Baringa

Report prepared on behalf of

Department for Energy Security & Net Zero

UK renewables deployment supply chain readiness study

Executive summary for industry and policymakers

April 2024

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UK RENEWABLES DEPLOYMENT
SUPPLY CHAIN READINESS STUDY

Executive summary

1. Executive summary

Achieving the renewables deployment ambitions outlined in the *British Energy Security Strategy* will be very challenging without significant coordination across industry and Government to resolve supply chain constraints.

We reached this conclusion based on a supply chain analysis of three renewables sectors – offshore wind, onshore wind and solar photovoltaics (PV), alongside transmission and distribution network supply chains. The research comprised interviews with over 80 renewables developers, network operators, suppliers, and trade associations, as well as modelling of many aspects of supply and demand.

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Overview of capacity constraints for key renewables components and installation services

Supply chain risk	Offshore wind	Onshore wind	Solar PV	Transmission and distribution
High	• Floating foundations • Export cables • Balance of plant (HVDC and HVAC stations) • Turbine and foundation vessels • Cable vessels • Ports	• Balance of plant (transformers, switchgear)	• Balance of plant (transformers and switchgear) • EPC design and installation	• Transformers • HVDC converter stations • HVDC cables • Electrical design and installation
Medium-high	• Monopiles and transition pieces • Turbines and towers	• Turbines		• Switchgear and circuit breakers
Medium	• Jackets • Array cables	• Cranes and transport	• Modules • Inverters	• Other cables and conductors • Pylons and poles • Flexibility and automation • Design and installation – civils
Medium-low		• Civils (including foundations) and electrical installation • Cables	• Racking • Cables	
Low				

Supply chain issues are most severe for the offshore wind and offshore transmission sectors

The components facing the greatest capacity constraints are:

- fixed and floating foundations
- high-voltage direct current (HVDC) cables and converter stations
- installation vessels and ports.

Developers and suppliers did not highlight capacity constraints for turbines, but there is a lack of manufacturing capacity data to support this. It is also noteworthy that while many turbine suppliers have announced investments in new factories, they face significant financial challenges across their offshore and onshore portfolios as a result of aggressive pricing, increasing input costs, and the shorter product lifecycles and reliability issues driven by market competition to achieve lower Levelised Costs of Electricity (LCOE).

For onshore wind and grid-scale solar PV, securing planning consent and grid connections arguably outweigh supply chain issues as constraints

The financial pressure on turbine manufacturers also raises concerns that they might reduce the number of turbine models offered in their onshore product portfolios, including the Class 1A models in greatest demand in the UK market.

Although securing planning consent and grid connections arose as more prominent constraints, onshore wind and solar PV do face shortages of transformers and switchgear (in common with onshore transmission and distribution networks).

All renewables sectors face skills-related constraints

Shortages are particularly acute for design and commissioning engineers, project managers, and installation technicians. There is intense national and international competition for new and experienced hires with these skillsets.

National and international competition for components and installation services contribute to many supply chain constraints

This competition comes from other renewables sectors as well as oil and gas, networks, and interconnectors – with suppliers likely to favour the customers and markets offering the most certainty, lowest cost to serve, and best prices.

Except for commoditised products such as onshore cable and conductors and solar modules, suppliers are often unwilling to invest speculatively in new manufacturing capacity without a concrete pipeline of orders and sufficient certainty around the size of components to be manufactured and installed. This is most acute for offshore wind, where the projects are largest and most heavily dependent on securing a financially viable Contracts for Difference (CfD) offer as the main route to market.

In addition, where factories are located in markets with local content requirements (such as the Inflation Reduction Act in the US), it is likely they would preferentially supply local developers who are willing to pay a premium to meet local content requirements. This leaves less supply available for the UK.

Whether having UK supply chains for key components would be advantageous is largely beyond the scope of this study, which is focused on constraints rather than industrial or economic strategy. UK factories would clearly contribute to UK employment and GDP – and could offer advantages to UK developers for specific components.

For example, the size of floating foundations means they are slow and costly to tow and vulnerable to weather-related disruptions, so local fabrication is desirable. In the longer term, manufacturing floating foundations close to deployment zones – and the consequent reduction in transportation cost and risk – would also contribute to the industrialisation and commercialisation of the technology, therefore enabling greater reduction in costs for developers.

Alleviating UK renewables supply chain constraints

Recent UK Government announcements include:

- significantly increasing the Administrative Strike Prices for Allocation Round (AR) 6 to reflect increases in input costs and the cost of capital
- the introduction of Sustainable Industry Rewards to encourage offshore wind supply chain investment
- further support for new facilities via the:
  - new over £1 billion Green Industries Growth Accelerator
  - up to £160 million Floating Offshore Wind Manufacturing Investment Scheme
  - 100% first-year capital allowances for main rate expenditure (alongside a special rate allowance on many components for developers).
- halving the time to build new grid infrastructure to seven years through the *Transmission Networks Acceleration Action Plan.*

Beyond this, there are further opportunities for standardisation and collaboration across developers, network operators, and suppliers. The research also highlighted the need for a holistic skills review and joint action to increase the number of engineers and technicians.

Baringa contacts

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Expert in energy supply chain

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Expert in renewables

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2. Introduction

In April 2022, the UK Government published its *British Energy Security Strategy* (BESS).[1] This outlined a series of measures to build a more self-sufficient British energy system, enhance the UK's energy security, and accelerate progress towards net zero. Notably, the BESS and the subsequent *Powering Up Britain* plan outlined a mid-term ambition of up to 50 GW of offshore wind energy by 2030 (including up to 5 GW of floating offshore wind) and 70 GW of solar PV by 2035.

To meet these high deployment ambitions, a significant number of new-generation projects must be constructed and connected to the grid. Delivering them requires robust supply chains for key components, raw materials, installation equipment, and skills.

However, there is currently a limited pool of suppliers globally. And there is fierce competition for materials and personnel – not only between sectors, but with European and US markets, which are setting their own increasingly ambitious renewable energy targets.

Securing UK renewable energy and network supply chains

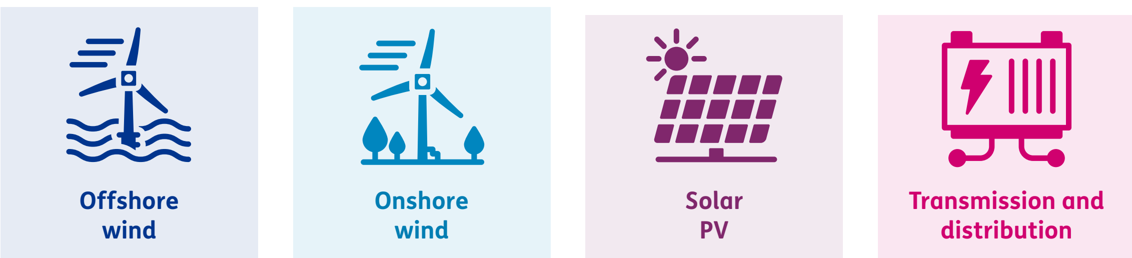
The Department for Energy Security and Net Zero (DESNZ) commissioned Baringa to conduct an in-depth investigation and analysis of the supply chains for key renewable and network technologies, both nationally and internationally. The purpose was to identify potential supply chain constraints the UK must address to achieve its deployment objectives.

DESNZ also asked us to recommend potential industry or policy-based interventions that could address those constraints for the period up to 2035.

The methodology for our analysis

The Baringa study assessed the four supply chains that support UK renewables deployment:

- offshore wind, including floating offshore wind
- onshore wind
- ground-based and commercial rooftop solar PV
- electricity transmission and distribution.



1 UK Government, British Energy Security Strategy, updated 7 April 2022.

We focused on the manufacture, assembly, and installation of components, accounting for the international nature of supply across the UK, Europe, and the US. Our scope of work excluded the grid connection process, land and planning, development and survey work, operations and maintenance, decommissioning, and regulatory compliance.

In addition to extensive desktop research, we conducted 85 semi-structured stakeholder interviews spanning renewables developers, network operators, component and installation suppliers, and trade associations. These helped us understand:

- the components and services facing the greatest constraints
- potential root causes of those constraints
- the UK's attractiveness to suppliers (as a customer base and potential manufacturing location)
- potential industry actions and policy opportunities to address the constraints.

We also carried out quantitative modelling of supply and demand for:

- offshore wind components and installation services in the UK, Europe, and the US
- selected onshore wind components in the UK and Europe
- polysilicon that has not been produced in Xinjiang, to assess the availability of forced labour-free material for global solar PV deployment.

Then, we validated the constraints and opportunities through multiple workshops with DESNZ and roundtables with offshore wind and electricity network stakeholders. We also presented to the UK Solar Taskforce's Supply Chain and Innovation Subgroup.

This report summarises our findings

This report gives an executive summary of the constraints, contributing factors and root causes, and recent Government announcements – as well as potential industry opportunities for addressing them. We look at the four supply chains and then shine a spotlight on skills, which is a common issue for all of them.

Acknowledgement

Although we have not named them in case of any commercial sensitivities, we would like to thank the many developers, network operators, suppliers and trade associations who participated in interviews for this study during 2023, without whom this report would not have been possible.

Offshore wind

3. Offshore wind

Offshore wind arguably faces the greatest supply chain constraints of all the technologies within the scope of this study. This is most severe for the supply of monopiles and floating foundations, HVDC cables and converter stations, all types of installation vessel, and – as a result of the financial vulnerability of turbine manufacturers – the turbines themselves.

Offshore wind	Supply chain risk		
	High	**Medium-high**	**Medium**
	• Floating foundations • Export cables • Balance of plant (HVDC and HVAC stations) • Turbine and foundation vessels • Cable vessels • Ports	• Monopiles and transition pieces • Turbines and towers	• Jackets • Array cables

There are multiple contributing factors for these shortfalls. UK offshore wind projects compete for components with European and US projects, electricity networks, interconnectors, and oil and gas. Suppliers are reluctant to invest in new capacity in the face of uncertainty regarding increasing component size for manufacture and installation – and whether there will be a sufficient pipeline of profitable, committed customer orders. This reflects the increasing uncertainty faced by their developer customers, such as securing planning permission, grid connections, and a sufficiently profitable route to market via the competitive Contract for Difference (CfD) auction and equivalent European schemes.

Recent UK Government announcements should help address some of these challenges. These include:

- significantly increasing the Administrative Strike Prices and budget for AR6 to reflect increases in input costs and the cost of capital
- the introduction of Sustainable Industry Rewards to encourage offshore wind supply chain investment
- further grant support for new facilities via the new over £1 billion Green Industries Growth Accelerator and the up to £160 million Floating Offshore Wind Manufacturing Investment Scheme.

In addition, RenewableUK, the Offshore Wind Industry Council, The Crown Estate and Crown Estate Scotland are publishing an Industrial Growth Plan in April 2024, which will identify priorities for investment in the UK's domestic offshore wind supply chain.

Component overview

Offshore wind farms consist of turbines mounted on either fixed or floating foundations.

