Offshore wind in Virginia

A vision

September 2018

BVG Associates

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- We have a global client base, including customers of all sizes in Europe, North America, South America, Asia and Australia.
- Our highly experienced team has an average of over 10 years' experience in renewable energy.
- Most of our work is advising private clients investing in manufacturing, technology and renewable energy projects.
- We've also published many landmark reports on the future of the industry, cost of energy and supply chain.

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Executive summary

Virginia has the potential to become a national leader in the emerging U.S. offshore wind industry within the next decade. The state's excellent infrastructure and geographical advantages provide Virginia, not only a path to meeting the state's goal of developing 5 gigawatts (GW) of renewable energy by 2028, but also an opportunity to establish Virginia as a hub for the East Coast offshore wind supply chain.

By immediately leveraging its competitive advantages, Virginia can already supply key components to the first wave of offshore wind projects under development in New England. As a result, Virginia will derive immediate economic benefits while maturing its offshore wind supply chain, ensure development of its own 2 GW of offshore wind by 2028, and provide the tipping point for a second wave of lower-cost projects off Dominion Energy's service territories, notably the Kitty Hawk lease area in North Carolina.

Virginia has five main competitive advantages:

- Industrial coastal infrastructure, with large areas for lay-down and storage, quayside length for load-out, and direct access to the open ocean with unlimited vertical clearance.
- A large skilled and experienced workforce in shipbuilding and ship repair, ports, logistics and vessel operations.
- Highway, rail, and inland waterway connections linking Virginia's ports to industrial centers throughout the Southeast, Mid-Atlantic, and Midwest.
- Eastern population centers with high and growing electricity demand, particularly for the internet economy. Northern Virginia is hosting a major and growing internet corridor, and in Virginia Beach, two new data centers are being built.
- High-voltage interconnection capability in Virginia Beach, sufficient for all the anticipated commercial lease area capacity after moderate investment.

These first two advantages make Hampton Roads a highly attractive location on the U.S. East Coast for the major offshore wind scope, notably for the fabrication and assembly of jacket foundations and offshore substation platforms. Two sites could be upgraded in 20-29 months, at a cost of $5 to $15 million, ready for investment by a steel fabricator. Virginia has the largest East Coast pool of suitably experienced and trained maritime workers, with more than 28,000 full-time jobs in shipbuilding and ship repair alone, which is more than New York and all New England states combined. This is a deep and rich pool of experienced maritime steel-working talent from which new fabrication facilities could immediately draw. Jacket and substation production in Hampton Roads could create more than 2,000 new direct and indirect jobs.

Virginia stands to benefit from early action to attract the offshore wind industry to its shores. There are several states on the Eastern Seaboard with plans to develop an offshore wind industry, because it creates new jobs, attracts private investment into local communities, and establishes a reliable, local source of clean renewable electricity. Many states on the Atlantic coast envision their ports as "the hub" for the offshore wind industry. A number of states – New York in particular – have already developed offshore wind master plans. Virginia has great potential and many natural advantages to attract this investment, but it must act now to be a leader in offshore wind.

1. Introduction

Offshore wind is a mainstream source of electricity in Europe. In the UK and Germany, offshore wind already contributes a significant proportion of total generation, and Denmark and the Netherlands have made significant commitments to offshore wind development. In Asia, the Chinese market is maturing rapidly, and the Japanese and Taiwanese markets are showing significant promise (see Figure 1).

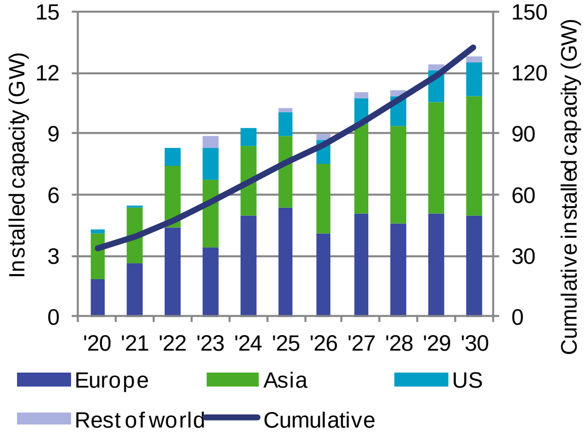

Figure 1 Globally installed capacity will exceed 30 GW at by 2020. By 2030, this is likely to exceed 120 GW.

A study by the National Renewable Energy Laboratory in 2016 showed there is technical potential for more than 1,100 GW of offshore wind along the Atlantic coast.[1] Offshore wind is attractive for coastal states because the technology can be installed at a scale equivalent to thermal or nuclear power stations, and located close to load centers. Compared to onshore wind, offshore wind offers key advantages due to its higher and more consistent wind speeds and the opportunity to build at scale using large turbines. Offshore wind also contributes to states' carbon emission reduction targets. The associated industrial investment creates a significant number of jobs, often in areas that have faced economic challenges in recent years.

High capacity factors, significant coastal load centers and the ability to overcome transmission system limitations by interconnecting at the beach, have blended to build a compelling business case for offshore wind development in the Atlantic. A bold commitment of local and global offshore wind market leaders, combined with the American drive to boost volume, will deliver substantial benefits to all stakeholders, similar to those already experienced from onshore wind. Offshore wind offers key advantages due to its higher and more consistent wind speeds and the opportunity to build at scale using large turbines.

In the US, Rhode Island's Block Island is the nation's first commercial offshore wind farm and several states, notably Massachusetts, New York, New Jersey and Maryland, have announced major plans to develop offshore wind projects (see Table 1).

Table 1 Offshore wind activity in first-mover states.

