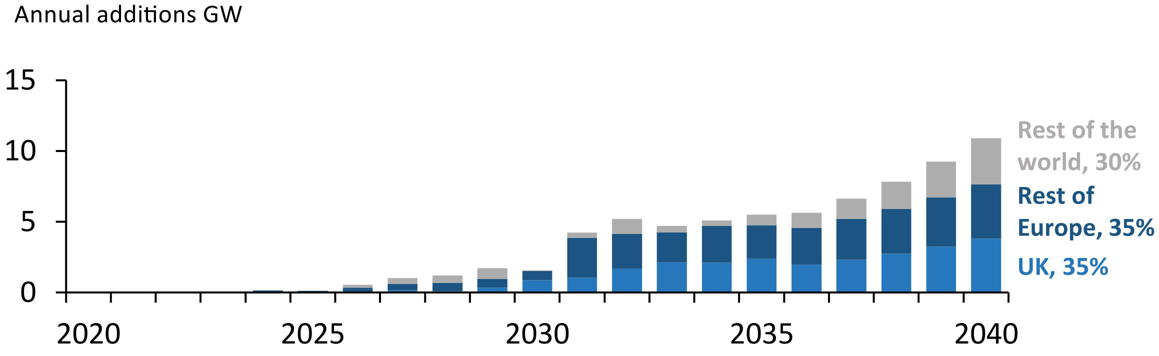
As can be observed from the annual addition chart, the capacity ramp-up will increase heavily after 2030, with a projected CAGR of 28% between 2030 and 2040. The main reasons for the energy vertical not to kick off until after 2030 are technological immaturity, high costs, pending infrastructure, and supply chain development. These factors combined make widespread deployment of floating offshore wind at a large scale more likely in the long term, with significant advancements after 2035 as these challenges are gradually overcome.

As seen from page 81, the global pipeline consists mostly of projects in the pre-sanctioning phase. Sanctioned and producing capacity as of 2023 is quite negligible. The anticipated wave of installed capacity is, therefore, contingent on the realisation of identified projects in the pipeline.

Global floating offshore wind capacity outlook



Global floating offshore wind capacity outlook



Source: Rystad Energy research and analysis

Europe makes up 70% of expected 2040 floating offshore wind expenditure

Average annual FOW expenditure is expected to increase five-fold over the next 15 years because of the expected capacity ramp-up. European suppliers are in a prime position to capitalise on the ramp-up due to the relative size of the European market.

Over the coming decades, annual floating offshore wind expenditure is expected to increase heavily. Globally, average yearly spending between 2035 and 2040 is expected to be five times higher than the average between 2025 and 2030. In numbers, we estimate global average spending between 2035 and 2040 to hit £29 billion.

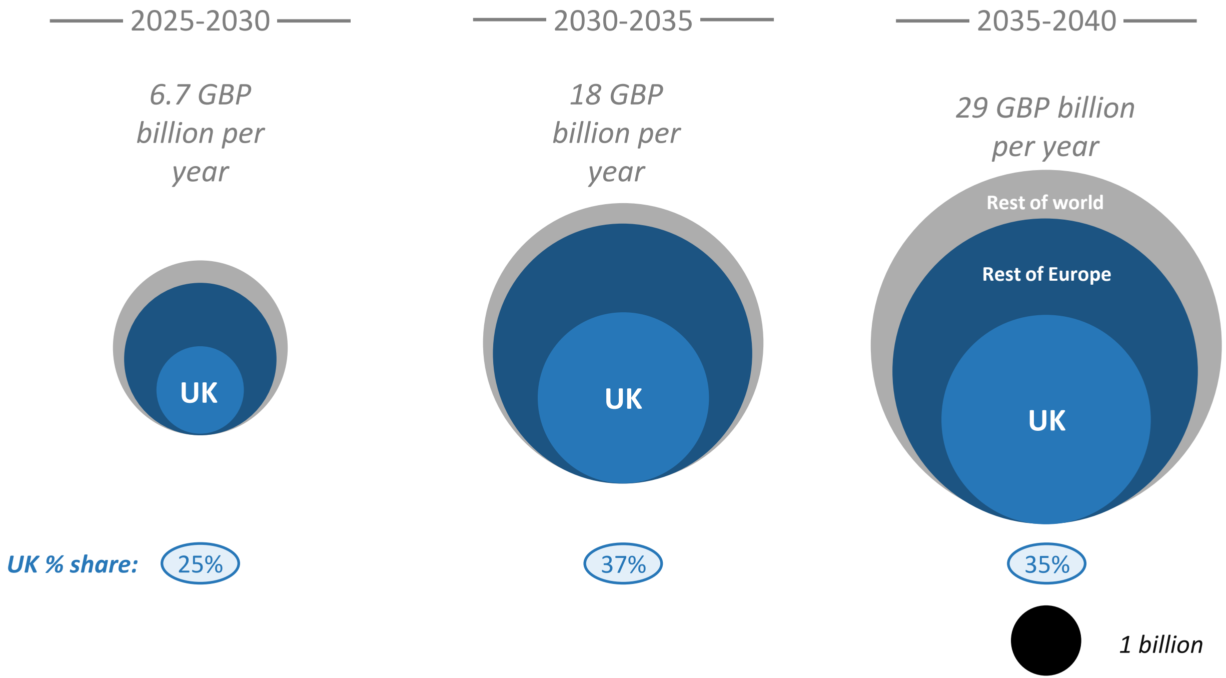
Although the unit cost is anticipated to decrease, annual spending is expected to increase by 9% CAGR from 2025 to 2030, then 13% CAGR from 2035 to 2040. New FOW projects are capex intensive with key segments such as manufacturing and installation of turbines and foundations driving annual spending.

The UK will increase its relative share of average global spending from 25% to 35% from 2025-2030 to 2035-2040, ending up with average annual spending of £10 billion. This corresponds to the current level of UK oil and gas supply chain spending. Meanwhile, European average annual spending between 2035 and 2040 corresponds to £22 billion, or 75% of global spending.

With the relative sizes of the projected expenditures in the UK and Europe, it is evident that suppliers in these regions are positioned well in the global FOW landscape to benefit from the expected expenditure ramp-up.

Average annual FOW expenditures by region

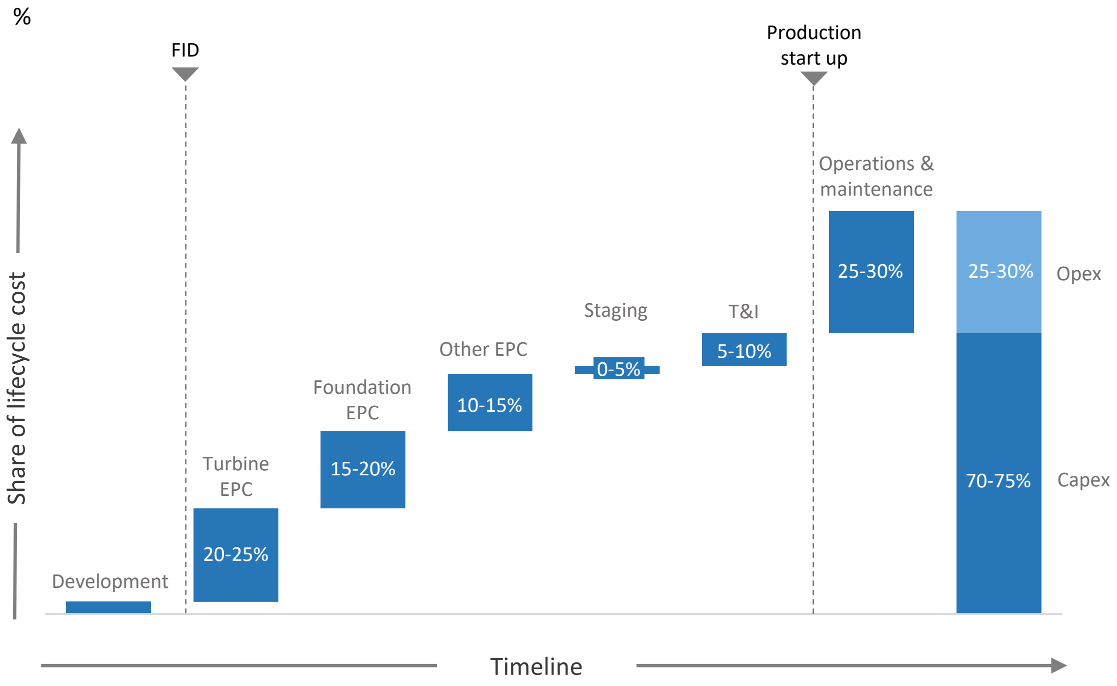
GBP billion real



Source: Rystad Energy research and analysis

EPC expenditure makes up 45% to 60% of total floating offshore wind lifecycle cost

Indicative lifecycle cost of a floating offshore wind farm



Source: Rystad Energy research and analysis

> **Depending on the applied concept, capital expenditure accounts for roughly 70% to 75% of total lifecycle cost of a floating offshore wind project, where the majority is related to turbine and foundation work.**

Around 70% to 75% of expenditure for an offshore wind project occurs before production starts, as displayed by the chart above. The initial investments cover the cost of manufacturing and installing wind turbines and extensive infrastructure such as subsea cabling, foundations, and substations.

Pre-FID costs typically include project development, management, administrative expenses, in addition to geophysical and geotechnical studies and surveys.

After FID, the engineering, procurement and construction (EPC) phase starts. The EPC phase covers the supply of turbine elements (nacelle, tower, rotor, etc.), foundation elements, cables, substations, moorings and anchors. After the EPC phase is concluded, the staging and transport and installation (T&I) phase begins. Now, key components are installed and commissioned offshore.

After production has started offshore, the operational expenditures begin. Operational costs cover day-to-day control of the wind farm, inspection of equipment, and monitoring of various weather and wave conditions. Maintenance covers both planned preventive and unplanned repairs and replacement of major equipment.

Not all floating offshore wind segments are targetable by oil and gas supply chain

Segment (% of lifecycle cost*)	Sub-segments		Targetable by O&G supply chain		OEUK capability assessment**
Development 3%	Development & project management	✅	O&G offshore engineering and surveying align well with FOW development.		Not addressed.
	Survey	✅			
Turbine EPC 20-25%	Nacelle	£ ⊗	Turbine rotor and engineering is already coverd by UK offshore wind dedicated supply chain. The UK currently lacks manufacturing capabilities for nacelle and tower, but a the Port of Nigg facility with tower production is set to start up in 2024.	🟦⬜⬜⬜	Limited growth opportunity - UK capability to manufacture is uncompetitive.
	Rotor	✔			
	Tower	£ ⊗			
	Engineering	✔			
Foundation EPC 15-20%	Material	✅	Foundation EPC is typically delivered by Asian yards, which also supplies larger O&G modules. Foundations are transported by heavy lift vessels, AHTS vessels, or smaller tugs, all traditionally used in O&G.	🟦⬜⬜⬜	UK port space is limited. The UK is better positioned in anchors and moorings.
	Pre-fabrication	✅			
	Assembly	✅			
	Engineering	✅			
	Transport	✅			
Other EPC 10-15%	Substations	✅	Other EPC largely targetable as substations are delivered by same suppliers as for O&G. Mooring and anchoring are already processes used in O&G to hook up FPSOS and rigs. Onshore cables are already served by UK offshore wind dedicated supply chain companies.	🟦🟦🟦⬜	Likely to be produced overseas and transported to location for offshore hook-up.
	Array cables	✅		🟦🟦⬜⬜	Critical subsector for the UK. Ambitions to expand and establish new UK OEM facilities.
	Export cables	£ ⊗		🟦🟦🟦⬜	Export cables are a UK strength.
	Onshore cables	✔		🟦🟦⬜⬜	There is confidence in electrical connections but further clarity on defining this is required.
	Mooring & anchor	✅		🟦🟦🟦⬜	The UK is well positioned in anchors and moorings.
	Engineering	✅			Not addressed.
	Electrical & instrumentation	✅			Not addressed.
Staging 0-5%	Staging	✅	Limited port infrastructure in UK.	🟦⬜⬜⬜	UK port space is limited.
T&I 5-10%	Foundation	✔	UK O&G players can target most T&I services related FOW, except installation of export cables as this segments is traditionally served by other European entities.	🟦🟦⬜⬜	Limited UK position in comparison to European counterparts.
	Substations	✅		🟦⬜⬜⬜	Likely to be produced overseas and transported to location for offshore hook up.
	Array cables	✅		🟦🟦🟦⬜	Strong UK capability – proven UK track record.
	Export cables	✔		🟦🟦⬜⬜	Existing expertise and transferability for UK capacity build-out.
	Mooring & anchor	✅		🟦🟦⬜⬜	
Operation & Maintenance 25-30%	Wet BOP	✅	Wet and dry bop targetable by subsea service vessels and turbine maintenance served by other supply chains.		Not addressed.
	Dry BOP	✅			
	Turbine	✔			

✅	Targetable by O&G supply chain	🟦🟦🟦🟦	The UK O&G supply chain has full coverage of the required capability
✔	UK offshore wind dedicated supply chain	🟦🟦🟦⬜	The UK O&G supply chain has majority coverage of the required capability
⊗	No UK supply chain capability	🟦🟦⬜⬜	The UK O&G supply chain has moderate coverage of the required capability
£	UK investment made	🟦⬜⬜⬜	The UK O&G supply chain has limited coverage of the required capability
		⬜⬜⬜⬜	The UK O&G supply chain has minimal coverage of the required capability

*Percentage of total lifecycle cost of a floating offshore wind farm. **Refer to more detail in OEUK Report 'Harnessing the potential'. The capability assessment is based on all UK supply chains, not only oil and gas related. Revisions in capabilities have been made for certain segments that has not been addressed by OEUK

Source: Rystad Energy research and analysis; OEUK; industry interviews

UK O&G supply chain has strong EPC capabilities it can put to use in FOW

The UK oil and gas supply chain offers several capabilities that match well with those needed within FOW. The similarities are especially present across selected EPC packages and installation services.

UK oil and gas suppliers can apply their offshore engineering expertise to FOW development projects due to similar engineering and surveying processes. Both oil and gas- and FOW projects conduct surveys to collect data on seabed, wave and weather conditions. Companies such as Subsea7 exemplify their engineering expertise by winning FEED contracts for FOW projects, effectively leveraging their traditional oil and gas skills in engineering foundations, moorings and cabling.

Turbine EPC is mostly covered by a dedicated offshore wind supply chain, and there is limited potential for existing UK oil and gas suppliers to deliver to this segment.

UK oil and gas suppliers have vast experience in fabricating and manufacturing large steel structures such as jackets and the logistics involved in transporting these structures to sea. Facilities and vessels initially intended for oil and gas components can be altered to suit FOW foundations and thus leverage their capabilities towards the FOW industry. However, the industry around floating foundations has yet to industrialise. As of now there are several foundation concepts, of which several are in the pilot, demonstration and pre-commercial stage. Few units have been produced, implying one-off manufacturing as opposed to full-scale production. This means that the UK currently has limited foundation production capabilities.

Other EPC covers key elements such as substations, cables, mooring and anchoring. While onshore and export cables are mostly served by non-oil and gas suppliers, suppliers to the existing oil and gas supply chain have extensive experience in terms of EPC and mooring solutions. As for the oil and gas industry, mooring and anchoring are critical for FOW operations, as securing the foundation to a fixed point on the seabed is essential.

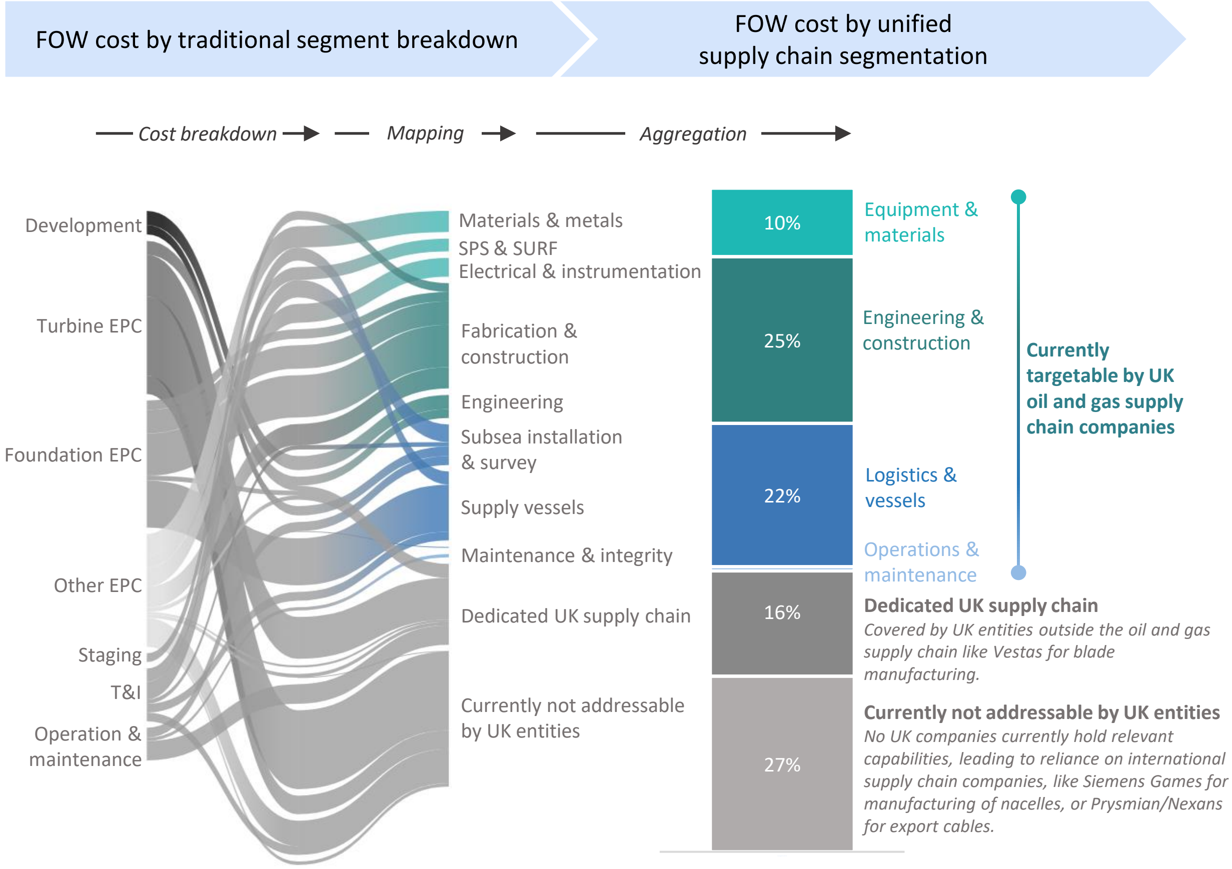
Ports are a critical part of the FOW value chain. As FOW components are larger and heavier than fixed-bottom offshore wind components, the anticipated FOW scale-up presents several challenges related to port infrastructure and deepwater access. From a UK perspective, available port space is currently limited. Thus, upgrading and developing ports will be critical to facilitate the expected mass deployment of floating offshore wind.

