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Offshore Wind Cost Reduction Opportunities and Economic Impact

Presented to:

SOUTHEASTERN WIND COALITION

SEWIND.ORG

January 12, 2015

Content of Report

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January 12, 2015

Task 1. Review of Cost Reduction Opportunities

Estimate the cost savings resulting from completing a 40 MW demonstration project in the Southeastern U.S. by 2020 prior to deployment of a large scale regional plan consisting of capacity growth of 500 MW per year for the period 2025 through 2044.

A review of existing offshore wind studies offered the following categories of cost reduction opportunities:

1. Reduce Risks and Increase Certainty
2. Kick Start Education Process for All Stakeholders
3. Gather Environmental and Performance Data
4. Begin Infrastructure Development in the Southeast Region
5. Refine Design and Technology for the Southeast Region

1. Reduce Risks and Increase Certainty

a. Reduce financial and technical risks by using the demonstration project as a test bed for research and development before proceeding with deployment of a large scale regional plan.

b. Progress further along the learning curve and uncover unforeseen issues with regional offshore wind power permitting, engineering, construction, operations and maintenance.

c. Clarify, harmonize, and streamline the permitting process by allowing agencies time to get up to speed, get comfortable, and express their concerns regarding offshore wind development.

d. Reduce the cost of financing future projects by reducing the perceived risks on the part of investors by demonstrating and validating offshore wind technologies in the Southeast region.

2. Kick Start Education Process for All Stakeholders

a. Educate regulatory and permitting agencies about the offshore environment, turbine technologies, and siting characteristics to reduce challenges to development process.

b. Advance regional financial institutions experience with offshore wind project financing, power purchase agreements, or other dedicated revenue streams.

c. Provide the opportunity to minimize community backlash to large scale regional deployment plans by starting with a relatively small demonstration project.

d. Raise public awareness and acceptance through distribution of fact-base information and regional outreach activities related to the demonstration project.

e. Prompt involvement with coastal and marine spatial planning process and ensure future offshore wind energy interests are represented among other ocean users.

3. Gather Environmental and Performance Data

a. Develop a process and implement collection of meteorological, wave, and seabed data in the Southeast region to be used for siting and designing future large scale projects.

b. Increase understanding of regional wind resource characterization to reduce uncertainty related to future project power production and turbine and array design.

c. Provide opportunity to gather performance data during actual hurricane conditions in order to improve design, technology, and survivability on future projects.

d. Implement a database for sharing offshore farm performance and maintenance data to inform future operational and maintenance decisions.

e. Provide data on impact of offshore wind farms on migratory air and sea animals, commercial and recreational fisheries, and marine/coastal habitats in the Southeast region.

4. Begin Infrastructure Development in Southeast Region

a. Advance general assessment of regional electrical facility specifications, cable routes, and grid interconnection requirements specific to offshore wind energy.

b. Initiate the process of building regional 'backbone' offshore transmission lines that could serve multiple future offshore wind projects along the Southeast coast.

c. Activate coordination among regional port operators and other regional players to support manufacturing, assembly, transport, installation, and maintenance processes.

d. Launch development of regional air and marine transportation facilities to support OSW projects including fit-out of local ocean vessels to carry out OSW installation.

e. Promote the establishment of regional supply chains for the manufacture, assembly, and maintenance of equipment components to support future offshore wind projects.

5. Refine Design and Technology for Southeast Region

a. Advance assessment of offshore wind design and technology best suited to the climatological, wave, and seabed conditions in the Southeast region.

b. Promote evaluation of foundation and substructure design options based on Southeast regional geotechnical and oceanographic surveys.

c. Further develop offshore wind farm siting selection opportunities in the Southeast region and the effects on future installation and maintenance operations.

d. Improve computational design tools, standards, and testing methods that can lay the foundation for safer, more reliable, cost-effective, and higher-performing turbines.

e. Provide the opportunity to uncover unforeseen issues with the design and technology during the demonstration project prior to deploying the large scale plan.

Capital Cost Reductions – Learning Curve

There is a learning curve which is representative of the global offshore wind industry, with total costs decreasing at 1% per year in real dollar terms.

The following slide shows the base case without a demonstration project (Column A). Two scenarios are offered with a demonstration project where the learning curve is accelerated by:

» One year (Column B "Low Case" = 1.0% annual savings) and

» Five years (Column C "High Case" = 4.9% annual savings).

The 20-year savings range from $535 million to $2,624 million (in 2015$)(Columns D and E).

Capital Cost Reductions – Learning Curve

	Millions of 2015$						
	A	B	C	D=A-B	E=A-C	F	G
Year	w/o demo project	w/demo project (low case)	project (high case)	1.0% ann. (low case)	4.9% ann. (high	% savings (low case)	savings (high case)
2018	3,019						
2019	2,989						
2020	2,959	2,930	2,814				
2021	2,930	2,900	2,786				
2022	2,900	2,871	2,758				
2023	2,871	2,843	2,731				
2024	2,843	2,814	2,703				
2025	2,814	2,786	2,676	28	138	1.0%	4.9%
2026	2,786	2,758	2,650	28	137	1.0%	4.9%
2027	2,758	2,731	2,623	28	135	1.0%	4.9%
2028	2,731	2,703	2,597	27	134	1.0%	4.9%
2029	2,703	2,676	2,571	27	132	1.0%	4.9%
2030	2,676	2,650	2,545	27	131	1.0%	4.9%
2031	2,650	2,623	2,520	26	130	1.0%	4.9%
2032	2,623	2,597	2,495	26	129	1.0%	4.9%
2033	2,597	2,571	2,470	26	127	1.0%	4.9%
2034	2,571	2,545	2,445	26	126	1.0%	4.9%
2035	2,545	2,520	2,420	25	125	1.0%	4.9%
2036	2,520	2,495	2,396	25	123	1.0%	4.9%
2037	2,495	2,470	2,372	25	122	1.0%	4.9%
2038	2,470	2,445	2,349	25	121	1.0%	4.9%
2039	2,445	2,420	2,325	24	120	1.0%	4.9%
2040	2,420	2,396	2,302	24	119	1.0%	4.9%
2041	2,396	2,372	2,279	24	117	1.0%	4.9%
2042	2,372	2,349	2,256	24	116	1.0%	4.9%
2043	2,349	2,325	2,233	23	115	1.0%	4.9%
2044	2,325	2,302	2,211	23	114	1.0%	4.9%
2045	2,302	2,279	2,189	23	113	1.0%	4.9%
2025 to 2045	68,053	67,372	64,718	535	2,624	0.8%	3.9%

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Capital Cost Reductions – Alternate Estimate Approach

The following slide provides a rough order of magnitude estimate of potential savings based on the cost reduction opportunities described on the previous slides (Items 1-5). These potential savings are applied to an estimate for a 500 MW project prepared by Navigant in its "Offshore Wind Market Economic Analysis" dated August 27, 2014.