State	Legislation or policy ambition	Committed offshore in MW
Massachusetts	3.2 GW	800 MW
Rhode Island	"100% renewable"	430 MW
Connecticut	Renewable Portfolio Standard of 40% by 2030	200 MW
New York	2.4 GW	90 MW + 800 MW tender round in 2018
New Jersey	3.5 GW	1.1 GW tender round in 2018
Maryland	At least 1 GW	368 MW

With recent legislation (The Grid Transformation and Security Act of 2018), Virginia set a goal of building 5 GW of renewable energy by 2028 – a goal that would be met by developing its current offshore commercial lease area. Delivery on this goal would:

- Reduce reliance on out-of-state electricity by 30%
- Generate thousands of local jobs
- Eliminate 3 million tons of CO^2 pollution each year, the equivalent of removing 650,000 cars[2] from the road or a 700MW coal plant

[1] Offshore Wind Energy Resource Assessment for the United States, National Renewable Energy Laboratory, 2016. Available online at https://www.nrel.gov/docs/fy16osti/66599.pdf.

[2] https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle

- Power more than 500,000 homes with clean, renewable energy
- Offer a mix of renewable energy sources each with a unique generation profile to reduce the need to rely on gas “peaker” plants, and
- Reduce consumer electricity prices over the long term.

Offshore wind creates new jobs, attracts private investment into local communities, and establishes a reliable, local source of clean electricity. Recognizing the economic and environmental benefits of developing offshore wind, several states on the Eastern Seaboard have plans to develop this proven technology, each envisioning their ports as a hub for the offshore wind industry.

2. The Virginia Vision

This report provides a simple yet credible and compelling case supporting a Virginia vision of developing at least 2 GW of offshore wind by 2028. The report also highlights the impacts of fulfilling that vision, including specific next steps. It considers what impact offshore wind would have on:

- Security of energy supply
- Economic development and job creation
- Power prices, and
- Carbon free electricity production

It finishes with a discussion of the options for the Commonwealth of Virginia.

The report draws on data developed internally by BVG Associates during more than a decade of work in offshore wind and drawn from a range of external sources. It incorporates the views of leading figures in U.S. offshore wind.

This report demonstrates why Virginia should seek to establish offshore wind as a key element of its energy and industrial development and discusses some options in terms of how to proceed.

2.1. Economies of scale

A pragmatic approach to the delivery of 5 GW of renewable energy for Virginia will include onshore wind, offshore wind and solar. For the purposes of this Vision document, BVG Associates has adopted a scenario in which offshore wind contributes 2 GW by the end of 2028. This matches the potential of Virginia’s current commercial lease area.

Offshore wind farms are major infrastructure projects that take time to develop and build, not just as a result of permitting and stakeholder management, but also driven by the need for appropriate infrastructure and a scalable, mature and efficient supply chain.

There is a consensus in increasing offshore wind capacity forecasts. Figure 2 shows a scenario in which 8 GW is built off the US East Coast by the end of 2028, with 2 GW in Virginia. The 8 GW has become a relatively conservative scenario, as some recent estimates are higher.

By the middle of the next decade, Virginia could be a leading U.S. market for offshore wind, driven by the ability to benefit from the lessons learned from northeast coast states and the maturing US supply chain, complemented by Virginia’s strong infrastructure, location benefits and deployment of offshore wind at-scale.

Suppliers to the wind industry, such as turbine, foundation and cable manufacturers, like to see a regular run-rate for installed capacity. This allows easier investment planning and more efficient facilities. Manufacturers also need projects of a certain size to achieve economies of scale. In the scenario shown in Figure 2 there are two major projects of 875 MW in 2026 and 2028 because a fewer number of larger projects is more likely to lead to investment in Virginia.

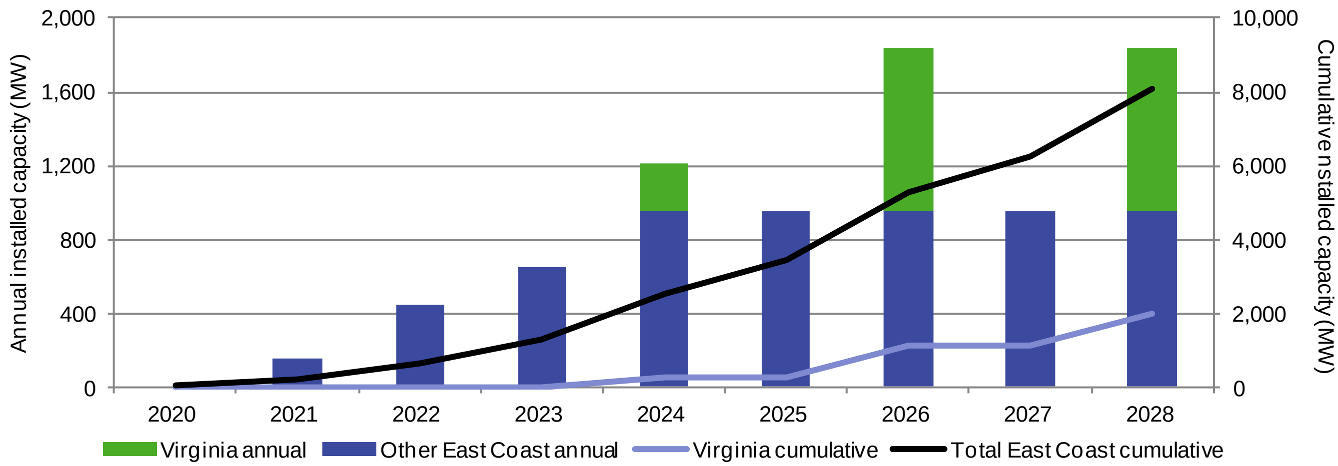

Figure 2 A scenario for offshore wind in Virginia and the rest of the Atlantic coast by the end of 2028.