After the floating offshore wind turbine is assembled, several vessel types are needed to transport, install and operate the FOW facility. Tugboats, AHTS vessels and OCVs – or a combination of vessels – must tow out and connect the facility to the pre-laid mooring lines prior to cable hook-up. Moreover, vessels intended for foundation, cable and substation installations will be needed in addition to service operation vessels to support construction and tend to the operational farm. Most of these operations are directly translatable from today’s oil and gas operations.

Operation and maintenance is currently the largest UK oil and gas expenditure segment. For FOW we split this cost between turbine, above-water and below-water expenditures. Maintenance and repairs for turbine and above-water items are expected to be managed by dedicated turbine suppliers and the existing offshore wind supply chain. Below-water services can be handled by the existing UK oil and gas supply chain. Maintenance and inspection of items such as mooring lines and foundations requires capabilities that match well with current services offered by UK oil and gas suppliers.

Source: Rystad Energy research and analysis

Around 45% of FOW project cost not addressable by oil and gas supply chain



Dedicated UK supply chain
Covered by UK entities outside the oil and gas supply chain like Vestas for blade manufacturing.

Currently not addressable by UK entities
No UK companies currently hold relevant capabilities, leading to reliance on international supply chain companies, like Siemens Games for manufacturing of nacelles, or Prysmian/Nexans for export cables.

About 55% of a typical FOW project cost is targetable by the oil and gas supply chain, while the current non-targetable segments involve specialised turbine equipment and maintenance services provided by dedicated supply chains.

By breaking down the traditional cost components of a typical floating offshore wind project from development, EPC and operations, we can identify targetable segments for the oil and gas industry.

The oil and gas supply chain will be able to target roughly 55% of the products and services needed for a FOW project. Oil and gas players can leverage their capabilities to deliver development, engineering, foundation EPC and T&I through their abilities within engineering and construction, logistics and offshore marine operations.

Currently not addressable segments are typically specialised services and products, where oil and gas players have little experience. This can be turbine equipment and services, or above-water structures and components .These segments are typically served by the equipment manufacturers or dedicated offshore wind supply chain companies.

Source: Rystad Energy research and analysis; Rystad Energy Wind Solution; Rystad Energy ServiceDemandCube

Majority of FOW expenditure segments targetable for UK O&G supply chain

The UK FOW market will reach £10 billion within the next two decades. The market will likely continue to grow after 2040 as the unrisked pipeline of identified projects is strong. Equipment and materials and engineering and construction will constitute the largest spending segments with 70% of total spending in 2040.

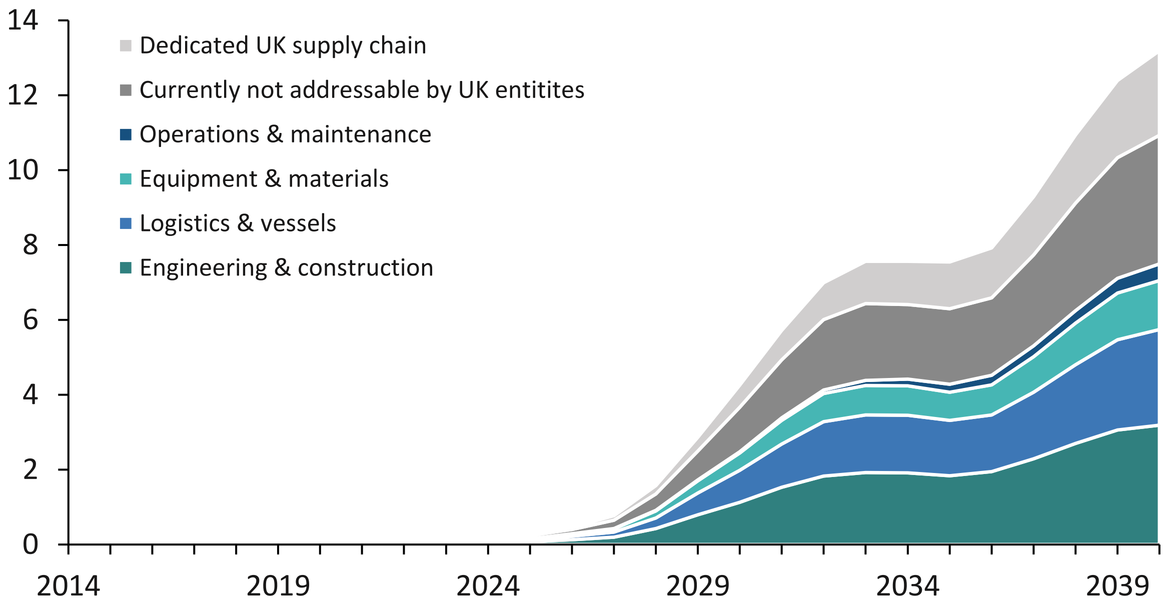
UK FOW expenditure is expected to get close to £10 billion in the late 2030s, highlighting how declining upstream spending will be offset by increased FOW spending. Given the strong pipeline of potential projects, we expect the spending curve to continue soaring after 2040.

The UK's largest spending segments will be engineering and construction as well as logistics and vessels. As seen from page 84, the lifecycle cost of a floating offshore wind plant is heavily capex-weighted. Consequently, with the anticipated rapid increase in capacity, the bulk of total UK FOW expenditure will be allocated to key equipment such as turbines and towers, alongside critical engineering and construction components, including foundations and transport.

Estimated total UK FOW spending in 2040 is £13.2 billion. Of total 2040 spending, 43% or £5.7 billion is deemed not addressable by the oil and gas supply chain due to the supply chain not having the necessary capabilities. That leaves £7.5 billion targetable for oil and gas players in high-spending segments such as logistics and vessels, where oil and gas players have strong capabilities that can be easily transferred to FOW.

UK floating offshore wind capex and opex expenditures per year by segment

GBP billion real



Source: Rystad Energy research and analysis

O&G players’ relevant addressable market outside UK is £96 billion

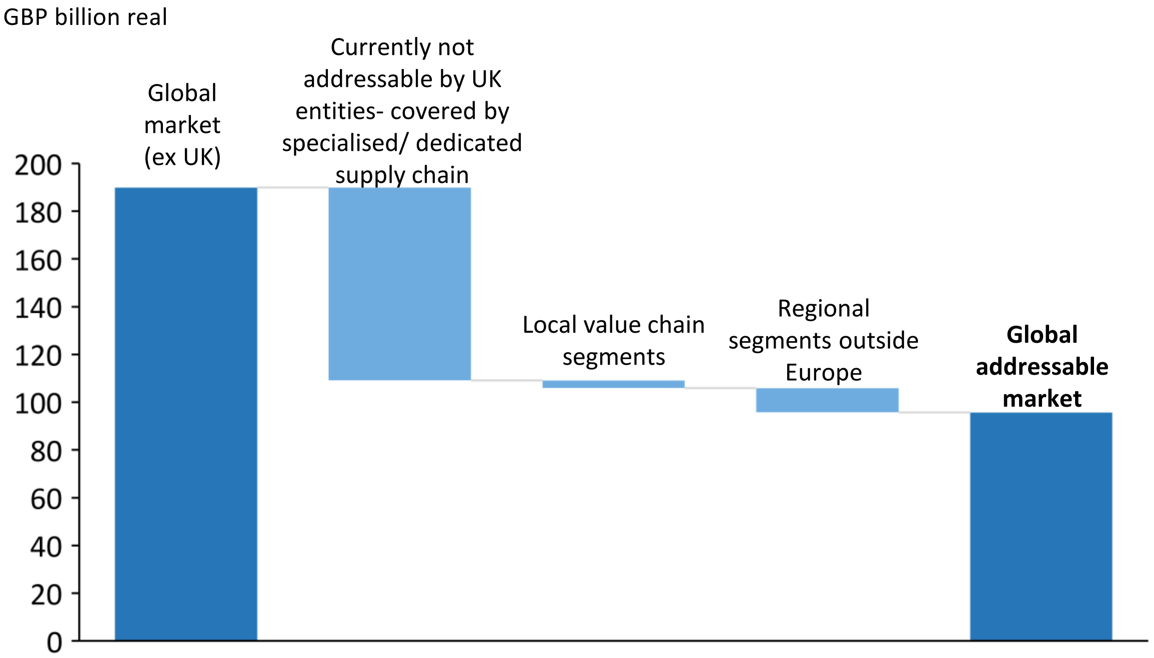
Adjusting the global addressable market by removing segments that are deemed less relevant reduces the global addressable FOW market available to UK oil and gas players by £95 billion or 50%. Market segments are excluded due to a combination of geography and capabilities.

Excluding the UK market, Rystad Energy estimates that accumulated floating offshore wind (FOW) spending between 2024 and 2040 to be almost £190 billion. However, not all segments and regions are addressable by UK oil and gas players due to their inherent capabilities.

Supply, maintenance and operations of turbines and structures are typically carried out by dedicated equipment suppliers and existing offshore wind suppliers. Consequently, these spending segments fall outside the scope of the traditional UK oil and gas supply chain participants and are therefore deemed currently not addressable. In addition, some expenditure is typically handled by local or regional players. Costs such as staging and under-water maintenance will typically be handled by local players, while transport and installation (T&I) services are conducted by regional players.

As a result, another £13 billion in spending from local (non-UK) and regional (non-Europe) markets are deemed currently not addressable by UK entities. However, as seen earlier, the main markets for FOW are Europe and the UK. By adjusting for local and regional markets, we remove only 7% of the pre-adjusted addressable market.

Floating offshore wind accumulated 2024 - 2040 spend



Source: Rystad Energy research and analysis

Port investment initiatives slip due to limited visibility and lack of scale

CASE: Demand for ports

> **Lack of suitable port infrastructure constitutes a roadblock for the UK's FOW deployment targets. Government action is likely needed to trigger port investments.**

Ports play a key role throughout the floating offshore wind (FOW) value chain and all phases of the FOW lifecycle. If the UK is to meet its capacity targets, this will entail towing out significant volumes of FOW structures from UK ports over the coming decades. Turbine sizes are expected to increase beyond what is seen in fixed-bottom today. Assuming turbine sizes are between 15 and 25 MW, this entails between 200 and 300 structures being towed out before the end of 2030. These volumes demonstrate the significant demand for suitable ports moving forward.

The chart 'UK Port space demand' illustrates the area demand in hectares based on Rystad Energy's FOW capacity outlook. The high case covers area needed for pre-fabrication, assembly, and staging, while the low case covers only staging. All scenarios require significant ramp-up.

Ports intended to serve the FOW industry must have significant space for storing and assembling large components (size highly dependent on scope of work performed at sight), heavy lift equipment for installations, water depth at quay side and sail-in suitable to accommodate large installation vessels and foundations with draught up to 15 meters. While pre-fabrication and assembly of substructure components can be carried out at offsite locations, staging should take place at a port in proximity to the wind farm to minimise tow-out distance and as such cost.

Compared to UKCS oil and gas assets, FOW farms will be more geographically dispersed, thus requiring port capacity scattered around the UK. With the need for dry storage, wet storage and inshore staging, most existing UK ports are unfit for FOW staging applications. This lack of suitable ports is a key challenge for the UK to deploy FOW capacity according to government ambitions. As such, significant port investments are required.

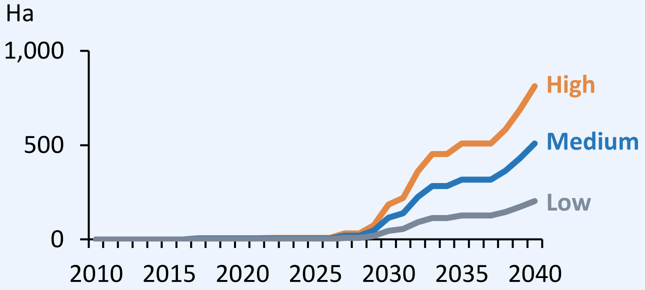
A roadblock for major port investments is the current risk attached: key port stakeholders such as developers, port owners, EPC contractors, or private investors are not willing to invest in port infrastructure before FOW wind projects have gone through a final investment decision as they need secure return on investment through long term contracts or future cash flow. This creates a problematic deadlock as investors are hesitant to fund ports in the absence of guaranteed projects, and developers do not want to commit to projects without available ports.

To initiate port investments, implementing government actions and support mechanisms such as tax benefits, grants, or loans would act as a catalyst. Such initiatives would reduce risk and provide financial incentives to invest.

Port size requirements and capabilities

	Prefab.	Assembly	Staging
Size* (Ha)	30	30	20
High	✓	✓	✓
Medium		✓	✓
Low			✓

UK port size demand



*Required size for ports with annual throughout of 25 turbines a 15 MW each
Source: Rystad Energy research and analysis

Mooring demand will quickly outgrow a supply chain scaled to cater for O&G

CASE: Demand for mooring solutions

> **Demand for permanent mooring lines to increase exponentially as FOW reaches industrialisation. A supply-gap is highly likely as the current supply chain is scaled to cater for the oil and gas sector with a supplier landscape dominated by Asian players**

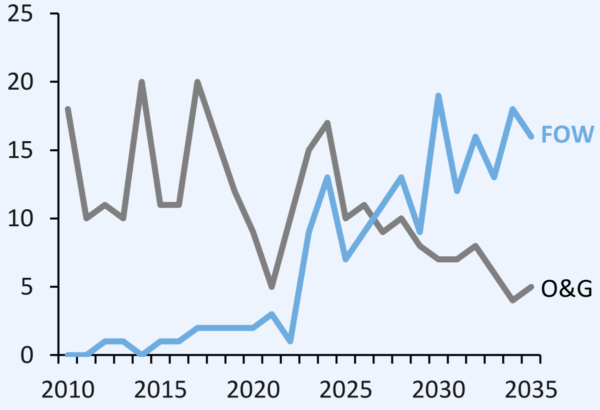
The permanent mooring and anchoring supply chain is currently scaled to accommodate the oil and gas industry, which historically has brought on 15 to 20 FPSOs per year at peak globally. While an FPSO such as Quad 204 is anchored using 24 mooring lines, each FOW installation will require between three to nine mooring lines and anchors. Large variations are expected across projects driven by the need for redundancy and number of shared mooring lines across turbines. Even when applying aggressive assumptions on turbine size, e.g. 25 MW turbines – the demand for mooring lines will grow exponentially.

To meet this demand, the mooring and anchoring supply chain will have to scale up significantly. While the industry does recognise the future demand, the players are hesitant to initiate the necessary ramp-up due to the un-developed characteristics of the FOW industry and associated uncertainties. In terms of urgency, scalability is most challenging for chains. It is easier to scale up anchors and jewelry, but the supply chain would benefit from more players entering the segment.

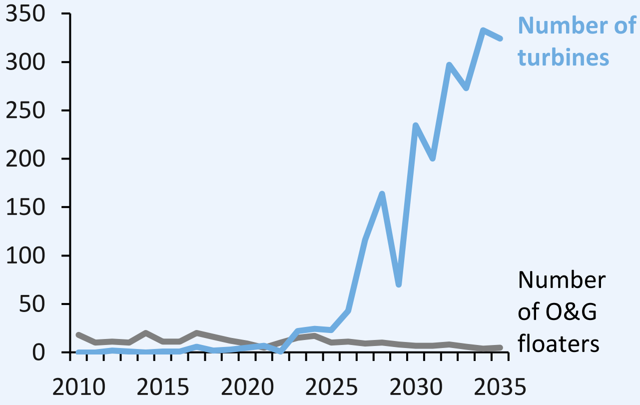
Manufacturing of mooring chains is currently dominated by foreign players, exemplified by Asian producers having three times the manufacturing capacity of European. Thus, UK and European players should develop local and regional mooring line manufacturing capacity to meet FOW's increasing demand and reduce their import dependence. In addition to ramping up European manufacturing capacity, demand for chains could be offset by increased use of fiber. This would relieve an already pressured value chain and allow the UK and Europe to utilise existing knowledge.

In terms of mooring system EPCI the UK has a strong position with world leading and renowned players. With vast mooring system EPCI experience from oil and gas, these UK players could leverage their existing position to gain a strong foothold in FOW.