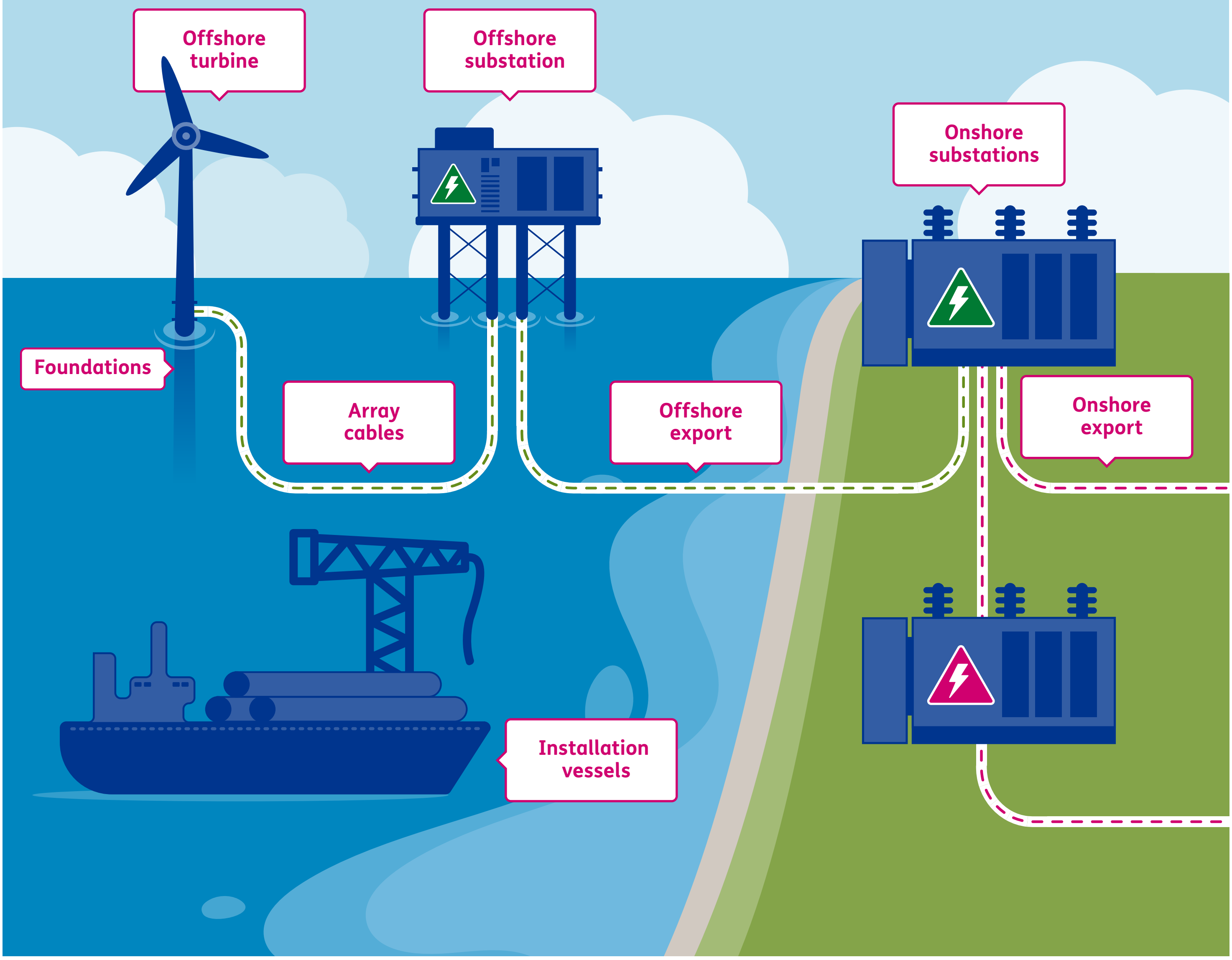
Array cables connect the turbines to an offshore substation or converter station.

Offshore and onshore export cables then connect to a final onshore substation or converter station, which leads to national transmission network access.

Key elements of the offshore wind supply chain:

- Turbines and towers
- Fixed and floating foundations
- Array and export cables
- Substations and converter stations
- Foundation, turbine, and cable installation vessels
- Ports.

For more information on how the supply chains are structured, including suppliers, see the appendix.



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3.1 Supply chain constraints

The following analysis is based on interviews with UK and international suppliers and developers active in the UK, combined with modelling of demand and supply across the UK, Europe, and the Eastern US. Both demand and supply modelling rely on a wide range of assumptions and are subject to significant uncertainty. For each component, we highlight key modelling assumptions, confidence in supply data, and consistency between the modelling and interview findings. The supporting commentary highlights the potential shortfall levels as minor (<25%), significant (<50%), or severe (>50%) across these markets.

We do not attempt to estimate how much supply the UK could secure in the face of international competition, as this will depend on factors which are subjective and difficult to model (such as demand certainty, suppliers' cost to serve, and developers' ability and willingness to offer the most attractive prices).

Financial vulnerability of turbine manufacturers

Turbine manufacturers did not highlight any short-term capacity constraints during our interviews, but they were unwilling to evidence this with manufacturing capacity data (which they consider highly commercially sensitive). They indicated they would invest to increase their capacity when there was a sufficient pipeline of committed orders.

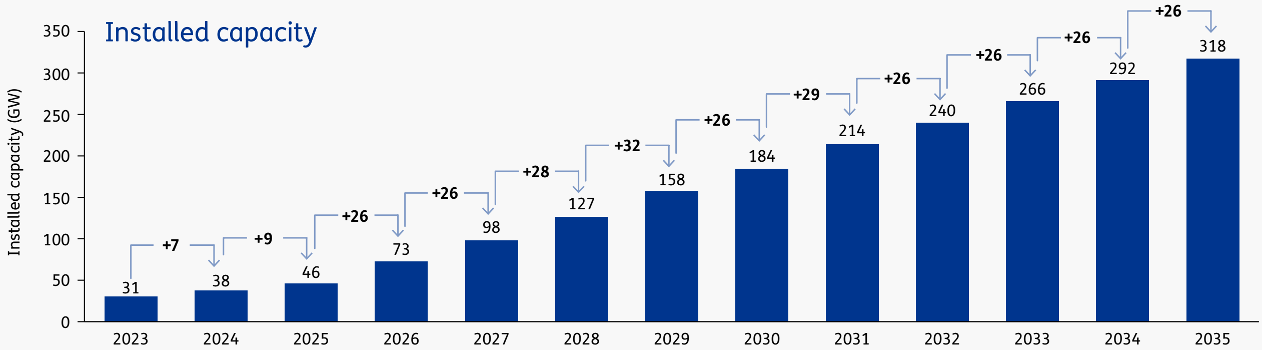
However, it is noteworthy that all three major European and US manufacturers (GE, Siemens Gamesa, and Vestas) currently face significant financial challenges across their offshore and onshore portfolios. Based on interviews and shareholder reports, these are in part due to:

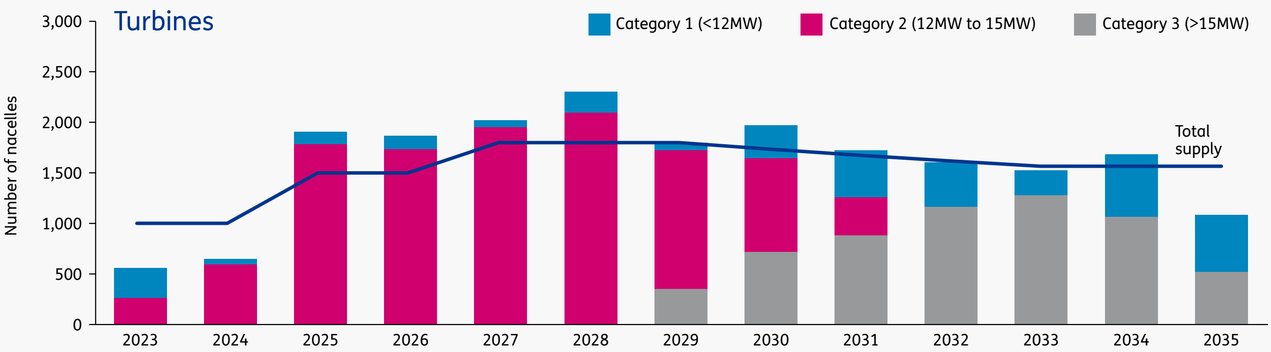
- past investments in new manufacturing capacity where demand failed to materialise
- aggressive pricing by competitors wishing to fill surplus capacity
- increased input costs due to inflation and limited ability to always pass these on to developers
- price pressure from developers as a result of competitive auction processes for renewables support mechanisms (for example, the CfD allocation rounds in the UK).

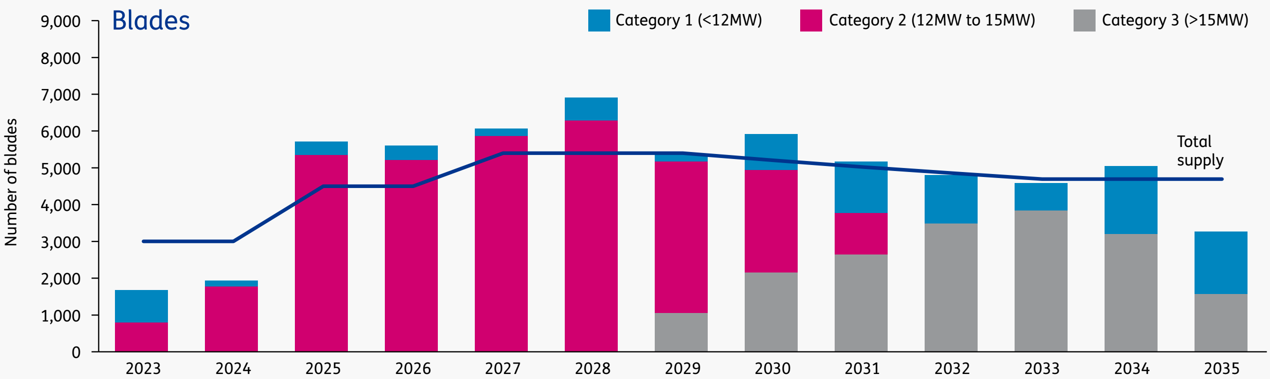
Another contributing factor is the ongoing 'turbine size race'. Competition between developers to secure routes to market is typically based on their levelised cost per megawatt hour of generation. As larger turbines typically offer lower levelised costs, turbines are getting progressively bigger. 15 MW models recently launched, and there is potential for up to 20 MW models in the next five to 10 years. The 'turbine size race' has reduced product lifecycles, which, in turn, has led to increasing investment in new product development – and both delayed and shortened serial production (manufacturing at higher volumes, which profitable sales rely on). It has also contributed to reliability issues, resulting in increased warranty claims.

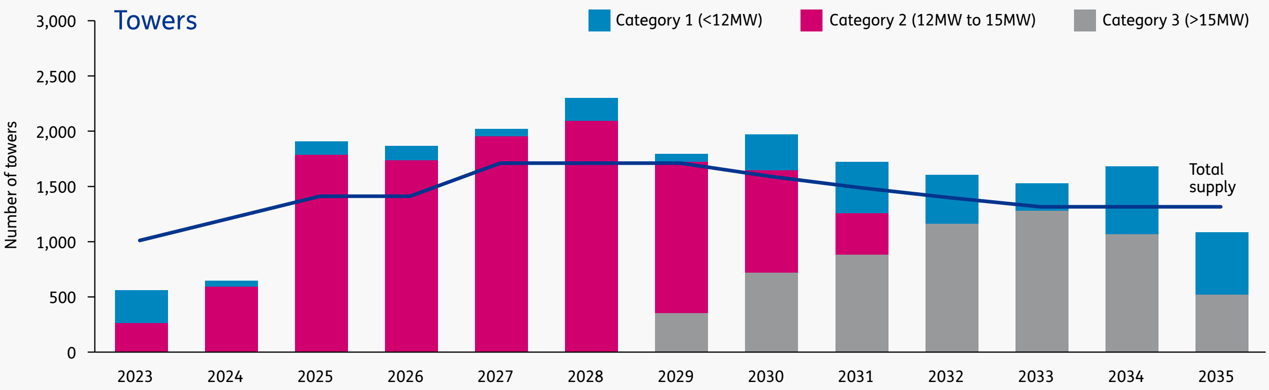
There are already examples of support packages to enable turbine manufacturers to return to profitability – and maintain and increase their capacity. These are underwritten by the governments where they are headquartered, together with higher turbine prices (which auction Administrative Strike Price increases have helped accommodate).

Estimated turbine, blade, and tower demand and supply: UK, Europe, and Eastern US









Estimated turbine, blade and tower demand and supply: UK, Europe & Eastern US (continued)

Modelling notes:

- Installed capacity is based on public offshore wind deployment targets for the UK, Europe, and Eastern US; the profile is based on the Baringa Central Reference Case.[2]
- Component demand is 'offset' by one to three years before installation (varying by component) to reflect build schedules.
- Split by Category 1 (<12 MW), 2 (12-15 MW), and 3 (>15 MW) turbines using the annual profile for relevant regions until 2028. After this, the average is applied, with smaller turbines retained for low wind speed regions.[3]
- Assumes a Category 3 turbine nacelle uses 15% more manufacturing capacity than a Category 2.
- Assumes a Category 3 turbine blade uses 15% more manufacturing capacity than a Category 2 (30% length increase is partly offset by manufacturing efficiencies).
- Assumes a Category 3 turbine tower uses 30% more manufacturing capacity than a Category 2 (30% length increase requires 30% more cans; manufacturing efficiencies offset the diameter increase).