2.2. Thresholds for investment

In general, the offshore wind supply chains in Europe like to see an annual market of at least 1 GW, the equivalent of 80 to 125 units (turbine nacelles, turbine towers, blades, or foundations). A cable factory owner would look to produce 200 km of cable per year. Such volumes achieve the economies of scale (or “tipping point”) required for infrastructure investment and skills development, and enables the supplier to apply lean manufacturing strategies. Manufacturers have to be comfortable that the risk and costs of establishing new facilities are lower than those of transporting the components from existing factories.

In the U.S., the scale required could be lower than in more established markets because of the likely large distances between future wind farms along the Atlantic coast. In addition, importing components from Europe or Asia will be costly, as long journeys increase the risk of delays (and so increased costs) due to adverse weather conditions. Thus, a U.S. factory could be viable with lower volumes than a European factory.

Of course, any supplier will only capture a proportion of the whole market. If the market leader with a 50% share needs an order book of equivalent to at least 500 MW offshore wind capacity to make investment worthwhile, it would wish to see a total annual market of 1 GW. In our scenario, this figure is only reached in Virginia with the construction of the first large wind farm in 2026. The Virginia market in our scenario is therefore not big enough by itself to attract investment, so the Atlantic coast market as a whole is crucial. **In our scenario, Virginia provides the tipping point, creating the demand needed to support an investment decision.**

In an optimistic scenario, the unique logistic, geographic and industrial benefits of Virginia may trigger supply chain investments to serve the northeast projects, enabling Virginia to foster a maturing supply chain even before its own large scale offshore wind projects materialize. However, accelerating the deployment of large scale wind projects off Virginia’s coast will only strengthen the state’s position as an attractive location for the supply chain.

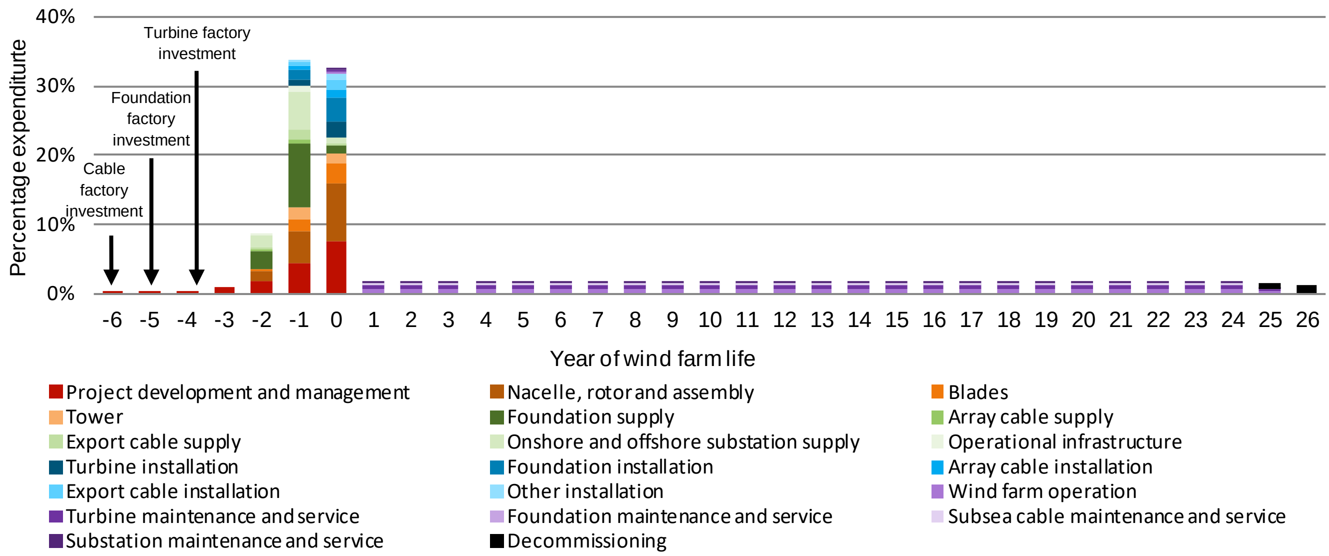

Figure 3 Expenditure profile for a typical offshore wind with the timing of investment decisions for key components.

2.3. Timing of investments

For a large scale wind farm commissioned by the middle of the decade, action is needed now to set those projects in motion and make the necessary investments in the supply chain. Figure 3 shows a typical spend profile for an offshore wind farm. Six or more years ahead of completion, work needs to start on site surveys to help design the wind farm and to understand the impact on wildlife. The wind farm then needs to be taken through the planning process. Only then can detailed design take place and procurement started. All these activities create jobs, often locally to the wind farm.

If new investments are needed to supply components to the wind farm, upgrades to ports are required and the factories built. Figure 3 also shows the times when investments need to be committed if the new factories are to supply the wind farm in time. It shows that little time can be wasted if these factories are to be ready to supply major wind farm components.

2.4. A vision of the future

Today's state of the art wind farms are being designed with turbines with rated capacities of 8-10 MW with rotors up to 170 meter in diameter. Larger turbines do not necessarily lead to lower turbine prices per MW for the turbines themselves, but they have profound implications for the number and cost of foundations and cables, and their installation and maintenance. A foundation for a 12 MW turbine will cost more than a foundation for a 6 MW turbine, but not twice as much. Larger turbines mean fewer turbines per MW, and so less cabling is needed. A vessel can carry fewer 12 MW turbine sets than it can 6 MW sets, but it can carry more total megawatts with the 12 MW turbine. The maintenance of a 12 MW turbine is more economical than the maintenance of two 6 MW turbines.

