

Castings & Forgings Bill of Works

UK Offshore wind demand for castings and forgings and review of UK capability



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Sponsor Forewords



This Bill of Works Report clearly sets out the scale of the opportunity for the UK foundry and forging industries to contribute significantly more to the offshore wind sector, with the potential to supply over two million tonnes of high value metal components into the sector through to 2050. The report sets out this case with rigour, quantifying what the offshore wind sector will actually need in castings and forgings, and the figure is an enormous 81,000 tonnes per annum.

As the single voice of the UK cast metals industry, The Cast Metals Federation welcomes this report. We have long argued that the UK's foundries – and the skilled people who work in them – have far more to offer the country's energy transition than is often recognised. This report shows that there is a clearly achievable path to grow from the current 8% of market share supplied by the UK, to a possible 14%, and potentially to a staggering 37%, which would be worth over £14.6Bn to the UK economy.

This is a huge opportunity. Offshore wind developers and OEMs increasingly want to source locally, close to the point of manufacture and assembly – shortening supply chains, cutting delivery risk and reducing embedded carbon. UK foundries are ready to respond: this report shows our members already supply into the sector today and hold the technical capability to do much more.

Our industry is also part of a bigger solution. A stronger UK castings supply chain increases energy security, supports UK economic growth, and spreads high-value manufacturing jobs across the regions – in Yorkshire, the Midlands, the North East, Scotland and Wales.

We look forward to working with OWGP, government and the offshore wind sector to turn these findings into orders for UK foundries.

Lee Marshall
Chief Executive, Cast Metals Federation



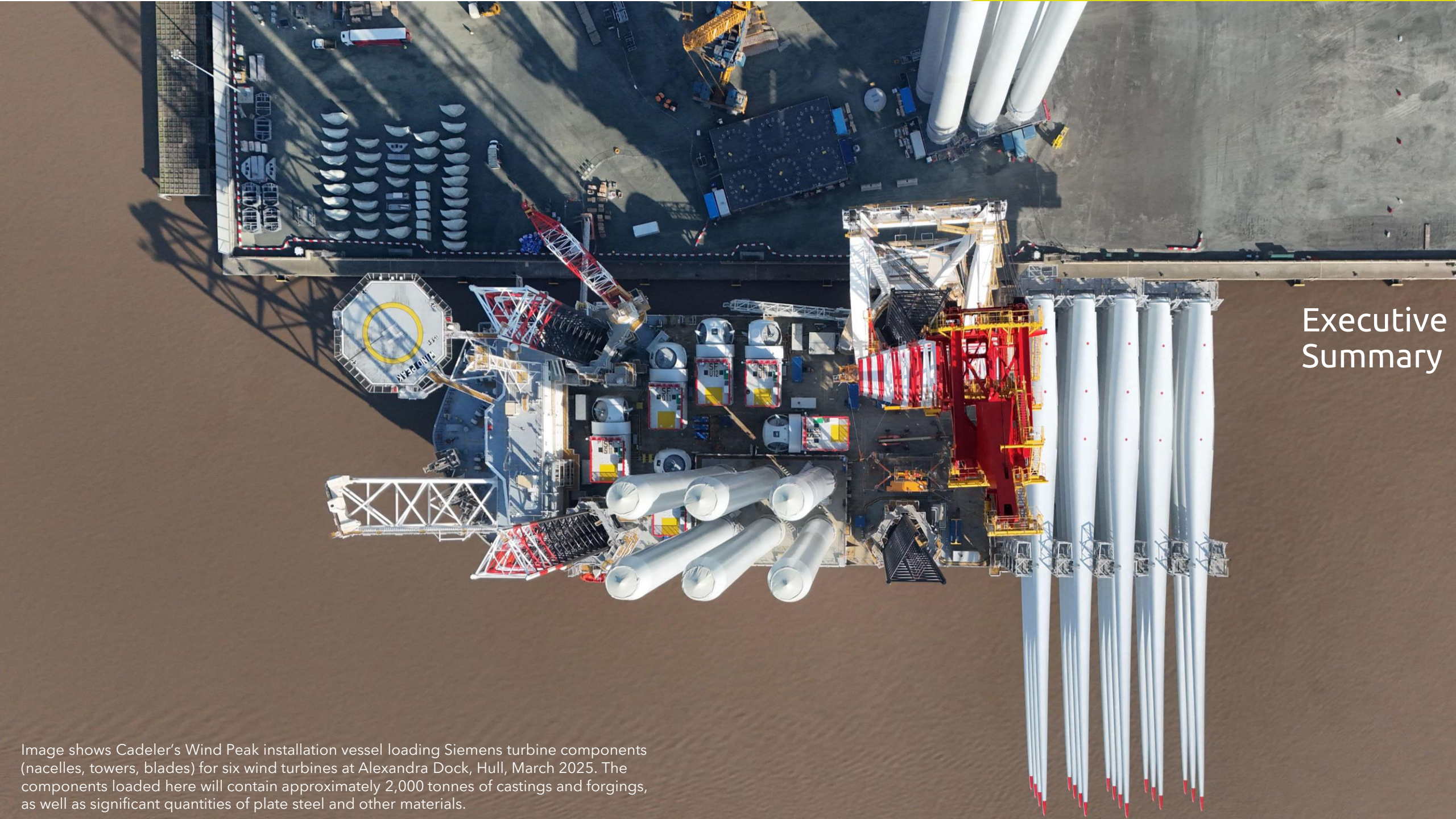
The Offshore Wind Growth Partnership exists to strengthen the UK's offshore wind supply chain, helping UK businesses scale, compete and thrive in one of the world's fastest-growing industries. As Delivery Body for the Industrial Growth Plan, we direct funding and business support to the areas where it can have the greatest impact to build a globally competitive supply chain that accelerates clean energy and economic prosperity.

We co-funded this study because unlocking opportunity starts with understanding the market. Castings and forgings are fundamental to offshore wind, sitting at the heart of turbines, foundations and infrastructure, yet until now there has been no detailed assessment of future demand alongside the UK's capability to supply it. This Bill of Works provides that evidence. It offers government, developers, OEMs and suppliers a clear, component-level picture of where UK foundries and forgers have the capability to supply today, and where targeted investment could unlock even greater value.

The findings speak for themselves: UK foundries and forgers are already supplying into offshore wind, and with the right support can capture significantly more. This evidence will help shape future programmes, investment priorities and industry engagement. We hope it will also provide a practical foundation for collaboration across the supply chain, helping businesses, policymakers and industry partners work together to capture more of the economic opportunity that offshore wind presents.

We are pleased to continue our collaboration with LumenEE, following the success of the Supply Chain Capability Analysis in 2024 and the Steel Bill of Works in 2025

Anil Sayhan
Programme Director, Offshore Wind Growth Partnership

An aerial photograph showing a large industrial vessel, the Wind Peak, docked at Alexandra Dock in Hull. The vessel is heavily loaded with Siemens turbine components, including nacelles, towers, and blades. The blades are stacked vertically on the deck, while the nacelles and towers are arranged in various configurations. A red and white striped tower section is prominent. The dock area is paved and contains various industrial structures, including a large building with a yellow circular logo and several smaller buildings. The water is a dark brown color.

Executive Summary

Image shows Cadeler's Wind Peak installation vessel loading Siemens turbine components (nacelles, towers, blades) for six wind turbines at Alexandra Dock, Hull, March 2025. The components loaded here will contain approximately 2,000 tonnes of castings and forgings, as well as significant quantities of plate steel and other materials.

Executive Summary

Offshore wind relies on a complex global supply chain for metal products with UK demand for over two million tonnes (81,000 tonnes per annum) of castings and forgings between 2026 and 2050. While the UK depends on a global supply chain for a significant number of these items, it has already built good capability in the supply of castings for cable protection and corrosion protection.

This study has looked in detail at the technical requirements of 63 different individual cast and forged components used in offshore wind projects, in turbines, foundations, moorings, substations and cable systems.

Currently UK foundries (which make castings) and forgers (which make forgings), are focused on supplying 15 of these different components, specifically sacrificial anodes (castings) for use on foundations, cable protection (castings), pump bodies for substations (castings) and bolts and fasteners (forgings) for use in turbines, towers and foundations. These different components where the UK is active make up 8% by weight of overall castings and forgings demand. The total GVA of these components is £1.6bn and would support 1,200 jobs.

However, UK foundries and forgers have existing technical capability that could be used to supply a wider range of components. This study's technical review identified a further 20 components that could be made by UK foundries and forgers, and which should be assessed for current competitiveness and potential future improvements. These components comprise an additional 6% by weight, taking UK capability to 14% of overall castings and forgings demand. Cumulative GVA at this level would be £8.4bn, supporting 6,200 jobs.

An example area where the UK has existing capability that could be nurtured are the different castings and forgings needed in load reduction devices, cable connectors and mooring components. Given the UK's priority within the Industrial Growth Plan (IGP) to focus on deepwater foundations, these are capabilities for the UK to nurture with the aim of UK manufacture.

This study has identified a further 11 larger castings and forgings – 8 forged ring components and 3 nacelle components – that are currently beyond the technical capability of the UK supply chain. These are the larger items needed in offshore wind nacelles, hubs and drivetrains, together with forged rings for the flanges connecting major components. They represent an additional 23% by weight of overall castings and forgings demand, taking UK supply potential to 37%, and would add £6.2bn of GVA and around 4,600 job years, bringing cumulative totals to £14.6bn and 10,800 jobs.

Value does not scale simply with volume and weight of components. The components within existing UK capability that are not the current focus are worth around five times more per tonne than those the UK supplies today, so lifting UK share from 8% to 14% by weight would raise GVA more than fivefold, from £1.6bn to £8.4bn. The further step to 37% adds more tonnage at closer to average value, taking GVA to £14.6bn.

This represents a significant economic opportunity for the castings and forging sectors. On average, across the 24-year period, this opportunity would enable the two sectors' direct employment to grow by between 14% and 25% depending on which scenario was pursued.

The geographic distribution of the forgings and castings sector would also support the distribution of economic benefit from the offshore wind sector to regions of the UK which have not traditionally been associated with the opportunities of the sector. Development of further capability in castings and forgings can particularly benefit areas such as West Midlands, where existing casting and forging capability is strong but has been less active in offshore wind compared to more coastal regions.

The UK already has capability to supply the high-grade steels needed for forged ring production, plus the technical capability for forged ring design and manufacture. Given IGP commitments to support deepwater foundation manufacturing, plus tower manufacturing, the UK should therefore be looking to nurture UK forged ring production as part of this work, subject to assessment of the competitiveness of a UK offering into those supply chains.

Executive Summary (continued)

Furthermore, with Vestas' potential inward investment into the UK of a new nacelle and hub factory in Scotland, now is the right time to assess priorities and identify routes to support UK larger castings and forgings production. UK foundries and forgers already have the capability to supply a range of smaller components for use inside nacelles. In addition, this study identifies hub castings and nacelle spaceframes (which are part of the turbine bedplate) as a future area of greatest potential and alignment with existing UK casting capability. That same capability base could be supported to deliver larger components as part of any UK effort to develop drivetrain manufacturing.

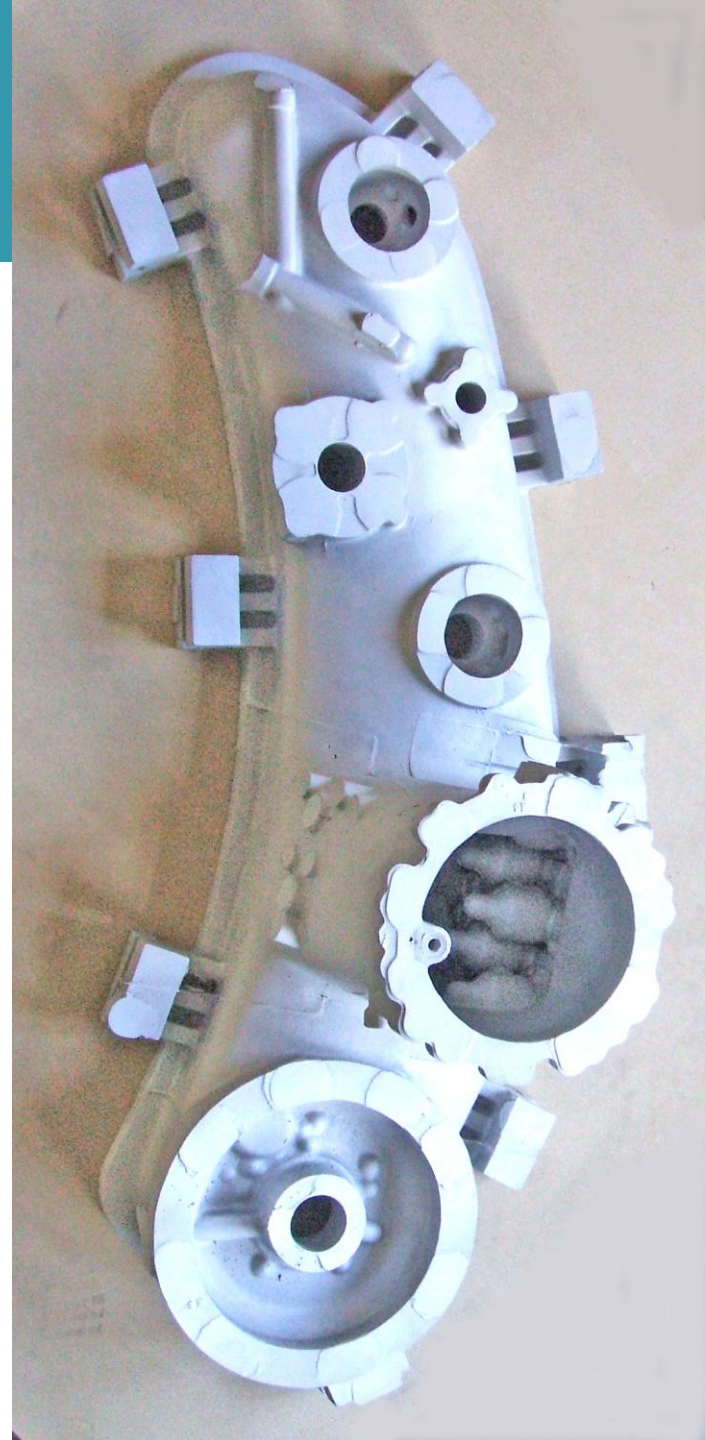
This report has used the IGP's *Make or Buy* framework to help prioritise potential UK opportunities. This analysis concludes that the UK has the technical capability to *Make or Nurture to Make* 37% of cast and forged offshore wind components by weight – £14.6bn of the £36bn total UK GVA, or 41% by value.

An important caveat is that this study has looked at technical capability only. There are other commercial requirements that would need to be fulfilled that would need to be assessed in more detail. Any UK move into the manufacture of larger castings or forgings would be a very significant undertaking. Localised production offers some benefits, but these will also depend on other enablers such as access to lower-cost electricity prices and other support beyond the British Industry Competitiveness Scheme.

However, separately the UK is looking to secure nacelle and hub assembly, tower manufacture, growth in foundation fabrication and a potential presence in future drivetrain manufacture. All these components have castings and forgings requirements, so any wider work to maximise UK content in the manufacture of these components needs to be aware of relevant cast and forged requirements.

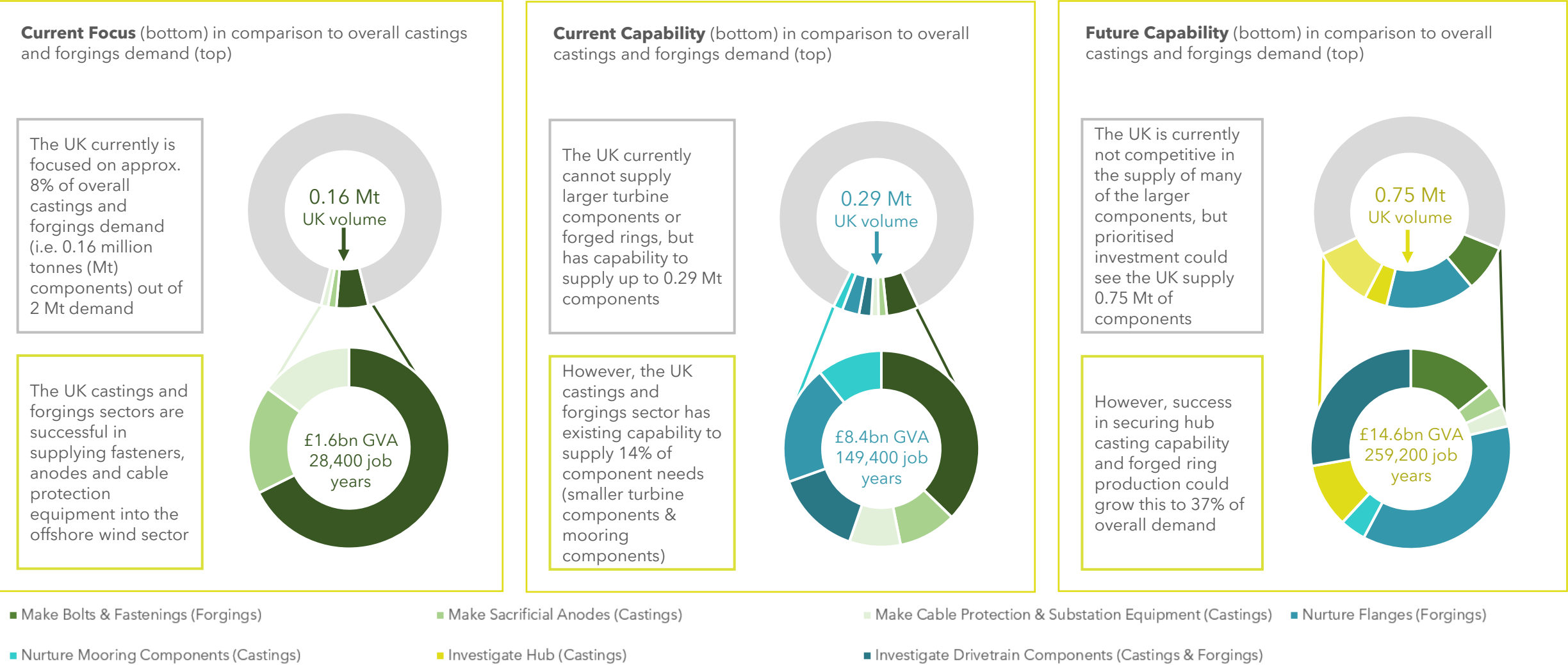
The UK's foundries and forgers are a strong and highly capable sector – supplying castings and forgings across a wide range of markets, and already active in offshore wind. As UK forgers have shown, there are opportunities to supply direct into turbine OEMs. In addition, with the right support they can move into larger castings, forged rings and the high-integrity components offshore wind demands, and they stand ready to work in partnership with UK industry bodies to grow their presence and value in the UK and global offshore wind market.