Global start-up of floating units
Number of announced projects



Global start-up of floating units
Number of announced projects



Source: Rystad Energy research and analysis

Challenging to see AHTS supply keep up with demand without long-term contracts

CASE: Marine operations and AHTS vessel demand

Marine operations for FOW will require AHTS vessels for installation and maintenance work. With the current fleet of AHTS vessels being under-specked and old, there will be a significant supply gap unless orders are placed or dedicated vessels being build

During both the installation and operational phases of FOW, anchor-handling tug supply (AHTS) vessels are expected to play a significant role while the industry is waiting for – potential – purpose-built vessels. The vessels are applied for marine operations such as pre-laying of mooring lines, anchor installation, tow-out and mooring hook up as well as mooring disconnecting in relation to potential in-shore maintenance or major component replacement. Note that part of the work scopes are often covered – or supported – by OCVs, e.g. pre-lay.

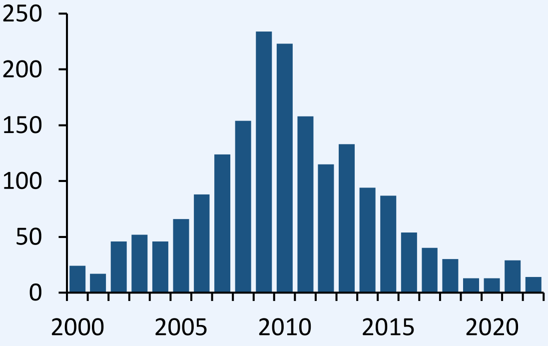
Historically, AHTS demand has been driven by the oil and gas sector. However, the magnitude of projected work from the anticipated FOW deployment will make FOW the primary driver of AHTS demand in the 2030’s.

Key vessel spec deciding an AHTS’ capability to work in the FOW segment include bollard pull, chain locker capacity and deck space. The current European fleet of vessels with relevant bollard pull capabilities is small, the effect being that supply will struggle to meet demand as FOW deployment ramps up. In addition, the FOW and oil and gas industries will compete for the same vessels, putting additional pressure on the supply-side.

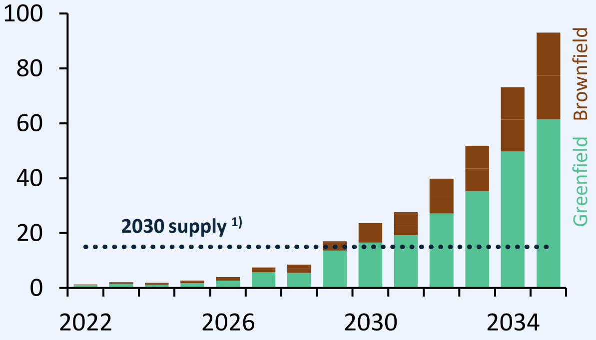
Since the 2009 AHTS newbuild peak, there has been a steady decline in deliveries of new AHTS vessels, driven by a saturated market that has yielded large financial losses for vessel owners and financial institutions. These losses have led to difficulties for vessel owners in receiving financing for new vessels. Additionally, the absence of definitive schedules for new projects has contributed to vessel owners' reluctance to invest in new vessels.

Contrary to the traditional spot market, financial institutions will require firm long-term agreements to provide financing for new vessels. However, the weather-sensitive operations in FOW make it difficult to enter long-term contracts with firm work scopes. As a result, a supply squeeze seems likely in the short term. However, in the long-term, financial institutions might increase their willingness to fund AHTS newbuilds as vessel demand increases.

Annual deployment of AHTS vessels
Number of vessels



AHTS vessel demand in Europe
Vessel years



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1) 2030 supply includes European AHTS vessels with BP > 200 tonnes and vessel age < 20 years in 2030
Source: Rystad Energy research and analysis

Content

UK hydrogen production forecast at around 3 million tonnes a year in 2040

Rystad Energy estimates the UK's hydrogen production will reach between 600,000 and 3 million tonnes annually by 2030 and 2040 respectively, driven by blue hydrogen.

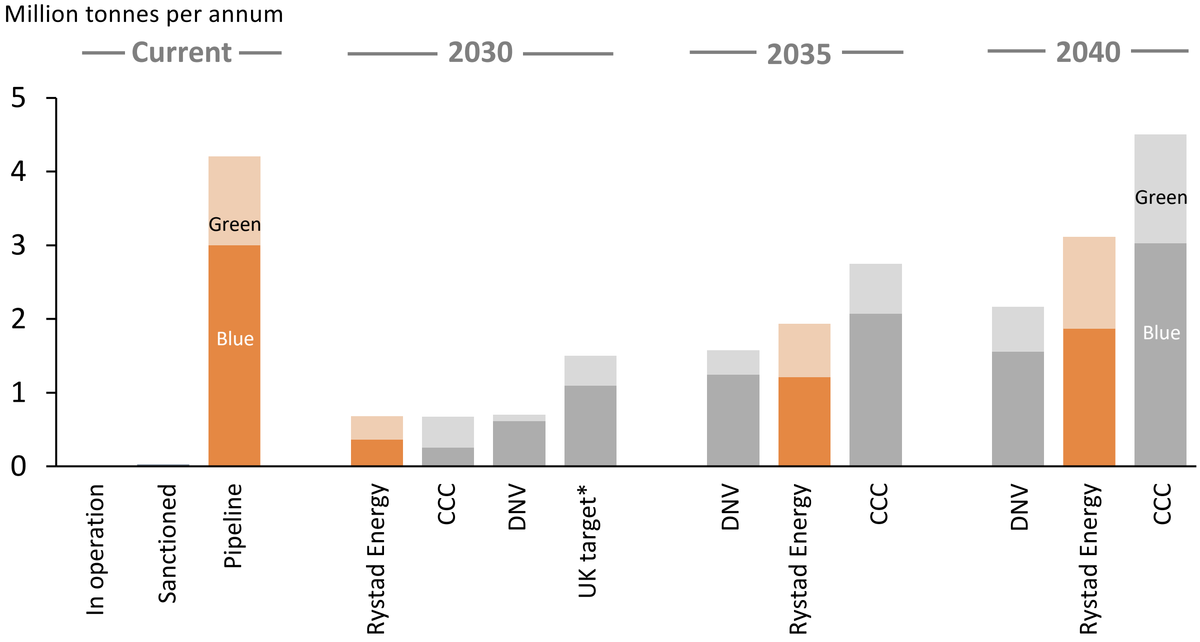
The UK government has set a target of achieving 10 GW of hydrogen production by 2030, with at least half of it from electrolytic hydrogen. The government has currently allocated £37.9 million in subsidies to 15 low-carbon hydrogen projects from its £240 million Net Zero Hydrogen Fund. The UK government has not communicated any targets beyond 2030, but the Scottish government has an ambition of 25 GW renewable hydrogen by 2045.

Currently, there is only a handful of small projects producing green hydrogen, with the Tyseley Refuelling Hub being the largest, producing 250 tonnes annually from its 3 MW electrolyser. The Acorn hydrogen project at the St Fergus gas terminal is expected to be one of the first blue hydrogen projects in the UK, with an anticipated start-up in 2026.

Rystad Energy estimates 600,000 tonnes of yearly hydrogen production by 2030. Blue hydrogen is forecast to make up the largest share in 2040. However, blue hydrogen capacity additions will decline after the early 2030s as it seen as a transitional fuel. Blue hydrogen is currently cheaper to produce than green hydrogen but is not net zero as it relies on fossil fuels. Also, green hydrogen is more favourable in terms of subsidies, and technology advances will make it more cost-efficient in the future.

DNV expects a lower uptake of hydrogen relative to the UK target, primarily attributed to the current high cost of hydrogen when compared to natural gas. The CCC foresees a rise in production driven by cost effectiveness of variable renewables, resulting in increased renewable investments after 2035. The projection suggests an oversupply of renewable electricity, which, instead of being curtailed, can be used for green hydrogen production.

UK green and blue hydrogen production outlook/targets



*Assumed 39.4 kilowatt-hours per kilogram as the higher heating value for GW to million tonnes conversion
Source: Rystad Energy; Rystad Energy Hydrogen Market dashboard; DNV UK Energy Transition Outlook 2022; CCC The Sixth Carbon Budget December 2020; UK government

Global hydrogen production to reach 150 million tonnes a year by 2040

Hydrogen will play an important role in decarbonising industrial and transportation processes. Policies and decarbonisation targets are key to driving the global growth expected from 2030 and onwards.

Global hydrogen production is expected to significantly expand after 2030 due to its role in decarbonisation strategies, in particular the way green hydrogen is expected to decarbonise energy systems in hard-to-abate sectors in heavy industries and heavy transport.

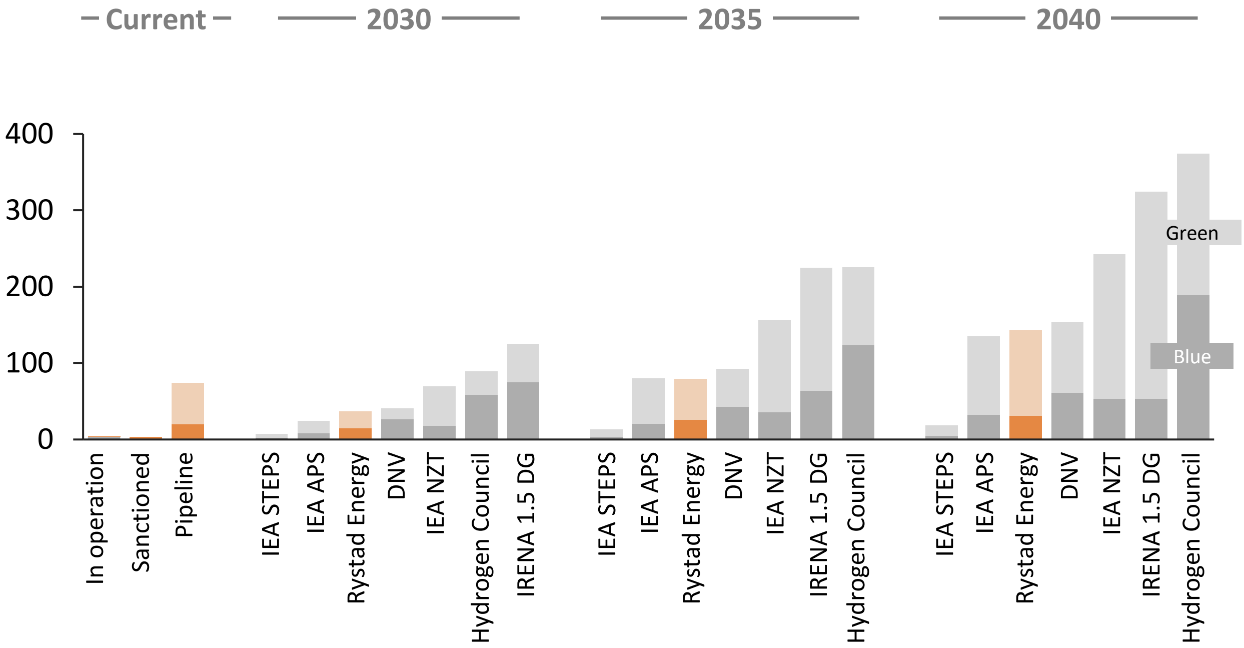
The outlook and target for global low-carbon hydrogen production varies among different peer groups due to varying assumptions, differences in views on project start-up year, and the probability of the realisation of projects. Rystad Energy, like peers, estimates that global hydrogen production will see substantial growth after 2030 largely driven by the acceleration of green hydrogen developments and increased availability of renewable energy.

The current project pipeline stands at 73 million tonnes of annual production, with only 3 million tonnes currently in operation. The pipeline has been risked and adjusted based on parameters such as funding, offtake secured and project developer history. Excluding the projects with highest risk, Rystad Energy expects that 35 million tonnes of hydrogen will be produced yearly by 2030. Towards 2040 green hydrogen will outgrow blue hydrogen in yearly capacity additions.

IRENA and the HydrogencCuncil estimate production of hydrogen at 320 million and 370 million tonnes yearly in 2040, respectively. These estimates are contingent on the phase out of grey hydrogen. DNV, is more conservative in its energy transition outlook with a global hydrogen capacity of 150 million tonnes in 2040.

Global green and blue hydrogen outlook/targets

Million tonnes per annum



Source: Rystad Energy; IEA World Energy Outlook 2023; DNV Energy Transition outlook October 2023; Hydrogen Council Hydrogen for Net-Zero November 2021; IRENA Word Energy Transitions Outlook 2023: 1.5° Pathway

UK hydrogen market is set to reach 2% of global production

Most of global hydrogen production will happen outside of Europe with the US and Australia as the largest producers. The UK will contribute with relatively small volumes globally, especially in green hydrogen production.

The European Union's hydrogen strategy promotes green hydrogen to align with the decarbonisation goals through a €3 billion green hydrogen bank, while blue hydrogen producers are not eligible to apply for funding as it is seen as a transitional fuel.

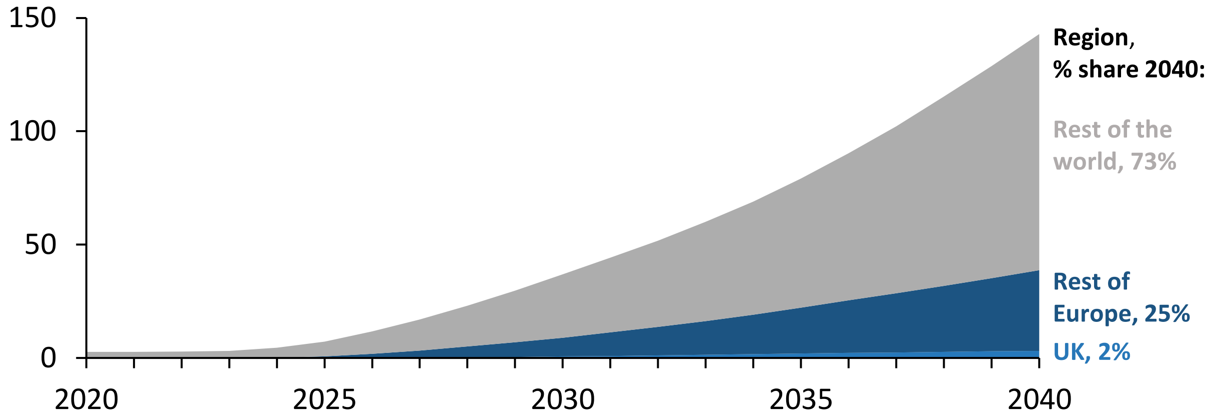
As can be observed in the chart below, there will be a steady increase of hydrogen production from 2026, driven by government policies and funding.

For example, the US Inflation Reduction Act (IRA) has allocated $100 billion in subsidies towards hydrogen production in the US. The subsidy is provided as a production subsidy, where the level of subsidy is dependent on the lifecycle emission intensity. Producers of green hydrogen stand to receive incentives of up to $3 per kilogram (kg) of hydrogen through the 45V tax credit, whereas blue hydrogen producers can receive awards of up to $1 per kg of hydrogen through the 45Q tax credit. The IRA has the best support mechanisms for green hydrogen production, and combined with low-cost input factors, the US is attractive for green hydrogen production.

A substantial amount of sanctioned production assets are projected to be operational in the next few years. However, most assets are currently in the pre-sanctioning phase. The steady increase is contingent on identified assets in the pipeline being sanctioned and new assets being announced in the coming years.

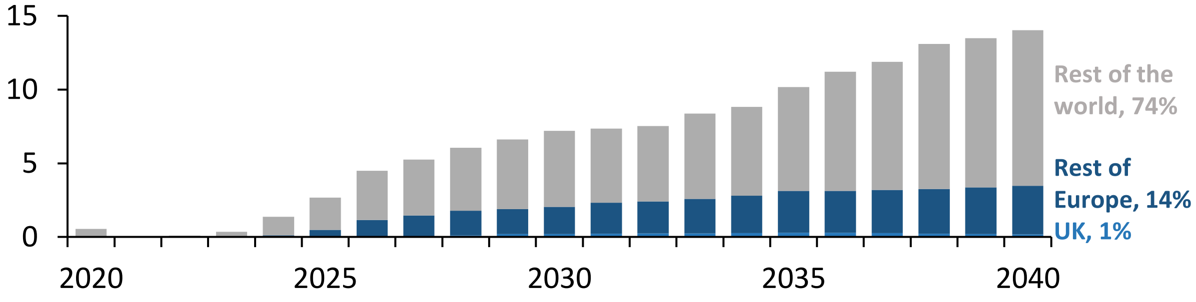
Global hydrogen production outlook

Cumulative, million tonnes per annum



Global hydrogen production outlook

Annual additions, million tonnes per annum



Source: Rystad Energy research and analysis; Rystad Energy Hydrogen Market dashboard

Hydrogen spending to grow to £93 billion, driven by countries outside Europe

Average global hydrogen expenditure is set to reach approximately £93 billion between 2035 and 2040. Non-European countries are set to drive market growth, while UK spend will remain limited.

Annual hydrogen supply chain spending is largely driven by the substantial capital investments related to growth in annual capacity additions. It should be noted that the expenditure estimates for hydrogen do not encompass selling, general and administrative costs, along with feedstock expenses.