Capacity constraints:

- **Blades and nacelles:** Initial surplus becomes a minor shortfall 2025-28 due to increased demand, with intermittent minor shortfalls thereafter despite the opening of new factories.
- **Towers:** Initial surplus becomes a significant shortfall 2025-28 due to increased demand, with minor shortfalls thereafter.
- **Note:** Installation demand (the annual increase in installed capacity) rises fourfold from 2024 to peak in 2029 and then declines by a quarter for the last three years.
- Capacity falls as demand shifts to larger turbines.

Confidence in supply data:

- Turbine suppliers did not share or publish factory capacity, and there are limited third-party sources, so this is challenging to assess.

Consistency with interviews:

- **Consistent:** Turbines not highlighted as a major constraint if suppliers overcome financial challenges and can proceed with investment.

2 European Commission, News announcement: Member States agree new ambition for expanding offshore renewable energy, 19 January 2023.

3 Informed by analysis of TGS | 4C Offshore's Global Offshore Wind Farm Intelligence Database.

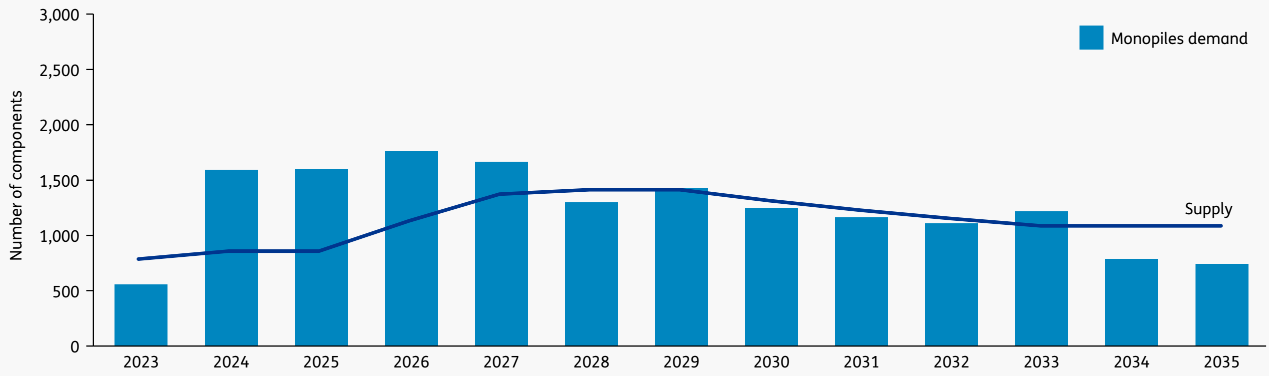
Shortage of monopile foundations and lack of a floating supply chain

According to interviews, existing monopile manufacturing capacity is often booked out for three to four years and will likely be insufficient to meet future demand. Not only will new factories be required, but – due to increasing monopile weight and length – existing factories may need upgrading. Only three to five steel mills globally can provide the widest, thickest, thermomechanically-rolled heavy steel plates – and they have very limited availability.

Currently, there is no established floating supply chain, and the existing (limited) manufacturing capacity can only deliver for small-scale pilot projects. Establishing this supply chain is complicated by:

- uncertainty over which floating foundation types will dominate
- suppliers struggling to build a secure order pipeline to underpin their investment
- lack of suitable ports without investing in upgrades.

Estimated monopile demand and supply: UK, Europe, and Eastern US



Modelling notes:

- Split by depth to inform foundation choice, using the annual profile for relevant regions until 2028. After this, the average is applied.[4]
- Assumes a Category 3 turbine monopile uses 30% more manufacturing capacity than a Category 2 (monopiles are 30% heavier, a combination of greater length and larger diameter, with heavy plate limiting manufacturing efficiencies).

Capacity constraints:

- Severe shortfall 2024-26 before improving to a minor shortfall in 2027.
- Capacity is tight thereafter, assuming the newly announced factories have opened.
- Capacity falls as demand shifts to larger turbines.

Confidence in supply data:

- Many foundation suppliers publish factory capacity.

Consistency with interviews:

- **Consistent:** Interviewees were also concerned about monopile capacity, increasing component size, and lack of floating supply chain.

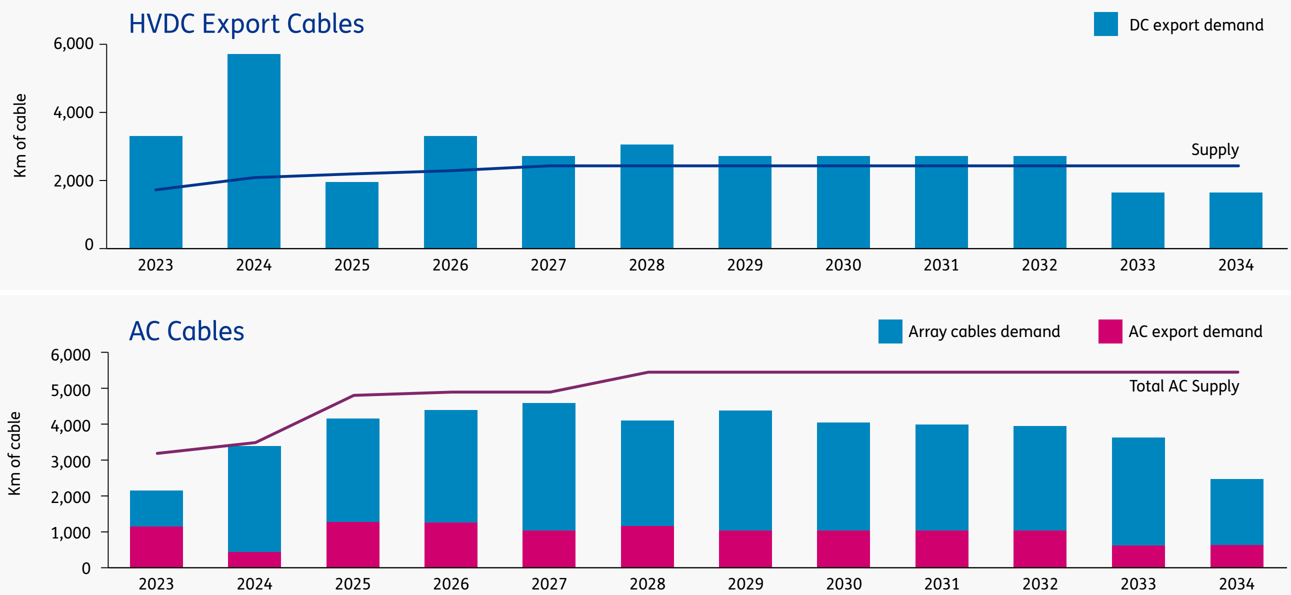
4 Informed by analysis of TGS | 4C Offshore's Global Offshore Wind Farm Intelligence Database.

HVDC cable shortages

Despite recent capacity investments, there are still significant constraints around high-voltage direct current (HVDC) export cables. According to interviews, some suppliers are booked out for several years – and modelling suggests they cannot meet the combined demand from offshore wind, grid, and interconnectors.

Other offshore wind markets have a more centralised approach to procurement than the UK. For example, interviews frequently highlighted that the Netherlands and Germany have TenneT, which promotes standardisation and has the purchasing power to secure a significant share of supply.

Estimated export and array cable demand and supply: UK, Europe, and Eastern US



Modelling notes:

- Split by distance from shore to inform export cable choice using the annual profile for relevant regions until 2028. After this, the average is applied.[5]
- Export cable length is based on 1.5x distance from shore, with HVDC used for lengths >80 km.
- Array cable length is based on 7x turbine rotor diameter.
- Average windfarm is 800 MW; HVDC export cable pair is rated at 1,400 MW.
- 50% of HVDC and 90% of HVAC supply is used by offshore wind; the remainder is shared by interconnectors and the grid.

Capacity constraints:

- Severe HVDC shortfall in 2023-24.
- Persistent minor (with occasionally significant) HVDC cable shortfalls thereafter up to and including 2032 – despite new factories opening.
- Sufficient HVAC cables throughout.

Confidence in supply data:

- Good third-party sources on cable supplier capacity.[6]

Consistency with interviews:

- **Model optimistic for HVDC:** Interviewees were concerned about availability and increasing competition.

5 Informed by analysis of TGS | 4C Offshore's Global Offshore Wind Farm Intelligence Database.
6 Informed by analysis of TGS | 4C Offshore's Offshore Transmission and Cables Intelligence Database.

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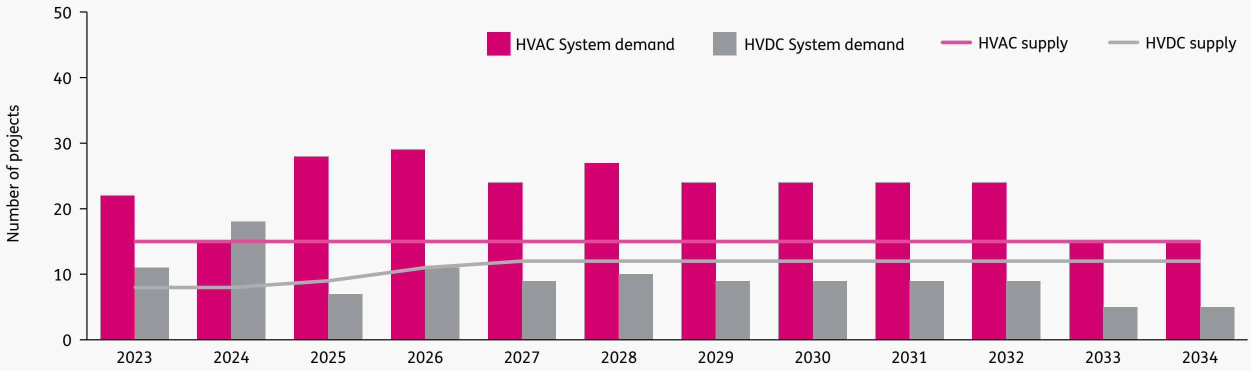
Shortage of balance of plant components

Developers and suppliers reported long lead times for HVDC and, to a lesser extent, high-voltage alternating current (HVAC) stations. This is because there is not enough manufacturing or test capacity for key components like transformers and converters. There is also a shortage of electrical steel used for transformer cores due to competition from electric vehicle motors and the loss of Ukrainian and Russian manufacturing. And as with HVDC cables, there is significant competing demand from offshore grids, interconnectors, and TenneT's centralised procurement. In addition, there is a lack of engineers for design and commissioning, which is complicated by bespoke designs as assets are value engineered to ensure full recovery of costs when sold to Offshore Transmission Owners (OFTOs). Developers and suppliers remarked that significant design work is needed during the tender process, leading some suppliers to refuse to participate in competitive tenders.

Estimated HVDC and HVAC system demand and supply: UK, Europe, and Eastern US



Modelling notes:

- Split by distance from shore to inform export cable choice using the annual profile for relevant regions until 2028. After this, the average is applied.[7]
- Export cable length is based on 1.5x distance from shore, with HVDC used for lengths >80 km.
- Average windfarm is 800 MW; HVDC export cable pair is rated at 1,400 MW.

Capacity constraints:

- HVDC severe shortfall in 2024, after which capacity improves through increasing engineering resources and standardisation.
- HVAC severe shortfall up to and including 2032.

Confidence in supply data:

- Suppliers did not share / do not publish factory capacity data, so this is difficult to estimate. Analysis is based on the number of projects supplier design teams can support.

Consistency with interviews:

- **Model is optimistic for HVDC and pessimistic for HVAC:** Interviewees were most concerned about availability and lead times for HVDC due to their greater significance in the UK.

7 Informed by analysis of TGS | 4C Offshore's Global Offshore Wind Farm Intelligence Database.

Difficulty sourcing key subcomponents

Interviewees reported that shortages of specialised subcomponents, such as flanges for towers and foundations, are contributing to increased lead times. For example, XXXL monopiles (monopiles with a diameter exceeding 11 metres) require the largest-diameter flanges. These are only available from a single European supplier (Euskal) and must otherwise be sourced from China and the Far East.

Vessel shortages

Operators anticipate a global vessel shortage in the next one to three years, particularly for those suitable for the largest turbines and foundations. Based on WindEurope's[8] analysis and additional desk research, only six of the existing 45 vessels may be capable of installing foundations exceeding 2,500 tonnes, and only 16 may be capable of installing turbines over 15 MW. This may be a highly optimistic analysis for foundations, which could exceed 3,000 tonnes.