The savings range from approximately 1% to 5% of total capital costs. Estimated 20-year total savings are approximately $561 million to $2,928 million (in 2015$), similar to the previous learning curve scenarios.

Reference project:

Location:	North Atlantic of the U.S.
Year of construction:	2018
Turbine Size:	3 to 5 MW
Water Depth:	20 meters
Distance to Staging Port:	100 miles
Distance to Interconnection:	50 miles
Distance to Servicing Port:	< 30 miles
Foundation Type:	Monopile

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Capital Costs for a 500 MW Offshore Wind Farm ($ million)

Description	2015$		Potential cost savings			Item
			Range	Low	High	
Equipment Costs	**55%**	**$ 1,654**	**1 to 5%**	**$ 8**	**$ 77**	
Turbine Costs	32%	$ 978	0 to 5%	--	$ 49	3,5
HV Cable/Converter/Substations	12%	$ 372	--	--	--	
Foundation & Substructure	7%	$ 220	0 to 5%	$ -	$ 11	3,5
Collection System	3%	$ 84	10 to 20%	$ 8	$ 17	3,4
Labor Costs	**11%**	**$ 339**	--	--	--	
Fdn & Substructure Installation	11%	$ 339	--	--	--	
Development Costs	**18%**	**$ 547**	**3 to 9%**	**$ 15**	**$ 47**	
Erection/Installation (Equip. services)	11%	$ 321	0 to 5%	--	$ 16	4,5
Air & Marine Transportation	3%	$ 76	5 to 10%	$ 4	$ 8	4
Insurance During Construction	2%	$ 71	5 to 10%	$ 4	$ 7	1,2
Ports & Staging	2%	$ 48	10 to 20%	$ 5	$ 10	4
Development Services (Engineering, Legal, PR, Permits)	1%	$ 31	10 to 20%	$ 3	$ 6	1,2,3
Subtotal	**84%**	**$ 2,540**	**1 to 5%**	**$ 24**	**$ 123**	
Other Costs	**16%**	**$ 480**	**1 to 5%**	**$ 4**	**$ 23**	
Interest during construction, due diligence, reserves, fees, decommissioning bonding, and sales tax are reduced in proportion to reduction in total project costs						
Total Costs	**100%**	**$ 3,019**	**1 to 5%**	**$ 28**	**$ 146**	
20-year savings				**$ 561**	**$ 2,928**	

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O&M Cost Reductions

In addition to capital cost reductions, there may be operations and maintenance cost reduction opportunities from completing a demonstration project prior to deployment of a large scale regional plan.

The following slide provides a rough order of magnitude estimate of potential savings based on the cost reduction opportunities described on the previous slides (Items 1-5). These potential savings are applied to an estimate for a 500 MW project prepared by Navigant in its "Offshore Wind Market Economic Analysis" dated February 22, 2013.

Total O&M savings range from approximately 1% to 5%, similar to the previous learning curve scenarios. 20-year O&M savings for a single offshore wind project range from $14 million to $74 million (in 2015$). The total savings in 2025-2044 for all projects installed during that period is approximately $152 million to $782 million (in 2015$).

O&M Costs for a 500 MW Offshore Wind Farm ($ million)

Description	2015$		Potential cost savings			Item
			Range	Low	High	
Corrective Maintenance Parts	49%	$ 33.6	0 to 5%	$ -	$ 1.7	3,4,5
Water Transport	21%	$ 14.5	5 to 10%	$ 0.7	$ 1.4	4
Site Facilities	11%	$ 7.2	0 to 5%	$ -	$ 0.4	4
Labor & Management	8%	$ 5.8	--	$ -	$ -	
Subcontractors	7%	$ 4.7	0 to 5%	$ -	$ 0.2	4
Machinery and Equipment	5%	$ 3.1	--	$ -	$ -	
Annual Costs (per 500 MW project)		**$ 68.9**	**1.1 to 5.4%**	**$ 0.7**	**$ 3.7**	
20-year Savings (per 500 MW project)				**$ 14.5**	**$ 74.5**	
2026-2045 Savings (20 projects)				**$ 152**	**$ 782**	

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Conclusion:

Considering that development of offshore wind power in the Southeast region is entering 'uncharted waters', it would be financially prudent to start with a demonstration project prior to deployment of full scale projects.

The demonstration project would reduce risks and increase certainty prior to investment in full scale projects. The demonstration project would begin the process of educating all stakeholders, developing necessary infrastructure, and refining design for the region which should help to reduce future costs.

The annual capital and O&M cost savings is estimated to be approximately 1% to 5%. Over a 20 year period, the potential savings for offshore wind power capacity additions of 500 MW per year is approximately $713 million to $3,710 million (in 2015$).

(Millions of 2015$)	20-year Savings	
	Low	High
Capital Costs	$561	$2,928
O&M Costs	$152	$782
Total	**$713**	**$3,710**

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Task 2: Local Economic Impact Analysis

- Create a large scale deployment plan consisting of 500 MW per year from 2025 to the end of 2044 (20 years, 10,000 total MW)
- Use NREL's Jobs and Economic Development Impact (JEDI) model to estimate regional employment impact (direct, indirect, and induced jobs) and investments by year

Navigant's Use of the JEDI[1] Model

- The wind JEDI model was developed for the U.S. Department of Energy to analyze the economic benefits of constructing and operating wind power plants.
- JEDI contains wind power manufacturing and construction labor intensity data and then uses IMPLAN modeling software to project indirect and induced economic impacts. More information on IMPLAN modeling software can be found at http://www.implan.com/.
- Navigant conducted JEDI runs for the year 2020, and each year in 2025-2044 for the Southeast Region using the state-by-state wind new installations for construction jobs and state-by-state cumulative installations for operations jobs.

