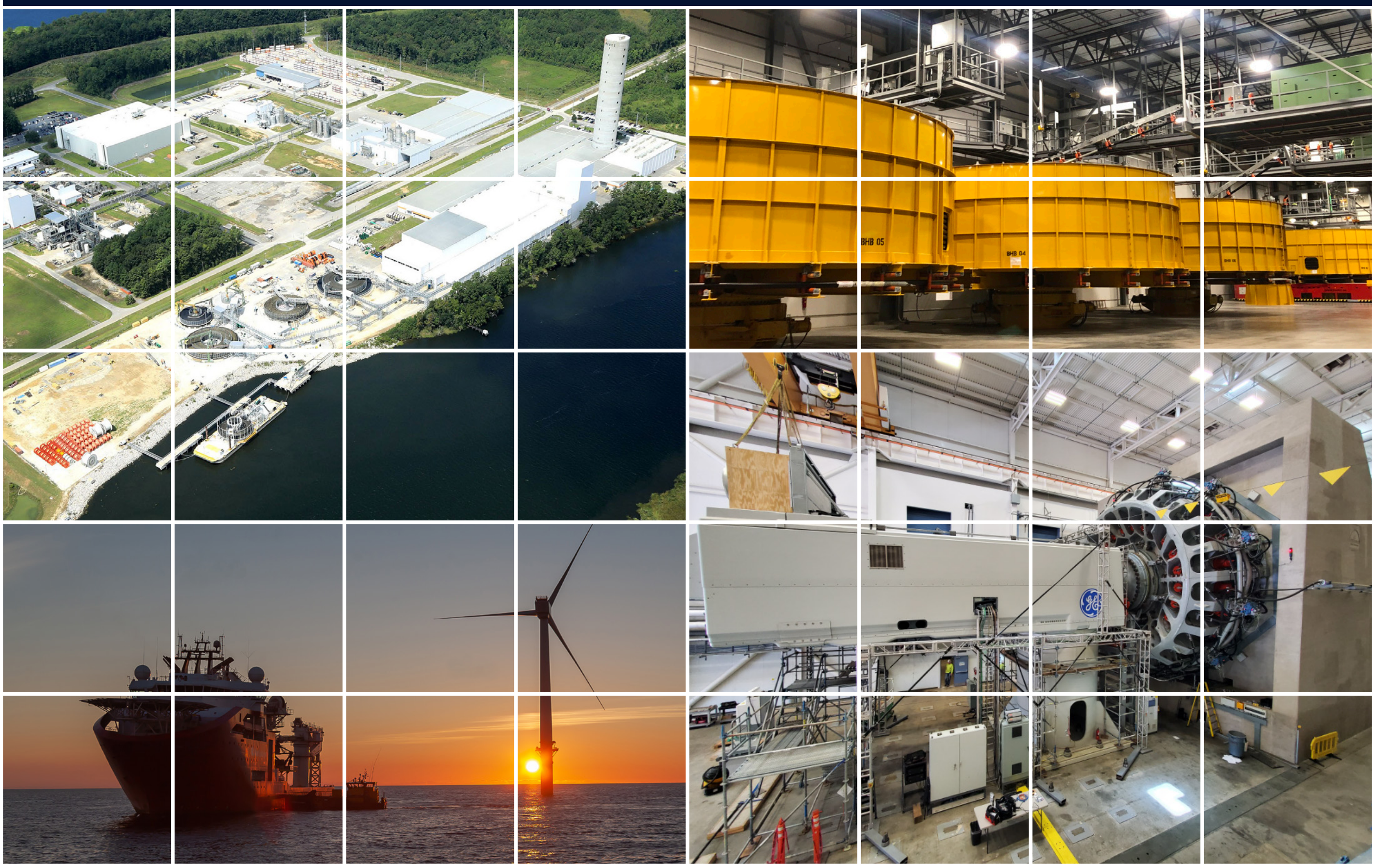
SOUTH CAROLINA OFFSHORE WIND SUPPLY CHAIN STUDY

September 2024



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ABOUT

The South Carolina 'Offshore Wind Industries' House Bill 4831 was approved in the 2023-2024 fiscal year. It directed the South Carolina Department of Commerce to conduct an economic development study to support the development of a roadmap for attracting the offshore wind industry to the State.

The Department of Commerce designated Clemson University to lead the project, and Clemson University subcontracted Xodus Group (Xodus) to complete the scope of work.

Xodus Group
Xodus is a global energy consultancy with specialist engineers, consultants, and scientists working across multiple disciplines, combining skills to provide a truly integrated offering to the energy industry.

Clemson University Regional Economic Analysis Laboratory
The Regional Economic Analysis Laboratory at Clemson University performs public policy, economic, and fiscal analysis for public, private, and non-profit sector clients.

Acknowledgements
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- GE Vernova
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- North Carolina Department of Commerce
- PivotGen
- South Carolina State Energy Office within the Office of Regulatory Staff
- South Carolina Manufacturing Extension Partnership
- South Carolina Ports Authority
- South Carolina Research Authority
- Southeastern Wind Coalition

Cover images courtesy of: Nexans (top left, top right) and Dominion Energy Innovation Center (bottom right).

EXECUTIVE SUMMARY

The US offshore wind industry is growing, with federal and state level procurement targets for offshore wind generation capacity in place and the first ten commercial-scale projects having received approval for construction.

Several offshore wind projects are under construction and in partial operation in the US Northeast and Central Atlantic, with a further pipeline in development including in the Gulf of Mexico and West Coast regions.

Early US offshore wind projects have relied on component supply from established supply chains outside the US. The growth of a US offshore wind industry introduces an opportunity to increase domestic manufacturing should barriers to investment be overcome. Both federal and state governments are seeking opportunities to grow local offshore wind supply chains that will bring the economic benefits of offshore wind manufacturing to US states.

The South Carolina legislature passed House Bill 4831, the 'Offshore Wind Industries Bill,' which directed the appointment of a third party to assess South Carolina's opportunity in the offshore wind industry. The purpose of this study is to provide South Carolina's legislators, businesses, and industry organizations with insight and information about the US offshore wind industry and to assess how South Carolina can further support and benefit from the growth of the US offshore wind supply chain.

KEY FINDINGS

South Carolina's lower business operating costs create an attractive environment for offshore wind component manufacturing.
South Carolina has created a strong environment for advanced manufacturing industries. South Carolina's relatively low corporate income tax rates and industrial electricity rates, as well as competitive labor rates, create lower operating costs for manufacturing businesses in South Carolina than those in US Northeast states. Advanced manufacturing research at South Carolina universities and innovation support from organizations such as SC Nexus and CLEANcarolinas have also contributed to the development of an attractive landscape in the State for manufacturing.

South Carolina already hosts the key offshore wind supplier Nexans, which generates hundreds of millions of dollars in total economic benefit for the State.
South Carolina is currently experiencing significant economic benefits from the Nexans export cable manufacturing facility, a key piece of the US offshore wind supply chain. The Nexans facility's competitiveness in the US and global market proves that Tier 1 offshore wind suppliers can benefit from the pro-business environment in South Carolina. The State should ensure that the Nexans facility remains competitive as additional facilities open on the US East Coast, and build on this early success to create an offshore wind manufacturing cluster within the state.

South Carolina is well-positioned to host another Tier 1 supplier.

The US Tier 1 supply chain landscape is not fully established, and there could be an opportunity for additional large scale offshore wind manufacturing in South Carolina. South Carolina's unique strengths for establishing new industries create an attractive environment for wind turbine and large component manufacturers. South Carolina has a history of successfully attracting new industries and investment to the State by offering resources and investment packages to international businesses. Lower tier companies in South Carolina could stand to benefit from the ability to supply a range of materials and subcomponents to Tier 1 manufacturers.

Industries in South Carolina have expertise in precision component manufacturing, advanced composites and polymers, and industrial electrical equipment, which could be leveraged for offshore wind subcomponent manufacturing.

The aerospace, automotive, and power generation industries in South Carolina give the State a strong reputation for manufacturing in areas relevant to offshore wind material supply and subcomponent manufacturing. Suppliers in these industries already meet strict quality and reliability standards, priorities shared by the offshore wind industry due to high performance and safety requirements. Manufacturing of precision components for industrial motion applications, advanced composites and polymers, and industrial electrical equipment are strengths of the South Carolina supply chain that could be leveraged in an offshore wind subcomponent manufacturing opportunity. Several global companies manufacture materials and subcomponents for relevant industries in South Carolina, including onshore wind, and some companies manufacture materials and subcomponents for the offshore wind industry at other facilities outside the State.

South Carolina could add upwards of $400 million of total economic output over the next ten years if in-state companies secure Tier 2 supply contracts in offshore wind.

South Carolina has a strong foundation of existing manufacturing capability developed for adjacent industries. These businesses could have opportunity to expand into the offshore wind industry with some investment. Onshore wind subcomponent and material suppliers can retool and expand to handle manufacturing at the size and scale required of offshore wind. Other manufacturers with relevant capabilities, such as steel fabrication, specialized equipment manufacturing, or polymer and composites manufacturing could also see opportunity as a result of the growth of the offshore wind industry. The State has the potential to further increase its economic gains by making successful investments in its supply chain and port infrastructure to support offshore wind development activities. The benefits of these investments range from hundreds of millions to billions of dollars in total economic output over a ten-year period.

Three existing South Carolina ports have the capabilities or availability to support offshore wind manufacturing, and a fourth greenfield development site is a promising option.

South Carolina has a strong port operations and shipping industry. Public ports in the Charleston area have high capability to support offshore wind manufacturing, but these ports will serve as major container and cargo ports over the long-term, which limits their ability to accommodate offshore wind industry requirements. Other locally operated ports would require significant infrastructure upgrades to be suitable for the needs of offshore wind manufacturing. Four port locations have strong potential and high compatibility with offshore wind component manufacturing and services in South Carolina: Columbus Street, the Port of Georgetown, the Jasper Ocean Marine Terminal, and a greenfield site along the Cooper River.

RECOMMENDATIONS

South Carolina's next steps should be to **organize** leadership, **engage** suppliers, and **invest** in supply chain development. This report recommends several actions the State can take to support the development of the South Carolina offshore wind industry:

ORGANIZE

1 **Establish an offshore wind working group** – The offshore wind working group should serve as the primary point of contact on offshore wind industry matters and facilitate collaboration between the State and industry participants. This group should establish clear ambitions regarding the offshore wind supply chain and/or project development in South Carolina waters.

2 **Establish South Carolina's presence in US offshore wind market** – Marketing the strengths of South Carolina's industrial environment would help ensure that Tier 1 suppliers are aware of renewable energy manufacturing-specific support from the State.

3 **Leverage regional collaboration opportunities** – Participating in regional collaboration efforts would ensure that companies within the State are included and considered in regional supply chain development efforts.

ENGAGE

4 **Equip South Carolina agencies and associations with educational tools to understand the offshore wind needs and opportunities** – Bringing in expertise from the industry to educate businesses and enabling organizations like the South Carolina Manufacturing Extension Partnership will help companies identify opportunities and plan and strategize offshore wind market entry.

5 **Engage with Tier 1 suppliers and promote South Carolina businesses** – South Carolina should help connect Tier 1 suppliers to South Carolina businesses. Existing businesses that manufacture offshore wind subcomponents outside the state should be interviewed to identify what support would be needed to bring those manufacturing operations to South Carolina.

6 **Explore opportunity for further Tier 1 manufacturing** – The State should work with offshore wind original equipment manufacturers to determine the state investment required to bring down upfront capital costs enough to enable private investment in a local Tier 1 manufacturing facility.

7 **Engage ports on offshore wind opportunities and determine what plans are feasible** – The Department of Commerce and South Carolina Port Authority should collaborate to assess interest in offshore wind component manufacturing at local ports and determine what plans are feasible. Efficient investments that make ports compatible for offshore wind activities should be explored.

INVEST

8 **Develop a Manufacturing Innovation Grant program** – This grant program would provide a framework through which South Carolina companies could receive State support to retool, certify, or upskill existing operations. Larger offshore wind companies could receive State support to innovate manufacturing technologies.

9 **Investigate the reintroduction of a renewable energy manufacturing tax credit** – This tax credit would help bring down the operating costs of suppliers enough to support offshore wind market entry and provide assistance to Tier 1 suppliers locating in South Carolina.

10 **Support existing offshore wind innovation efforts** – South Carolina should support offshore wind innovation development efforts and position South Carolina to lead offshore wind manufacturing research in key areas of local expertise.

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1 INTRODUCTION

Commercial-scale offshore wind in the US kicked off with federal regulatory support in early 2021, when the federal government announced a target to develop 30 gigawatts (GW) of offshore wind by 2030 and 110 GW of offshore wind by 2050. Several individual states have also set ambitious targets for offshore wind procurement, currently totaling over 85 GW by 2045. Driven by these federal and state targets, a pipeline of offshore wind projects has emerged in the Northeast and Central Atlantic with long-term development prospects in the Gulf of Mexico and the West Coast. The emergence of the US offshore wind industry on the East Coast is attributable to favourable site conditions that more closely resemble shallower water depth locations where global offshore wind projects have predominantly been installed to date.

The pipeline of future offshore wind projects is anticipated to grow across the US coasts, increasing demand for the supply of components, subcomponents, and materials. As a state with strong manufacturing capability, South Carolina has an opportunity to capture further economic benefits from the growth of this industry.

1.1 Background

South Carolina has previously explored the potential benefits for the State through enabling offshore wind energy generation and associated supply chain participation. Discussion took place in 2007 at the Southeast Regional Offshore Wind Symposium, where universities in South Carolina hosted government, academia, and private industry experts to discuss the opportunity for offshore wind development in South Carolina.

Research into the potential economic benefits of offshore wind for the State has been conducted over the last two decades. In 2007, Clemson University, contracted by the State, published *The Potential Economic Impact of an Off-Shore Wind Farm to the State of South Carolina* which examined the impact of the manufacture, installation, and operation of a 480-megawatt (MW) wind farm off the coast of South Carolina and found that approximately 155 full-time jobs would be created and between $114 million and $287 million in economic output would be generated. Later, the State commissioned the *2012 Wind Energy Supply Chain Study (Phase 1)*. The study found that the wind energy supply chain employed approximately 1,134 workers across 33 companies, generating an estimated $520 million in total economic output in the State. In 2014, the State commissioned the *South Carolina Wind Energy Economic Impact Study (Phase 2)* to assess the economic impact of a 40 MW offshore wind demonstration project, including the effect on electricity rates. The study found that the economic impact would equal 959 total jobs (direct, indirect, and induced), $46.3 million in wages, and $148.4 million in construction and component manufacturing output.

The State has also supported technical research and industry road-mapping during this time. In 2008, a research consortium led by the South Carolina State Energy Office within the Office of Regulatory Staff (State Energy Office) secured private and public funding (including a federal grant) for their initiative, the *South Carolina Roadmap to Gigawatt-Scale Coastal Clean Energy Generation: Transmission, Regulation and Demonstration*. The three focus areas within the project included the *Offshore Wind Energy Transmission Study*, a desktop-based study that concluded the State's grid infrastructure was already relatively robust and with medium investment, could accommodate up to

350 MW of offshore wind power; the *Palmetto Wind Study*, during which the Coastal Carolina University deployed six metocean buoys to document and enable advanced modeling of offshore wind resource; and establishing the Regulatory Task Force for Coastal Clean Energy, which identified an existing state regulatory path as a strong foundation for regulating offshore wind development in state waters. The Regulatory Task Force for Coastal Clean Energy also recommended that South Carolina establish a policy of support for renewable energy development, a state waters leasing framework and marine spatial plan, and a permit facilitation office to coordinate permitting and leasing.

The South Carolina Act 318 of 2008 created the Wind Energy Production Farms Feasibility Study Committee to review, study, and make additional recommendations on wind energy. The legislative committee generated recommendations for the State to support offshore wind energy production and industry development within the State, including:

1. The State Energy Office should establish a Wind Energy Cluster within South Carolina to bring together existing wind industry members and develop a strategy to recruit others; and

2. The South Carolina Department of Revenue should review existing in-state incentives for manufacturing to ensure compatibility for wind component manufacturing and prepare draft legislation for the South Carolina General Assembly if modifications are required.

In 2012, the North Myrtle Beach city government passed a resolution proclaiming the city to be a "wind-powered economic zone," establishing the city's target of an electricity portfolio of 100% offshore wind power. In 2013, the Charleston City Council approved a resolution in support of offshore wind power. It urged the State to maintain efforts to develop the industry through the State's Regulatory Task Force.

The South Carolina Intergovernmental Task Force was established in 2012, marking the State's official initial engagement with Bureau of Ocean Energy Management (BOEM) regarding offshore wind. In 2015, BOEM issued a Call for Information and Nomination, ultimately leading to BOEM identifying four potential Wind Energy Areas adjacent to the State. Following stakeholder engagement in-state and within the federal government, it was assessed that the four potential Wind Energy Areas would not be progressed due to concerns raised by the Department of Defense, possible environmental impacts, and potential impacts on other ocean users. The South Carolina Intergovernmental Task Force has not met since 2016.

In 2021, the State Energy Office hosted the South Carolina Wind Energy Workshop to facilitate discussion between South Carolina manufacturing industry stakeholders. The workshop underscored the continued interest in the opportunity to reap the economic benefits of offshore wind development. Since 2021, State actions related to offshore wind industry development have largely plateaued, and the State Energy Office has focused on clean transportation and electric vehicle infrastructure, solar energy development, and energy resilience.

In May 2022, BOEM auctioned two offshore wind lease areas in the Carolina Long Bay. Total and Duke Energy were awarded lease areas, placing winning bids worth $315 million. As these sites are close to South Carolina, they offer future opportunities for companies in the State to potentially participate in offshore wind.

1.2 Objectives

The purpose of this study is to provide South Carolina's legislators, businesses, and industry organizations with information about the US offshore wind industry and South Carolina's opportunity to supply manufactured components in the US market. Specifically, the objectives of this study are to determine:

- The needs and requirements of the existing offshore wind supply chain;
- The forecast for future offshore wind component demand in the US market;
- The manufacturing capabilities of South Carolina's supply chain and ports as they relate to these demands;
- South Carolina's opportunity to generate economic benefits from leveraging and/or expanding the State's supply chain and ports to serve the demand; and
- Actionable recommendations for the State to leverage and/or expand the State's supply chain.

1.3 Document Structure

This study analyzes South Carolina's opportunity to manufacture components for US offshore wind projects within the context of the existing US offshore wind market. The document is structured as follows:

- **Section 1 – Introduction** provides the context for this study and explanation of this document.
- **Section 2 – Offshore Wind Manufacturing Supply Chain** describes various components in the offshore wind supply chain and details their manufacturing needs, established suppliers, and forecasted supply and demand over time in the US market.
- **Section 3 – US Offshore Wind Policy and Incentives** provides contextual insights on state and federal policies to incentivize offshore wind industry development.
- **Section 4 – South Carolina Capability** presents relevant findings related to the strengths of the industrial environment, relevant capabilities of South Carolina companies, and the compatibility of various South Carolina ports with the requirements of the offshore wind industry.
- **Section 5 – South Carolina Opportunity** analyzes the opportunity for South Carolina companies to manufacture offshore wind components or subcomponents based on informed evaluation of various criteria.
- **Section 6 – Economic Impact Potential** provides the inputs and the results of the economic impact study for various investment scenarios based on the best opportunity for South Carolina.
- **Section 7 – Discussion and Recommended Actions** summarizes the main themes of the study and presents recommendations for how state agencies can support the development of a South Carolina offshore wind supply chain.

1.4 Definitions

Glossary of Terms

Developer – An offshore wind developer is the owner and operator of an offshore wind farm. Generally, they are large multi-national energy producers and responsible for the delivery of the project in alignment with the terms agreed with local and/or national regulatory agencies and any agreed power purchase agreement.

Original Equipment Manufacturer – An OEM is the manufacturer of a product that is fully developed by the company. OEMs may still purchase parts from other manufacturers and use them to assemble their finished products.

Tier 1 – Tier 1 companies are suppliers of equipment or services to the project that generally contract directly with the Developer. Contracts are typically worth tens or hundreds of millions for the top level (Tier 1) packages such as supply or installation of WTGs or remaining balance of plant. Generally, the Tier 1 contractor will take the risk for schedule and cost overrun and be penalized accordingly should they not comply with agreed delivery dates.

Tier 2/3 – Tier 2 contractors supply products and services directly to the Tier 1 contractors. These are likely to more specialized in what they can produce and smaller than a Tier 1 company. These are likely to provide a more bespoke or specific component or service. Some Tier 1 suppliers will have a small selection of Tier 2 companies from which they exclusively source certain material, equipment, or services (to guarantee quality, price and/or schedule certainty) with other Tier 2 supply opportunities being subject to a competitive tender process to encourage competition in the supply chain. Tier 3 companies supply directly to Tier 2 suppliers and may be further specialized in what they supply.

List of Acronyms

ACRONYM	DEFINITION
BOEM	Bureau of Ocean Energy Management
CLV	Cable Lay Vessel
COD	Commercial Operation Date
CTV	Crew Transfer Vessel
EPCI	Engineering, Procurement, Construction and Installation
GW	Gigawatts
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IRA	Inflation Reduction Act
ITC	Investment Tax Credit

ACRONYM	DEFINITION
MOU	Memorandums of Understanding
MW	Megawatts
NAICS	North American Industry Classification System
NPV	Net Present Value
O&M	Operations and Maintenance
OEM	Original Equipment Manufacturers
OREC	Offshore Wind Renewable Energy Certificates
PMT	Private Marine Terminal
PPA	Power Purchase Agreement
PTC	Production Tax Credit
RAG	Red, Amber, Green
REMI	Regional Economic Models, Inc.
SCSPA	South Carolina Port Authority
SMBCC	Small and Minority Business Contracting and Certification
SOV	Service Operation Vessels

2 OFFSHORE WIND MANUFACTURING SUPPLY CHAIN

The South Carolina opportunity to benefit from the growth of the offshore wind industry will be influenced by requirements from project developers for the supply chain, the scale and timing of project development, and the response from other states and Tier 1 manufacturers to market evolution.

2.1 US Offshore Wind Market

The US offshore wind industry has experienced relatively quick progression, with East Coast states procuring over 15 GW of offshore wind capacity since the first full-scale offshore wind array was commissioned in 2016. A pipeline of offshore wind projects have secured seabed leases enabling the design of generation infrastructure and planning for connecting with the transmission network. The current projected pipeline of US offshore wind projects described in Figure 2.1 based on project developers' target installation dates shows that East Coast states are anticipated to lead the development of the industry. Offshore wind is expected to develop later in the Gulf of Mexico and on the West Coast once technology, policy and financial solutions emerge to challenges in those regions.

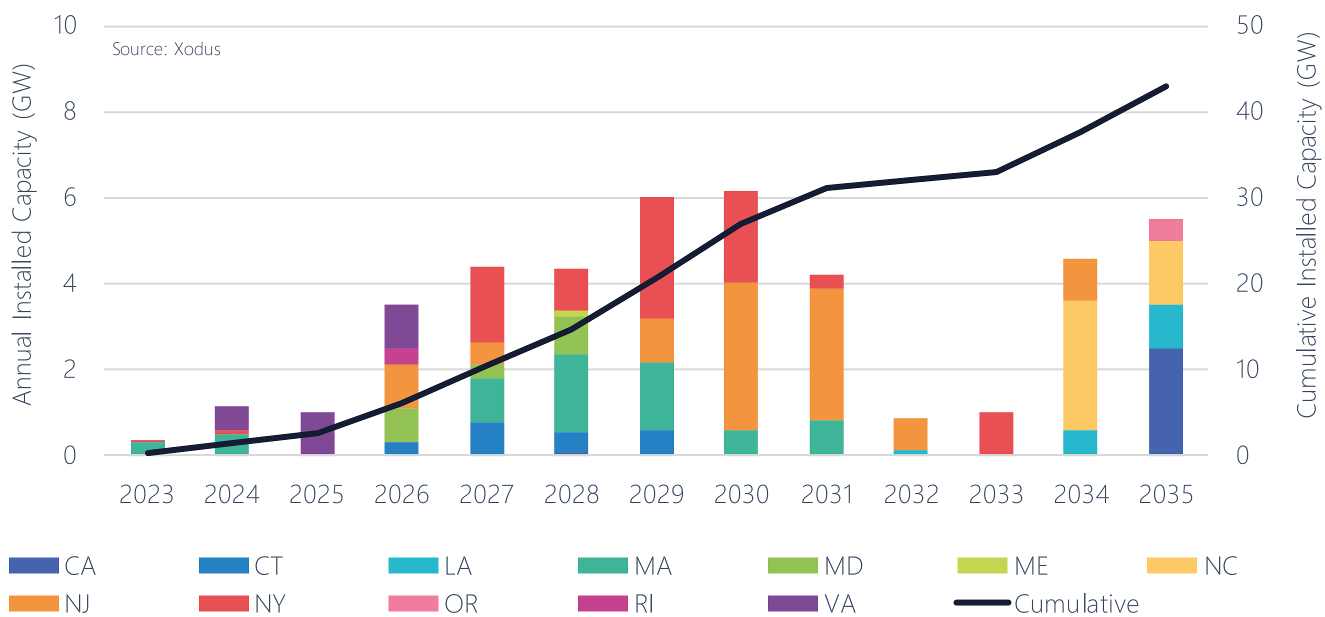

Figure 2.1 - US offshore wind installed capacity by state to 2035.

There remains some uncertainty in the ability to meet the federal target of 30 GW of developed capacity by 2030, including uncertainty in scale and timing of the projected pipeline. Anticipated near-term projects have negotiated procurement contracts with states to sell electricity, enabling higher certainty in their development and allowing stronger projections of the timing and scale of construction and installation. The projected dip in projected installation pipeline shown early next decade is representative of the uncertainty in timing for projects yet to secure a procurement contract and may level off as these projects update their installation plans to account for new or adjusted agreements to sell electricity or for changes in the availability of supply chain and grid connections.

The development of offshore wind projects is also sensitive to changes in the policy and the political landscape. Like other large infrastructure and energy projects, the nascent offshore wind industry has benefited from comprehensive federal and state planning and organization as well as public investment to develop ports, manufacturing, and transmission infrastructure. The offshore wind industry will likely need to retain political support to maintain the projected capacity pipeline.

2.2 US Offshore Wind Supply Chain

Offshore wind farms are comprized of multiple large, independently supplied components to generate and deliver power to the electrical grid. Power generated by individual offshore wind turbines is collected via array cables at an offshore substation before transmission via export cable to the onshore substation where the power is injected into the onshore electrical grid. The manufacturing of these components are advanced processes that require an assortment of raw or processed materials and subcomponents.

The supply of components for an offshore wind project can be broken down into a chain of tiers. Tier 1 original equipment manufacturers (OEMs) are contracted by project developers to supply the largest components. Tier 1 suppliers may manufacture the component from supplied materials or procure intermediate subcomponents from Tier 2 companies for assembly in-house. Tier 3 companies supply products, services or materials to Tier 2 suppliers and may be further specialized in what they supply. The generalized offshore wind manufacturing supply chain is summarized in with examples of products and services supplied at each tier.

Table 2.1 - Summary of tiered offshore wind supply chain.

COMPONENT	TIER	EXAMPLE PRODUCT OR SERVICE
Nacelle	1	Nacelle assembly, electrical commissioning.
	2	Gearbox, generator, main bearing system, pitch and yaw systems, power offtake.
	3	Bedplate, gears, bearings, switchgears, transformers, motors, brakes, lubricant, fire protection.
Blade	1	Blade layup, final testing.
	2	Consumables, adhesives, coatings, lightning protection.
	3	Fiberglass, carbon fiber, resin, steel, aluminum, iron/cast iron.
Tower	1	Steel forming, tower assembly, welding.
	2	Steel plates, flanges, steel fixtures, coatings.

COMPONENT	TIER	EXAMPLE PRODUCT OR SERVICE
	3	Steel, aluminum, resins.
Monopile	1	Steel forming, monopile assembly, welding.
	2	Steel plates, flanges, steel fixtures, coatings.
	3	Steel, aluminum, resins.
Transition Piece	1	Steel forming, transition piece assembly, welding.
	2	Steel plates, flanges, steel fixtures, coatings.
	3	Steel, aluminum, resins.
Jacket	1	Steel forming, jacket assembly, welding.
	2	Steel plates, flanges, steel fixtures, coatings.
	3	Steel, aluminum, resins.
Array Cable	1	Array cable extrusion, electrical commissioning.
	2	Stranded copper, stranded aluminum, crosslinked polyethylene insulation, ethylene propylene rubber, steel wire, lead wire, adhesives, fiber optic cable.
	3	Copper, aluminum, steel, lead, polyethylene, ethylene, polypropylene.
Export Cable	1	Array cable extrusion, electrical commissioning.
	2	Stranded copper, stranded aluminum, crosslinked polyethylene insulation, ethylene propylene rubber, steel wire, lead wire, adhesives, fiber optic cable.
	3	Copper, aluminum, steel, lead, polyethylene, ethylene, polypropylene.
Substation Electrical Infrastructure	1	Electrical infrastructure assembly, electrical commissioning.
	2	Switchgear, transformers, converters, reactive power compensation, cable.
	3	Steel, aluminum, copper.
Other Supporting Manufactured Components	1	Ring crane assembly, sea fastener assembly, shipbuilding, welding.
	2	Drivetrain system, rope, steel plates, steel pipes.
	3	Steel, aluminum, copper.

2.2.1 Tier 1 Manufacturing Facilities

The offshore wind industry has a global supply chain with many component products and services specialized to meet bespoke industry needs. For most large components that are a relatively low number of established suppliers with qualified capability and track record capturing the majority of the global market share of supply. These companies are often global corporations with extensive experience and robust financing structures that have enabled them to invest in manufacturing facilities that meet the needs of the offshore wind sector.

The industry has seen an increased desire to further localize the economic benefits of offshore wind projects, including in the US. States' scoring of project proposals submitted by developers during offshore wind power procurement tend to favor offshore wind projects that commit to delivering economic benefits to the state. Developers are motivated to procure offshore wind components and services from the state to which they are contracted to sell power to deliver on these promises. Developers may accept a cost premium associated with any local component supply to secure local content through the purchase, particularly if doing so enables a supplier to make inward investment that better sets them up for future success.

To date, the US has limited established Tier 1 manufacturing capability to supply the offshore wind sector. Some Tier 1 suppliers have announced their intent to construct new or enhance existing manufacturing facilities in the US to meet the demands of the growing offshore wind market, as described in Table 2.2. However, several announced facilities have subsequently faced technical or economic barriers that have seemingly delayed their investment. An explanation of the current confidence level in announced US Tier 1 manufacturing capability and the location of announced facilities are given in Table 2.3 and Figure 2.2 respectively.

Table 2.2 - Operational and announced US Tier 1 offshore wind manufacturing facilities.

COMPONENT	SUPPLIER	FACILITY LOCATION	PUBLICALLY ANNOUNCED INVESTMENT	CONFIDENCE LEVEL
Nacelle	Vestas	Wind Port, NJ	Unknown	Lower
Tower	Marmen Welcon	Port of Albany, NY	$700 million*	Lower
	US Forged Rings	East Coast	$700 million*	Medium
	Haizea Wind Group	Sparrows Point, MD	$150 million	Medium
Monopile	EEW	Paulsboro Marine Terminal, NJ	$250 million	Operational
	Haizea Wind Group	Sparrows Point, MD	$150 million	Medium
Transition Piece	Marmen Welcon	Port of Albany, NY	$700 million*	Lower
Array Cable	Hellenic Cables	Sparrows Point, MD	Unknown	Higher
	Prysmian	Brayton Point, MA	$200 million	Medium
Export Cable	Nexans	Charleston, SC	$310 million	Operational
	LS Greenlink	East Coast	$99 million	Medium
Substation Electrical Infrastructure	Kiewit	Ingleside, TX	Unknown	Operational

*Total announced investment covers capability to supply more than one component type

Table 2.3 - Definition of manufacturing facility confidence levels.

CONFIDENCE LEVEL	DEFINITION
Operational	Facility is operational and able to manufacture components.
Higher	Facility under development and has reached final investment decision.
Medium	Facility development plan has been announced, but lack of public updates has made development timeline unclear.
Lower	Facility development needs more funding.

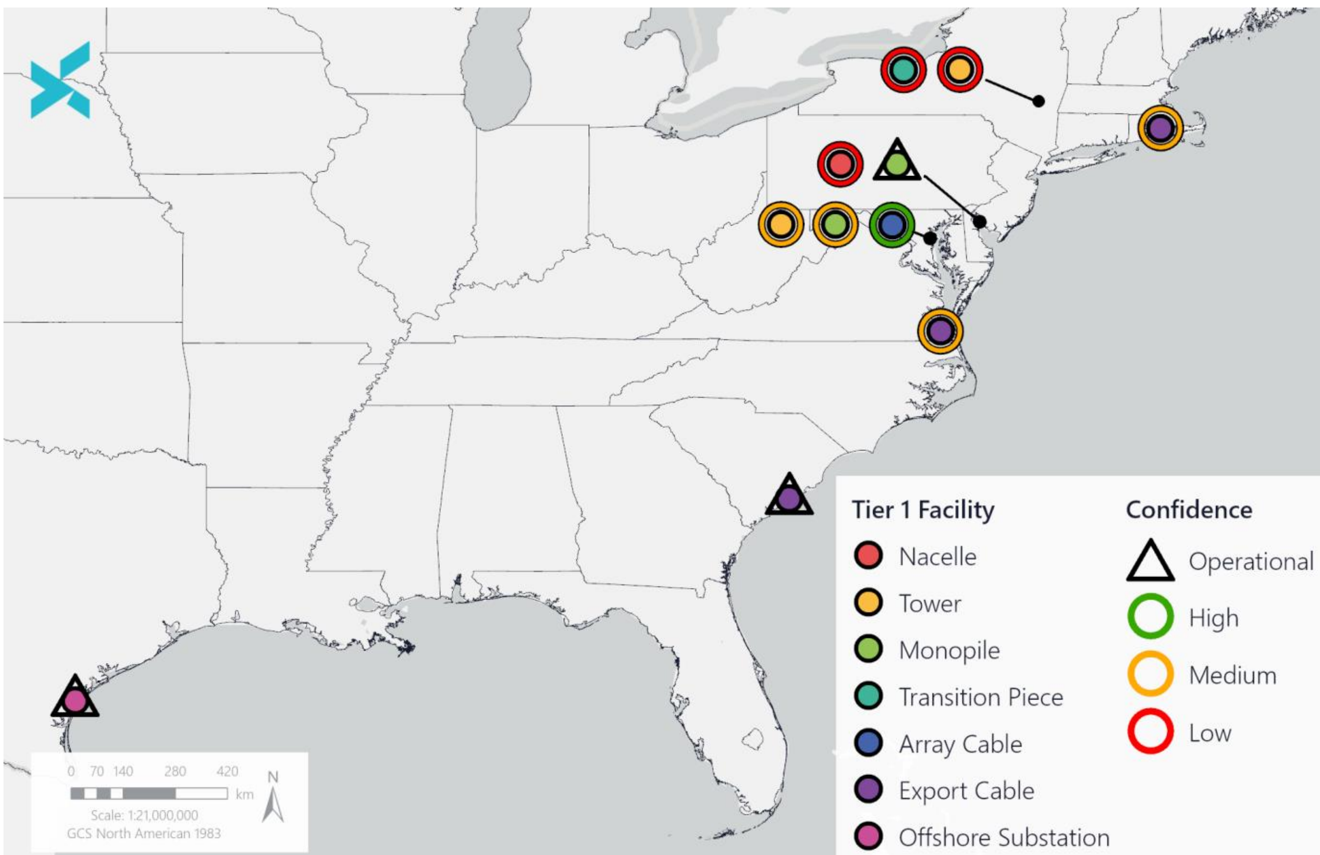

Figure 2.2 - Operational and announced US Tier 1 manufacturing facilities.