Right: gearbox casting



Executive Summary (continued)

Of the two million tonnes of castings and forgings needed to deliver the UK’s offshore wind pipeline, UK foundries and forgers have approx. 8% market capability, based on the sectors they supply into. However, current capacity means this could grow to up to 14% of this market. This report also identifies priorities for UK growth in new castings and forgings capabilities that could grow this to 37% capability.



Recommendations

While the UK may be reliant on a mature and global market for the majority of casting requirements, there are ways to protect, nurture and grow UK castings and forgings supply into the UK offshore wind market. Using the IGP’s Make or Buy Priorities leads to the following recommendations

- 1

Make - sacrificial anodes
Action: defend existing presence and encourage co-working between foundation designers, Tier 1 fabricators and UK casting companies to identify innovations that sustain UK competitiveness.
- 2

Make - cable equipment
Action: defend existing presence and encourage co-working between cable system designers and casting companies, to identify new products and innovations in casting to maintain UK competitiveness.
- 3

Make - bolt and fastener production
Action: build on the deep expertise of UK based Cooper Turner Beck (CTB) in high grade materials and volume production, helping ensure UK companies remain market leaders in offshore wind fasteners as the market evolves.
- 4

Nurture to Make - flanges, substation components and mooring systems
Action: as each supply chain develops, assess UK competitiveness and support routes to market, with OWGP connecting UK castings and forgings firms directly with prospective Tier 1s. OWGP assessment of monopile, transition piece and tower manufacturing should consider UK flange production and steel supply into forged rings; electrical component business cases should account for UK casting capability; and moorings and anchors work should reflect UK strengths in cast and forged connectors and load reduction devices.
- 5

Investigate - turbine, hub and drivetrain components
Action: across smaller turbine castings, large hub castings and drivetrain components, OWGP and GBE should assess UK competitiveness, support focused R&D towards a saleable proposition for the next product generation, and build routes to market into relevant Tier 1s and OEMs, with OWGP connecting UK foundries and forgers to them. Hub castings are the priority; drivetrain work must involve UK forgers and foundries from the outset.
- 6

Secure UK nacelle spaceframe production, bringing better alignment with existing fastener capabilities.
Action: OWGP and GBE to work with turbine OEMs in the identification of UK fabricators able to supply spaceframes into any UK nacelle facility.



Above: image shows a grit blaster ready to clean and prepare the surface of a cast component

Methodology



Approach

LumenEE was contracted by the Offshore Wind Growth Partnership (OWGP) and the Cast Metals Federation (CMF) to develop a model for understanding the castings and forgings requirements in offshore wind, and to then assess current areas of strength in UK companies, plus assess wider capabilities that would allow UK foundries and forgers to grow their footprint in offshore wind.

This work builds on the previous LumenEE led Bill of Works project that looked at steel requirements for offshore wind based on foundations and towers. However, that work had excluded nacelle components as these were seen as outside of UK capabilities. That study had quantified a small number of castings and forgings (e.g. flanges and mooring components), but this data was to be reviewed in this more detailed bit of work. The proposal also made use of economic data and structure developed for the UK offshore wind *Supply Chain Capability Analysis*.

The working hypothesis of this proposal was that there would be opportunities for UK foundries and forgers and greater use of UK cast and forged components, with separate work needed to (a) identify UK capability to supply a wide range of smaller specialist components, alongside (b) deepening knowledge of future potential growth areas around the supply of larger nacelle components.

To do this, the study has sought to understand overall volumes and requirements, large and small and castings and forgings in the turbine, so that UK foundries and forgers can better understand potential market opportunities.

Critically, the study has been able to identify a wide number of **smaller castings and forgings** required across lower tiers of the offshore wind supply chain within cables, electricals, corrosion protection and moorings, and forgings being supplied for bolts and studs. Some of these items are being supplied by UK foundries and forgers into the offshore wind sector currently, but there had been very low visibility of this UK capability prior to this study.

As well as current supply chain successes, the study also sought to understand future opportunities for UK foundries and forgers, based on an assessment of their capabilities. Different companies have developed specialisms in casting and forging based on metal, size, volumes, designs. Our study sought to map the capabilities within UK companies to find what other cast and forged components could be supplied by UK companies. The study has sought to quantify the volume of components, as well as to give technical data to the client. Where data has not been available, or it has been hard to quantify future volume or technical requirements

(particularly in floating offshore wind where there are different platform and mooring design options), we have sought to make estimates or to provide a qualitative review of opportunities.

The project team has worked closely with both OWGP and CMF in the delivery of this work and has made use of expertise within the CMF membership as well as direct interview with a number of foundries and forgers, plus an advisory group providing offshore wind expertise.



Above: airset moulding casting employs chemically bonded sand that cures at room temperature, making it suitable for larger and heavier castings.

Castings Bill of Works stages & methodology

WP1: Opportunity Review



WP1a: Component mapping

- LumenEE and Everoze worked together to develop a 1st draft Castings & Forgings Bill of Works of component requirements for different parts of the offshore wind value chain (e.g. substations, foundations, nacelle)
- With expert associates & Industry Advisory Group, this initial model was tested and any additional data gaps filled.
- The result was a full scope of offshore wind component requirements requiring casting or forging.
- For each component base data was gathered to give details on volume and specifications, material (e.g. iron, steel, aluminium), machining requirements, etc for each identified component.
- This material was collated in a Technical Report.



WP1b: Pipeline development

- Using the original IGP pipeline used for the first Bill of Works project, the project team developed castings and forgings requirements for each of the 12 reference project types. Different reference projects were used to reflect different turbine sizes, foundation types, water depths and electrical system designs.
- For each of these reference projects, a full list of castings and forgings requirements was developed (e.g. a floating offshore wind project using a concrete barge will have some common and some different component requirements compared to a fixed monopile project).
- Between 2026 and 2050 the volume requirements for each cast and forged component was calculated, based on these standard reference projects and agreed UK pipeline.

WP2: Supply Side Analysis



WP2a: Capability mapping

- Interviews arranged with CMF its company members and wider companies. Members were invited to attend interview after presentation to members of initial results.
- With individual companies, a review of the requirements identified in the Technical Report took place.
- In these structured conversations, LumenEE gathered information about which companies were already supplying components into offshore wind to understand existing UK benefit from offshore wind contracts into UK foundries and forgers and what parts of the offshore wind market are being served by UK foundries and forgers.
- LumenEE used the Technical Report data to test which other components could potentially be made by UK companies based on feedback of their technical capability.



WP2b: GVA analysis and call to action

- Using the Bill of Works steel model and experience from SCCA modelling; BiGGAR Economics conducted a GVA assessment to estimate the overall value of cast and forged components for each individual item. Where data was missing (e.g. due to needing to identify values of lower supply chain tier items when data was only held down to a tier above), BiGGAR Economics used the expertise of the project team to either find additional data, or to estimate percentage of value.
- LumenEE took the GVA and Jobs data to estimate the current and potential UK value based on calculated castings and forgings capabilities.
- Write up of results has utilised IGP make-buy framework to make recommendations based on capability map and knowledge of offshore wind supply chain market.

A male worker wearing a white hard hat and safety glasses is focused on inspecting a large, curved industrial casting. He is dressed in a blue work uniform. The casting is a complex, multi-layered metal structure with a series of parallel slots. In the foreground, several vertical metal rods with threaded sections are visible. The background shows a clean, industrial setting with various metal components and machinery.

Background on the UK Castings & Forgings sectors

Background to the UK castings and forgings sectors

Profile of the UK Foundry Industry

Casting is the process of making a component by pouring molten metal into a mould that contains a hollow cavity in the desired shape. Foundries use a range of specialist casting processes depending on the metal, size, complexity and quantity required to produce complex, precision-engineered and near net shape parts. One of the key benefits of casting is that it can create complex shapes as a single piece, often reducing the need for machining, fabrication and assembly – while improving efficiency, consistency and performance.

Foundries play a vital and enduring role in the circular economy for metals as the main raw material for foundries is



Above: Ductile Castings, Scunthorpe

secondary (sometime erroneously termed scrap) metal. The metal used to produce castings has often been reprocessed from scrap parts at end of life, thereby helping to turn recovered material into valuable new components, again and again.

The global market for castings is growing, supported by a move towards larger more complex components, lightweighting and more recycling of metal.

The UK foundry industry directly employs 10,000 people and is geographically spread with foundries all around the UK and concentrations in the West Midlands and South Yorkshire ranging from small companies serving niche markets, to large global groups on multiple sites.

UK foundries can produce components in a wide range of sizes, weights and volumes from prototypes and one-offs to series production and finished assemblies in range of ferrous and non-ferrous alloys and support a wide range of industries both in the UK and internationally including automotive, aerospace, rail, defence, power generation, consumer goods, construction, medical, marine and general engineering.

Castings produced in the UK, where much of the energy for melting and casting production is derived from sustainable sources can be lower in their carbon footprint compared with castings produced where melting is done using fossil fuels.

Profile of the UK Forging Industry

Forging is the process of shaping metal by applying compressive force – through pressing, hammering or rolling – to a heated billet or bar. Forging works the grain structure of the metal, producing components with superior strength, toughness and fatigue resistance. Forgings range from simple open-die shapes to complex closed-die near-net-shape components, and can be produced in ferrous and non-ferrous alloys across a wide spectrum of sizes and weights.

UK forgers directly employ 11,400 people. It has deep roots, particularly in South Yorkshire and the West Midlands, and serves demanding sectors including aerospace, defence, nuclear, oil and gas, rail, power generation and offshore energy.

Sheffield Forgemasters – now state-owned by the Ministry of Defence – is one of the world's foremost producers of large, high-integrity steel forgings and castings, with a particular role in nuclear, defence and offshore applications. Cooper Turner Beck, headquartered in Sheffield, brings over 150 years of engineering heritage to the manufacture of safety-critical forged fasteners and bolting systems for global energy, renewables and infrastructure markets.

The global forging market is growing, driven by demand for high-strength, lightweight components and the expansion of energy and defence infrastructure. UK forgers are well-placed to serve these markets, combining metallurgical expertise, advanced process capability and established supply-chain relationships with major international OEMs.

Quantifying Castings and Forgings Requirements



The UK Offshore Wind Pipeline

The UK offshore wind pipeline is globally significant, with a high volume of fixed and floating offshore wind projects at different stages of development. This project makes use of the pipeline model developed for the Industrial Growth Plan and used for the original Bill of Works project, to enable data comparison for different steel types and requirements.

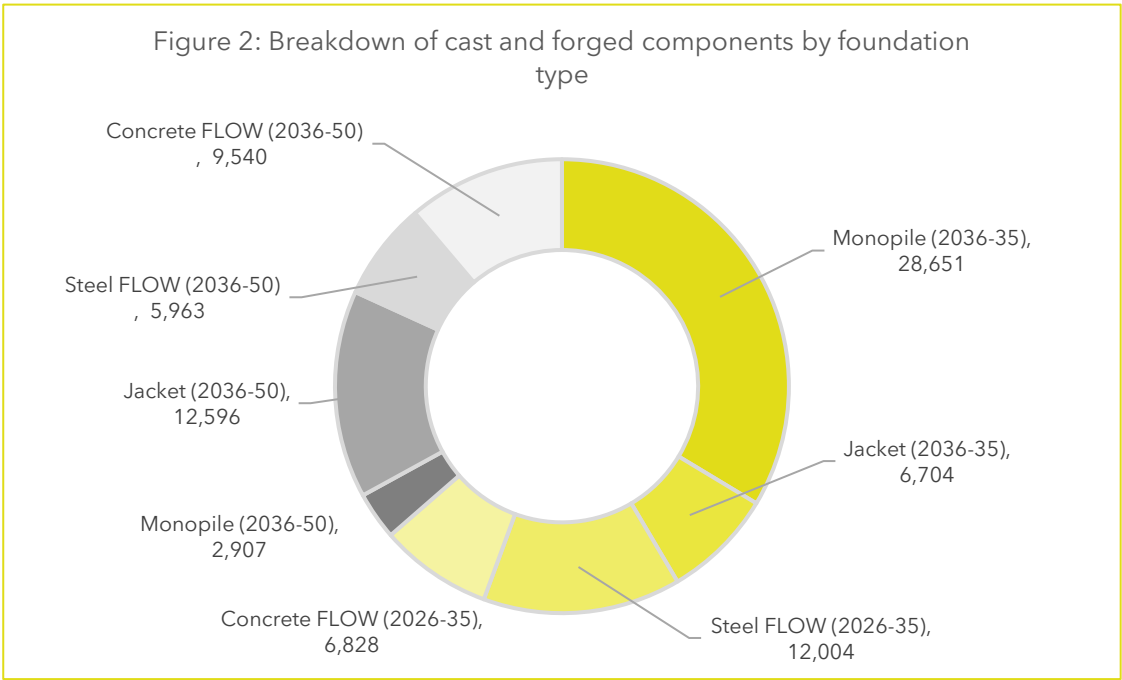
The UK is a mature offshore wind market with significant growth expected. A primary driver in this immediate growth is the UK Government’s Clean Power 2030 Plan, with associated contract for difference auctions expected to drive high capacities for delivery by the end of the current decade.

However, to ensure that figures presented here are comparable with previous steel analysis in the first Bill of Works report, plus to enable comparison to recommendations and priorities identified in the Industrial Growth Plan, the modelling here makes use of the original IGP scenario pipeline used for modelling.

That pipeline has a mix of fixed and floating projects, with a turbine size increase from 15MW today up to 20+ MW in future. The IGP models an industry where the current focus is on monopile foundation projects, but with a gradual shift to projects in deeper waters making use of jacket and floating foundations. Note, since the IGP, there has been a greater focus on deepwater offshore wind, and a growth in interest in use of hybrid devices. The original Bill of Works steel model made use of TLP designs; this work found that model was representative of hybrid designs and their steel requirements.



Left: 3D sand printing for sand moulds and cores for prototype and production metal castings. 3D printing allows rapid prototyping without costly tooling and cost-effective production of smaller castings.



2036-2050:
The IGP models 31GW of capacity delivered over the last 15 years out to 2050. These projects are primarily in deeper waters, with monopiles only representing 9% of capacity in this period.

The IGP models delivery as steady across the 2040s, with floating and fixed projects making up 50% of capacity.

2026-2035:
The IGP models 54GW of capacity being delivered in the 10 years between 2026 and 2035, dominated by monopiles, but with jackets and floating projects also being part of the capacity mix.

Delivery in this period is modelled to spike in the early 2030s with fixed projects making up 2/3 of capacity.

Castings and Forgings Demand

The UK has an estimated demand of 2.03 million tonnes of castings and forgings. 1.54 million tonnes of this is for a range of nacelle components, with a further 0.49 million tonnes for use needed across a range of components for use in towers, cables, foundations and moorings.