[1] The JEDI model used for this study is Release Number OSW3.24.14

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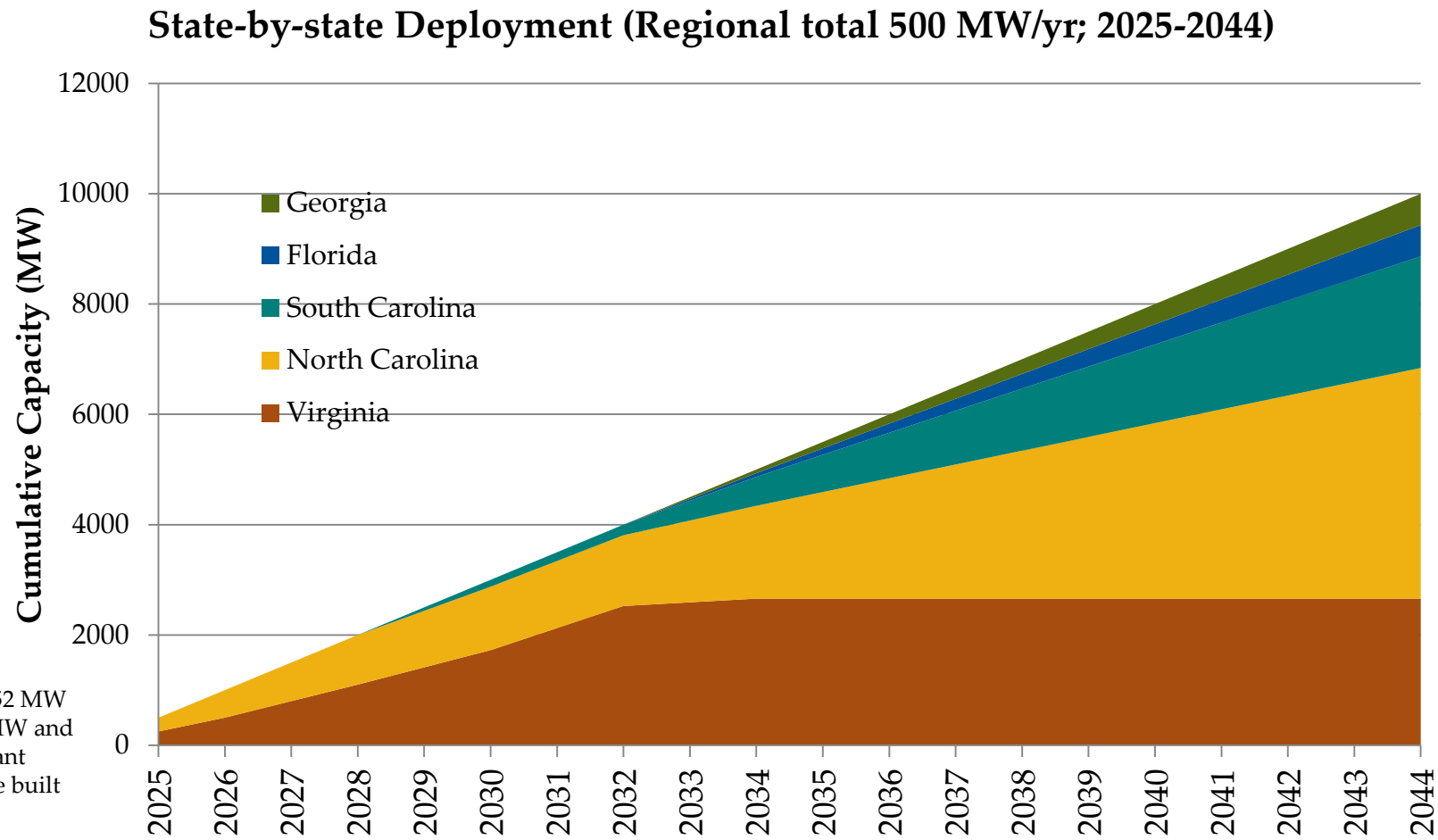
We obtained an estimate of deployment using the NOWEGIS[1] study and developed a state-by-state deployment scenario totaling 500 MW/yr[2]



Assumes 52 MW pilot (40 MW and 12 MW plant sizes) were built in 2020.

[1] Source: National Offshore Wind Energy Grid Interconnection Study. Report can be found at: http://energy.gov/eere/downloads/national-offshore-wind-energy-grid-interconnection-study-nowegis

[2] Deployment scenario provided by Southeastern Wind Regional Resource Center.

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JEDI model inputs were developed in Task 1, and using the NOWEGIS and JMU studies.

Methodology

» We obtained JEDI results for each year (2025-2044) with inputs:

- Each state (NC, SC, VA, GA, FL)
- Capacity installed that year in each specified state
- % local production; depending on specified year

» We ran 2 scenarios based on the "Low" and "High" cost reduction scenarios from Task 1

- These cost reductions (obtained by installing a pilot project in 2020) only affect the first year of the model (2025); costs for subsequent years (2026-2044) are based on 2025 costs using a different cost reduction scheme (see following "Cost Reduction Scheme" slide)

JEDI Input	Source
Construction and O&M costs	Task 1
Construction and O&M cost reductions	Task 1 (2025); cost reduction scheme (2025-2044) developed based on Task 1
State-by-state capacity installations	Developed based on NOWEGIS study; see Appendix for details
% local content	Developed based on various investment scenarios from JMU study

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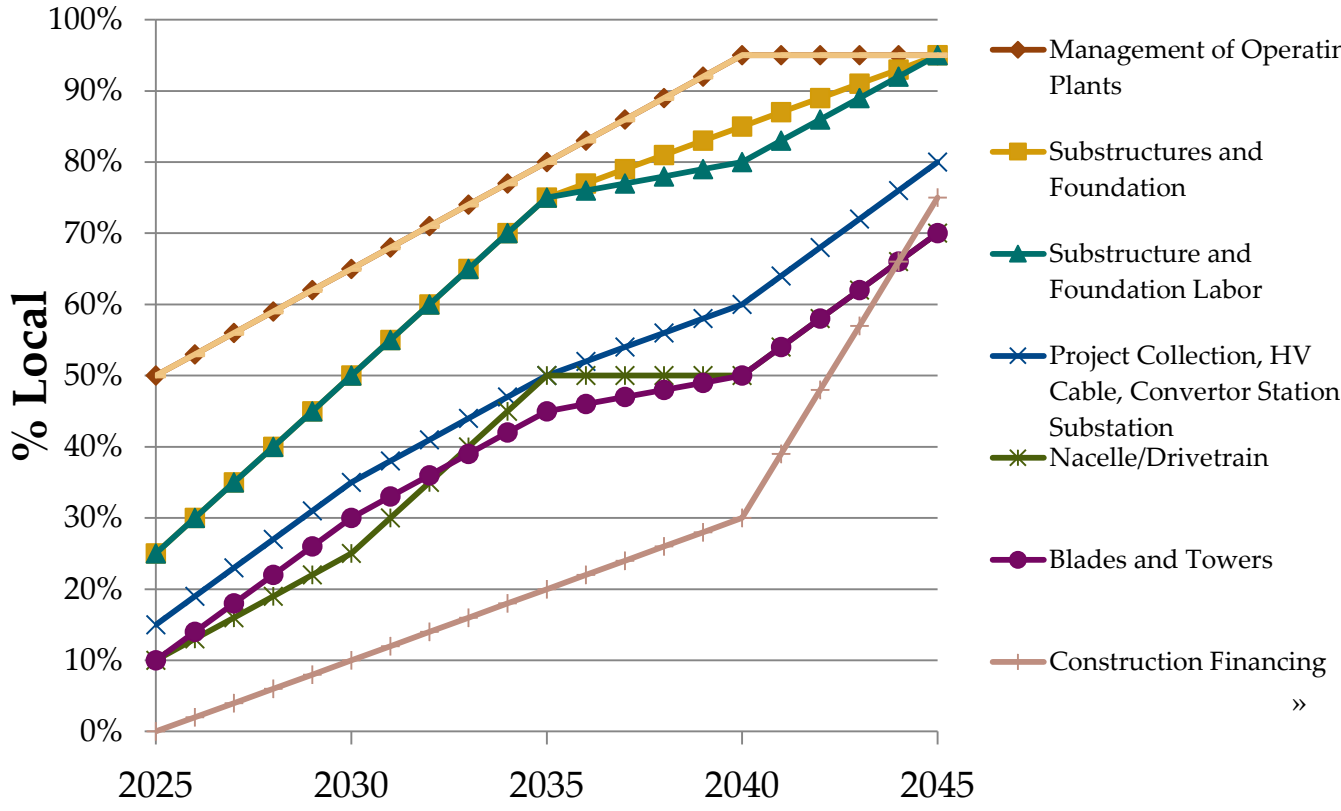
The % local [1] for various project components were based on multiple JMU scenarios.