2.2.2 Steel Production Facilities

Steel is a primary material used to manufacture most large offshore wind components. Production of steel plates and forgings for Tier 1 components are major operations that require their own dedicated facilities. Secondary steel refers to the steel fixtures that fit on or around the components and are often fabricated at separate facilities from the Tier 1 manufacturing facilities.

Suppliers have announced major investments in steel product manufacturing facilities in the US. These investments include Nucor Steel's $1.7 billion investment in steel plate manufacturing in Kentucky, the only facility in the US currently manufacturing steel plates for the offshore wind industry. Riggs Distler's manufacturing facility in Rhode Island is currently the only operational offshore wind secondary steel manufacturing facility in the US. Ljungström, North Shore Steel, Smulders, Red Ironworks, Crystal Steel Fabricators, and Riggs Distler have made commitments to establish more secondary steel fabrication facilities in New York and Maryland. Table 2.4 lists operational and announced steel product manufacturing facilities for the US offshore wind industry in the US to date.

Table 2.4 - Operational and announced US steel product manufacturing facilities for the offshore wind market.

STEEL PRODUCT	SUPPLIER	LOCATION	INVESTMENT	CONFIDENCE LEVEL
Forged Steel	US Forged Rings	East Coast	$700 million*	Higher
Steel Plate	Nucor Steel	Bradenburg, KY	$1.7 billion	Operational
Secondary Steel	Riggs Distler	ProvPort, RI	$100 million	Operational
		Port of Coeymans, NY	$86 million	Medium
		Sparrows Point, MD	$14 million	Lower
		New Windsor, NY	Unknown	Medium
	Ljungström	Wellsville, NY	Unknown	Medium
	North Shore Steel	Newburgh, NY	Unknown	Medium
	Smulders	Ravena, NY	Unknown	Medium
	Red Ironworks	West Babylon, NY	$70,000	Medium
	Crystal Steel Fabricators	Federalsburg, MD	$70 million	Lower

*Total announced investment covers capability to supply more than one component type

2.3 Nacelle

Description

The turbine nacelle houses the subcomponents that converts kinetic energy from the rotor into three-phase alternating current electricity. The nacelle is an enclosed housing that contains electro-mechanical systems including the main shaft and bearing, gearbox, and generator, and pitch and yaw systems. The nacelle can weigh over 700 t with dimensions up to 25 m in length and 12 m in height and width.

An OEM typically owns the quayside facility where nacelles are assembled from a variety of subcomponents and subassemblies before being supplied to an offshore wind project. Such a facility can have physical footprint up to 75,000 sqm with an annual output up to 100 nacelles. The nacelle assembly process includes inspecting, lifting, surface cleaning, tensioning, and aligning these subcomponents and subassemblies. Table 2.5 describes the key materials, goods, and/or services required in the assembly of a nacelle.

Table 2.5 - Key subcomponents, materials, and/or services required for nacelle assembly.

SUBCOMPONENT, MATERIAL, OR SERVICE	DESCRIPTION	INDUSTRIAL CAPABILITY APPLICATION
Auxiliary electrical systems	Elements supporting function of the nacelle including the anemometer, condition monitoring system, air cooling system, control system.	Industrial electrical equipment Other goods supply
Bedplate	Two-part metal structure, with the heavier, front section cast from EN-GJS-400-18U-LT grade spheroidal graphite iron weighing over 30 t and the lighter, rear section fabricated from S355 grade steel.	Metal castings and forgings
Coatings	System of two-component epoxy- or polyurethane-based resins, typically including zinc rich and zinc phosphate primers with up to 80% volume solids, with a total dry film thickness between 100 and 250 micrometers. Coatings applied to internal subcomponents (e.g., structural bolts) and nacelle cover.	Coatings and marine corrosion protection supply
Cover	Fiberglass or steel structure weighing over 20 t.	Glass fiber supply Metal castings and forgings
Gearbox	System of gears mounted to the main drive shaft, typically with a first stage of planetary gears followed by high-speed parallel helical gears and a brake disc mounted at the rear, forged from steel or cast from high-grade SG iron like EN-CJS-700-2U.	Precision component fabrication Metal castings and forgings

SUBCOMPONENT, MATERIAL, OR SERVICE	DESCRIPTION	INDUSTRIAL CAPABILITY APPLICATION
Generator	Complex electromechanical device consisting of permanent magnets derived from rare-earth alloys, coils of copper wire known as windings, deep-groove bearings with ceramic rolling elements, and industrial electrical equipment like power converters, transformers, and switchgears.	Industrial electrical equipment supply
Hub casting	Cast iron spheroid weighing over 50 t with a diameter up to 8 m, cast from EN-GJS-400-18U-LT grade SG iron.	Metal castings and forgings
Main shaft and bearing	Hollow shaft weighing over 50 t, forged and machined from high-grade steel like 42CrMo4 or hollow cast from EN-GJS-400-18U-LT grade SG iron, mounted atop a single spherical-roller or tapered-roller bearing, comprised of a forged rolled ring over 4 m in diameter, rolling elements, and a cast SG iron housing.	Metal castings and forgings Precision component fabrication
Pitch and yaw systems	System of hydraulic actuators or electric geared motors, each weighing up to 1 t, driving a single-row 4-point contact ball bearing or three-row roller bearing weighing 5 to 10 t, comprised of forged rings of 42CrMo4 grade steel 6 to 8 m in diameter and rolling elements made from 100Cr6 grade steel.	Precision component fabrication

Domestic Supply and Demand

Supply contracts between developers and OEMs typically include the supply of the nacelle, blades, and tower and supervisory services during installation and commissioning, as well as operations and maintenance (O&M) services during the warranty period.

Three global OEMs dominate the Western offshore wind market: Vestas, GE Vernova, and Siemens Gamesa. They mostly assemble their nacelles in Denmark, the United Kingdom (UK), and other European countries. Developers have sought to drive down the levelized cost of electricity of their projects by encouraging OEMs to increase wind turbine size and thus increase turbine nameplate capacity. The largest offshore wind turbine currently on the market outside of China has a nameplate capacity of 15 MW. Key industry players are calling for OEMs to standardize wind turbines and build a supply chain with reliable assumptions on wind turbine size and corresponding installation needs. The industry anticipates offshore wind turbine size plateauing at 18 MW.

To manufacture a nacelle, an OEM procures many subcomponents from a global network Tier 2 suppliers, many of whom are regular, trusted suppliers of the OEM. New Tier 2 suppliers are subject to rigorous reliability and quality requirements because failed subcomponents in offshore wind turbines are challenging to access and expensive to repair in their offshore environment. Certain subcomponents are highly bespoke and therefore there are very few suppliers; there are 18 large turbine gearbox suppliers active in the supply chain, and most of the production capacity is in China. China is also home to most of the world's production of generators for offshore wind turbines.

There are no facilities in the US that currently supply nacelles for offshore wind turbines, but GE Vernova and Vestas have previously announced plans to establish nacelle assembly facilities in New York and New Jersey. GE Vernova's plans were canceled after the company decided not to advance their 18 MW wind turbine model and focus instead on the 15.5 MW model, impacting project offtake agreements and ending New York state and developer funding for the facility. Vestas has announced plans to build a nacelle assembly plant at the New Jersey Wind Port, where construction of the marshaling facility is underway. However, Vestas has not announced any progress on the assembly facility and has stated that development of the facility could be delayed or not built due to macroeconomic conditions.

Figure 2.3 shows the forecasted annual supply and demand of nacelles in the US in terms of the number of units and value. The approach to component supply and demand forecasting approach is included in Appendix A.

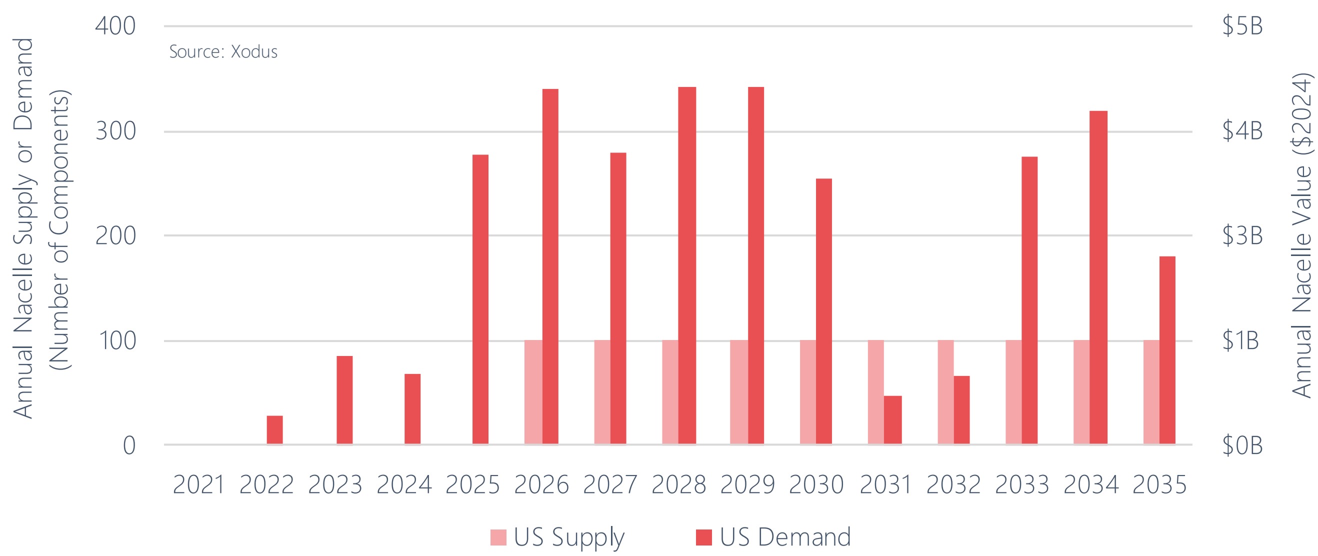

Figure 2.3 - Projected annual supply of, demand for, and value of nacelles in the US market.

Nacelles represent the largest component market (in total expenditure) due to their complexity and criticality. OEMs likely need subsidies from project developers and governments to justify initial investment in nacelle assembly facilities because of the associated complexity and high cost of nacelle assembly, and relatively large size of the facilities. The lack of domestic supply and the nacelle's high cost per component create a need for domestic nacelle assembly.

2.4 Blades

Description

Blades are structural aerofoils formed with fiber-reinforced polymer composites that attach to the nacelle and rotate in the wind. A single blade can weigh up to 50 t with dimensions up to 115 m in length and 6 m in width.

OEMs manufactures blades at a quayside facility with area up to 135,000 sqm and annual output of up to 300 blades. The manufacturing process is highly automated. Glass or carbon fibers are laid in large molds with other structural materials, infused with epoxy or polyester resin, and cured. The entire blade may be assembled and cured in one step, or two full-length half-shells may be glued together around a central load-bearing spar. The blades are finished with lightning protection systems and leading-edge erosion protection. Table 2.6 describes the key subcomponents, materials, and/or services required for blade manufacturing.

Table 2.6 - Key subcomponents, materials, and/or services required for blade manufacturing.

SUBCOMPONENT, MATERIAL, OR SERVICE	DESCRIPTION	INDUSTRIAL CAPABILITY
Adhesives	Two-component epoxy-based bonding agent.	Resin and adhesive supply
Auxiliary electrical equipment	Lightning protection system, condition monitoring system.	Electrical accessory supply
Carbon fibers	High-strength, lightweight carbon fibers derived from polyacrylonitrile and manufactured to diameter 7 microns.	Carbon fiber supply
Coatings	System of two-component polyurethane- or polyaspartic-based putty and resins with a total dry film thickness of 950 micrometers.	Coatings and marine corrosion protection supply
Core material	150 m^3 balsawood filler or closed-cell foam, commonly comprised of polyvinyl chloride and polyethylene terephthalate.	Polymer and polymer foam supply
Glass fibers	High-strength, lightweight glass fibers derived from borosilicate e-glass and manufactured to diameter 3-20 microns.	Carbon fiber supply Glass fiber supply
Resins	Two-component epoxy- or polyester-based liquid resins of density 1100-1300 kg/m^3 used as binder for carbon fiber reinforcement.	Resin and adhesive supply

Domestic Supply and Demand

There are currently no facilities in the US that manufacture offshore wind blades, nor are there any planned blade manufacturing facilities, as two previously announced facilities have since been cancelled. Siemens Gamesa previously announced plans to build a blade manufacturing facility in Port of Virginia's Portsmouth Marine Terminal, but these plans were cancelled because development milestones to establish the facility could not be met. LM Wind Power also announced a blade manufacturing facility in New York alongside GE's nacelle assembly facility investment, but plans for the blade manufacturing facility were also cancelled when GE Vernova decided not to advance their 18 MW wind turbine model. Figure 2.4 shows the forecasted annual supply and demand of blades in the US in terms of number of units and value.

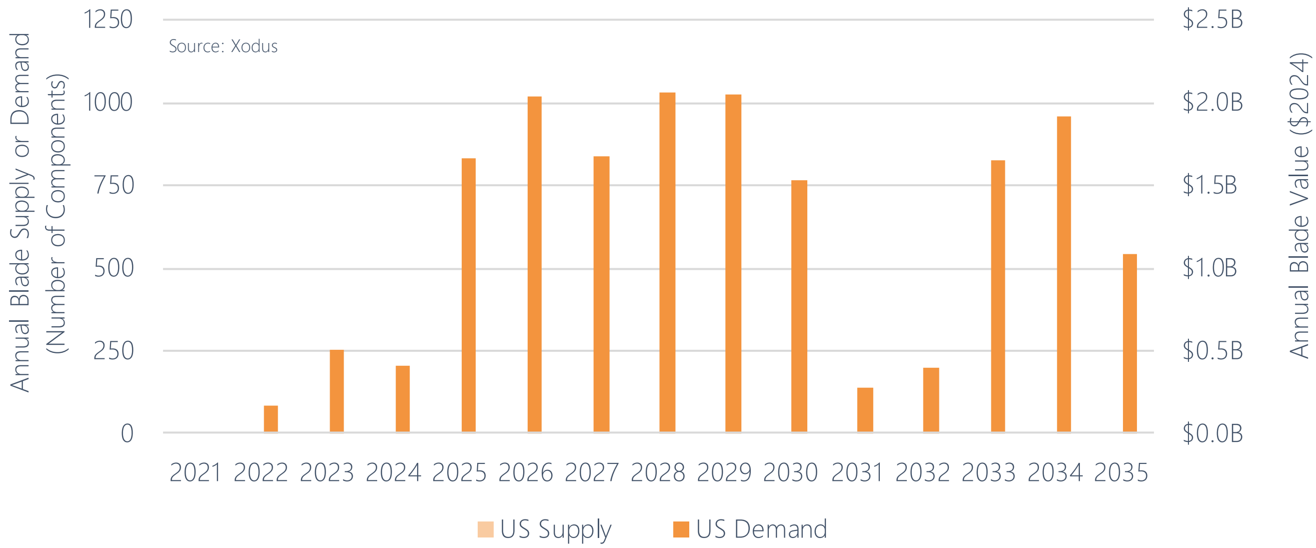

Figure 2.4 - Projected annual supply of, demand for, and value of blades in the US market.

2.5 Tower

Description

The tower is a tapered, tubular steel structure that supports the nacelle and blades. It weighs over 800 t with a height over 130 m and top and base diameters up to 6 m and 10 m, respectively.

A supplier typically manufactures towers at a quayside facility up to 100,000 sqm in area with an annual output of 100 towers. The supplier cuts, rolls, and welds up to 45 offshore-grade steel plates into cans with specialized equipment. The cans are welded together into three to four tower sections with heights up to 40 m, fitted with flanges and structural fasteners at each end, shot-blasted, and sprayed with surface finish for corrosion protection. Table 2.7 describes the key subcomponents, materials, and/or services required for tower manufacturing.

Table 2.7 - Key subcomponents, materials, and/or services required for tower manufacturing.

SUBCOMPONENT, MATERIAL, OR SERVICE	DESCRIPTION	INDUSTRIAL CAPABILITY
Auxiliary electrical equipment	Ventilating and cooling system, internal lighting, uninterruptible power supply, control and monitoring system (e.g., accelerometers, strain gauges, thermocouples, etc.).	Industrial electrical equipment supply Other

SUBCOMPONENT, MATERIAL, OR SERVICE	DESCRIPTION	INDUSTRIAL CAPABILITY
Auxiliary structural equipment	Steel or aluminum tower internals (e.g., ladder, stairway, elevator, platforms, cable trays, tower door, etc.).	Secondary steel/aluminum fixture fabrication
Coatings	System of two-component epoxy- or polyurethane-based resins, typically including zinc rich and zinc phosphate primers with up to 80% volume solids, with a total dry film thickness between 100 and 250 micrometers.	Coatings and marine corrosion protection supply
Fasteners	Steel bolts, studs, and nuts with rolled threads, typically of grade 10.9.	Precision component fabrication
Flanges	Forged and rolled rings, typically of S355 EN10.113-2 NL grade carbon steel, with a diameter up to 10 m.	Major steel structure fabrication
Steel plates	Steel plates up to 70 millimeter (mm) thick, typically of grade S355J2G3 NL, rolled and welded into cans with a height up to 3 m and a diameter up to 10 m.	Steel supply

Domestic Supply and Demand

Established global tower suppliers include CS Wind Offshore, GSG Towers, Haizea Wind Group, and Welcon. These fabricators operate across Europe with facilities in Denmark, Poland, and Spain.

There is one facility in the US producing steel plates for offshore wind towers. Nucor Steel opened a steel plate mill in Brandenburg, Kentucky in 2023. The facility is the only US mill and one of only few mills in the world capable of supplying heavy gauge steel plates at the grade, thickness, and scale necessary for offshore towers and monopiles.

There are currently no facilities in the US that manufacture offshore wind towers, although three facilities have been proposed, and one port awaits a tenant for tower manufacturing. Marmen, an onshore tower manufacturer, and Welcon announced plans in 2022 to invest in a tower manufacturing facility at the Port of Albany, New York. The Marmen Welcon facility's construction has stalled after some initial tree clearing in 2023 because market forces and macroeconomic conditions doubled the costs of development, and the joint venture is currently looking for funding sources to fill the gap. Haizea Wind Group proposed in 2023 a joint tower and monopile fabrication facility in Baltimore, Maryland, but the proposed facility has not released updates on its development since its announcement. US Forged Rings proposed in 2024 a steel forging plant and a tower fabrication facility to supply offshore wind projects, but the supplier has not released its selected location on the East Coast. The New Jersey Wind Port planned for tower manufacturing on a developed former greenfield site, and several New Jersey offshore wind projects committed to purchasing towers manufactured here; however, the New Jersey Wind Port has not secured a tenant to manufacture towers at the time of writing. Figure 2.5 shows the forecasted annual supply and demand of towers in the US in terms of number of units and value.

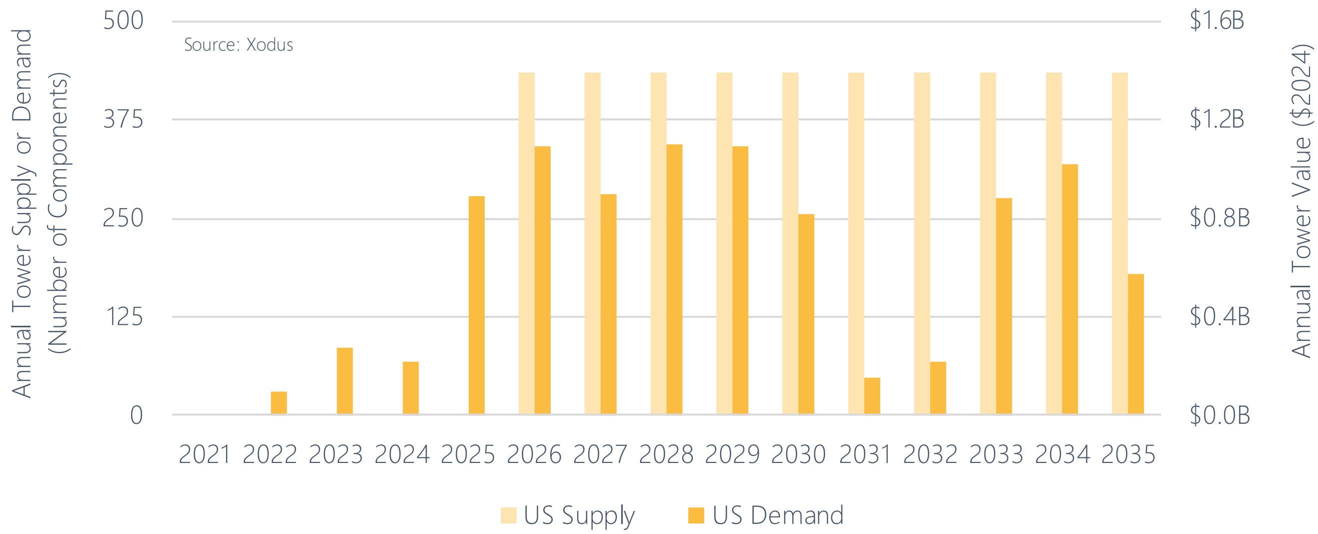

Figure 2.5 - Projected annual supply of, demand for, and value of towers in the US market.

Tower manufacturing is a less complex process than blade and nacelle manufacturing, but towers still represent a significant portion of relative project spend, and costs are largely tied to the price of steel. The relative ease of the tower manufacturing process has acted as a catalyst for the three planned tower manufacturing facilities and the port development plans. None of the facility development plans are on track to be developed on time, and none received a "high" confidence score. This trend is due to the heightened sensitivity tower manufacturers have to macroeconomic conditions, particularly the price of steel. These cost fluctuations are a large reason tower manufacturing plants require significant subsidies from project developers and governments, which can be difficult to source. This trend also alludes to a potentially larger opportunity for a new domestic tower manufacturing facility than suggested in Figure 2.5.

2.6 Monopile and Transition Piece

Description

The monopile is a steel structure driven into the seabed that transfers loads from the tower to the seabed, fixing the whole turbine to the seabed. Monopiles are the most common foundation type in the US to date, as they can be deployed in water depths up to 55 m and are suitable for the most offshore wind projects on the US East Coast. They have been utilized at all but one US offshore wind project. Monopiles have significantly increased in size and thickness in recent years, with extra-large monopiles reaching diameters of 10 m and lengths of 110 m.

Monopile manufacturing occurs at large quayside facilities of varying size. These facilities receive steel plates, transport them through the facility with cranes, and then mill, weld, and roll them into cones and cans before transporting them on the self-propelled modular transporters. The process utilizes highly automated large steel rolling and welding machinery. Table 2.8 describes the key subcomponents, materials, and/or services required for monopile manufacturing.

Table 2.8 - Key subcomponents, materials, and/or services required for monopile manufacturing.

SUBCOMPONENT, MATERIAL, OR SERVICE	DESCRIPTION	INDUSTRIAL CAPABILITY
Anodes	System of electrically charged metal structures, typically of aluminum, titanium, or zinc alloys, each weighing 100 to 500 kg.	Secondary steel/aluminum fixture fabrication
Coatings	Typically glass-reinforced epoxy coatings or and glass-flake polyester coatings.	Coatings and marine corrosion protection supply
Fasteners	High-strength steel bolt and nut, typically of stainless or S316 grade steel.	Precision component fabrication
Flanges	Forged and rolled rings up to 10 m in diameter, typically from S355 EN10.113-2 NL grade steel, that will mate to the flange of the tower and the monopile.	Metal castings and forgings
Grout	Ultra-high strength cement grout, typically with 28-day characteristic strengths of 100 Megapascals or higher.	Other goods supply
Scour protection	Filter stone and rock armor (large rock material, typically natural limestone, granite, and basalt or manufactured material), concrete mattresses, or geotextile bags.	Riprap supply
Steel plates	Steel plates up to 150 mm thick, typically of S355 EN10.113-2NL grade steel, rolled and welded into cans up to 10 m in diameter.	Steel supply

A transition piece connects the tower to the monopile and supports secondary steelwork like boat landings, davit cranes, cable entry, and work platforms. Monopiles typically require a separate transition piece, but “TP-less” monopiles, which do not require a transition piece, are currently being explored in the US market.

Transition pieces consist of rolled and welded steel cans and are fitted with joints at the top and base. The flange at the top of the transition piece mates to the flange at the base of the tower, while the flange or grouted joint at the base secures the transition piece to the monopile. Secondary steelwork is attached by welded or bolted joints, and the transition piece is finished with protective coatings and painted yellow for visibility. Table 2.9 describes the key subcomponents, materials, and/or services required for transition piece manufacturing.

Table 2.9 - Key subcomponents, materials, and/or services required for transition piece manufacturing.

SUBCOMPONENT, MATERIAL, OR SERVICE	DESCRIPTION	INDUSTRIAL CAPABILITY
Anode	System of electrically charged metal structures, typically of aluminum, titanium, or zinc alloys, each weighing 100 to 500 kg.	Secondary steel/aluminum fixture fabrication
Boat landing	System of bumper bars and secondary steel support structure, including cable trays and other internals. Size dependent on tidal range at site (e.g., 5 to 10 m).	Secondary steel/aluminum fixture fabrication
Coatings	Typically glass-reinforced epoxy coatings or and glass-flake polyester coatings, with varying degrees of protection depending on application in atmospheric zone, splash zone, or immersion zone.	Coatings and marine corrosion protection supply
Davit crane	System of 316L stainless steel and mechanical drive train, bearings, and electrical controls with lifting capacity of 2+ t.	Secondary steel/aluminum fixture fabrication
Flange	Forged and rolled ring, typically of S355 EN10.113-2 NL grade steel, with a diameter up to 10 m.	Major steel structure fabrication
Steel plates	Steel plates up to 150 mm thick, typically of S355 EN10.113-2NL grade steel, rolled and welded into cans up to 10 m in diameter.	Steel supply
Work platforms	Ladder, handrail, grating and decking, typically of steel or aluminum.	Secondary steel/aluminum fixture fabrication

Domestic Supply and Demand

Global steel fabricators contracted to supply monopiles and transition pieces for US offshore wind projects include EEW Group, CS Wind Offshore, Steelwind Nordenham, and Windar Renovables. These components have been manufactured in European countries including Denmark, Germany, and Spain.

There is one facility in the US producing steel plates for offshore wind monopiles. Nucor Steel's steel plate mill in Brandenburg, Kentucky produces steel plates for offshore wind monopiles in addition to towers.

There is one facility in the US currently able to manufacture offshore wind monopiles, and one facility announced. EEW Group opened a monopile manufacturing facility at the Port of Paulsboro, New Jersey in 2023 with significant investment from developers and governments. It will achieve a production capacity of 100 monopiles a year with the capability to handle 12 m steel plates once the second phase of development is completed between 2026 and 2027. Three offshore wind projects off the coast of New Jersey have committed to procuring monopiles from the facility.

Haizea Wind Group announced plans to fabricate monopiles at a multipurpose facility in Baltimore, Maryland but has not released updates on the facility since 2023. The facility's development is effectively tied to the progress of Maryland's offshore wind market, which is projected to initiate in 2026. Figure 2.6 shows the forecasted annual supply and demand of monopiles in the US in terms of number of units and value.

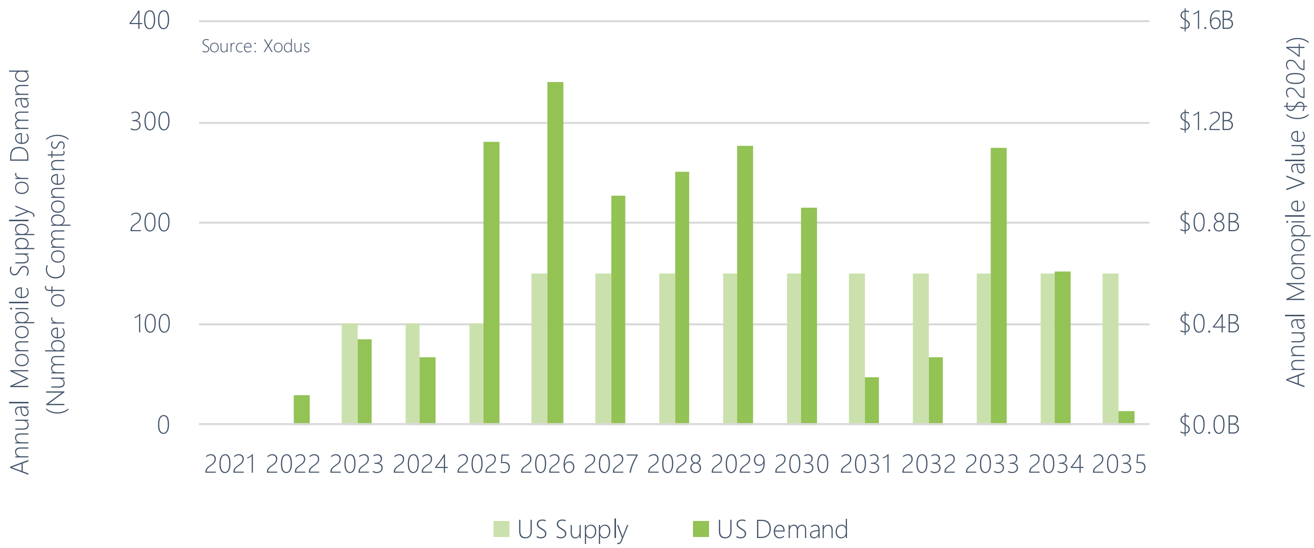

Figure 2.6 - Projected annual supply of, demand for, and value of monopiles in the US market.

Technical barriers like water depth limit monopile's market size, as jackets and floating foundations will likely be utilized for projects in deeper waters, despite the large domestic market size for monopiles in the short term. EEW's operating monopile manufacturing facility and Haizea Wind Group's facility are expected to satisfy a large portion of the domestic monopile market, capping the potential domestic export market for a new monopile manufacturing facility.

Secondary steelwork fabrication requires less specialized equipment than monopiles or transition pieces. It is often sub-contracted to a smaller steelwork supplier within the state procuring power for local content benefit, although it may be supplied as part of the transition piece package.

There are currently no facilities in the US that manufacture offshore wind transition pieces, although one facility has been proposed. Marmen Welcon has announced plans to manufacture transition pieces at same facility as their tower manufacturing facility at the Port of Albany, New York. As noted above, the facility's construction has stalled, and the joint venture is currently looking for funding sources to fill the gap. Figure 2.7 shows the forecasted annual supply and demand of transition pieces in the US in terms of number of units and value.

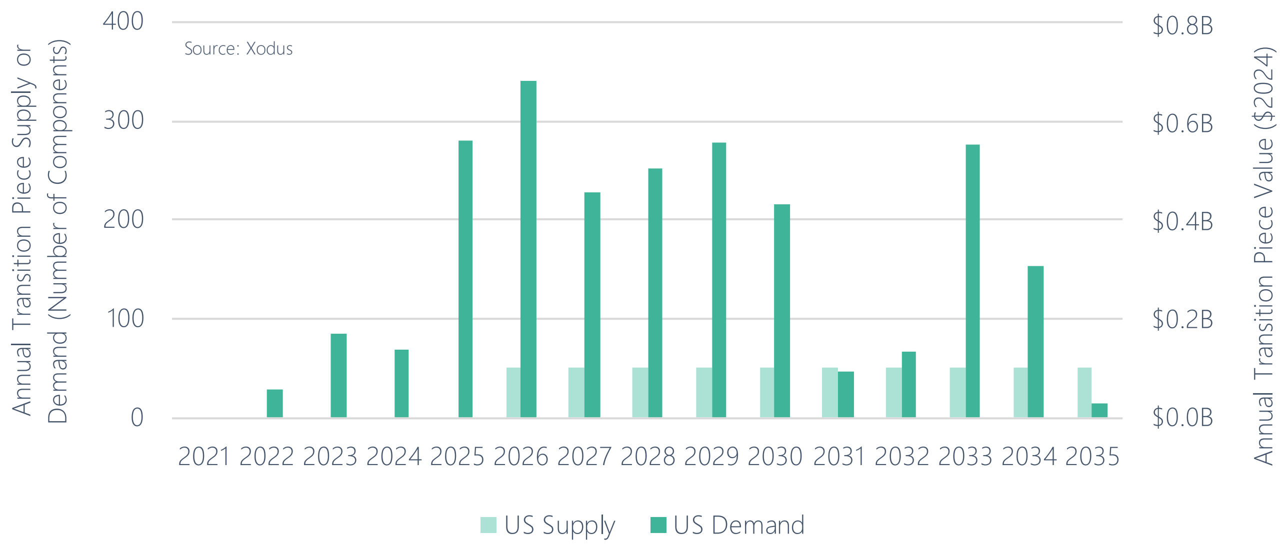

Figure 2.7 - Projected annual supply of, demand for, and value of transition pieces in the US market.