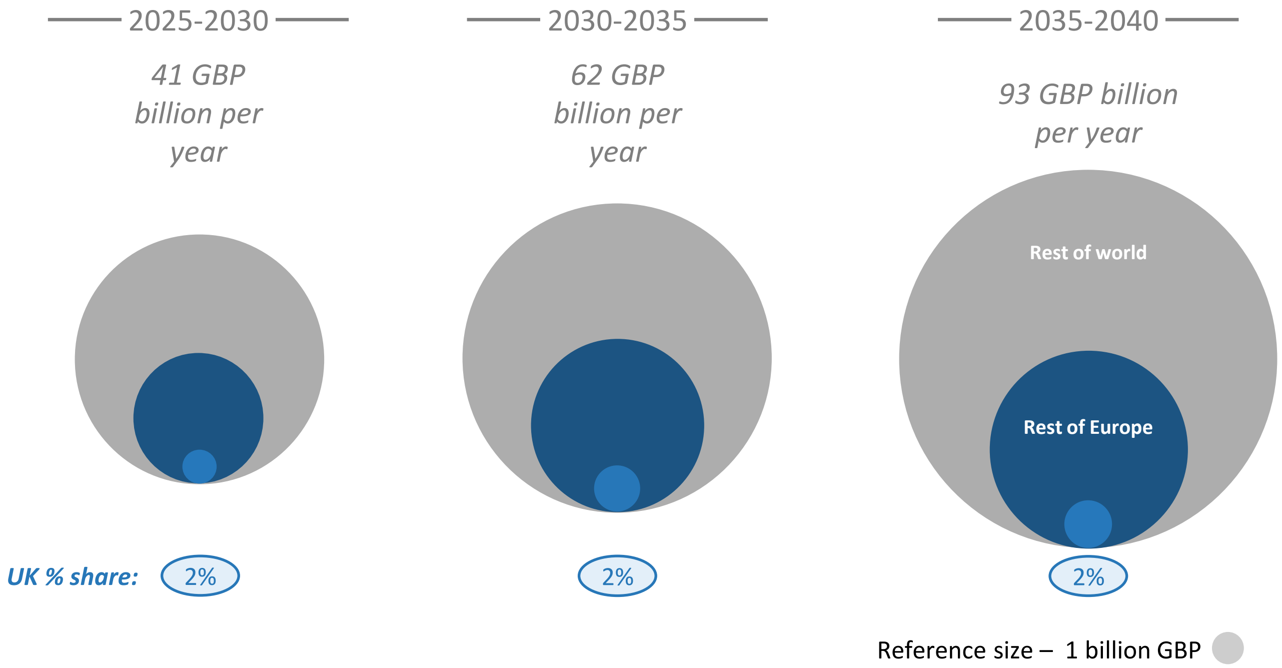
Global average annual hydrogen expenditure is expected to average £41 billion between 2025 and 2030. It is largely driven by investments outside Europe by countries such as the US and Australia, which currently lead the low-carbon hydrogen race. Australia, as the biggest anticipated green hydrogen producer with around 15% of global announced capacity, and the US, with more than 40% of announced blue hydrogen production capacity, are driving expenditure in the industry. The UK is expected to be a modest market for hydrogen with a minor market share of about 2%, with average annual spending of £700 million between 2025 and 2030. The rest of Europe, on the other hand, will see substantially higher average annual expenditure of roughly £11 billion between 2025 and 2030, accounting for roughly 27% of the market in the period.

The UK is expected to account for a small share of the market throughout the 2030s, while the rest of Europe retains a market share just below 30% between 2035 and 2040.

Towards 2040, global annual hydrogen expenditure is expected to increase significantly, primarily driven by deployment of new green hydrogen production capacity. Global average spending between 2035 and 2040 is expected to reach around £93 billion per annum, roughly 2.3 times higher than the average spend between 2025 and 2030.

Average annual hydrogen expenditure by region

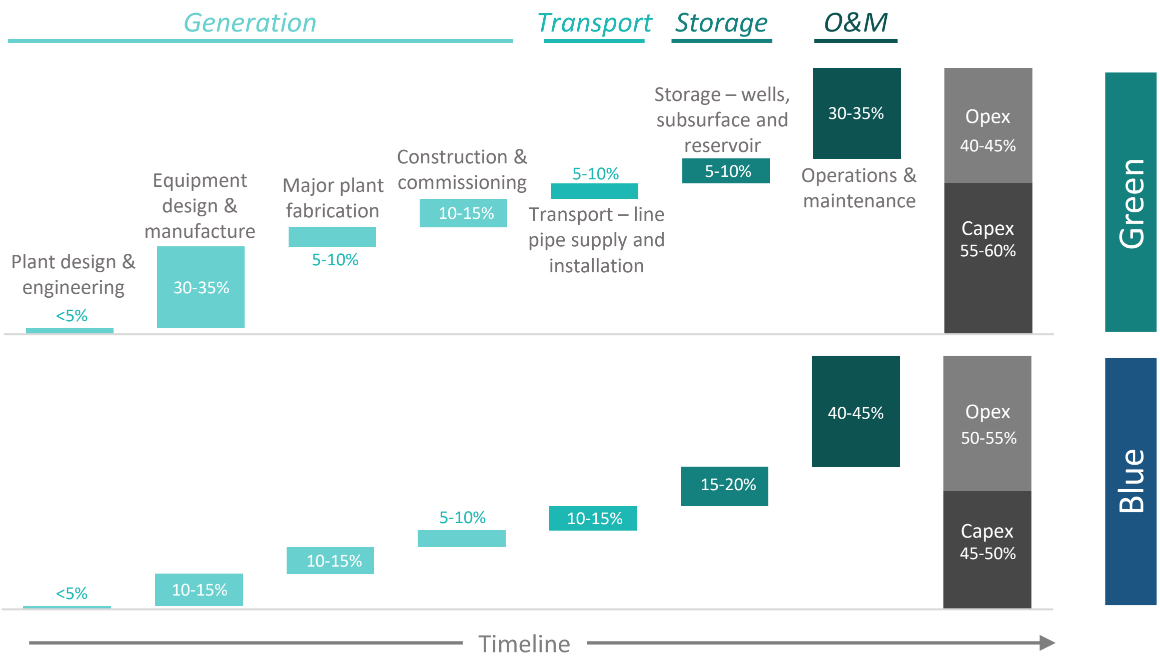
GBP billion real



Source: Rystad Energy research and analysis; Rystad Energy Hydrogen Market dashboard

Equipment design and manufacture makes up most of capital expenditure

Indicative lifecycle cost of a hydrogen project based on type*



Capital expenditure makes up 40% to 60% of total lifecycle costs for hydrogen projects. There is a higher capex share in green hydrogen production due to costly generation equipment.

Hydrogen production is a capital-intensive industry where around half the total expenditure occurs before the start of production. This expenditure is primarily related to the design and manufacturing of production equipment together with construction, commissioning and fabrication of the main plant. The estimated expenditure for hydrogen production does not encompass selling, general and administrative costs, along with feedstock expenses.

The equipment design and manufacture segment makes up a significantly larger share for green hydrogen than for blue hydrogen as the cost of producing hydrogen through electrolyser is much higher than blue hydrogen production via SMR or ATR with carbon capture. Making up 30% to 35% of a green hydrogen project and only 10% to 15% of a blue hydrogen project.

Costs related to transportation cover mainly domestic transportation and thereby trucking and construction or repurposing of onshore pipelines for hydrogen. Transportation costs make up between 5% to 15% of a hydrogen project. Storage costs include hydrogen storage tanks for surface storage and underground salt caverns for typically bulk storage. Storage costs make up between 15% to 20% for a blue hydrogen project and only 5% to 10% for green hydrogen

Operational expenditures start once production commences, covering costs related to the maintenance of the electrolyser, SMR and ATR, pipelines, and other equipment in addition to maintenance of the plant and storage. Opex costs makes up around half of the project with underground storage, transportation via pipelines and a lifetime of 25 years.

*Excludes purchases of input factors renewable electricity and natural gas
Source: Rystad Energy research and analysis; Rystad Energy ServiceDemandCube

Majority of hydrogen segments are addressable by O&G supply chain

	Segment (% of spend)*	Sub-segments	Targetable by O&G supply chain		OEUK capability assessment**	
Generation	Plant design & engineering 3%	Engineering	✅	O&G process engineering, and project management align well with hydrogen.	■■■■	UK supply chain strength.
	Major plant fabrication 9%	Fabrication & construction	✅	Shared demand for modular design and materials. Similar requirement for equipment, materials and services as for most refinery, petchem or power generation project.	■□□□	Capability has declined; barriers to competitiveness.
		Materials & metals	✅			
	Equipment design & manufacture 34%	Electrolyser stacks	✔	Production of electrolyser stacks is traditionally served by hydrogen supply chain, while other major equipment like compressors and other electrical equipment are transferable to O&G. Reformer design contain specific intellectual property belonging to the licensors of the process, which is closely guarded, and hence a limited number of suppliers therefore exists. Wood uses non-UK manufacturers of its reformer packages. Carbon capture equipment such as absorbers/strippers used in blue hydrogen production are traditonally served by dedicated manufacturers.	■□□□	Electrolysers, compressors and reformer package manufacture UK supply chain gap. Limited coverage of specialised equipment such as main reformers and reforming catalysts.***
		Other major equipment	✅			
		Electrical equipment and instrumentation	✅			
		Steam methane reforming (SMR)	✔			
		Autothermal reforming (ATR)	✔			
		Carbon capture equipment	✔			
	Construction & commissioning 10%	Logistics and supply bases	✅	O&G supply chain likley to support construction and commissioning of green hydrogen plants.	■■■□	Potential for large-scale resource and efficiency gap – depleted and ageing workforce. Major opportunity.
		Construction and installation	✅			
H2 Transport	H2 transport - line pipe supply & installation 10%	Engineering	✅	Similar equipment and services as provided in the O&G industry.	■■□□	Lack capability in linepipe supply and fabrication at required specification. Capability for onshore and offshore installation.
		Fabrication and construction	✅			
		Materials and metals	✅			
		Subsea installation and survey	✅			
H2 Storage	H2 storage - underground & surface 17%	Engineering	✅	Onshore and offshore hydrogen storage like salt caverns relies on similar technology found in O&G storage.	■■■■	Strong existing capability within supply chain. Some reliance on globally optimised equipment and services.
		Underground storage	✅			
		Surface storage	✅			
O&M	Operations & maintenance 16%	Balance of plant	✔	Balance of plant are traditionally served by hydrogen supply chain while maintenance of storage and transportation facilities are transferable.	■■■■	Proven experience.
		T&S maintenance	✅			Not addressed.

✅ Targetable by O&G supply chain
✔ UK offshore wind dedicated supply chain
⊗ No UK supply chain capability
£ UK investment made

■■■■ The UK O&G supply chain has full coverage of the required capability
■■■□ The UK O&G supply chain has majority coverage of the required capability
■■□□ The UK O&G supply chain has moderate coverage of the required capability
■□□□ The UK O&G supply chain has limited coverage of the required capability
□□□□ The UK O&G supply chain has minimal coverage of the required capability

*Percentage of total hydrogen expenditure from 2024-2040.**Refer to more detail in OEUK Report ‘Harnessing the potential’. The capability assessment is based on all UK supply chains, not only oil and gas related. Revisions in capabilities have been made for certain segments that has not been addressed by OEUK. ***Supply Chains to Support a Hydrogen Economy, Wood Plc, 2022
Source: Rystad Energy research and analysis; OEUK; industry interviews; Wood Plc

UK supply chain lacks capabilities within major hydrogen equipment

Most of the UK oil and gas supply chain's capabilities align with the capabilities required for building hydrogen supply chains. Yet, their experience of supplying key technology enablers such as the electrolyser, SMR and ATR is limited.

The oil and gas supply chain can effectively target the majority of the hydrogen supply chains. However, hydrogen production requires specialised, industry specific equipment such as electrolysers to produce green hydrogen, in which UK oil and gas suppliers have moderate coverage and experience of supplying. Additionally, the manufacture of reformer packages in SMR and ATR plants to produce blue hydrogen is also an element where the UK oil and gas supply chain is lacking capabilities. Blue hydrogen production also requires carbon capture equipment which is a technology that the oil and gas supply have limited exposure to.

The UK's oil and gas supply chain demonstrates strong capabilities within the engineering segments, which will be critical in the design and engineering segments associated with hydrogen plants. This assessment is in accordance with previous studies made for green hydrogen by the OEUK.

However, the UK's oil and gas supply chain is considered to hold limited capabilities within major plant fabrication, notably in fabrication and construction. The UK has fabrication and construction capabilities from the refinery, petrochemicals and oil and gas industries. On the other hand, there is a deficiency in the capacity to scale. Although the oil and gas supply chain's capacity is sufficient for constructing small-scale pilot projects, it lacks the necessary scalability for full industrialisation. The industry's capabilities, once considered moderate, have experienced a gradual decline in domestic strengths as certain aspects of oil and gas scopes were outsourced.

Furthermore, there are also existing limitations in the equipment design and manufacture segment, notably within electrolyser and compressor packages. Key components such as electrolysers are traditionally delivered by specialised supply chain entities and have limited targetability for the current UK oil and gas supply chain. The UK holds a range of suppliers with the ability to deliver smaller hydrogen compressor packages, but currently lack the capability to deliver larger packages required in commercial scale low-carbon hydrogen developments.

Moreover, hydrogen will be transported from the production site to a storage facility and transportation methods may include pipelines or road transport. The UK's oil and gas supply chain holds moderate capabilities within hydrogen transportation, with strong capabilities within engineering, installation and commissioning of pipeline infrastructure, whereas there are limitations related to infrastructure fabrication such as pipelines.

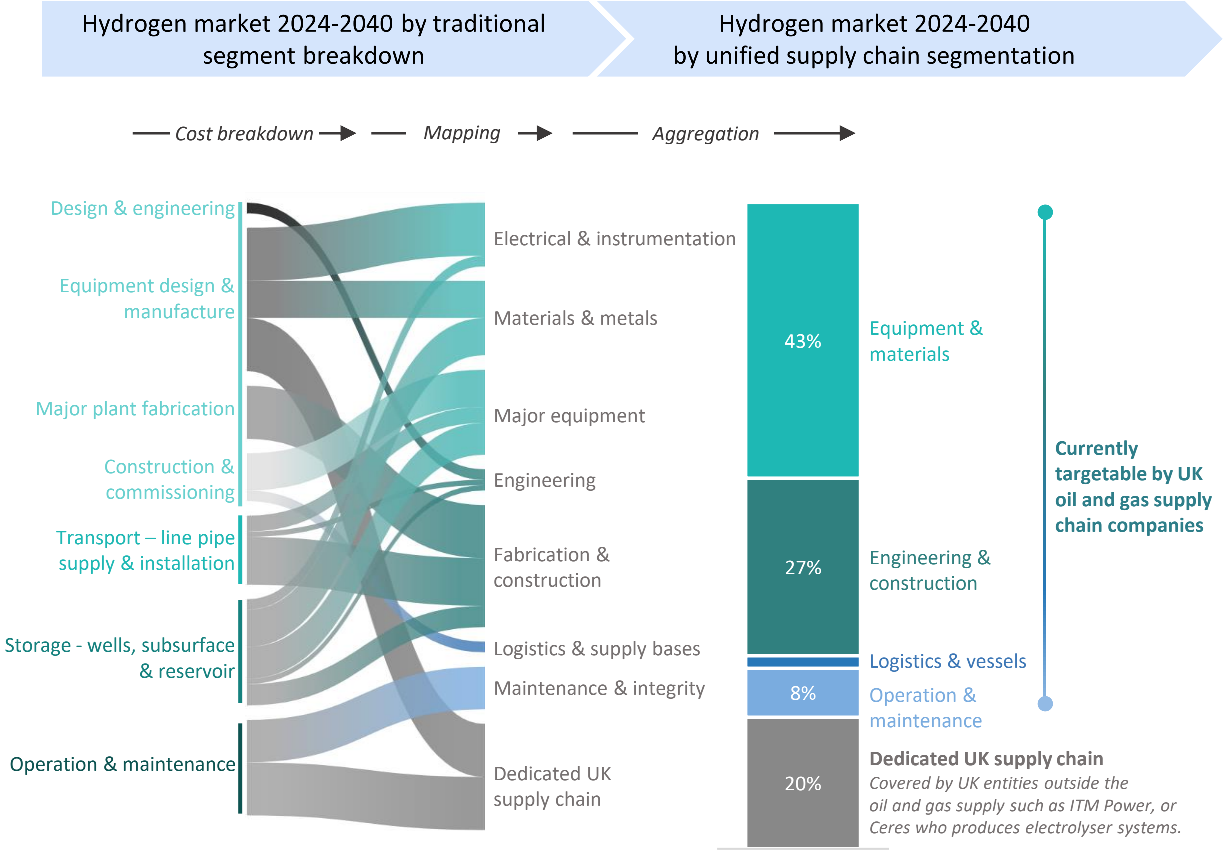
Hydrogen is expected to be stored either in compressed storage vessels or underground storage facilities such as salt caverns. The UK's oil and gas supply chain boasts comprehensive coverage in the engineering of storage facilities, and a moderate coverage in fabrication and construction due to outsourcing.

OEUK's prior studies have highlighted strong capabilities on balance of plant. However, in the context of hydrogen, the maintenance of specialised equipment, in the generation part, is typically handled by the specialised supply chain entities that provide the equipment, resulting in low coverage, according to our analysis. Conversely, our findings indicate that the UK's oil and gas supply chain maintains a majority coverage in the maintenance of transportation and storage facilities, leveraging its existing strengths in handling molecules from the oil and gas sector.

The UK oil and gas supply chain is well positioned to target the future hydrogen supply chain in terms of its capabilities. However, to meet the forthcoming demand, it may be necessary to scale up materially.

Source: Rystad Energy research and analysis

Two supply chain segments can target 70% of hydrogen market



About 80% of the hydrogen market can be targeted by the oil and gas supply chain, driven mainly by the onshore construction supply chain and equipment and materials.

By breaking down the traditional cost components of hydrogen plants from generation, storage and transportation, we can identify targetable segments for the oil and gas industry.

Existing oil and gas suppliers can target 80% of the hydrogen market which compromises four segments: equipment and materials; engineering and construction; logistics and vessels; together with operation and maintenance.

The equipment and materials segments make up more than 40% of the market in the 2024 to 2040 timeframe and is made up by the demand for electrical and instrumentation, materials and metals (i.e. pipes and valves), and major equipment (i.e. CO2 compressors, hydrogen compressors, pumps and other rotating equipment).