Year	JMU Scenario[2]
2025	MED 2020
2030	MED 2025
2035	MED 2030
2040	HIGH 2025
2045	HIGH 2030

» Based on 500 MW/yr deployment in Southeastern states from 2025 to 2045

» JMU scenarios were selected based on a) MW capacity deployment, and b) MW deployment in years prior.

» We used linear interpolation for each component between the above years

[1] % local refers to the Southeast region

[2] Source: James Madison University – Potential Economic Impacts from Offshore Wind in the United States – The Southeast Region. Page 22.

Report can be found at: http://wind.jmu.edu/research/documents/JEDI%20Paper%20-%20Final%20Draft.pdf

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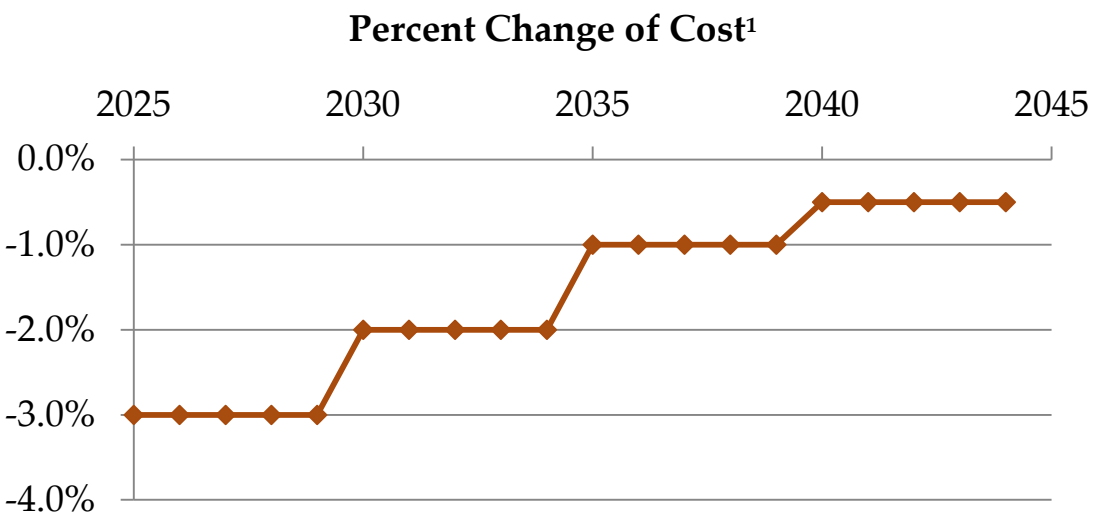
Cost reduction scheme (2020-2025)

» We used two scenarios created in Task 1: Low Cost Reduction and High Cost Reduction

» These scenarios represent the cost savings to a 500 MW project (2025) from a 40 MW pilot project (2020)

Cost reduction 2020-2025 (from Task 1) [1]	Low Scenario	High Scenario
Average capital cost reduction	1%	5%
Average O&M cost reduction	1.1%	5.4%

Cost reduction scheme (2025-2044)



» **Cost reduction scheme is used for both Low and High cost reduction scenarios from Task 1 for 2025-2044**

» Average of 1.6% cost reduction over 20 years

» "Low" scenario estimates 1%/yr cost reduction over 20 years

» "High" scenario estimates 4.9%/yr cost reduction over 20 years

» Consistent with our general knowledge of declining cost reductions over time of project