The demand for transition pieces could diminish over time if "TP-less" monopiles become a favored foundation type in the market. This potential trend was not factored into the component forecast due to technological uncertainty, so the demand trends for monopiles and transition pieces are one-to-one. The high cost of transition piece facility development and relatively low market size create a relatively small business case for a new transition piece manufacturing facility, despite large domestic demand for transition pieces.

2.7 Jacket

Description

A jacket foundation is a fixed lattice-truss structure made up of large steel tubes (legs and x-braces) driven into the seabed. The jacket supports the offshore substation on the seabed.

Jackets can also serve as foundations for offshore wind turbines when seabed conditions or water depths are not suitable for monopiles, which are less expensive; however, jackets have not yet been utilized as turbine foundations in any commercial-scale US offshore wind projects to date. The demand for offshore substations is low enough for jackets to be manufactured in one-off scopes, so Tier 1 manufacturers typically have not dedicated facilities to full-time manufacturing of jackets for the offshore wind industry. Rather, jackets have traditionally been manufactured at large fabrication yards that possess the necessary equipment, labor, and capacity and serve other industries as well.

At these fabrication yards, thick steel plates up to 300 mm thick are rolled into jacket legs and x-braces; while the required plates are thicker than those used for the monopile, the overall outer diameter of the legs can be smaller at up to 5.5 m. The jacket legs and x-braces are welded together into two dimensional frames that are fitted together with additional x-braces to form the lattice-truss structure. Secondary steelwork is attached by welded or bolted joints. Each subcomponent of a jacket can be manufactured at different sites then transported to an assembly site, where the assembled jacket is coated with protective coatings. Table 2.10 describes the key subcomponents, materials, and/or services required for jacket manufacturing.

Table 2.10 - Key subcomponents, materials, and/or services required for jacket manufacturing.

SUBCOMPONENT, MATERIAL, OR SERVICE	DESCRIPTION	INDUSTRIAL CAPABILITY
Anode	System of electrically charged metal structures, typically of aluminum, titanium, or zinc alloys, each weighing 100 to 500 kg.	Secondary steel/aluminum fixture fabrication
Boat landing	System of bumper bars and secondary steel support structure. Size dependent on tidal range at size (e.g., 5 to 10 m).	Secondary steel/aluminum fixture fabrication
Coatings	Typically glass-reinforced epoxy coatings or and glass-flake polyester coatings, with varying degrees of protection depending on application in atmospheric zone, splash zone, or immersion zone.	Coatings and marine corrosion protection supply
Davit crane	System of 316L stainless steel and mechanical drive train, bearings, and electrical controls with lifting capacity of 2+ t.	Secondary steel/aluminum fixture fabrication
Flange	Forged and rolled ring, typically of S355 EN10.113-2 NL grade steel, with a diameter up to 10 m.	Major steel structure fabrication
Scour protection	Filter stone and rock armor (large rock material, typically natural limestone, granite, and basalt or manufactured material), concrete mattresses, or geotextile bags.	Riprap supply
Steel plates	Steel plates up to 300 mm thick, typically of S355 EN10.113-2NL grade steel, rolled and welded into cans with a height up to 3 m and a diameter up to 5.5 m.	Steel supply
Work platforms	Ladder, handrail, grating and decking, typically of steel or aluminum.	Secondary steel/aluminum fixture fabrication

Domestic Supply and Demand

Special jacket manufacturing facilities do not exist in the US, nor are announced facilities anticipated, because jackets have traditionally not been manufactured in serialized production facilities. Gulf Island Fabrication manufactured jackets and a variety of other complex steel structures at the company's facility in Louisiana. CS Wind Offshore and Smulders have manufactured jackets for US and European offshore wind projects at their various facilities across Belgium, the Netherlands, Poland, the UK, and Denmark. Other large manufacturing companies like EEW also manufacture components like pipes and topsides for jacket structures. Figure 2.8 shows the forecasted annual demand of jackets in the US in terms of number of units and value.

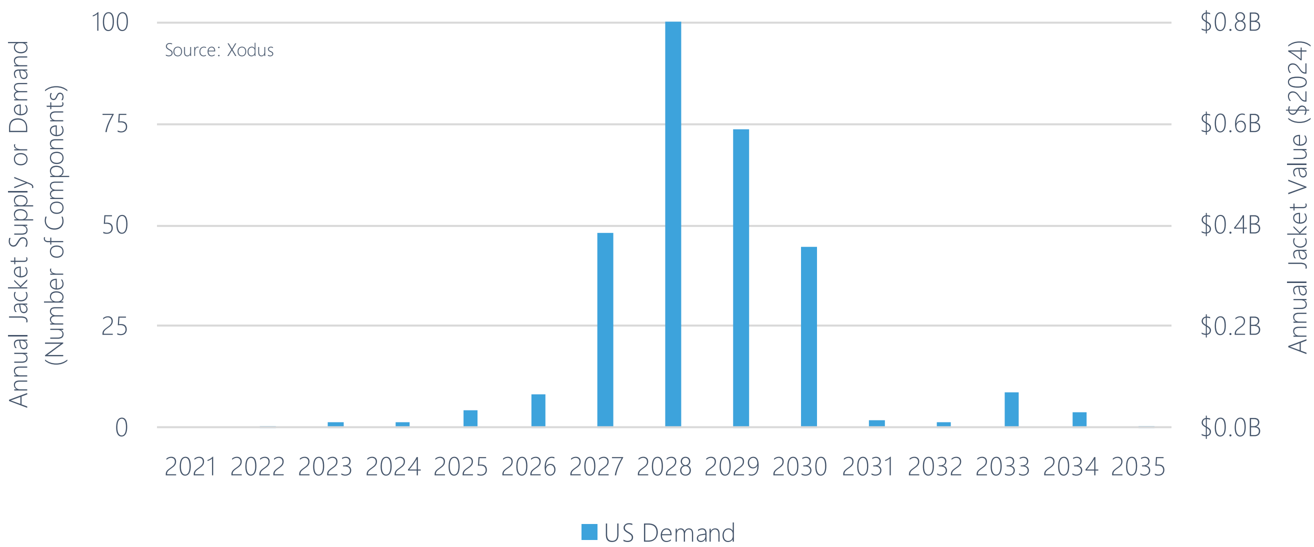

Figure 2.8 - Projected annual demand for and value of jackets in the US market.

For US offshore wind projects, jacket foundations have largely been considered for offshore substations rather than for turbines themselves (outside of the Block Island Wind Farm project). This trend is due to monopiles being a preferred foundation type for projects under 55 m of water depth, due to lower costs. Jackets may be used as turbine foundations for projects in deeper waters, as technical and cost barriers could constrain monopile usage. This is anticipated to lead to an increase in demand for jackets, but not to the scale seen for monopiles.

2.8 Array Cables

Description

Array cables transport the electricity from each turbine to the offshore substation. These cables are 66 kV alternating current cables because turbines generate alternating current electricity. Array cables consist of three cable cores, the fiber optic cable, and the cable outer. The cable cores are extruded from raw materials and laid up in a single production line. The cores consist of stranded conductor like copper or aluminum surrounded by semi-conducting tape, cross-linked polyethylene insulation, and a protective lead sheath. The outer surrounds the cable core and fiberoptic cable with armoring layers like polypropylene and bitumen to protect against corrosion and provide additional adhesion. These cables are typically 200 mm to 300 mm in their outer diameter. Table 2.11 describes the key subcomponents, materials, and/or services required for array and export cable manufacturing.

Table 2.11 - Key subcomponents, materials, and/or services required for array and export cable manufacturing.

SUBCOMPONENT, MATERIAL, OR SERVICE	DESCRIPTION	INDUSTRIAL CAPABILITY
Cable accessories	Cable clamps, concrete mattresses bend stiffeners, secondary steel j-tubes (450 to 750 mm diameter), cable trays	Secondary steel/aluminum fixture fabrication
Cable sheath and armor	Bitumen and helical stainless steel or non-magnetic galvanized steel wires surrounding cable core	Steel supply
Conductor core	Stranded copper, stranded aluminum	Steel supply Other
Core insulation	Cross-linked polyethylene	Polymer and polymer foam supply
Core protection	Semiconductive screening, taping, swelling tape, PE sheath, filler, insulation	Polymer supply Other
Fiberoptic cable	Multimodal for multiple data frequencies, and designed with custom fiber count and type, filling compound type, and armor type but typically with 48 strands.	Fiber optic cable supply

Domestic Supply and Demand

Suppliers such as Prysmian Group, JDR Cable Systems, Hellenic Cables, and NKT have manufactured array cables for US offshore wind projects. These manufacturers operate cable facilities across Europe in Greece, Italy, Norway, and the UK.

There are currently no facilities in the US that manufacture array cables, although two facilities have been proposed. Hellenic Cables announced plans to build an array cable manufacturing facility in Baltimore, Maryland in 2023 and received a transferrable tax credit of $58 million from the US Department of Energy in 2024. Prysmian Group also announced plans to build a subsea cable manufacturing facility in Brayton Point, Massachusetts in 2022. Figure 2.9 shows the forecasted annual supply and demand of array cable in the US in terms of cable length and value.

The Hellenic facility is anticipated to serve many East Coast offshore wind projects, but its ability to provide cables for West Coast projects is currently unclear because of logistic challenges due to transportation through the Panama Canal. West Coast projects are projected to begin installation in the mid-2030s, so long-term market demand for a South Carolina-based array cable manufacturing facility may rely on the continued expansion of offshore wind on the East Coast and Gulf of Mexico.

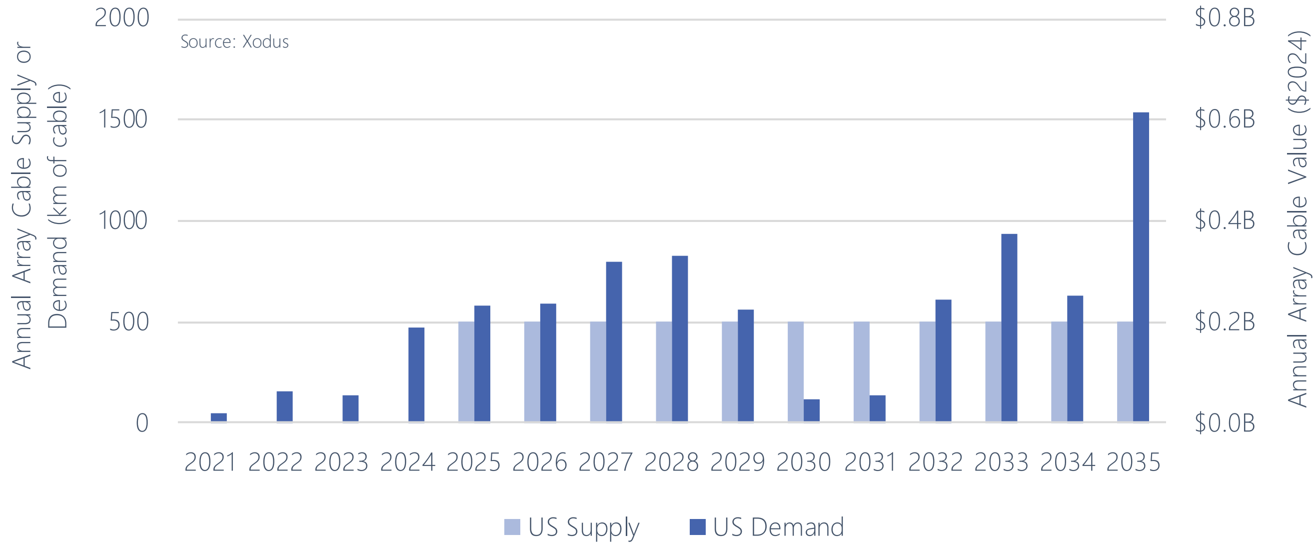

Figure 2.9 - Projected annual supply of, demand for, and value of array cables in the US market.

2.9 Export Cable

Description

Export cables transport electricity from the offshore substations to the onshore substation. 145 to 400 kV high voltage alternating current (HVAC) cables or up to 525 kV high voltage direct current (HVDC) cables may be used for export cables depending on the amount of power being transported and distance to shore. HVDC cable can cost around 30% more than HVAC depending on component specifications; however, HVDC systems experience lower electrical loss over long distances than HVAC systems and are therefore the preferred cable choice for projects further from shore.

HVAC cables have three cores, while HVDC cables have a single core but must be installed in bipolar pairs. Export cables are often manufactured in different facilities than array cables because they have a slightly different manufacturing process to account for the difference in power transmitted (i.e., higher voltage and, in HVDC cases, direct current) and are heavier, requiring different transport equipment. However, the export cable manufacturing process is relatively similar to the array cable, so a supplier can sometimes manufacture both. Table 2.11 included above describes the key materials, goods, and/or services required in export cable manufacturing.

Domestic Supply and Demand

Subsea cable manufacturers like Nexans, Hellenic Cables, JDR Cable Systems, and Prysmian Group have supplied array cables for US offshore wind projects. These manufacturers operate cable facilities across Europe in Greece, Italy, Norway, and the UK.

There is one facility in the US manufacturing export cable – Nexans' facility in Goose Creek, South Carolina – and two other facilities have been proposed. The Nexans facility is capable of manufacturing export cables up to 400 kV HVAC or 525 kV HVDC. Nexans procures bespoke materials globally but has contracted South Carolina businesses for some operations tasks such as calibration, maintenance, and scrap metal removal and local vessel companies for safe transportation of their cable product. LS Greenlink announced plans for an HVDC export cable manufacturing facility in Virginia. The federal government provided an investment tax credit of $99 million for the proposed facility, which is planned to be the largest export cable facility in the US. Prysmian Group also announced plans to build a subsea cable manufacturing facility in Brayton Point, Massachusetts in 2022, which will manufacture export cables up to 275 kV AC or 525 kV DC in addition to array cables. Figure 2.10 shows the forecasted annual supply and demand of array cable in the US in terms of cable length and value.

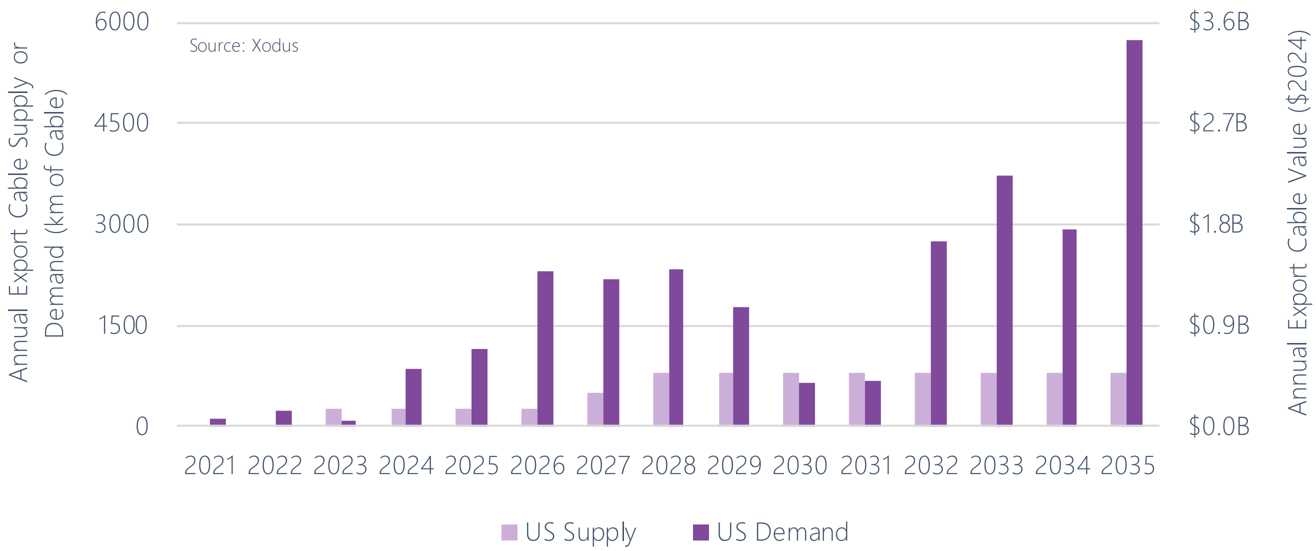

Figure 2.10 - Projected annual supply of, demand for, and value of export cables in the US market.

The Nexans facility is considered a key piece of the domestic offshore wind supply chain. Even assuming announced facilities reach operation alongside this Nexans facility, there is still a large supply-demand gap for domestic export cable, particularly as projects are sited further from shore over the coming decades.

2.10 Substation Electrical Infrastructure

Description

Offshore wind farm construction involves the procurement of both onshore and offshore substations, which transform the power generated by the turbines for export and connection to the electrical grid. The offshore substation steps up the power to a higher voltage to reduce transmission losses during transport to the onshore substation. The offshore substation consists of the topside and the foundation. The topside houses the electrical system that collates the power from individual turbines, increases the voltage, and in some cases converts alternating current to direct current with equipment such as high voltage switchgear, transformers, converters, and reactive power compensation. The foundation, like that of a turbine, supports the offshore substation and is most often a jacket, as previously discussed.

The onshore substation transforms power received from the export cable to electrical grid voltage, in some cases converting direct current to alternating current. The onshore substation requires an electrical system of high voltage switchgears, transformers, converters, and other transmission equipment. Onshore substations are sometimes contracted to the same EPCI as the offshore substation, who is likely to sub-contract a local transmission system supplier or civil engineering contractor.

Table 2.12 - Key subcomponents, materials, and/or services required for substation electrical infrastructure manufacturing.

SUBCOMPONENT, MATERIAL, OR SERVICE	DESCRIPTION	INDUSTRIAL CAPABILITY
Auxiliary structural equipment	Davit cranes, cable trays	Secondary steel/aluminum fixture fabrication
Auxiliary support equipment	Fire alarm, control equipment, Supervisory Control and Data Acquisition, ventilation and cooling system, lighting, telecom	Industrial electrical equipment supply Other
Electrical equipment	Transformer (66 kV transformed to 145 to 400 kV), converter, gas insulated switchgears, switchboards, electric panels, shunt reactor, cabinets	Industrial electrical equipment supply
Topside structure	Steel, helideck	Major steel structure fabrication Secondary steel/aluminum fixture fabrication

Domestic Supply and Demand

Offshore substations are typically manufactured in large fabrication yards that have experience with large-scale electrical systems rather than at facilities specifically focusing on serial production of offshore substations. For example, companies like Kiewit and CS Wind manufacture large steel components and have been contracted for offshore wind substations for US offshore wind projects.

Global manufacturers of HVAC and HVDC electrical equipment for offshore wind projects include ABB, GE, Hitachi, Mitsubishi, and Siemens. Although these suppliers operate in the US, their manufacturing capabilities are localized across Asia and Europe, where there is significant investment in high voltage infrastructure projects. HVDC system manufacturing does not exist in the US, and there are only a handful of facilities capable of manufacturing large power transformers for HVAC applications.

While many minor components comprise the entire substation, they are typically delivered as a single contracted component. The cost of offshore substations can also vary significantly depending on size and whether HVAC or HVDC is used.

Kiewit is the only supplier currently manufacturing offshore substations in the US. Offshore substations, including both the topside and the foundation, are designed and manufactured at its facility in Ingleside, Texas. The yard was originally built in 2001 as a major oil rig construction yard with a $100 million budget, and the facility has since played a key role in engineering and constructing some of the most complex offshore deepwater infrastructure projects in the US. Cables, high and medium-voltage equipment, instruments, meters, and other components are all procured by Kiewit. Figure 2.11 shows the forecasted annual supply and demand of offshore substations in the US in terms of number of units and value.

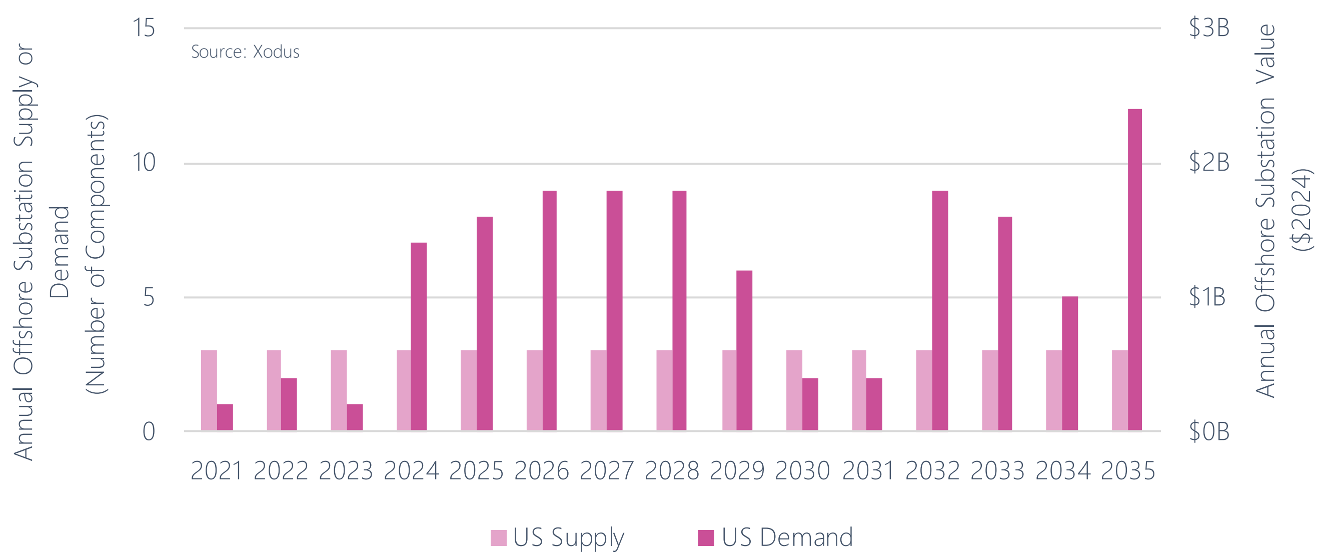

Figure 2.11 - Projected annual supply of, demand for, and value of offshore substations in the US market.

2.11 Other Supporting Manufactured Components

Description

A variety of equipment is required to support offshore wind component manufacturing and transportation. Manufacturing facilities require large handling equipment, including heavy lift cranes and self-propelled modular transporters, to move components around the facility, and equipment for activities including plate cutting, welding, and shotblasting. Much of the equipment required for transportation and installation of components are sea fasteners designed, engineered, and manufactured specifically for individual projects by the EPCI companies contracted by the developer. This sea fastening equipment includes blade racks, monopile cradles, tower grillages, and subsea cable spools. Additionally, monopile grippers, spreader bars, lifting and flange tools, and upending hinges are rented or fabricated for use in lifting and maneuvering the monopile and transition piece. Other equipment including tracked cable tensioners and cable hold-back winches maintain controlled tension during subsea cable installation. The reliability of these equipment is crucial, and therefore the manufactured components must withstand strict inspection.

Offshore installation services are often contracted to a single EPCI that owns and operates a vessel fleet, although some installation scopes may be sub-contracted to specialist marine contractors. Offshore installation requires a variety of specialized vessels; some examples include wind turbine installation vessels (WTIVs), service operation vessels (SOVs), crew transfer vessels (CTVs), guard vessels, cable laying vessels (CLVs), cable burial vessels. WTIVs are outfitted with large heavy-lift cranes and install wind turbine components on top of the monopile foundation. SOVs and CTVs are used to transfer and house crew offshore for component installation, and guard vessels monitor the installation activities, manage vessel traffic, and facilitate emergency response. CLVs and cable burial vessels lay and bury the subsea cable after a remotely operated vehicle digs a cable trench in the seabed. Few of these vessels have been built in the US to date.

Components are transported from the marshaling port to the installation site on barges and installed by specialized vessels, as the Jones Act restricts foreign vessels from loading components at US ports. Table 2.13 includes descriptions of some key other supporting manufactured components.

Table 2.13 - Descriptions of other supporting manufactured components.

SUBCOMPONENT, MATERIAL, OR SERVICE	DESCRIPTION	INDUSTRIAL CAPABILITY
Personnel access equipment	Walk-to-work gangway, offshore evacuation systems	Secondary steel/aluminum fixture fabrication Specialized equipment manufacturing
Port equipment	Self-propelled modular transporter, ring crane	Specialized equipment manufacturing
Sea fastening equipment	Blade rack, monopile cradle, tower grillage, subsea cable steel drum	Secondary steel/aluminum fixture fabrication
Vessels	WTIV, SOV, CTV, guard vessel, CLVs, cable burial vessels	Major steel structure fabrication

Domestic Supply and Demand

The manufactured components described above are typically fabricated in-house by EPCI companies and vessel owners or subcontracted to shipbuilders and metal fabricators. Specialized heavy lift companies like Mammoet Transport and Sarens manufacture ring cranes and other offshore installation equipment. Manufacturers of sea fastening equipment include global suppliers like Semco Maritime, Holmatro, MacArtney Offshore Wind Solutions, and APT Global Marine. EPCI companies and maritime contractors, such as Jan De Nul, Deme Group, and Hereema, often contract specialized shipyards for the supply of installation vessels.

This study did not forecast the supply and demand of other manufactured components because the number of different types of supporting manufactured components is vast and the necessary inputs (e.g., assumptions on when information is manufactured or rented for a given project) could not be sourced from public domain. However, it is anticipated that the established global players will continue to lead the EPCI market in the US. For example, Chet Morrison Contractors in Louisiana was subcontracted by GE to supply vertical tower stands for transportation and storage in Vineyard Wind 1. Several vessels have also been manufactured in the US by shipbuilders Seatrium and Edison Chouest Offshore for several proposed projects.

3 US OFFSHORE WIND POLICY AND INCENTIVES

Political incentives and initiatives are important tools in developing any new industry and supply chain. Comprehensive policy mechanisms can establish frameworks for investment, provide regulatory terms that lower the risk of new investments, and encourage private companies to consider entering a new market. These policies can occur at the state and federal levels, vary in degrees of intervention, and offer a range of benefits to the offshore wind supply chain.

3.1 State Policies and Legislative Initiatives

Many states have catalyzed their respective offshore wind industries through policy initiatives, specifically legislation or executive order. Some states, including Massachusetts and Maryland, have used legislation to create offshore wind procurement targets and provide financial incentives for developing an offshore wind supply chain. Other states, including New York and California, have used executive orders to create offshore wind procurement targets and mandate the creation of comprehensive offshore wind development strategies. Table 3.1 highlights state-level policy offshore wind initiatives and their associated actions.

Procurement targets are one of the core policy mechanisms states use to support the growth of an in-state offshore wind industry. Procurement targets provide a strong market signal by reducing risk and encouraging investment in offshore wind projects and the supply chain. Offshore wind targets have historically stemmed from a state's existing Renewable Portfolio Standard, which requires utilities to ensure that a determined percentage of the electricity they sell is generated by renewable sources. Each state's RPS and offshore wind procurement target, along with information on procurement mechanisms, are included in Appendix B.

States can encourage offshore wind supply chain development outside of a procurement structure by offering stand-alone tax incentives, grants, and subsidies. Tax incentives can provide a wide range of financial benefits, from providing tax credits for suppliers who set up manufacturing facilities to alleviating offshore wind projects from property tax. These incentives aim to lessen the upfront private investments in developing an offshore wind sector. Table 3.2 shows several state-level tax incentive programs and their prospective value.

Table 3.1 - State offshore wind policy initiatives and their associated actions.

STATE	POLICY INITIATIVE	CREATES PROCUREMENT TARGET	CREATES PROCUREMENT MECHANISM	FUNDS INFRASTRUCTURE	FUNDS SUPPLY CHAIN DEVELOPMENT
California	Assembly Bill 525	✓			
Connecticut	House Bill 7156	✓		✓	
	Public Act 19-71		✓		
Maine	Legislative Document 1895	✓	✓	✓	✓
Maryland	Offshore Wind Energy Act		✓		✓
	Maryland Clean Jobs Act	✓			
Massachusetts	Offshore Wind Energy Act	✓		✓	
New Jersey	Offshore Wind Economic Development Act	✓	✓	✓	
New York[1]	Climate Leadership and Community Protection Act	✓			
	Senate Bill S6218A			✓	
	$500 million Investment in Offshore Wind			✓	✓
	Offshore Wind Master Plan			✓	✓
North Carolina	Executive Order 218	✓			
Rhode Island	Affordable Clean Energy Security Act	✓	✓		✓
Virginia	Virginia Clean Economy Act	✓	✓		

[1] New York's procurement mechanism was created by New York State Public Service Commission's order in 2018, rather than a specific policy initiative.

Table 3.2 - State tax incentives relevant to offshore wind industry development.

STATE	PROGRAM	VALUE
Massachusetts	Economic Development Incentive Program	Investment tax credit (ITC) of 3% of offshore wind projects
Maryland	Maryland Offshore Wind Energy Act	Exemption from state sales and use tax for the production of offshore wind components
New Jersey	Offshore Wind Economic Development Tax Credit	Up to $100 million in tax credits for offshore wind project developers and supply chain
New York	New York State Real Property Tax Law Section 487	15-year real property tax exemption
Rhode Island	Renewable Energy Development Fund	Up to 30% of corporate income tax credit for offshore wind development

States can offer a range of grants and subsidies to incentivize offshore wind supply chain investment, workforce development, and research and development. States typically sponsor these programs through their state agencies, such as the Massachusetts Clean Energy Center, the Maryland Energy Administration, and the New York State Energy Research and Development Authority. States may offer businesses and educational institutions development grants, typically between $500,000-$5,000,000.

States can also incentivize offshore wind supply chain development by funding key infrastructure upgrade projects. These funding opportunities can be tied to procurement and stand-alone bond or grant opportunities. Most of this funding has gone to upgrading ports, with manufacturing funding tied to procurement rounds. This trend largely stems from the necessity of component manufacturing taking place at ports. Additionally, many ports have received federal funding through the US Department of Transportation. Table 3.3 provides examples of significant state-level funding for offshore wind infrastructure development. New York and New Jersey offer the most robust investment packages for offshore wind component manufacturing.

Table 3.3 - State funding for infrastructure development relevant to offshore wind.

STATE	ADMINSITERING BODY	DESCRIPTION	FUNDING
California	California Energy Commission	Port of Humboldt Bay upgrades	$10.5 million
Connecticut	Department of Energy and Environmental Protection	State Pier upgrades	$157 million
Massachusetts	Massachusetts Clean Energy Center	New Bedford Marine Commerce Terminal upgrades	$113 million

STATE	ADMINSITERING BODY	DESCRIPTION	FUNDING
		Salem Offshore Wind Terminal upgrades	$75 million
Maryland	Maryland Energy Administration	Tradepoint Atlantic Terminal upgrades	$13 million
		Port of Baltimore upgrades	$3 million
New Jersey	New Jersey Economic Development Authority	New Jersey Wind Port	$500 million[2]
New York	New York State Energy Research and Development Authority	South Brooklyn Marine Terminal upgrades	$200-250 million
		Port of Albany upgrades	$300 million[3]
		Port of Coeymans upgrades	$86 million
Rhode Island	Rhode Island Commerce Corporation	Port of Davisville upgrades	$60 million
Virginia	Virginia Port Authority	Portsmouth Marine Terminal upgrades	$40 million

3.2 Regional Collaboration

Some states have taken a regional approach when planning and developing their offshore wind sectors. While these regional strategies do not have significant enforcement power, as they are usually structured as Memorandums of Understanding (MOUs), they can provide meaningful coordination to maximize regional cooperation. In particular, the Southeast and Mid-Atlantic Regional Transformative Partnership for Offshore Wind Energy Resources (SMART-POWER) and the Offshore Wind Multistate Coordination MOU have been the landmark regional agreements specifically targeting offshore wind.

The SMART-POWER plan (signed in 2020) is an MOU between North Carolina, Virginia, and Maryland. The initiative aims to coordinate future offshore wind procurement and transmission planning and to collaborate on relevant environmental and technical studies.

The Offshore Wind Multi-State Coordination MOU (signed in 2023) is an initiative between Massachusetts, Connecticut, and Rhode Island. This MOU led to a coordinated Request for Proposal (RFP) to procure up to 6,000 MW of offshore wind power. The MOU also provides language regarding transmission planning, data sharing, and stakeholder engagement.

[2] *This includes both initial investment and investment added during procurement rounds.*

[3] *The exact state-to-private funding breakdown for the Port of Albany is not public information.*

3.3 Federal Tax Incentives through the Inflation Reduction Act

The Inflation Reduction Act (IRA) was signed into law in 2022 and provides significant expansions to renewable energy tax credits for developers and manufacturers. While both a production tax credit (PTC) and an ITC program are available to developers, US offshore wind projects have traditionally used the ITC program due to the relatively large capital expenditure. The clean energy ITC (Section 48E) has a base credit of 6% but is increased to 30% if projects meet prevailing wage and registered apprenticeship requirements. The ITC also has two bonus credits, a domestic content credit, and an energy community credit, each valued at 10%.

The requirements that developers must satisfy to earn various values of the ITC are described in Table 3.4. The ITC will begin to be phased out in 2030 and end in either 2032 or once annual greenhouse gas emissions from electricity production in the US have decreased by 75% (from 2022 levels), whichever comes later. The IRA also introduced new routes to monetize tax credits, such as transferability, which will likely positively impact the industry's access to tax equity financing.

Unlike many other states, South Carolina does not already possess prevailing wage requirements, so the requirements of the Davis-Bacon Act (a federal-level prevailing wage law) will apply. This requirement may present challenges and opportunities for the local workforce, as wages will likely vary from traditional rates, potentially increasing labor costs. Additionally, the IRA's 15% apprenticeship requirement, which will scale up to 25%, will likely impact the design of project labor agreements, contracting, and workforce development programs.