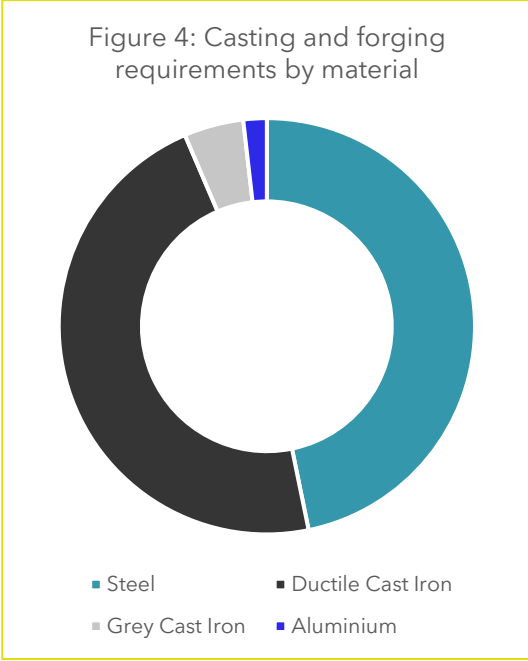
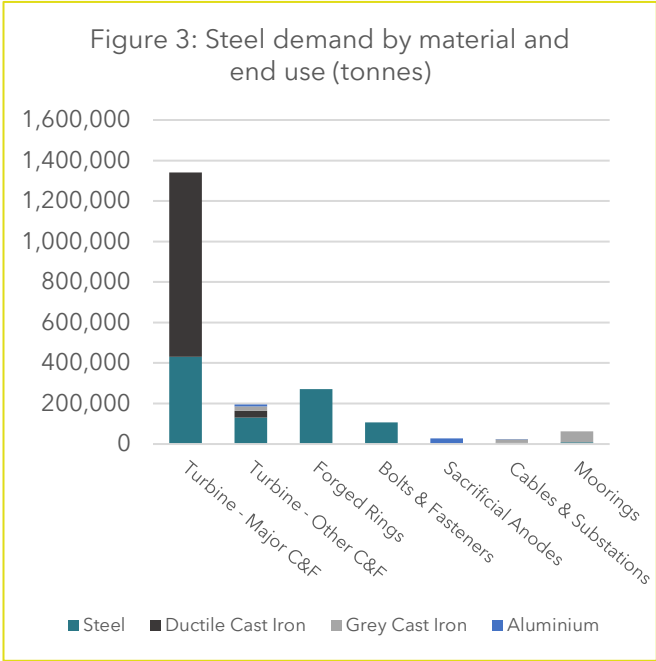
Table 1: Tonnes of castings & forgings required

	Turbine - Major Components	Turbine - Other Components	Forged Rings	Bolts & Fasteners	Sacrificial Anodes	Cables & Substations	Moorings	Total (2025-2050)	Tonnes pa (average)
Steel	430,396	131,250	271,102	107,244	-	-	8,854	948,847	37,954
Ductile Cast Iron	910,835	32,442	-	-	-	5,595	-	948,872	37,955
Grey Cast Iron	-	22,570	-	-	-	18,116	53,117	93,803	3,752
Aluminium	-	8,667	-	-	27,576	619	-	36,862	1,474
	1,341,231	194,929	271,102	107,244	27,576	24,330	61,972	2,028,384	81,135

Table 1 sets out the total weight requirements of different castings and forgings by end use and material type. Note, all steel components are forgings either for specialist forged components in the turbine, bolts, forged rings or mooring connectors.

Castings are required in both the turbine and more widely. Larger ductile castings for use in the nacelle make up the single largest requirement for castings. These large ductile castings are for items such as the Hub and Bedplate as well as a wider group of components.

A smaller amount of ductile cast iron is required in castings used for cable protection.



Grey cast iron is used for castings to make smaller turbine components, and also for cable equipment such as cable protection and cable ballast, as well as clump weights for floating offshore wind moorings.

Aluminium or alloy castings are required in a number of small turbine components, as well as for sacrificial anodes and some electrical components.

There may also be additional cast parts required, such as for onshore connections and other installations including pumps and valves, which provide additional opportunities for UK supply chains.

Castings and Forgings Demand

The UK has an estimated demand of 2.03 million tonnes of castings and forgings required for different turbine components. Two thirds of demand is for larger nacelle and hub castings, a further 10% for smaller turbine castings and forgings, 19% for forgings for flanges and fasteners, and a further 5% for other components.

Figure 5 shows the flow of castings and forgings required for different parts of the offshore wind supply chain.

The primary requirement in offshore wind is for larger castings and forgings (76%) required in the turbine nacelle and hub. The small number of very large ductile iron castings needed for the bedplate and hub and comprise 45% of overall castings and forgings weight.

There are a number of large forgings (21%) needed for different ring gears and bearings in the drive train itself as well as the rotor.

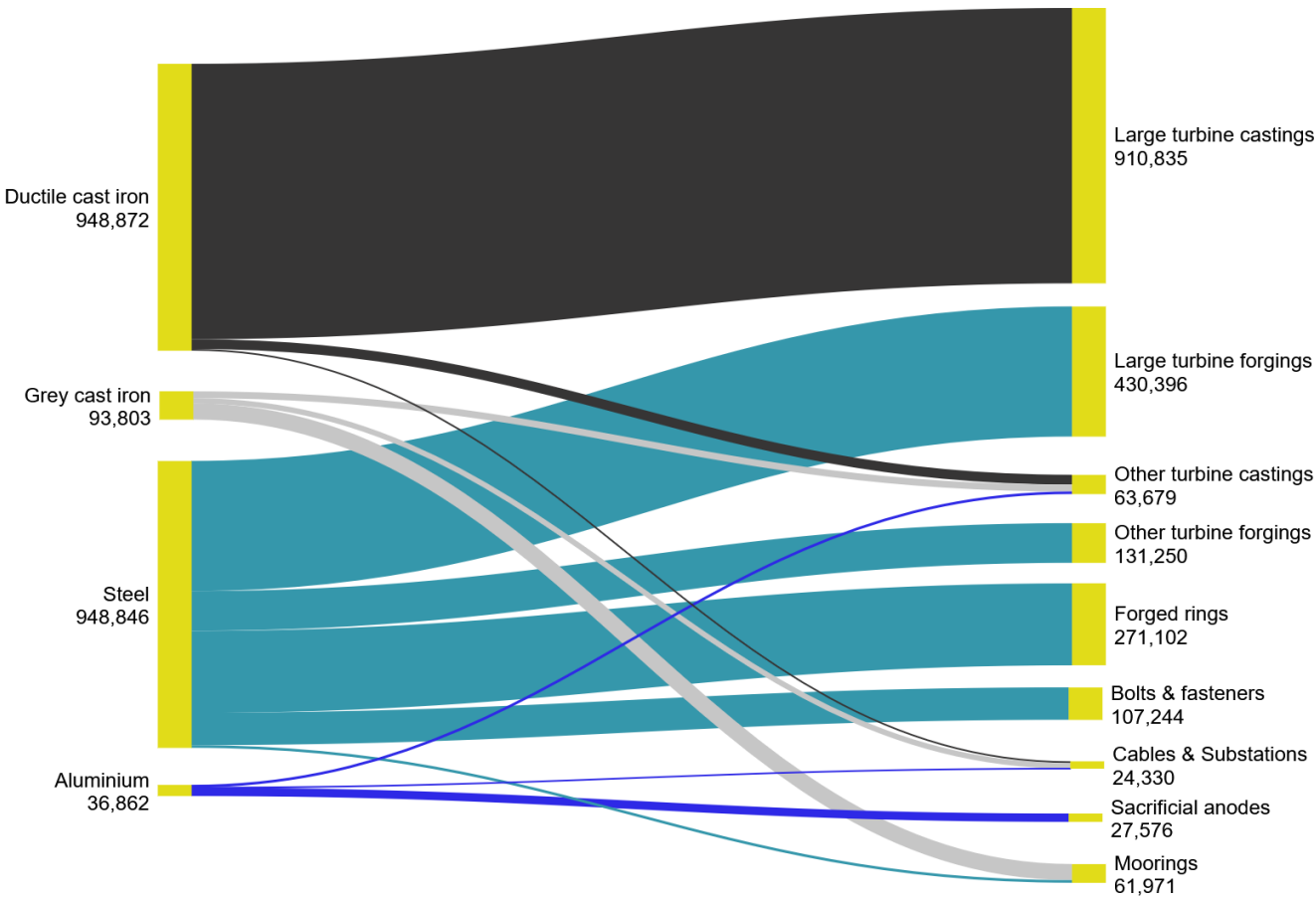
Smaller cast and forged components in the nacelle make up a further 9.6% of overall demand.

Outside the nacelle, other castings and forgings make up approx. ¼ of demand by weight. Forgings for flanges (forged rings) and bolts and fasteners make up the largest part of this and together equate to 18.7% by weight.

There are a range of other castings needed which make up 2.6% of demand. This includes grey cast iron which is used in cables, substations and moorings, and aluminium based castings used for sacrificial anodes and for electrical component bodies.

Finally, 3.1% of demand will come from a range of castings and forgings used in mooring systems.

Figure 5: Sankey Diagram showing overall castings and forgings requirements by component



Castings and Forgings Demand – nacelle and hub castings and forgings

Nacelle and hub castings and forgings make up 75.7% of all castings and forgings by weight. 45% of demand is for major nacelle and hub castings, and 21% is for major nacelle forgings used in the drivetrain. There are also a range of smaller castings and forgings used across the nacelle, including in the drive train, heat sinks, electricals, pumps and motors.*

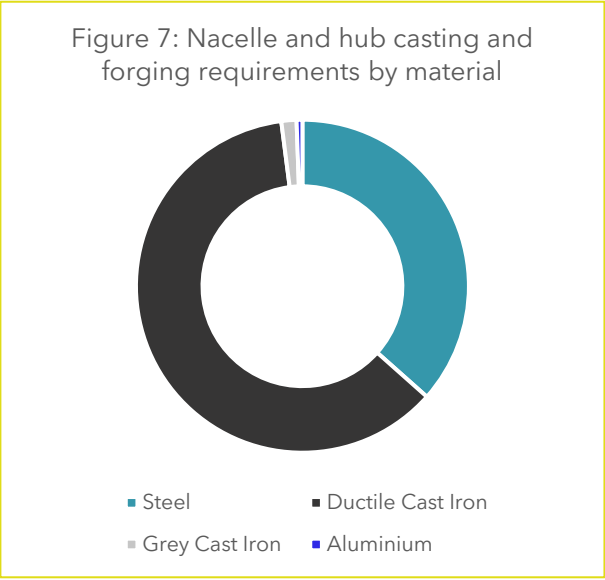
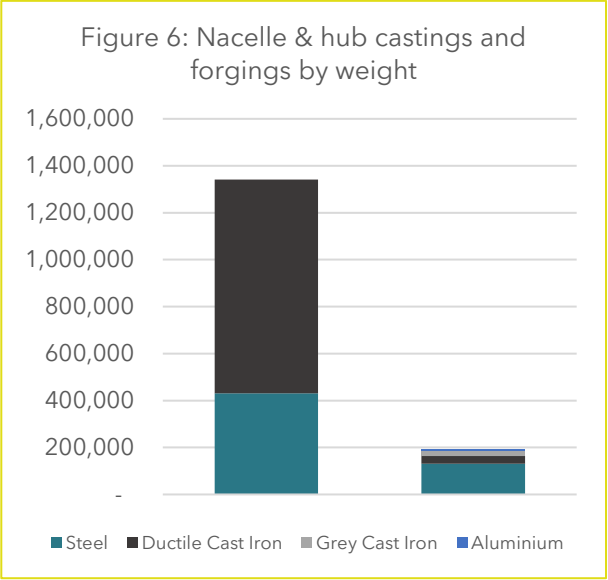


Table 2: Tonnes of castings & forgings required for nacelles and hubs

Material	Tonnes Required (2026-50)	Tonnes pa (average)
Steel	561,646	22,466
Ductile Cast Iron (SGI)	943,277	37,731
Grey Cast Iron	22,570	903
Aluminium Castings	8,667	347
Total	1,536,160	61,446

Table 2, Figure 6 and Figure 7 highlight the split of materials for different castings and forgings required within a turbine nacelle and hub.

The requirements are dominated by the larger castings needed for the hub, bedplate, main bearing housing and main shaft which will weigh between 30 and 50 tonnes per turbine (and per casting). There are also approx. 10 (depending on design or drive train type) different smaller castings required for items such as gearbox casings, planet carriers, brake disc, heat sinks, pump housings and switchgear housings.

Cast nacelle and hub components make up 48.0% by weight of all offshore wind cast and forged components (split 44.9% for major nacelle and hub castings and 3.1% for the wider list of smaller castings).

There are a small number of large forgings required for the main ring gears and blade, plus a wider range of smaller forgings for drive train and gear components.

Forged components make up 27.7% of total cast and forged offshore wind components by weight (split 21.2% for larger nacelle and hub forgings and 6.5% for other smaller nacelle and hub forgings).

* Note, there are a range of fasteners (bolts and studs) also used inside the nacelle, though these are covered separately as similar fasteners are used across the whole turbine.

Castings and Forgings Demand – excluding nacelle and hub castings and forgings

Removing turbine castings and forgings used in the nacelle changes the picture and focus of discussion, looking at the quarter of castings and forgings (by weight) used in flanges, connectors, anodes, cables, substations and moorings.

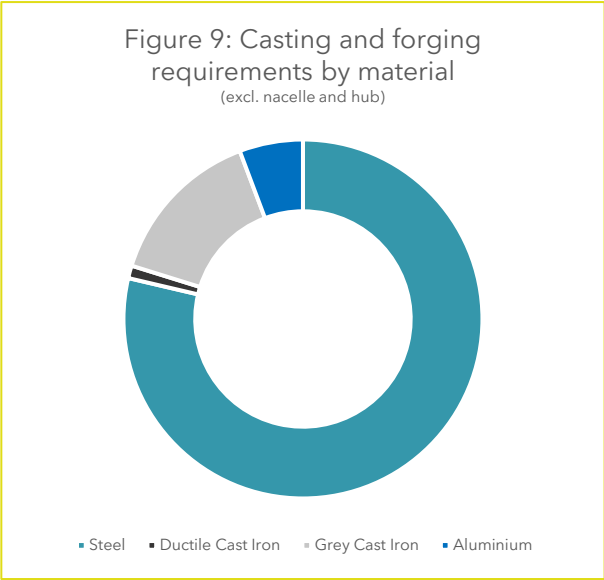
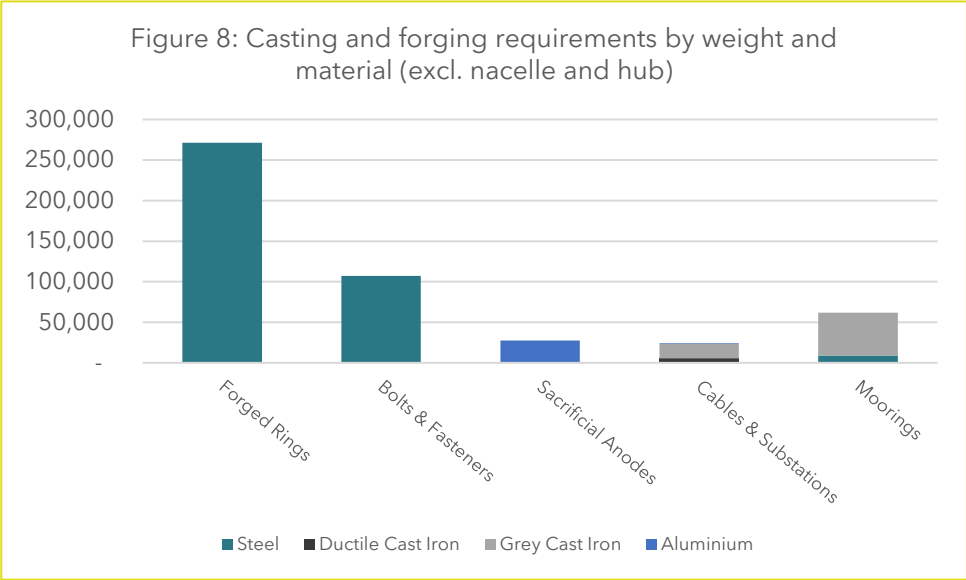


Table 3: Castings & forgings required, excluding nacelle and hub

Material	Tonnes Required (2026-50)	Tonnes pa (average)
Steel	387,201	15,488
Ductile Cast Iron (SGI)	5,595	244
Grey Cast Iron	71,233	2,849
Aluminium	28,195	1,128
Total	492,224	19,689

Table 3, Figure 8 and Figure 9 highlight the split of materials for different castings and forgings required outside the turbine nacelle and hub.

The largest requirements are for forgings needed for flanges (forged rings) and fasteners (bolts & studs). Forged rings are made from high strength steels and forged into a large ring shape. They are used at interfaces to connect different components (e.g. nacelle to tower, tower to foundation) or to join sections of components such as towers.

Fasteners are used in multiple locations in wind turbines including for connection of flanges, plus in the nacelle (e.g. blade bolts, yaw bolts, gear bolts).

There are a range of castings used outside the turbine nacelle and hub. The largest volume is for alloy sacrificial anodes used as passive protection to protect steel structures like transition pieces, monopiles, jackets, and steel semi-subs. There are also active corrosion protection systems in operation, and we have assumed a 1/3 passive/2/3 active market penetration in these calculations.

There are a wide range of castings needed for cable protection, ballast, plus switchgear housings and other switchgear equipment.

Finally, a mixture of castings and forgings are required for mooring equipment, connectors etc.

Capability Review

Image shows shell moulding casting method. This uses resin-coated sand to create thin, rigid moulds, offering high precision and excellent surface finishes

UK Castings and Forgings Capability Review

This report has looked at what current parts of the offshore wind supply chain are supplied by UK foundries and forgers. From this the analysis then considered what capability already exists that could supply other parts of the supply chain. Finally, it considered options for the future, growing UK foundry and forge capability.

The UK has a range of foundries and forgers in operation. They operate at different scales, and supply into a range of industries. To identify areas of current success and identify which other parts of the offshore wind supply chain UK foundries and forgers supply into, this study undertook technical interviews with relevant companies, focused primarily on Cast Metal Federation members, but also engaging with known UK forgers working in (Cooper Turner Beck) or seeking to enter the offshore wind supply chain (Sheffield Forgemasters).