As crane ratings are based on capacity at a 30-metre boom extension, which may be insufficient for monopile installation, one operator claimed only five to seven vessels would be able to install foundations for 15 MW turbines by 2025, and only two vessels on the market could install the very largest turbines. Additionally, only a single Japanese foundry supplies the largest hammers for monopile pile driving. As these are limited to an 8-metre diameter, they may be too small for the largest monopiles.

A final factor contributing to vessel shortages is that, although 270 installation days are expected per vessel, in reality it is much lower. It can take two to three months to change mission equipment and sea fastenings.

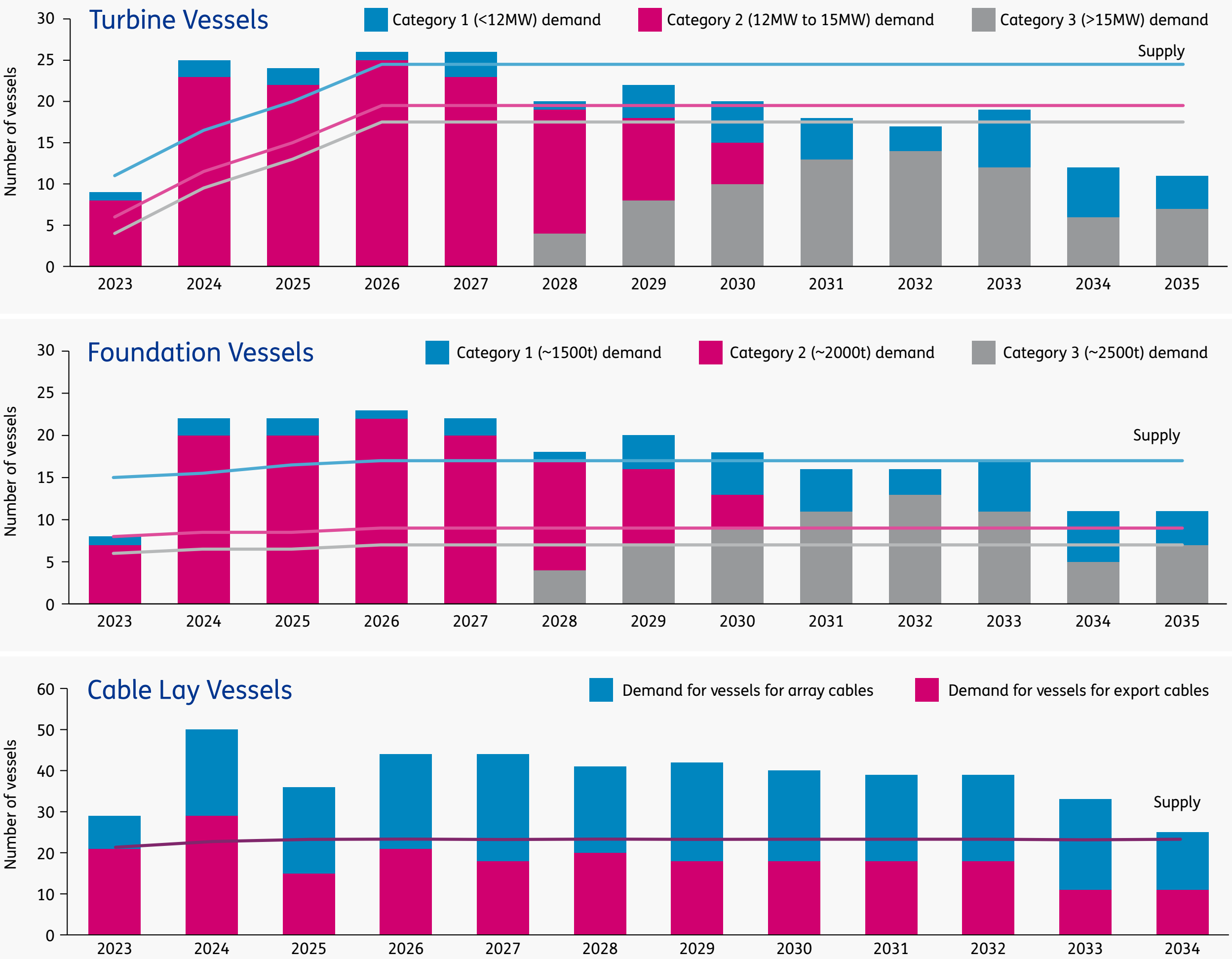
There is a similar shortage of cable installation vessels driven by increased demand from offshore wind, interconnectors, and offshore grid.

However, operators are hesitant to commission new builds without more certainty around project pipeline, especially since the 'turbine size race' has accelerated vessel obsolescence.

The typical lead time for a new vessel is three to four years, and there are only a limited number of shipyards (fewer than 10) that can supply the largest, specialist vessels.

8 H-BLIX, PWEA, and WindEurope, Offshore Wind Vessel Availability Until 2030: Baltic Sea and Polish Perspective, June 2022.

Estimated turbine, foundation, and cable installation vessel demand and supply: UK, Europe, and Eastern US



Modelling notes:

- Assumes turbine and foundation vessels are dedicated to offshore wind.
- Turbines and foundations are assigned to the most appropriate vessel based on hook height and crane capacity.
- Where vessels are capable of installing either component, their capacity is split 50/50.
- 70% of vessel capacity is used by offshore wind; the remainder is shared by interconnectors and the grid.

Capacity constraints:

- **Turbine vessels:** Significant (occasionally severe) shortfall for Category 2 and 3 up to and including 2026. There are minor shortfalls in 2027.
- **Foundation vessels:** Severe shortfalls for Category 2 and 3 from 2024-29, with varying years of minor and significant shortfall remaining up to and including 2033.
- **Cable vessels:** Severe constraints expected up to and including 2032, falling to significant and then minor constraints in 2033 and 2034.
- Initial surplus of small turbine and foundation vessels, which become redundant.
- New turbine vessels become available from 2028.

Confidence in supply data:

- Good third-party sources on vessel fleet except for uncertainty around installation rate and for foundations' 'real-world' lifting capacity.

Consistency with interviews:

- **Consistent:** Reflects concerns about availability of all vessel types.

Lack of port infrastructure and investment strategies

Although not modelled, according to interviewees, the UK has a shortage of deep-water port capacity, which puts offshore wind asset deployments at risk. To meet expected demand, significant and well-coordinated investment is required to increase quayside and laydown area size and load capacity, as well as channel depth and width. This is particularly critical for floating offshore wind due to the larger dimensions of floating foundations.

Offshore wind will also be competing for port capacity with projects decommissioning and constructing offshore oil and gas infrastructure.

3.2 What causes those constraints – and potential opportunities to address them

Competition from grid, interconnectors, and oil and gas

Interviewees noted significant competition with other industries for key components and installation vessels, notably:

- jacket foundations, topsides, and umbilical cables (oil and gas)
- HVDC export cables and converter stations (interconnectors and offshore grid)
- substations (grid)
- heavy-lift and cable vessels (oil and gas, interconnectors, and offshore grid).

When demand exceeds supply, suppliers prioritise customers and markets offering the best prices, greatest volume commitments, and lowest cost to serve. This can be challenging for individual UK offshore wind projects.

Potential industry opportunities for becoming more attractive to suppliers

- Developers, transmission operators, and suppliers could standardise designs for offshore grid connections. This would reduce the engineering workload for tendering and delivery.
- Developers could streamline and coordinate procurement with transmission operators to aggregate demand across multiple projects, underpinned by a suitable regulatory framework. Care would be required to ensure dependencies were not created between projects, and that cancellation or delays in one project would not affect others.

Lack of funding for anticipatory investment

Although capital is available, interviewees noted component suppliers, vessel operators, and ports hesitate to invest ahead of committed customer demand – they view it as high risk. The risk is more severe when suppliers rely on a relatively small number of large projects, as with offshore wind.

Recent UK Government announcements for encouraging anticipatory investment

- Government has recently announced the new over £1 billion Green Industries Growth Accelerator[9] to support domestic clean energy supply chains, including electricity networks and offshore wind.
- Government has also published its consultation response and draft allocation framework on Sustainable Industry Rewards[10] as a mechanism to incorporate non-price factors to encourage developers to support investment in manufacturing facilities.

The CfD process has disincentivised collaboration

The highly competitive nature of CfD auctions has discouraged collaboration in areas like supplier development and procurement for components such as HVDC converters and floating foundations. It would also be the case for merchant projects, absent a CfD mechanism. This can reduce the forward visibility of demand for elements of the supply chain and make it harder to aggregate demand to underpin investment cases for new factories and ports.

Specific initiatives to improve collaboration with respect to supply chain development could help counter the CfD allocation's competitive dynamics.

Potential industry opportunities for reducing margin pressure and fostering collaboration

- Developers, ports, and floating foundation manufacturers could collaborate more on aggregating demand and agreeing shared designs and manufacturing locations.

Uncertainty around CfD success and alignment with procurement timelines

Auction-based processes (such as the CfD and equivalent European schemes) are competitive by nature, which means developers do not know whether they will secure a route to market in any given round. Interviewees noted developers are reluctant to commit to contracts until after the CfD award, which means suppliers generally hold off investing where additional capacity may be required. Then, there may not be enough time to build new factories or vessels before they are needed for construction. As we saw in Allocation Round (AR) 5,[11] the Administrative Strike Price for offshore wind itself can be too low, deterring developers from bidding at all and further damaging confidence in the supply chain.

Furthermore, the CfD process fixes the price for offtake at a point in the development lifecycle when not all project costs have been fixed. In a world of rapidly increasing input costs and interest rates, project margins have reduced – and without sufficient management of these risks, some projects may fail. This, in turn, has limited what generators can pay for key components – squeezing supplier margins.

9 UK Government, Press release: Huge boost for UK green industries with £960 million government investment and major reform of power network, 23 November 2023.

10 UK Government, Consultation Outcome: Introducing a Contracts for Difference (CfD) Sustainable Industry Reward, 13 March 2024.

11 UK Government, Contracts for Difference (CfD) Allocation Round 5: Results, 8 September 2023.

The solution on CfD timing is not a simple one. Earlier award would increase confidence for developers to place orders but would exacerbate the above-mentioned margin risk because of greater cost uncertainty ahead of final investment decision (FID) and construction. If this risk cannot be effectively managed between developers and suppliers, there is an increased risk of project failure.

Experience from the last few years has meant all parties are more attuned to what commodity and interest rate risks they face – and how those risks should be managed.

Recent UK Government announcements and potential industry opportunities for reducing CfD-related uncertainty

- Government has significantly increased the Administrative Strike Prices and budget available for AR6. These changes should help additional projects secure routes to market, subject to final auction outcomes later this year.[12]
- Developers could explore alternative routes to market, such as corporate power purchase agreements (PPAs) and the Hybrid CfDs which combine PPAs and CfDs and for which there has been limited uptake to date.

Wider policy and regulatory uncertainty

Overall uncertainty around regulation, planning consent, and grid connection contributes to further risk for developers and suppliers across the value chain.

The current UK system lacks an integrated, forward-looking deployment plan linking targets to processes like seabed leasing, consenting, and CfD auction volumes. Also, aside from the UK's target to decarbonise the grid by 2035, there are no deployment targets beyond 2030. This creates concern about a cliff-edge reduction in component demand, as well as stranded manufacturing and installation assets.

Recent UK Government announcements for reducing policy and regulatory uncertainty

- Government's *Connection Action Plan, Transmission Acceleration Action Plan,* and *Strategic Spatial Energy Plan* (SSEP) will reduce the uncertainty and timescales associated with grid connections.

Components are getting bigger, and technology is developing rapidly

Rapid technology development timeframes place significant pressure on supply chains. In particular, the 'turbine size race' has effects that cascade through the supply chain, as noted by many interviewees.

Vessel operators must upgrade or replace their vessels. Turbine blade and foundation manufacturers must upgrade their factories to accommodate larger components. Shorter product lifecycles shorten serial production, which manufacturers rely on to optimise costs and maximise output and profitability. And more frequent product launches increase development costs and the risk of reliability issues, which can further erode margins.

12 UK Government, AR6 Core Parameters, November 2023.

Potential industry opportunities for reducing technology risks

- Developers and suppliers could enter into a voluntary moratorium on further increases in turbine capacity or tip height (a 'turbine size cap'). This would reduce disruption to suppliers and vessel operators and improve profitability and reliability. It is likely this would need to include both UK and European markets to be effective. The Dutch NWEA has proposed a North Seas Standard[13] along these lines.