Table 3.4 - Description and value of tax credits provided in Section 48E of the IRA.

REQUIREMENT	DESCRIPTION	TAX CREDIT VALUE
Baseline	Construction on the offshore wind project must begin before 2026.	6%
Prevailing Wages	All laborers and mechanics must be paid prevailing wages as defined by the Department of Labor for a given locality and job type.	+24%
Apprenticeships	Qualified apprentices in registered apprentice programs must perform 15% of the total labor hours for projects constructed after 2024.	
Domestic Content	All steel, iron, and other manufactured products that comprise the project must be produced in the US.	+10%
Energy Community	The project's interconnection, power conditioning, and/or supervisory control and data acquisition equipment must be located in a federally recognized Energy Community.	+10%

Manufacturing Credits

In addition to the ITC, the IRA established two credits to support domestic manufacturing: the Advanced Manufacturing Production Credit (45X) and the Advanced Energy Project Credit (48C).

45X introduced a federal PTC for domestic manufacturing of offshore wind components. The value of the PTC depends on the component being manufactured and the total wattage of the turbine it will support. For example, a nacelle assembled in the US is eligible for a PTC of $50,000 per MW of rated turbine capacity. As such, a nacelle for a 12 MW turbine would generate a PTC of $600,000. The PTC will be phased out between 2030 and 2032, with components sold in 2030 receiving a PTC equal to 75% of the rate, components sold in 2031 receiving a PTC equal to 50% of the rate, and components sold in 2032 receiving a PTC equal to 25% of the rate.

The tax credit for construction-related vessels is based on the sales price, not a traditional PTC mechanism. While these PTCs will play a role in OEMs' decision-making to develop manufacturing facilities inside the US, they will likely not be the primary determining factor. Other variables such as proximity to projects, state-based incentives, material costs, and existing supplier relationships will also influence where manufacturing facilities are established. Additionally, since the values in 45X are set in absolute terms and do not adjust for inflation, the relative value of each credit will weaken over time. Table 3.5 provides the PTC value for US offshore wind component and construction vessel manufacturing.

Table 3.5 - Components eligible for the 45X tax credit and the associated potential value of the credit.

COMPONENT	PTC VALUE (PER MW)	THEORETICAL CAPEX REDUCTION[4]
Blade	$20,000	10-20%
Nacelle	$50,000	5-10%
Tower	$30,000	10-20%
Fixed Foundation (Monopile, Jacket)	$20,000	2-5%
Floating Foundation and Mooring System	$40,000	2-5%
Construction Related Vessels	10% of sales price	N/A

48C provides a 30% ITC for new manufacturing facilities selected in a competitive application process. The first round of 48C awards was allocated in March 2024 and awarded sites that intend to manufacture offshore wind components. The second round of submissions for 48C credit proposals was due in June 2024. Manufacturers cannot claim 45X and 48C credits for a single facility and stack credit value. This restriction means that depending on what type of component is being manufactured (e.g., cables are not covered under 45X), the total upfront costs (e.g., some manufacturing sites have a larger CapEx than others) will influence which tax credit scheme provides the most value for a given facility.

[4] *Pathways to Commercial Liftoff, DOE, 2024*

4 SOUTH CAROLINA CAPABILITY

South Carolina's existing manufacturing industries, academic institutions, and port infrastructure present a case for expanding the State's participation in the domestic offshore wind supply chain. The opportunity for South Carolina to support the growing offshore wind industry is proportional to the quality of the manufacturing industry landscape and the capability held by supply chain and ports in the State.

4.1 South Carolina Industry Landscape

4.1.1 Prominent Manufacturing Sectors and Trends

Over 250,000 people are employed in South Carolina across over 4,000 manufacturing companies, contributing 15% to the State's gross state product as of 2021 according to the National Association of Manufacturers. Most workers engaged in manufacturing work in the 4th Congressional District in the northwest region of the State. Charlotte and its suburbs support a network of advanced manufacturing, as does the Charleston region with companies like Volvo, Mercedes, and Boeing.

South Carolina's manufacturing sector rose to prominence through textiles in the early 1900s, drawing companies from northern states with abundant labor and a business-friendly environment. As the textile industry shifted to overseas markets, demand for skilled labor and advanced manufacturing in support of the automotive and aerospace sectors grew within the State. Today, the BMW assembly plant in Greer employs 11,000 people, the Michelin tire facility employs 9,000 people over 14 sites, and Boeing employs nearly 6,000 people across two sites in Charleston. The State also hosts Mercedes-Benz, Lockheed Martin, Honda, and Samsung, all of whom operate manufacturing facilities. South Carolina's relatively low operating costs for businesses continue to draw manufacturing to the State.

The shift to advanced manufacturing was largely a result of the State's aggressive efforts in the late 1950s to spur industrialization through policy; tax reforms, an aggressive economic development strategy, investments in infrastructure, including highways, ports, and railways, and improved technical education programs helped develop a new identity for the State. This effort stimulated massive growth in foreign direct investment, attracting French firm Michelin in the 1970s and setting the stage for an influx of foreign investment as four more tire manufacturers set up operations. South Carolina provided a $150 million incentive package to support BMW's market entry in the 1990s, which helped establish an automotive manufacturing cluster in the State. In 2011, Boeing opened its 787 Dreamliner final assembly and delivery plant in South Carolina after the State provided a total incentive package estimated between $800 million and $1 billion in value. Similar incentives also spurred the relocation of Lockheed Martin's F-16 production line from Texas to South Carolina.

Currently, South Carolina's largest manufacturing sector is chemical manufacturing, with several major global firms producing a wide range of advanced textiles, chemical additives, coatings, and medicinal and food products. The second largest manufacturing sector by value of output is automotive vehicles and parts, followed by plastics and rubber products, paper, and machinery.

Charleston County is nearing full capacity for industrial manufacturing, according to local economic development groups. There is greater potential for growth in Berkeley County; new industrial projects in South Carolina are being developed along the Cooper River in that county.

4.1.2 Industrial Manufacturing Advantages

South Carolina is in a strong economic position; the State is ranked 10th out of US states for economic growth and has relatively low unemployment. Top industries by employment are Manufacturing, Real Estate, and Professional, Scientific and Technical Services. South Carolina's strong manufacturing sector is a result of several factors, which could potentially be leveraged for manufacturing in support of offshore wind.

South Carolina has among the lowest corporate income tax rates (5%) of the states currently participating in offshore wind, as shown in Figure 4.1. Offshore wind projects that leverage the IRA can receive elective pay or transfer credits for amounts in excess of taxes paid, so this low corporate tax rate makes South Carolina especially attractive for manufacturers producing offshore wind components.

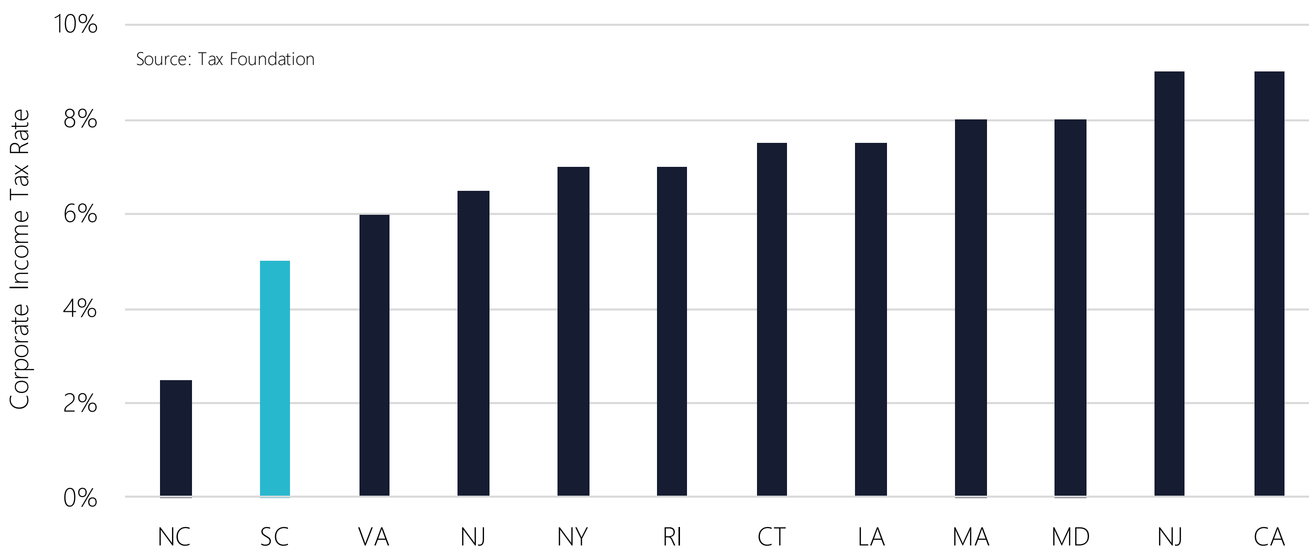

Figure 4.1 - Corporate income tax rates in selected states supporting offshore wind industry development.

In addition to having very low corporate income tax rates, South Carolina also has no state property tax, inventory tax, wholesale tax, or local income tax. There is no sales tax on manufacturing machinery, industrial power, or finished products, and no unitary tax on worldwide profits. A favorable tax environment is highly impactful to the business case for manufacturing offshore wind components because the high capital expenditure and profit margin associated with these components means significant revenue can be lost to taxes.

Many manufacturing processes are energy intensive and demand substantial electricity. South Carolina has among the lowest industrial electricity rates in the US at 6.38 cents/kWh, as shown in Figure 4.2. This represents significant cost savings for manufacturing operations when compared to other states with offshore wind manufacturing ambitions, like New Jersey and California, whose rates are nearly double and triple those of South Carolina, respectively.

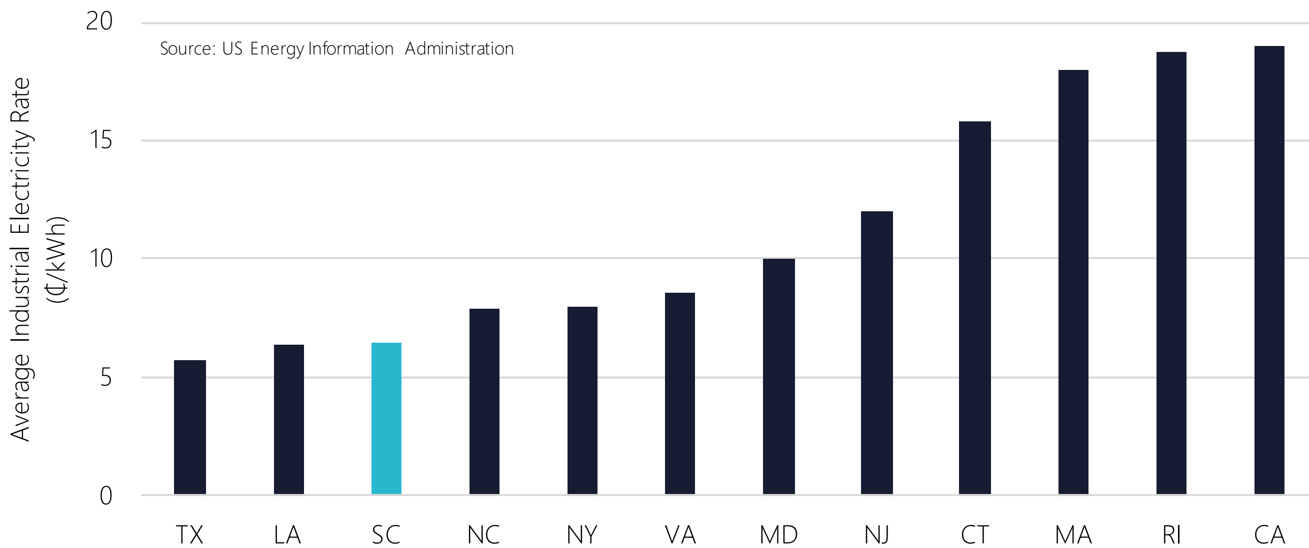

Figure 4.2 - Average industrial electricity rate in selected states supporting offshore wind industry development.

Wages and unionization rates represent another important consideration for labor-intensive manufacturing operations, such as those required for most offshore wind components. South Carolina has competitive labor rates across the offshore wind job roles with highest demand, as shown in Figure 4.3.

To access the domestic content incentives in the IRA, companies must meet prevailing wage and apprenticeship requirements. While union representation is low in South Carolina at 3% overall, as shown in Figure 4.4, there is a robust workforce development network that could be expanded to meet industry demand, with a state-wide technical college and apprenticeship system comprised of 16 colleges.

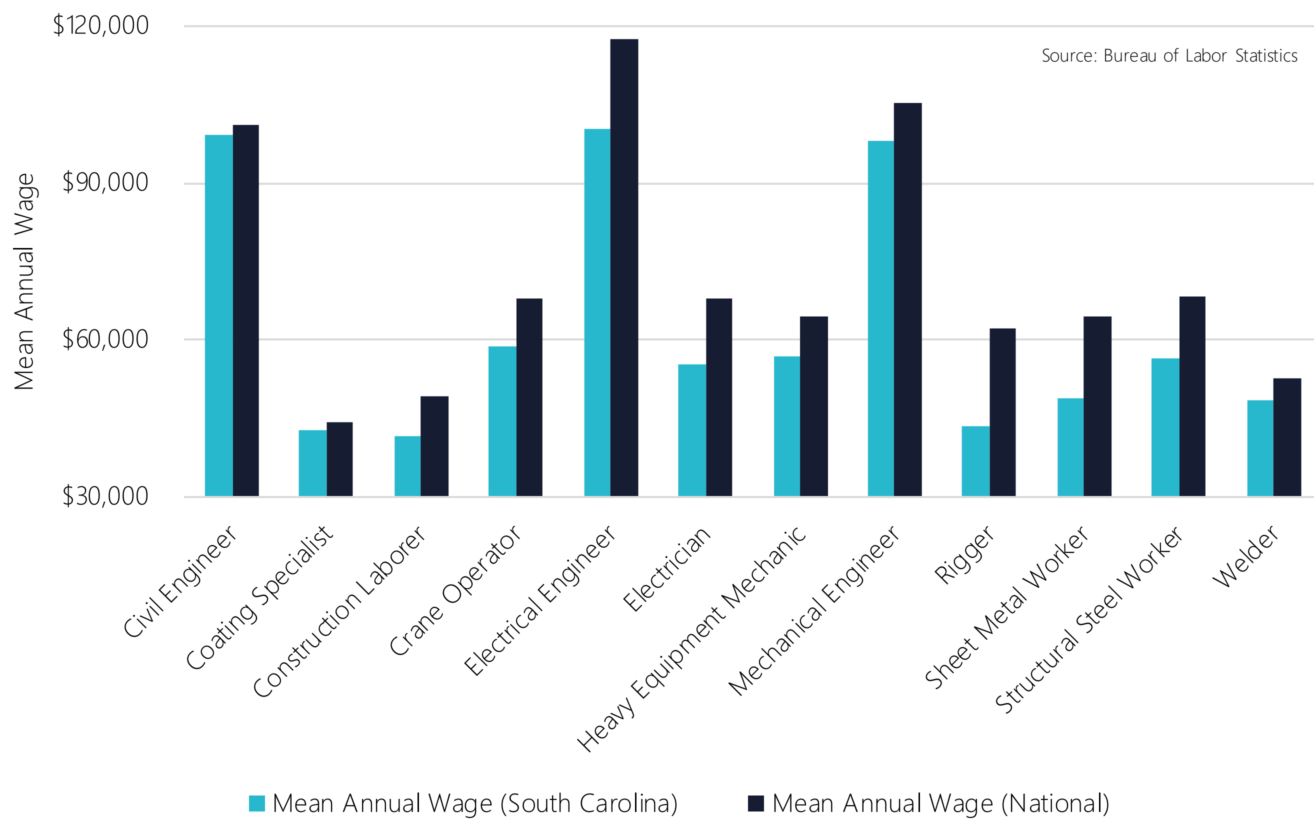

Figure 4.3 - Mean annual wages for priority offshore wind job roles.

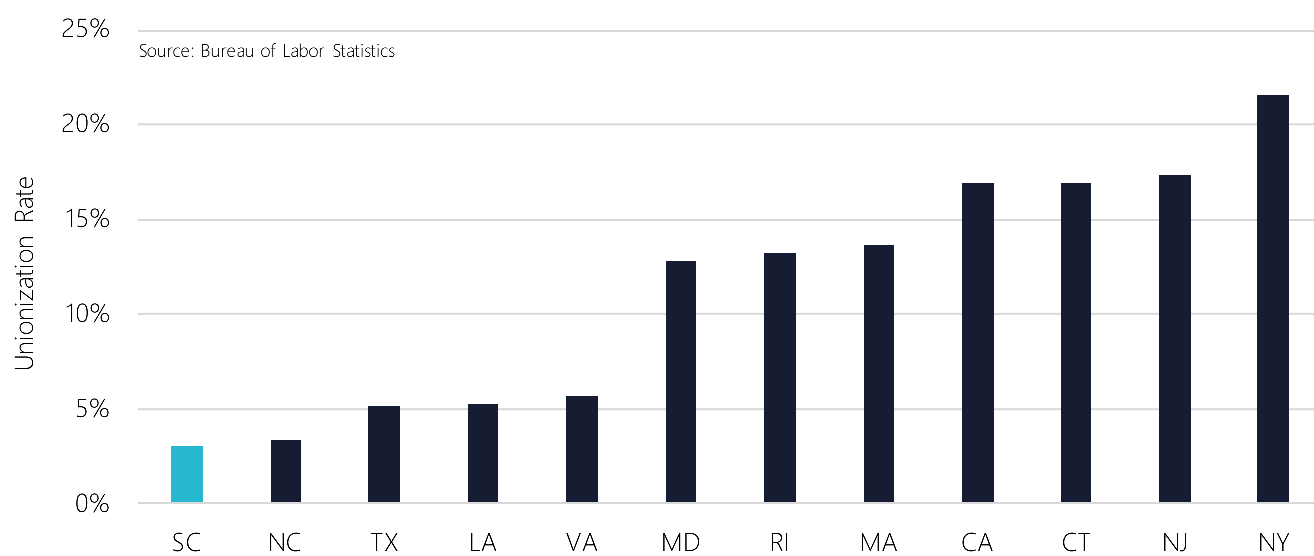

Figure 4.4 - Unionization rates in selected states supporting offshore wind industry development.

4.1.3 Manufacturing Tax Incentives

South Carolina's tax incentives and subsidies are favorable for manufacturing compared to those of other US states. While South Carolina has not developed any tax incentives or subsidies specific to the offshore wind sector, the State has several programs that could attract offshore wind manufacturing companies. Some of these programs are described in Table 4.1.

Table 4.1 - South Carolina tax credits potentially applicable to offshore wind industry development.

INCENTIVE	DESCRIPTION
Jobs Development Credit	Eligible companies can claim credits based on the personal withholding taxes of new employees.
ITC	Companies can claim a credit of up to 2.5% of their investment in new manufacturing equipment, which can be carried forward for 15 years or more.
Port Volume Increase Credit	Provides a credit against income taxes or withholding taxes to entities that use state port facilities and increase base port cargo volume by 5% over base-year totals
Port Transportation Credit	Provides a credit to offset the costs associated with transporting goods, materials, and freight to and from the state's ports.
Sales Tax Exemption	Sales Tax exemptions for manufacturing equipment.

South Carolina's Jobs Development Credit, ITC, and Sales Tax Exemption could benefit new offshore wind manufacturers as they hire and retool for large-scale manufacturing. The State's port volume and transportation credits could bring down the costs of transporting offshore wind components out of ports. South Carolina previously offered a Renewable Energy Manufacturing Tax Credit, which provided a 10% income tax credit to manufacturers involved in the fabrication of clean energy systems and components for solar, wind, geothermal, or other clean energy uses, but this credit was allowed to lapse in 2020. This credit required companies to invest at least $50 million in the State, but solar energy systems, the primary manufacturing sector to leverage this credit, shifted to international markets. The State reprioritized spending towards solar installation programs, utility reform, long-term energy planning, and other clean energy workforce initiatives.

While South Carolina has not directly invested in offshore wind development, the State has provided $1.6 million to the Nexans subsea cable manufacturing facility for early site development in 2012. Ørsted and Eversource helped enable the expansion of Nexans plant in 2021 by committing to purchase export cable for their offshore wind farms (now solely owned by Ørsted) in the Northeast, including South Fork Offshore Wind, Revolution Wind, and Sunrise Wind. Empire Wind 1 also committed to purchase export cable manufactured by Nexans. While not planned initially at conception, this manufacturing facility has serviced several offshore wind projects and has become a key piece of the US offshore wind supply chain.

Additionally, South Carolina has provided hundreds of millions of dollars of state funding for its ports. The Charleston Harbor Deepening Project, the development of the Hugh K. Leatherman Terminal, and the Wando Welch Terminal upgrade all represent South Carolina's significant investment in its marine infrastructure. While not directly aimed at increasing offshore wind development, investments like these indicate South Carolina's willingness to subsidize its marine economy, given sufficient economic and political conditions.

South Carolina has also invested hundreds of millions of dollars in its automotive and aviation manufacturing capabilities. These funds have significantly strengthened both sectors and indicate the State's ability to use state funding to enhance local manufacturing capacity and capabilities.

4.1.4 Innovation Landscape

South Carolina has established itself as a hub for research and innovation for specific sectors and industries. Like many manufacturing centers, it has seen a shift towards more sustainable processes and future-focused industries. There is increasing pressure from buyers for products manufactured using lower emissions processes and to include sustainability-minded companies in their supply chains. This is driving innovation in the sustainability and clean-energy sector within South Carolina. More than 90% of the State's automotive suppliers will shift to electric vehicle production in the coming years, increasing demand for battery manufacturing. High-density industrial regions like Charleston and Berkeley are prioritizing firms with strong sustainability priorities to manage space demands and non-renewable resources like natural gas.

CLEANcarolinas is a technology development engine led by the University of North Carolina at Charlotte that combines academic, industrial, and governmental partners, including Siemens, the South Carolina Research Authority, and Clemson University. Funded initially by a $1 million grant from the US National Science Foundation's Regional Innovation Engines program, the initiative aims to foster an innovation ecosystem for clean energy technologies, including offshore wind technologies, across 16 counties in North and South Carolina. CLEANcarolinas has partnered with York Technical College, Central Carolina Technical College, and Trident Technical College for advanced energy workforce development. York Technical College's workforce development plan adds curricula on the supply chain for components and subassemblies for wind turbines, new training to relevant existing curricula, and corporate training on offshore wind.

The SC Nexus for Advanced Resilient Energy (SC Nexus) is another technology and innovation initiative operated by a consortium of more than 50 academic and state agency members. The hub empowers South Carolina companies to commercialize emerging energy storage materials and manufacturing techniques for energy generation, transmission, distribution, and storage. In 2023, the federal government designated SC Nexus as a Regional Technology and Innovation Hub, one of 31 hubs selected nationwide, and granted SC Nexus a $45.4 million award for the hub to develop and expand its offerings. SC Nexus' offerings include a battery manufacturing pilot line, a cyber testing range for grid-connected equipment, and a grid emulation facility, as well as business development services for growing startups, and an Education and Workforce Center for enhancing awareness of and education about South Carolina's energy industries and job opportunities. The South Carolina Technical College System was designated to lead the Education and Workforce Center project.

In addition to technical colleges, South Carolina is home to large research universities, two of which conduct research in fields directly applicable to the offshore wind industry. Clemson University's Advanced Materials Research Lab conducts material science and chemistry research to serve the advanced manufacturing and energy industries. The Dominion Energy Innovation Center on Clemson University's Charleston Innovation Campus hosts the world's most advanced offshore wind turbine drivetrain testing facility. The 15 MW wind turbine drivetrain test rig conducts mechanical and electrical testing endurance for research and development purposes and quality assurance. The drivetrains can be connected to the eGRID simulator within the same facility to showcase real-world electricity generation scenarios in a controlled and calibrated environment without impacting the surrounding grid. In addition, the University of South Carolina's Molinaroli College of Engineering and Computing is home to several laboratories researching various advanced manufacturing practices to support the aerospace industry, including advanced composite manufacturing, non-destructive testing, and metal additive manufacturing. Findings in these fields could be applied to innovate offshore wind manufacturing practices.

The South Carolina Research Authority (SCRA) is a public, non-profit corporation supporting innovation in South Carolina. The SCRA supports innovation and commercialization through grant funding, coaching, industry-to-innovator matchmaking, and providing laboratory space to startups and universities. The SCRA's remit includes key focus areas such as Advanced Manufacturing and Materials and Clean Tech, Sustainability, and Resilience, which are all relevant to the offshore wind industry.

4.2 South Carolina Supply Chain

4.2.1 Assessment Approach

An assessment of South Carolina's current manufacturing supply chain determined the level of relevant capability in the State to support the delivery of offshore wind projects. South Carolina supplier information was sourced from:

- South Carolina Department of Commerce SourceSC Industry Directory
- Southeastern Wind Coalition Wind Industry Supply Chain Database
- Xodus' internal supply chain database

Company data was collated to form a broad supplier database that included representation from adjacent manufacturing sectors. Existing company capabilities were then mapped against the supply requirements for materials, subcomponents, and manufacturing services in the offshore wind supply chain. This mapping exercise leveraged Xodus in-house expertise and feedback from ongoing industry engagement, as well as publicly available industry data on supplier capability needs. The relevant supply categories which South Carolina companies were assessed against are listed in Table 4.2.

Table 4.2 - Breakdown of supply category by capability.

SUPPLY CATEGORY	CAPABILITY CATEGORY
Material Supply	Aluminum
	Carbon fiber
	Copper
	Glass fiber
	Lead alloy
	Polymer and polymer foam
	Rare earth metal
	Resin and adhesive
	Riprap
	Steel
Subcomponent Supply	Cable accessory
	Coatings and marine corrosion protection
	Electrical accessory
	Fiber optic cable
	Grease or oil
	Industrial electrical equipment
	Major steel structure fabrication
	Metal castings and forgings fabrication
	Other relevant subcomponent (e.g., tools, monitoring systems, standby generators, etc.)
	Precision component fabrication
	Secondary steel/aluminum fixture fabrication
Service Supply	Construction and electrical services
	Fabrication services (welding, finishing, blasting, etc.)
	Heavy equipment leasing services
	Marine and transportation logistics services
	Specialized equipment manufacturing
	Vessel construction

The collated database of South Carolina suppliers included North American Industry Classification System (NAICS) codes tagged to each company. NAICS is the US federal standard for classifying organizations into industry categories. These six-digit NAICS codes were mapped to the various capability categories to enable allowed screening the database by capability.

Businesses within the database were screened by size (removing companies with fewer than 10 employees) and relevant capability (removing companies with NAICS codes deemed irrelevant). An in-depth assessment of larger companies (greater than 100 employees) was conducted to better understand the capability of each. Companies were assigned to relevant capability categories based on an assessment of publicly available company information. Company capability was also assessed based on the applicability of products and services to the needs of the offshore wind sector:

- **Higher applicability**: Company has direct experience in offshore wind or provides products/services that are highly relevant to offshore wind in design, scale and production volume; investment required to transition company into offshore wind is minimal, and/or would be directly applied to scaling/qualification operations.

- **Moderate applicability**: Company has no direct experience in offshore wind but provides products/services that are similar to those relevant to offshore wind in design and scale; investment required is moderate and would be needed to help company retool, meet standards/qualifications, and scale operations.

- **Lower applicability**: Company provides products/services that resemble those needed in offshore wind but would need to significantly change operations to enter the industry; significant investment in retooling, meeting specifications/qualifications, and scaling would be required.

4.2.2 Supply Chain Assessment

Over 550 South Carolina companies were assessed for capability to support the offshore wind industry, of which over 280 were considered relevant and evaluated as having higher, moderate, or lower applicability across their capabilities. Of these companies, 85 were assessed as having higher applicability, 110 as having moderate applicability, and 130 as having lower applicability.

Material Supply

20 companies were assessed as having higher applicability in the supply of materials relevant to offshore wind component manufacturing, as shown in Figure 4.5. Although companies supplying raw or processed materials do not manufacture offshore wind components, they may be able to support the development of South Carolina's offshore wind supply chain through new supplier relationships with Tier 1 and 2 manufacturers.

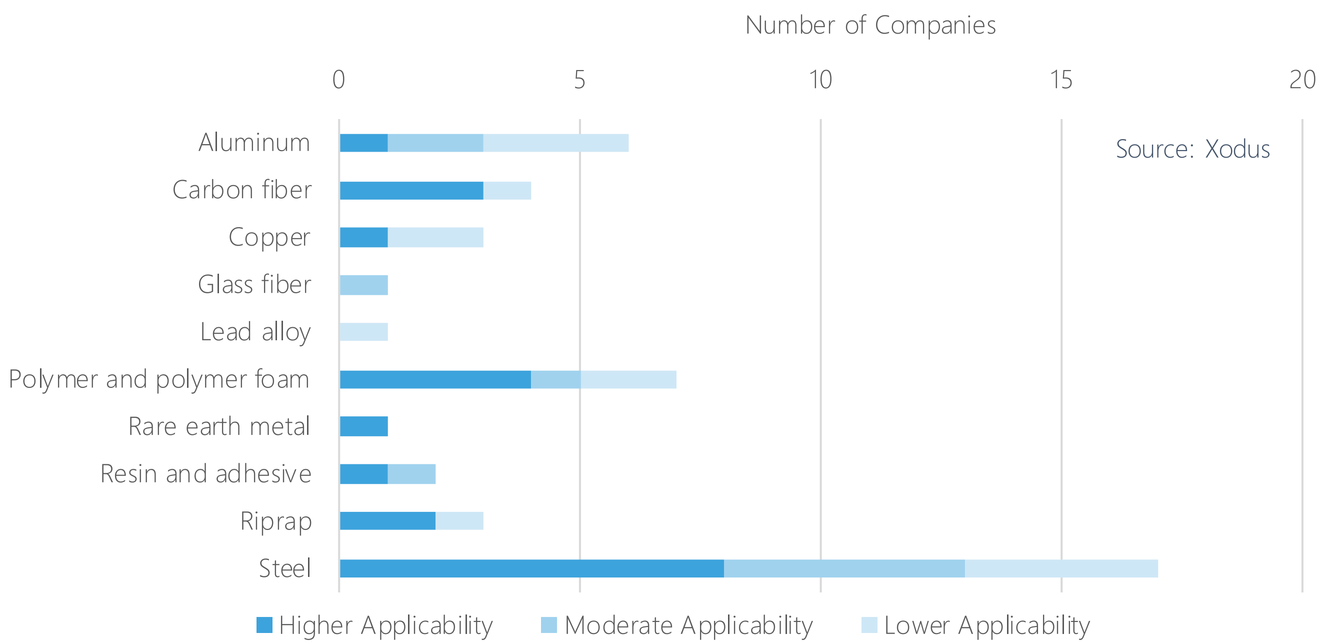

Figure 4.5 - Number of South Carolina companies assessed as having higher, moderate, or lower applicability supplying materials relevant to offshore wind component manufacturing.

Chemical manufacturing is an apparent strength in the South Carolina supply chain landscape. Several global materials companies manufacture advanced composites and polymers, such as carbon and glass fibers, polymer foams, resins, and adhesives for several industries in the State, including the aerospace, fiberglass-hulled boat, and onshore wind sectors. Examples of these companies include:

- Celanese manufactures polymers (including fiber reinforced thermoplastics, polybutylene terephthalate, and polyethylene) for wind turbine blades, bushings, housings, gears, lubrication system components and insulation, tethers, and hoses at the company's facility in Moncks Corner, South Carolina on the Cooper River.
- Chomarat North America, LLC manufactures composite reinforcements for wind turbine blades, in addition to other applications in the construction, marine, transportation, automotive, and aerospace markets. The company has three locations in Williamston and Anderson, South Carolina.
- JPS Composite Materials manufactures fiberglass fabrics and composite reinforcements that can be used across several industries, such as aerospace, insulation and power generation, electronics, marine, and more. The company's headquarters are in Anderson, South Carolina.
- Milliken & Company manufactures composites reinforced with fiberglass and closed-cell foam for wind turbine blade cores out of the company's facility in Laurens, South Carolina. The company's global headquarters are in Spartanburg, South Carolina.

- Syensqo manufactures carbon fiber products used in defense and aerospace operations, with production facilities in Piedmont and Rock Hill, South Carolina. They also supply high-performance polymers to the offshore oil sector and are committed to sustainability in their operations.

South Carolina also has a range of companies supplying metal alloys for critical applications, including the aerospace and defense industries. Examples of these companies include:

- ATI Specialty Materials is a global supplier of advanced alloys for critical applications, including the aerospace and offshore oil and gas industries. The company is a major player in the production of specialty steel, operating out of 57 different facilities worldwide.
- Carpenter Technology Corporation operates a high-performance specialty alloy-based materials production facility in McBee, South Carolina. The facility has the capabilities to manufacture several components found within the nacelle such as the gearbox and drive shaft for offshore wind turbines.
- Century Aluminum is a global producer of primary aluminum with three locations in the US. Its Mount Holly, South Carolina facility has an annual production capacity of 229,000 t and can produce slab aluminum in the 5000 series grades, which is suitable for offshore applications.
- e-VAC is a rare earth neodymium-iron-boron permanent magnet production facility under development in Sumter, South Carolina, with operations scheduled to begin in fall of 2025. The facility will serve the automotive, defense, industrial industries, with intentions to supply magnets for wind turbine generators.

Subcomponent Supply

South Carolina has over 45 companies assessed as having higher applicability in the supply of subcomponents relevant to offshore wind component manufacturing, as shown in Figure 4.6. Out of these 45 companies, very few currently supply the offshore wind industry at their South Carolina facilities. Their higher applicability assessment indicates their capability to manufacture or assemble subcomponents for adjacent industries, such as aerospace, defense, onshore wind, and marine sectors, that are of a similar size, scale, and technology as those for offshore wind. These companies would be well-placed to participate in an offshore wind supply chain with minimal investment and/or upskilling required.