Such are the advantages of larger turbines that wind farms built in the second half of the next decade will be larger still. GE Renewable Energy recently announced the development of a 12 MW machine with a 220 meter rotor, and this is likely to be 'stretched' following (or even before) its commercialization, perhaps to 15 MW. Competitors such as MHI Vestas Offshore Wind and Siemens Gamesa Renewable Energy are working on bigger turbines also.

A wind farm built in 2028 could feature 18 MW turbines. A 600 MW wind farm would therefore feature only about 33 turbines. These larger turbines will be a tried and tested technology by the time they are installed in Virginia. Typical water depths for Virginia offshore wind farms are expected to be 20-25 meters. Depending on soil conditions and installation restrictions, monopile foundations are likely to be a competitive option. However, designs such as 'jackets' or gravity-base foundations will also be considered as they would be a better fit to existing local industrial capabilities. Advances in subsea cables and electrical design are likely to mean that the wind farms will have a compact offshore substation, or perhaps can dispense with one altogether.

The mass of the components and the hub height for a wind farm with 18MW turbines will mean that the majority of the existing fleet of European installation vessels would be inadequate. A Virginia offshore wind farm will probably be installed with a state-of-the-art jack-up vessel. The Jones Act prevents foreign vessels transporting components between U.S. harbors, so vessels for the U.S. offshore wind industry will need to be built in the U.S. Virginia's strong shipbuilding heritage places it in a strong position to benefit.

Offshore turbine design places high priority to reliability and maintainability because of the costs and risks of offshore turbine service and maintenance. Future Virginia offshore wind farms will require relatively little maintenance compared to the early offshore wind farms built in Europe and service operation vessels could work across multiple wind farms. The construction of these vessels again creates an opportunity for Virginia shipyards.

Figure 4 Illustration of a wind farm using the GE Renewable Energy 12MW Haliade turbine. Image courtesy of GE Renewable Energy.

3. The benefits

Deciding on the right energy mix is a complex issue, balancing several key considerations. In this vision document, we will explore how offshore wind can help Virginia achieve this balance.

The key benefits of offshore wind are that it can:

- Enhance security of energy supply by providing power close to coastal load centres
- Enable economic development and job creation
- Provide low carbon electricity to mitigate the scale and impacts of climate change, and
- Provide long term confidence of low electricity prices.

3.1. Security of supply

Electricity imports

In 2016, about 25% (29.5TWh) of the electricity used in Virginia came from outside of the state.[3] With the marginal price of electricity about $29/MWh, this electricity cost about $850 million directly that year.[4] The fuel for Virginia’s coal-fired plants typically comes from Ohio. Also, most of Virginia's natural gas is imported from other states. If 2 GW of offshore wind were added to the grid, it would generate about 9 TWh and so reduce the reliance on out-of-state electricity by about 30%.

Grid

Virginia needs to serve major load centers close to the coast. These centers are not necessarily close to power generation sites. This places a burden, and thus costs, on the electricity transmission system. This pressure on the grid is only likely

[3] U.S. EIA, Virginia Electricity Profile 2016, Table 10, Supply and Disposition of Electricity, 1990 through 2016, Net interstate imports 29,463,366 MWh against a total supply of 122,018,242MWh.

[4] Joe Bowring, 2016 State of the Market Report for PJM, March 23, 2017, Slide 25, Available online at http://www.pjm.com/~/media/committees-groups/committees/mc/20170323-state-of-market-report-review/20170323-2016-state-of-the-market-report-for-pjm.ashx Slide 25

to intensify with the growth in the internet economy. Northern Virginia has a major and growing internet corridor, and in Virginia Beach, two new data centers are being built. Installing new transmission lines through heavily developed communities can be complex or controversial. There is already a high-voltage grid connection in Virginia Beach, which is sufficient for all the anticipated commercial lease area capacity after moderate investment.

Figure 5 shows the Virginia transmission network in relation to its load centres and wind resource. The proximity of offshore wind resource to load centers is an advantage and has been an important consideration in some northeastern states.

In meeting Virginia's 5GW target, the complementarity of wind and solar generation is important. As the grid penetration of renewable energy increases, intermittency becomes an important issue. A mix of renewable energy sources with different generation profiles can mitigate the need to rely on storage or gas peaker plants. At a seasonal level, solar and wind complement each other, with higher wind speeds in the winter months and more daylight in the summer. There is also evidence to show that the two sources are complementary at an hourly level.

The combination of wind and solar in Virginia state policy also has advantages in that it creates competition between the technologies that enables lower prices to be negotiated.