From these interviews, this study was able to review technical data held on individual cast and forged components to calculate a number of points:

Based on feedback about markets currently supplied, this study has calculated overall weight and value of these parts of the offshore wind supply chain based on demand to fulfil the modelled UK offshore pipeline.

Note, we have not made assessments as to what percentage of the market UK companies are supplying or looked at the value of supply into export markets.

Note, no assessment has been made of the competitiveness of UK companies or of issues around oversupply or market bottlenecks that could influence market entry.

A final step has been to identify items that could potentially be cast or forged in the UK, despite a lack of current capability. This exercise has necessarily been more speculative. Areas where UK foundries do not have capability are the larger specialist castings used in the turbine nacelle and hub.

These are a small number of very large components – among the largest cast items produced anywhere – making up a significant share of offshore wind casting demand. Alongside them sit specialist forged components such as flanges and drivetrain parts, which need equipment the UK does not currently have.

These are the future potential areas identified in Table 4: high-value components currently outside UK technical capability, where investment could bring them within reach. We set out the main areas assessed as follows:

- i. **Hub castings – the single large casting with greatest potential for UK manufacture. UK companies have examined this market before, retain interest, and have the financial and technical base to enter it, but would need significant investment. A detailed business case is still required.**
- ii. **Bedplates – very large, but lower value than hubs. The Vestas V236 uses a mix of bedplate and fabricated spaceframe, so there is scope for UK supply of the spaceframe and its fastenings even though UK foundries are unlikely to compete on the bedplate castings themselves.**
- iii. **Drivetrain components – identified in the IGP as a future UK opportunity. Attracting drivetrain manufacture would require UK-sourced forgings and castings; this study sets out the demand and value.**
- iv. **Forged rings – Sheffield Forgemasters can supply the high-grade steel and Freudenberg Flow Technologies the design and manufacturing capability for flange production. Flanges are needed across nacelles, towers and foundations, all either already produced in the UK or IGP priorities.**

UK Castings and Forgings Capability Review

The UK has well defined pockets of activity supplying into offshore wind, plus wider capability that could be utilised to supply a wider range of sector castings and forgings requirements. Below are mapped out different cast and forged products, with identification of UK companies known to be supplying or with wider capability that potentially enables future supply.

To identify expertise within the UK castings and forgings sector, supply chain knowledge from the SCCA was crossed with sector coordination with CMF members and other industry engagement.

LumenEE presented findings of casting requirements to CMF members at a member workshop, and followed this up with one-to-one interviews with castings companies currently involved in supplying into the offshore wind market. These companies were supplemented through engagement with South West Wales steel companies through related project work.

This has enabled LumenEE to get a clear picture of current supply into offshore wind, as well as potential opportunities for more castings and forgings supply into the offshore wind sector. This section sets out these results. On the following page, we summarise the different components in Table 4.

CURRENT MANUFACTURE

Areas of current capability identified where the UK is successfully supplying into the offshore wind market include:

Cable protection systems: foundries such as Newby Foundries; Ductile Castings and WM Lee are currently supplying cable protection systems to UK companies such as Tekmar and Subsea Energy Solutions.

Corrosion protection: companies such as Metec are providing alloy castings to companies such as Smulders, Severfield and SeAH for use on offshore wind foundations. While active corrosion systems are also in use, there is continued demand for large aluminium alloy sacrificial anodes for mounting onto monopiles and jackets.

Pump bodies and impellers: companies such as Furniss and White are providing specialist castings for pumps in use in offshore wind substations.

Forged bolts: Cooper Turner Beck provide bolts and studs into the offshore wind sector from their Sheffield factory to both Vestas and Siemens.

CURRENT CAPABILITY

As well as this existing success, based on our review of castings and forgings technical specifications and existing capability (i.e. sizes of castings, materials and standards supplied to), the UK can potentially also supply into the following additional areas:

Cable ballast: as well as cable protection, UK companies could be providing grey cast iron cable ballast into the offshore wind market.

Smaller turbine castings: as well as the larger castings required in turbines, there are a wide range of smaller castings that are within the capability of UK castings companies. This is a mature supply chain market based around turbine OEMs and generator manufacturers. Companies need to be able to provide castings to high specifications and at high volumes.

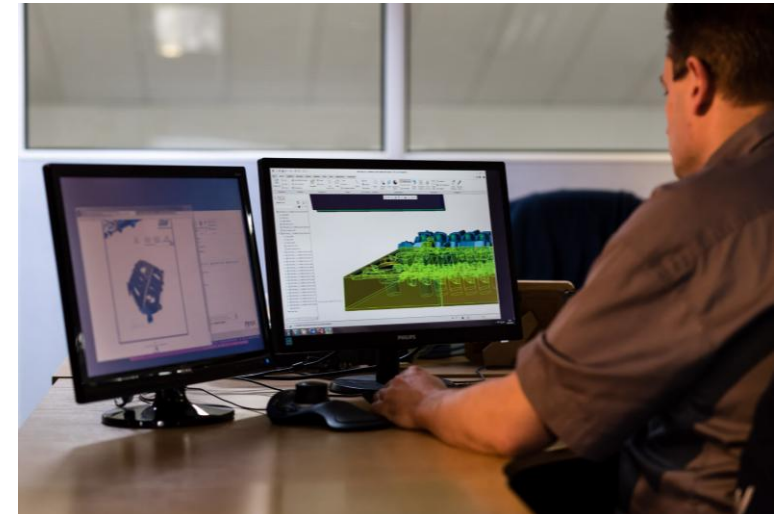
Switchgear: offshore wind needs a multitude of electrical components, including items such as switchgear that need bodies casting.

Mooring systems & connectors: floating offshore wind will need a variety of forged components for fasteners. UK companies such as Griffin and Woodhouse currently provide these from outside of the UK, but there is potential for growth of UK supply. Port Talbot based Wall Colmonoy

has capability to produce high strength steel components through its high strength coatings, which could support use of connectors and pins needed in a range of deepwater offshore wind structures.

FUTURE POTENTIAL

Flanges: offshore wind also requires flanges for the connection and bolting together of different offshore wind structures such as tower sections and also joining of foundations to towers. Sheffield Forgemasters has the capability to supply the high grades of steel needed, while Port Talbot based Freudenberg Flow Technologies has the design and materials capabilities for supply and coordination of flange production (though not currently direct flange production).



Above: complex casting design work

UK Castings and Forgings Capability Review

Our assessment has identified 15 cast and forged components (in three product groups) that are currently being manufactured in the UK, plus a further 20 (in four product groups) where the UK has existing capability, and a further 11 individual components (in two product groups) where the UK should consider domestic production.

Table 4: UK Castings and Forgings Capability Review Summary

Currently manufactured (15 components)	Current Foundry Capability to supply (16 components)	Current Forge Capability to supply (4 components)	Future potential (11 components)
CATHODIC PROTECTION (CASTINGS)	SMALL TURBINE COMPONENTS (CASTINGS)	SMALL TURBINE COMPONENTS (FORGINGS)	MAJOR NACELLE & HUB (CASTINGS)
Sacrificial Anodes for Monopiles	Hydraulic components	Rolling elements - Blade Bearings	Hub Casting
Sacrificial Anodes for Jackets	Pitch gearbox casings - WTG Electric	Rolling elements - Main Bearings	Nacelle Main Frame (bedplate) & spaceframe
Sacrificial Anodes for Semi-Subs	Lightning protection system - WTG Rotor Assembly	Motors & bearings - Yaw System	Main bearing housing
	Planet carrier - Gearbox		
CABLE PROTECTION (CASTINGS)	Main casing - Generator - Geared Drive Train	MOORING COMPONENTS (FORGINGS)	FORGED RING (FORGING)
Array cable protection system for WTG	Brake disc - High speed shaft brake	Mooring shackles and fasteners	Tower/WTG Flange
Array cable protection system for OSS	Yaw gearbox casings - Yaw System		Intermediate Tower Flanges
Export cable protection system for OSS	Nacelle motors & pumps		Top TP flange
	Heat sinks - WTG Converter		MP/TP Tower Flange
FASTENERS (FORGINGS)			MP/TP connection flanges
Tower Bolts	ELECTRICAL COMPONENTS (CASTINGS)		Top MP flange
Blade Bolts	Gas Insulated Switchgear housings - WTG		Jacket flange
Nacelle fastenings	OSS Switchgear housings - OSS Structure		Floater-Tower Interface Flange
Gearbox studs	OSS auxiliary systems - motors & pumps		
Yaw bearing bolts	Onshore Switchgear housings - Onshore Substation		
Set of bolts for MP/TP connection			
Jacket bolts	CABLE PROTECTION (CASTINGS)		
Set of bolts for Jacket/WTG Connection	Ballast Units		
Set of bolts for floater tower interface flange			
	MOORING COMPONENTS (CASTINGS)		
	Mooring shackles and components		
	Mooring Clump Weights		

Capability Review – current status

Across all castings and forgings needs, the UK is currently focused on approx. 8% of the available market, with a focus on fastenings, cable protection and cathodic protection. Excluding turbine components this is equivalent to one third of castings and forgings needs.

Figure 10: Turbine and non-turbine capability – current status

Figure 11: UK castings and forgings capability – current status (excl. areas with no UK capability)

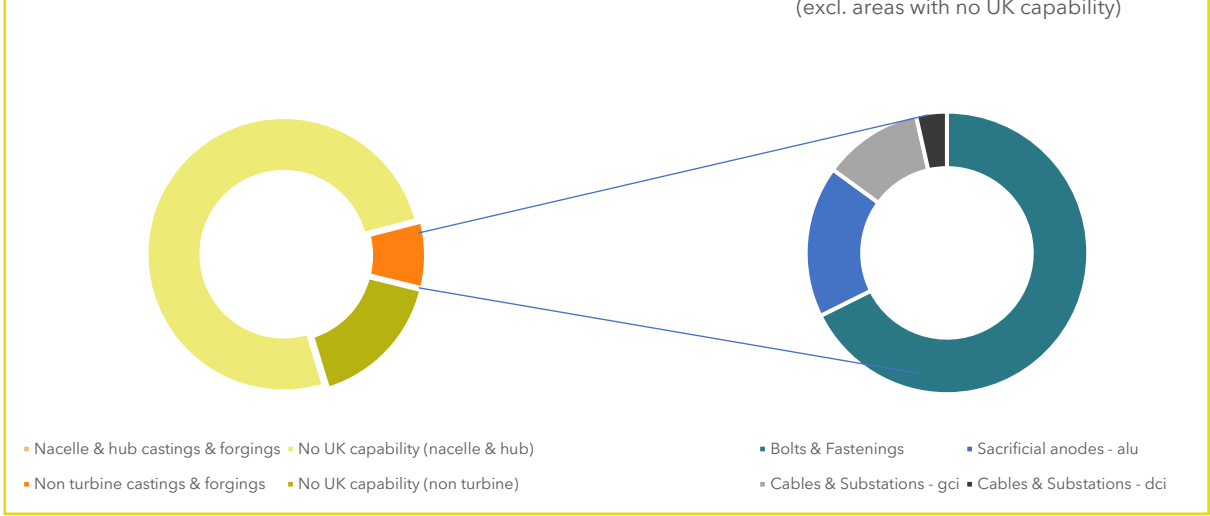
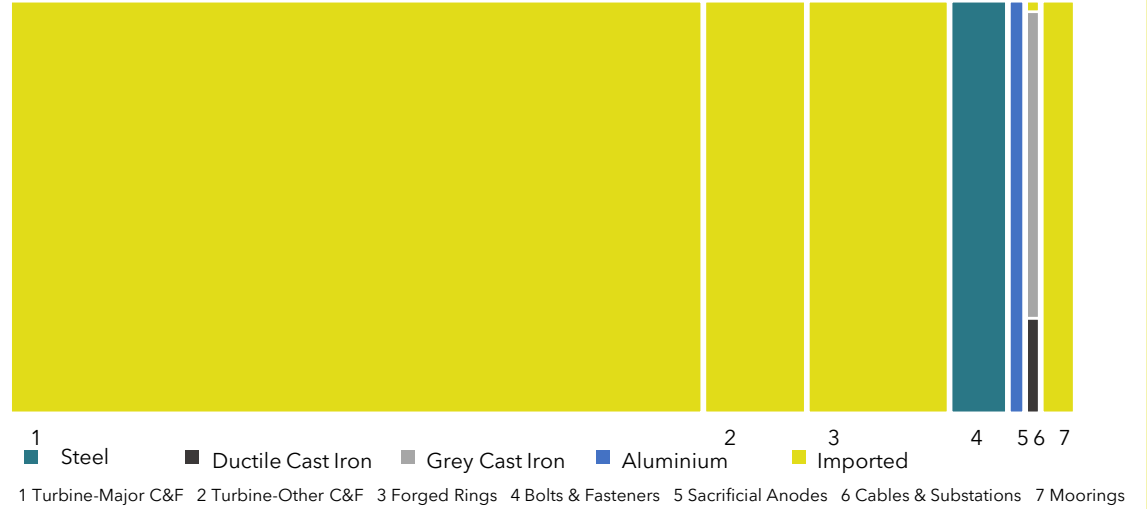


Figure 12: Components UK companies currently supply, compared with total demand - current status (column width = total demand)



UK supply is concentrated outside the nacelle, particularly in fastenings, cables and sacrificial anodes. Figure 10 shows that the UK castings and forgings sector is currently focused on supplying for castings and forgings outside the turbine. Note this excludes fastenings (bolts and studs), which are used in turbines, towers and foundations but are captured as a separate item (see Figure 11). This means that the UK is currently focused on supply of 7.8% by weight – 158,530 tonnes, or 6,341 tonnes per annum (Figure 10) of overall sector casting and forging requirements.

Note, this does not necessarily mean that UK companies are capturing 7.8% of the market's value, only that the part of the market they are supplying into represents this percentage of overall castings and forgings needs.

Outside turbine components all fasteners and all sacrificial anode requirements, and almost all cable protection components, sit within UK supply. This is where value is being captured and where supply chain resilience in the near term will be important. Cooper Turner Beck can supply all required fasteners, all manufacturable in Sheffield – one of the strongest single capabilities identified in this study.

Figure 12 sets out the data as a Marimekko Chart.* This shows that currently the UK's offshore wind pipeline is dependent on imports for major and other turbine castings and forgings, forged rings and moorings.

Inside the nacelle the picture is different. The UK supplies almost none of the major nacelle and hub castings and forgings, and closing that gap is a longer-term project contingent on OEM and Tier 1 investment decisions. The exception is focused, high-volume components such as fasteners, where UK suppliers are already established.

Assessment of the nacelle opportunity therefore needs to be done jointly with OEMs and their Tier 1 suppliers, rather than by the UK foundry and forge base alone.

* For background about Marimekko charts and how to interpret their data see Annex.

Capability Review – current potential

Above and beyond its current focus on supply into fasteners, anodes and cable protection, UK foundries have existing capability to supply other parts of the offshore wind supply chain, focused in particular on smaller turbine components. This capability would be capable of meeting 14% of offshore wind castings and forgings needs.

Figure 13: Turbine and non-turbine capability – current potential

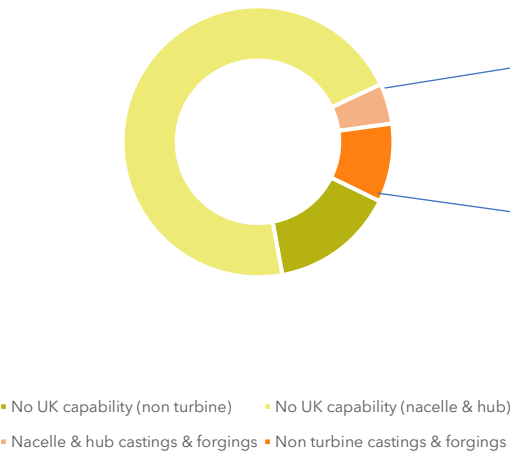


Figure 14: UK castings and forgings capability – current potential (excl. areas with no UK capability)

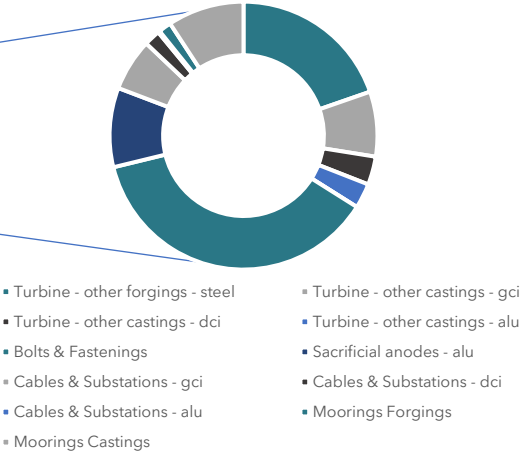


Figure 15: Components UK companies currently supply, compared with total demand - current potential (column width = total demand)

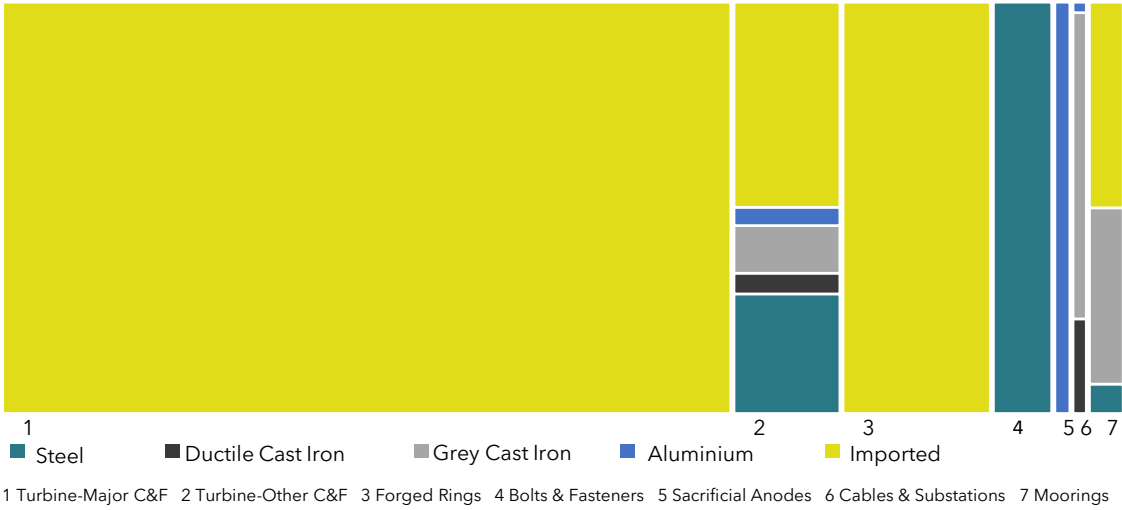


Figure 13 shows where the UK has potential to supply, based on current technical capability. While the previous page showed that current supply is into non-turbine supply, there are areas in both turbine supply (smaller components) as well as other non-turbine areas where the UK could supply.