13 NWEA, The North Seas Standard: Enable Growth with Wind Turbine Standardisation, 29 September 2023.

Onshore wind

4. Onshore wind

Supply chain constraints for onshore wind are less severe than for offshore wind – and are generally overshadowed by greater constraints around securing planning permission and grid connections. This is because onshore windfarms do not require complex foundations, installation vessels, or HVDC cables and converter stations. In addition, lead times for onshore turbines are shorter than for their offshore counterparts.

Onshore wind	**Supply chain risk**			
	High	**Medium -high**	**Medium**	**Medium -low**
	• Balance of plant (transformers, switchgear)	• Turbines	• Cranes and transport	• Civils (including foundations) and electrical installation • Cables

The most significant supply chain constraints are:

- uncertainty regarding the ongoing availability of the Class 1A turbines required for the UK's challenging wind conditions
- increasing lead times to secure transformers and switchgear.

As onshore turbines increase in size, there is also some concern about the availability of sufficiently large installation cranes.

The availability of Class 1A turbines may depend on whether turbine manufacturers seek to reduce the number of turbine models offered in their product portfolios to improve their financial performance. In part, this will be based on the attractiveness and certainty of projects demanding these turbines, which is determined by how likely they are to secure planning permission, grid connections, and a profitable route to market. Transformer availability is a result of increasing demand from renewables projects, electricity networks, and industrial and commercial sectors. There is also a reluctance to source transformers from non-European suppliers due to perceived reliability concerns.

Recent UK Government announcements to significantly increase the Administrative Strike Price and remove some planning barriers facing onshore wind in England should help address several of these issues. Developers could also benefit from the transformer sourcing expertise of electricity networks, which conduct significant factory visits and type testing to source transformers from a more global supplier base.

Component overview

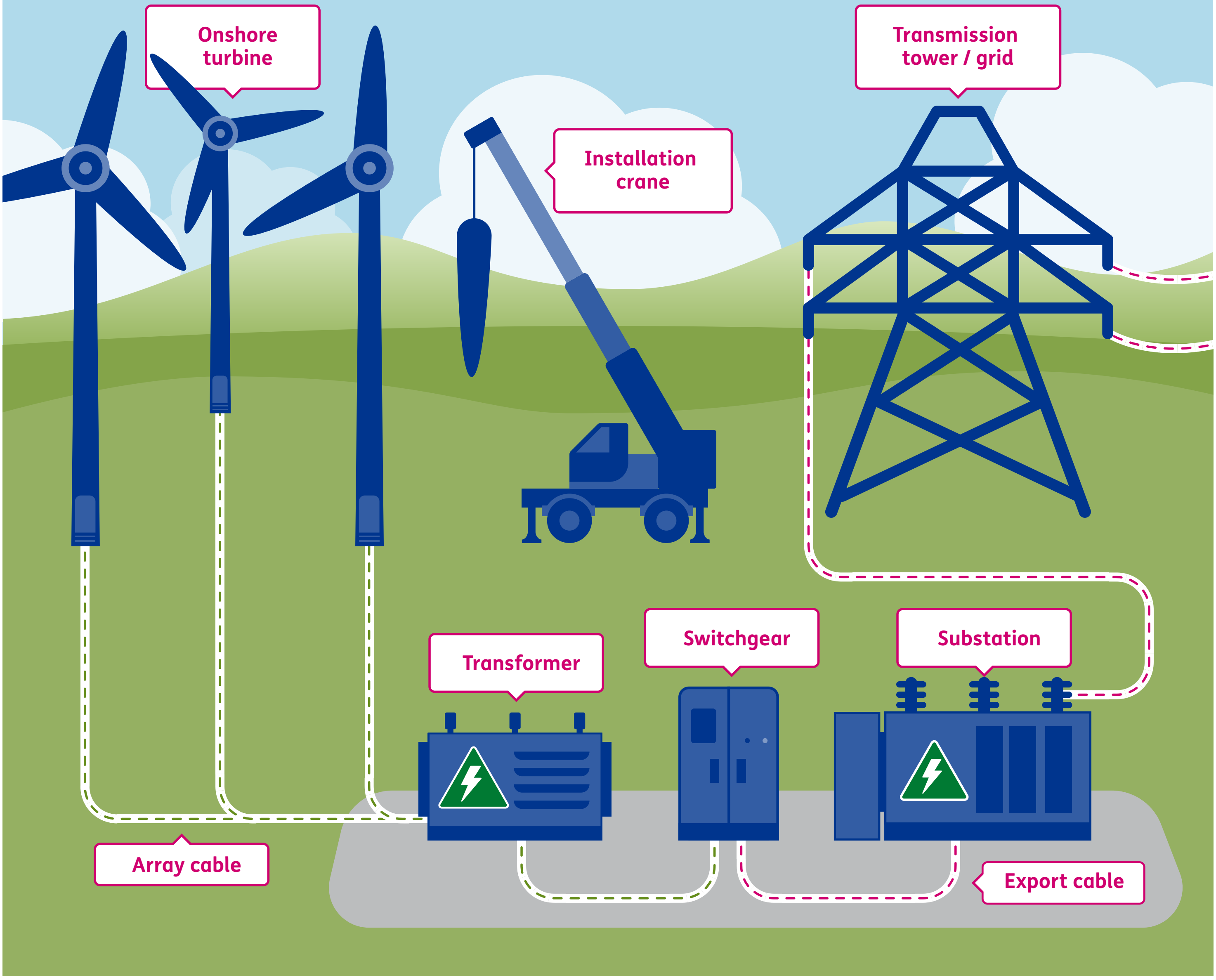
Onshore wind farms consist of turbines mounted on reinforced concrete foundations or rock anchors.

Array cables connect turbines to transformers and switchgear, which connect to the nearest transmission or distribution substation via an export cable.

Key elements of the onshore wind supply chain:

- Turbines and towers
- Foundations and civil works
- Transport and installation
- Balance of plant (transformers, switchgear, and SCADA systems)
- Array and export cables.

For more information on how the supply chains are structured, including suppliers, see the appendix.



4.1 Supply chain constraints

Availability of UK-specific Class 1A turbines

Interviewees advised that the majority of turbines deployed in Scotland are Class 1A models, which can withstand extreme wind conditions. However, these models are more expensive than alternatives and are not common in other European markets. Onshore wind turbines also continue to increase in size, with new models reaching 6 to 7 MW. However, these increases are less disruptive for onshore wind supply chains than offshore ones. There are several reasons for this:

- manufacturing and operating turbines of this size are already well-proven for offshore wind, where the latest turbines are twice as large
- onshore foundations are generally reinforced concrete poured in situ, which can more easily be scaled up than factory-made offshore foundations
- offshore installation requires specialist turbine and foundation installation vessels rather than the multi-purpose cranes used onshore.

Turbine original equipment manufacturers (OEMs), both onshore and offshore, are under financial pressure – and are streamlining their product portfolios to reduce costs. Therefore, there is a risk that some could cease manufacturing Class 1A turbines, which would constrain supply for UK projects.

Transportation restrictions in Scotland

Scotland's abnormal load transport policy requires a police escort for large turbine components like towers, blades, and nacelles. Interviewees explained that abnormal loads must be transported at off-peak hours, and that there are a limited number of available police officers to provide the required escort. These restrictions delay onshore wind component transport and lengthen project timescales.

Extended transformer lead times

Due to growing cross-industry demand, lead times have increased to 24 months for 132 kV transformers and to four years for 400 kV ones.

Many onshore developers highlighted an unwillingness to source transformers from non-European markets due to reliability concerns. Transformers represent a single source of failure for wind farms, and a defective device can cause significant financial losses.

The market is also transitioning away from the use of sulphur hexafluoride (SF_6) in switchgear, as it is an extremely powerful greenhouse gas. This is also constraining supply, extending lead times, and increasing costs.

Reduced crane availability

While the crane shortage was not highlighted as a significant constraint during our interviews, some OEMs noted that availability had become more difficult following Brexit (although it was unclear whether this was a direct consequence of that event). Additionally, onshore turbine size increases – requiring even larger cranes – could constrain future crane supply.

4.2 What causes those constraints – and potential opportunities to address them

Planning difficulties and grid connection delays

Many developers indicated that planning and grid constraints were significantly greater barriers to onshore wind deployment than supply chain constraints.

While we were conducting this study, the Government announced a partial lifting of planning restrictions for onshore wind in England. Previously, wind farms were only given consent if they were located in areas local authorities had identified as suitable in their local plans. They could be blocked by a single resident's objection.

Under the new proposals:[14]

- the focus has shifted from single objections to addressing overall community impacts, supported by potential community incentives
- supplementary planning documents have been deemed acceptable alternatives to local plans
- there is the potential to use Local Development and Community Right to Build Orders as an alternative to the planning process.

Despite these changes, planning is expected to remain a significant constraint and source of uncertainty for onshore wind – and it is unclear to what extent the changes will encourage new projects. Our research found that onshore wind still faces planning restrictions not placed on other infrastructure projects.[15] And interviewees raised concerns about whether there would be enough experienced local authority planning staff to accommodate additional requests.

Developers were also frustrated by the uncertainty and delays around grid connection dates. In some cases, these delays required them to select alternative turbines and update planning applications because the originally specified turbines would no longer be available when grid connection finally occurred.

Lack of clear political support for onshore wind

There is no clear political support for the onshore wind industry in England. Specifically, there is no onshore wind deployment target in the BESS, resulting in uncertainty for investors. This is exacerbated by unresolved issues with planning restrictions.

14 House of Commons Library, Planning for Onshore Wind, 16 January 2024.

15 Renewable UK, Press release: Government's policy changes do not go far enough to bring back onshore wind in England, 5 September 2023.

Uncertainty around CfD success and profitability

As with offshore wind, the CfD's competitive nature creates uncertainty as to whether a developer will be successful in a given round.

Prior to AR5, there were concerns that onshore wind projects would lose out because offshore wind had a lower Administrative Strike Price. Ultimately, these fears did not materialise, as broader financial constraints meant that offshore wind developers declined to bid because they were unable to compete under AR5's set parameters.

Although onshore developers were successful in AR5, many interviewees remained concerned about the Administrative Strike Price, which did not increase in AR5 from the £53/MWh (in 2012 prices) in AR4 and might not reflect input cost inflation. This would potentially reduce margins for developers and suppliers.

Despite these concerns, onshore developers were less likely to report issues with CfDs than offshore developers. This is likely due to a combination of factors, such as the more widespread use of alternative routes to market for onshore wind projects (like power purchase agreements selling power to corporate customers) and the shorter lead times for onshore wind components and projects (which reduce uncertainty).

Recent UK Government announcements for reducing CfD-related uncertainty

In common with offshore wind:

- Government has significantly increased the Administrative Strike Prices and budget for AR6 to reflect increases in input costs and the cost of capital.

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Non-European transformers are considered less reliable

Transformers represent a single point of failure for onshore wind farms. Developers are hesitant to invest in non-European transformers because they are perceived as less reliable than European equivalents.

Potential industry opportunities for opening up transformer procurement

In common with solar PV:

- Network operators could support developers with procuring transformers and switchgear beyond sharing approved equipment lists. Potential ideas include promoting standardisation and sharing type testing and site visits.

Developers have limited leverage when sourcing transformers and switchgear

Distribution network operators (DNOs) can ensure a consistent and secure pipeline of transformers and switchgear because they share forward-looking plans with approved suppliers.

Onshore wind developers cannot give suppliers that same certainty because projects have shorter timescales and lower, non-recurring demand. Onshore developers also make less use of frameworks and approved supplier lists. It is therefore more challenging and expensive for them to source balance of plant components.

Potential industry opportunities for increasing transformer and switchgear purchasing power

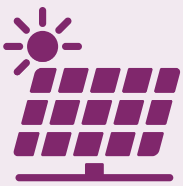
In common with solar PV:

- Network operators could open up frameworks and potentially offer centralised procurement and delivery. They could also pool replacement assets in case of failures.

Solar PV

5. Solar PV

Our modelling and interviews were less extensive for solar photovoltaics (PV) than for other technologies, and module manufacturers declined to participate. However, our research shows that supply chain constraints for solar PV appear to be less severe than for other technologies – and are generally overshadowed by greater constraints around securing grid connections. This is because many solar components such as modules, cables, and inverters are more commoditised, and there has been significant investment in new manufacturing capacity (albeit the vast majority in China).