[1] Cost reduction percentages are based on constant $

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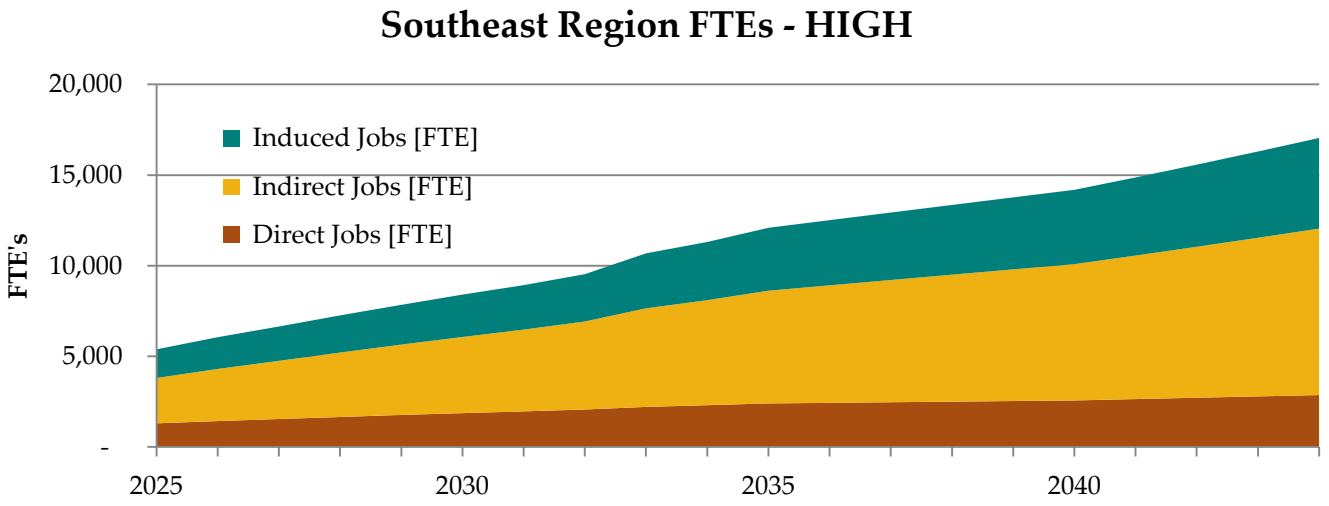
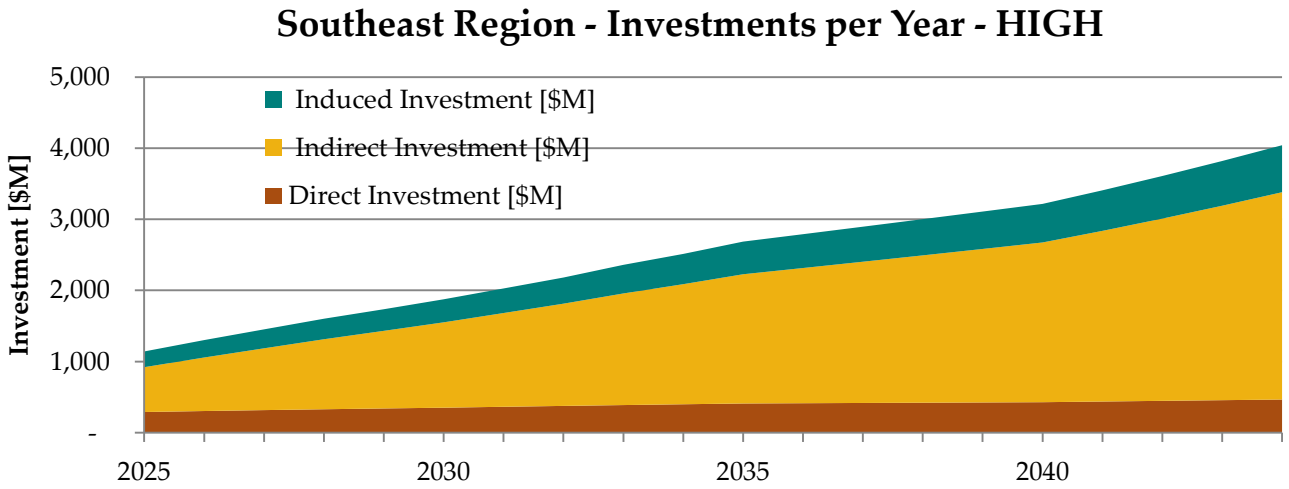
State-by-state modeling using JEDI resulted in ~1,300 direct jobs in 2025, growing to ~2,800 direct FTEs by end of 2044.





- **HIGH cost reduction scenario (Low scenario results are similar plots)**
- We ran JEDI to obtain state-by-state jobs and investments
- State results were summed and presented as regional results.
- Please refer to Appendix for tabulated state-by-state data

[1] Investments are based on constant $2015

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Consistent 500 MW/yr OSW development in the SE (2025-2044) could yield over 44,000 direct job years and over $8B in direct investments.

» Significant increases to manufacturing and construction % local content over the project timeframe

Component	2025	2044
Nacelle/Drivetrain	10%	66%
Blades and Towers	10%	66%
Substructures and Foundation	25%	93%
Substructure and Foundation Labor	25%	92%
Project Collection, HV Cable, Convertor Stations, Substation	15%	76%
Construction Financing	0%	66%
Management of Operating Plants	50%	95%
Erection and Installation Services	50%	95%

» Increases in % local production results in increasing the number of local FTEs and investment $ per year of development. See Appendix for year-by-year results.

Cumulative FTEs [Job-Years]	Low	High
Direct FTEs	44,533	44,152
Indirect FTEs	116,204	116,505
Induced FTEs	64,725	64,556
Total FTEs	**225,462**	**225,213**
Cumulative Investments [$M] [1]	**Low**	**High**
Direct Investment	8,005	7,811
Indirect Investment	34,323	34,388
Induced Investment	8,690	8,668
Total Investment	**51,018**	**50,867**

[1] Investments are based on constant $2015

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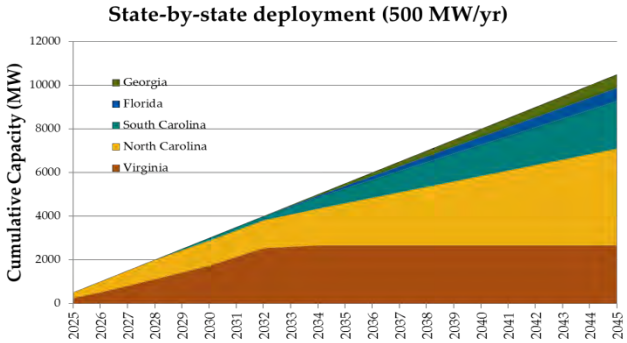
Navigant used the JEDI model to calculate direct, indirect, and induced construction and O&M jobs based on the MW forecasts for 2 scenarios.



Capital and O&M costs (Task 1); modified by yearly cost reductions

JEDI model[2]

State multipliers & locational cost-adjustment factors

U.S. direct, indirect, and induced employment from wind power construction/installation.

Notes:

1. Total installed cost estimates are in 2015$ and internally developed by Navigant. They are adjusted for each state using the JEDI locational adjustment factors.
2. Allocation of direct and indirect impacts derived from Total Turbine and Supply Chain Impacts, based on historical job studies and Navigant experience.

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State-by-state offshore wind installation forecast for 2020 (pilot) and 2025-2044 (500 MW/year).