In total, the UK could supply 14% of all offshore wind castings and forgings needs. These different types are broken down in Figure 14.

The additional capability sits in two areas: smaller nacelle components, where UK foundries can supply more than they currently do, and the moorings supply chain for floating offshore wind.

The near-term opportunity lies outside the nacelle: half of UK mooring component requirements could be met from existing UK capability, without new foundry or forge capability being built. These are the areas that should now be assessed for competitiveness. However, longer term, around half of smaller turbine components could also be made by UK foundries.

Figure 15 sets out this data as a Marimekko Chart.* This shows that currently the UK's offshore wind pipeline is dependent on imports for major castings and forgings, and forged rings but potentially approx. half of smaller turbine components, and half of UK mooring component requirements could be supplied from UK foundries and forges.

Inside the nacelle the constraint for the UK supplying smaller cast and forged components is route to market rather than capability. The challenge for UK foundries and forges is how to build links to OEMs and their suppliers for supply of smaller turbine castings, as well as helping them assess potential competitiveness.

In addition, UK foundries and forges need support in understanding the moorings supply chain needed around floating offshore wind.

* For background about Marimekko charts and how to interpret their data see Annex.

Capability Review – future potential

Looking into the future, with UK priorities to see more foundation and tower manufacture, plus the potential for UK nacelle and hub assembly, and longer-term aspirations for next generation drivetrain manufacture, there is potential for the UK to supply over one-third cast and forging needs.

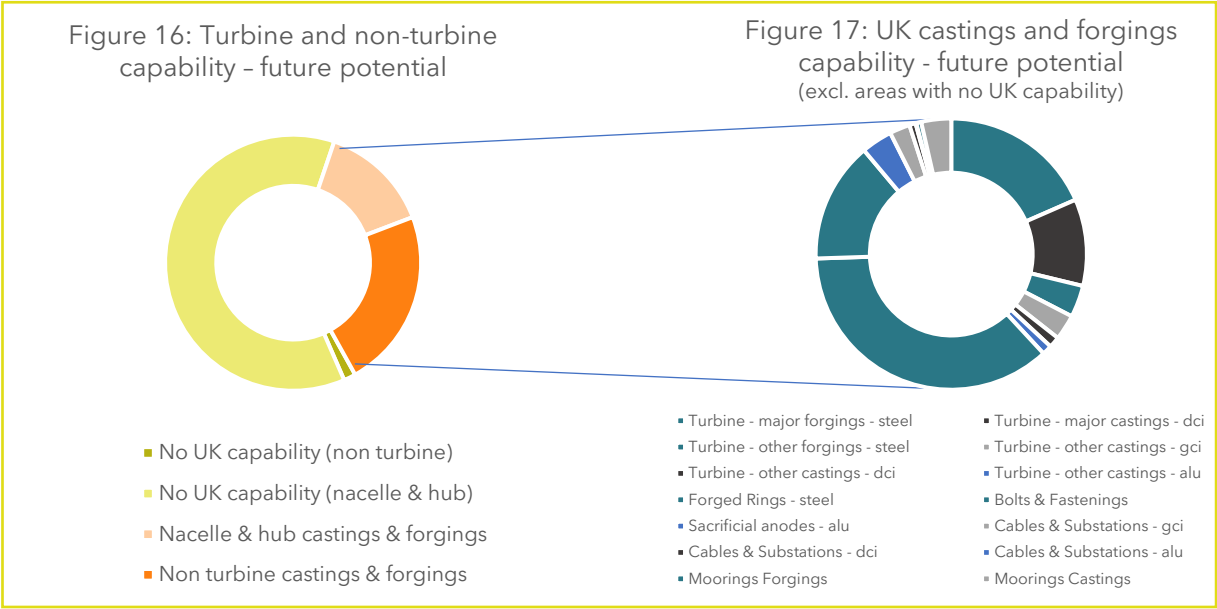
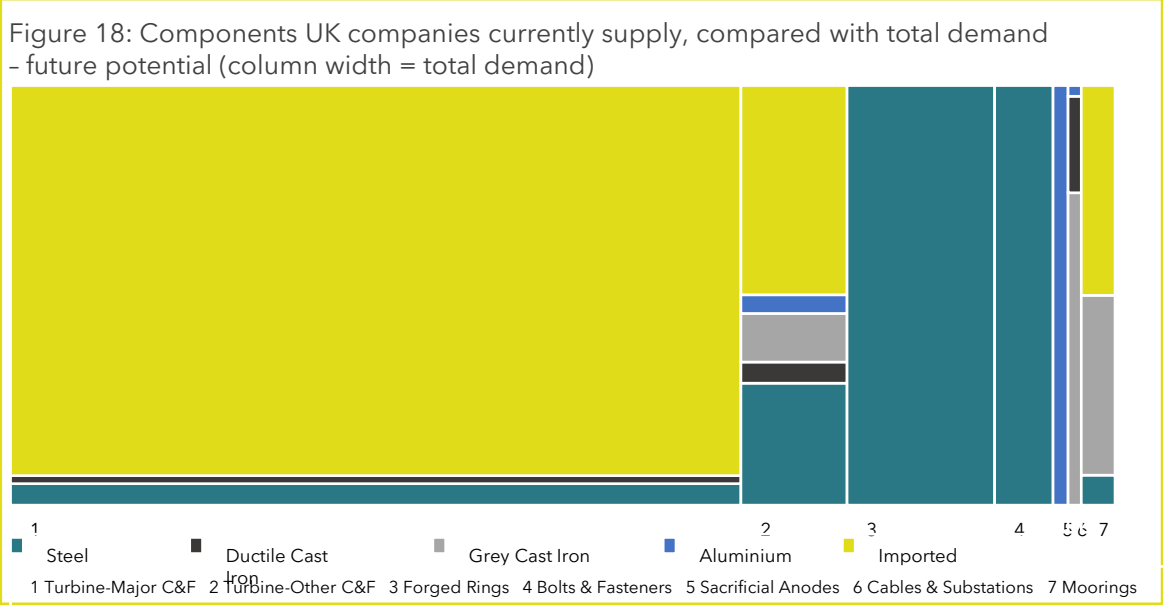


Figure 16 shows that with investment, the UK’s technical capability could reach 36.7% of all offshore wind castings and forgings needs. This would include delivering capability to supply over 90% of requirements outside the nacelle and hub (Figures 16 and 17) as well as some larger and smaller turbine components.

This change is based on the assumption that one OEM sources UK hub castings from a UK supplier as part of establishment of UK nacelle and hub assembly capacity, and that therefore 50% of hub castings in the UK market can be technically supplied into the UK offshore wind pipeline. This assumption presupposes that UK suppliers win this work on competitiveness as well as capability; neither has been tested.

Outside the nacelle, investment in UK forged ring manufacturing could take UK supply above 90% of requirements, approaching self-sufficiency in areas such as forged rings. This is the largest single opportunity in the analysis and should be assessed for competitiveness.

Figure 18 sets out this data as a Marimekko Chart.* This shows that currently the UK’s offshore wind pipeline could potentially be supplied by UK foundries and forges, with some ability to supply major turbine components, up to self-sufficiency in areas like forged ring production.



Inside the nacelle the step change would be investment in UK hub castings, plus UK forged ring production for offshore wind flanges.

These would clearly require significant investments to happen and would also need input and support of OEMs and other top tier supply chain such as foundation and tower manufacturers.

* For background about Marimekko charts and how to interpret their data see Annex.

Sankey diagrams of UK castings & forgings current focus vs current capability vs future potential

Figure 19: Sankey diagrams showing (a) current areas of UK supply; (b) areas of current supply and current capability; (c) areas of current supply and capability plus future potential. Data in metric tonnes showing total weights for delivering UK 2026-2050 pipeline.

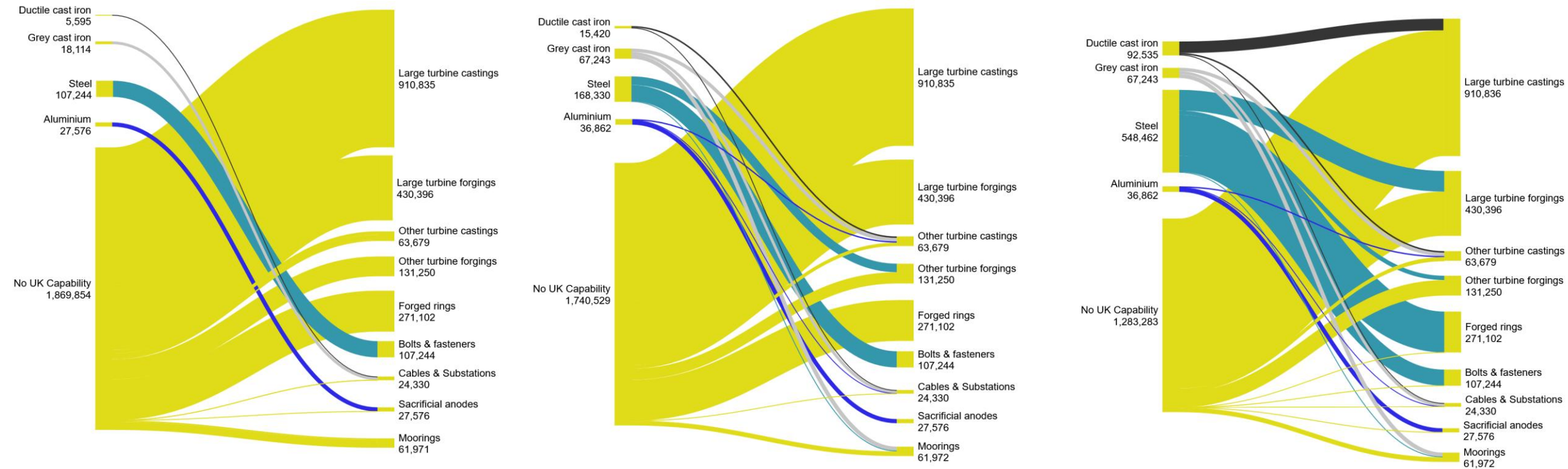


Figure 19 shows the flow of castings and forgings using three different measurements of UK capability. The Sankey diagrams visualise the relative size of different castings and forgings markets and the flows of different metals into the groups of end products.

Left shows how the UK has current experience of supplying ductile cast iron, grey cast iron and aluminium castings for

cable protection, some substation pump components and sacrificial anodes, plus steel forgings for bolts and fasteners.

Centre is shown how the UK could build on current supply chain presence and use its existing capability to make a wider range of components, including for moorings and also smaller turbine components.

Both the current actual and current potential casts show that the majority of cast and forged components cannot be supplied by UK forgers and castings. This is primarily due to the size of the castings and forgings needed by the offshore wind sector for larger nacelle, hub and drivetrain components. However, right is an assessment of future potential, based on UK investment in forged rings, hub castings and drivetrain components.



GVA and Job
Years Analysis

Image shows electric arc furnace
at Sheffield Forgemasters

GVA and Job Years Analysis – 2026-2050

INTRODUCTION

To calculate gross value added (GVA) and job values, BiGGAR Economics worked using their economic model and a work breakdown structure (i.e. a taxonomy of different components and supply chain contracts) developed for the UK Offshore Wind Supply Chain capability analysis (SCCA).

LumenEE’s steel model works from the same WBS codes, with further detail and sub-codes being added for individual components to ensure that all sub-components are categorised separately. Within the SCCA, BiGGAR Economics worked with lead consultancy Everoze, plus LumenEE to establish values for different individual WBS packages.

For this castings and forgings review, BiGGAR Economics took the technical data from LumenEE and Everoze, and for each of the listed cast or forged components worked to establish a specific value. This was done either through using consultant or market knowledge to establish a contract package value, and if this was not known, BiGGAR Economics and Everoze worked to estimate percentage value of each sub-component in relation to the parent WBS code and value.

The resulting analysis gave values for individual components based on supply into a 1GW offshore wind farm (different project types were modelled based around different turbine sizes and different foundation types). LumenEE then used this data to adjust for different project sizes used in the overall steel model.

The result is a comprehensive set of GVA (direct, indirect, total) and jobs (direct, indirect, total) for a range of cast and forged offshore wind components.

Table 5: UK castings and forgings capability review – GVA and jobs summary

Capability Level	Total Market GVA	Total Market Jobs	Current Focus GVA	Current Focus Jobs	Current Potential GVA	Current Potential Jobs	Future Potential GVA	Future Potential Jobs
UK Foundries (Castings)	£16.55bn	293,213	£0.54bn	9,650	£4.14bn	73,416	£4.93bn	87,208
UK Forgers (Forgings)	£19.41bn	344,150	£1.06bn	18,754	£4.29bn	76,024	£9.70bn	171,977
TOTAL	£35.96bn £16.5bn direct £19.4bn indirect	637,363 323k direct 314k indirect	£1.60bn £0.7bn direct £0.9bn indirect	28,404 14k direct 14k indirect	£8.43bn £3.9bn direct £4.5bn indirect	149,440 75k direct 74k indirect	£14.63bn £6.7bn direct £7.9bn indirect	259,185 131k direct 128k indirect

RESULTS

The total GVA for the value of castings and forgings required to build out the UK pipeline is £36bn, or an average of £1.44bn per annum. This would create an estimated 637,000 job years of work between 2026-2050 or 25,500 jobs each year.

The UK castings and forgings sector is currently focused on supplying bolts and fasteners, sacrificial anodes and cable protection. This has a calculated GVA of £1.60bn or 28,404 job years.

However, UK foundries and forgers have capability to supply a wider part of the offshore wind supply chain worth £8.43bn, equivalent to 149,440 job years.

If the UK were to invest in additional castings and forgings capability, focused on hub castings, some drive train

components, and forged rings, this would deliver an additional £6.2bn GVA (i.e. total GVA of £14.63bn) and additional jobs of approx. 109,745 (i.e. total job years of 259,185).

Note, only UK production for supply into a UK pipeline has been calculated, and results also assume supply into one UK nacelle and assembly facility (with assumed 50% market share). These figures represent the GVA available if UK suppliers secure the work. They measure technical capability converted to value rather than forecasting an outcome; realising them depends on UK competitiveness against global suppliers

Impact in Context

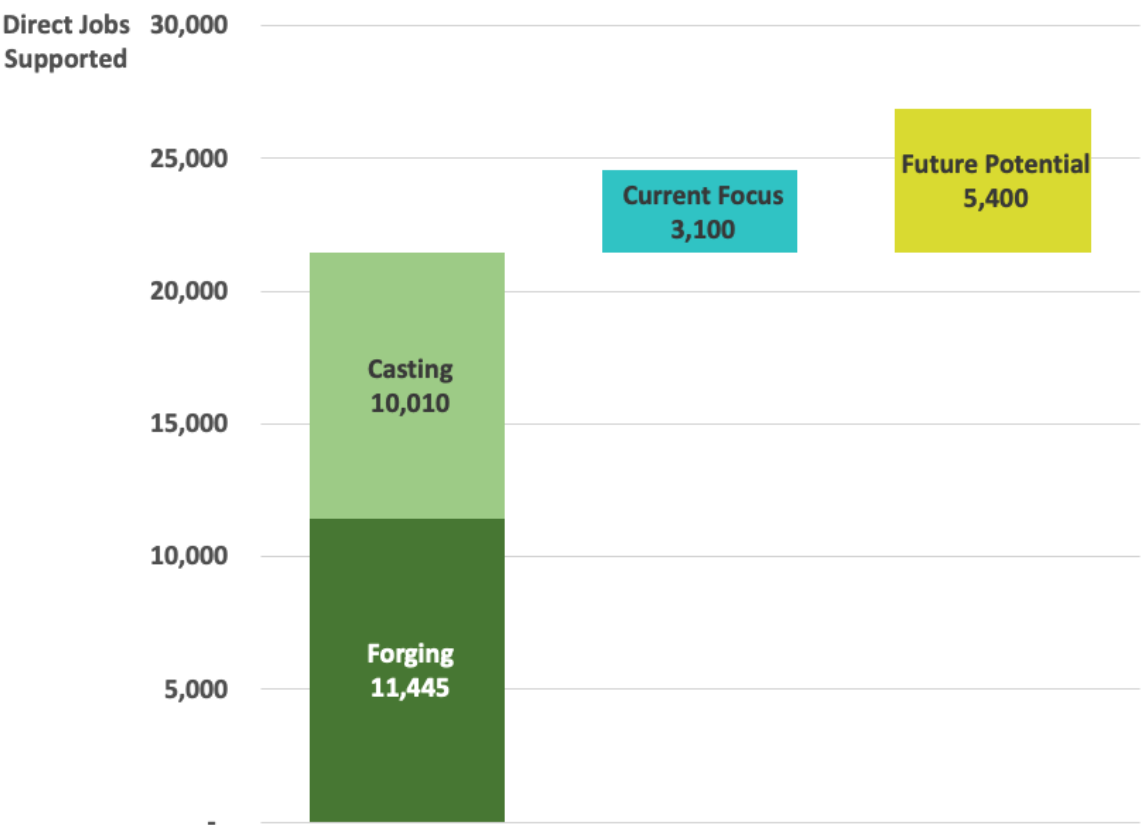
The economic potential from the offshore wind sector represents a significant opportunity for growth and retention in the casting and forgings sector. Under both scenarios, the offshore wind sector represents an opportunity for the sector to noticeably grow.