Solar PV	Supply chain risk		
	High	**Medium**	**Medium-low**
	• Balance of plant (transformers and switchgear) • EPC design and installation	• Modules • Inverters	• Racking • Cables

The most significant supply chain constraints are the increasing lead times for securing transformers and switchgear (in common with onshore wind). And although there is expected to be sufficient module supply to meet rising demand, there is uncertainty regarding any impacts of potential forced labour in the polysilicon supply chain. Availability of design and installation labour is also a constraint (this is discussed in the skills section on page 46).

As with onshore wind, solar developers could also benefit from the transformer sourcing expertise of electricity networks, who conduct significant factory visits and type testing to source transformers from a more global supplier base. The Solar Stewardship Initiative also provides a platform for improving labour standards and traceability in the polysilicon and module supply chains. However, this will require cooperation across the solar value chain in China and internationally.

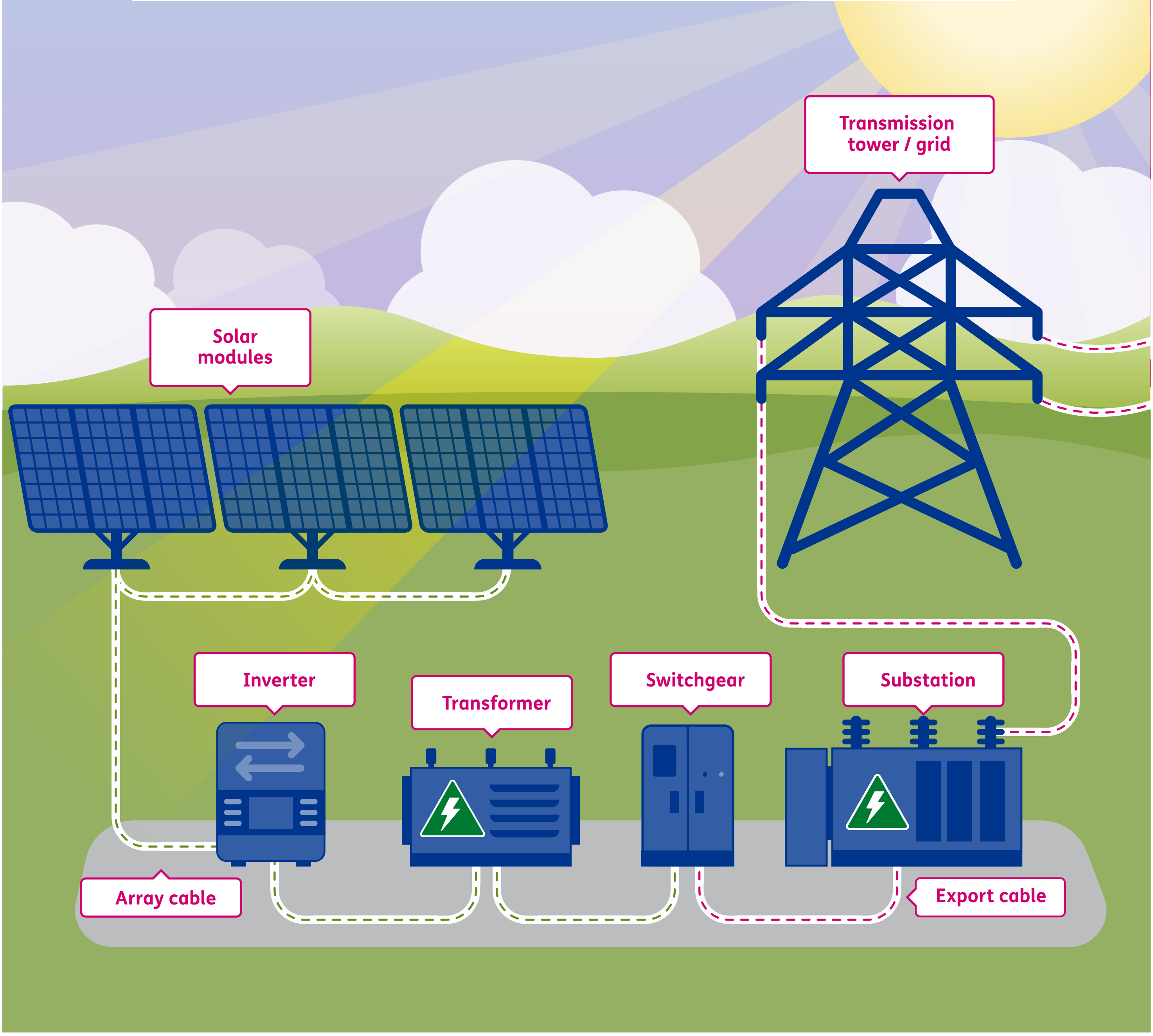
Component overview

Ground-based and commercial rooftop solar installations consist of photovoltaic modules mounted on racks or frames and connected by string cables to inverters, transformers, and switchgear. An export cable connects them to the nearest transmission or distribution substation.

Key elements of the solar PV supply chain:

- Silicon PV modules
- Balance of plant (inverters, transformers, and switchgear)
- Array and export cables
- Racking
- Engineering, procurement, and construction.

For more information on how the supply chains are structured, including suppliers, see the appendix.



5.1 Supply chain constraints

Potential shortages of modules without the risk of forced labour

Despite increasing demand, the volume of new factory announcements means the IEA does not anticipate shortages in global solar PV manufacturing capacity,[16] which it estimates will reach 1,000 GW by 2024. This significantly exceeds the predicted 2030 annual global demand of 650 GW in its Net Zero 2050 scenario.

According to academic research carried out by Sheffield-Hallam University, Xinjiang accounts for around 35% of global polysilicon supply[17] (the main raw material for solar cells). Therefore, there are widespread concerns about the availability of PV modules without the risk of Uyghur forced labour. In the US, the Uyghur Forced Labor Prevention Act prohibits the import of goods produced in Xinjiang using forced labour, and it names specific polysilicon suppliers alongside other raw material suppliers[18]. In the UK and Europe, interviewees noted that investors and developers are setting their own anti-forced labour requirements.

Our analysis suggests there will be sufficient non-Xinjiang polysilicon production to meet module demand in North America and Europe, but this would be dependent on effective segregation and traceability across the PV supply chain. The timescale to achieve this at sufficient scale is uncertain, but sufficient traceability is unlikely to be possible for some time in China. Non-Chinese supply chains will also take significant time to establish at scale.

Transformer and switchgear shortages

According to some solar developers, lead times have increased from 16 to 24 months for transformers and from four to 12 months for switchgear. This has been due to increasing demand from renewables, grid upgrades, and industrial and commercial customers. There is also an electrical steel shortage due to the Ukraine war.

It is noteworthy that developers did not see inverter supply as a constraint.

16 A Crawford and LT Murphy, "Over-Exposed: Uyghur Region Exposure Assessment for Solar Industry Sourcing," Sheffield Hallam University Helena Kennedy Centre for International Justice, 5 September 2023.
17 IEA, Solar PV Global Supply Chains, July 2022.
18 US Department of Homeland Security, UFLPA Entity List.

5.2 What causes those constraints – and potential opportunities to address them

Limited visibility into the Chinese polysilicon supply chain

Developers struggle to prove that their module supply chain is free from forced labour. Although the Solar Stewardship Initiative[19] has been established to improve transparency and supply chain standards, it is not yet fully operational, and a widely recognised chain-of-custody system for segregated polysilicon supply is not yet available. This makes it hard to track and evidence polysilicon origin. In response, some suppliers have started to 'bifurcate' their supply chains – separating factories and production lines that serve markets with strict anti-forced labour requirements so they do not use polysilicon from Xinjiang. However, this can be hard to verify.

Potential industry opportunities for increasing supply chain visibility

- Government, developers, and suppliers should collaborate in the UK and internationally to establish assurance and traceability programs, building on the Solar Stewardship Initiative.

Non-European transformers are considered less reliable

As with onshore wind, transformers represent a single point of failure for solar farms. If a transformer does not work properly, the solar farm cannot feed electricity into the grid. This leads to significant financial losses for asset owners. Therefore, developers and engineering, procurement, and construction companies (EPCs) advised that they are hesitant to source transformers from markets outside Europe, with several interviewees expressing doubts about the quality of non-European transformers. In comparison, network operators are willing to source from a wider range of suppliers because they invest in type testing and factory visits.

As a result, UK developers and EPCs exclude a wide range of possible global suppliers, reducing component availability and indirectly extending lead times.

Potential industry opportunities for opening up transformer procurement

In common with onshore wind:

- Network operators could support developers with procuring transformers beyond sharing approved equipment lists. Potential ideas include promoting standardisation and sharing type testing and site visits.

19 Solar Stewardship Initiative, Supply Chain Traceability Standard.

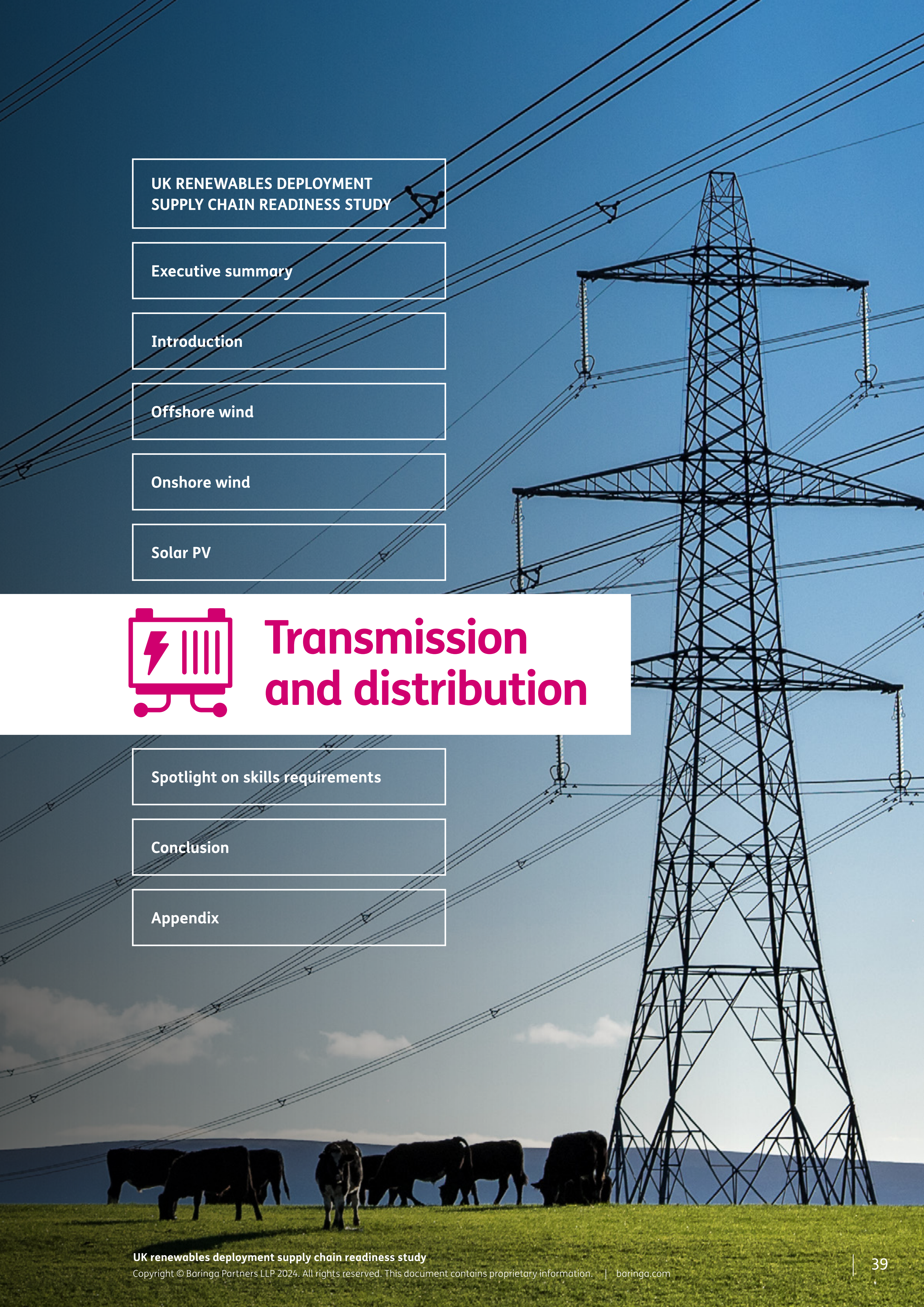
Developers and EPCs have limited leverage when sourcing transformers and switchgear

DNOs and transmission owners (TOs) have a much higher demand for transformers. This limits the buying power of solar PV developers and EPCs – and increases transformer prices. Additionally, DNOs and TOs can give suppliers five-year demand plans, which builds confidence and secures their pipeline. In contrast, there is uncertainty around individual solar farm projects being cancelled or delayed.