Nexans is the only company that manufactures offshore wind components in South Carolina. The Nexans export cable manufacturing facility in Goose Creek, South Carolina has been in operation since 2021 and has supplied several US offshore wind projects to date. While Nexans may not procure materials from South Carolina manufacturers, the company does employ local subcontractors for auxiliary services.

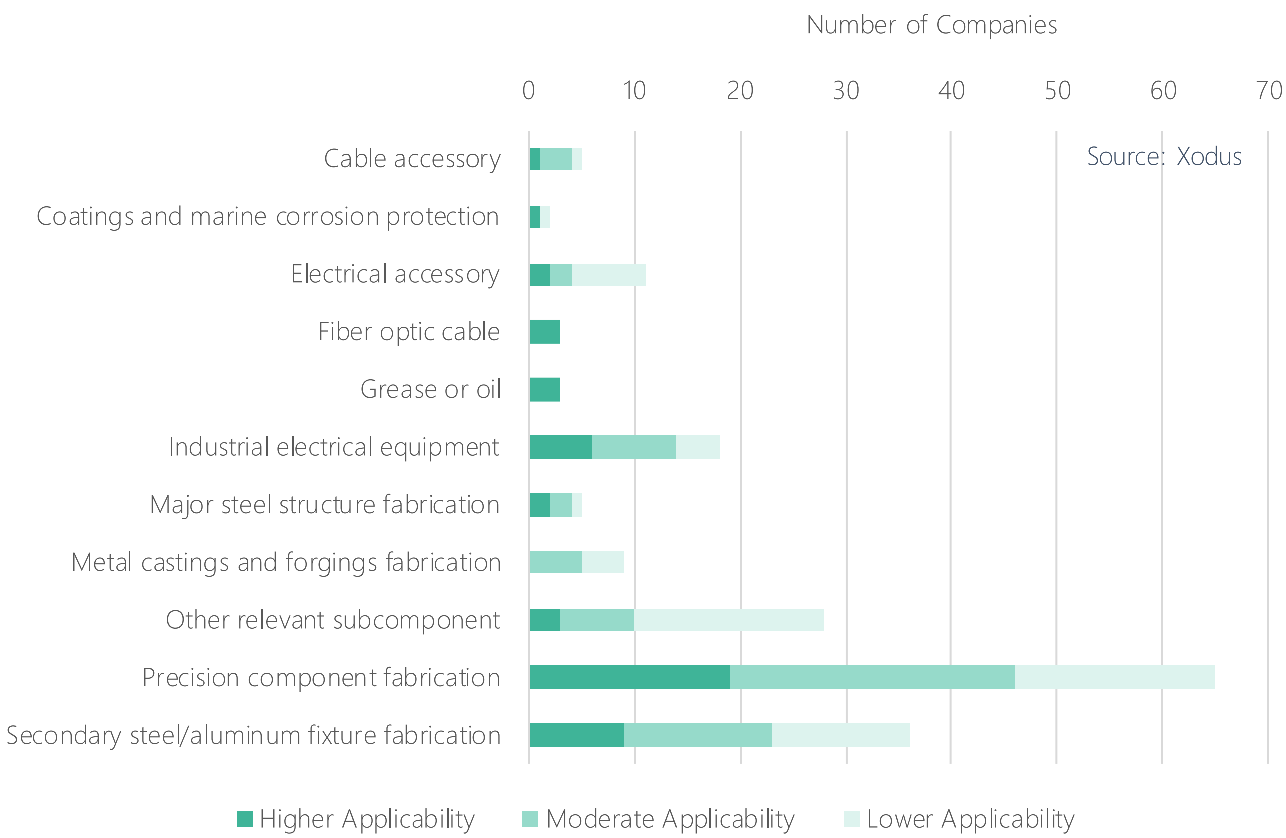

Figure 4.6 – Number of South Carolina companies assessed as having higher, moderate, and lower applicability in the supply of goods relevant to offshore wind component manufacturing.

Machining precision components for industrial motion applications is a strength in the South Carolina supply chain landscape. Several of these companies supply the onshore wind industry, including the following:

- JTEKT North America has multiple locations across South Carolina, including three bearings manufacturing facilities in Orangeburg, Blythewood, and Walhalla. The Orangeburg facility manufactures precision components for the industrial and automotive industries. The company manufactures bearings for the main shaft, gearbox, generators, yaw-drives, and other products including main shaft oil seals, hydraulic pumps, and machine tools for the manufacturing of other relevant parts.
- ILKIN America manufactures bearings for wind turbine generators and pitch and yaw systems at its facility in Greer, South Carolina.
- Morgan Advanced Materials manufactures wind turbine generator system components like carbon brushes, brush holders, slip rings, terminal blocks, and bearing protection at its facility in Greenville, South Carolina.
- Timken Company is a global bearings and power transmission product manufacturer with several locations across South Carolina. The company supplied bearings to GE Vernova for the company's offshore wind

turbine. Renewable energy is Timken's single largest end-market sector, and the company has made tens of millions of dollars in targeted capital investments to increase renewable energy capabilities across its footprint, including in South Carolina.

Many large, global companies manufacture components for the automotive and power industries in South Carolina and have the capability to manufacture components for the offshore or onshore wind supply chains at other locations. However, in some cases, it is unclear whether their wind component manufacturing occurs in South Carolina, or at other facilities in their networks, potentially outside the US. Some of these companies are listed below:

- The Bosch Charleston facility is Bosch's largest manufacturing site in the US, manufacturing gasoline fuel injection systems, ESP/ABS brake systems, and electric motors. Another major auto supplier, Bosch has similarly found synergies with wind energy – Bosch Rexroth, an engineering division in Germany, supplies wind turbine hydraulic systems and gearbox oil. Their hydraulics manufacturing location in Fountain Inn, South Carolina produces hydraulic pumps and motors for the construction, material handling, and oil and gas exploration industries.
- FOMAS Inc. manufactures forgings, gears, transmissions, bearings, and seamless rolled rings in steel and non-ferrous alloys for the oil and gas and power generation industries out of the company's facility in in York, South Carolina. The FOMAS Group, headquartered in Italy, has manufactured main turbine shafts and rolled ring components – including gearbox gears, structural flanges, and yaw and pitch system bearings – for wind turbines.
- GE Vernova's presence in South Carolina is expansive. The company assembles, repairs, and inspects gas turbines at its service center in Greenville, South Carolina, which is the largest gas turbine manufacturing plant with the most powerful off-grid gas turbine validation facility in the world. Key capabilities of this facility that are highly relevant to offshore wind nacelle assembly include advanced coatings application, highly precise assembly, innovative welding and joining, high precision machining across large and small parts, and heavy lifting up to 550 tons. The company once assembled onshore wind turbine nacelles at this facility, as the facility requirements for onshore wind nacelle assembly and gas turbine assembly operations are relatively similar; however, the ability for the facility to assemble onshore wind nacelles depends on availability – i.e., the demands of the gas turbine market.
  - The Greenville service facility also serves as GE Vernova's center for its onshore wind design engineering team. Back in 2017, GE Vernova also announced plans for a research and development facility in Clinton, South Carolina, where the company will test and evaluate prototype bearing designs for its onshore wind turbine designs. The company considered South Carolina the ideal location for an expansion because of the State's highly skilled workforce and proximity to other GE facilities.
- KP Components, Inc. manufactures manifolds and housings for offshore wind turbine hydraulic systems, working with a range of different materials, including cast iron, aluminum, and high-alloyed steel. The Denmark-based company operates a manufacturing facility in Easley, South Carolina, and supplies the agriculture and building industries.
- Röchling Automotive US's plant in Duncan, South Carolina manufactures composites for the aerodynamics, powertrain, and new mobility markets. Röchling Industrial manufactures composites that are employed within

electrical equipment in the nacelle including generators, transformers, and switchgears, as well as sliding elements for the yaw and pitch drives.
- Schaeffler Group US, one of the largest private employers in the State, develops and manufactures precision products for motion in machines, equipment, and vehicles and the aviation and aerospace industries. The company's headquarters and two manufacturing facilities are located in Fort Mill, South Carolina. The company supplies precision components, including bearings for the rotor shaft, gearbox, generator, and blade pitch system.
- ZF Transmissions Gray Court, LLC (ZF) is one of the largest manufacturers in South Carolina. ZF has been supplying transmissions for passenger vehicles out of its facility in Grey Court, South Carolina for the past decade. This year, the company has committed to investing $500 million to enable the ZF Grey Court facility to produce components for traditional Internal Combustion Engines and e-mobility technologies. ZF Wind Power designs offshore wind turbine gearboxes that are modular and marketed as flexible to changing market requirements (e.g., covers a range of gearbox-generator combinations and aligns gear outer dimensions across the full torque range, eliminating the need for redesigns). The division holds a strategic partnership with ABS Wind in Texas, such that designates ABS Wind as the exclusive repair company for ZF gearboxes and related components; however, the major ZF Grey Court planned expansion is indicative of the company's interest in South Carolina as a strategic location and offshore wind industry development in the State could create an opportunity for ZF Wind Power to expand its business within the State.

Many electrical equipment manufacturers also have operations in South Carolina, which supply the automotive, construction, industrial manufacturing, and power plant generation industries. While none of these companies manufacture in South Carolina the type of high voltage electrical equipment required by the offshore wind industry, several have supplied to the industry through facilities abroad. Examples of these companies include:

- ABB supplies electrical equipment such as converters, switchgears, and transformers to offshore wind turbine OEMs. The company's facility in Florence, South Carolina offers service and support (i.e., repairs, retrofits, and upgrades) for power and electricity infrastructure found in the electric utilities and power generation industries, such as switchgears and breakers.
- Eaton Electrical Division is a power management company that supplies dozens of power management products to several markets, including aerospace, data centers, marine, oil and gas, and renewables.
- Prysmian Group is global manufacturer of cables for power and telecommunications industries. The company has two manufacturing facilities in Abbeville and Lexington, South Carolina, which manufacture fiber optic telecommunications cables and high voltage and extra high voltage power cables for the power grid. Prysmian Group manufactures export and array cables for offshore wind at facilities outside of the US.
- Schneider Electric is a global supplier of industrial technology for energy generation, transmission, distribution, and storage applications. Its engineer-to-order facility in Hopkins, South Carolina manufactures low-voltage switchgear and switchboards.
- Siemens manufactures products for electrical distribution and control, including switchboards for the construction and industrial markets, out of the company's facility in Spartanburg, South Carolina. Siemens Gamesa is a key supplier to the global offshore wind industry, but much of the South Carolina operations focus on Smart Infrastructure manufacturing support.

Global coatings companies also draw on the chemical manufacturing strength of the South Carolina supply chain. Examples of these companies include:

- Honeywell International Inc.'s facility in Greer, South Carolina, is a center for machining, maintenance, and repair for commercial and military aircraft. The facility also produces high-temperature thermal barrier coating systems for gas turbine engine components.
- Mankiewicz Coatings manufactures wind turbine blade coatings in the company's two facilities in Charleston, South Carolina. One facility hosts a research and development lab for developing new coating concepts.
- PPG manufactures coatings for purely the automotive and large truck markets at its coating services facility in Greenville, South Carolina. The company is a major provider of marine grade coatings for all offshore wind components installed offshore.

Most South Carolina major steel fabrication companies that were assessed produced generic steel sheets and beams. Although major steel structure fabrication and metal casting and forging are not very prevalent in South Carolina, two companies of note are listed below:

- Collins Machine Works is an industrial machining and fabrication company with quayside access, heavy lift crane, and heavy lathe capacity at its facility in Charleston, South Carolina. The company serves the power generator, steel, and marine industries.
- W International has 40 years of experience in the heavy manufacturing of large, complex steel structures. Their facility in Goose Greek, South Carolina, has deepwater barge access on the Cooper River and supports Navy submarine and Navy aircraft carrier construction. Identifying their highly applicable skillset, the company has previously expressed interest in offshore wind component manufacturing, including monopile, transition piece, jacket, and anchor manufacturing. This pivot would require significant investment to expand their facility on greenspace.

Service Supply

Companies in Service Supply category include businesses that support manufacturing facilities (e.g., trucking and shipping products, construction and electrical wiring for facilities, forklift leasing, manufacturing tooling equipment, etc.) Several South Carolina companies were assessed as having higher applicability across the supply of services relevant to offshore wind component manufacturing, depicted in Figure 4.7. While companies supplying these services do not manufacture offshore wind components, they provide critical services to industrial manufacturing processes, such as marine and transportation logistics, heavy equipment leasing, and construction services. Development of the South Carolina supply chain to support offshore wind manufacturing would be likely to benefit a broad range of local suppliers providing services to manufacturers.

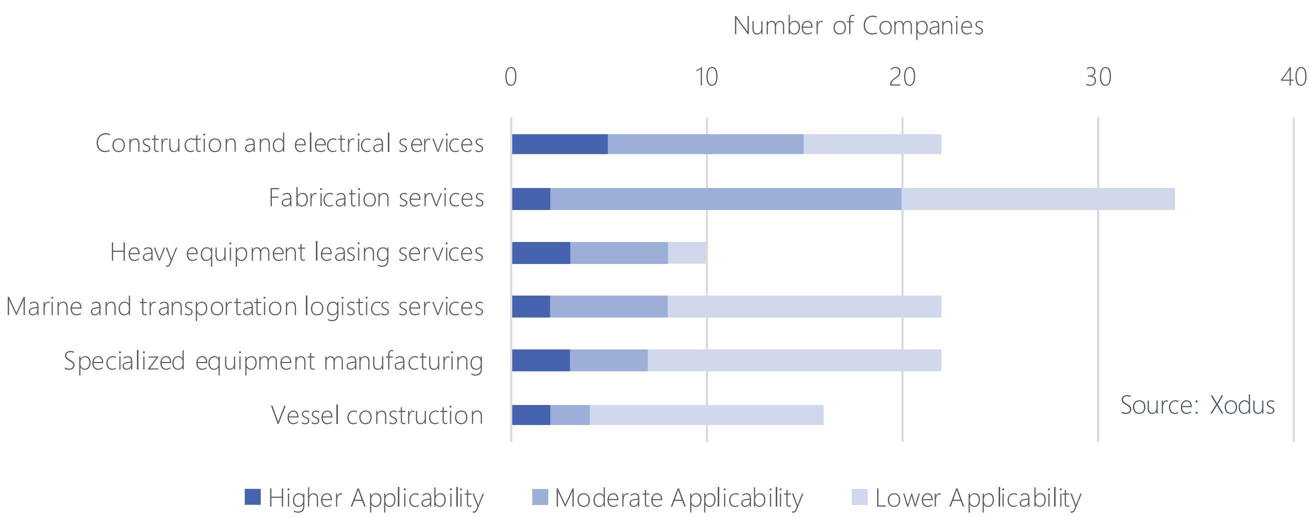

Figure 4.7 – Number of South Carolina companies assessed as having higher, moderate, and lower applicability in the supply of services relevant to offshore wind component manufacturing.

South Carolina has strong capability in construction and electrical services and fabrication services. Strengths in these services is common in US states with strong manufacturing industries, from residential and commercial construction to manufacturing and industrial applications. However, South Carolina's robust manufacturing environment indicates that these companies may be prepared to supply these services at the size and scale demanded by the offshore wind manufacturing industry. A selection of companies is included below:

- Crowder Industrial is a major general contractor in Spartanburg, South Carolina, offering industrial, power, electrical, and fabrication services.
- Palmetto Industrial Construction Co. is an industrial construction and maintenance company operating a 45,000 sq. ft fabrication facility in Gaston, South Carolina. The company fabricates structural steel, sheet metal, handrails, stairs and ladders, and miscellaneous steel components. Palmetto Industrial Construction Co. serves several markets currently, some of which include steel and metals, power generation, engineering services, and manufacturing facilities.
- Sargent Metal is an advanced metal fabrication and finishing facility serving several industries including construction, data centers, energy management, and transportation. The company works with a variety of metals including stainless steel, galvanized steel, and aluminum.
- Wildcat Steel and Fabricating specializes in steel fabrication and structural steel erection. It is a veteran-owned and operated business located in Hardeeville, South Carolina. Its main service offerings include steel fabrication, structural steel erection, commercial mezzanines, stairs, ladders, and handrails, heavy equipment repair, and miscellaneous steel sales.

Marine logistics is a strength of South Carolina, as the massive flow of container vessels has made this a strength of the region. Many companies support shipping, port operations, and cargo tracking and monitoring. South Carolina ports include many vessels such as tugs, barges, and local harbor pilots that may be readily available to support offshore wind construction. The South Carolina Ports Authority (SCSPA) is continuously expanding and upgrading their sites and services, ensuring that the ports are kept up to date and running smoothly.

4.3 South Carolina Ports

4.3.1 Assessment Approach

South Carolina's commercial ports were assessed for their ability to establish quayside manufacturing and deployment of offshore wind components through a red, amber, green (RAG) assessment. Parameters and criteria were developed to assess the ports and define the guidelines that justified a score of red, amber, or green for each criterion. A list of ports and their capabilities was compiled using desktop research and information gathered from engagement with local sources.

The ports were assessed using the RAG criteria to obtain a short list of ports considered favorable for offshore wind manufacturing. The risks and opportunities associated with the manufacturing and transportation of components at each port were taken into consideration as part of the assessment.

The RAG criteria developed for the study are shown in Table 4.3. The parameters, criteria, and values aim to cover a wide range of components and vessels, allowing for the adaptation of component manufacturing. These criteria were determined by examining existing large-scale manufacturing sites, installation/transportation vessels, and previous studies for reference. These specific criteria will differ depending on the size and type of components that the facility will be manufacturing. Small-scale manufacturing may not need to be located at a port where quayside manufacturing is only required for components too large for road or rail transportation.

Large-scale offshore wind manufacturing includes supply of the nacelle, tower, blades, foundations and offshore substations. Manufacturing at this scale would require significant quayside acreage and berths adequate for the largest transportation and installation vessels. A port achieving the minimum criteria for large-scale offshore wind manufacturing would be suitable for offshore wind farm component storage or marshaling of the largest components.

A port with moderate-scale manufacturing potential could support the supply of components such as transition pieces, access platforms, pin piles, cables, moorings, and secondary steel. These components require less space and more moderately sized vessels for transportation to the installation site or other marshaling port. A port achieving these criteria would also be considered suitable to support wind farm O&M or as secondary site for storage or marshaling.

Table 4.3 - Ports assessment scoring criteria.

Criterion	Large-Scale Manufacturing Potential	Moderate-Scale Manufacturing Potential	Unlikely to be Suitable for Manufacturing	Reasoning for Criterion
Acreage/Laydown/ Storage	Greater than or equal to 25 acres	Between 10 acres and 25 acres	Less than 10 acres	Adequate space for manufacturing and storage of components
Quayside Length	Greater than or equal to 1,000 ft	Between 500 ft and 1,000 ft	Less than 500 ft	Adequate berth length for largest vessel that is required
Draft at Quayside	Greater than or equal to 50 ft	Between 30 ft and 50 ft	Less than 30 ft	Adequate draft for largest vessel that is required
Quayside Strength	Expected to have high quayside strength e.g. large container cranes	Expected to have moderate strength e.g. breakbulk/Ro-ro capabilities	Expected to have low quayside strength or no quayside	Ensures quayside is fit for supporting components
Channel Width	Greater than or equal to 500 ft	Between 400 ft and 500 ft	Less than 400 ft	Adequate space for largest vessel that is required
Channel Draft	Greater than or equal to 50 ft	Between 30 ft and 50 ft	Less than 30 ft	Adequate draft for largest vessel and components
Air Draft	Unrestricted	Greater than or equal to 150 ft	Less than 150 ft	Adequate air draft for largest vessel and components
Current Usage/ Available Space	Available	Expected to be some availability	Busy, currently fully occupied	Ensures there is space for new industry on site
Road/Rail/Land Access	Has rail and road access	Has road or rail access	Does not have rail or road access	Ensures arrival of component materials and parts, and departure of finished components

4.3.2 Ports Assessment

Nearly 40 South Carolina ports were identified as being potentially relevant to offshore wind manufacturing and were grouped into ports owned and operated by the SCSPA, those owned and operated locally, and those privately owned and operated (categorized as Private Marine Terminals (PMT)). The majority of South Carolina's ports, both private and state-operated, are located in the Charleston area or along the Cooper River.

Table 4.4 - South Carolina ports relevant to offshore wind manufacturing.

OWNERSHIP TYPE	PORTS
SCSPA Owned and Operated Ports	• Columbus Street • Hugh K. Leatherman • Inland Port Dillon • Inland Port Greer • Jasper Ocean Terminal (under planning development – best estimates operational 2035) • Navy Base Intermodal Facility • North Charleston • Union Pier • Wando Welch Terminal
Locally Owned and Operated Ports	• Port of Georgetown • Safe Harbor Port Royal
Private Marine Terminals	• Agru America • Amalie Oil • Buckeye Terminal • Bushy Park SC • Carver Companies • Charleston Harbor Pilots • CMMC Navy Yard • Detyens Shipyards • GEL Engineering • Holy City Docking Pilots • Host Agency • Kinder Morgan • KMD Marine • MainOcean • Maybank Management • McAllister Towing • Moran Tug • Nexans • Nucor • Odfjell Terminal • Salmons Dredging • SJ Hamill • Stevens Towing • W International • Woolpert • WSE Inc.

Ports owned and operated by the SCSPA have a long-term business model revolving principally around container logistics and do not currently host tenants for manufacturing. The two locally owned and operated ports are the Port of Georgetown operated by Georgetown County, and Harbor Port Royal operated by the town of Port Royal. The RAG assessment of the SCSPA and locally owned ports is shown in Table 4.5.

South Carolina's PMTs have not publicly committed to supporting offshore wind development to date. The Nexans cable manufacturing facility is located on the Cooper River in the Charleston area and supplies offshore wind, among other industries. W International, also along the Cooper River, has expressed interest in offshore wind manufacturing but has not committed to any development at the time of writing.

Table 4.5 - Assessment of South Carolina ports.

Criterion	Wando Welch Terminal	Hugh K. Leatherman	North Charleston	Columbus Street	Union Pier	Inland Port Dillon	Inland Port Greer	Navy Base Intermodal Facility	Jasper Ocean Terminal	Port of Georgetown	Safe Harbor Port Royal
Acreage/Lay-down/Storage	689 acres	268 acres	201 acres	155 acres	12 acres	40 acres	91 acres	118 acres	1,500 acres	45 acres	10 acres
Quayside Length	3,800 ft	1,400 ft	2,200 ft	3,500 ft	2,500 ft	N/A	N/A	N/A	TBC	600 ft	550 ft
Draft at Quayside	45 ft	48 ft	43 ft	40 ft	25 ft	N/A	N/A	N/A	TBC	30 ft	28 ft
Quayside Strength	Container cranes	Container cranes	Container cranes	Breakbulk and RO/RO	Breakbulk	N/A	N/A	N/A	Container cranes	Unknown – previously major cargo	Marina
Channel Width	490 ft	700 ft	550 ft	430 ft	700 ft	N/A	N/A	N/A	500 ft	250 ft	320 ft
Channel Draft	52 ft	52 ft	48 ft	52 ft	52 ft	N/A	N/A	48 ft	42 ft	20 ft	20 ft
Air Draft	186 ft	186 ft	155 ft	No	No	N/A	N/A	186 ft	No	No	No
Current Usage	Containers	Containers	Containers	Breakbulk and RO/RO	Breakbulk	Containers, train to truck	Containers, train to truck	Intermodal Facility	Currently vacant	Currently vacant	Marina
Road/Rail/Land Access	Road and Rail	Road and Rail	Road and Rail	Road and Rail	Road and Rail	Road and Rail	Road and Rail	Road and Rail	Proposed	Road and Rail	Road and Rail
Suitability	Capability but long-term business plan	Capability but long-term business plan	Capability but long-term business plan	Capability – long-term plan unknown	Some capability however tourism plan	Potential for small compo-nents only	Potential for small compo-nents only	Potential for small components only	Capability but undeveloped site with long-term plan	Potential capability but significant upgrades required	Unlikely to be suitable

4.3.3 Ports Discussion

There are several ports in South Carolina that have large-scale manufacturing potential when considering the physical criteria (i.e., laydown area, quayside length, water depth etc.). However, most of these ports are at maximum capacity supporting container shipping, have a long-term business plan, or are not expected to be available to support offshore wind manufacturing. The existing ports outside Charleston are smaller and have narrower and/or shallower access channels however, Port of Georgetown is expected to have high potential.

South Carolina ports can be considered across five geographical areas: Georgetown, Charleston, Port Royal, Savannah River, and inland ports. The distribution of South Carolina ports across these regions is shown in Figure 4.8 with the highest density of ports and marine terminals in the Charleston area.

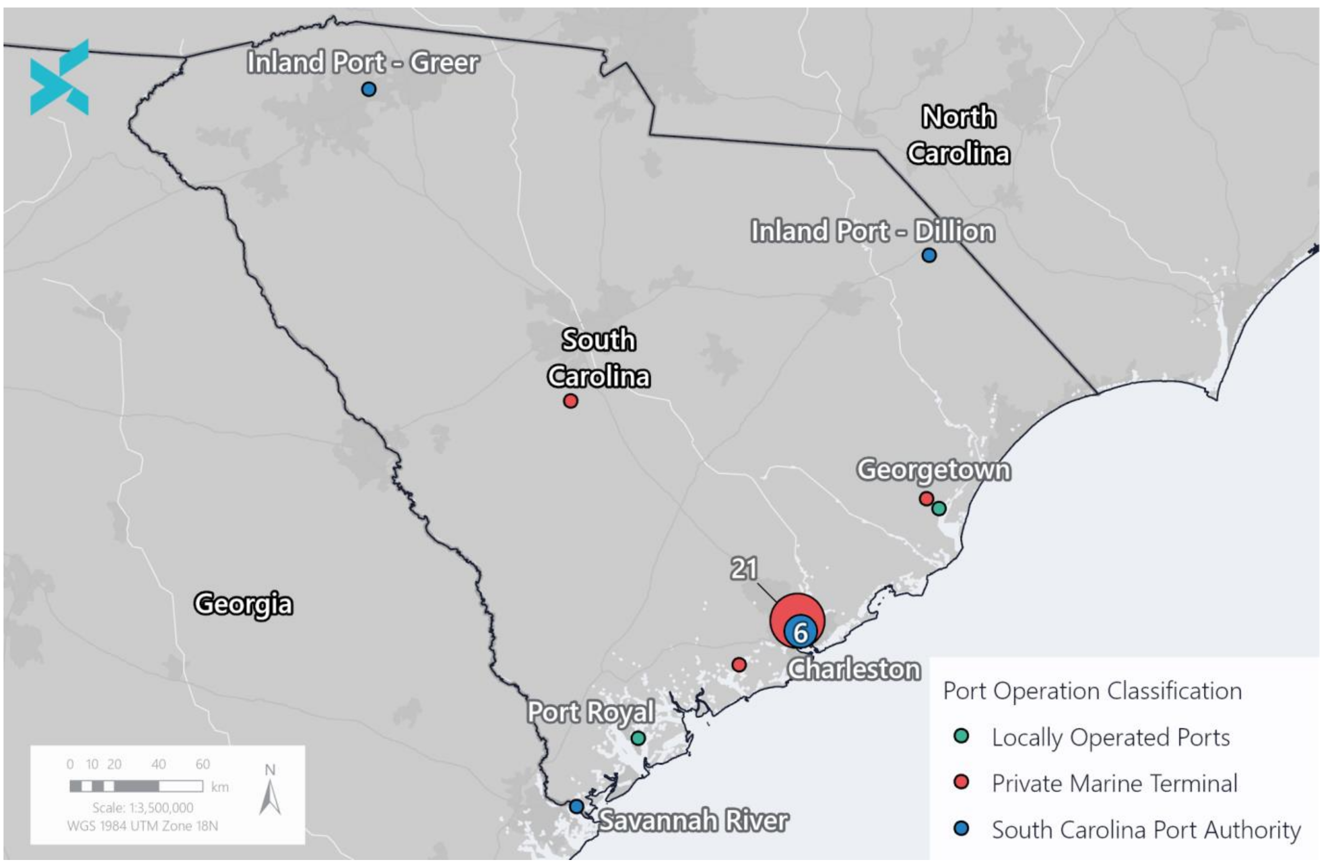

Figure 4.8 - Distribution of South Carolina ports.

Georgetown

The Port of Georgetown was once active in handling breakbulk, biofuel manufacturing, and export before its last cargo shipment in 2017. The port also has history as a steel mill, but the mill was closed in 2015. The port was acquired by

Georgetown County from the State in 2022 in an effort to transform the County's economy; however, the port has no current public plans for development. The port has adequate space for large-scale manufacturing of offshore wind components but will likely require infrastructure upgrades to ensure it can handle the weight of the components and has the necessarily manufacturing machinery and equipment.

There have been several unsuccessful proposals to dredge the channel to a consistent navigable depth. The channel is authorized to a depth of 27 ft according to the US Army Corps of Engineers but has not been regularly maintained since 2008. Based on the latest survey the current navigation channel depth is mostly below 20 ft, but some stretches are <20 ft with some areas <10 ft. The county has secured $6.5 million from the State to deepen the harbor area to 12 ft. The port is expected to require major channel and berth upgrades and maintenance in order to support a manufacturing site for offshore wind.

Given its former use and development needs, the Port of Georgetown has potential to support offshore wind manufacturing but will require significant investment to upgrade the port and channel to meet the requirements of most operations.

Figure 4.9 - Aerial view of Port of Georgetown.

Charleston

In Charleston there are many PMTs and several major commercial ports with substantial infrastructure and adequate water depth for access by large vessels. Figure 4.10 shows all ports and PMTs in the Charleston area.

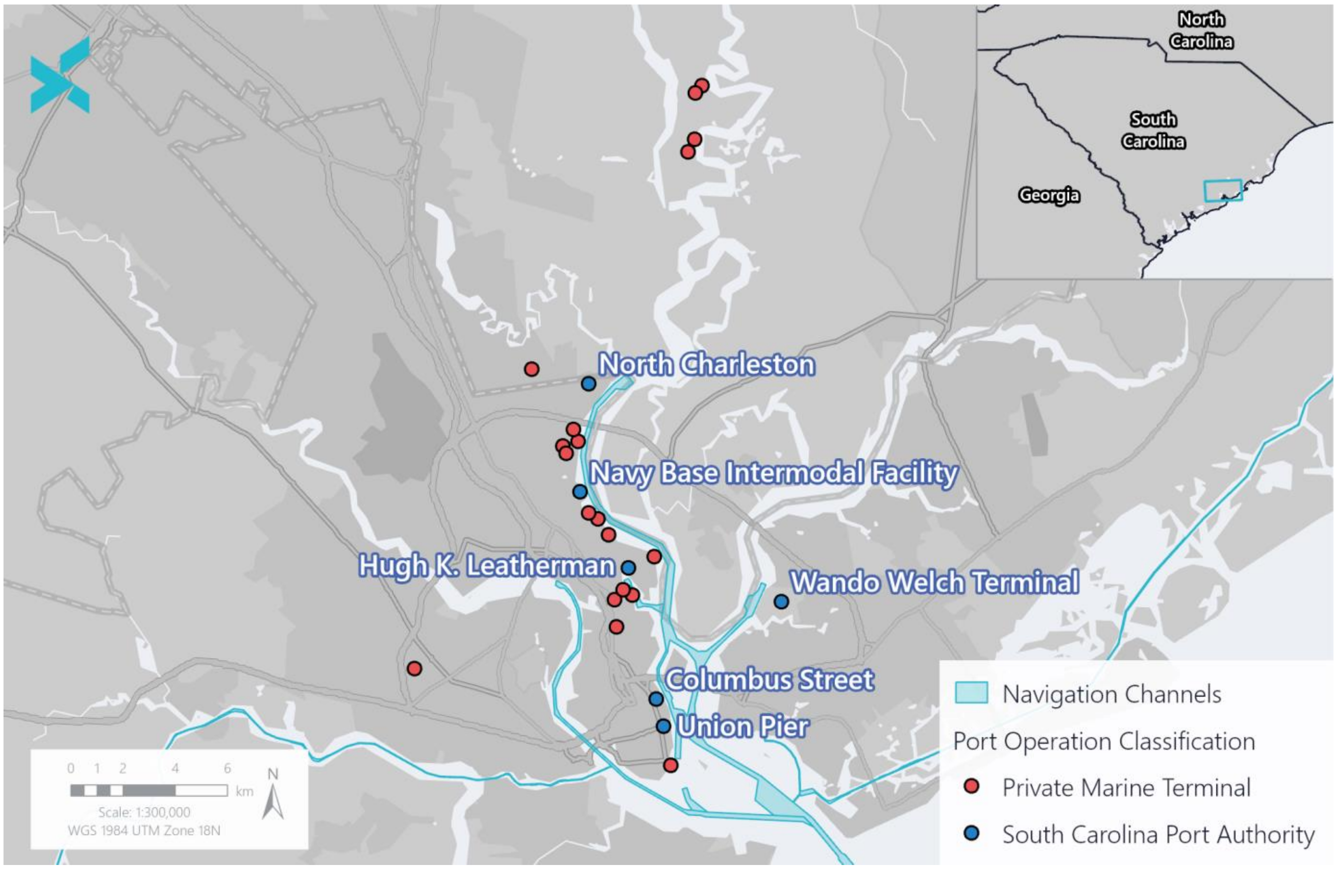

Figure 4.10 - Ports and PMTs in the Charleston area.

Ports including Wando Welch, Hugh K. Leatherman and North Charleston meet many infrastructure requirements for offshore wind components but are already at capacity as the three major container ports in the State. They have not been utilized previously by any external tenants or other industries. In 2021, the State invested $1 billion to complete Phase One of the Hugh K. Leatherman terminal, making it the country's first new container terminal since 2009. Phases Two and Three are expected to be built out through 2032. The next two phases will add two more berths to the site allowing the port to handle larger amounts of cargo. The State is also developing an inner-harbor barge operation that will support the new Navy Base Intermodal Facility by moving containers via waterways between Wando Welch and Hugh K. Leatherman. The State is investing $150 million to support this project. Wando Welch is also benefiting from $500 million of state funding, adding 15 new ship to shore cranes and general modernization. These ongoing investments in container ports demonstrate an appetite for port development in South Carolina as a response to demand.