The economic opportunity presented by the current focus of forged and cast products for the offshore wind sector would support 3,100 jobs directly in the sector on average across the 24 years of the study. This is equivalent to a **14% growth** in the current number of jobs supported in the casting and forging sectors.

The economic opportunity presented by the future potential of forged and cast products for the offshore wind sector would support 5,400 jobs directly in the sector on average across the 24 years of the study. This is equivalent to a **25% growth** in the current number of jobs supported in the casting and forging sectors.

The concentration of the sector in Yorkshire and the Humber and the West Midlands also represents an opportunity for these regions to significantly grow their potential benefits from offshore wind. According to the OWIC/RenewableUK (2025) Wind Industry Skills Intelligence Report the West Midlands is the area of the UK with the smallest expected jobs benefit from offshore wind. Achieving the future potential employment of 5,400 direct jobs would be the equivalent of **a 50% increase in offshore wind jobs** across the West Midlands, Yorkshire and the Humber.

Figure 20: Average annual direct employment in casting and forgings, 2024 compared to future scenarios





Nacelle Components Deep Dive

Image shows a Vestas V236-15.0 MW turbine
at Thyborøn wind farm, Denmark

Vestas' Nacelle assembly facility in Scotland

The March 2026 announcement by Vestas that it plans to establish a nacelle and hub assembly factory in Scotland, subject to securing sufficient UK-based orders in AR7 and AR8, is a big shift in terms of UK offshore wind supply chain. To date, OEM focus has been on UK blade production, with the IGP seeing nacelles as not a UK priority. However, UK production provides opportunities for UK supply into this new plant, and opportunities for clustering of a supply chain to serve Vestas in its UK and wider factory network.

The Vestas V236 15.0MW turbine is the company's most recent introduction into the global offshore wind market. These turbines were first used commercially on **EnBW's He Dreiht** (Germany, 960 MW) project, with the company now having a healthy order book of projects. Vestas' main offshore nacelle facility is **Lindø, near Odense**, with a second plant in **Szczecin, Poland** ramping up production in support. With continued offshore wind growth in Europe, an additional facility in Scotland would help Vestas boost capacity in Europe.

A critical point for understanding UK opportunities depends on understanding nacelle production and the supply chain involved. Any Scottish plant would be focused on assembly, with key components arriving, primarily by ship, prior to assembly, storage, load out and transport either direct to a project or for wind turbine staging.

ZF Wind Power, Belgium has been named as the integrated drivetrain supplier, while EnVentus will supply power converter modules – meaning that any castings such as the planet carrier and gearbox casing or forgings such as the gear shafts, rings and bearings would need to be supplied direct to ZF Power's Belgium plant for integration into a drivetrain, while any castings such as switchgear would need to be supplied to EnVentus or other suppliers if used by Vestas, or subcontracted to EnVentus. However, as discussed earlier in the report, the IGP includes turbine drive trains as a "nurture to make" priority, meaning that future opportunities may arise to secure UK drive train

manufacture and assembly. The business case for this is likely strengthened by the potential supply from UK foundries and forgers.

Vestas will also need to procure a range of large castings such as the bedplate and rotor hub, bearings, fabricated steel framing, as well as fastenings and bolts and electrical and control equipment.

Vestas' Lindø "launch factory" offers a template for what a Scottish plant could become. Sited on former shipyard grounds near Odense, Lindø benefits from direct deep-water access for cost-effective nacelle shipping, with halls originally built for the V164/V174 progressively repurposed for V236 components, hub assembly and end-of-line testing. Production there has been industrialised at pace: in 2025 the plant ramped up to supply more than 2GW to two major European projects, with fully assembled and pre-commissioned drivetrains held in temporary storage ahead of nacelle integration. For Scotland this points to three siting priorities: quayside deep-water access for load-out, extensive laydown and storage space for staging, and room for co-located sub-suppliers. Each factor also shapes where UK castings, forgings and fasteners could most efficiently enter the supply chain.

In the next few pages of this report, we set out more detail about the primary components required, the assembly process, and also recommendations as to specific opportunities for the UK in terms of supply into the nacelle and hub market.



Above: a Vestas V236 nacelle and hub is moved on an SPMT. Image courtesy of Vestas

Inside a Vestas nacelle & hub

A large modern offshore wind nacelle and hub, such as the Vestas V236, requires a multitude of components, ranging from huge iron castings for the hub and bedplate, through to multiple small components such as fasteners. A turbine OEM will run a complex supply chain to ensure availability of this wide range of components to ensure efficient assembly and ability to deliver to customers. Quality thresholds are paramount given the high performance and long life-time of offshore wind drivetrain and other components.



Above: Vestas nacelle and hubs after assembly. Image courtesy of Vestas

The main components within a Vestas V236 nacelle and hub are as follows:

- **The three-element bedplate** with a front **cast main carrier** (made from ductile iron that holds the rotor and drivetrain), a middle **steel spaceframe** and a rear **cast main bed** (ductile iron, which carries the yaw bearing). The spaceframe uses studs (supplied by companies such as Cooper Turner Beck) for fastening the different components together.
- **Drivetrain** mounted on a cast carrier, with a ZF Wind Power 3-stage planetary gearbox and a permanent magnet generator.
- **Two power converter side compartments** – which flank the drivetrain and contain the EnVentus power converter modules and associated equipment.
- **The yaw bearing** connecting the nacelle to the tower. Around the bearing are 8 yaw drives for moving the turbine into position.
- **The hub** with three pitch bearings and blade roots.
- **Rear compartment**, with the passive cooler.

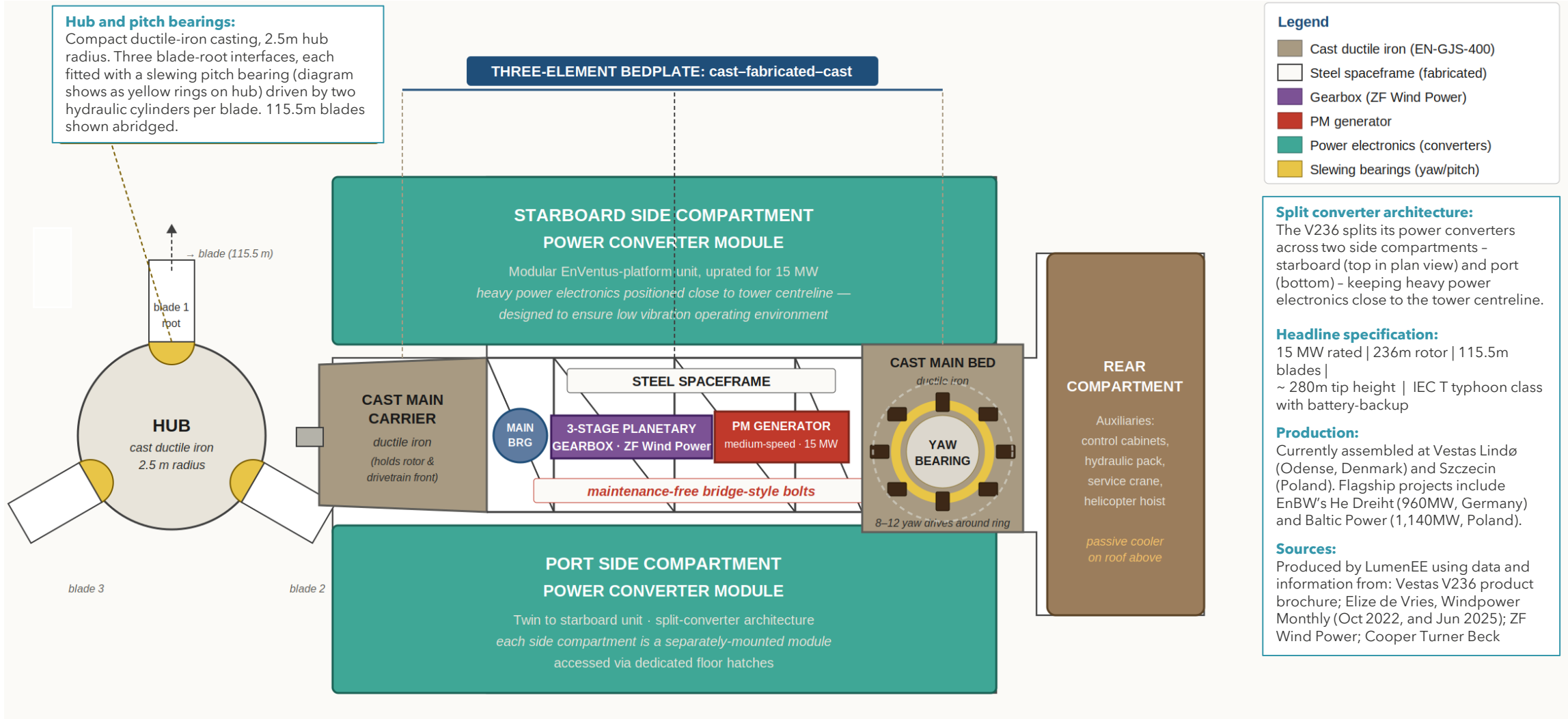
Fasteners illustrate the supply-chain depth involved: a modern offshore turbine contains some 23,000–25,000 fasteners, with the safety-critical bolted joints – foundation studs, tower flange bolts, blade-root T-bolts, slewing-ring and structural bolts – numbering in the low thousands. On the V236, Vestas has moved to maintenance-free, bridge-style tension-control bolting that requires no re-tensioning across the turbine's 30-year operating life. At the other end of the scale, the cast hub is a single ductile iron piece (EN-GJS-400-18U-LT) up to eight metres in diameter and 40–50 tonnes, supported by secondary castings including bearing and gearbox housings and planet carriers.

Currently, the only identified UK supply chain into the Vestas V236 nacelle is Cooper Turner Beck. However, there are UK suppliers with equivalent capability or potential to grow this to supply required components, and potential to investigate working with larger UK casting companies such as Castings plc and/or Goodwin Steel Castings.

Vestas V236-15.0MW Nacelle – Top-down technical breakout

Plan view with nacelle roof and passive cooler removed. Rotor shown on left, tower interface (yaw bearing) on right. Note diagram is stylised and not drawn to proportion to aid visualisation.

Figure 21: Plan view of turbine nacelle and hub (based on Vestas V236)



V236 Component Review — Nacelle & Drive Train

The table below sets out the main steel components needed within the nacelle and hub, with identification of UK capability or potential, plus the existing global network of suppliers into wind turbine OEMs

Table 6: Summary of nacelle and hub component requirements

Component	Cast / Forged	Customer	UK Capability	UK Potential	Dominant Suppliers	Other Suppliers
Rotor Assembly						
Blade Bearings	F	WTG OEM			Liebherr Components (Germany)	Thyssenkrupp Rothe Erde (Germany); IMO Group (Germany); Schaeffler (Germany)
Rotor - Blade Bearings - Rolling elements	F	WTG OEM	Yes		Tier-2 to the pitch-bearing maker – typically vertically integrated by the bearing OEM (Liebherr / Rothe Erde / Schaeffler)	
Rotor - Blade Bolts	F	WTG OEM	Yes		Cooper Turner Beck (UK, Sheffield)	August Friedberg (Germany); Boltun (Taiwan); Yokelink (China); Ningbo Datian, JNZC, Fastenwell (China)
Pitch System						
Pitch System - Miscellaneous range of components	C	WTG OEM	Yes		Tier-2 to pitch-system integrators (Bosch Rexroth, HAWE Hydraulik, Parker, Moog if hydraulic-pitch); regional European foundries for small castings	
Hydraulic	C	Pitch gearbox supplier	Yes		Pitch-drive gearboxes typically from Bonfiglioli, Brevini (Dana), Comer Industries; small (~10 kg) castings drawn from regional European foundries, not the offshore-scale specialists	
Pitch Gearbox Bearings						
Hub	C	WTG OEM		Yes	Siempelkamp Giesserei (Germany, Krefeld)	MeuselWitz Guss (Germany); Silbitz Group (Germany); Sakana Group (Spain); Fonderia Vigevanese (Italy); Baettr (Sweden/Germany/ China); Riyue Heavy Industry, DHHL (China)
Lightning protection system	C	Blade manufacturer	Yes		Specialist LPS suppliers (Global Lightning Protection Services, Stronglead, Vaisala for sensing)	

Key:



UK currently supplies



With investment, UK could potentially supply into a UK nacelle facility



UK does not supply but has capability



With investment, UK could potentially supply, but would need to export

V236 Component Review — Nacelle & Drive Train

The table below sets out the main steel components needed within the nacelle and hub, with identification of UK capability or potential, plus the existing global network of suppliers into wind turbine OEMs

Component	Cast / Forged	Customer	UK Capability	UK Potential	Dominant Suppliers	Other Suppliers
Nacelle Assembly						
Nacelle bedplate	C	WTG OEM		Explore further	Siempelkamp Giesserei or MeuselWitz Guss (Germany).	Silbitz Group (Germany); Sakana Group (Spain); Fonderia Vigevanese (Italy)
Nacelle main bearing housing	C	WTG OEM		Explore further	Siempelkamp Giesserei or MeuselWitz Guss (Germany)	Silbitz Group (Germany); Sakana Group (Spain); Fonderia Vigevanese (Italy)
Spaceframe	Fabricated	WTG OEM		Yes	The spaceframe is a rectangular-tube fabrication arranged in triangulated patterns wrapped around the free-hanging drivetrain assembly. It is expected that fabricated structure is secured from relevant steel fabricators around existing assembly halls	
HRC (High Resistance Calibrated) tension-control bolts	F	WTG OEM	Yes		Cooper Turner Beck (UK, Sheffield)	August Friedberg (Germany); Boltun (Taiwan); Yokelink (China); Ningbo Datian, JNZC, Fastenwell (China)
Brake disc	C	WTG OEM	Yes		Svendborg Brakes (Altra Industrial Motion, Denmark), Altra (Germany), Antec, Pintsch Bubenzer	
Yaw gearbox casings	C	WTG OEM	Yes		Bonfiglioli, Brevini (Dana), Comer Industries; small (~50 kg) casings sourced from regional European foundries, not offshore-scale specialists	
Nacelle auxiliary systems - motors & pumps	C	Various	Yes		Grundfos, KSB, WEG, SEW-Eurodrive; cast components from broad European/Asian foundry base	
WTG Drive Train						
Main casing	C	Generator supplier	Yes		Tier-2 casting to the generator package – generator itself likely OEM-internal or close partner	European mid-tier foundries (Silbitz Group, Baettr, regional Polish/Spanish foundries) for ~1 t generator-frame castings; Chinese foundries (Riyue) for any export-sourced share
Heat sinks	C	Converter supplier	Yes		Specialist aluminium die-casters serving the power-electronics market (e.g. Mecaer, Endurance, Nemak for IGBT cooling); not a publicly attributed V236 line item	
Gas Insulated Switchgear housing	C	Switchgear supplier	Yes		MV/GIS switchgear from ABB, Siemens Energy, Schneider Electric, Hitachi Energy; cast housings sourced by the switchgear OEM	

Key:

 UK currently supplies	 UK does not supply but has capability
 With investment, UK could potentially supply into a UK nacelle facility	 With investment, UK could potentially supply, but would need to export

Recommendations on UK priorities for building capability to support UK nacelle and hub assembly

Below are recommendations for UK action based on our assessment of existing UK capabilities and areas for potential growth. These recommendations are used to feed into the main recommendations within this report.

1. Support OEM planning

Build on relationships between OEMs, OWGP and GBE to understand aspirations for supporting UK supply chain growth and opportunities for clustering around any future UK nacelle and hub factory. OEMs already have areas of interest in UK supply, and the first priority is to support those existing plans – UK foundries have proven capability in the smaller castings required, such as casings and brake discs.