Potential industry opportunities for increasing transformer and switchgear purchasing power

In common with onshore wind:

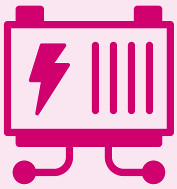
- Networks operators could open up frameworks and potentially offer centralised procurement and delivery. They could also pool replacement assets in case of failures.



Transmission and distribution

6. Transmission and distribution

Interviews suggest that supply chain constraints for transmission and distribution networks are on a similar level to offshore wind. However, it has not been possible to model this in detail due to the lack of supply and demand data.

Transmission and distribution	**Supply chain risk**		
	High	**Medium-high**	**Medium**
	• Transformers • HVDC converter stations • HVDC cables • Electrical design and installation	• Switchgear and circuit breakers	• Other cables and conductors • Pylons and poles • Flexibility and automation • Design and installation – civils

The components facing the greatest constraints are:

- transformers
- switchgear
- HVDC cables and converter stations.

There are multiple contributing factors for these shortfalls. UK network operators compete for components with their European counterparts, as well as with interconnectors, renewables developers, electric vehicle charge points, and industrial and commercial users. Also, despite the huge increase in network build required for the future, suppliers are reluctant to invest in new capacity given uncertainty about long-term demand for specific components, wider regulation, and funding. There is also a lack of electrical design and installation labour (this is discussed in the skills section on page 46).

The UK Government recently announced further support for new facilities via the over £1 billion Green Industries Growth Accelerator, which may help stimulate investment. The *Transmission Networks Acceleration Action Plan* (in response to the *Winser Review*) aims to halve the time to build new grid infrastructure to seven years. The *SSEP* and *Centralised Strategic Network Plan* (CSNP) – together with more standardisation and demand aggregation through collaborative procurement – could reduce uncertainty and make UK customers more attractive to international suppliers.

Component overview

Transmission and distribution networks consist of low-, medium-, and high-voltage alternating current underground cables and overhead conductors. Some subsea cables are also used for connections to islands and international interconnectors. Subsea HVDC cables and converter stations (similar to those used for offshore wind export) are increasingly used for long-distance offshore transmission, such as the interconnectors between UK and European networks and bootstraps between sections of the mainland UK network.

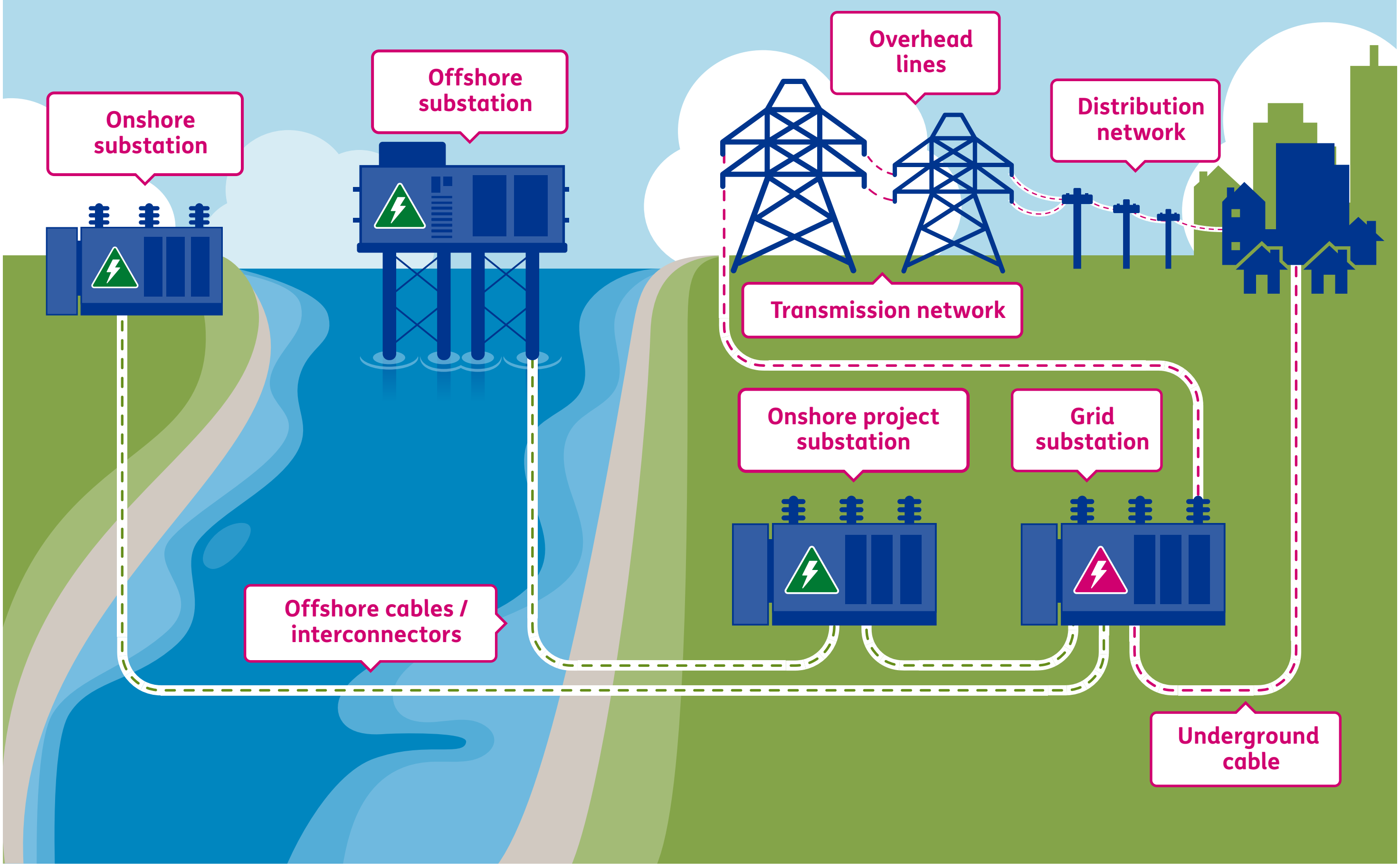
To transport power from generation sources to consumption loads, transformers and switchgear link transmission and distribution networks at grid supply points, and they step down voltages at distribution substations.

Additional equipment like reactive compensators are used to manage power quality.

Key elements of the transmission and distribution supply chain:

- Transformers
- Overhead conductors
- Underground and submarine cables
- HVDC converter stations
- Switchgear and circuit breakers
- Other electrical equipment
- Pylons and poles
- Design and installation.

For more information on how the supply chains are structured, including suppliers, see the appendix.



6.1 Supply chain constraints

Transformer shortages

Interviewees noted forward-looking transformer demand exceeds what the existing supply base can produce. The market is already seeing significantly longer lead times (in some cases doubling) of up to 15 months for 33 kV, two years for 132 kV, and four years for 400 kV.

Suppliers said customer demand forecasts are not granular or long-term enough to inform their business cases for capacity expansion – especially at the component level. As with solar PV, wider inflation and electrical steel shortages are also driving up costs and further impacting those business cases.

HVDC cable, converter station, and installation vessel shortages

These shortages are due to rising demand from interconnectors, offshore wind, and grid upgrades. There is limited transformer and converter valve manufacturing capacity for converter stations, where a shortage of design engineers also limits the number of competitive tenders and projects suppliers can take on. Despite investment in new capacity, many cable manufacturers are sold out for three to four years. A shortage of cable installation vessels mirrors this.

In continental Europe, customers such as TenneT (a Dutch and German network operator) have been highly effective at securing capacity through centralisation, aggregation, and requirement standardisation. This reduces the capacity available to the UK and other markets.

Switchgear and circuit breaker shortages

Interviewees reported switchgear lead times have doubled. This is partly due to increased demand from other sectors, but also because of the transition to SF6-free, gas-insulated switchgear (which is not yet widely available).

As with transformers, manufacturers reported challenges around obtaining detailed, long-term customer forecasts to inform their investment decisions.

6.2 What causes those constraints – and potential opportunities to address them

Long-term demand uncertainty is reducing anticipatory investment

To build an effective business case for expansion, suppliers need sufficient certainty of component and service demand over an extended period. While Ofgem's Accelerated Strategic Transmission Investment (ASTI) framework has provided some additional opportunity for network companies to gain certainty over demand beyond the five-year price control period, this remains limited to the medium term. Although suppliers expect a significant demand uplift in future price control periods and successors to ASTI, it is not guaranteed.

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Interviewees suggested funding has also been based on more conservative scenarios about future electricity demand and renewables deployment. It is unclear how effective the uncertainty mechanisms associated with this funding will be at reflecting increases in future demand and costs. Under traditional RIIO price controls, these allowances are determined in advance of the regulatory funding period. However, ASTI introduces the opportunity for network companies to bring projects forward within the regulatory period. This is intended to allow for additional flexibility, accounting for projects that are uncertain at the time of the price control review.

Potential industry opportunities for providing long-term certainty

- National Energy System Operator (NESO) and Ofgem could proceed with the CSNP. Ofgem could use it as the basis for approving long-term investment in network expansion and to give networks and suppliers more certainty.
- Ofgem and DNOs could explore whether a similar mechanism could be applied to distribution, potentially facilitated by an expanded role for regional system planners.

Barriers to a longer-term procurement approach

Project-specific competitive tenders have focused on using competition to drive down costs to maximise value to consumers. However, this approach can create significant additional workload and uncertainty for suppliers, inhibiting long-term relationships and investment in the supply chain.

Meanwhile, utilities procurement regulations limit framework contracts to eight years. Once a framework's advertised value has been exceeded, buyers should no longer award business through it.

Network operators reported that Ofgem licence conditions make it difficult to collaborate on joint procurement. However, any licensing changes would need to be complemented by mechanisms to jointly manage differences in network priorities and supplier performance management – and to allocate scarce resources in the event of supply shortages.

Finally, Ofgem's ability to contest major project delivery between network operators and third parties creates an additional level of complexity and uncertainty for the supply chain and staffing.

Potential industry opportunities for improving procurement

- Ofgem could update network licences to encourage joint procurement, so network operators can aggregate demand should they wish to.
- Network operators could procure more on a portfolio level rather than a project basis, underpinned by the appropriate regulatory framework.

Onerous planning processes and regulatory uncertainty

Network operators view planning consent processes as out of date, cumbersome, and ineffective when it comes to facilitating network expansion. They significantly delay projects, which disrupts procurement.

Longer-term regulatory and funding uncertainty also inhibit supply chain investment. For example, Ofgem makes individual funding decisions for each ASTI project. Some interviewees also felt that Ofgem overemphasised the risk of potential stranded network assets, leading to more piecemeal approval of major projects. This makes it harder to aggregate demand and provide certainty to suppliers.

Recent UK Government announcements and potential industry opportunities for streamlining planning and regulation

- Ofgem could approve funding at a portfolio level rather than a project level, based on the SSEP and CSNP – and accept a higher risk of stranded assets to avoid implementation delays.
- Government has recently published a *Transmission Networks Acceleration Action Plan* to halve the time to build new grid infrastructure to seven years. This was in response to the review by Nick Winser, Electricity Network Commissioner.[20]

20 UK Government, Transmission Acceleration Action Plan, November 2023.

Competition from interconnectors, renewables, and overseas networks

There is significant domestic and international competition for key network components. HVDC converters and cables, transformers, and switchgear are particular concerns.

The US Inflation Reduction Act and the EU's Net Zero Industry Act are making these markets more attractive to suppliers, both as customer bases and as manufacturing locations. TenneT's procurement model has secured a significant share of HVDC cable and converter capacity in the nearer term.

Recent UK Government announcements and potential industry opportunities for managing competition

- Network operators could collaborate on standardisation and to aggregate demand, mirroring TenneT's approach and potentially supporting developers if procurement and licence constraints were relaxed. This could include exploring pan-European collaboration opportunities for offshore transmission.
- Government has recently announced in the new *Transmission Acceleration Action Plan* that industry have agreed to explore standardisation and establish a new UK supply chain council.

In common with offshore wind:

- Government has recently announced the new over £1 billion Green Industries Growth Accelerator to support domestic clean energy supply chains, including electricity networks and offshore wind.