Capacity (MW)	Scenario under Analysis																				
State	2020	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
North Carolina	20	250	250	200	200	125	125	67	67	200	200	250	250	250	250	250	250	250	250	250	250
South Carolina	20	0	0	0	0	63	63	33	33	167	167	150	150	150	150	150	150	150	150	150	150
Virginia	12	250	250	300	300	313	313	400	400	67	67	0	0	0	0	0	0	0	0	0	0
Georgia	0	0	0	0	0	0	0	0	0	33	33	50	50	50	50	50	50	50	50	50	50
Florida	0	0	0	0	0	0	0	0	0	33	33	50	50	50	50	50	50	50	50	50	50
Southeast Region	52	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Cumulative Capacity	52	552	1052	1552	2052	2552	3052	3552	4052	4552	5052	5552	6052	6552	7052	7552	8052	8552	9052	9552	10052

Pilot installations in 2020:

40 MW – pilot project built near NC/SC border

12 MW - Dominion, 2-turbine demo

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Total Jobs and Investments by State and Region (High Scenario, 2020-2044)

FTEs	Direct Jobs	Indirect Jobs	Induced Jobs	Total Jobs
North Carolina	18,377	47,979	26,970	**93,326**
South Carolina	9,376	23,964	13,187	**46,528**
Virginia	11,249	29,568	15,267	**56,084**
Georgia	2,588	6,816	4,095	**13,499**
Florida	2,561	8,178	5,038	**15,776**
Southeast Region	**44,152**	**116,505**	**64,556**	**225,213**

[$M]	Direct Investment	Indirect Investment	Induced Investment	Total Investment
North Carolina	3,267	14,399	3,663	**21,329**
South Carolina	1,606	7,080	1,528	**10,213**
Virginia	2,047	8,638	2,218	**12,902**
Georgia	446	2,085	570	**3,101**
Florida	446	2,186	690	**3,321**
Southeast Region	**7,811**	**34,388**	**8,668**	**50,867**

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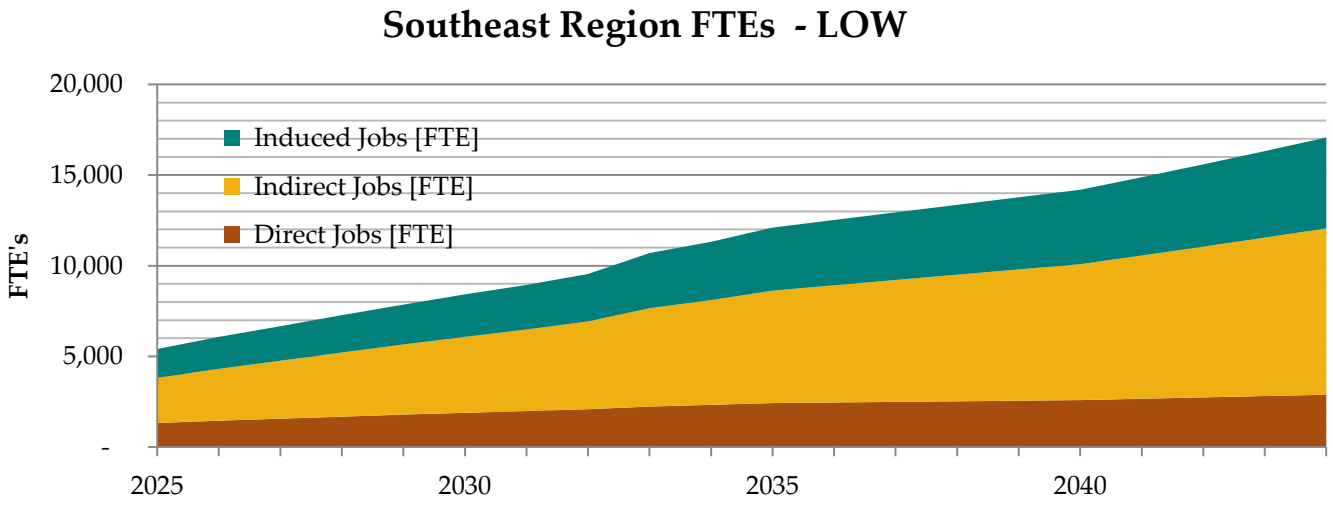
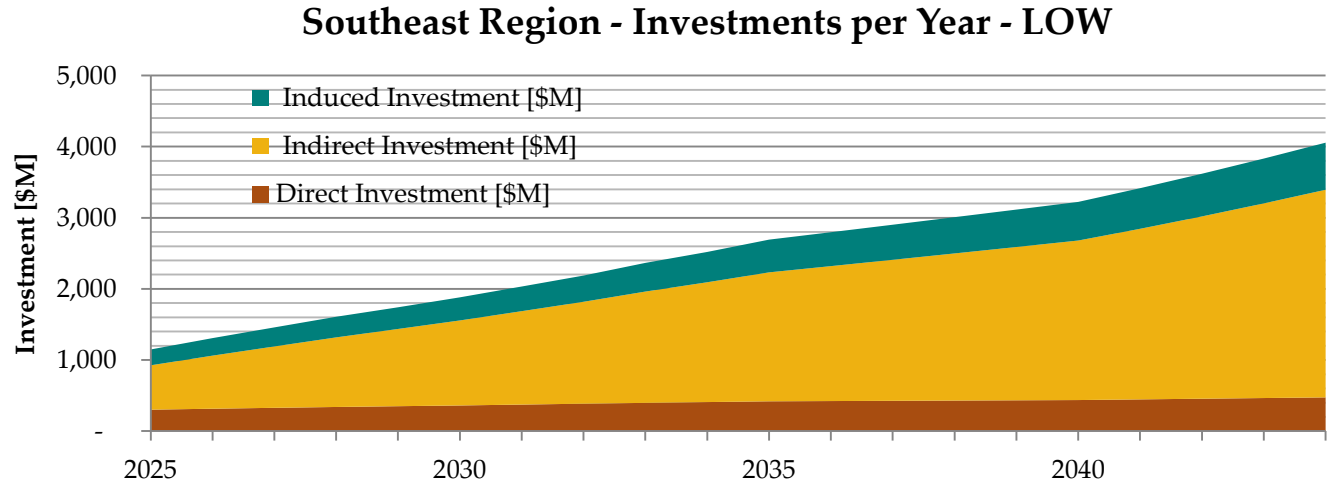
State-by-state modeling using JEDI resulted in ~1,300 direct jobs in 2025, growing to ~2,800 direct FTEs by 2044.





- **LOW cost reduction scenario**
- We ran JEDI to obtain state-by-state jobs and investments
- State results were summed and presented as regional results.