In particular, the UK oil and gas supply chain has strong capabilities in engineering, which is transferrable to the engineering and construction segment, that constitute 27% of hydrogen cost.

Furthermore, specialised equipment, such as the electrolyser and SMR/ATR packages along with its maintenance, is currently deemed not addressable as such equipment is supplied by dedicated or specialised supply chain enterprises. However, the required scale up of electrolyser supply creates opportunities for companies currently within the oil and gas sector and represents a potential upside to the targetable market.

Source: Rystad Energy research and analysis; Rystad Energy ServiceDemandCube

Targetable UK hydrogen market estimated at £1 billion in 2040

The targetable hydrogen market for the UK oil and gas supply chain is estimated to roughly £1 billion in 2040. The supply chain spend declines from a peak around 2035 at £1.3 billion due to a decline in blue hydrogen capacity additions.

Hydrogen production is a capital-intensive industry. Capital expenditure will mainly be driven by additional hydrogen production plants with costs related to electrolyser, SMR's and ATR's, engineering and construction.

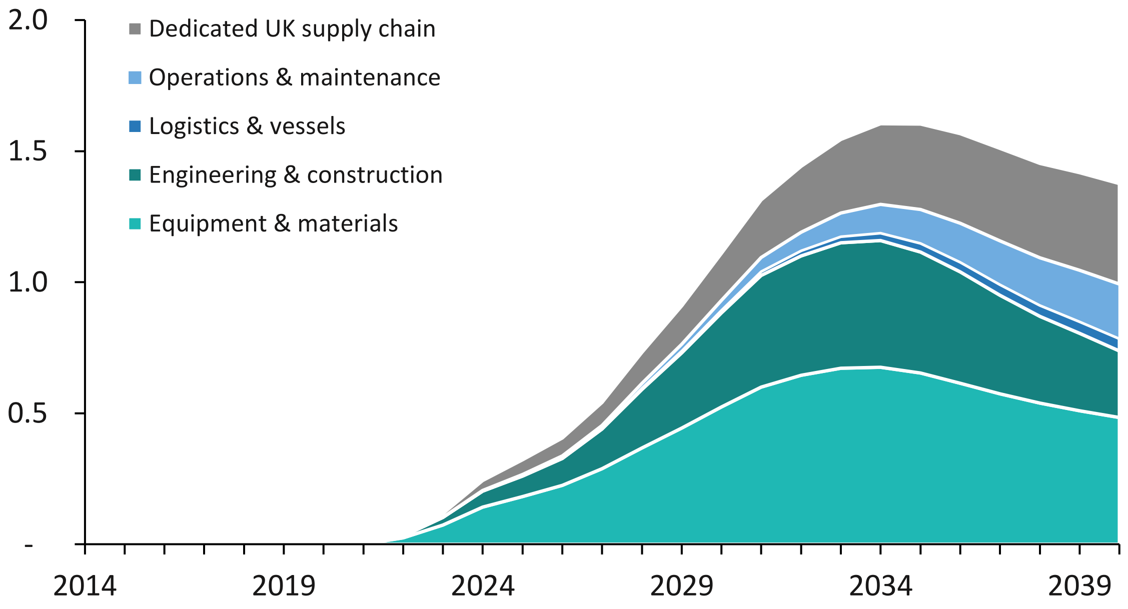
Since most of the capital expenditure occurs prior to the start-up year, expenditure is expected to rise significantly in 2025 as large production volumes are expected to come online around 2030. Operational expenditure, mainly operations and maintenance costs will, on the other hand, be largely driven by the cumulative production as a larger base of installed production equipment.

A significant part of the expenditures are assessed to be handled by dedicated UK supply chain, notably expenditure related to supplying and maintaining electrolysers, SMR and ATR in which the expenditures equals about £110 million in 2040. Together with carbon capture equipment required in the process of blue hydrogen generation.

The targetable expenditure for UK supply chain suppliers therefore remains limited to £930 million in 2030 and £1 billion in 2040. Moreover, 2023 UK upstream expenditure constitutes roughly £10 billion. Hence, the domestic hydrogen market will not be large enough to sustain the upstream oil and gas supply chain by itself.

UK hydrogen capex and opex expenditures per year by segment

GBP billion real



Source: Rystad Energy research and analysis; Rystad Energy ServiceDemandCube

£590 billion accumulated spending is addressable for UK oil and gas suppliers

The global addressable market for UK oil and gas supply chain companies accumulates to roughly £590 billion in spending between 2024 and 2040.

Rystad Energy estimates the global hydrogen market between 2024 and 2040 to reach about £1.04 trillion accumulated globally. However, not all segments and regions will be addressable for UK oil and gas suppliers. The global addressable export market is then derived by first excluding the segments covered by dedicated hydrogen supply chain companies such as electrolysers, SMR, ATR, carbon capture equipment, compressor packages, among others, amounting for approximately £220 billion.

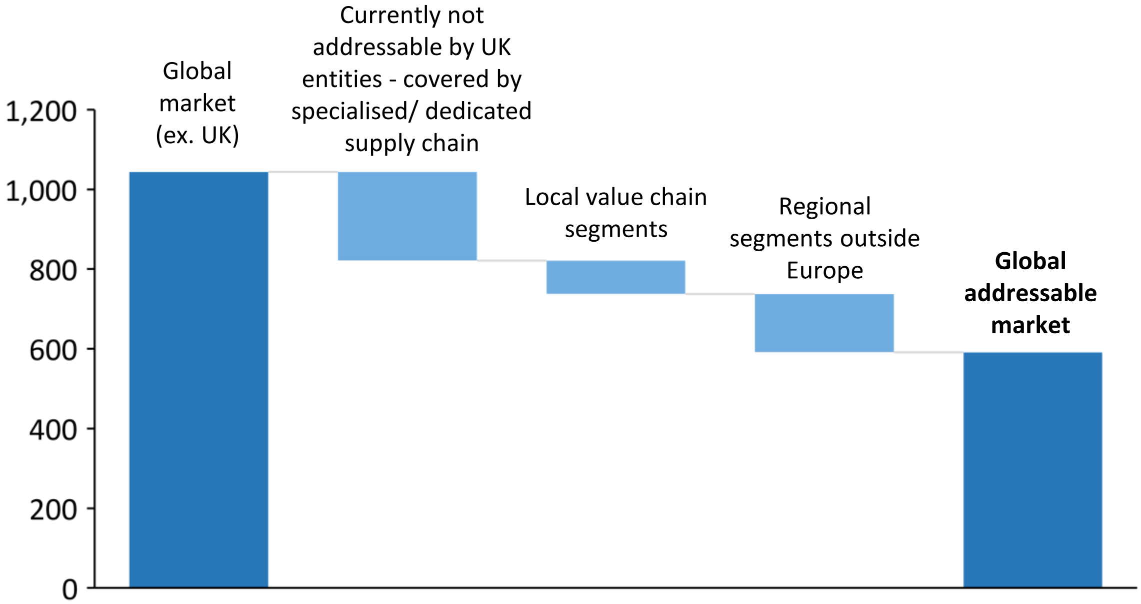
The next step is to exclude the local value chain segments, notably operations and maintenance of the hydrogen plant, pipelines and storage facilities and logistics and supply bases, as these have limited export potential for UK entities. This equates to about £80 billion accumulated between 2024 and 2040. The final step is then to exclude the regional segments outside Europe, which equates to roughly £150 billion.

The global addressable market for the UK supply chain, covering regional and global segments in the green hydrogen industry, accumulates to around £590 billion of spending between 2024 and 2040. This equates to 39 times more than the accumulated domestic targetable UK hydrogen market in the same period. Therefore, UK supply chain companies have significant global potential.

However, the accumulated global addressable hydrogen market only makes up 16% of the addressable oil and gas export market measured at the same timeframe.

Hydrogen accumulated 2024 - 2040 spend

GBP billion real



Source: Rystad Energy research and analysis

UK leading on intermittent renewables – a cradle for hydrogen?

CASE: Hydrogen as balancing source for wind power intermittency

The UK is experiencing high intermittency due to rapidly expanding power generation from wind. Therefore, the UK will likely rely on hydrogen for balancing longer deficits.

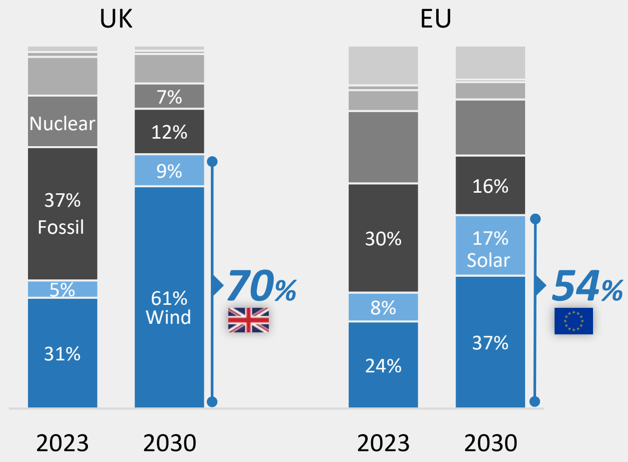
The UK is one of the leaders in European renewables development, particularly with wind, which is forecast to make up more than 60% of the total of 70% renewables in the 2030 power mix. In contrast, the EU lags the UK in development, with solar and wind expected to constitute 54% of the 2030 power mix. However, the transition to renewables brings challenges related to intermittency.

Unlike power generation from fossil fuels, wind and solar follow daily or seasonal cycles that are not necessarily aligned with power demand patterns. Therefore, balancing mechanisms are required to offset power supply deficits. Batteries are well suited to cover short-duration deficits lasting less than 12 hours, which fits the pattern of solar power's daily cycles. Thus, batteries are likely to be a key balancing source in countries with solar accounting for a large share of the power mix.

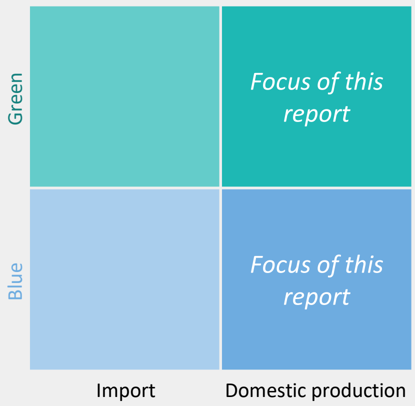
In a wind-dominated power system, long duration supply deficits occur when the wind is not blowing for longer time periods, such as days, weeks or months. Batteries are not ideal to solely balance deficits extending beyond one or two days. Instead, dispatchable energy sources, such as hydrogen, capable of supplying power for longer cycles, are required. Green hydrogen can be produced from excess wind power generation, stored, and then utilised in fuel cells to generate power to cover demand.

With a fast-growing wind share in the UK power mix, hydrogen can play a crucial role as balancing source for longer duration deficits, where batteries may not be the optimal solution. While this report only considers domestic production of green and blue hydrogen, there are more types of hydrogen, and hydrogen can be imported, not necessarily requiring domestic production.

UK's and EU's power mix*



Hydrogen types and supply options



*Power mix as power generation by energy source
Source: Rystad Energy research and analysis; Rystad Energy PowerCube

Limited UK presence in European electrolyser market can be challenging

CASE: Potential disadvantages related to limited global presence of UK-based electrolyser companies

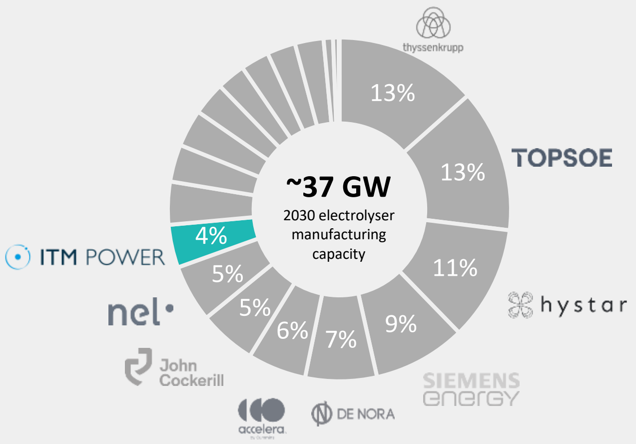
> **For the UK oil and gas supply chain to seize the opportunities in green hydrogen, electrolyser capabilities are essential. Looking at the global and even European electrolyser market, UK-based companies have limited presence. This can pose challenges for UK technology owners.**

In the green hydrogen supply chain, the electrolyser package is the key enabling technology. Owning this technology is crucial for the UK to establish a robust position in the green hydrogen supply chain, as the electrolyser package often is included in larger EPC contracts. Ensuring scalability is also pivotal to unlocking the potential in this sector.

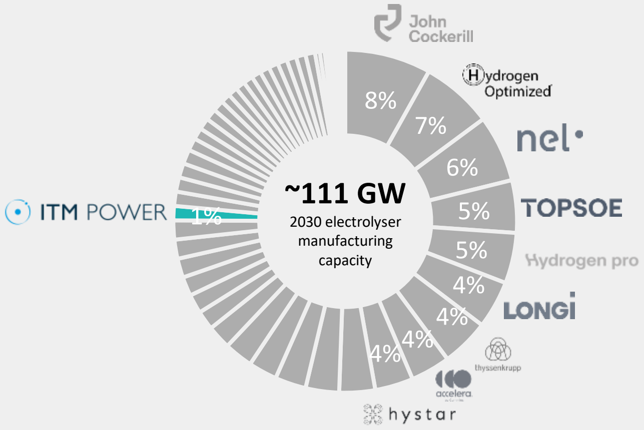
ITM Power is currently the leading UK-based company holding electrolyser package capabilities. Looking at announced European electrolyser manufacturing capacity in 2030, ITM Power is expected to hold 4% of manufacturing capacity. On a global scale, ITM Power is predicted to hold 1% of manufacturing capacity, highlighting the UK's limited presence in international markets.

As the green hydrogen industry evolves, maintaining the position in the supply chain can become increasingly challenging. This is because other technology owners, supported by system integrators, are gaining stronger foothold in the market. Consequently, this can pose challenges for the UK supply chain to win EPC contracts at home and abroad.

European electrolyser manufacturing capacity in 2030



Global electrolyser manufacturing capacity in 2030



Source: Rystad Energy research and analysis

UK's hydrogen production could require 25% of offshore wind capacity by 2030

CASE: Installed capacity of offshore wind to meet UK targeted hydrogen production

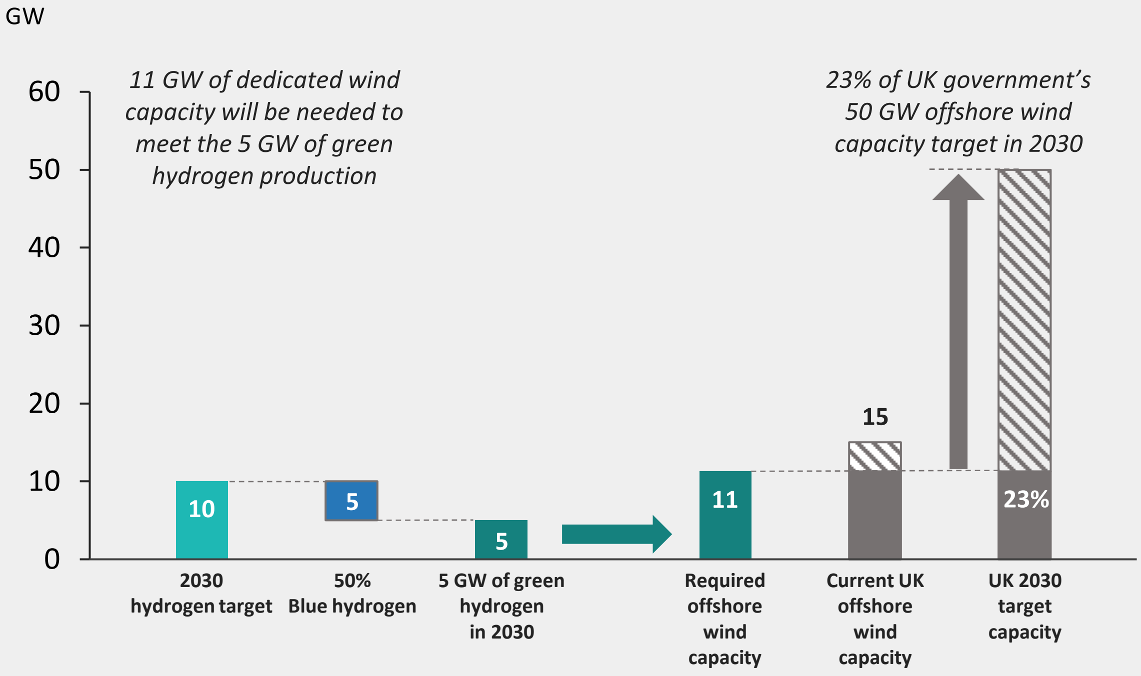
The UK government has an announced target of production capacity of 10 GW of low-carbon hydrogen in 2030. This amount would consume a quarter of the targeted offshore wind capacity.

The production of green hydrogen requires renewable electricity produced from renewable sources including wind. The UK government has ambitious targets for both hydrogen and wind. The stated target of hydrogen production at 10 GW could consume around a quarter of the UK's offshore wind capacity in 2030.

In order for the UK to reach the hydrogen production target, both blue and green hydrogen will be necessary. The UK government has indicated that up to 50% of hydrogen production capacity may be derived from blue hydrogen. However, both blue and green hydrogen technologies are still in the developmental stage. As a result, the representative shares of the two types will depend on the costs of the input factors and technology development. Also, cost efficiency of electrolyser, SMR, ATR and transport and storage of hydrogen will play a crucial role in helping the UK achieve its targets.

Utilising offshore wind for green hydrogen production will result in notable energy efficiency losses compared to its direct use as electricity. Therefore, considering the current energy scarcity, it may be preferable to avoid the production of hydrogen through this method.