Columbus Street has open space to develop a manufacturing site and was highlighted as the main port of interest during the South Carolina Wind Energy Workshop in 2021. The port is well maintained and is owned and operated by the SCSPA. It is currently being used as a combination breakbulk and roll-on/roll-off (RO/RO) terminal and is not currently at maximum capacity. Columbus Street is in the Charleston area with additional access via the maintained channel. The water depth in the channel and at berth are suitable for many of the required vessels needed to transport components.

Figure 4.11 - Aerial view of Columbus Street.

Based on conversations with local sources, the Union Pier is currently being sold to the City of Charleston to be developed into a tourist attraction. There are plans to add hotels, buildings, and green space for public use. This rules the pier out for development of a manufacturing site. The Navy Base Intermodal Facility is actively under construction but is not currently considered a viable port to support an offshore wind manufacturing site. When finished, this facility will be used to move containerized freight to other transportation modes like trains and trucks. This site does not currently have water access. It does have close proximity to the port and a rail connection to the Hugh K. Leatherman Terminal and the CSX rail yard. This makes the Navy Base Intermodal Facility an important site for containers to be transported via rail or truck to the rest of the State.

Port Royal

In Port Royal, there is an existing marina, Safe Harbor Port Royal, which is currently a small port but has plans for infrastructure upgrades and port expansion. However, the major upgrades required to be suitable for offshore wind component manufacturing are expected to be prohibitively expensive with other sites having more potential. The port plans to expand by adding several piers to provide more docking space for small vessels. The area will also need significant channel and berth upgrades to allow for vessel access.

Savannah River

Jasper Ocean Terminal is proposed on the Savannah River and is currently under development, with an expected operational date of 2035. This site was identified back in the 1990s but has remained undeveloped. In 2008, there was an Intergovernmental Agreement between South Carolina and Georgia to form the Jasper Ocean Terminal Joint Project Office. This office submitted the Jasper Ocean Terminal project to the US Army Corps of Engineers in 2015 and the Intergovernmental Agreement was superseded by a Joint Venture Agreement between Georgia Ports Authority and South Carolina Ports Authority. In 2016, the preparation of an Environmental Impact Statement formally began.

Figure 4.12 - Planned terminal layout for Jasper Ocean Terminal.

Jasper Ocean Terminal is proposed to serve as a major container terminal in the future but is unlikely to be built until needed (i.e., Charleston at capacity). The planned terminal would be an ideal port for offshore wind manufacturing with adequate laydown storage space, a deep-water channel, and new infrastructure that could be built to handle the required loads for offshore wind component manufacturing. There is potential for Jasper to serve as a manufacturing port, especially if the Joint Venture Agreement serves to speed up development of the port.

Inland Ports

The inland ports, Greer and Dillon, are owned and operated by the SCSPA. They do not have water access but do have access to rail and highways. These ports transfer cargo between trains and trucks. Due to their location, they are viable options for smaller component manufacturing that can be transported by rail but will not be viable options for major component manufacturing.

Four potential ports merit additional consideration for offshore wind component manufacturing in South Carolina:

- Columbus Street Terminal
- Port of Georgetown
- Jasper Ocean Terminal
- Develop a Greenfield Site (PMT) in the Charleston area

Each of these ports presents strengths and challenges for the construction of a manufacturing site as summarized in Table 4.6.

Table 4.6 - Strengths and challenges of establishing a manufacturing site.

PORT	STRENGTHS	CHALLENGES
Columbus Street	• State-owned and operated; well-maintained • Large acreage • Several warehouses on site • Understood to be less utilized than other Charleston ports • Good access channel • No air draft restrictions • Rail access	• Currently utilized as a combination breakbulk and RO/RO terminal – quayside upgrades expected • State-operated ports currently do not host tenants • Access by largest vessels to be confirmed
Georgetown	• Locally owned and looking to develop the local economy • Currently not utilized with no plans for development • Suitable acreage • Previously used as a major cargo port and biofuel manufacturing	• Channel and quayside water depth not maintained since 2008, will require major dredging • Has not hosted large vessels or cargo since 2017 • Quayside upgrades required but level is unknown

PORT	STRENGTHS	CHALLENGES
	• Funding ($6M) secured for inner harbor channel dredging • No air draft restrictions • Rail access	• Funding ($66M) requested and denied for full channel restoration (Winyah Bay to the ocean) in 2014
Jasper Ocean Terminal	• State-owned and operated • Good access channel • Planned rail access • Site identified, baseline studies, regulatory review and permit efforts underway • Offshore wind manufacturing potential has potential to speed up development of the port • If not the proposed terminal, then the identified site could be a smaller purpose-built PMT on the Savannah River	• Site is a joint venture between the SCSPA and the Georgia Port Authority – development may be complicated • Currently undeveloped with timeline unknown • Site reserved for container terminal when South Carolina and Georgia outgrow their current container terminals • Cost associated with building a new port
Greenfield Site in the Charleston Area	• Good access channel • Current area for majority of port manufacturing operations • Industrial area and raw materials • Could be State or privately owned • Custom-built site • Does not disrupt the existing ports	• High costs associated with building a new site • Dredging at the quayside would be required • Research into available greenfield sites is required

The three major container ports for the State (i.e., Wando Welch, Hugh K. Leatherman and North Charleston) have the potential and capability for offshore wind manufacturing; however, because they are understood to be at capacity and have not previously been utilized by external tenants or other industries, they would require alignment between the State and the SCSPA to encourage entry into the offshore wind industry. The inland ports and intermodal facility are also potential options for the manufacturing of smaller components that can be transported by rail but would require alignment and will not be a viable option for large-scale component manufacturing.

5 SOUTH CAROLINA OPPORTUNITY

5.1 Assessment Approach

The opportunity for the South Carolina supply chain to benefit from the growth of the US offshore wind industry will depend on a range of factors including which major component area within an offshore wind project is being procured, the capability of South Carolina companies against the established US and global supply chain, the dynamics of project capacity pipeline and procurement, and the investment landscape for local and national businesses.

The outputs of the supply chain capability assessment were analyzed to identify areas where South Carolina companies are well positioned to support or quickly adapt to the needs of the offshore wind industry. The opportunity analysis was carried out using a consistent set of criteria applied to each supply chain element that describes some of the influencing forces facing supplier procurement and investment decisions. These criteria were:

- **Relevant industry experience**: The strength and applicability of supply chain expertise in South Carolina supplying offshore wind or relevant adjacent industries, such as the aerospace, automotive, marine, and energy sectors.
- **Market volume resilience**: The dependence of supply chain companies' success on the volume of the offshore wind project pipeline.
- **Opportunity for US market supply**: The potential for capable South Carolina companies to supply projects in the US market, given the current and future competition should capability be established.
- **Relative project spend**: Proportion of total project spend typically attributable to the component.
- **Investment case**: Level of investment and market confidence needed to transition the supply chain and infrastructure capability.

A scoring system was applied to each criterion as described in Table 5.1.

Table 5.1 - Scoring system for opportunity analysis.

CRITERION	SCORE 1	SCORE 2	SCORE 3	SCORE 4
Relevant industry experience	No known local companies with relevant experience in an adjacent industry.	Local companies with some relevant experience but are unlikely to offer a competitive solution in offshore wind.	Local companies with some relevant experience that may need some change in strategy or additional investment to support supply to offshore wind projects.	Local companies with some relevant experience and are likely to supply in offshore wind with minimal change in strategy or additional investment.
Market volume resilience	Local companies' success is likely to depend almost entirely on orders from the offshore wind sector.	Local companies' success is likely to depend on >50% of order book from the offshore wind sector.	Local companies' success is likely to depend on <50% of order book from the offshore wind sector.	Local companies' success can be independent of orders from the offshore wind sector.
Opportunity for export supply	Significant logistics barrier to non-local supply or established competing supply harms export opportunity.	Some logistics benefit to local supply or established competing supply limits export opportunity.	No particular logistics benefit to supply or lack of established competing supply means non-local suppliers are not disadvantaged.	No particular logistics benefit to supply and lack of established competing supply means non-local suppliers will be required on nearby export projects.
Relative project spend on supply area	Average spend in elements is <1% of project lifetime expenditure.	Average spend in elements is between 1% and 3% of project lifetime expenditure.	Average spend in elements is between 3% and 7% of project lifetime expenditure.	Average spend in elements is >7% of project lifetime expenditure.
Investment case	Investment required to supply is significant enough to need public support and requires long-term confidence in offshore wind market.	Investment required to enable supply triggered by long-term confidence in offshore wind market.	Investment required to enable supply can be triggered by single offshore wind contract.	Little or no further investment needed to enable supply.

5.2 Opportunity Assessment

5.2.1 Nacelle

Summary

RELEVANT INDUSTRY EXPERIENCE	MARKET VOLUME RESILIENCE	OPPORTUNITY FOR US MARKET SUPPLY	RELATIVE PROJECT SPEND	INVESTMENT CASE
3	2	4	4	1

Relevant Industry Experience

While there are no suppliers of offshore wind turbine nacelles or secondary tier suppliers actively involved in the offshore wind supply chain in South Carolina, the State hosts a wind turbine drivetrain testing facility at Clemson University, with a 15 MW testing rig that has tested GE and Vestas offshore wind turbine drivetrains. This facility, designed for both quality assurance and testing endurance for research and development purposes, is the world's most advanced wind turbine drivetrain testing facility capable of mechanical and electrical testing. This facility is one of the State's main offshore wind assets.

Many South Carolina companies have extensive experience in adjacent industries. Some South Carolina companies already manufacture advanced composites and polymers for nacelle subcomponents, such as brushing and lubrication system components. Several multinational companies with presence in South Carolina manufacture nacelle subcomponents at their facilities outside of the State. Many of these companies manufacture industrial motion equipment such as bearings, hydraulic systems, and gears and supply these components to industries such as aerospace and automotive which must meet strict quality and reliability standards.

The Tier 2 supply chain for offshore wind nacelle components is not driven by the location of suppliers, where the quality of component supply is paramount. The onboarding process for new companies producing operationally critical nacelle components is intensive. It can take significant time and expense for suppliers, with OEMs having well-established networks of trusted suppliers. Only companies possessing a strong desire to enter this industry, with the requisite track record and financial positioning, would be well placed to consider supply in this space. Given the production volumes required for the offshore wind industry, companies must have significant manufacturing capacity and access to capital to meet order requirements while de-risking their operations by pivoting to other industries during production downturns.

Market Volume Resilience

A South Carolina based nacelle assembly facility would be entirely dependent on the size of the offshore wind market.

Companies that could support the nacelle supply chain are already finding success supplying other industries requiring precision and electrical components. The number and variety of components required in a nacelle result in a broad array of Tier 2 and Tier 3 suppliers, most of whom supply several different industries, including oil and gas, nuclear, aerospace, and mining.

Opportunity for US Market Supply

As no offshore wind nacelle facility exists or is under construction in the US, any established facility would be well placed to serve a significant volume of the total US market. Given the volume of projects in the US pipeline, there could be an appetite from the turbine OEMs to eventually establish a domestic nacelle assembly facility located in South Carolina that can export to the entire US industry.

Where turbine OEMs are highly consolidated to relatively few wind turbine designs, this allows for the potential broad applicability of any individual Tier 2 or Tier 3 component for future offshore wind projects. Should US nacelle assembly of component manufacturing facilities be established, investments in the supply chain for these components could position one or more South Carolina companies as national suppliers.

Relative Project Spend

The nacelle is a wind turbine's most complex and expensive component, representing approximately 12-15% of project costs. Any increase in efficiency in the procurement or manufacturing of the nacelle has a significant impact on the financial footprint of the entire project.

Investment Case

Nacelle assembly is highly intricate, as the nacelle houses multiple complex integrated systems, electronics, and large mechanical components. Nacelle manufacturing facilities require significant investment, ranging from $200-$500 million, depending on size and scale. Nacelle assembly facilities employ many workers, typically between 300 and 400 people.

A turbine OEM would need to secure multiple GWs of contracts and would likely require additional funding from a developer or governmental body to justify the investment. As seen in the case of GE's proposed nacelle assembly facility at the Port of Coeymans, removing government funding can directly curb the appetite to fund a facility of this scale.

The absence of a domestic offshore wind nacelle assembly facility does increase the investment case for a nacelle facility in South Carolina, as a nacelle's high cost and demand have led to a large market size. Additionally, South Carolina's strong innovation sector, as seen with Clemson University's Wind Turbine Drive Train Test Facility, alongside its strong manufacturing capabilities, make it a more attractive option for a nacelle facility than in other states in the US.

5.2.2 Blades

Summary

RELEVANT INDUSTRY EXPERIENCE	MARKET VOLUME RESILIENCE	OPPORTUNITY FOR US MARKET SUPPLY	RELATIVE PROJECT SPEND	INVESTMENT CASE
3	2	4	3	2

Relevant Industry Experience

Large chemical manufacturing companies like Chomarat North America and Celanese produce fibers, polymers, resins, adhesives, and coatings in South Carolina. While several multinational companies in South Carolina are known to supply to the offshore wind industry, it is unclear whether they do so from in-state facilities or abroad.

South Carolina has a robust supply chain for the supply of structural composite materials to several industries, including aerospace, automotive, and fiberglass boat applications. Many of these companies also supply the onshore wind industry with a high adjacency with offshore wind for producing fibers, resins, polymers, and adhesives. Due to the corrosive marine conditions to which blades are subject offshore, there is less adjacency between onshore and offshore wind coatings.

Market Volume Resilience

Offshore wind blades are highly specialized, requiring specialized manufacturing processes and controls, quality assurance procedures, and significant storage space. With respect to lengths, manufacturing processes, component materials, etc., offshore turbine blades are specific to turbine designs.

There is a greater market volume resilience for Tier 2 and Tier 3 suppliers providing raw materials such as fiberglass/carbon fiber, resins, coatings, etc., as they can supply to multiple industries and are not supplying custom parts.

Opportunity for US Market Supply

As no offshore wind blade manufacturing facilities exist or are under construction in the US, any established facility would be well placed to serve a significant volume of the total US market. Given the volume of projects in the US pipeline there could be appetite from the turbine OEMs to eventually establish a US blade manufacturing facility located in South Carolina with the ability to export to the entire US industry. South Carolina has some opportunity to supply at the Tier 2 and Tier 3 levels to support blade manufacturing should a US Tier 1 facility be established.

Relative Project Spend

Blades represent approximately 5-7% of project investments. Blades are potentially a recurring investment, as they may need to be replaced after repeated stress cycles before the end of each project.

Investment Case

Setting up a blade manufacturing facility requires significant investment, likely greater than $200 million. Blade fabrication uses a precise manufacturing process and specialized equipment not typically utilized in other industries. However, blade manufacturing facilities offer strong workforce development opportunities, as these facilities typically employ over 500 workers.

To justify this investment, an OEM would need to secure multiple GWs of contracts and would likely require additional funding from a developer or governmental body. While no blade manufacturing facilities are currently planned in the US, there is only a medium investment case for one, as the immense complexity of blade manufacturing adds significant risk.

5.2.3 Tower

Summary

RELEVANT INDUSTRY EXPERIENCE	MARKET VOLUME RESILIENCE	OPPORTUNITY FOR EXPORT SUPPLY	RELATIVE PROJECT SPEND	INVESTMENT CASE
2	1	2	2	3

Relevant Industry Experience

South Carolina has little to no experience in serialized fabrication of large steel structures like towers. While a handful of fabricators like W International likely have experience rolling and welding heavy steel plates for large one-off fabrications in the marine and defense industries, none of these facilities can supply the offshore wind industry without significant investment. Any such facility will require a costly expansion, retooling, and certification effort or, more likely, the development of a new facility on a greenfield site. Without a partnership or investment from an established global tower supplier, the lack of brand recognition also poses a barrier to market entry.

Market Volume Resilience

Offshore wind tower requirements are bespoke to offshore wind turbines and are significantly larger than onshore turbine towers. The long-term success of an offshore wind tower facility would be entirely reliant on the offshore wind project pipeline.

Tower manufacturing requires substantial space and load-bearing requirements at production and storage facilities. Steel plates of a specific thickness and grade are required, as are sophisticated welding and non-destructive testing equipment and expertise. Heavy lift cranes and transportation equipment are needed to move and manipulate such large and heavy components.

Opportunity for US Market Supply

A tower fabrication facility can serve a wide geographical market. With the expected volume of projects in the Northeast, there may be an appetite for a supplier to establish in South Carolina. However, several announced (but not yet constructed) tower manufacturing facilities for the US market could provide a competitive supply to the region.

Relative Project Spend

Tower manufacturing requires large facilities with machinery capable of rolling massive steel cans. The cost of procuring towers represents approximately 2% of overall project spend.

Investment Case

Tower manufacturing is a less complex process than blade and nacelle manufacturing. This reduced complexity lowers the barrier to entry for the local workforce and increases the ease of developing and operating a tower manufacturing facility.

However, due to the large equipment needed to roll such large steel structures, tower manufacturing facilities still require hundreds of millions of dollars of investment. Additionally, tower manufacturing is a relatively low-margin business due to the price of steel being the most significant cost driver. This business model can lead tower manufacturers to look to amortize risk through costly first contracts, causing an initial increase in cost for project developers. This, alongside global macroeconomic conditions, has been a driver in why many of the announced tower manufacturing facilities in the U.S. have yet to be built.

5.2.4 Monopile and Transition Piece

Summary

RELEVANT INDUSTRY EXPERIENCE	MARKET VOLUME RESILIENCE	OPPORTUNITY FOR US MARKET SUPPLY	RELATIVE PROJECT SPEND	INVESTMENT CASE
2	2	2	3	2

Relevant Industry Experience

South Carolina has limited capability in the serial production of large steel structures like towers, monopiles, and transition pieces. Several metal fabricators like W International may have experience rolling and welding heavy steel plates for large one-off components in the marine and defense industries. However, none of these facilities can supply towers, monopiles, or transition pieces without major investment. Any such facility will require a costly expansion, retooling, and certification effort or, more likely, the development of a new facility on a greenfield site. Without a partnership or investment from an established global supplier, the lack of brand recognition also poses a barrier to market entry.

South Carolina metal fabricators may be able to fabricate secondary steelwork for towers and transition pieces including work platforms, boat landings, and davit cranes. Companies like Kloechner Metals likely have experience in the serialized fabrication of steel and aluminum support structures. However, they will likely require some investment in retooling and certifications to supply offshore-grade fabrications. Steel and aluminum suppliers like ATI Specialty Materials and Century Aluminum may also be able to supply offshore-grade metals for secondary steelwork.

Market Volume Resilience

Offshore wind foundations are bespoke to the offshore environment with some synergies with supply to the oil and gas industry. Monopile manufacturing requires substantial space and load-bearing requirements at production and storage facilities. Steel plates of a specific thickness and grade are required, as well as sophisticated welding and non-destructive testing equipment and expertise. Tier 1 supply success in this sector would be largely reliant on the size of the offshore wind industry. However, supplies of secondary steel structures will be able to service other industries.

Opportunity for US Market Supply

A foundation fabrication facility would serve a wide geographical market but compete with established US facilities. Monopiles have been the favored foundation technology solution for commercial-scale offshore wind projects in waters less than 60 m deep. The demand has created a monopile manufacturing facility developed by EEW in New Jersey. This facility is currently operating at capacity and has announced plans to expand. Despite monopiles' utilization in the US market thus far, their market size is capped because monopiles are also only used in relatively shallow water. As shallow water ocean areas develop, projects are starting to be planned for deeper waters incompatible with monopiles. The market size of transition pieces is also shrinking and even faster than that of monopiles: transition pieces are only utilized in tandem with monopiles, but several new monopile designs are "TP-less" (i.e., do not require a transition piece).

Relative Project Spend

While the main purpose of the transition piece is to connect the monopile to the turbine tower, it also holds several components, including platforms, boat landing systems, and ladders. Transition pieces usually account for 1-2% of total project spending.

Monopiles' simple design has made them a lower-cost foundation option than other designs seen in offshore wind (jackets, gravity-base, etc.), typically accounting for 3-5% of total project spend. However, as the use of monopiles extends into deeper waters (>50m), this overall cost will likely increase and could reach >5% of total project spend.

Investment Case

Monopile and transition piece manufacturing processes share the primary functions of steel plate rolling, welding, heavy lifting, and protective coatings application which are less complex processes than required in the fabrication of other components. This lower complexity reduces the barrier to entry for the local workforce and increases the ease of developing and operating these manufacturing facilities. Additionally, it is not uncommon to see monopile or tower manufacturing facilities also capable of manufacturing transition pieces, although standalone transition piece manufacturing facilities exist.

While the demand for these components is still high, developing manufacturing facilities for them requires major investment in both the facility and associated ports due to the immense weight of the structures and the large equipment needed to roll such large steel structures. This investment would likely be greater than $200 million.

The existing announced tower and monopile manufacturing facilities, decreasing market size of monopiles and transition pieces, high cost of investment, and the described economic risk make the investment cases for tower, transition piece, and monopile manufacturing facilities lower.

5.2.5 Jacket

Summary

RELEVANT INDUSTRY EXPERIENCE	MARKET VOLUME RESILIENCE	OPPORTUNITY FOR US MARKET SUPPLY	RELATIVE PROJECT SPEND	INVESTMENT CASE
2	3	1	4	1

Relevant Industry Experience

No facilities in South Carolina have supplied jackets for offshore wind projects to date. While global coatings manufacturer PPG has supplied coating systems to an offshore wind jacket fabrication yard in Spain and a Swedish offshore wind company, its South Carolina facility only serves the automotive and large truck markets.

South Carolina companies have some transferrable capability in the supply of jackets from the marine and defense industries. Fabricators like W International have experience producing and machining large one-off weldments for ships and aircraft carriers, which can be akin to the complex fabrication of a small number of bespoke jackets for an offshore substation or several deepwater turbines. While these facilities will still require upgrades like site expansion and retooling to supply jackets, the capital expenditure is likely to be significantly less than that required for heavy steel rolling for towers, monopiles, or transition pieces. Project developers have procured jackets from a broad range of large to mid-size steel fabricators in the US and abroad, so lack of brand recognition is unlikely to pose a significant barrier to market entry.

Market Volume Resilience

While high-volume production is required for jacket foundation fabrication, there is typically more flexibility in the fabricator's ability to pivot to other components or sectors than for the more specialized monopile foundation manufacturing process. This means there is generally a higher market volume resilience for companies producing jacket foundations. Jacket structures are large and require substantial fabrication sites and specialized lifting and transportation equipment at the quayside, which are made of welded tubular steel members. More labor is required in fabricating a jacket than a monopile, but this is less specialized as plate thicknesses are in a more standard range, meaning when jacket production is not required, efforts can be directed to other types of steel fabrication.

Jackets are also required as offshore substation foundations, allowing for one-off productions versus serial production, further increasing the opportunity for companies to service multiple industries simultaneously due to reduced high-volume production requirements.

Opportunity for US Market Supply

Currently, the demand for jacket structures in the US offshore wind market is very low, with no commercial-scale projects in development known to be planning to use jacket foundations for their turbines. Should there be demand for jacket structures in the US market, there is likely to be a strong competitive supply from existing fabrication facilities in the Gulf of Mexico serving the oil and gas market.

Relative Project Spend

The tendency to select monopiles over jackets as turbine foundations may change as projects are planned in deeper waters. Still, if jackets are only used for substations, jacket expenditure would account for less than 1% of total project spend. For projects using jackets as turbine foundations, they could make up 7-10% of the total project spend.

Investment Case

Due to high costs and the scale of the facility required to manufacture steel foundations, a significant project pipeline and high confidence in the industry would be required to justify the investment levels needed for a foundation manufacturing facility. Public sector support may be required due to the risk of highly uncertain future demand for jacket foundations in the US offshore wind market.

5.2.6 Array Cables

Summary

RELEVANT INDUSTRY EXPERIENCE	MARKET VOLUME RESILIENCE	OPPORTUNITY FOR US MARKET SUPPLY	RELATIVE PROJECT SPEND	INVESTMENT CASE
2	1	2	2	2

Relevant Industry Experience

South Carolina has no facilities supplying array cables to the offshore wind industry. While Nexans supplies array and export cables to the global offshore wind industry, its South Carolina facility only manufactures export cables. Prysmian Group, another global supplier of subsea cables, has two facilities in South Carolina supplying fiber and electrical cables for onshore applications in the telecommunications and energy industries. However, both facilities are inland without river access, limiting the company’s ability to supply array cables without developing a new facility.

Market Volume Resilience

An array cable manufacturing facility will be dependent on the size of the offshore wind market, which has limited demand for high-voltage submarine cables in adjacent local sectors.

Opportunity for US Market Supply

An array cable facility would serve a wide geographical market. Planned investment in US array cable manufacturing facilities may limit the opportunity for additional facilities in the US market until project demand increases.

Relative Project Spend

Array cables are critical components that ensure power is transmitted from the turbine to the offshore substation while providing auxiliary power to turbines when not generating power. Array cables are complex electrical components that need to be able to endure harsh marine environments. This requirement is extenuated for floating offshore wind projects, as array cables will have a dynamic cable length between floating substructures and the seabed. Additionally, while current array cables are typically rated 66 kV, cable voltages are anticipated to increase to 132 kV, increasing complexity and cost. They comprise 1-2% of total project expenditure.

Investment Case

A small number of cable manufacturers have provided array cables for offshore wind projects in Europe and the US, increasing competition in the market. These manufacturers have established supply chains, and the niche nature of many of the subcomponents needed in array cable manufacturing can make it challenging for local supply chain engagement. However, the US' potential demand for array cables is high, as only one manufacturer has announced plans to open a domestic array cable manufacturing facility. An array cable facility would require between $100-200 million investment and has a medium investment case.

5.2.7 Export Cable

Summary

RELEVANT INDUSTRY EXPERIENCE	MARKET VOLUME RESILIENCE	OPPORTUNITY FOR US MARKET SUPPLY	RELATIVE PROJECT SPEND	INVESTMENT CASE
4	3	4	3	4

Relevant Industry Experience

The Nexans facility in South Carolina is the nation's only domestic producer of export cables for the offshore wind industry. The company's Goose Creek facility was retrofitted in 2021 to supply high-voltage subsea cables, and it has since delivered export cables to three offshore wind projects in the US. The facility procures materials from a global network of Tier 2 suppliers but contracts local subcontractors for on-site services such as scrap metal removal and equipment calibration and maintenance.

Market Volume Resilience

Export cable manufacturing is typically a specialized process for the offshore market. These facilities can serve the global subsea interconnector market and may have the ability to serve the onshore transmission sector.

Opportunity for US Market Supply

Nexans is already exporting cables produced in their South Carolina facility to US and European offshore wind projects.

Relative Project Spend

Export cable expenditure depends on various factors, but it largely depends on the project's distance from shore and whether HVAC or HVDC technology is used. If HVAC is used, export cable makes up 3-5% of project expenditure; if HVDC is used, it makes up 5-7% of project expenditure.

Investment Case

South Carolina is currently home to the Nexans export cable facility, the only offshore wind export cable manufacturing in the US. This facility has already obtained several contracts to supply export cable to US offshore wind projects. It will likely remain a key manufacturing facility in the US offshore wind industry.

5.2.8 Substation Electrical Infrastructure

Summary

RELEVANT INDUSTRY EXPERIENCE	MARKET VOLUME RESILIENCE	OPPORTUNITY FOR US MARKET SUPPLY	RELATIVE PROJECT SPEND	INVESTMENT CASE
3	4	3	2	4

Relevant Industry Experience

South Carolina has no facilities that manufacture high-voltage electrical infrastructure for offshore substations. However, there are several global manufacturers of power and electricity distribution equipment operating in South Carolina. ABB, Schneider Electric, and Siemens all currently service or supply low- and medium-voltage electrical equipment in-state for the power grid, critical infrastructure like data centers, and commercial and industrial buildings.

None of these facilities are anticipated to pivot to the supply of high-voltage electrical infrastructure for offshore wind applications without significant investment. However, given sufficient market demand and state investment, these companies could be incentivized to construct a high-voltage electrical infrastructure facility in South Carolina.

Market Volume Resilience

Companies manufacturing electrical infrastructure would look to supply other industries in addition to offshore wind.

Opportunity for US Market Supply

Electrical infrastructure manufacturing capability would serve a wide geographical market beyond offshore wind.

Relative Project Expenditure

Offshore substation expenditure depends on various factors, but they largely depend on the project's size and whether HVAC or HVDC technology is used. The relative project expenditure is between 3% and 5%, with a significant portion of the spend on the substation foundation in addition to the electrical infrastructure. Onshore substations spend amounts to 1% or less of relative project expenditure.

Investment Case

The case to establish a facility to manufacture complex electrical infrastructure that would serve the offshore wind market would not be made based on the ability to serve offshore wind projects alone.

5.2.9 Other Supporting Manufactured Components

Summary

RELEVANT INDUSTRY EXPERIENCE	MARKET VOLUME RESILIENCE	OPPORTUNITY FOR US MARKET SUPPLY	RELATIVE PROJECT SPEND	INVESTMENT CASE
3	4	2	1	4

Relevant Industry Experience

Metal fabricators with opportunity to supply secondary steelwork, such as W International, may also be poised to supply transportation structures like blade racks, monopile cradles, and tower grillages. Although they may require retooling to supply offshore-grade fabrications, they likely have experience and capability in the serial production of steel and aluminum transportation structures.

Market Volume Resilience

Market volume resilience depends on the component or service in question but generally the capability to supply is shared with the manufacturing requirements of other industries.

Opportunity for US Market Supply

Where manufacturing supply is non-specialized South Carolina companies will face competition from established suppliers in other states.

Relative Project Spend

While supporting manufactured components are not installed as part of the permanent offshore wind project infrastructure, they can still amount to millions of dollars of total contracts with Tier 1 and 2 suppliers.

Investment Case

The case for investment in facilities to manufacture additional supporting components would not be made based on the ability to serve offshore wind projects alone. Manufacturers will typically make inward investment in expanding their capabilities based on a longer-term view of the expected return on investment.

5.3 Opportunity Summary

Table 5.2 - Summary of opportunity assessment.

SUPPLY CHAIN ELEMENT	RELEVANT INDUSTRY EXPERIENCE	MARKET VOLUME RESILIENCE	OPPORTUNITY FOR US MARKET SUPPLY	RELATIVE PROJECT SPEND	INVESTMENT CASE
Nacelle	3	2	4	4	1
Blades	3	2	4	3	2
Tower	2	1	2	2	3
Monopile and Transition Piece	2	2	2	3	2
Jacket	2	3	1	4	1
Array Cables	2	1	2	2	2
Export Cable	4	3	4	3	4
Substation Electrical Infrastructure	3	4	3	2	4
Other Supporting Manufactured Components	3	4	2	1	4

South Carolina has a range of opportunities to supply the growing US offshore wind industry. These are driven by both the strength of the potential relevant capability of the existing South Carolina supply chain as well as current gaps in the wider US supply while the domestic Tier 1 offshore wind landscape is yet to be established. Public sector support could be deployed to bring further Tier 1 manufacturing to South Carolina, enable lower tier suppliers to expand adjacent capability into the offshore wind sector, connect suppliers with contracting opportunities on offshore wind projects, and de-risk private investment.

While there are currently no established US offshore wind turbine nacelle or blade manufacturing facilities, there could be opportunity to attract OEMs to locate production in South Carolina. These facilities' investment case will be highly dependent on the size and certainty of the US offshore wind market and will likely require public sector investment to help de-risk the significant capital and operating costs required to establish and maintain any new plant, where OEMs likely still have capacity to supply US projects from existing manufacturing facilities elsewhere in the world. South Carolina companies could have opportunity to supply a range of nacelle and blade materials and subcomponents with some inward investment, should US Tier 1 capacity be established.

US domestic supply of large steel structures for the offshore wind market is still emerging with only one announced Tier 1 facility on the East Coast having begun operations. South Carolina companies could see Tier 2 opportunities in the supply of towers and foundations for the offshore wind sector, though these may be harder to capture than equivalent opportunities in other elements. South Carolina suppliers will be competing on cost and quality against US companies established in other states that may be benefiting from implicit or explicit local content ambitions placed on offshore wind projects.

Nexans capability to supply high voltage export cables to the offshore wind market is the primary strength of the current South Carolina offshore wind supply chain. Nexans' global industry experience and track record makes it one of the market leaders in the supply of subsea cables and their facility in Berkeley County has produced cable for US and global offshore wind projects. A priority for the State should be to ensure that the facility is supported to remain a highly competitive supplier to US offshore wind projects as the industry continues to grow.

South Carolina has good opportunity to support the manufacturing of electrical infrastructure and other accessories that enable the construction of offshore wind projects. An advantage to South Carolina supporting supply chain development in the provision of these types of components is that these companies will have opportunities to supply products to a broader range of adjacent industries independent of the growth of the offshore wind sector. Existing South Carolina suppliers are likely to be able to meet procurement requirements in the offshore wind sector with minimal investment beyond the effort to establish relationships, demonstrate qualifications and capability, and stay aware of potential contracting opportunities.

6 ECONOMIC IMPACT POTENTIAL

Offshore wind may present significant opportunities for economic benefits through job creation, increased investments, and increases in tax revenue. The State already realizes significant economic benefits through the existing Nexans export cable manufacturing facility, a key piece of the US offshore wind supply chain. South Carolina could realize additional economic benefits by enhancing in-state supply chain capabilities, investing in ports, adapting policy, and increasing investment in infrastructure.

6.1 Assessment Approach

South Carolina has the potential to achieve significant economic benefits through supporting the offshore wind industry. To highlight these potential impacts, The Clemson University Regional Economic Analysis Laboratory conducted economic impact modeling of existing and potential future mobilization of the offshore wind supply chain in South Carolina. Xodus provided Clemson University with inputs for this analysis based on findings of this study, which can be seen in Appendix C.

The analysis was organized according to three scenarios (Scenario A, B, and C) that characterise varying levels of offshore wind supply chain activity occurring in South Carolina over the next decade, as described in Table 6.1. The scenarios were chosen to represent the various potential ways offshore wind manufacturing could economically benefit South Carolina. Scenario C is further subdivided into three separate variations (C.1, C.2, C.3) to account for a range of impacts that could be seen should the State support large scale investment in manufacturing infrastructure in South Carolina.