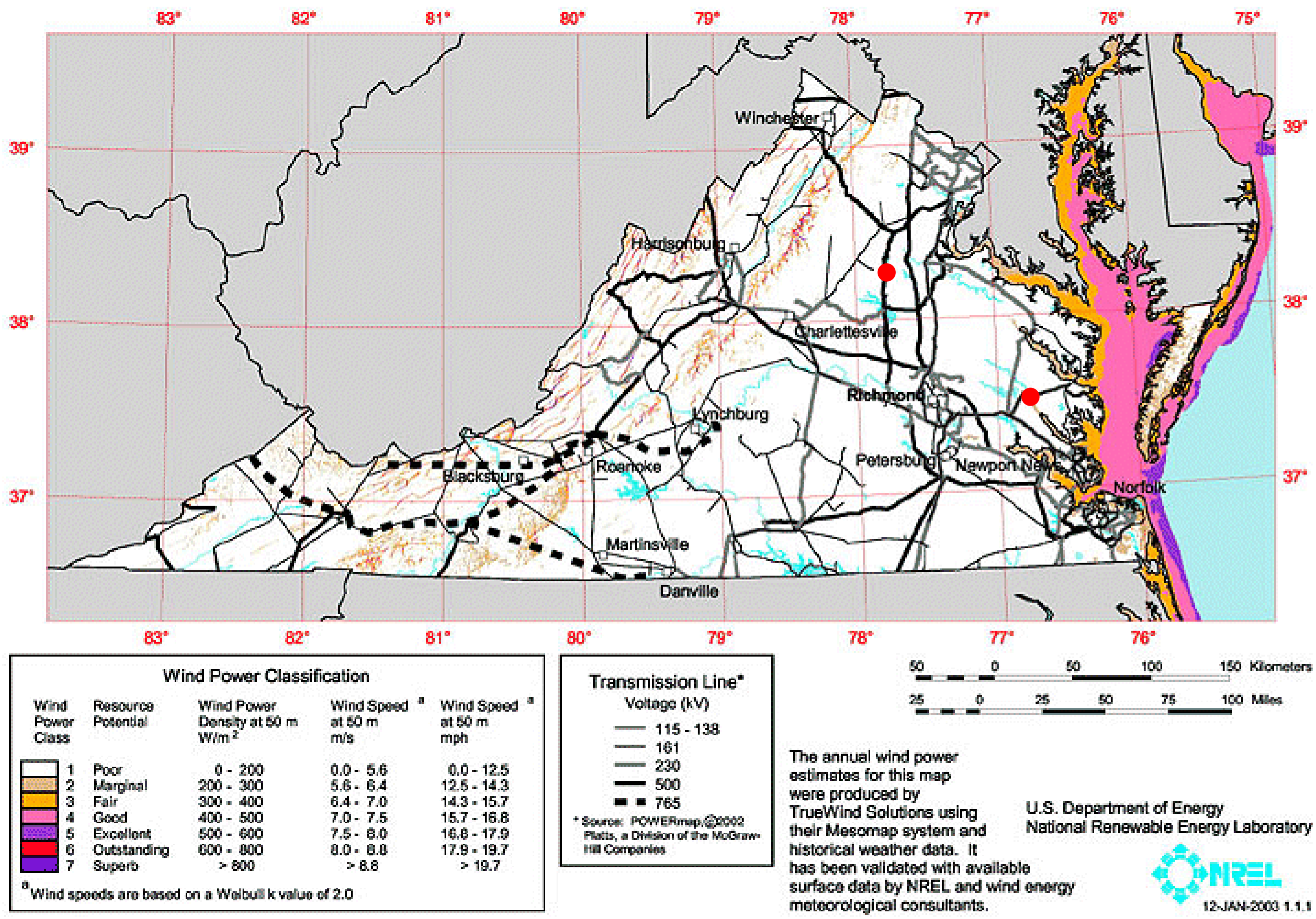

Figure 5 Virginia transmission network and wind resource. Source: NREL

3.2. Economic development and job creation

The global offshore wind supply chain

The offshore wind industry developed first in Europe and the supply chain is still dominated by suppliers based in the main markets of the UK, Germany, Denmark and the Netherlands.

Turbine manufacturers generally seek to locate their facilities close to the markets they are supplying, while looking for a significant and long-term pipeline of business before establishing plant. They are increasingly excited by the commitments by several states that are building this pipeline.

For balance of plant components such as cables, foundations and substations, developers historically source from suppliers across Europe. Some foundations have been imported from Asia but quality has been a concern. That scope is likely to be the most promising contribution, a new Virginia supply base could offer to the East Coast market.

All the major marine contractors are European owned but most have commissioned vessels from Asia shipyards.

The U.S. offshore wind supply chain

There is considerable optimism about the future of offshore wind, and significant new investments in the U.S. that will occur once it reaches a critical mass in the mid-2020s. In the short term, the main component opportunities are likely to come from turbine towers, foundations and substations.

The Jones Act prevents the use of European installation vessels for most activities, which can lead to opportunities for U.S. shipyards, including those in Virginia. In our scenario, the Virginia offshore wind market takes off in 2026, which is well timed to coincide with the U.S. market as a whole reaching critical mass. At this time, the US can expect investments in all parts of the offshore wind supply chain, creating a significant opportunity.

Virginia will not be alone in wishing to attract offshore wind business. All the states developing their own markets want to capture a share. Already, the Massachusetts Clean Energy Center has positioned the New Bedford Marine Commerce Terminal to support the construction, assembly, and deployment of offshore wind projects. In Maryland, developers have been required make a $76 million investment in a Maryland steel fabrication plant and $39.6 million in upgrades in Baltimore ports. The companies are required to use port facilities in the Greater Baltimore region and Ocean City for construction and operations, maintenance and service.

Virginia's competitive advantage

Virginia has an opportunity to be the best place to do offshore wind business with a sustainable future. In making a decision about where to locate their offshore wind facilities, investors consider:

- Proximity to market
- Site availability
- Developing costs
- Local labor skills
- Local labor costs, and
- Transport connections.

Proximity to market

Our scenario shows that Virginia is relatively late to the market with developments further advanced in Maryland, Massachusetts, Rhode Island, New Jersey and New York. Virginia is relatively well located to supply wind farms in these states. The closeness of Avangrid's Kitty Hawk lease area just to the south is further increases the attractiveness of offshore wind investment in Virginia. The timing and certainty of the Virginia offshore wind market is critical, however. If investors have confidence in a Virginia market, even if it comes later than other states, then this could swing a decision in Virginia's favor. Such preference would likely be driven by Virginia's excellent infrastructure and labor advantages, enabling more competitive logistic processes and therefore optimize production economies.