2. Defend UK bolt and fastener expertise

Sheffield's Cooper Turner Beck is already a global supplier into the offshore wind sector, including to Vestas and Siemens. Its fasteners are likely already in use in the V236 fabricated spaceframe that sits between the two bedplate sections as well as a wider group of bolts and fasteners in the whole turbine.

3. Investigate UK hub castings

The UK has a small number of larger casting companies of the size and technical ability to make larger hub castings. Support via OWGP, GB Energy and UK manufacturing support bodies should be used to help position these potential suppliers ready to engage with wind turbine OEMs.

4. Investigate UK spaceframe production

While not a casting or forging, Vestas will need fabricated spaceframes for use in its three-part bedplate. Fasteners from Cooper Turner Beck will be required, and it is expected that Vestas will look to identify capable UK fabricators to manufacture these spaceframes. Companies such as Severfield - which has experience in offshore wind secondary steel and has the ability to volume manufacture large structural steel beams - should be supported to engage with Vestas.

5. Integrate UK foundries and forgers into work to secure UK drivetrain production

The IGP has future drivetrain production as a UK priority. If this work is to be successful, it will require engagement of specialist component production, and drivetrains are dominated by a number of cast and forged components.

Therefore any industry or agency work to investigate or support UK drivetrain production needs to also involve the foundries and forgers that will be needed to deliver the required components.



Above: a Vestas V236 cast hub body. An individual hub casting will be approx. 50 tonnes, meaning only a few specialist foundries in Europe can supply. Image courtesy of Vestas



Findings and IGP Alignment

Aligning castings and forgings capabilities with the Industrial Growth Plan

The offshore wind sector's Industrial Growth Plan set out priorities for UK supply chain growth, based on an in-depth Make or Buy assessment of the numerous contract packages within offshore wind. Some of these identified priorities map well with UK capabilities in castings and forgings

The UK Industrial Growth Plan (IGP) identified a number of priorities for UK supply chain growth. Of the five identified "Make" priorities, castings and/or forgings are needed in three:

- **Advanced Turbine Technology** (blades; towers)
- **Industrialised Foundations & Substructures** (deeper water foundations; moorings and anchors)
- **Future Electrical Systems & Cables** (static cables, export cables)

To successfully make these, UK companies will need a range of castings and forgings, including sacrificial anodes; cable protection systems, mooring connectors and flanges. The UK has capability to cast relevant materials, plus ability to provide the specialised steels needed for flange production. In addition, the IGP set out a number of areas for the UK to protect including monopile and transition piece manufacturing, which require alloy castings for corrosion protection as well as flanges.

Finally, the IGP identified areas for the UK to "Nurture to Make". Of the nine areas identified, three have casting and/or forging requirements:

- **turbine drive train;**
- **steel semi-submersibles;**
- **electrical system design**

The IGP also sets out areas where the UK is unlikely to secure supply chain value, with a recommendation to "Buy" from the global market. Of the nine areas identified here, three have casting and/or forging requirements. These tend to be the larger

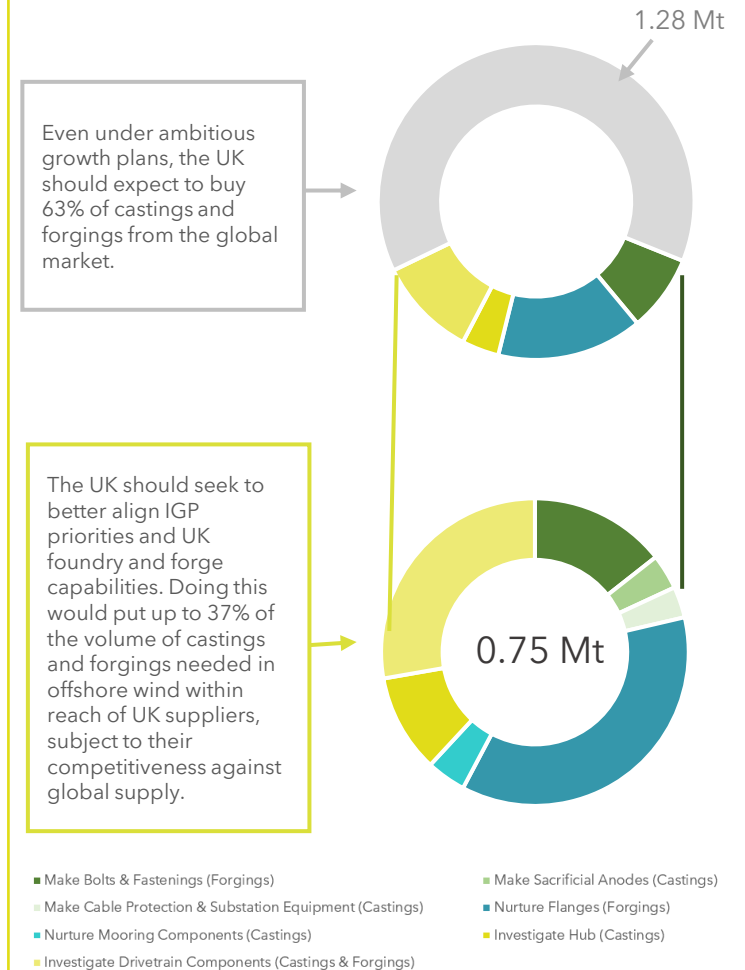
castings and forgings that this report classifies as "major turbine components" – i.e. multi-tonne specialist castings such as the hub or bedplate. Currently, the UK IGP sees nacelles as a "Buy" category, which will cover larger castings and forgings needed within these nacelles.

However, the potential for Vestas establishing a UK facility of course changes this calculation. Currently the UK has no existing capability to supply the larger nacelle castings such as the hub or bedplate. However, it already has equivalent capability and would be able to produce some of the castings and forgings required in nacelle assembly. It also has a small number of larger companies with castings and forgings expertise that it could work with to build capability.

Based on this analysis, our work identifies a number of areas within castings and forgings that should be viewed as UK priorities. They have been chosen because they align between the IGP's own priorities *and* where UK foundries and forgers have clear expertise and strengths. We have adapted IGP priorities in light of the Vestas nacelle announcement to assume that nacelles are a potential UK "nurture to make" priority. Commercial competitiveness has not been used as a selection criterion, and each priority will need to be assessed on that basis before investment decisions follow.

We have grouped these using the IGP categories: Make (incl. Protect); Nurture, and; Buy. In addition, two areas we see as suitable for further investigation by OWGP. Figure 21 right shows the relative quantity of these different castings and forgings, grouped by offshore wind component type. More information can be found on the following pages of this report section.

Figure 22: UK priorities (bottom) in comparison to overall castings and forgings demand (top)



Aligning castings and forgings capabilities with the Industrial Growth Plan

The offshore wind sector's Industrial Growth Plan set out priorities for UK supply chain growth, based on an in-depth Make or Buy assessment of the numerous contract packages within offshore wind. Three (turbines, foundations, electrical systems shown below) of the five priorities have casting and/or forging requirements.

Table 7: IGP "Make" priorities, and alignment to UK foundry and forge capabilities

Component area	Casting capabilities	Forging capabilities	Commentary
Make - The UK's Priorities			
Advanced Turbine Technology			
Blades	- Bearings - Numerous small castings for pitch system	Blade bolts	- UK companies such as Cooper Turner Beck (CTB) successfully supplying bolts into global offshore wind market - UK casting supplies have capability to supply castings into blade pitch systems, particularly if integrated into UK nacelle assembly supply
Towers		- Flanges for connecting tower sections - Bolts for flanges	- See Cooper Turner Beck above. Sheffield Forgemasters (SF) can provide high strength steels required for flange production Freundenberg Flow Technologies (FFT) offer capabilities in steel supply, and flange design
Industrialised Foundations & Substructures			
Deeper water foundations	Sacrificial anodes	- Flanges for connections - Bolts for flanges - Potential for nodes for connection of foundation structures	- UK companies like Metec successfully supplying sacrificial anodes Wall Colmonoy (WC) offers high strength materials and coating for pins and connectors. See CTB, SF and FFT above re. bolts and flanges
Moorings and anchors	- Clump weights - Potential for castings in load reduction devices and quick-connector systems	Mooring connectors	- UK foundries have widespread capability to produce castings such as clump weights as well as more specialist castings needed in load reduction and connection systems. - UK's Griffin Woodhouse currently uses forgers outside of UK to provide shackles etc, though is longer term potential for UK manufacture

Aligning castings and forgings capabilities with the Industrial Growth Plan

In addition to the identified UK “Make” priorities, the IGP also identified areas to “Protect” UK success. Within this report we have categorised both Make and Protect within the “Make” definition.

Table 7 continued

Future Electrical Systems & Cables			
Static and dynamic array cable	- Cable protection systems for static cables - Cable ballast		UK casting companies such as Ductile Castings; Newby Foundries and WM Lee supplying cable protection to cable supply companies such as Tekmar and Subsea Cable Solutions
Offshore export cable	Cable protection systems		See above
Offshore substation foundation	Sacrificial anodes	- Potential for nodes and pins for connection of jackets - Flanges for connection of components - Bolts for flanges	- UK companies like Metec successfully supplying sacrificial anodes Wall Colmonoy offers high strength materials and coating for pins and connectors - See CTB, SF and FFT above for fasteners and flanges

Table 8: IGP “Protect” priorities, and alignment to UK foundry and forge capabilities

Component area	Casting capabilities	Forging capabilities	Commentary
Protect			
Monopile foundation manufacturing	Sacrificial anodes	- Flanges for connection of components - Bolts for flanges	See Metec, CTB, FFT & SF above
Transition piece manufacturing	Sacrificial anodes	- Flanges for TP/Tower connection of components - Bolts for flanges	See Metec, CTB, FFT & SF above

Aligning castings and forgings capabilities with the Industrial Growth Plan

The IGP also identified areas for the UK to “Nurture to Make”. Given potential for the UK to secure nacelle assembly, we have moved nacelle assembly from “Buy” to “Nurture to Make”.

Table 9: IGP “Nurture to Make” priorities, and alignment to UK foundry and forge capabilities

Component area	Casting capabilities	Forging capabilities	Commentary
Nurture to Make			
Turbine drive train	- Planet carrier - Gear casings - Brake disc - Heat sink	- Bearings and rolling elements - Gears and gear elements	- UK Foundries have capabilities to make smaller sized components needed in turbine drive train - UK Forgers can potentially supply smaller drive train components for bearings and gears
Steel semi-submersible	Sacrificial anodes	Potential for nodes and pins for connection of semi-submersible braces	- UK companies like Metec successfully supplying sacrificial anodes - See CTB, SF, WC and FFT above
Electrical system design	Gas insulated switchgear housings		UK Foundries have capabilities to make housings for switchgear and currently provide this capability into other markets
Nacelle assembly *	- Auxiliary systems and pumps - Gas Insulated Switchgear housing	Bolts and fasteners for blade, yaw and flange bolts, plus for space frame within bedplate	- UK has a number of larger foundries, including Sheffield Forgemasters, Ductile Castings and Goodwin Steel Castings with potential to take on production of larger nacelle castings. - Bedplates also require fabricated spaceframes requiring fasteners and steel fabrication

* Nacelle assembly has been moved from a “Buy” to “Nurture to Make” category due to in response to Vestas’ potential investment in UK nacelle & hub assembly.

Table 10: IGP “Buy” priorities, and alignment to UK foundry and forge capabilities

Component area	Casting capabilities	Forging capabilities	Commentary
Buy			
Turbine electrical system	Gas Insulated Switchgear housing		UK has capability to produce castings for turbine electrical equipment
HVDC offshore substation topside	- Gas Insulated Switchgear housing - Pumps and impellers		UK Foundries have capabilities to make housings for pumps, switchgear and currently provide this capability into other markets

Aligning IGP priorities and UK castings and forgings capabilities

This study has identified good synergies and overlap between the UK's Industrial Growth Plan work and capability within its foundries and forgers.

The UK's foundries and forgers provide castings and forgings respectively to a wide range of industries including defence, automotive, oil and gas and utilities.

With the world's second largest offshore wind pipeline, plus an increased focus on securing UK supply chain value from this pipeline, there is scope to identify where UK foundries and forgers can benefit from this work.

This study has found that in parts of the offshore wind supply chain, UK foundries are already supplying components such as sacrificial anodes, cable protection systems and pump housings and impellers, with potential to extend this capability. Below each relevant component is considered in turn.

SACRIFICIAL ANODES: The UK has recently seen success in sacrificial anode production, with companies like Metec supplying into this market. With sector efforts to protect manufacturing of monopiles and transition pieces, and increased focus on deep water offshore wind foundations, it makes sense for the UK to be able to protect and grow its anode production.

Note, in our study we assumed that one-third of the market for corrosion protection uses passive systems.

These aluminium/alloy castings (occasionally zinc based alloys are used) represent a clear opportunity and align well with IGP priorities to protect monopile and transition piece

manufacturing, plus to make and nurture industrialised foundations and substructures.

Recommendation One: Make - Sacrificial Anodes

Action: defend existing presence and encourage co-working between foundation designers, Tier 1 fabricators and UK casting companies, to identify product and process innovations that sustain UK competitiveness, as part of wider work on industrialised foundations.

CABLE PROTECTION: the availability of highly capable castings companies should be seen as part of the reason for UK supply chain success in cable protection. Cables and electrical systems are seen as a UK success and one for the IGP to build on. The important role that UK casting companies like Newby Foundries, Ductile Castings and Wm Lee play here should not be overlooked.

Opportunities in cable protection castings are clearest in fixed rather than floating offshore wind. This study has found that UK foundries are reliant on UK cable companies to bring them business and cannot easily enter a market and begin supplying products into it.

The UK's cable sector was identified in the IGP as a clear strength. Our study has identified UK casting expertise as one of the areas of strength that contributes to this UK strength. There are opportunities to build on UK cables success by leveraging castings expertise.

There is a role for the OWGP and other sector groups to help strengthen partnership working between critical offshore wind supply chain companies and UK foundries to ensure that

the UK cables sector is benefiting from innovations in castings, and that UK casting companies are able to stay ahead in supplying both a UK and international market.

Recommendation Two: Make - Cable Equipment

Action: defend existing presence and encourage co-working between cable system designers and casting companies, to identify new products and innovations in casting to maintain UK competitiveness.

BOLTS AND FASTENERS: As well as this UK success story in castings for cable protection, UK forgers like Cooper Turner Beck are active supplying bolts and studs into the global offshore wind supply chain. UK companies have demonstrated an ability to compete in a global market and highlight potential future possibilities for other forging requirements such as smaller turbine components and mooring fasteners.

Cooper Turner Beck recently benefited from an OWGP Sprint programme, helping it invest ready for new market demands. This support highlights the benefit that industry programmes can make to the UK supply chain.

Recommendation Three: Make - Bolt and Fastener production

Action: build on CTB's deep expertise in high grade materials and volume production, helping ensure UK companies remain market leaders in offshore wind fasteners as the market evolves.

Aligning IGP priorities and UK castings and forgings capabilities

This study has identified good synergies and overlap between the UK's Industrial Growth Plan work and capability within its foundries and forgers.

FLANGES: Offshore and onshore wind require forged ring flanges to join tower sections together and to attach towers to foundations – a high-volume requirement across the global market.

With capability to supply the high grades of steel needed for forged ring production, plus wider design and materials capability, there may be wider opportunities for securing UK value from supply of offshore wind flanges. Both routes – UK steel into forged ring production, and UK flange production drawing on Freudenberg Flow Technologies' design and materials capability – are technically credible today and serve a global market rather than depending on UK tower, transition piece or monopile production. UK monopile production, potential re-establishment of transition piece production and options for tower production would give any UK flange producer a domestic customer base, strengthening the case further.

Sheffield Forgemasters is able to make the high-grade steels required for flanges, meaning there are opportunities to support use of this steel export for flange production. Freudenberg Flow Technologies (FFT) offers wider capability including flange design and high-integrity wear resistant materials. This ability to develop new flange designs is the basis of a credible route to UK flange production serving a global market, independent of UK tower or foundation manufacturing. What is untested in both cases is commercial competitiveness: entering such a specialised market would be a significant step carrying real commercial risk.

SUBSTATION COMPONENTS: As well as work to look at offshore wind supply chain, separate initiatives are currently looking at UK opportunities from the major grid upgrade programme, as well as related opportunities in electrical equipment.

It is clear from this study that there exists technical capability in UK foundries to supply switchgear housings and other components such as pumps needed in substations for offshore wind and other generation technologies.

UK casting companies already supply castings into UK substation equipment, including high integrity pump housings. There are also opportunities for supply of other components such as switchgear casings. Establishment of UK switchgear component manufacture is a wider issue than covered in this report. However, UK castings expertise could strengthen a business case for investing in substation component manufacturing.

MOORING COMPONENTS: Floating offshore wind will require a range of forged and cast mooring and anchor components such as connectors and clump weights. UK company Griffin and Woodhouse sources its forged components from a global marketplace, and the industry expects to use components from China, rest of Asia and Europe.

A large volume of large shackles and connectors will be needed for floating offshore wind, dependent on platform and mooring designs. In addition, there may be future opportunities for supply of castings into connection systems and load reduction devices.

The UK has capability to provide these range of components, as well as existing wider expertise around mooring and anchor systems that can be used to help UK casting companies enter this market.

Recommendation Four: Nurture to Make - flanges, substation components and mooring systems

Action: These three areas share a common pathway rather than needing separate action. As each supply chain develops, UK foundries and forgers with relevant capability should be assessed for competitiveness and supported to develop routes to market, with OWGP using established Business Support programmes to engage prospective Tier 1 suppliers and then connect them to UK castings and forgings firms directly.