- Please refer to slides 29-34 for tabulated state-by-state data

[1] Investments are based on constant $2015

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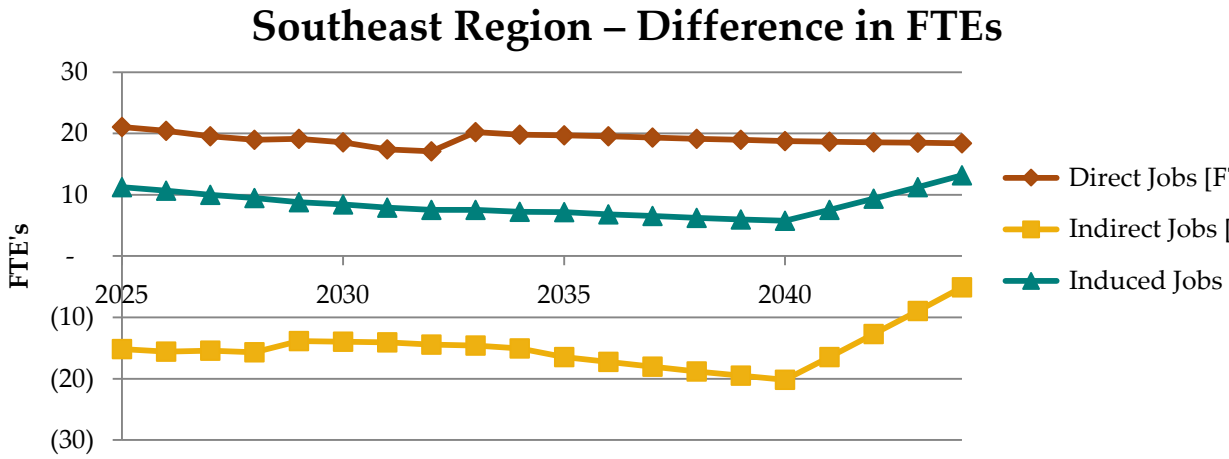
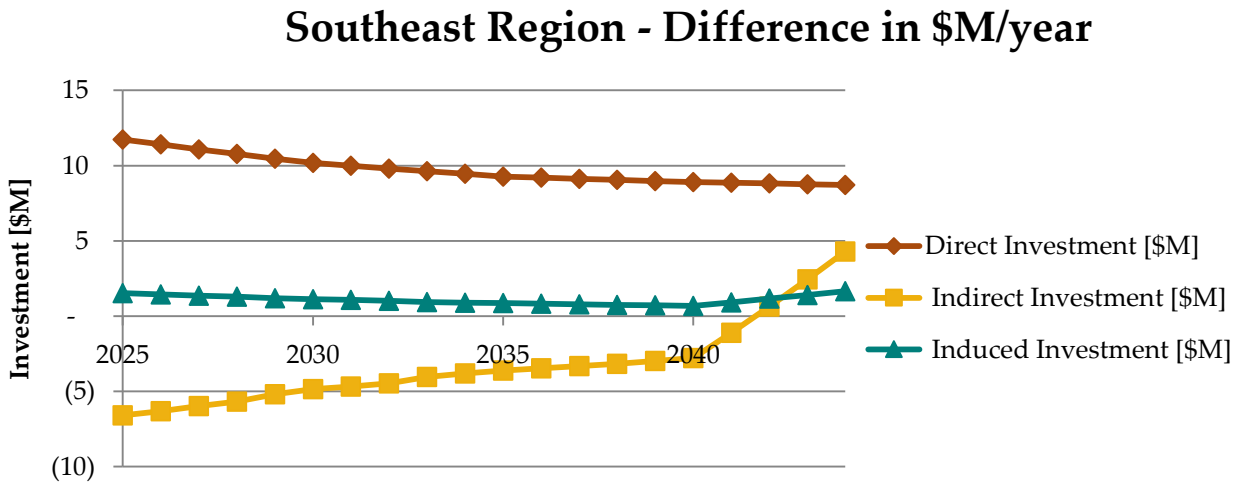
Comparing high and low scenarios, we found a yearly difference of <5% in results, and a cumulative difference of <2.5%.





Jobs and Investment	Cumulative % Difference
Direct FTEs	1%
Indirect FTEs	0%
Induced FTEs	0%
Direct Investment	2%
Indirect Investment	0%
Induced Investment	0%

» **Difference calculated: (Low – High)**

» **% Difference calculated: (Low – High) / Low**

[1] Investments are based on constant $2015

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Direct Jobs by State

FTEs	HIGH COST REDUCTION Scenario under Analysis																				
State	2020	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
North Carolina	40	661	723	632	677	473	498	318	331	854	892	1132	1149	1166	1182	1199	1215	1253	1290	1327	1364
South Carolina	45	1	1	1	1	216	228	133	140	675	706	666	676	686	696	706	715	738	760	782	804
Virginia	23	643	705	909	976	1079	1141	1513	1596	423	435	180	180	180	180	180	180	180	180	180	180
Georgia	0	0	0	0	0	0	0	0	0	131	137	213	216	220	223	226	229	237	244	252	259
Florida	0	0	0	0	0	0	0	0	0	129	136	211	214	217	220	224	227	235	242	249	257
Southeast Region	108	1,306	1,430	1,543	1,654	1,768	1,867	1,964	2,067	2,211	2,306	2,402	2,436	2,469	2,502	2,535	2,568	2,643	2,717	2,791	2,865

FTEs	LOW COST REDUCTION Scenario under Analysis																				
State	2020	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
North Carolina	40	672	734	641	685	478	503	320	334	861	899	1141	1157	1174	1191	1207	1224	1261	1299	1336	1372
South Carolina	45	1	1	1	1	219	231	135	141	683	714	673	683	693	702	712	722	744	767	789	811
Virginia	23	653	715	921	987	1090	1152	1526	1609	425	437	180	180	180	180	180	180	180	180	180	180
Georgia	0	0	0	0	0	0	0	0	0	133	139	215	218	222	225	228	232	239	246	254	261
Florida	0	0	0	0	0	0	0	0	0	131	137	212	216	219	222	226	229	236	244	251	259
Southeast Region	108	1,327	1,450	1,563	1,673	1,787	1,885	1,981	2,084	2,231	2,326	2,422	2,455	2,488	2,521	2,554	2,586	2,662	2,736	2,810	2,883

NAVIGANT ENERGY

Indirect Jobs by State

FTEs	HIGH COST REDUCTION Scenario under Analysis																				
State	2020	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
North Carolina	97	1317	1506	1386	1525	1154	1235	891	937	2057	2192	2757	2880	3003	3125	3245	3365	3545	3730	3919	4112
South Carolina	99	8	8	8	8	430	472	302	327	1428	1547	1520	1602	1683	1764	1845	1926	2050	2178	2311	2447
Virginia	52	1178	1363	1818	2023	2299	2497	3320	3594	1331	1376	872	872	872	872	872	872	872	872	872	872
Georgia	0	0	0	0	0	0	0	0	0	283	308	485	512	539	566	593	619	661	704	749	795
Florida	0	0	0	0	0	0	0	0	0	340	371	586	616	647	678	708	738	791	845	900	958
Southeast Region	248	2,502	2,877	3,211	3,556	3,883	4,204	4,513	4,859	5,440	5,794	6,221	6,483	6,744	7,004	7,263	7,520	7,919	8,329	8,751	9,184