Availability of sites

A 2015 study showed that 10 sites in the Hampton Roads area had available or underused waterfront infrastructure and nine had potential for offshore wind manufacturing or construction staging. Six sites could be used for subsea cable manufacturing without significant upgrade and four could be used with only minor upgrade: Portsmouth Marine Terminal, Newport News Marine Terminal, Peck Marine Terminal and BASF Portsmouth.[5]

[5] An evaluation of 10 Virginia ports: A report to the Virginia Department of Mines, Minerals and Energy, April 2005. Available online at www.dmme.virginia.gov/de/LinkDocuments/OffshoreWind/PortsStudy-Report1.pdf.

[5] http://americanjobsproject.us/wp-content/uploads/2016/05/VA-FullReport-5.14.pdf

[5] Data is for Standard Occupation Classification code 51-4121

Costs of developing those sites

The development of Virginia ports would require investment. For example, Portsmouth Marine Terminal would need between $11 million to $25 million to upgrade the port for major offshore wind use, with additional costs in the facilities themselves.

Offshore wind has demanding requirements for the length and weight-bearing capacity of quays and for adjacent land. Because of this, few sites anywhere can be used for offshore wind without significant investment. With good infrastructure already, this gives Virginia an advantage over other states.

Availability of skilled labor

Offshore wind has a high requirement for skilled labor. In general, suppliers to the offshore wind industry assume that they will need to train their workforce. Nevertheless, they will be looking for generic skills needed by similar sectors, notably for mechanical and electrical technicians, and for welders.

Virginia has strengths in wind turbine technology, composites and engineering and these sectors should provide a pool of suitably experience workers.[6] The shipbuilding sector has a long history in Virginia and this has built a pool of highly skilled labor, not only in shipbuilding but also in associated equipment and services. Many of these will be directly relevant to offshore wind.

Cost of labor

Figure 6 shows the mean salaries for workers in the shipbuilding and repairing industry selected states.[7] It shows that Virginia has more competitive wages than for states to the north. These are mean figures for each state and may mask significant differences within states. Nevertheless, they show Virginia to be competitive on wages. Virginia's status as the most northern 'right-to-work' state makes it an attractive place to invest.

Transport connections.

A challenge for the U.S. offshore wind supply chain is to capture the knowledge and experience of the European market. European suppliers looking to invest in the US will want good transport links with their existing facilities.

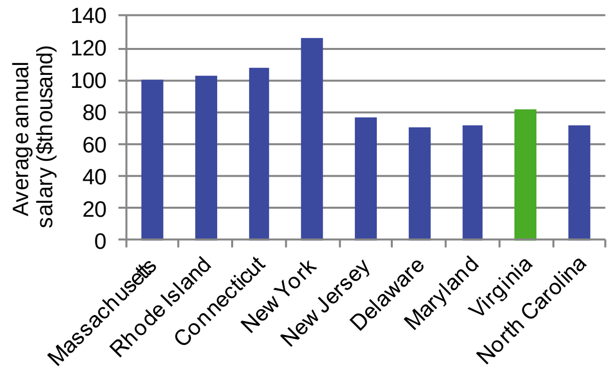

Figure 6 Mean salaries for workers in the shipbuilding and repairing industry.[8]

Virginia's offshore wind supply chain to 2030

One of Virginia's advantages is its competitive labor costs, and provides access to a strong labor pool. It is therefore likely to be most successful in attracting manufacturing investment for labor-intensive processes. Its main disadvantage lies in its distance from early projects to the north. It is therefore most likely to attract investment in areas where either the cost of transport is low or where weather-related delays will not severely impact the project schedule. The most likely investments in Virginia are therefore turbine blades, subsea cables and foundations. Virginia is especially attractive for components where transport is hindered by bridges, which makes towers and jacket foundations an especially good fit. These activities depend on the good coastal infrastructure in Virginia. Unlike turbine nacelle components, they are not dependent on the specialized local supply chain. Investments in these facilities are therefore lower risk.

Number of jobs

Table 2 shows the number of jobs that could be created by offshore wind investments.[9] Many jobs are created at lower tiers of the supply chain. Because lower tier components can be moved using inland transport, factories can be located farther from the coast. As those suppliers are more likely to be supplying other sectors too, the correlation with offshore wind growth is less obvious.

[6] http://americanjobsproject.us/wp-content/uploads/2016/05/VA-Full-Report-5.14.pdf

[7] Data is for Standard Occupation Classification code 51-4121

[8] Maritime Administration, November 2015, The Economic Importance of the U.S. Shipbuilding and Repairing Industry

[9] The figures are estimates because the factory sizes are smaller than those built for offshore wind. For non-turbine components, factories are likely in supply other sectors.

Table 2 Indicative number of jobs created by offshore wind investments in a 800 MW or equivalent facility. Source BVG Associates

Activity	Direct jobs (at main site of manufacture)	Indirect jobs (at other locations or lower in the supply chain
Turbine hub and nacelle assembly	250	2,500
Turbine blades	300	200
Turbine towers	100	300
Foundations	550	500
Subsea cables	220	250
Staging port	100	20

3.3. Low carbon electricity

About 62% of Virginia's 94 TWh of electricity consumed in 2016 came from fossil fuels, with a further third from the state's two nuclear reactors (see Figure 7). About 6% is from renewable sources. Just under 40% of electricity is from low carbon sources. In 2016, Virginia consumed 35 TWh of low carbon electricity. If 2 GW of offshore wind were added to the grid, this is likely to produce about 9 TWh annually. Virginia's annual demand for electricity has been forecast to rise to 140 TWh (see Figure 8). [10]