Current and targeted UK offshore wind capacity and estimated offshore wind requirement for 5 GW green hydrogen production



Note: wind capacity factor 41%; electrolyser efficiency: 54 kilowatt-hours per kilogram of hydrogen
Source: Rystad Energy research and analysis

Content

UK government comes out early with ambitious CCS targets

Rystad Energy expects CCS capacity in the UK will reach 18 million tonnes of CO2 captured and stored per annum by 2030, slightly below the UK's target of between 20 million and 30 million tonnes per annum.

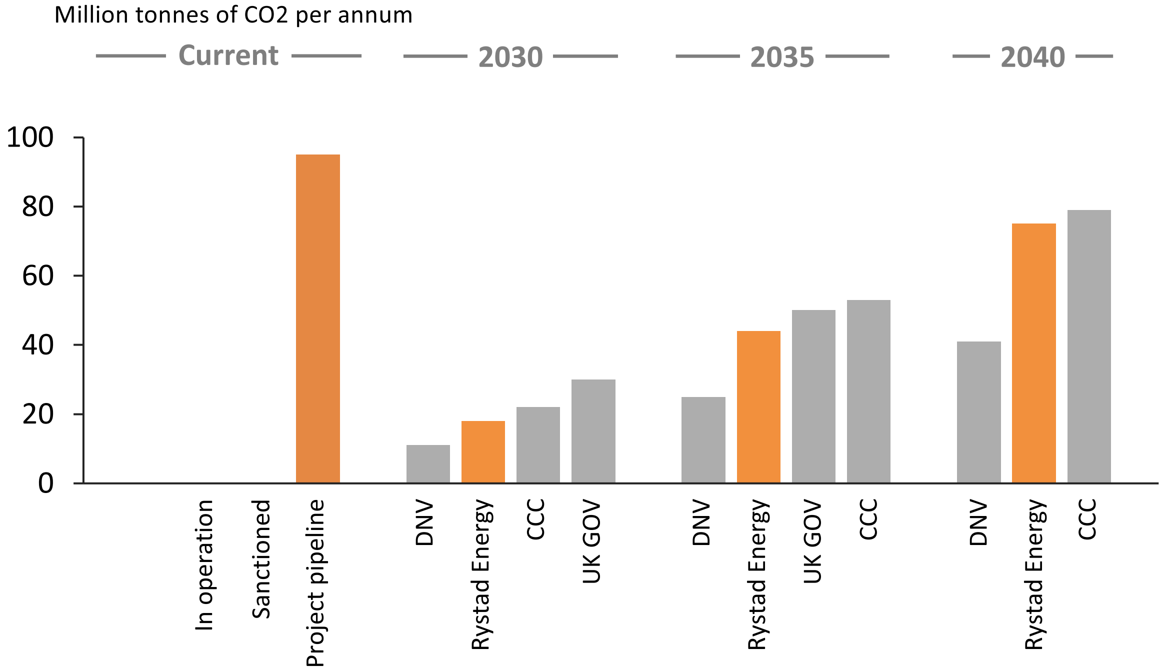
The UK government has an ambition of 20 million to 30 million tonnes of CO2 captured and stored by 2030. The government announced its cluster sequencing process to support the establishment of CCS in two industrial clusters by the mid-2020s (track-1), and an additional two by 2030 (track-2). Up to £1 billion will be invested from the CCS infrastructure fund. The East Coast cluster and HyNet NorthWest were announced as track-1 clusters, while the Acorn and the Viking clusters have been announced as candidates for track-2.

Another milestone was reached in 2023, when the North Sea Transition Authority (NSTA) granted 21 licenses in the UK's inaugural carbon storage licensing round.

Rystad Energy has assessed the UK capture pipeline, noting that it exceeds all other 2040 forecasters’ targets. The pipeline have been adjusted and risked based on available infrastructure, project maturity and storage proximity. In the transport and storage value chain, the upside of importing CO2 from other countries has not been included. Similarly, no CO2 captured in the UK has been assumed stored outside the country.

Looking beyond 2035, the government has not officially communicated any targets. Nevertheless, DNV and CCC anticipate continued growth in capture and storage capacity. However, they have different views on the future, as shown in the graph. with the CCC being rather optimistic, while DNV is more conservative.

UK CCS capacity with different targets and benchmarks*



*Carbon capture targets
Source: Rystad Energy research and analysis; Rystad Energy CCUS Solution; DNV UK Energy Transition Outlook 2022; CCC The Sixth Carbon Budget December 2020; UK government

Around 4 billion tonnes of global CCS capacity needed by 2040 in 1.5°C scenario

> **CCS may play an important role in cutting emissions from large industrial and power generation plants. Policies and technology development are key to drive growth expected from 2030 and onwards.**

CCS applications for industrial decarbonisation is expected to gain significant momentum already by 2030. Solutions to scale the industry both through infrastructure and bilateral agreements are needed.

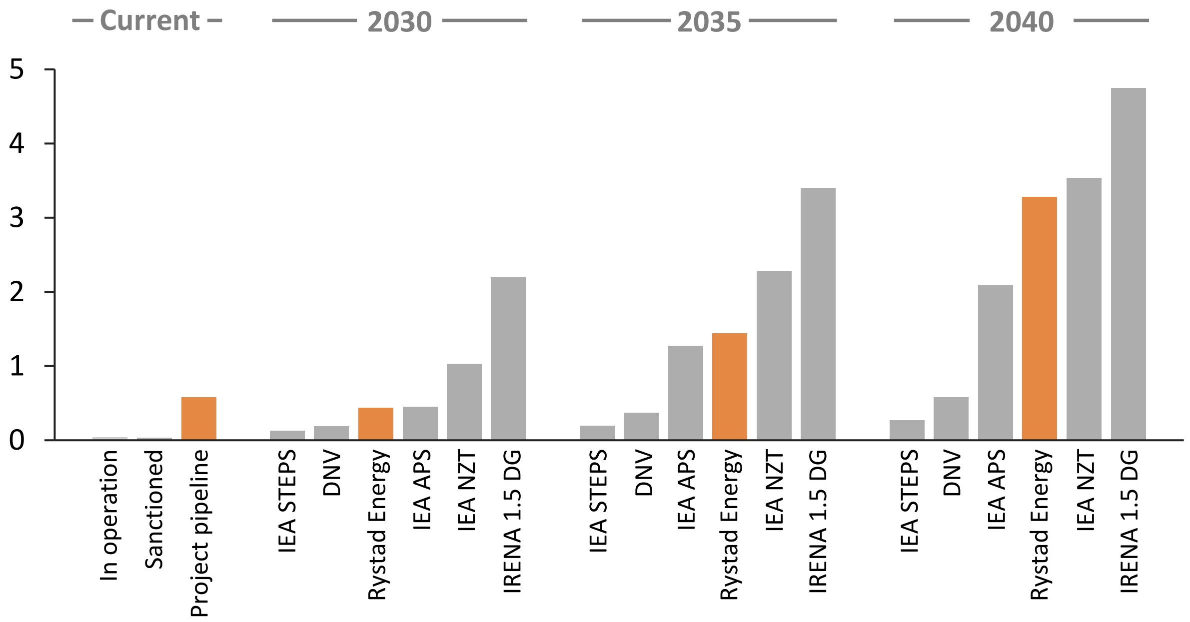
The outlook and targets for CCS vary among different forecasters due to different assumptions in the different scenarios. Moreover, different assessments on the projects currently in progress and the likelihood of these projects being successfully realised contribute to the varied perspectives on CCS within different peer groups, in 2030.

The current pipeline implies projects with an estimated capacity at around 600 million tonnes of CO2. With the Rystad Energy 1.8°C scenario, global CCS capacity is estimated to grow from a capacity of 400 million tonnes CO2 in 2030 to more than 3 billion tonnes of CO2 capture and storage capacity per year in 2040. This implies a significant ramp-up after 2030.

In the net-zero scenarios provided by IRENA and the IEA, between 1 billion and 2 billion tonnes of captured and stored CO2 is needed already by 2030. This underscores the pressing need for accelerated and widespread adoption of CCS technologies to effectively mitigate carbon emission and advance the global transition towards a carbon-neutral future. In the more conservative scenario provided by DNV, the lack of an attractive business model for the industry is emphasised, resulting in an estimated total of around 600 million tonnes of CO2 captured and stored in 2040.

Global CCS capacity outlook

Billion tonnes of CO2 per annum



Source: Rystad Energy research and analysis; Rystad Energy CCUS Solution; IEA World Energy Outlook 2023; DNV Energy Transition outlook October 2023; IRENA Word Energy Transitions Outlook 2023: 1.5° Pathway

Global CCS capacity expected to ramp up significantly after 2030

Global CCS capacity is expected to ramp up significantly after 2030. Most of the future capacity additions will come from outside Europe.

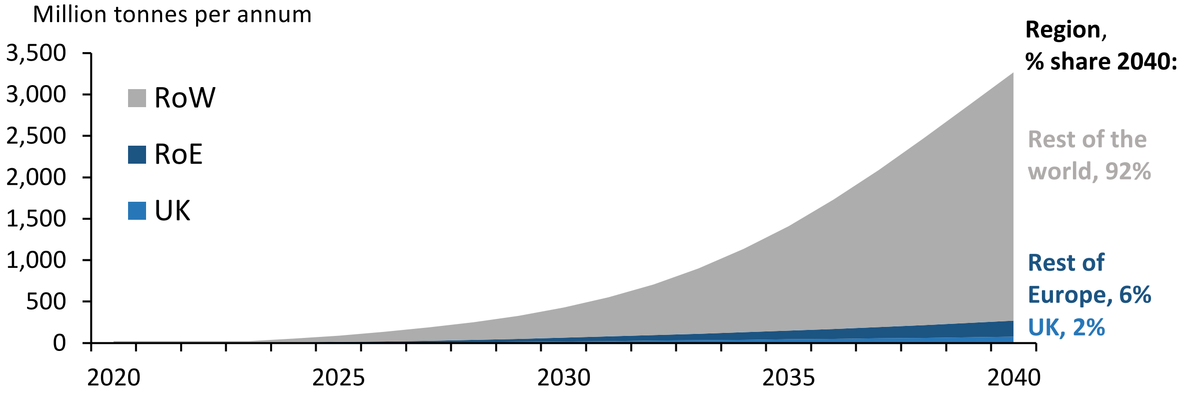
Looking towards 2040, most of the buildout of CCS capacity will be outside Europe, with North America as the biggest market player. In North America, a significant share of upcoming CCS capacity is expected to be in onshore storage sites, offering cost advantages compared to offshore storage.

As seen in the annual capacity additions chart, the capacity will ramp up significantly after 2030, with a projected CAGR between 2030 and 2040 of 22.6%. Ramp-up is expected to accelerate with cost compression and implementation of carbon pricing or quota schemes outside Europe.

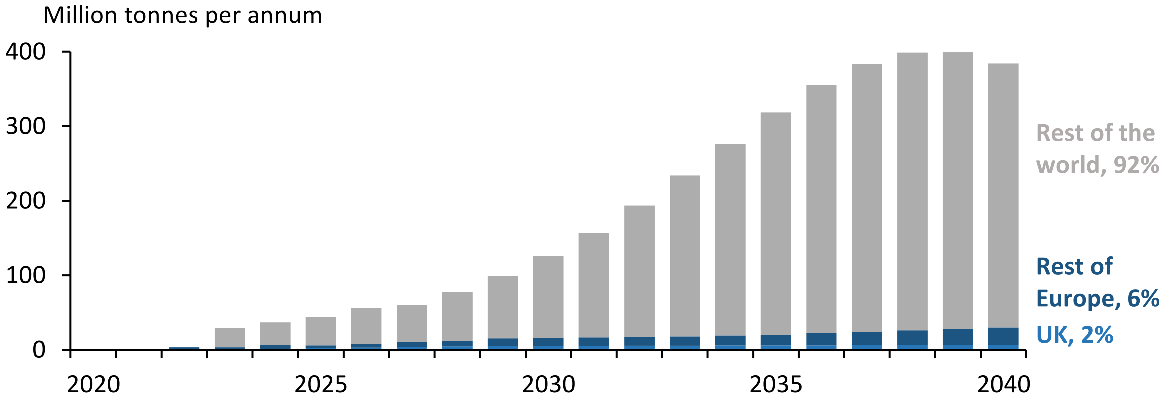
In Europe, onshore CO2 storage faces challenges due to opposition and regulations. Towards 2040, the North Sea is expected to host most of Europe's offshore storage capacity, with Norway and the UK as key players. In the UK, all anticipated storage is offshore in the Irish Sea and the North Sea, offering an attractive option for significant emitters in continental Europe to store captured CO2.

However, to enable cross-border transportation of CO2, bilateral agreements between the involved countries are needed. The requirement of such agreements may be viewed as a challenge for CCS projects. For instance, the UK cluster sequencing process targets individual projects across capturing applications connecting to track-1 and track-2 clusters, meaning the UK is currently only targeting CO2 captured domestically.

Global cumulative CCS capacity outlook



Global CCS annual capacity additions outlook



Source: Rystad Energy research and analysis; Rystad Energy CCUS Solution

Global CCS spending to reach £115 billion in 2040, with UK to be a major European player

UK CCS projects expected to account for 3% of the global spend, with most of the spending in the CCS industry happening outside of Europe. UK is expected to be a major player in Europe, accounting for roughly 30% of spend throughout 2040.

Annual CCS expenditure is expected to increase significantly in the coming decades. Globally, average annual spending between 2035 and 2040 is expected to be almost five times higher than the annual average spending between 2025 and 2030. Put in numbers, global average spending between 2035 and 2040 is expected to be around £115 billion.

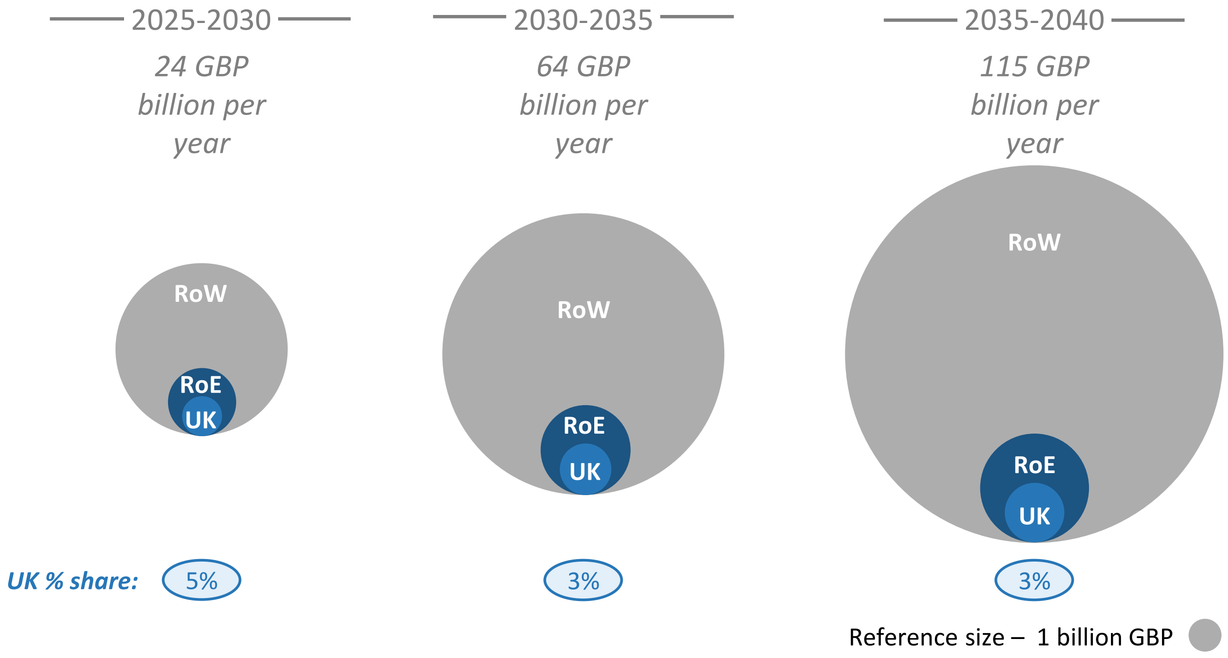
Annual spending will be driven heavily by the annual capacity additions happening after 2030, as illustrated above. In the CCS value chain, capturing technology stands as a major dependency, involving substantial initial investments.

As seen from the figures below, the European market makes up a small share of global investments. Further, as the global market grows towards 2040, the European market along with the UK accounts for an even smaller share of total spending. Global average spending between 2035 and 2040 is 1.8 times higher than the prior five years. Asian countries are expected to contribute to a large share of the growth globally between 2035 and 2040, while European and UK spending grows by 1.4 and 1.3 times, respectively, in the same period.

The figures illustrate the importance of the UK market in Europe. Between 2035 and 2040, European expenditure is anticipated to constitute 8% of global spending, with the UK accounting for more than 30% of European expenditure. When only considering CCS projects with offshore storage, the UK has a larger market share given its sole focus on offshore storage.