Table 6.1 - Economic impact scenario definitions.

SCENARIO	DEFINITION
Scenario A	Accounts for the current offshore wind activity in the region. This focuses solely on the economic impacts of the operations and output of the Nexans facility.
Scenario B	Accounts for the current offshore wind activity in the region and the impacts if the State allocated funding towards supporting offshore wind industry growth in the State and enabled Tier 2 contracts for in-state manufacturing.
Scenario C	Accounts for the current offshore wind activity in the region, the estimated impacts if all this report's recommendations are implemented, and if one of the following investments are made: • (C.1) Investment in upgrading the Columbus St. port; • (C.2) Investment in an existing fabrication facility to manufacture jacket foundations; or • (C.3) Investment to attract the establishment of a nacelle assembly facility.

Scenario B assesses the economic benefits of in-state companies securing several Tier 2 supply chain contracts that could realistically be delivered from within the State in the future. Select Tier 2 contracts were chosen for the basis of this analysis (supply of bearings and transportation frames) as analogues for several potential Tier 2 contracts that could be supplied in the future from South Carolina (including low-voltage equipment, installation support equipment, transformers, coatings, etc). The three variants of Scenario C were chosen to showcase the most ambitious outcomes of economic benefits South Carolina may see through offshore wind development, with the most aggressive being the localization of a nacelle assembly facility (C.3). While it remains unlikely that the benefits of this scenario are likely to occur in South Carolina without significant effort, they were modeled to highlight the substantial economic benefits localizing a major component manufacturing facility would bring to the State.

The Clemson University Regional Economic Analysis Laboratory utilized the Regional Economic Models, Inc. (REMI) PI+ modeling engine and its Fiscal Impact Analysis Tool for this analysis. REMI utilizes input-output modeling, computable general equilibrium, and econometric modeling to project a baseline of economic activity assuming ceteris paribus except for normal economic growth. Impacts on the economy, including direct, indirect, and induced effects, are then modeled regarding departures from that baseline.

The REMI model is a new economic geography model that considers trade flows between regions based on labor and natural resources availability and the efficacy of transporting goods and services to and from the region. The model can project economic impacts over multiple years, allowing for intertemporal effects, i.e., "spillover" effects from one year to the next.

The Fiscal Impact Analysis Tool uses outputs from the REMI model to project the net fiscal impact of the modeled economic shocks on state government. The tool is calibrated using US Census of Governments data to estimate revenue and expenditure changes based on metrics generated by the REMI model. The analysis results were rounded in this section for a simpler interpretation of the data, with full results provided in Appendix D.

Impacts are reported using the following metrics with **all dollar amounts stated in real 2024 USD**:

- **Employment** is the number of jobs or job equivalents created within the region through direct, indirect, and induced effects.
    - **Direct employment** involves those employed by a specific economic activity (such as a nacelle assembly facility).
    - **Indirect employment** effects are the jobs created at first and second-tier suppliers in the region.
    - **Induced employment** effects are jobs created by consumer spending of wage income generated by direct and indirect effects.
- **Total compensation** is the total impact on aggregated annual wage income (including fringes) for all regional workers.
- **Output,** or total sales, is the total impact on the quantity of all goods and services produced within the region within a given year, stated in terms of its dollar value.
- **Net state government revenue**: Economic activity impacts government revenue; this analysis estimates revenue impact from all revenue sources, including taxes, licensing, fees, and intergovernmental transfer.

However, economic activity also demands government services, including infrastructure, education, and so forth; therefore, this fiscal analysis also projects the impact on state government expenditures. The estimated fiscal impact is therefore reported as revenue net of expenses.

Impacts are projected for an eleven-year period, defaulted to 2025-2035, but the results are not constrained to these specific years.

Inputs and Assumptions

Several assumptions were made to develop economic inputs used to model each scenario.

Model regions within the State are configured according to generally accepted regional definitions within South Carolina: Lowcountry, Pee Dee, Midlands, and Upstate. The geographic location of each modeled activity was sometimes dictated by existing activities within that region (for example, the Columbus Street Port is located in Charleston, which is in the Lowcountry). Additional investment was located in the most likely region. State government investments in the medium model were applied to all four regions. All activities in the model will have a "spillover" effect (when an event has a ripple effect on the economy of another) throughout the State; these are reflected in the model results.

In Scenario B, all government investments are assumed to be implemented in the same year, with employment beginning in the year following the completion of each respective investment. Government spending on these investments is assumed to be redirected from other spending areas; as such, this amount was entered into the REMI model as a negative change in state government spending, which partially offset the positive impact of the modeled investment spending. These government expenditures are also included in the fiscal model.

In each variant of Scenario C, the State government is assumed to contribute 25 percent of the investment for each project. As stated above, this government spending is assumed to be redirected from other spending areas in the years the investment occurs.

6.2 Economic Impact Assessment

6.2.1 Scenario A

Scenario A estimates a statewide impact of an average of 840 annual jobs, $69 million in annual compensation, and $356 million in annual output. The annual statewide and state government economic impact can be seen in Table 6.2.

The largest impact is in the Lowcountry because the Nexans facility is there. Still, all four regions in the State see positive economic impacts from the activity. State net revenue is projected to be positively impacted by an average of $4.1 million annually.

Table 6.2 – Annual statewide and state government economic impact on employment, compensation, output, gross revenue, expenditures, and net revenue in Scenario A.

YEAR	CATEGORY					
	Employment (Jobs)	Compensation (Millions)	Output (Millions)	Gross Revenue (Millions)	Expenditures (Millions)	Net Revenue (Millions)
2025	770	$58.7	$316	$7.43	$2.46	$4.97
2026	830	$62.6	$332	$8.68	$4.16	$4.52
2027	865	$66.8	$344	$9.84	$5.48	$4.35
2028	875	$69.1	$350	$10.7	$6.47	$4.18
2029	870	$70.4	$355	$11.3	$7.28	$4.03
2030	855	$71.1	$359	$11.8	$7.94	$3.91
2031	850	$71.7	$364	$12.3	$8.47	$3.88
2032	830	$71.8	$367	$12.7	$8.96	$3.75
2033	825	$72.1	$371	$13.1	$9.37	$3.73
2034	820	$72.7	$376	$13.5	$9.76	$3.73
2035	820	$73.4	$381	$13.9	$10.1	$3.77

6.2.2 Scenario B

Table 6.3 shows the statewide impact averaged over the study period for this model includes 935 jobs, $77 million in annual compensation, and $393 million in annual output iunder Scenario B.

Table 6.3 – Annual statewide and state government economic impact on employment, compensation, output, gross revenue, expenditures, and net revenue in Scenario B.

YEAR	CATEGORY					
	Employment (Jobs)	Compensation (Millions)	Output (Millions)	Gross Revenue (Millions)	Expenditures (Millions)	Net Revenue (Millions)
2025	720	$51.6	$311	$6.97	$2.32	$4.65
2026	790	$56.2	$328	$8.24	$3.98	$4.27

YEAR	CATEGORY					
	Employment (Jobs)	Compensation (Millions)	Output (Millions)	Gross Revenue (Millions)	Expenditures (Millions)	Net Revenue (Millions)
2027	955	$71.3	$382	$10.5	$5.6	$4.90
2028	1,020	$80.6	$397	$12.0	$7.05	$4.97
2029	1,115	$82.0	$402	$12.9	$8.05	$4.74
2030	1,000	$82.9	$406	$13.4	$8.85	$4.57
2031	985	$83.5	$410	$14.0	$9.52	$4.49
2032	965	$83.5	$412	$14.4	$10.1	$4.32
2033	955	$83.8	$416	$14.9	$10.6	$4.26
2034	950	$84.3	$421	$15.3	$11.0	$4.26
2035	945	$85.0	$427	$15.7	$11.5	$4.27

As state expenditures included the modeled investments over the first three years of the study period, the net fiscal impact averages $4.5 million in expenditures above revenue. This results in negative economic impacts in the Midlands region during the first three years due to the significant state government presence in the region (which includes the State capital, Columbia); however, the overall economic impact during the study period is positive for the Midlands, as for the Pee Dee and Upstate regions.

6.2.3 Scenario C.1

Table 6.4 shows the statewide economic impact of upgrading the Columbus Street Port in Charleston is projected to average 1,135 jobs, $90 million in annual compensation, and $434 million in annual output over the study period.

Table 6.4 – Annual statewide and state government economic impact on employment, compensation, output, gross revenue, expenditures, and net revenue in the Columbia Street Port upgrades scenario.

YEAR	CATEGORY					
	Employment (Jobs)	Compensation (Millions)	Output (Millions)	Gross Revenue (Millions)	Expenditures (Millions)	Net Revenue (Millions)
2025	760	$52.8	$326	$7.31	$2.45	$4.86
2026	835	$57.7	$344	$8.67	$4.20	$4.47
2027	1,190	$86.3	$428	$12.43	$6.47	$5.96

YEAR	CATEGORY					
	Employment (Jobs)	Compensation (Millions)	Output (Millions)	Gross Revenue (Millions)	Expenditures (Millions)	Net Revenue (Millions)
2028	1,260	$95.8	$444	$14.1	$8.29	$5.86
2029	1,255	$97.8	$450	$15.2	$9.65	$5.53
2030	1,235	$98.9	$454	$16.0	$10.6	$5.32
2031	1,220	$99.6	$459	$16.7	$11.5	$5.18
2032	1,195	$99.9	$461	$17.2	$12.2	$4.99
2033	1,180	$99.9	$465	$17.8	$12.9	$4.90
2034	1,175	$100	$470	$18.3	$13.4	$4.87
2035	1,170	$101	$476	$18.8	$13.9	$4.88

As Charleston is in the Lowcountry, the largest portion of this impact will naturally be seen there. The remaining regions will again see relatively small negative impacts during the first three years due to the assumed reallocation of state government expenditures. Nonetheless, each region will see a net positive impact over the study period.

6.2.4 Scenario C.2

As shown in Table 6.5, investment in fitting an existing facility to fabricate jacket foundations is projected to generate an average statewide impact of 1,840 jobs, $146 million in annual compensation, and $626 million in annual output. This facility is assumed to be in the Lowcountry; this region sees the largest portion of the impact. Only the Midlands is projected to see negative impacts over the first two years due to the large state government presence there. Nonetheless, each region of the State is projected to see positive impacts from this activity.

Table 6.5 – Annual statewide and state government economic impact on employment, compensation, output, gross revenue, expenditures, and net revenue in the jacket foundation fabrication facility scenario.

YEAR	CATEGORY					
	Employment (Jobs)	Compensation (Millions)	Output (Millions)	Gross Revenue (Millions)	Expenditures (Millions)	Net Revenue (Millions)
2025	780	$54.8	$324	$7.44	$2.52	$4.92
2026	855	$59.6	$342	$8.79	$4.27	$4.52
2027	2,055	$150	$652	$19.5	$9.30	$10.2

YEAR	CATEGORY					
	Employment (Jobs)	Compensation (Millions)	Output (Millions)	Gross Revenue (Millions)	Expenditures (Millions)	Net Revenue (Millions)
2028	2,160	$162	$678	$22.5	$13.0	$9.50
2029	2,175	$167	$691	$24.6	$15.7	$8.92
2030	3,145	$169	$697	$26.2	$17.7	$8.44
2031	2,110	$170	$700	$27.5	$19.4	$8.06
2032	2,050	$169	$698	$28.3	$20.7	$7.61
2033	2,010	$168	$698	$29.1	$21.8	$7.34
2034	1,970	$168	$700	$29.9	$22.7	$7.15
2035	1,950	$167	$703	$30.7	$23.6	$7.03

Despite small net fiscal impacts to the State government in the first three years of the study period (due to the assumed reallocation of state expenditures), the impact on state revenues net of expenses over the study period is positive, averaging $8 million per year.

6.2.5 Scenario C.3

Table 6.6 shows the projected statewide impact of investing in and operating a nacelle assembly facility, assumed to be located in the Lowcountry, averages 5,24 jobs, $468 million in annual compensation, and $2.1 billion in annual output. This scenario projects the largest positive economic impact on the state.

Table 6.6 – Annual statewide and state government economic impact on employment, compensation, output, gross revenue, expenditures, and net revenue in the nacelle assembly facility scenario.

YEAR	CATEGORY					
	Employment (Jobs)	Compensation (Millions)	Output (Millions)	Gross Revenue (Millions)	Expenditures (Millions)	Net Revenue (Millions)
2025	1,960	$117	$562	$16.3	$6.30	$10.2
2026	2,095	$126	$597	$19.4	$10.2	$9.15
2027	6,105	$519	$2,346	$62.6	$25.8	$36.3
2028	6,330	$538	$2,407	$69.8	$36.3	$33.5
2029	6,365	$555	$2,439	$76.0	$44.2	$31.8

YEAR	CATEGORY					
	Employment (Jobs)	Compensation (Millions)	Output (Millions)	Gross Revenue (Millions)	Expenditures (Millions)	Net Revenue (Millions)
2030	6,240	$560	$2,442	$80.1	$49.4	$30.1
2031	6,085	$559	$2,388	$83.1	$54.3	$28.9
2032	5,855	$552	$2,366	$84.9	$57.6	$27.3
2033	5,675	$545	$2,352	$86.5	$60.3	$26.3
2034	5,530	$540	$2,343	$88.1	$62.6	$25.5
2035	5,415	$537	$2,340	$89.7	$64.6	$25.0

As the facility is assumed to be located in the Lowcountry, this region sees the most significant share of the impact. All three remaining state regions also see significant overall positive impacts despite negative impacts in each over the first two years of the study period due to the assumed reallocation of state expenditures.

While the first two years (the assumed construction period for the facility) see lower impact on net state revenue due to assumed state government investment in the facility, the positive revenue impacts in the following years more than offset this, leading to an overall positive annual average impact of $25 million in state revenue.

6.3 Summary Comparison

When comparing the economic impact of the analyzed scenarios in terms of potential economic output, each scenario presents incremental economic benefits to South Carolina. The baseline Scenario A highlights the importance of the Nexans cable manufacturing facility in the State, contributing substantial economic benefits including supporting hundreds of millions of dollars of annual economic output. Maintaining existing economic benefit is as important as creating new positive economic impacts, particularly when the scale of benefits is as substantial as those providing by existing facilities in South Carolina.

Scenario B supports an optimistic but plausible scenario in which South Carolina's focus on enhancing its offshore wind supply chain enables local companies to win Tier 2 contracts, generating $400 million of additional economic output in-state compared to Scenario A. This scenario represents a case where only some of South Carolina's additional potential capability to support the growing offshore wind sector is fulfilled and thus is not the maximum economic benefit that could be theoretically captured from interventions that increase the opportunity for South Carolina suppliers to participate in the industry.

Table 6.7 – Comparison of annual economic output in South Carolina of Scenarios A, B and C.

YEAR	ECONOMIC OUTPUT ($2024 MILLIONS)				
	Scenario A	Scenario B	Scenario C.1	Scenario C.2	Scenario C.3
2025	$316	$311	$326	$324	$562
2026	$332	$328	$344	$342	$597
2027	$344	$382	$428	$652	$2,346
2028	$350	$397	$444	$678	$2,407
2029	$355	$402	$450	$691	$2,439
2030	$359	$406	$454	$697	$2,441
2031	$364	$410	$459	$700	$2,435
2032	$367	$412	$461	$698	$2,412
2033	$371	$416	$465	$698	$2,398
2034	$376	$421	$470	$700	$2,389
2035	$381	$426	$476	$703	$2,385
TOTAL	$3,917	$4,313	$4,776	$6,882	$22,812

Figure 6.1 shows a comparison of the three variants of Scenario C. Scenario C.1 provides the least economic output compared to the other proposed variant due to assumed activities related to the upgraded Columbia Street Port being logistics-related rather than manufacturing-related. This shows that while investment in port upgrades can bring economic benefit to the state, that without securing additional manufacturing at the developed quayside the benefits will not be maximized.

Scenarios C.2 and C.3 generate substantial economic output, with Scenario C.3 generating over 8 times the economic output projected in Scenario A. Manufacturing capability such as a nacelle assembly facility would generate significant revenue in the State. However, developing a new facility would require the most investment and significantly more market confidence than any other proposed scenario to realize these benefits.

Scenario C.2 still provides significant economic benefit, generating an average of over $500 million annually. Retooling an existing facility to meet the needs of the offshore wind industry does not require as much investment as establishing a new facility. However, the availability of alternative steel substructure solutions for offshore wind projects and a larger number of competing suppliers in the market would mean any local supplier would carry greater risk of inability to capture a sustainable market share that justifies investment.

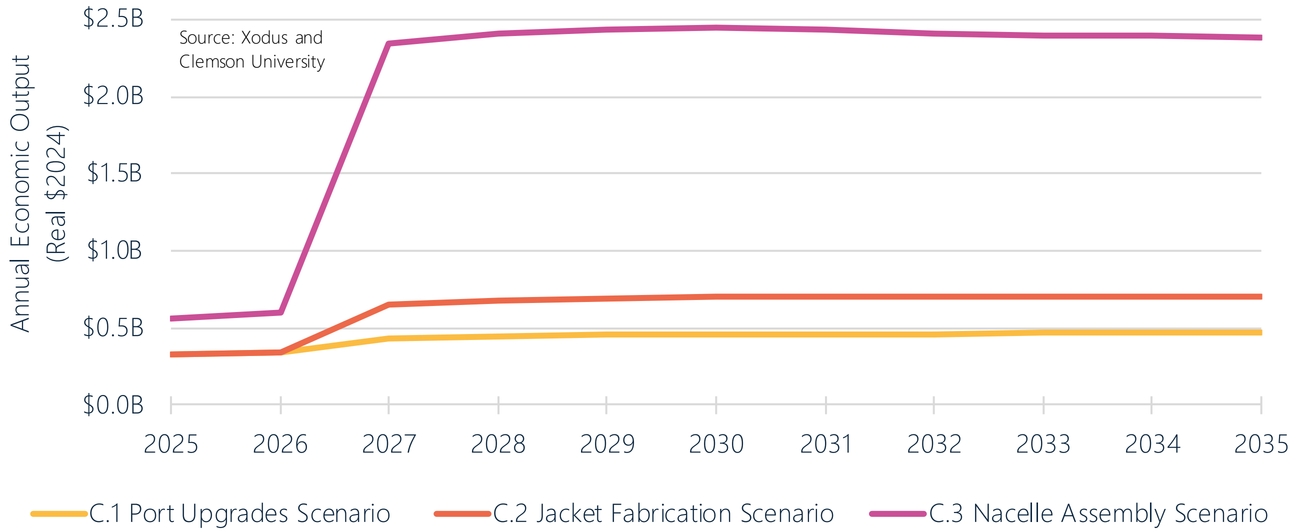

Figure 6.1 – Annual economic output for South Carolina under Scenarios C.1, C.2 and C.3.

7 DISCUSSION AND RECOMMENDED ACTIONS

South Carolina's state policies, proximity to US East Coast offshore projects, and existing supply chain capability position the State for further participation in the domestic offshore wind market. There is potential for South Carolina to both support the development of existing local companies and to attract additional component manufacturing to be established in the State to supply subcomponents for the offshore wind industry. The State can prioritize near-term and long-term actions to help realize these opportunities and capture the economic benefits of offshore wind development on the East Coast.

Several themes emerged from this study covering a range of opportunities to be leveraged and challenges to be addressed. These themes informed actionable recommendations for the State and industry to take to further benefit from the growth of the US offshore wind industry.

7.1 Study Themes

Clarity needed on South Carolina's offshore wind goals

South Carolina's support for offshore wind varies regionally. Stakeholders have cited that the State already has low electricity costs for rate payers, does not have a Renewable Portfolio Standard driving renewable energy adoption, and does not have a clear state-level political champion and so lacks some of the typical economic, environmental or political drivers seen in other states that have helped foster offshore wind industrial growth. However, the cities of North Myrtle Beach and Charleston have made statements in support of offshore wind project development off South Carolina's coast, showing some communities in the Northern part of the State are more amenable to constructing offshore wind projects off the coast of South Carolina than communities in the Southern part of the State.

Despite some regional support, at a state level South Carolina has not expressed strong interest in developing an offshore wind procurement goal which is a primary driver for project development. In 2008, South Carolina's state legislature formed the Wind Energy Production Farms Feasibility Study Committee to make recommendations on how to advance offshore wind in South Carolina. Although the Committee's 13 recommendations for supporting South Carolina project development did not result in offshore wind leases, the committee's findings indicated a previous interest in offshore wind that could be rekindled should there be benefits of doing so.

This initial interest from the State followed by a long period of lower activity has introduced uncertainty into South Carolina's ambitions for supporting the development of the offshore wind industry. The State could benefit from sending a clearer message about its ambitions in offshore wind that would enable certainty in the private sector on how to invest; whether to prepare for offshore wind project development in South Carolina's adjacent federal waters, or to instead prepare for the supply and export of subcomponents to support a regional offshore wind supply chain. Either scenario can offer economic opportunity for South Carolina, but will be achieved through different approaches.

With clearer messaging, companies can make smarter investments in the offshore wind supply chain. Port operators need some amount of lead time to prepare for any quayside manufacturing, project development, installation or O&M

services to geographically close projects such as the Carolina Long Bay lease areas, even if they might not offtake power to South Carolina. A path to in-state procurement will send strong signals to offshore wind developers and Tier 1 manufacturers, which can help South Carolina capture these major investments before they are made in other neighboring states.

Manufacturing challenges without an offshore wind power procurement goal

States with offshore wind leases in adjacent waters are not guaranteed the economic benefits of those projects based solely on proximity. Projects in federal waters may be developed using ports in adjacent states, global supply chains, and the energy generated may be sold in any state willing to enter into a procurement contract. However, states that do procure power from offshore wind projects have been able to secure higher levels of local supply chain content.

New York's procurement contracts have included provisions for local manufacturing. Developers in New York, in turn, have actively sought that their Tier 1 suppliers explore the use of local Tier 2 manufacturing capability to satisfy local content requirements. Should South Carolina ever seek an offshore wind procurement goal with requirements for in-state investment, developers and Tier 1 manufacturers could be incentivised to make investments in offshore wind component manufacturing to meet the terms of procurement. Some service industries within the project development, installation, and O&M phases can also often be contracted to businesses in the same state that is procuring power, where these services can be relatively easy or advantageous to localize to meet local content requirements.

Without an offshore wind procurement goal to drive project development in waters off the South Carolina coast, the State is disadvantaged in its ability to attract private sector investment and secure larger manufacturing contracts from the US offshore wind market. The State's proximity to the Carolina Long Bay projects alone is not enough to ensure that the economic opportunity lands within state borders, particularly during the project development, installation, and O&M phases.

It may benefit South Carolina to join the SMART-POWER initiative. Joining SMART-POWER would ensure that the State is involved in any coordinated procurements, regional transmission planning, and other key development activities that would assist in setting the State's future offshore wind industry. It would also help ensure that the State government is aware of and can communicate any future opportunities for South Carolina-based companies.

Offshore wind manufacturing incentives

South Carolina has repeatedly demonstrated a propensity for attracting highly specialized advanced manufacturing business to the State through strategic policy and tax incentives. Offshore wind represents another advanced manufacturing market for South Carolina to consider as part of its state portfolio. Many of the State's most successful strategies for attracting firms like BMW, Michelin, and Boeing could be similarly attractive to component manufacturers in the offshore renewables sector.

Suppliers will be more eager to invest in developing their capability or establishing presence in South Carolina if the State incentivizes manufacturing through tax incentives, grants, and subsidies. South Carolina's Renewable Energy Manufacturing Tax Credit, which applied to eligible companies between 2010 and 2020, offered income tax credits to manufacturers of renewable energy systems and components. A similarly structured tax credit could help bring down the costs associated with offshore wind component manufacturing, although the credits will need to be aligned with offshore wind's exceptionally high capital costs.

The existing tax credits offered by South Carolina, in addition to the IRA tax credits for domestic content and any new tax incentives would need to drive down the cost of manufacturing offshore wind components in South Carolina to the point that they are competitive on cost, quality and risk with imported components, greatly incentivizing developers and manufacturers to invest in South Carolina as the US offshore wind industry grows.

South Carolina's success attracting large businesses

South Carolina has successfully helped many large foreign businesses establish manufacturing operations in the State, driven by the strategy and effort of the Department of Commerce. South Carolina has transformed the State's industrial landscape at several points in history through incentive packages and strategic, large-scale state investments. The Landing Pad program, a collaboration launched in 2016 between the South Carolina Department of Commerce and other regional economic development alliances, has helped streamline the process of foreign businesses establishing US business operations in South Carolina.

Many key offshore wind companies are similarly well-established, high-revenue firms based overseas. To bring major offshore wind manufacturers to the State, South Carolina will need to drive the creation of a top-down strategic framework that mirrors the State's past efforts for the automotive, chemical, and aerospace industries. Other US states are investing large sums on the scale of hundreds of millions of dollars to incentivize Tier 1 manufacturers to expand existing or establish new operations to meet the upcoming demand from the pipeline of US offshore wind projects.

South Carolina's offshore wind manufacturing opportunity

The US does not yet possess domestic offshore wind turbine nacelle assembly capability. While significant challenges exist to establishing any new nacelle assembly facility, there could be an opportunity to attract an offshore wind turbine OEM to the US, including to South Carolina, that would benefit South Carolina suppliers. Elements of South Carolina's existing gas turbine assembly capability and mechanical and electrical manufacturing capabilities may be able to support the manufacturing of subcomponents for nacelles with some investment in retooling. Other favorable attributes that have enabled manufacturing to be established in the State (i.e., relatively low taxes, electricity rates, and labor costs) may also incentivize new suppliers to invest in South Carolina.

New large-scale manufacturing, such as a nacelle assembly facility, could have the potential to generate up to $2 billion in annual economic output for the State including through an extended supply chain of Tier 2 and 3 suppliers. South Carolina could empower Tier 2 and 3 companies to enter these supply chains. Turbine OEMs must maintain rigorous reliability and quality requirements on every component due to the challenge and expense associated with the design, manufacture, operation, and repair of offshore wind turbines. South Carolina's existing aerospace, automotive, and defense manufacturing suppliers already meet rigorous security and reliability standards in their respective industries and may be better prepared to expand their capabilities to serve the offshore wind market.

Other South Carolina industries could also benefit from the establishment of US domestic supply of offshore wind turbines. The State's robust chemical manufacturing industry includes several coatings and composite companies that could supply manufacturers of blades and turbine protection systems. A new rare earth metal manufacturing facility under development in Sumter, SC may disrupt the global dependence of wind turbine manufacturers on China's rare earth metal supplies. Linking potential South Carolina suppliers with Tier 1 manufacturers will be beneficial to help them better prepare for any future supply opportunity.

South Carolina companies will likely need to register their capabilities and go through an audit process with Tier 1 suppliers. Companies with experience supplying Tier 1 offshore wind businesses in adjacent industries (such as those manufacturing components for Tier 1 suppliers' automotive market segment, composites for onshore wind turbine blades, or coatings for onshore wind turbine structures) should leverage their relationship and track record and begin engaging these Tier 1s to understand their potential capability gap to expand their supply into offshore wind.

South Carolina's environment for innovation

South Carolina has cultivated a strong environment for fostering innovation through its educational and research institutes. Organizations like SC Nexus, SCRA, and CLEANcarolinas have significantly progressed sustainability, EV, battery manufacturing, and economic development research.

These organizations are well-placed to lead offshore wind innovation in the State by collaborating with academic institutes like Clemson University. They have created strong frameworks for supporting businesses entering new industries, and advancing innovative manufacturing and technological developments through research investment. In particular, CLEANcarolinas' existing regional framework with North Carolina could catalyze regional innovation and offshore wind development.

Clemson University hosts an advanced offshore wind turbine drivetrain testing facility, which should continue to be utilized and maintained to ensure active engagement with turbine OEMs. Innovation hubs with strong industry ties can help Clemson University strategize how to leverage this relationship to the OEMs to increase the likelihood of a major investment in a nacelle manufacturing facility as the industry continues to develop.

South Carolina's ports' compatibility with manufacturing

Ports play a key role in large-scale manufacturing for the offshore wind industry. Many components must be assembled or manufactured at quayside where they are too large to be transported by rail or road. Ports in South Carolina have many desirable characteristics for hosting the manufacturing (or staging) of offshore wind components but would likely still need to address some economic or technical challenges before being able to do so.

Most of the ports in the Charleston area are owned and operated as major container terminals by the SCSPA. The physical infrastructure of these ports could support major offshore wind manufacturing; however, many of these ports are at full capacity supporting the container shipping industry with long-term development plans by the port authority. The ports identified outside of the Charleston area are smaller and locally owned, requiring significant infrastructure upgrades to support manufacturing.

The Port of Georgetown, previously owned and operated by the SCSPA but now managed by the county and city, was once used for major cargo and renewable energy manufacturing. Currently the port is not being used and there are no public plans for its future. There may be an opportunity for a port developer or manufacturer to repurpose the port to support the offshore wind industry. However, there are several challenges that would need to be first addressed to do so including dredging and quayside upgrades required along the navigation channel.

A greenfield site could be developed to support offshore wind component manufacturing along the Cooper River, where many of the PMTs are currently located, including terminals where steel manufacturers and Nexans HV cables are located. Investment in a greenfield site would be best undertaken once a Tier 1 manufacturer has been engaged to create a manufacturing facility in South Carolina.

Many services for installation and O&M are typically contracted at ports local to the project location where capability exists and there is a cost advantage to mobilizing supply locally. However, where local ports are not available or not capable of supporting offshore wind installation, developers may consider using ports further from the project site to enable construction. South Carolina's ports could be upgraded to support the development of East Coast projects in the near term.

Small, Minority- or Women-Owned Business engagement

South Carolina's early and deliberate strategic engagement of small, minority-owned and women-owned businesses will ensure that the developing offshore wind industry in the State is equitable and resilient. This engagement can help these businesses secure contracts in the burgeoning industry and diversify participation in the supply chain and workforce, a goal reflected in the mission and priorities of the US offshore wind industry as a whole.

The South Carolina Division of Small and Minority Business Contracting and Certification (SMBCC) assists in identifying minority- and women-owned small businesses for State contracting and procurement opportunities. The SMBCC also addresses key issues affecting small and disadvantaged business communities. While this is a necessary step towards increasing diversity and access to any opportunities in the South Carolina offshore wind industry, additional early actions in offshore wind will establish a strong foundation as the industry grows.

Engagement with small, minority- and women-owned businesses must be intentional and begins by identifying eligible businesses. While the SMBCC offers a great platform for finding local companies, many potential supply chain entrants may not be registered due to a lack of knowledge of the platform or the opportunity. It is necessary to ensure small, minority- and women-owned businesses understand the certification processes that will enable their companies to appear on these lists so that they are visible to contractors looking for supply capability.

Awareness and education campaigns detailing the offshore wind industry opportunity is essential for businesses to identify where their company may fit in the supply chain. Workshops and, eventually, meet-the-buyer events will allow companies to grasp the opportunity and then self-promote and register to tender with Tier 1 and 2 companies. These workshops can also assist these companies in designing an appropriate offshore wind capability statement, identify the required certifications they will need in their role, and generally inform them of industry requirements and timelines.

Developers and OEMs that wish to operate in South Carolina should be encouraged to create Supplier Diversity Plans. This is a requirement in many state offtake solicitations in New York, Massachusetts, and others. These plans will detail a company's commitments to hiring minority- and women-owned businesses where possible during their in-state operations. These plans could include the formation of diversity, equity and inclusion committees, plans for considering diverse ownership status during the procurement process, and plans for outreach and educational initiatives. Commitments may be binding (e.g., a percentage of total spend is required to go towards minority- and women-owned businesses) or non-binding (e.g., a commitment to make best efforts to contract minority- and women-owned businesses).

The federal and state-recognized tribes of South Carolina also form an important group for engagement and inclusion in the offshore wind supply chain. Regarding project development, there is an obligation to consult tribal organizations regarding historically and culturally significant sites and impacts, and these considerations should also feature prominently in any supplier diversity plan developers, or their subcontractors produce. New England projects have found early success in contracting with tribal organizations for roles relating to environmental protection and marine mammal protection.

7.2 Recommendations

To build a local offshore wind supply chain, South Carolina must commit to supporting South Carolina businesses and research institutions over several years by facilitating dialogue across multiple state agencies, funding grant programs, implementing tax incentives, engaging with Tier 1 suppliers, coordinating with Tier 1 suppliers, and educating local companies on their opportunities. This study proposes 10 discrete recommendations to support the development of the South Carolina offshore wind industry, categorized and summarized in Table 7.1.

Table 7.1 – Recommendations for the development of the South Carolina offshore wind supply chain.

RECOMMENDATION	RESPONSIBLE ORGANIZATION
ORGANIZE	
1. Establish an offshore wind working group.	State Energy Office
2. Establish South Carolina presence in US offshore wind market.	South Carolina Offshore Wind Working Group
3. Leverage regional collaboration opportunities.	State Energy Office South Carolina Office of the Governor
ENGAGE	
4. Equip South Carolina agencies and associations with educational tools to understand the offshore wind needs and opportunities.	South Carolina Offshore Wind Working Group South Carolina Manufacturing Extension Partnership South Carolina companies
5. Engage with Tier 1 suppliers and promote South Carolina businesses.	South Carolina Offshore Wind Working Group South Carolina companies Tier 1 suppliers
6. Explore opportunity for further Tier 1 manufacturing.	South Carolina Offshore Wind Working Group Tier 1 suppliers
7. Engage ports on offshore wind opportunities and determine what plans are feasible.	South Carolina Offshore Wind Working Group
INVEST	
8. Develop a Manufacturing Innovation Grant program.	South Carolina Offshore Wind Working Group
9. Investigate the reintroduction of a renewable energy manufacturing tax credit.	South Carolina Department of Revenue State Energy Office
10. Support offshore wind innovation efforts	South Carolina Department of Revenue State Energy Office

1. Establish an offshore wind working group within the State Energy Office. The offshore wind working group would serve as the primary point of contact within the government for the offshore wind industry and would facilitate collaboration between the State and industry, academia, businesses, and labor organizations. The goals of this group are to raise awareness about the economic opportunities from the offshore wind industry supply chain, provide a centralized platform to present South Carolina's existing legislative benefits for South Carolina businesses and advertise the State's manufacturing capabilities.