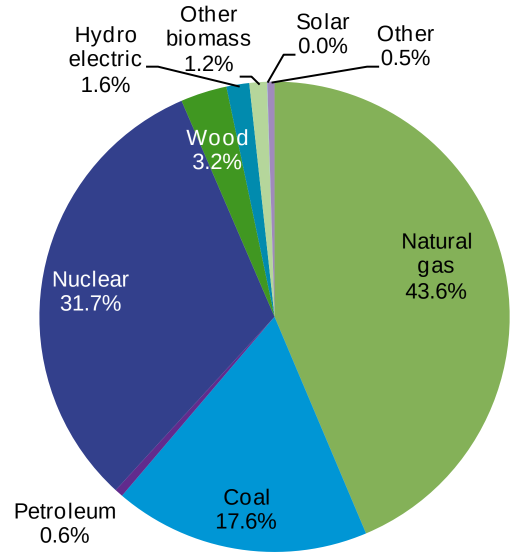

Figure 7 Breakdown of Virginia's electricity consumption by energy source for 2016.[11]

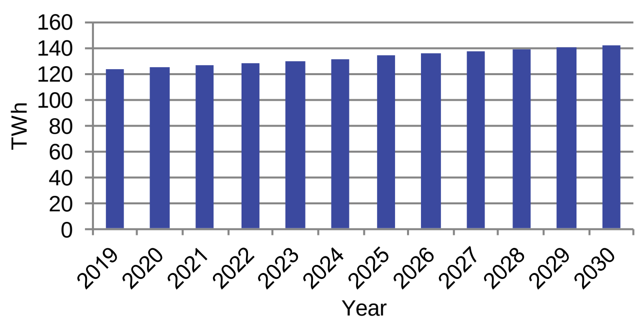

Figure 8 Forecast electricity demand in Virginia to 2030.

Virginia produces about 100 million tons of CO_2 annually, equivalent to about 12 tons per head of population.[12] The construction of 2GW of offshore wind would eliminate the emission of about 3 million tonnes of CO_2 each year.[13]

3.4. Offshore wind cost of energy

Offshore wind in Europe has been a significant success story. A combination of technology development, particularly

[10] AEE Institute, Assessing Virginia's Energy Future, April 2015, Available at http://info.aee.net/hubfs/PDF/aeei-virginia-energy-future.pdf

[11] U.S. EIA, Virginia Electricity Profile 2016, Table 5, Supply and Disposition of Electricity, 1990 through 2016, Coal, natural gas and petroleum account for 57,939,675MWh of 93,717,512MWh.

[12] U.S. EIA, Energy-Related Carbon Dioxide, Emissions by State, 2000–2015, January 2018, Available at https://www.eia.gov/environment/emissions/state/analysis/pdf/stateanalysis.pdf

[13] MHI Vestas Offshore Wind, MHI Vestas Offshore Wind secures 252 MW Deutsche Bucht project press release, 21 August 2017, Available online at http://www.mhivestasoffshore.com/mhi-vestas-secures-252-mw-deutsche-bucht-project/

with the introduction of larger turbines and the consolidation of learning, has led to dramatic falls in prices for offshore wind. An important part of the learning process has been with optimizing project design. Key factors are keeping the turbine installation program within a single year while avoiding adverse winter weather conditions and optimizing the transmission to minimize the number of substations needed. The 'sweet spot' depends on the conditions at the wind farm site but the size of the wind farm is likely to be 1-1.2 GW.

Figure 9 shows recent trends. With power prices typically higher in Europe, recent bids in Germany and the Netherlands have been won with zero bids.

Although the U.S. can benefit from progress in Europe, there are two main reasons why the U.S. costs will be higher than those in Europe in the short term:

- European companies have assembled highly experienced teams that have learnt from mistakes and how to manage risks, and
- The European supply chain has invested in state-of-the-art facilities and equipment.

The involvement of European developers such as Avangrid, CIP, EDF, Equinor and Ørsted is important but even here U.S. project teams and suppliers will need time to reach economies of scale. We may still see highly competitive prices as developers take a long-term view and conclude that they will compromise on returns on their investments in order to grow their U.S. offshore wind businesses.

Until the U.S. reaches critical mass, perhaps 1 GW annual installed capacity, it will be difficult to build a business case for U.S. investment. The options are to use suppliers where manufacturing costs are likely to be higher or to import from Europe and bear the additional transportation costs.

A particular challenge comes from the Jones Act, which limits the use of foreign installation vessels and teams. Until there is a case for investment in a Jones Act compliant vessel, suboptimal installation strategies are inevitable.

Offshore wind has proved attractive to investors, particularly pension funds, because it is not subject to the price volatility of fossil fuels.

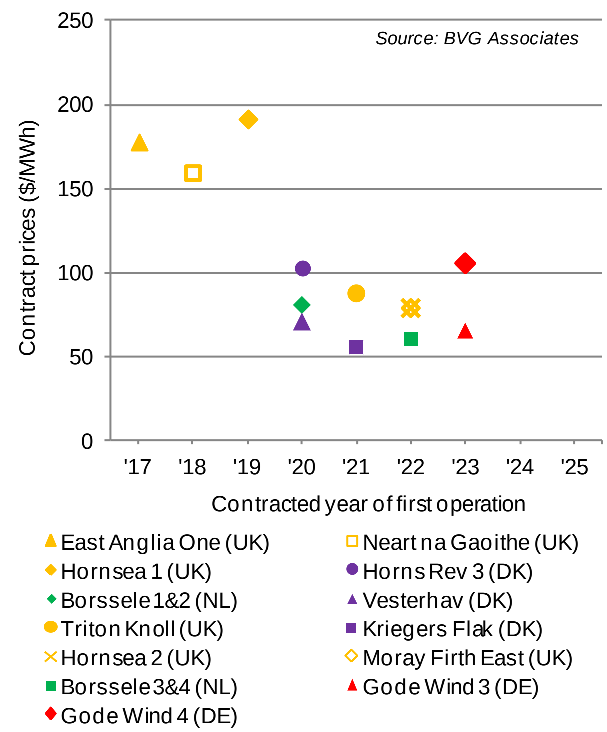

Figure 9 Trends in offshore wind contract prices to 2025 and results of European subsidy auctions. All prices are shown in 2017 $. Only UK projects (in yellow) include transmission. Zero contract prices have been excluded.