Average annual CCS expenditures by region

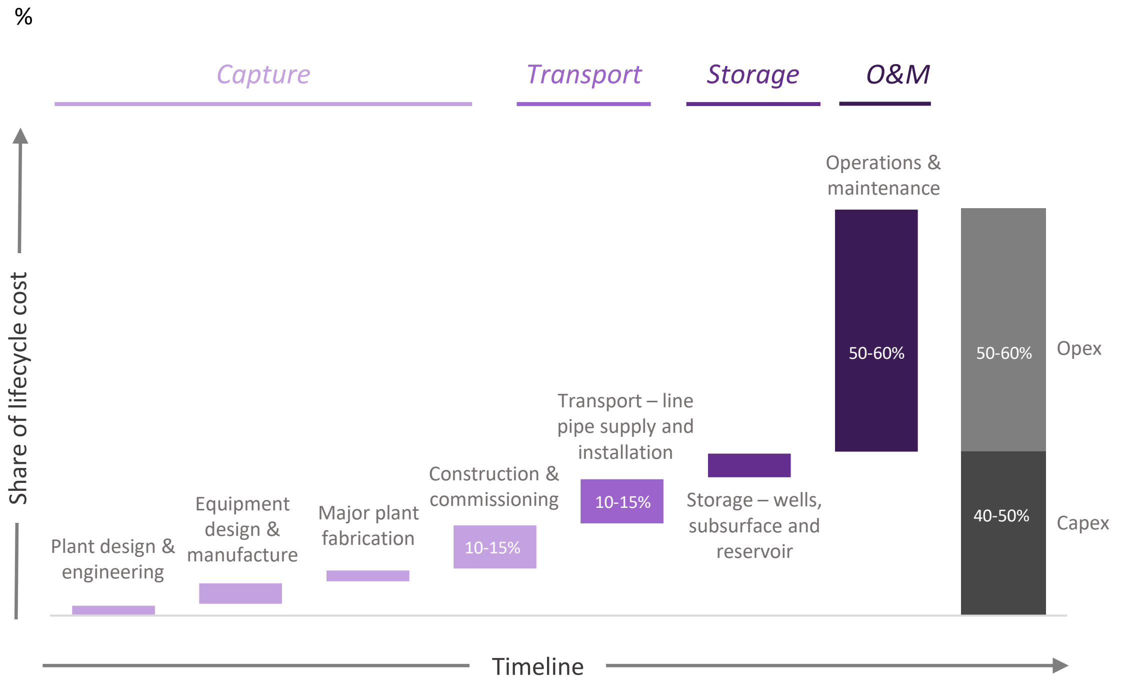
GBP billion real



Source: Rystad Energy research and analysis; Rystad Energy CCUS Solution

Capex makes up 40% to 50% of CCS project cost

Indicative lifecycle cost of a CCS project*



Capital expenditure accounts for roughly 40% to 50% of the total lifecycle cost of a CCS project. Most of these costs are related to construction and commissioning of the capture plant along with transport infrastructure.

Roughly 40% to 50% of the expenditure for a CCS project occurs before the start-up of injection of CO2 for permanent storage. Initial investments encompass manufacturing and installing technologies at carbon capture facilities, as well as substantial investments in transportation infrastructure, which may involve repurposing existing pipelines or greenfield construction.

In the storage segment, drilling services, as well as subsea production systems (SPS) and subsea umbilicals, risers and flowlines (SURF), constitute a significant portion of offshore storage costs.

Once capture, transport and injection commence, operational expenditures come into play. These operational costs involve maintenance, subsurface and reservoir monitoring, as well as logistics and supply base expenses. Opex costs can make up 60% of a CCS project with onshore capture, and offshore storage and transportation of CO2 via pipelines and a typical lifetime of 25 years.

*Project assumptions here are for a project with offshore pipelines and offshore storage
Source: Rystad Energy research and analysis; Rystad Energy CCUS Solution

CCS segments largely targetable by O&G supply chain

	Segment (% of spend)*	Sub-segments	Targetable by O&G supply		OEUK capability assessment**	
Capture	Plant design & engineering 5%	Engineering	✅	O&G process engineering, and project management align well with CCS plant design.	■■■■	UK supply chain strength.
	Equipment design & manufacture 11%	Capture units	☑	Major equipment such as compressors, absorbers/strippers traditionally served by dedicated CCS supply chain while other electrical equipment are highly transferable to O&G.	■□□□	Relatively commoditised; limited growth opportunity. May be opportunity in niche areas.
		Other major equipment	✅			
		Electrical equipment and instrumentation	✅			
	Major plant fabrication 6%	Fabrication & construction	✅	Shared demand for modular design, structural integrity, materials such as valves, pipes etc.	■■□□	Capability has declined; barriers to competitiveness. Opportunities in specific areas of major plant fab.
		Materials & metals	✅			
	Construction & commissioning 22%	Construction and installation	✅	O&G supply chain are likely sufficient to support construction and commissioning of carbon capture plants.	■■■□	Potential for largescale resource and efficiency gap. Major opportunity.
		Logistics and supply bases	✅			
Transport	Transport - linepipe supply & installation 21%	Engineering	✅	Similar equipment and services as provided in O&G industry.	■■□□	Lack capability in linepipe supply and fabrication at required specification. Capability for onshore and offshore installation.
		Fabrication and construction	✅			
		Materials and metals	✅			
		Subsea installation and survey	✅			
	Ship transport of CO2 4%	Engineering	☑	Fabrication and construction of CO2 carriers highly likely to be served by yards in Asia as with majority of ship construction.	□□□□	New industry; no UK activity. Major driver could be CO2 importation.
		Fabrication and construction	⊗			
		Major equipment	☑			
Storage	Storage - wells, subsurface & reservoir 14%	Engineering	✅	CCS onshore and offshore storage relies largely on similar technology and services that can be found in O&G subsurface, well construction and drilling industries.	■■■■	Strong capability. Already servicing early clusters. Some reliance on globally optimised equipment and services.
		Subsurface	✅			
		Subsea installation and survey	✅			
		SPS & SURF	✅			
		Drilling rigs & equipment	✅			
		Drilling services & tools	✅			
O&M	Operations & maintenance 16%	Balance of plant	☑	Specialised capture equipment likely to require OEM maintenance.	■■■■	Proven experience.
		T&S maintenance	✅			Not addressed.

✅ Targetable by O&G supply chain
☑ UK offshore wind dedicated supply chain
⊗ No UK supply chain capability
£ UK investment made

■■■■ The UK O&G supply chain has full coverage of the required capability
■■■□ The UK O&G supply chain has majority coverage of the required capability
■■□□ The UK O&G supply chain has moderate coverage of the required capability
■□□□ The UK O&G supply chain has limited coverage of the required capability
□□□□ The UK O&G supply chain has minimal coverage of the required capability

*Percentage of total CCS expenditure from 2024-2040. **Refer to more detail in OEUK Report 'Harnessing the potential'. The capability assessment is based on all UK supply chains, not only oil and gas related. Revisions in capabilities have been made for certain segments that has not been addressed by OEUK. Source: Rystad Energy research and analysis; OEUK; industry interviews

UK O&G has strong well construction capabilities that can be utilised in CCS

The UK oil and gas supply chain offers several capabilities that are transferrable to the CCS industry. The similarities are especially present for services required in the storage segment.

With the lion's share of the carbon capture and storage (CCS) supply chain being highly targetable for oil and gas supply companies, it becomes evident that the UK holds a unique position to be at the forefront of this emerging sector, amplified by ambitious domestic capture targets set by the government. While the UK's oil and gas industry is poised to leverage its well-established supply chain capabilities to secure a robust position, certain segments are likely to remain the domain of dedicated CCS supply chain companies.

Notably, the engineering segments within the UK's oil and gas supply chain demonstrate strong proficiency, which will be critical in the design and engineering scopes associated with carbon capture plants.

However, it is essential to acknowledge the existing limitations, notably in the design and manufacture of specific carbon capture equipment. Components such as compressors, absorbers and strippers, integral to CCS infrastructure, typically have their specialised expertise concentrated within dedicated supply chain entities.

Furthermore, the UK oil and gas supply chain is considered to only hold moderate capabilities within the major plant fabrication segment due to the decline in recent years of its domestic fabrication and construction capabilities as oil and gas work scopes has been outsourced to other low-cost regions.

While previous studies conducted by OEUK highlight the UK's substantial coverage in the construction and commissioning of carbon capture plants, our analysis suggests a moderate capability, drawing from the nation's fabrication and construction strengths.

The captured CO2 needs to be transported from the capture plant to the storage destination, either through onshore and offshore pipelines or by ship/rail or truck – or a combination of these. Notably, offshore pipelines emerge as a promising target for the UK's oil and gas supply chain. Drawing parallels with the industry's existing strengths in oil and gas, particularly in subsea installation and survey capabilities, the UK is well positioned to assume a significant role in the installation and commissioning of offshore pipelines for CCS.

Fabrication and construction of CO2 carriers is highly likely to be served by yards in Asia, as with most of the ship construction. Engaging in the market for CO2 carriers also involves entering a new industry in which the UK has minimal coverage of the required capabilities.

Storage of CO2 also shares extensive similarities with the oil and gas industry. Both onshore and offshore storage of carbon requires drilling and construction of wells, and installation and commissioning of injection equipment such as subsea trees for offshore storage. The UK holds strong capabilities in onshore drilling through housing land rig giant KCA Deutag, offshore drilling contractor Valaris and several subsea entities.

Operation and maintenance of transportation and storage has similarities with the oil and gas industry. Such similarities are visible in reservoir monitoring and pipeline transportation of CO2. On the other hand, maintenance of carbon capture plants will be handled by the plant manufacturer. Hence, there is a limited potential for existing UK oil and gas suppliers to handle capture maintenance.

While current capabilities suggest that the UK is poised for a substantial role in the future supply chain of carbon capture, the scale and timing of domestic and export opportunities may necessitate a strategic scaling-up of the supply chain to meet the forthcoming demand.

Source: Rystad Energy research and analysis

Around 80% of UK CCS expenditure targetable by O&G supply chain

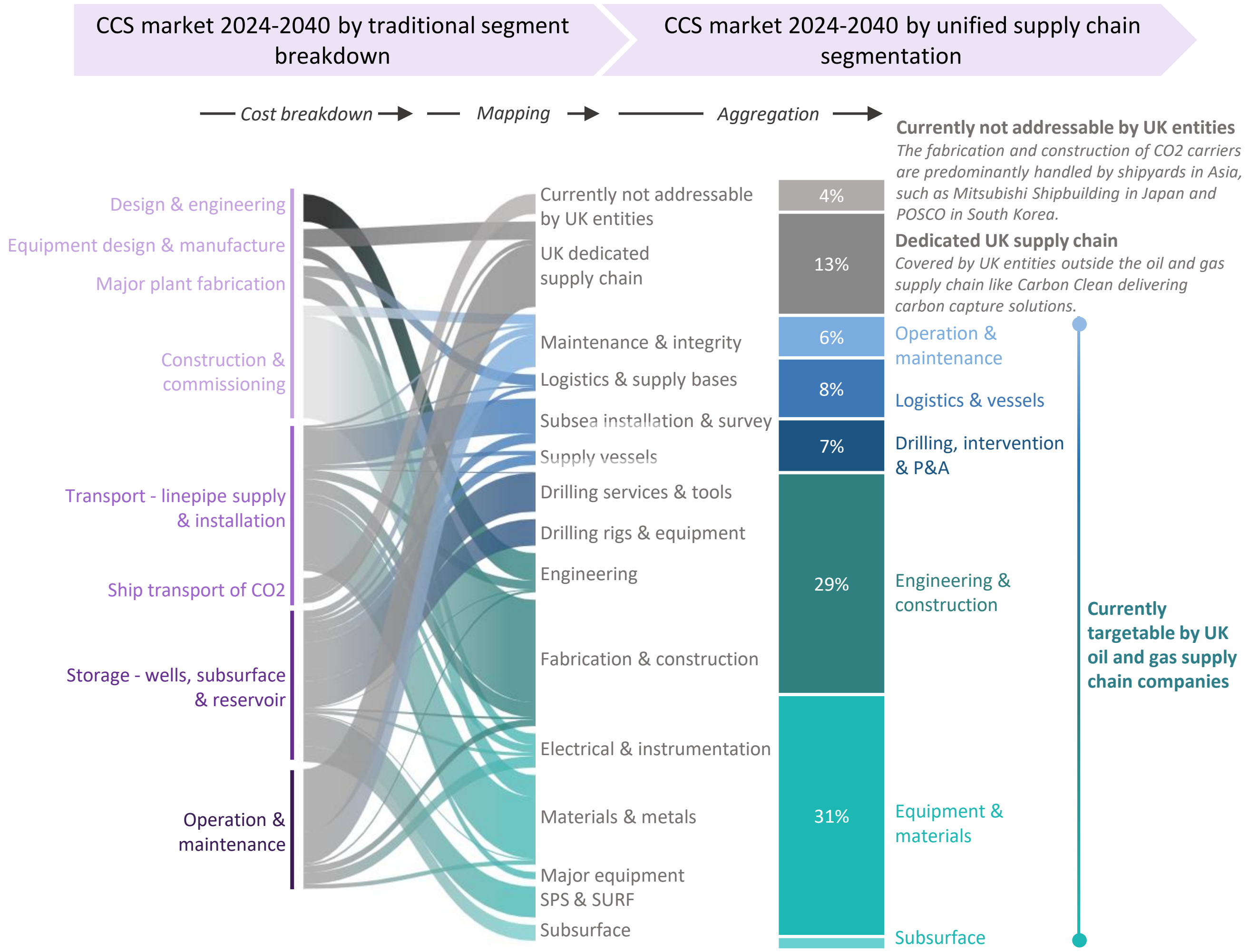
About 80% of the domestic UK CCS market is targetable by the oil and gas supply chain. The not addressable segments include carbon capture equipment, maintenance and CO2 shipment services from specialised supply chains.

By breaking down the traditional cost components of a carbon capture and storage project from capture, transportation and storage we can identify targetable segments for the oil and gas industry. Oil and gas supply chain will be able to deliver roughly 80% of the products and services needed in the CCS supply chain across six targetable segments.

The largest segment being engineering, and construction constitutes 30% of the market, driven by fabrication of capture plants and pipeline infrastructure. The second largest segment, equipment and materials, constituting 26% of the targetable market is largely driven by the demand for materials and metals, along with minor demand for electrical and instrumentation together with SPS and SURF equipment required for offshore storage of CO2.

Within the drilling, intervention and P&A segment roughly 45% is made up of activities related to offshore storage. Here the oil and gas supply chain can utilise strong capabilities from previous endeavours with rigs and drilling services.

By aggregating the demand for each of the targetable segments, we can better understand the magnitude of the addressable market for the UK's oil and gas supply chain.



CCS market 2024-2040 by traditional segment breakdown

CCS market 2024-2040 by unified supply chain segmentation

Currently not addressable by UK entities
The fabrication and construction of CO2 carriers are predominantly handled by shipyards in Asia, such as Mitsubishi Shipbuilding in Japan and POSCO in South Korea.

Dedicated UK supply chain
Covered by UK entities outside the oil and gas supply chain like Carbon Clean delivering carbon capture solutions.

Source: Rystad Energy research and analysis; industry interviews

Targetable UK CCS supply chain market at £2.6 billion in 2040

The targetable CCS market for the UK equates to £2.6 billion where investment costs related to equipment and materials, and engineering and construction accounts for the largest parts.

CCS expenditure in the UK is closely correlated with capacity growth, with capital expenditures related to new capacity additions as the key driver of expenditure. Most of the capital expenditure occurs before and in the start-up year of a CCS project. Hence, expenditure is expected to grow towards 2030, when the UK has a target of capturing and storing between 20 to 30 million tonnes of CO2 annually.

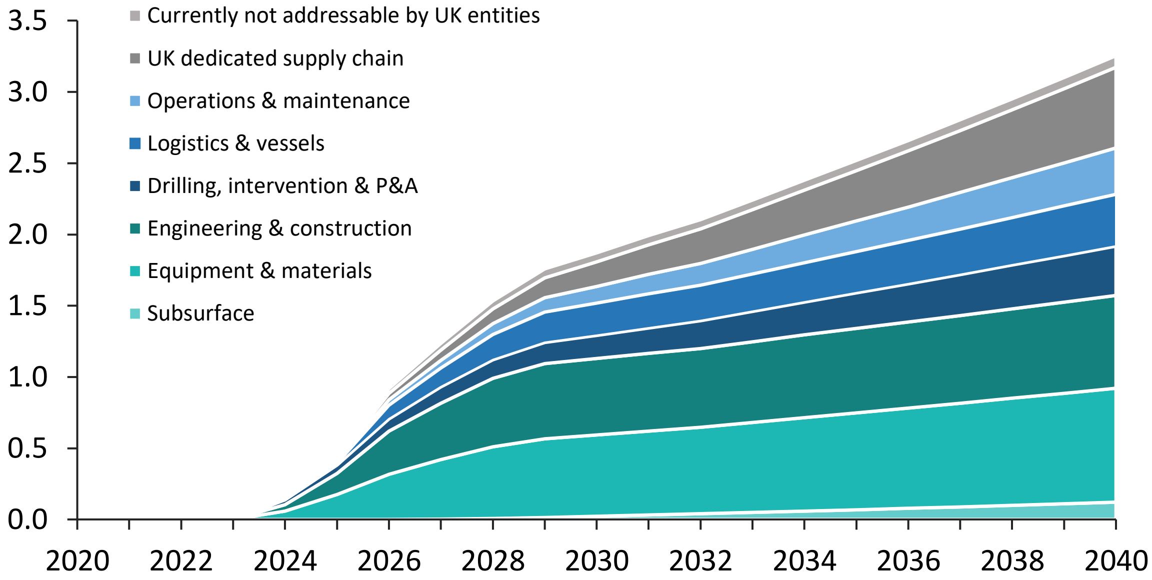
Projected targetable expenditure for the UK supply chain is expected to increase from just over £1.6 billion annually in 2030 to approximately £2.6 billion in annual spending by 2040. Notably, the two segments—equipment and materials, along with engineering and construction—are estimated to collectively constitute around 60% of the addressable expenditure.

Conversely, segments considered to be handled by UK dedicated supply chain include specialised equipment and services such as carbon capture systems, that are not considered a targetable scope of the UK oil and gas supply chain. Segments considered to be handled by dedicated UK supply chain in the chart below equate to £600 million in 2040.