Specifically, any OWGP assessment of UK monopile, transition piece and tower manufacturing should consider the role UK flange production, and UK steel supply into forged ring production, could play alongside them; work to build a business case for UK electrical component manufacturing that takes into account UK casting capability in switchgear housings and pump bodies; and OWGP engagement on moorings and anchors should reflect UK strengths in cast and forged connectors and load reduction devices.

Aligning IGP priorities and UK castings and forgings capabilities

This study has identified good synergies and overlap between the UK's Industrial Growth Plan and capability within its foundries and forgers.

TURBINE & NACELLE COMPONENTS: With potential for UK nacelle and hub assembly, it is appropriate for a fresh look at options for supply of castings and forgings into any UK nacelle facility.

A critical point to make is that such facilities only assemble nacelles, using a range of components brought together on site.

Within a nacelle is the drive train as well as a number of larger castings and forgings in the nacelle, hub and yaw systems of turbines.

Alongside the major components, there is a range of smaller turbine castings that sit inside current UK capabilities. Furthermore, the UK offers strengths in terms of design, testing and advanced materials.

There is a need to better understand how to support UK castings companies supply into OEMs for smaller castings such as heat sinks, lightning protection and gearbox casings.

Large turbine castings can be between 10 and 70 tonnes per cast, and OEMs rely on a small number of specialist suppliers in Europe and Asia. The UK does not have companies currently supplying this market. However, there are a small number of UK companies including Goodwin Steel Castings, Ductile Castings and Sheffield Forgemasters of sufficient size and with equivalent, or near equivalent capability. With investment, OEM and wider industry support, these companies could individually or collectively look at market entry.

DRIVE TRAINS: The UK sees drive trains as a future priority, yet currently is reliant on an overseas market.

Drive trains tend to be produced by specialist suppliers who work closely with OEMs to deliver commissioned designs. These drive trains in turn require a range of specialist components – particularly forgings as well as castings that are sourced from a specialised European and Asian supply chain.

Our study has found equivalent capability in the UK for supplying these castings and forgings. However, the current challenge for UK firms is the need to supply into a global export market.

However, with the OWGP seeking to secure drive train manufacture into the UK, it needs to also understand better UK forge and foundry capability. That capability should be seen as a plus in work to secure drive train manufacture, given the skills present in the UK.

Recommendation Five: Investigate - turbine, hub and drivetrain components

Action: These three areas need a common approach rather than separate actions.

Across smaller turbine castings, large hub castings and drivetrain components, OWGP and GBE should assess UK competitiveness against global supply, support focused R&D to build a saleable proposition for the next product generation, and develop routes to market into the relevant Tier 1 suppliers and OEMs.

This report identifies hub castings as the priority within the group, with further investigation needed of potential for the UK's larger forgers to move into this market segment.

Finally, any UK work on future drivetrains must consider UK forgers and foundries from the outset if a UK business case is to be credible.

SPACEFRAMES: While not a casting or forging, this study has identified the use of spaceframes in modern offshore wind turbine bedplates. The Vestas V236 has a three part bedplate made up of two castings connected by a central spaceframe made of fabricated steel joined by High Resistance Calibrated tension-control bolts.

Recommendation Six: Secure UK spaceframe production, backed up by UK fasteners supplied by companies such as Cooper Turner Beck.

Action: OWGP and GBE to work with turbine OEMs in the identification of UK fabricators able to supply spaceframes into any UK nacelle facility.

Other areas for investigation: Pins and Nodes for floating and deepwater foundations are a potential area for UK forgers and casting companies. A number of different floating and hybrid designs have a need for high-integrity components such as pins or connectors. As these components are design specific it is hard to quantify the volume of demand, but we have identified UK companies able to provide these components into the floating market. However, companies such as Sheffield Forgemasters (supplying high grade steels, plus an ability to forge or cast these materials) and Wall Colmonoy (high strengths coatings required for long lifetime) are clearly well placed to supply this potential market.

Concluding Thoughts

The UK's focus on supply chain growth, with industry led action via the Industrial Growth Plan, alongside UK Government action led by GB Energy, creates a significant opportunity for UK forgers and foundries. In turn the offshore wind industry needs to better understand the high capabilities present within these UK businesses and use these to strengthen inward investment and business growth cases across different parts of the Industrial Growth Plan.

When this work commenced in 2025, it was not clear what if any involvement the UK castings sector had in the UK offshore wind industry.

LumenEE's 2025 Bill of Works report for UK Steel had demonstrated that offshore wind was a major steel user, with a demand for 25 million tonnes of steel - mostly plate - out to 2050. However, this analysis only looked at towers, foundations and anchors so only presented part of the picture. This successor report fills in the blanks.

Furthermore, it has shown not only that UK foundries and forgers are successfully supplying into offshore wind, it charts a path to build on this further using the IGP priorities as a means to growth *and* building on the potential establishment of a UK nacelle and hub assembly facility as a route to secure large scale casting production.

Today, foundries such as Ductile Castings, Newby Foundries and Wm Lee are supplying castings into the UK cables sector while Furniss and White is supplying pump bodies for offshore wind substations. Cables is a clear UK strength and an area where the UK has a widespread network of companies involved in the manufacture, installation and servicing of almost the whole cables value chain. Thanks to this study, it is now clear that a small but important part of this value chain comes from the expertise of UK casting companies. As this report highlights, there is a need to better understand and support learning and adoption of best practice so that UK castings expertise can better support continued UK leadership in cables.

Another great example of UK excellence is Sheffield's Cooper Turner Beck. This company provides cold and hot forging of fasteners (bolts and studs) that it supplies into multiple markets, including offshore wind.

Beyond these named companies this report identified wider capabilities in companies such as Goodwin Steel Castings, Sheffield Forgemasters, Freudenberg Flow Technologies and Wall Colmonoy. All these are companies of significant size and technical abilities and capable of supplying into the offshore wind sector.

UK success in cable protection and fasteners demonstrates that foundries and forgers here in the UK are able to supply to the quality needed in offshore wind. These two component examples are often overlooked but demonstrate UK success that can be built on, particularly as the UK seeks to build manufacturing capability in deep water foundations, towers, drive trains and latterly, nacelles.

Vestas is considering nacelle and hub production in Scotland. Currently it relies on a supply chain predominantly based in continental Europe, supplemented from Asia. While Cooper Turner Beck is the only UK forger or foundry we identified as a current supplier into offshore wind nacelle production, the UK has a number of companies with equivalent capabilities, or of sufficient size that they could potentially supply larger castings required in modern nacelles.

There are clear benefits to the UK from defending and growing UK castings and forgings presence. Equally, ongoing

supply chain pressures, a demand to accelerate offshore wind build out, plus geopolitical considerations all help strengthen the case for UK manufacturing of components.

This study also highlights that forgers and foundries need to build different types of relationships with offshore wind.

UK forgings companies have an ability to control and develop products that can be produced in volume, leaning on technical development to serve the needs of customers. UK casting companies operate to a different model. Their success comes from their ability to supply complex cast structures to high grade specifications but they must also work closely with customers for product definition and technical requirements.

This means that support for forgers and foundries needs to be structured differently. Forgers need support on product development and market growth. Foundries need support to help build partnerships with higher tier suppliers.

For both forgings and castings though, there are clear routes to grow UK output. Those UK foundries and forgers that continue to thrive are excellent businesses which have invested heavily and which thrive on early adoption of innovation. They have also focused on higher quality and complexity as a clear USP to distinguish them from global competition. That makes them excellent partners for an offshore wind sector always looking to innovate so it can build in longer design life and to build bigger and build for longer lifetimes.

Annexes

- Components Breakdown
- References
- Reading Marimekko Charts
- Version Control



Components Breakdown - major components and other higher volume / high weight components

Below is an aggregated list of components, showing major components such as hub, bedplate etc used in the turbine. As well as these large individual components, there are some medium sized turbine components as well a wider group of components such as anodes and connectors which are needed in multiples, meaning that their overall weight and contribution per turbine is significant. The UK has current experience supplying a number of these items, as well as equivalent capability. There is also potential for the UK to manufacture a number of these items, subject to investment.

Table 11: Summary of major component requirements

Component	Weight per turbine	Material	Cast or Forged	UK Capability
Hub	25-80 t	Ductile Cast Iron (SGI)	Cast	Potential
Nacelle Main Frame (bedplate)	25-80 t	Ductile Cast Iron (SGI)	Cast	Requires further investigation
Main bearing housing	25-80 t	Ductile Cast Iron (SGI)	Cast	Potential
Main Shaft	25-80 t	Ductile Cast Iron (SGI)	Cast	Potential
Gearbox casing	5-25 t	Ductile Cast Iron (SGI)	Cast	Potential
Main ring gears	25-80 t	Steel	Forged	None
Flanges	5-80 t	Steel	Forged	Potential
Sacrificial Anodes - multiples	5-25 t	Alloy	Cast	Current
Mooring Lines – Connectors & Clump Weights – multiples	5-25t	Steel	Forged	Equivalent
Ballast Units - multiples	0.5-5 t	Grey Cast Iron	Cast	Current
WTG Rotor bearings	0.5-5 t	Steel	Forged	None
Drive train - bearing rings	0.5-5 t	Steel	Forged	None
Planet carrier	0.5-5 t	Ductile Cast Iron (SGI)	Cast	Equivalent
Brake disc	0.5-5 t	Grey Cast Iron	Cast	Equivalent
Bolts	0.5-5 t	Steel	Forged	Current

Key:



UK currently supplies



With investment, UK could potentially supply into a UK nacelle facility



UK does not supply but has capability to



With investment, UK could potentially supply, but would need to export

Components Breakdown – smaller components

As well as larger components (see previous slide), offshore wind needs a multiple of different smaller sub-components. Smaller turbine components are primarily required for within pitch, gear and yaw systems. In addition, there are several smaller castings for electrical and pump systems in turbines as well as in substations and specialist castings needed for cable protection. The UK has current experience supplying a number of these items, as well as equivalent capability to supply almost all others, subject to client engagement and better understanding technical requirements.

Table 12: Summary of other component requirements

Component	Weight per turbine	Material	Cast or Forged	UK Capability
Rolling elements	1-100 kg	Steel	Forged	Equivalent
Pitch System - miscellaneous components	1-100 kg	Various: iron / steel / bronze / aluminium	Cast	Equivalent
Pitch gearbox casings	1-100 kg	Grey Cast Iron	Cast	Equivalent
Lightning protection system	1-100 kg	Aluminium	Cast	Equivalent
Gear shafts & Gears	1-100 kg	Steel	Forged	Equivalent
Gearbox bearings - main rings	1-100 kg	Steel	Forged	None
Yaw bearing rolling elements	1-100 kg	Steel	Forged	Equivalent
Yaw system motors & bearings	1-100 kg	Steel, various	Forged	Equivalent
Yaw gearbox casings	1-100 kg	Grey Cast Iron	Cast	Equivalent
WTG Electricals - Heat sinks	1-100 kg	Aluminium	Cast	Equivalent
Switchgear housings	1-100 kg	Aluminium	Cast	Equivalent
Nacelle auxiliary systems - motors & pumps	1-100 kg	Grey Cast Iron	Cast	Equivalent
Cable protection system	1-100 kg	Ductile Cast Iron (SGI)	Cast	Current
OSS Switchgear	1-100 kg	Aluminium	Cast	Current
OSS auxiliary systems - pumps	1-100 kg	Grey Cast Iron	Cast	Current
OSS auxiliary systems - impellers	1-100 kg	Grey Cast Iron	Cast	Current
Onshore Switchgear	1-100 kg	Aluminium	Cast	Current

Key:



UK currently supplies



UK does not supply but has capability to

Castings & Forgings Bill of Works

References

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Reading Marimekko Charts

Reading the Marimekko charts

A Marimekko (or “Mekko”/mosaic) chart shows two things at once. Each column is a component, and its **width** is scaled to that component's share of total demand – so wide columns are the high-volume items and thin columns are the minor ones.

Each column is then filled to **100% height** and split by colour

to show **which components UK companies supply into** – and which are met from outside the UK.

In short, *width* tells you how much demand a component represents, and the *colour split* tells you which components UK companies supply into. (A standard stacked column makes every bar the same width; the Marimekko's variable widths let large and small components be compared at their true scale).

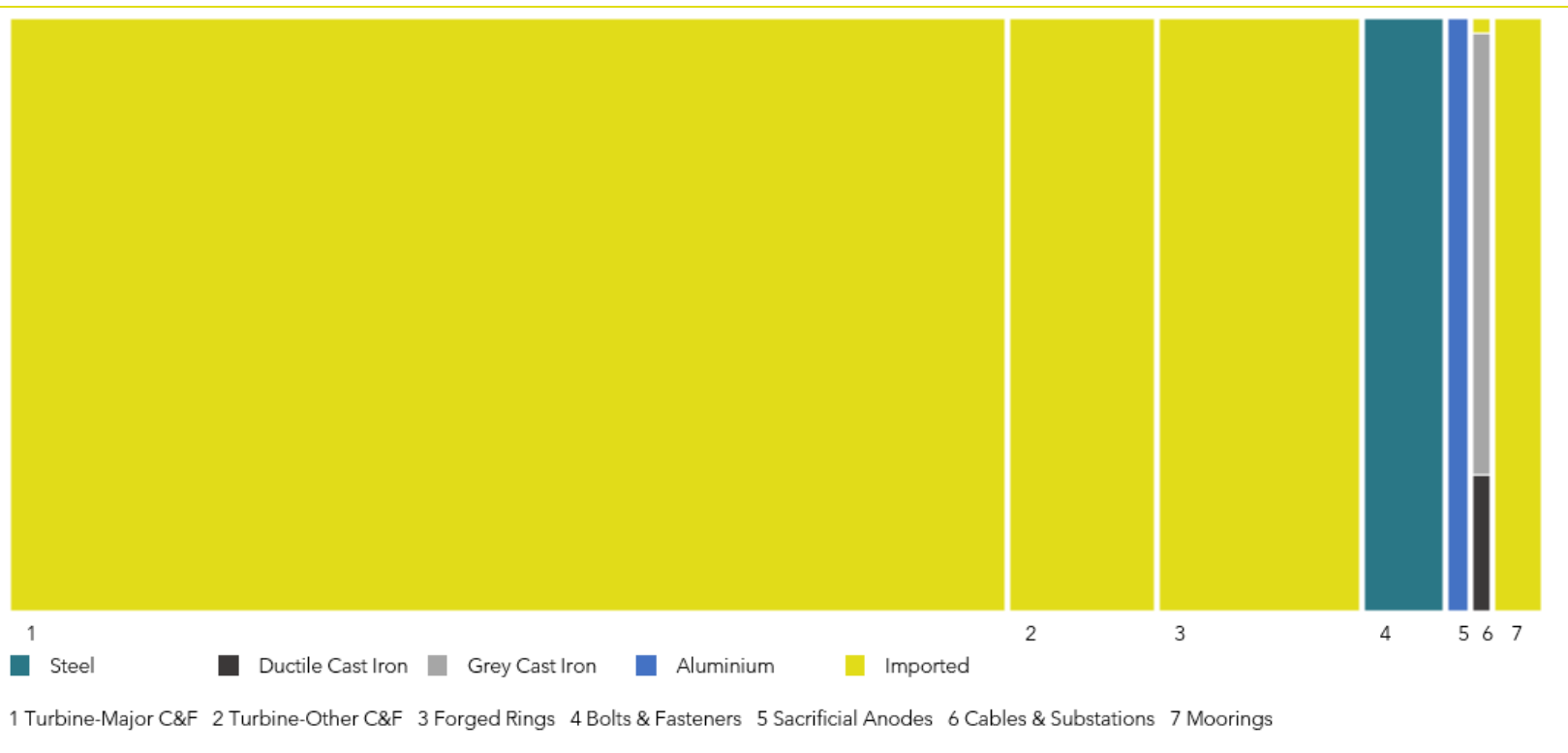
Below is shown Figure 12. This shows current supply of UK foundries and forgers into the offshore wind market. The chart makes the gap immediate: UK companies currently supply into components accounting for about **8%** of the roughly **2.0 Mt** of total demand; the remaining **~92%** (yellow) covers components they do not supply into at all.

The single widest column – **Turbine major castings & forgings** – is about **two-thirds of all demand on its own and has no UK supply at all**, and Turbine “other”, Forged Rings and Moorings are likewise not supplied into by UK companies.

The only demand the UK currently supplies sits in the narrow columns to the right: **Bolts & Fasteners**, **Sacrificial Anodes**, and most of **Cables & Substations** (this is primarily castings for cable protection, though the UK castings sector has equivalent capability to make castings for substations).

Because those UK-supplied items are low-volume, they barely register against the rest of demand – showing that the UK’s existing castings capability is focused on small parts of the wider supply chain.

Note: as set out on slide 22, we have not assessed what percentage of each component’s demand UK companies supply. A column shown as UK-supplied means UK companies supply into that component, not that the component is wholly UK-supplied.



Version Control

Version	Purpose	Date
A	Technical Report draft	09/25
B	Technical Report finalised	11/25
C	Draft summary report for client	03/26
D	2 nd draft summary report for client	07/26
E	Draft for advisory group review	08/26
F	Final report to client	09/26

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