By coming later to the offshore wind market than other states such as Massachusetts, Rhode Island, New York and Maryland, Virginia can benefit from the cost reduction efforts in other states. By adding volume to the U.S. market overall, it also stimulates new investment and increases learning, which will be a wider benefit to the whole U.S. offshore wind sector.

By 2027, developers and the U.S. supply chain will be more experienced, purpose-built U.S. installation vessels will be used and we expect investment in new manufacturing facilities, where Virginia is an attractive location. That maturity of supply chain will help compensate for the lower power prices in the mid-Atlantic (compared to New England) and therefore further improve the competitiveness of offshore wind. A further factor could be the cost of capital, with U.S. investors increasingly attracted to the sector.

Offshore wind costs will continue to fall in the next decade in Europe and Virginia projects will benefit, lowering the cost to Virginia ratepayers and consumers.

4. Achieving Virginia's Vision for offshore wind

Other East Coast states have initiated their offshore wind plans via political mandates. These provide the market with significant confidence to invest within those states.

Virginia is different because it has currently no mechanism to mandate the development of offshore wind, as the State Corporation Commission regulates its utilities. Its options would therefore need to be focused on enabling initiatives that lower risk and reduce the cost of energy.

Enabling options include undertaking initial site investigations, streamlining the planning process and lowering the risk of investments in staging ports.

Several European governments have invested in initial site investigations, notably the Netherlands and Denmark. This provides the developer with greater certainty of costs and wind resource before it invests in significant project development.

In England, planning consent for offshore wind farms has been streamlined, giving a guaranteed timescale for a decision. This lowers the development risk considerably.

Virginia should consider offering grants or low-cost financing to support investment in a staging port for use during construction. Staging ports are vital in reducing project risk and therefore the cost of energy.

The recent and dramatic fall in offshore wind cost of energy in Europe will continue over the next decade thanks largely to developments in technology (notably increased turbine size) and industry learning, which has been consolidated by leading developers and suppliers.

These benefits cannot be easily transferred to the U.S., however. As a result, the potential for cost reduction in U.S. offshore wind will take more time. But as a late-comer, Virginia can benefit from the efforts made by others. For example, there is a precedent in Europe where the UK has been the dominant market. The Netherlands was relatively slow to support the industry but is now heavily committed and achieving much cheaper (in fact, zero subsidy) bids for future projects than in the UK.

As section 4.2 shows, there are significant job creation opportunities for Virginia from offshore wind. The challenge for Virginia, however, is to secure the cost of energy benefits of arriving late to the market while simultaneously giving sufficient confidence in its own market to encourage investments in the state. With its first-rate ports infrastructure, Virginia has an excellent chance of attracting manufacturing, particularly if it demonstrates confidence in its own offshore wind projects. Virginia's shipbuilding and repair industry can also benefit, not only in producing Jones Act-compliant assets but also maintaining them and fabricating sea fastenings.

Another option for Virginia is to demand local content in its projects, as for example Maryland has implemented. Although conceptionally attractive, if followed by all states, this could reduce supply chain competition and slow the pace of cost reduction.

Virginia could also consider adopting the UK policy of demanding the production of a 'satisfactory' supply chain plan to be eligible to build projects. These do not explicitly require developers to source products and services locally but they do require developers to demonstrate that they have engaged with local companies and removed barriers to their participation in the supply chain. The requirement for supply chain plans also sends a political signal that economic development is an important consideration. The UK publishes industry figures on local content to ensure that developers are fully aware of the impact of their sourcing decisions.

To secure the economic benefits from offshore wind, Virginia could pursue a range of indirect activities to support the development of its supply chain and encourage developers to reach out to the Virginia supply chain.

Virginia could support technology development in companies in offshore wind by offering research and development grants. This will leverage companies' investment and make them nationally competitive. Many companies and regions have invested in helping their companies make contacts in the industry, for example through industry conferences, trade delegations or participation in federal grants in collaboration with other states.

Virginia has many advantages in capturing the benefits from offshore wind. With many Atlantic coast states in competition, it is not a foregone conclusion. There are real benefits in developing a master plan to position Virginia as a major supply chain hub, providing a framework for government, ports and suppliers to work together and articulating a clear offer to offshore wind investors.

Here again, Virginia has many advantages. Many of the elements making up a master plan have already been developed or are pending. The Commonwealth's Department of Mines, Minerals and Energy (DMME) produced a port readiness study whereby several Virginia ports were identified as viable staging and development sites. DMME has also commissioned a strategic plan to identify current and potential supply chain businesses in Virginia and to market Virginia as a hub for the industry.

There are additional areas of interest that the master plan should focus on:

- Market barriers to deployment of offshore wind in the Virginia Wind Energy Area
- Virginia's assets that make it attractive to the offshore wind supply chain and how to leverage those assets
- How Hampton Roads localities can coordinate to develop an offshore wind industry cluster
- Existing and new economic development incentives that can be used to attract industry businesses, including those that facilitate the deployment of offshore wind
- Opportunities to coordinate with regional partners, including Maryland and North Carolina – acknowledging work being done in other states to gain a strategic, regional advantage
- Workforce needs for the offshore wind industry and the preparedness of Virginia's workforce
- Strategies to lower costs of deployment of offshore wind in the Virginia Wind Energy Area

In conclusion, Virginia has a significant opportunity from offshore wind to reduce carbon emissions, increase security of supply and create job opportunities. It can do this in a way that is consistent with the aim of providing low cost electricity to consumers.