Additionally, the base assumption is that vessels that will be used for the emerging industry of CO2 ship transport will be built overseas. Hence, the fabrication and construction of such vessels are considered as currently not addressable by UK entities.

UK CCS capex and opex expenditures per year by segment

GBP billion real



Source: Rystad Energy research and analysis; Rystad Energy CCUS Solution

Accumulated global addressable CCS market at £470 billion by 2040

The global addressable CCS market for UK supply chain companies between 2024 and 2040 surpasses the domestic targetable market in 2040 by more than 180 times, at £470 billion.

The addressable market for UK supply chain companies consists both of addressable segments in the UK and segments with regional or global sourcing abroad.

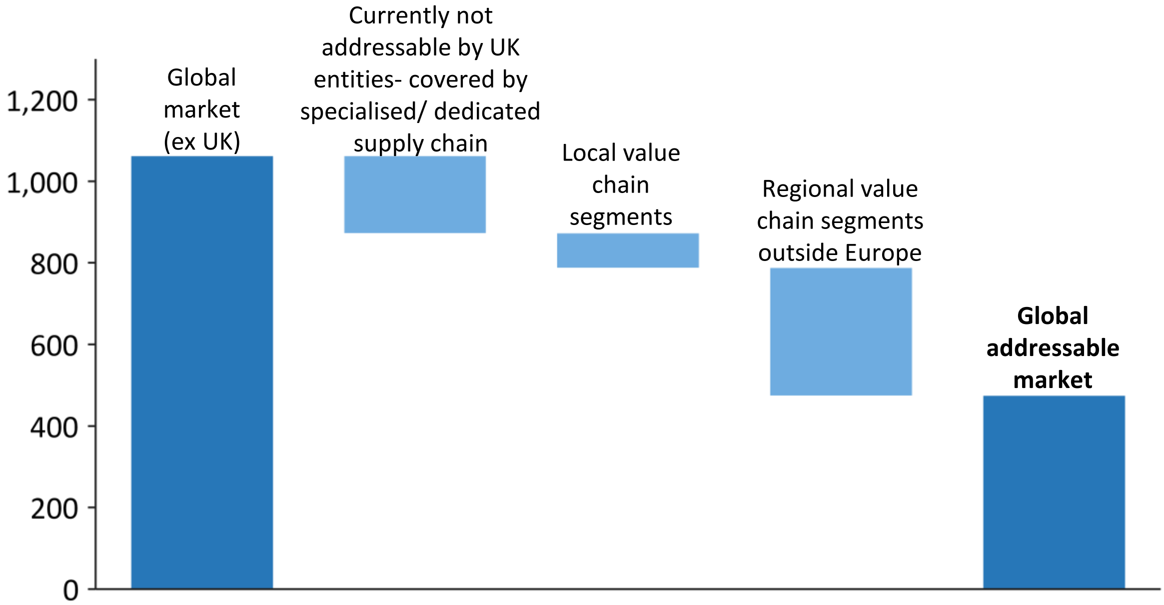
The global addressable CCS market is derived by starting with the global CCS market (excluding the UK domestic market). The second step involves an exclusion of currently not addressable oil and gas supply chain segments in which are supplied by other dedicated supply chains, either in the UK or other parts of the world. Thirdly, local value chain segments, such as maintenance and integrity, have been excluded as these have limited export potential for UK entities. Finally, non-European regional value chain segments, such as drilling services and tools, have been excluded as these are primarily served by regional market players.

The global addressable export market for the UK supply chain, covering regional and global segments in the CCS industry, accumulates to roughly £470 billion between 2024 and 2040. This equates to 180 times more than the domestic targetable UK CCS market in 2040. Hence, there is a very material potential for UK supply chain companies globally.

There is connected significant uncertainty to these market sizes, that are highly dependent on that governments facilitate for regulated carbon markets and initial subsidies, competition from other abatement options and technology development within CCS.

Accumulated CCS spend 2024-2040

GBP billion real



Source: Rystad Energy research and analysis

Blue hydrogen production accounts for 15% of UK's carbon capture pipeline

CASE: Carbon capture demand for blue hydrogen production

The unrisked carbon capture demand pipeline in the UK stands at 95 million tonnes per annum. The pipeline is made up of different emitting sources, of which hydrogen production makes up around 15%.

Currently the largest share of capture projects included in the UK pipeline are situated in the four industrial clusters that are included in track-1 and track-2.

In the figure below, the UK carbon capture pipeline is split into the respective groups. The biggest group is power generation, which makes up more than half of the pipeline. Included in this category are projects covering waste incineration like Tarmac's project in Buxton. Further examples are Drax's bio power generation project in North Yorkshire and BP's capture project with gas power generation in Teesside.

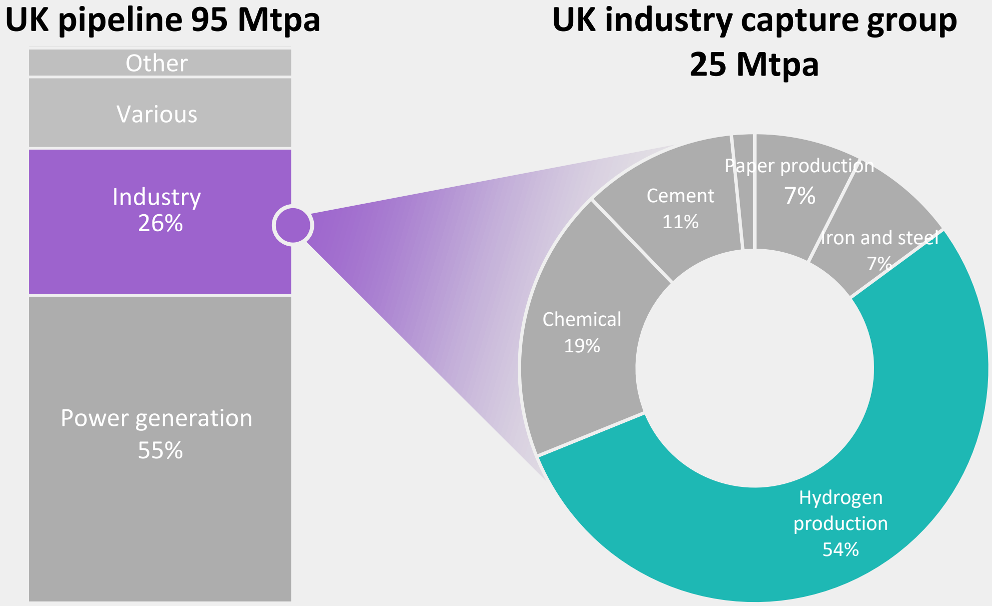
The second largest carbon source group is the industry group. These assets include assets that produce power as part of industrial production which includes hydrogen production, chemical, cements and others. As seen in the figure below, hydrogen production is the biggest contributor of the industry group with more than half of the estimated capacity.

One of the largest blue hydrogen projects in the UK is part of the Acorn cluster. Located in Northern Scotland the St Fergus terminal takes a shore more than 30% of the natural gas that is being used in the UK. As such it is seen as an ideal candidate for blue hydrogen production. Other potential candidates for hydrogen production are in HyNet Northwest, Teesside and Humber.

When looking at hydrogen production in this figure it is important to note that the numbers are stating million tonnes of CO2 captured per annum and not the amount of hydrogen produced.

UK carbon capture project pipeline by carbon source group

Million tonnes per annum



Source: Rystad Energy research and analysis; Rystad Energy Hydrogen Market dashboard; Rystad Energy CCUS Solution

Significant CCS storage volumes needed to anchor UK drilling supply chain

CASE: Additional CCS storage needed to retain drilling, intervention and P&A supply chain

To prevent a downturn in UK spending in drilling, intervention, and P&A, the CCS industry needs to have an estimated capacity of around six times higher than government targets in 2030.

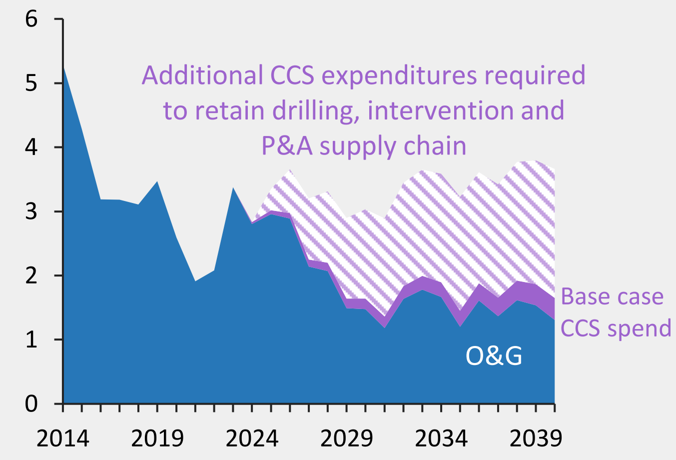
Between 2014 and 2021, the drilling, intervention, and P&A segment in the UK's oil and gas industry declined due to lower oil prices and decreased activity, with companies scaling back investments and a reduced demand for new projects. With fewer new projects and a mature shelf, the spend levels from the oil and gas industry is expected to gradually decline towards 2040.

The UK has a strong presence in the drilling rig market, with companies such as Awilco, Valaris and KCA Deutag. Given the increasing demand for drilling services in the CCS industry, it is crucial for the UK to maintain and leverage its capabilities in this segment. Reducing the capacity to provide drilling services would not be beneficial, especially given the growing demand in the CCS industry. As the CCS industry continues to expand, there is an expected increase in the need for drilling services in the years to come.

The graph illustrates the required expenditures from the CCS industry to maintain stability in the drilling services segment towards 2040. As shown the current base case scenario is not enough to maintain the segment at current levels. Combined with the oil and gas expenditure, more than an additional 500 million tonnes of storage capacity will be needed in 2040 to offset the downturn in UK drilling services.

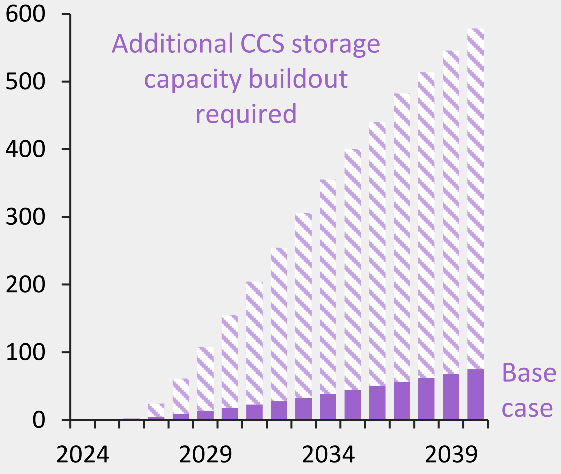
Expenditure in UK drilling services

GBP billion real



UK storage capacity additions

Million tonnes per annum



Source: Rystad Energy research and analysis; Rystad Energy CCUS Solution

Noteworthy upside potential for CCS industry in the UK when adding imports

CASE: Upside potential with imported CO2 from Western Europe

> **There is a noteworthy upside potential to the UK's CCS industry by importing CO2 captured elsewhere in Western Europe. Imported CO2 could boost the domestic spend by roughly 20%, depending on the amount imported.**

In this scenario we have used the assumptions that the UK will open for importing CO2 captured in Western Europe after 2030. We have excluded imports from countries such as Denmark and Norway as these countries are likely to store their own CO2. In the case below we have assumed without any further qualification that the UK could transport and store 30% of the CO2 captured in Western Europe after 2030.

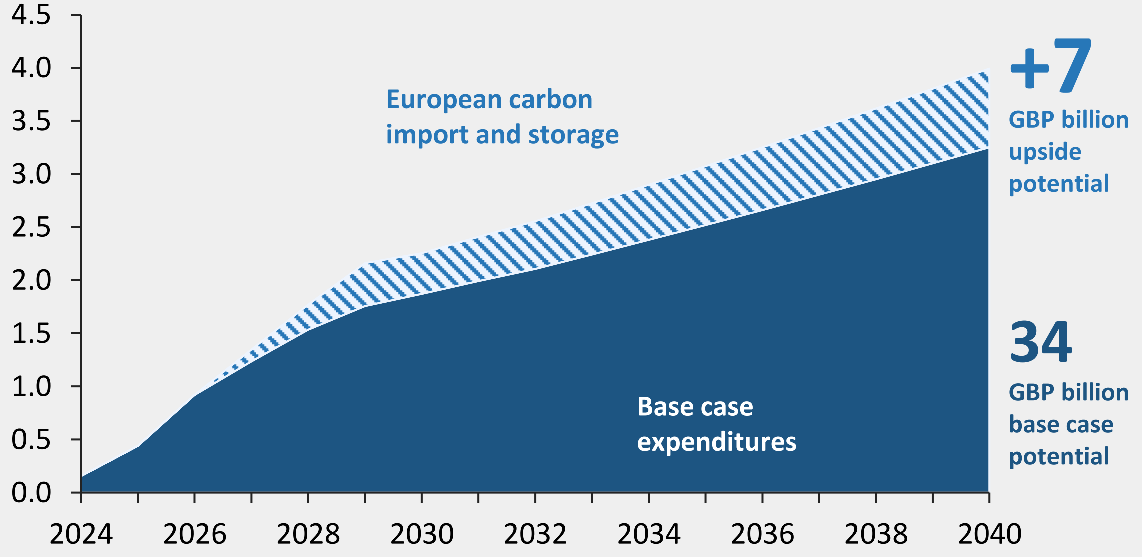
In this scenario, expenditure related to the two segments drilling, intervention and P&A and subsurface, increases the most. Both of these segments increase by roughly 40%, as imported CO2 leads predominately to an increase in storage related expenditures.

Further, segments related to the transportation will increase a lot in the import scenario. We have assumed that most of the volumes will be imported using CO2 carriers. Many CO2 carriers may be able to inject directly at the storage sites, limiting the need for import terminals.

On the other hand, the engineering and materials segment increases by only 9% as this segment is mostly related to expenditures from capturing CO2. The growth in UK expenditure related to the segment is limited as the CO2 is captured in other countries before being transported to the UK.

UK CCS capex and opex expenditure per year with imports

GBP billion real



Source: Rystad Energy research and analysis; Rystad Energy CCUS Solution

UK can leverage existing strength in subsea to secure CCS expenditure abroad

CASE: Export potential in segment with high UK capability

> **The UK has high capability within SPS and SURF, with players winning integrated subsea contracts and significant manufacturing capacities in the UK.**

The UK serves as a key hub for many of the most successful subsea contractors worldwide. Subsea7, TechnipFMC and Baker Hughes have the ability to win larger subsea scopes (full SPS or SURF scopes) as well as integrated contracts in the UK and abroad.

Baker Hughes and TechnipFMC, both prominent contributors to the subsea production systems segment, have manufacturing plants in the UK. TechnipFMC, a global consortium headquartered in the UK, and Baker Hughes, with a UK subsidiary, collectively represent about half of the worldwide supply of subsea trees.

The UK also holds 20% of global umbilical, cables and flexibles manufacturing. Here TechnipFMC has also been present in the UK after acquiring Duco Ltd in 2003. With a plant in Newcastle, Duco has delivered umbilicals to the oil and gas industry since the 1970s.

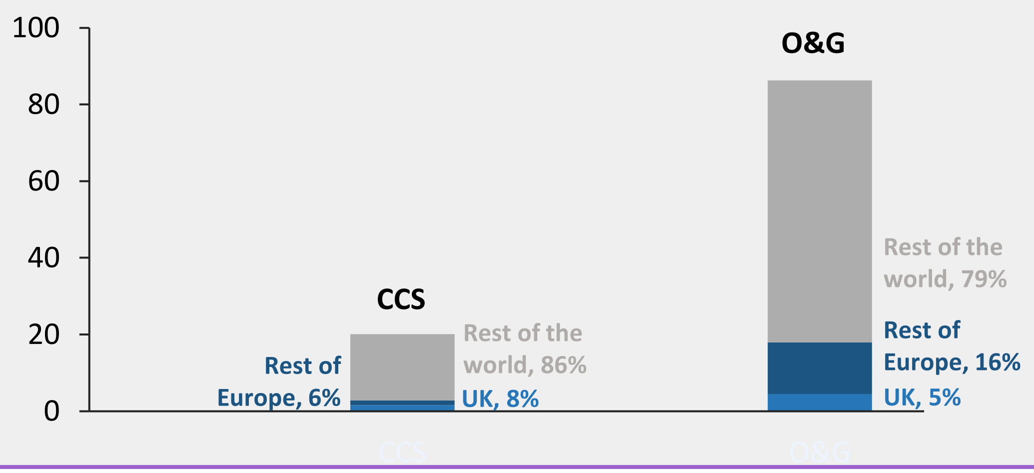
With corrosive streams, flow assurance challenges and leakage concerns, current subsea systems needs to be tailored to meet the demands from CCS. Export routes for the global subsea market is already well established with UK-located players such as Subsea7, TechnipFMC and Baker Hughes. As the UK is among the first to scale CCS offshore, there should be significant opportunity in utilising these export routes for subsea CCS technology.

TechnipFMC entered a strategic alliance with Talos Energy in 2021 to develop technical and commercial solutions to CCS projects along the US Gulf Coast. As such, TechnipFMC is showing its ambition to continue delivering solutions to the CCS industry.

In the chart below, it is evident that the global oil and gas market for SPS and SURF exceeds the market size of the CCS industry. Nevertheless, the total global SPS and SURF market for CCS makes up 20% to 25% of the oil and gas market between 2024 and 2040. The UK is an early mover in the offshore CCS market and its suppliers should be well positioned to take part in the growing industry.

Market sizes for SPS & SURF in different regions for CCS and O&G (2024-2040)

GBP billion real



Source: Rystad Energy research and analysis; Rystad Energy CCUS Solution; Talos Energy

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