Supply chain disruptions and geopolitical tensions

Global inflation and the Ukraine war have driven up commodity prices globally, notably for energy, steel, and copper. Higher freight costs and logistical challenges increase lead times and component costs. Additionally, built-in inflation protections are not sufficient to cover network operators' cost rises.

Potential opportunity to reduce macroeconomic and geopolitical impacts

- Ofgem could review indexation terms in price controls to more closely reflect movements in network operators' input costs.

UK RENEWABLES DEPLOYMENT
SUPPLY CHAIN READINESS STUDY

Executive summary

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Conclusion

Appendix

7. Spotlight on skills requirements

Skills gaps and shortages exist across renewables and electricity networks. These range from electrical design, test, and commissioning engineers for cables, transformers, and converter stations to project managers and installation technicians.

A more detailed, holistic skills assessment examining the skills pipeline and demand across these sectors would help inform how secondary and higher education and employers should respond.

Our study found that skills-related constraints affect all four sectors, causing issues across their value chains. From engineering and design professionals to the commissioning and installation workforce, personnel shortages may limit the UK's ability to meet the BESS deployment targets.

Skills supply constraints and their causes

It was not possible to obtain detailed headcount information from interviews with developers, network operators, or suppliers during this study. Therefore, our key findings are qualitative rather than quantitative. There are a number of industry and government publications that cover renewables and network workforce issues. Those that contain estimates of current and future requirements include:

- OWIC's *Offshore Wind Skills Intelligence Report*,[21] which estimates that the current UK offshore wind workforce of over 32,000 will need to increase to over 104,000 by 2030 to achieve the 50 GW target. 54% of these are anticipated to be direct manufacturing, development, construction, operation, and maintenance jobs.
- National Grid's *Building the Net Zero Energy Workforce*,[22] which estimates that 260,000 new roles will need to be filled to provide the 400,000-strong workforce required by 2050. This spans a far wider scope than renewables and networks, including electric vehicles; hydrogen; carbon capture, utilisation, and storage; and heat pump installation. However, the report does not provide a breakdown by sector.
- The UK Government's *Green Jobs Taskforce Report*[23] and *Winser Review*, which include coverage of workforce challenges but do not quantify them.

21 Offshore Wind Industry Council, Offshore Wind Skills Intelligence Report, June 2023.
22 National Grid, Building the Net Zero Energy Workforce, January 2020.
23 UK Government, Green Jobs Taskforce Report, 14 July 2021.

Engineering and design personnel

Although the UK has excellent engineering universities, there are ongoing shortages of design, test, and commissioning engineers across mechanical, electrical, and power systems. Although the number of UK engineering students has increased over the last decade, there is fierce competition for graduates across developers, suppliers, networks, and other industries. To supplement domestic shortages, there is a reliance on overseas workers.

Three to seven years of experience is required post-university to become a fully qualified power networks engineer, with the most skills and experience required at the highest voltage levels. There is also significant competition for these engineers across developers, suppliers, the international market, and outside the power sector. Senior authorised person roles, the skilled specialists responsible for safety, are in particularly high demand, and engineers frequently change roles to secure the best pay.

These shortages of power systems engineers are compounded by the bespoke designs required for sectors like offshore wind, where converter stations and substations are value engineered to ensure full cost recovery at sale. Additionally, significant design work is needed during tender processes, meaning some suppliers refuse to participate in competitive tenders because they lack resources.

Installation technicians

Some solar developers and EPCs interviewed noted that they have historically relied on installation crews from Southern and Eastern Europe, where there are well-established, experienced, and low-cost workforces. However, the UK is now seen as less attractive because Brexit reduced international mobility. Without a work visa, 'standard' visitors from the EU/EEA are now limited to six months and are only permitted to undertake specific business-related activities (such as installing, dismantling, repairing, servicing, or advising on equipment) where a contract is in place with a UK customer.[24] This has been compounded by the ending of the UK's offshore wind workers visa concession for workers on construction, operations, and maintenance vessels. Interviewees also said that more stringent UK health and safety standards deterred international installation technicians.

24 UK Government, Visas and Immigration: Visit the UK as a Standard Visitor.

As a result, several solar EPCs have ceased UK operations to focus on European markets like Germany, which have lower barriers to entry. The remaining UK EPCs can therefore be more selective about which projects they support. Some have also diversified into development, reducing their provision of EPC services to the wider market as they focus on their own projects.

Reskilling for offshore wind has also been challenging. While oil and gas workers have proved useful for cable and floating foundation installations, some interviewees reported that their skills are less transferable for turbine and fixed-bottom offshore foundation installation.

Skilled trades

OEMs, DNOs/TOs, and renewables are demanding more skilled labour as the energy sector decarbonises and electricity networks expand. However, not enough new people with technical skills are entering the market. There are significant shortages across a wide range of roles – project managers, cable jointers, transformer installers, overhead linesmen, electricians, and senior authorised persons, as well as unskilled labour.

One network operator interviewee reported that their main contractor had estimated that the trades and installation workforce would have to double by 2028 to meet network demand. In addition, visa delays have been reported, which makes international recruitment more challenging (for example, attracting linesmen from the Philippines). At the same time, European recruitment is impacted by post-Brexit restrictions. Meanwhile, competition from Europe and the Middle East exacerbates recruitment and retention difficulties.

7.1 Recent UK Government announcements and potential industry opportunities for addressing skills constraints

- Government convened the Green Jobs Taskforce and Green Jobs Delivery Group to gather evidence on the skills required for the green economy, provide recommendations, and develop an action plan to address the associated challenges and opportunities. This will inform the Green Jobs Plan, which Government intends to publish later this year.
- Trade associations could conduct a holistic skills gap assessment for the renewables and transmission and distribution sectors.
- Schools, colleges, and universities could encourage interest in engineering degrees and technical qualifications – particularly among women and traditionally under-represented demographics.
- Developers, network operators, suppliers, colleges, and universities could incorporate more applicable technical skills into post-secondary curricula so they remain relevant and attractive.
- Developers, network operators, and suppliers could increase the number and uptake of apprenticeships across manufacturing and installation.
- Developers, network operators, and suppliers could reskill more workers from other industries (like oil and gas) to fill labour gaps.

Conclusion

8. Conclusion

Our study identified a range of constraints, causes, and opportunities across renewable energy and network supply chains. Although each sector has its own challenges, there are notable overlaps in what is required to achieve BESS deployment targets. Here, we end by summarising the supply chain constraints facing the four sectors, as well as the Government announcements and opportunities for industry to tackle them.

Components and technologies experiencing the greatest supply chain constraints

This infographic provides an overview of the components and technologies experiencing the greatest constraints, now and looking forward. It is noteworthy that no components or technologies are in the 'green' zone, indicating the severity of constraints facing the four sectors.

Supply chain risk	Offshore wind	Onshore wind	Solar PV	Transmission and distribution
High	• Floating foundations • Export cables • Balance of plant (HVDC and HVAC stations) • Turbine and foundation vessels • Cable vessels • Ports	• Balance of plant (transformers, switchgear)	• Balance of plant (transformers and switchgear) • EPC design and installation	• Transformers • HVDC converter stations • HVDC cables • Electrical design and installation
Medium -high	• Monopiles and transition pieces • Turbines and towers	• Turbines		• Switchgear and circuit breakers
Medium	• Jackets • Array cables	• Cranes and transport	• Modules • Inverters	• Other cables and conductors • Pylons and poles • Flexibility and automation • Design and installation – civils
Medium -low		• Civils (including foundations) and electrical installation • Cables	• Racking • Cables	
Low				

Recent UK Government announcements and potential industry opportunities for addressing the causes of supply chain constraints

What Government announcements and industry interventions could help alleviate those constraints? This infographic summarises the efforts policymakers, those operating within the sectors, and supporting stakeholders are currently making (and should consider in future). Many of these have an impact across multiple sectors, and therefore play an important role in streamlining the journey to achieving BESS deployment targets.

Make renewables more attractive to suppliers

Manage competition from other industries and markets

Developers, ports, and floating foundation manufacturers could collaborate more on aggregating demand and agreeing shared designs and manufacturing locations.	• Offshore wind
Developers, network operators, and suppliers could collaborate on standardisation (for example, offshore grid connections for wind and transmission, and transformers and switchgear for wind, solar, and networks).	• Offshore wind • Onshore wind • Solar PV • Transmission and distribution
Network operators could centralise procurement and delivery of grid connections, transformers, and switchgear.	• Offshore wind • Onshore wind • Solar PV
Developers and transmission networks could streamline and coordinate procurement to aggregate demand across multiple projects, underpinned by a suitable regulatory framework.	• Offshore wind • Transmission and distribution
Networks could pool replacement assets (transformers and switchgear) in case of failures – and support developers with sharing type testing and site visits.	• Onshore wind • Solar PV
Ofgem could update network licences to encourage joint procurement, so network operators can aggregate demand.	• Transmission and distribution
Government has recently announced in the new *Transmission Acceleration Action Plan* that industry have agreed to explore standardisation and establish a new UK supply chain council.	• Transmission and distribution

Make renewables more attractive to suppliers

Encourage anticipatory investment

Government has recently announced the new over £1 billion Green Industries Growth Accelerator to support domestic clean energy supply chains, including electricity networks and offshore wind.	• Offshore wind • Transmission and distribution
Ofgem could update inflation protections for network operators to reflect market conditions.	• Transmission and distribution
Developers and suppliers could enter into a voluntary ‘turbine size cap’.	• Offshore wind
Government has also published its consultation response and draft allocation framework on Sustainable Industry Rewards as a mechanism to incorporate non-price factors to encourage developers to support investment in manufacturing facilities.	• Offshore wind

Increase supply chain visibility

Government, developers, and suppliers could collaborate in the UK and internationally to establish assurance and traceability programs, building on the Solar Stewardship Initiative.	• Solar PV

Improve the policy and regulatory climate

Signal political support and provide long-term certainty

Recommendation	Technologies
NESO and Ofgem could proceed with the CSNP, and Ofgem could use it as the basis for approving long-term investment in network expansion.	• Transmission and distribution
Ofgem and DNOs could explore whether a similar mechanism could be applied to distribution, potentially facilitated by an expanded role for regional system planners.	• Transmission and distribution

Streamline planning and regulation

Recommendation	Technologies
Government has recently published a Transmission Networks Acceleration Action Plan to halve the time to build new grid infrastructure to seven years (in response to the review by Nick Winser, Electricity Network Commissioner). Primarily focused on networks, along with the Connection Action Plan and SSEP, this will benefit all technologies.	• Offshore wind • Onshore wind • Solar PV • Transmission and distribution
Ofgem could approve funding at a portfolio level rather than a project level, based on the SSEP and CSNP – and accept a higher risk of stranded assets to avoid implementation delays.	• Transmission and distribution
Ofgem could update network licences to encourage joint procurement, so network operators can aggregate demand should they wish to.	• Transmission and distribution

Reduce CfD-related uncertainty

Recommendation	Technologies
Government has significantly increased the Administrative Strike Prices and budget available for AR6. These changes should help additional projects secure routes to market, subject to final auction outcomes later this year.	• Offshore wind • Onshore wind
Developers could explore alternative routes to market, such as corporate PPAs, which are more common in onshore wind.	• Offshore wind

Address skills shortages

Government convened the Green Jobs Taskforce and Green Jobs Delivery Group to gather evidence on the skills required for the green economy, provide recommendations, and develop an action plan to address the associated challenges and opportunities. This will inform the Green Jobs Plan, which Government intends to publish later this year.	• Offshore wind • Onshore wind • Solar PV • Transmission and distribution
Schools, colleges, and universities could encourage interest in engineering degrees and technical qualifications.	• Offshore wind • Onshore wind • Solar PV • Transmission and distribution
Developers, suppliers, colleges, and universities could incorporate more applicable technical skills into post-secondary curricula.	• Offshore wind • Onshore wind • Solar PV • Transmission and distribution
Developers and suppliers could increase the number and uptake of apprenticeships across manufacturing and installation, including providing clear career pathways from entry-level jobs to higher-skilled roles.	• Offshore wind • Onshore wind • Solar PV • Transmission and distribution
Developers and suppliers could reskill more workers from other industries (like oil and gas) to fill renewable energy labour gaps	• Offshore wind • Onshore wind • Solar PV • Transmission and distribution
Trade associations could conduct a holistic skills gap assessment.	• Offshore wind • Onshore wind • Solar PV • Transmission and distribution

UK renewables deployment supply chain readiness study

Executive summary for industry and policymakers

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