The offshore wind working group should consider and establish clear ambitions of the State concerning offshore wind projects and industry development. South Carolina could look to other state governments to compare the costs and benefits of different approaches to procurement.

Additional studies could also provide further insight into the opportunities and path forward for the State. For instance, the offshore wind working group could contract an assessment of South Carolina ports against North Carolina capability for marshaling and installation of the Carolina Long Bay offshore wind projects where gaps in availability and capability could justify out-of-state port use for states procuring offshore wind power.

Responsible Organization(s): State Energy Office.

2. Establish South Carolina's presence in the US offshore wind market to enable opportunities for businesses at all levels of the supply chain. South Carolina should proactively promote its activities and capabilities through regional clean energy organizations, such as the Southern Alliance for Clean Energy or the Southeastern Wind Coalition, and industry trade organizations, such as the Oceanic Network or American Clean Power. The State should establish and maintain presence in the wider offshore wind industry to represent South Carolina capabilities and interests, such as through participation in a broader range of industry conferences and events. The State should promote its reputation for having a strong industrial environment and electrical and precision component manufacturing capabilities. Many Tier 1 suppliers in the offshore wind industry are foreign companies that may not be aware of the industrial landscape of US states, South Carolina's strong manufacturing environment, or the potential competitiveness of South Carolina operations compared with overseas locations.

Responsible Organization(s): South Carolina Offshore Wind Working Group.

3. Leverage regional collaboration opportunities. Regional collaboration can ensure that South Carolina is actively engaged in regional offshore wind industry development activities regardless of offshore wind project development ambitions. Participating in regional collaboration agreements like the SMART-POWER MOU would allow South Carolina to be included and influential in important regional supply chain, environmental, and other offshore wind development decisions. For example, the National Renewable Energy Laboratory is conducting an in-depth regional supply chain study for all members of the SMART-POWER MOU; if South Carolina had been a part of this agreement, the State's supply chain would have been included in this research.

Specifically, with North Carolina actively pursuing in-state offshore wind development and presenting similar economic advantages to South Carolina, it is important that South Carolina explore collaboration opportunities with North Carolina to reduce the risk of being left out of regional development. Initiatives like the CLEANcarolinas also provide a mechanism to further regional collaboration efforts.

Responsible Organization(s): State Energy Office, South Carolina Office of the Governor.

4. Equip South Carolina agencies and associations with educational tools to understand the offshore wind needs and opportunities. This study serves as a tool for South Carolina stakeholders to understand the needs of the industry, the manufacturing demands of the US market over time, and the best opportunities for South Carolina businesses to join the supply chain; however, knowledge gaps at a company-level will need to be closed for companies to find success in the offshore wind supply chain. For instance, onshore wind companies should be educated on their capability gap with regards to offshore wind manufacturing. To further educate South Carolina companies on their offshore wind opportunity, the offshore wind working group could provide resources to the South Carolina Manufacturing Extension Partnership to hold informational webinars or coaching workshops led by offshore wind industry experts. The offshore wind working group should also compile existing industry resources and direct South Carolina businesses to the relevant industry and manufacturing trade organizations such as the Oceantic Network, American Clean Power, and the South Carolina Manufacturing Extension Partnership.

Responsible Organization(s): South Carolina Offshore Wind Working Group, South Carolina Manufacturing Extension Partnership, South Carolina companies.

5. Engage with Tier 1 suppliers and promote South Carolina businesses. South Carolina business development agencies should work with Tier 1 suppliers to understand their need and priorities including cost, quality, and environmental, social, and governance policies so that South Carolina companies can start to internally assess their competencies and work towards filling their gaps. The State should encourage South Carolina companies to leverage any existing relationship with Tier 1 suppliers to learn how to be onboarded as a supplier in the Tier 1's offshore wind side of business.

Additionally, South Carolina should engage the State's key suppliers in the state to understand their interest in locating offshore wind manufacturing at existing or new South Carolina facilities and their needs for support, given South Carolina's stated intentions to cultivate a local offshore wind industry.

The State could host Business-to-Business events both to introduce South Carolina companies with developers and Tier 1 suppliers and to match South Carolina companies with one another so they can find synergies in their manufacturing capabilities and potentially forge strategic partnerships.

Responsible Organization(s): South Carolina Offshore Wind Working Group, South Carolina companies, Tier 1 suppliers.

6. Explore opportunity for further Tier 1 manufacturing. South Carolina is already seeing considerable economic benefit from the presence of Tier 1 offshore wind manufacturing capability in the State. This study has found further Tier 1 manufacturing in South Carolina could be possible, supported by several different unique strengths of the State's existing industry and supply chain. The State should work with OEMs to understand the interest in and obstacles to setting up further Tier 1 manufacturing at an existing port or greenfield site. South Carolina has proven its willingness to attract new industry to the State by providing subsidies to large foreign companies looking to land in a US state. The right amount of State investment could help decrease the upfront capital costs needed to establish new facilities, a major barrier in the offshore wind industry that has been responsible for the cancelation of several announced Tier 1 manufacturing facilities.

Additionally, the State should conduct a full cost-benefit analysis to determine if and how Tier 1 components, such as turbine nacelles assembled and supplied from South Carolina, could be competitive with existing supply in the global market. This cost-benefit study should estimate transport costs to various established and emerging markets globally and investigate the potential kick-on effects to the local supply chain, based on collaboration with OEMs. Another study could examine labor availability in the Charleston and Berkely counties, where manufacturing facilities could demand hundreds of skilled workers, and relatively low unemployment in these industrial regions could make worker recruitment a challenge.

Responsible Organization(s): South Carolina Offshore Wind Working Group, Tier 1 suppliers.

7. Engage ports on offshore wind opportunities and build long-term business plans. South Carolina ports have potential to support offshore wind manufacturing and installation should limitations be addressed. A first step to adapting a South Carolina port for manufacturing offshore wind components would be for the Department of Commerce to engage the SCSPA and/or the city and county of Georgetown. After initial conversations to determine the level of interest, the Department of Commerce and SCSPA would then work together to determine what economic development plans are feasible.

Early conversations, future studies, and targeted outreach between the Department of Commerce, the ports, and potential Tier 1s will be critical to ensuring the authorities understand the requirements to support offshore wind and get the key information they need to make informed decisions about the potential usage of their infrastructure.

Responsible Organization(s): South Carolina Department of Commerce.

8. Develop a Manufacturing Innovation Grant program. Ensuring local companies have the resources to expand and adapt to the offshore wind industry is critical, given that South Carolina's planned immediate focus is on supporting economic development from the growth of the US offshore wind industry through provision of manufacturing services to projects having their power procured by other states.

To do this, South Carolina should launch and maintain an "Advanced Marine Manufacturing Innovation Grant" program to provide companies with funding to expand and develop their capabilities to serve the offshore wind market and build on South Carolina's existing innovative manufacturing sector. Businesses could apply for funding to retool, certify, or upskill for offshore wind subcomponent manufacturing.

This program would be especially beneficial to the offshore wind industry as the industry continues to evolve, and technological and manufacturing practices have yet to be standardized. For example, export cables for floating offshore wind projects may possess requirements that are currently not serviceable at the existing South Carolina facility. Should the manufacturer wish to expand its testing and certification programs to capture this future market opportunity funding could be available through this program that would enable a South Carolina business to expand capability and bring further economic benefits to the State.

Additionally, by not limiting the program to just offshore wind, companies operating in adjacent marine sectors could benefit from the initiative, providing flexibility in how funds may be distributed should US offshore wind market conditions change. The South Carolina Offshore Wind Working Group should begin advocating for and drafting this proposal from the group's inception to prepare for the State's budget cycle and legislative sessions.

Responsible Organization(s): South Carolina Offshore Wind Working Group.

9. Investigate the reintroduction of a renewable energy manufacturing tax credit. A previous State Renewable Energy Manufacturing Tax Credit ended in 2020, and there is not a tax credit offered by South Carolina today specifically for renewable energy manufacturing. The State should investigate reintroducing this type of tax credit and ensure offshore wind component manufacturing is an eligible operation for the income tax credit.

The actioned parties could lead drafting of a legislative proposal for the South Carolina General Assembly, including an outline of the purpose, the criteria for eligibility, and the cost of the tax credit. Inputs on the scale of incentive required to spur private investment, gathered through the engagement with key offshore wind players, should help offer guidance on the cost and value of credits. This should be designed with consideration of potential synergy with IRA tax credits for domestic content to maximize the benefits for South Carolina.

Responsible Organization(s): South Carolina Department of Revenue, State Energy Office.

10. Support offshore wind innovation efforts. South Carolina has built a strong ecosystem for innovation, which has recently focused significantly on EVs and battery manufacturing. The State should use the efforts of organizations like CLEANcarolinas and SC Nexus as building blocks to introduce offshore wind innovation development efforts and position South Carolina to lead offshore wind manufacturing research. The State can work with these organizations to see what actions are needed to enable these groups to introduce offshore wind research into their portfolio and how efforts can be best allocated. The State could sponsor a study on the current state of innovation in the offshore wind sector and assess what and how companies in the State can participate.

CLEANcarolinas' regional approach to innovation development makes it a strong organization to spearhead these efforts. Collaboration with North Carolina could be highly valuable for furthering South Carolina's offshore wind efforts.

While the organization is pursuing National Science Foundation funding, ensuring that CLEANcarolinas has sufficient investment to continue operations will be essential to further advancements in offshore wind innovation development.

Clemson University's drivetrain testing facility is a major innovation center that the State should continue to support. Ensuring its active utilization will be important for South Carolina to remain at the cutting edge of nacelle research and development.

Responsible Organization(s): South Carolina Department of Revenue, State Energy Office.

APPENDIX A SUPPLY AND DEMAND FORECAST APPROACH

This study used an in-house forecast model to understand the US offshore wind market outlook for project development and major components needs until 2035. This report only forecasts until 2035 due to the heightened uncertainty of projects planned more than ten years out. In-depth research on all announced and planned US offshore wind projects was collected to understand project timelines, technology, sizing, site conditions, and other key project variables. The project forecast was then used to project major component demands. An assumption was made manufacturing for an offshore wind project would occur in either one or two years before project commercial operation date, depending on the component being procured.

While some projects have confirmed their specifications and timelines through confirmed procurement and permitting, many projects in the US are in early development. Several project-level assumptions were made to forecast project size, technology, and timelines to account for this unknown. These assumptions are:

- All projects with unknown turbine size will use 18 MW turbines;
- Monopiles will be used as a turbine foundation for projects <55 m of water depth, jacket foundations for projects between 55 – 75 m of water depth, and floating foundations for projects in >75 m of water depth;
- One offshore wind substation per 500 MW of capacity;
- Array cable lengths are 200 km per 1500 MW of capacity for fixed projects, 200 km per 1000 MW of capacity for shallowing floating projects, and 250 km per 1000 MW for deeper water floating projects;
- Export cable technology (HVAC or HVDC) determined based on distance from shore;
    - The number of substations and distance from the shore determined export cable length.

High-level cost assumptions for each forecasted component were then created to determine the average cost per component and the number of needed components. These assumptions were generated through external resources and in-house expertise. All expenditure values are presented in $2024 net present value (NPV).

The throughput of the active and announced US manufactured facilities listed in Section 2.2 was calculated based on assumptions generated through industry engagement and in-house knowledge.

Table A.1 - List of operating and announced US major component manufacturing facilities, their estimated throughput, and estimated operations start date.

COMPONENT	MANUFACTURER	ESTIMATED THROUGHOUTPUT	ESTIMATED START OF OPERATION
Nacelle	Vestas	100	2026
Transition Piece	Marmen Welcon	50	2026
Tower	Marmen Welcon	135	2026
Tower	US Forged Rings	200	2026

COMPONENT	MANUFACTURER	ESTIMATED THROUGHOUTPUT	ESTIMATED START OF OPERATION
Tower	Haizea Wind Group	100	2026
Monopile	EEW	100	2023
Monopile	Haizea Wind Group	50	2026
Offshore Substation	Kiewit	3	2023
Array Cable	Hellenic	500 km	2025
Export Cable	Nexans	250 km	2023
Export Cable	Prysmian	250 km	2027
Export Cable	L.S. Greenlink	250 km	2028

This report used these supply and demand forecasts to capture the domestic market size of each major component. It is important to note that this high-level market sizing does not factor in several variables that would be needed to determine the true market opportunity for developing a domestic manufacturing facility, including international markets, site-specific considerations, and macroeconomic conditions. This analysis is better utilized to provide a high-level understanding of the broader trends and opportunities the offshore wind industry presents for a potential South Carolina-based manufacturer.

APPENDIX B STATE OFFSHORE WIND PROCUREMENT MECHANISMS

South Carolina currently does not have a mandatory RPS but does possess several voluntary and incentive-based renewable energy programs. The Distributed Energy Resource Program and the Energy Freedom Act (known as Act 62), promote renewable energy projects by providing rebates and removing caps on net metering. Additionally, Dominion Energy and Duke Energy have created initiatives that have encouraged minor renewable development in the State. These initiatives highlight that there are potential alternative pathways to encourage renewable development in South Carolina without an RPS.

Table B.1 - State Renewable Portfolio Standards and offshore wind procurement targets.

STATE	RENEWABLE PORTFOLIO STANDARD TARGET	OFFSHORE WIND PROCUREMENT TARGET
California	60% by 2030	5,000 MW by 2030 and 25,000 MW by 2045
Connecticut	48% by 2030	2,000 MW by 2030
Maine	80% by 2030	5,000 MW by 2030
Maryland	50% by 2030	8,500 MW by 2031
Massachusetts	35% by 2030	5,600 MW by 2030
New Jersey	50% by 2030	11,000 MW by 2040
New York	70% by 2030	9,000 MW by 2035
North Carolina	12.5% by 2021 by investor-owned utilities	2,800 MW by 2030 and 8,000 by 2040
Rhode Island	100% by 2030	1,200 MW by 2024
Virginia	40% by 2030 (Dominion Energy Virginia)	5,2000 MW by 2034

Offshore wind procurement in the US has used one of two approaches: using a power purchase agreement (PPA) or an Offshore Wind Renewable Energy Certificate (OREC). A PPA is a long-term supply agreement that usually lasts twenty years to purchase energy, energy services, capacity, and environmental attributes from a generator. An OREC is a tradeable credit representing the environmental attributes of one MW-hour of electricity generated by an offshore wind project. Both PPAs and ORECs have varying pros and cons and are largely chosen based on the utility and energy market that exists within a respective state.

States typically hold an auction to procure a specific amount of offshore wind electricity through a competitive RFP. States evaluate developers' proposals based on a wide range of criteria, which usually include cost, experience, economic impact, and environmental impact.

Table B.2 - State-level procurement structures and lead government agency.

STATE	PROCUREMENT STRUCTURE	LEAD AGENCY
Connecticut	PPA	Department of Energy and Environmental Protection
Massachusetts	PPA	Department of Public Utilities
Maryland	OREC	Public Service Commission
New York	OREC	New York State Energy Research and Development Authority
New Jersey	OREC	Board of Public Utilities
Rhode Island	PPA	Office of Energy Resources
Virginia	Regulated Utility with PPA	State Corporation Commission

Although whether South Carolina would use a PPA or OREC would largely depend on policy objectives, if the State were to develop an offshore wind procurement system, it would likely utilize a PPA structure. PPA structures are relatively simple and would likely be more easily integrated by the Public Service Commission and the utility companies in the State.

APPENDIX C ECONOMIC IMPACT INPUTS

Table C.1 - Activities, investment values, output, and assumptions for economic impact modeling.

ACTIVITY	ANNUAL INVESTMENT ($2024 NPV)	FIXED INVESTMENT ($2024 NPV)	ESTIMATED ANNUAL ECONOMIC OUTPUT ($2024 NPV)	ASSUMPTIONS
Operation of Nexans Facility*[5]	N/A	N/A	$152,750,000	Assumes throughput of 250km of cables per year.
Leverage regional collaboration**[6]	$200,000	N/A	N/A	Assumes two FTEs
Establish an offshore wind working group.**	$500,000	N/A	N/A	Assumes five FTEs
Market the existing strength of South Carolina. **	$250,000	$1,750,000	N/A	Assumes attendance at conferences, marketing/promotional materials
Equip South Carolina agencies/trade associations with resources on the needs and opportunities of the offshore wind industry.**	$250,000	$2,750,000	N/A	Assumes that on top of this South Carolina Offshore Wind Supply Chain Study, the State provides funding for four other studies) to fill a knowledge gap in South Carolina
Provide technical assistance services for relevant businesses to upskill for offshore wind supply opportunities.**	$250,000	$2,750,000	N/A	Assumes South Carolina businesses can apply for grant funding for training, upskilling, and market entry support

[5] *Designates an input for Scenario A*
[6] *Designates an input or Scenario B*

ACTIVITY	ANNUAL INVESTMENT ($2024 NPV)	FIXED INVESTMENT ($2024 NPV)	ESTIMATED ANNUAL ECONOMIC OUTPUT ($2024 NPV)	ASSUMPTIONS
Funds for marine manufacturing innovation grant program for South Carolina organizations (academia, companies, non-profits, etc.).**	$250,000	$50,000,000	N/A	Assumes two consultant FTEs reporting to the offshore wind working group
Local company wins bearing contract**	N/A	N/A	$18,000,000.00	Assumes a bearing contact for 50, 18MW turbines per year
Local company wins transportation frame contract**	N/A	N/a	$5,000,000.00	Assumes a contract of fabricating 10 transportation frames a year
Investment and operation of a nacelle assembly facility***[7]	N/A	$300,000,000	$1,200,000,000	Assumes throughput of 100 nacelles per year for 18 MW turbines
Investment and operation of an existing facility to fabricate jacket foundations***	N/A	$15,000,000	$260,000,000	Assumes an upgrade of an existing fabrication yard to create the ability to manufacture 20 jackets annually for offshore substations and 18 MW turbines.
Invest in Port of Charleston Columbus Street upgrades.***	N/A	$75,000,000	N/A	Assumes upgrades to port infrastructure for nacelle manufacturing and/or staging and integration (e.g., bearing capacity, building upgrades, quayside upgrades)

[7] *Designates an input for Scenario C*

APPENDIX D ECONOMIC IMPACT POTENTIAL RESULTS

D.1 Scenario A

Table D.1 - Annual employment, compensation, and output results for Lowcountry in Scenario A.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	715	773	805	812	809	799	792	779	773	770	770
Compensation	Thousands (Real 2024)	$55,338	$59,033	$63,056	$65,242	$66,594	$67,354	$68,038	$68,187	$68,616	$69,224	$69,988
Output	Thousands (Real 2024)	$303,263	$318,224	$329,260	$335,742	$340,910	$345,126	$349,800	$352,823	$357,177	$362,234	$367,861

Table D.2 - Annual employment, compensation, and output results for Peed Dee in Scenario A.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	18	19	20	20	20	19	19	19	18	18	18
Compensation	Thousands (Real 2024)	$1,037	$1,021	$1,095	$1,124	$1,140	$1,143	$1,148	$1,136	$1,139	$1,148	$1,164
Output	Thousands (Real 2024)	$4,262	$4,529	$4,751	$4,829	$4,883	$4,893	$4,917	$4,883	$4,913	$4,971	$5,051

Table D.3 - Annual employment, compensation, and output results for Midlands in Scenario A.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	26	30	31	31	30	28	27	25	24	23	22
Compensation	Thousands (Real 2024)	$1,749	$1,869	$2,006	$2,026	$1,988	$1,916	$1,853	$1,758	$1,698	$1,658	$1,638
Output	Thousands (Real 2024)	$6,210	$6,958	$7,308	$7,316	$7,174	$6,952	$6,790	$6,528	$6,386	$6,316	$6,310

Table D.4 - Annual employment, compensation, and output results for Upstate in Scenario A.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	9	10	10	10	9	9	9	9	9	9	9
Compensation	Thousands (Real 2024)	$621	$636	$680	$695	$697	$692	$691	$679	$675	$679	$687
Output	Thousands (Real 2024)	$2,218	$2,401	$2,512	$2,532	$2,528	$2,502	$2,498	$2,458	$2,458	$2,480	$2,516

Table D.5 - Annual statewide and government employment, compensation, output, gross revenue, expenditures, and net revenue in Scenario A.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	768	832	866	873	868	855	847	832	824	820	819
Compensation	Thousands (Real 2024)	$58,745	$62,560	$66,836	$69,087	$70,419	$71,104	$71,729	$71,760	$72,128	$72,709	$73,477
Output	Thousands (Real 2024)	$315,954	$332,111	$343,831	$350,418	$355,495	$359,473	$364,004	$366,693	$370,934	$376,002	$381,738
Gross Revenue	Thousands (Real 2024)	$7,433	$8,682	$9,840	$10,655	$11,313	$11,847	$12,346	$12,713	$13,100	$13,500	$13,899
Expenditures	Thousands (Real 2024)	$2,463	$4,167	$5,488	$6,473	$7,281	$7,941	$8,471	$8,961	$9,369	$9,763	$10,126
Net Revenue	Thousands (Real 2024)	$4,970	$4,516	$4,352	$4,182	$4,032	$3,906	$3,875	$3,752	$3,732	$3,737	$3,773

D.2 Scenario B

Table D.6 - Annual employment, compensation, and output results for Lowcountry in Scenario B.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	690	750	899	937	935	925	915	898	888	882	879
Compensation	Thousands (Real 2024)	$52,629	$56,592	$70,243	$75,309	$77,047	$78,015	$78,752	$78,803	$79,124	$79,631	$80,311
Output	Thousands (Real 2024)	$300,161	$315,578	$365,608	$377,101	$383,037	$387,463	$392,049	$394,631	$398,620	$403,391	$408,828

Table D.7 - Annual employment, compensation, and output results for Peed Dee in Scenario B.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	18	20	24	25	24	23	23	22	22	22	22
Compensation	Thousands (Real 2024)	$453	$515	$836	$1,370	$1,342	$1,334	$1,337	$1,325	$1,333	$1,349	$1,373
Output	Thousands (Real 2024)	$4,518	$4,867	$5,779	$5,834	$5,747	$5,705	$5,711	$5,675	$5,718	$5,797	$5,902

Table D.8 - Annual employment, compensation, and output results for Midlands in Scenario B.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	-21	-14	-3	38	36	35	33	31	30	29	28
Compensation	Thousands (Real 2024)	-$2,789	-$2,349	-$1,472	$2,330	$2,249	$2,256	$2,237	$2,162	$2,110	$2,076	$2,060
Output	Thousands (Real 2024)	-$923	$363	$2,612	$9,091	$8,860	$8,684	$8,522	$8,230	$8,055	$7,962	$7,944

Table D.9 - Annual employment, compensation, and output results for Upstate in Scenario B.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	32	32	33	21	18	16	15	15	15	15	15
Compensation	Thousands (Real 2024)	$1,305	$1,434	$1,686	$1,548	$1,369	$1,257	$1,208	$1,180	$1,188	$1,213	$1,249
Output	Thousands (Real 2024)	$7,360	$7,660	$7,972	$4,935	$4,338	$4,009	$3,890	$3,846	$3,907	$4,023	$4,171

Table D.10 - Annual statewide and government employment, compensation, output, gross revenue, expenditures, and net revenue in Scenario B.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	719	788	953	1021	1013	999	986	966	955	948	944
Compensation	Thousands (Real 2024)	$51,598	$56,192	$71,293	$80,557	$82,008	$82,862	$83,534	$83,470	$83,755	$84,269	$84,993
Output	Thousands (Real 2024)	$311,117	$328,468	$381,971	$396,961	$401,982	$405,860	$410,172	$412,382	$416,300	$421,173	$426,845
Gross Revenue	Thousands (Real 2024)	$6,976	$8,254	$10,539	$12,014	$12,784	$13,417	$14,007	$14,428	$14,872	$15,303	$15,746
Expenditures	Thousands (Real 2024)	$2,325	$3,984	$5,634	$7,048	$8,045	$8,846	$9,519	$10,105	$10,615	$11,042	$11,469
Net Revenue	Thousands (Real 2024)	$4,651	$4,270	$4,905	$4,967	$4,739	$4,571	$4,489	$4,323	$4,257	$4,261	$4,277

D.3 Scenario C.1 Columbus Street Port Upgrades

Table D.11 - Annual employment, compensation, and output results for Lowcountry in the Columbus Street Upgrades scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	809	874	1130	1168	1166	1152	1139	1119	1106	1099	1095
Compensation	Thousands (Real 2024)	$59,492	$63,834	$84,983	$90,293	$92,416	$93,545	$94,329	$94,379	$94,709	$95,259	$96,019
Output	Thousands (Real 2024)	$327,164	$344,037	$410,246	$422,437	$428,984	$433,602	$438,195	$440,789	$444,902	$449,958	$455,812

Table D.12 - Annual employment, compensation, and output results for Peed Dee in the Columbus Street Upgrades scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	7	8	26	28	27	26	26	25	25	25	25
Compensation	Thousands (Real 2024)	-$349	-$303	$963	$1,485	$1,490	$1,497	$1,505	$1,493	$1,498	$1,514	$1,537
Output	Thousands (Real 2024)	$2,904	$3,248	$6,366	$6,467	$6,447	$6,422	$6,418	$6,367	$6,391	$6,458	$6,556

Table D.13 - Annual employment, compensation, and output results for Midlands in the Columbus Street Upgrades scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	-65	-59	0	42	41	40	38	36	34	32	31
Compensation	Thousands (Real 2024)	-$6,142	-$5,773	-$1,374	$2,440	$2,472	$2,525	$2,516	$2,429	$2,357	$2,301	$2,266
Output	Thousands (Real 2024)	-$8,147	-$6,988	$3,296	$10,008	$9,980	$9,844	$9,637	$9,259	$8,987	$8,807	$8,719

Table D.14 - Annual employment, compensation, and output results for Upstate in the Columbus Street Upgrades scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	11	12	34	23	20	18	17	16	16	17	17
Compensation	Thousands (Real 2024)	-$209	-$108	$1,692	$1,560	$1,442	$1,358	$1,318	$1,292	$1,293	$1,309	$1,337
Output	Thousands (Real 2024)	$3,922	$4,135	$8,124	$5,227	$4,757	$4,473	$4,350	$4,277	$4,298	$4,378	$4,493

Table D.15 - Annual statewide and government employment, compensation, output, gross revenue, expenditures, and net revenue in the Columbus Street Upgrades Scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	762	835	1190	1261	1254	1236	1220	1196	1181	1173	1168
Compensation	Thousands (Real 2024)	$52,792	$57,651	$86,263	$95,778	$97,820	$98,925	$99,668	$99,593	$99,857	$100,384	$101,160
Output	Thousands (Real 2024)	$325,843	$344,431	$428,032	$444,139	$450,168	$454,340	$458,600	$460,692	$464,578	$469,601	$475,580
Gross Revenue	Thousands (Real 2024)	$7,312	$8,674	$12,429	$14,148	$15,184	$15,970	$16,704	$17,221	$17,756	$18,286	$18,824
Expenditures	Thousands (Real 2024)	$2,448	$4,204	$6,469	$8,290	$9,654	$10,643	$11,528	$12,231	$12,857	$13,412	$13,942
Net Revenue	Thousands (Real 2024)	$4,864	$4,470	$5,960	$5,858	$5,530	$5,327	$5,176	$4,990	$4,900	$4,874	$4,882

D.4 Scenario C.2 Jacket Foundation Fabrication Facility

Table D.16 - Annual employment, compensation, and output results for Lowcountry in the jacket fabrication scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	765	828	1943	2019	2034	2012	1982	1931	1892	1862	1839
Compensation	Thousands (Real 2024)	$56,866	$61,070	$145,037	$152,943	$158,357	$160,716	$161,784	$160,898	$160,301	$159,975	$159,975
Output	Thousands (Real 2024)	$314,639	$330,932	$623,010	$645,108	$658,153	$664,238	$668,366	$667,169	$668,174	$670,654	$674,547

Table D.17 - Annual employment, compensation, and output results for Peed Dee in the jacket fabrication scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	17	18	43	44	44	43	42	41	40	39	39
Compensation	Thousands (Real 2024)	$337	$393	$1,918	$2,394	$2,434	$2,437	$2,434	$2,381	$2,358	$2,352	$2,357
Output	Thousands (Real 2024)	$4,363	$4,723	$10,096	$10,319	$10,424	$10,392	$10,340	$10,133	$10,047	$10,029	$10,068

Table D.18 - Annual employment, compensation, and output results for Midlands in the jacket fabrication scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	-28	-21	50	96	96	92	86	79	72	67	63
Compensation	Thousands (Real 2024)	-$3,370	-$2,940	$1,901	$5,834	$5,961	$5,907	$5,714	$5,317	$4,969	$4,674	$4,443
Output	Thousands (Real 2024)	-$2,074	-$775	$14,066	$21,813	$22,069	$21,590	$20,817	$19,480	$18,382	$17,504	$16,868

Table D.19 - Annual employment, compensation, and output results for Upstate in the jacket fabrication scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	28	29	42	30	28	25	24	23	22	22	22
Compensation	Thousands (Real 2024)	$1,020	$1,144	$2,265	$2,114	$1,977	$1,870	$1,812	$1,752	$1,732	$1,734	$1,753
Output	Thousands (Real 2024)	$6,732	$7,023	$10,032	$7,138	$6,636	$6,292	$6,118	$5,947	$5,907	$5,943	$6,034

Table D.20 - Annual statewide and government employment, compensation, output, gross revenue, expenditures, and net revenue in the jacket fabrication facility scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	782	854	2053	2162	2174	2145	2110	2052	2006	1972	1947
Compensation	Thousands (Real 2024)	$54,853	$59,668	$149,551	$161,653	$167,004	$169,236	$170,135	$168,891	$168,044	$167,542	$167,436
Output	Thousands (Real 2024)	$323,661	$341,903	$651,925	$678,496	$691,174	$696,548	$699,963	$697,544	$697,758	$699,750	$703,430
Gross Revenue	Thousands (Real 2024)	$7,441	$8,790	$19,494	$22,475	$24,643	$26,200	$27,514	$28,330	$29,119	$29,897	$30,661
Expenditures	Thousands (Real 2024)	$2,518	$4,268	$9,295	$12,978	$15,726	$17,761	$19,452	$20,720	$21,782	$22,748	$23,630
Net Revenue	Thousands (Real 2024)	$4,923	$4,522	$10,199	$9,497	$8,917	$8,439	$8,062	$7,610	$7,337	$7,149	$7,031

D.5 Scenario C.3 Nacelle Assembly Facility

Table D.21 - Annual employment, compensation, and output results for Lowcountry in the nacelle assembly scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	2189	2311	5685	5852	5879	5772	5633	5434	5276	5148	5047
Compensation	Thousands (Real 2024)	$137,390	$146,171	$493,995	$509,374	$524,730	$528,885	$528,530	$522,533	$517,421	$513,299	$510,325
Output	Thousands (Real 2024)	$589,705	$622,644	$2,238,888	$2,291,041	$2,320,901	$2,324,539	$2,320,602	$2,302,800	$2,291,926	$2,285,831	$2,284,336

Table D.22 - Annual employment, compensation, and output results for Peed Dee in the nacelle assembly scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	-11	-8	149	153	156	153	150	143	138	135	132
Compensation	Thousands (Real 2024)	-$1,872	-$1,905	$8,143	$8,455	$8,863	$8,944	$8,928	$8,699	$8,543	$8,432	$8,367
Output	Thousands (Real 2024)	$1,424	$1,989	$36,099	$37,032	$37,875	$37,746	$37,359	$36,315	$35,662	$35,231	$35,006

Table D.23 - Annual employment, compensation, and output results for Midlands in the nacelle assembly scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	-169	-160	174	231	236	228	216	199	184	172	162
Compensation	Thousands (Real 2024)	-$14,411	-$14,139	$10,197	$14,383	$15,206	$15,250	$14,897	$14,034	$13,269	$12,609	$12,089
Output	Thousands (Real 2024)	-$23,953	-$22,394	$45,166	$55,171	$56,558	$55,697	$53,997	$50,896	$48,374	$46,340	$44,851

Table D.24 - Annual employment, compensation, and output results for Upstate in the nacelle assembly scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	-47	-47	99	92	92	89	86	81	77	74	72
Compensation	Thousands (Real 2024)	-$4,409	-$4,382	$6,367	$6,268	$6,522	$6,520	$6,462	$6,235	$6,071	$5,943	$5,857
Output	Thousands (Real 2024)	-$5,205	-$5,058	$25,699	$23,877	$24,117	$23,751	$23,322	$22,429	$21,826	$21,401	$21,144

Table D.25 - Annual statewide and government employment, compensation, output, gross revenue, expenditures, and net revenue in the nacelle assembly facility scenario.

CATEGORY	UNITS	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Employment	Individuals (Jobs)	1962	2096	6107	6328	6363	6242	6085	5857	5675	5529	5413
Compensation	Thousands (Real 2024)	$116,698	$125,744	$518,702	$538,481	$555,320	$559,600	$558,817	$551,501	$545,304	$540,284	$536,637
Output	Thousands (Real 2024)	$561,971	$597,181	$2,345,852	$2,407,121	$2,439,450	$2,441,732	$2,435,280	$2,412,440	$2,397,788	$2,388,803	$2,385,337
Gross Revenue	Thousands (Real 2024)	$16,308	$19,372	$62,568	$69,828	$76,029	$80,096	$83,125	$84,906	$86,524	$88,123	$89,653
Expenditures	Thousands (Real 2024)	$6,063	$10,220	$25,785	$36,327	$44,188	$49,945	$54,264	$57,608	$60,253	$62,588	$64,571
Net Revenue	Thousands (Real 2024)	$10,245	$9,152	$36,783	$33,501	$31,841	$30,151	$28,861	$27,298	$26,271	$25,535	$25,082