FTEs	LOW COST REDUCTION Scenario under Analysis																				
State	2020	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
North Carolina	97	1308	1497	1378	1518	1149	1230	888	935	2048	2183	2745	2868	2990	3111	3231	3351	3532	3718	3909	4104
South Carolina	99	8	8	8	8	429	472	302	326	1425	1545	1518	1600	1681	1762	1842	1923	2048	2178	2312	2450
Virginia	52	1171	1356	1810	2015	2291	2489	3309	3583	1330	1374	872	872	872	872	872	872	872	872	872	872
Georgia	0	0	0	0	0	0	0	0	0	282	307	484	511	537	564	591	617	660	703	748	794
Florida	0	0	0	0	0	0	0	0	0	340	370	585	616	646	676	707	737	790	844	901	958
Southeast Region	248	2,487	2,861	3,195	3,541	3,869	4,190	4,499	4,844	5,425	5,779	6,204	6,466	6,726	6,986	7,243	7,500	7,902	8,316	8,742	9,179

NAVIGANT ENERGY

Induced Jobs by State

FTEs	HIGH COST REDUCTION Scenario under Analysis																				
State	2020	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
North Carolina	62	840	932	832	900	656	696	479	502	1168	1236	1560	1619	1678	1737	1796	1855	1952	2052	2155	2263
South Carolina	60	3	3	3	3	256	276	170	182	829	887	860	896	932	969	1005	1042	1104	1168	1236	1306
Virginia	33	737	817	1059	1147	1278	1364	1803	1925	640	660	380	380	380	380	380	380	380	380	380	380
Georgia	0	0	0	0	0	0	0	0	0	179	192	300	314	328	341	355	369	392	416	441	468
Florida	0	0	0	0	0	0	0	0	0	218	235	369	386	402	419	435	452	482	513	546	580
Southeast Region	155	1,580	1,751	1,894	2,050	2,190	2,336	2,452	2,609	3,033	3,210	3,470	3,595	3,720	3,846	3,972	4,099	4,309	4,530	4,759	4,997

FTEs	LOW COST REDUCTION Scenario under Analysis																				
State	2020	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
North Carolina	62	846	937	836	904	659	698	480	503	1171	1239	1563	1622	1681	1740	1799	1858	1955	2056	2160	2269
South Carolina	60	3	3	3	3	257	277	170	182	831	889	861	898	934	970	1007	1044	1106	1171	1239	1309
Virginia	33	743	822	1064	1153	1284	1370	1809	1931	641	661	381	381	381	381	381	381	381	381	381	381
Georgia	0	0	0	0	0	0	0	0	0	179	192	301	315	328	342	355	369	393	417	443	469
Florida	0	0	0	0	0	0	0	0	0	219	236	370	387	403	420	436	453	483	515	548	582
Southeast Region	155	1,591	1,762	1,903	2,060	2,199	2,344	2,460	2,616	3,041	3,217	3,477	3,602	3,727	3,852	3,978	4,104	4,317	4,539	4,770	5,010

NAVIGANT ENERGY

Direct Investment by State

$M (2015) HIGH COST REDUCTION Scenario under Analysis																					
State	2020	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
North Carolina	11	145	152	128	132	88	91	55	56	153	157	199	201	202	204	206	208	213	217	222	227
South Carolina	11	0	0	0	0	41	42	24	25	120	124	115	116	118	119	120	121	124	126	129	132
Virginia	6	145	152	189	196	211	218	285	295	68	69	21	21	21	21	21	21	21	21	21	21
Georgia	0	0	0	0	0	0	0	0	0	24	24	38	38	38	39	39	39	40	41	42	43
Florida	0	0	0	0	0	0	0	0	0	24	24	38	38	38	39	39	39	40	41	42	43
Southeast Region	27	290	304	317	329	340	351	364	376	388	399	410	414	418	421	425	428	438	447	457	466

$M (2015) LOW COST REDUCTION Scenario under Analysis																					
State	2020	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
North Carolina	11	151	158	132	137	91	94	56	58	157	161	203	205	207	209	210	212	217	222	226	231
South Carolina	11	0	0	0	0	42	43	24	25	123	127	118	119	120	121	122	123	126	129	132	135
Virginia	6	151	158	196	203	218	224	293	303	69	70	21	21	21	21	21	21	21	21	21	21
Georgia	0	0	0	0	0	0	0	0	0	24	25	38	39	39	40	40	40	41	42	43	44
Florida	0	0	0	0	0	0	0	0	0	24	25	38	39	39	40	40	40	41	42	43	44
Southeast Region	27	302	316	328	340	351	361	374	386	398	409	420	423	427	430	434	437	447	456	466	475

NAVIGANT ENERGY

Indirect Investment by State

$M (2015) HIGH COST REDUCTION Scenario under Analysis																					
State	2020	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
North Carolina	23	320	382	361	408	312	340	245	261	597	644	824	865	907	949	992	1035	1110	1190	1274	1363
South Carolina	22	2	2	2	2	114	127	82	90	405	445	441	466	491	517	543	569	614	663	714	768
Virginia	13	308	369	506	575	665	733	991	1087	398	414	258	258	258	258	258	258	258	258	258	258
Georgia	0	0	0	0	0	0	0	0	0	82	90	144	152	161	170	179	188	204	220	238	257
Florida	0	0	0	0	0	0	0	0	0	86	95	151	160	169	178	187	197	213	231	250	270
Southeast Region	58	630	753	869	984	1,091	1,200	1,318	1,437	1,569	1,688	1,817	1,901	1,986	2,072	2,158	2,246	2,399	2,562	2,734	2,915

$M (2015) LOW COST REDUCTION Scenario under Analysis																					
State	2020	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
North Carolina	23	317	378	359	406	311	338	244	260	595	643	821	863	905	947	990	1033	1109	1190	1275	1364
South Carolina	22	2	2	2	2	113	127	82	90	404	443	440	465	491	516	542	568	614	663	715	770
Virginia	13	305	366	502	572	662	730	987	1083	398	414	258	258	258	258	258	258	258	258	258	258
Georgia	0	0	0	0	0	0	0	0	0	82	90	143	152	161	169	178	187	203	220	238	257
Florida	0	0	0	0	0	0	0	0	0	86	94	150	159	168	178	187	196	213	231	250	270
Southeast Region	58	624	746	863	979	1,086	1,195	1,313	1,433	1,565	1,684	1,813	1,897	1,982	2,068	2,155	2,243	2,398	2,563	2,736	2,919

NAVIGANT ENERGY

Induced Investment by State

$M (2015) HIGH COST REDUCTION Scenario under Analysis																					
State	2020	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
North Carolina	8	114	126	113	122	89	95	65	68	158	168	211	220	228	236	244	252	265	279	293	308
South Carolina	7	0	0	0	0	30	32	20	21	96	102	99	104	108	112	117	121	128	136	143	152
Virginia	5	107	118	153	166	185	197	260	278	93	96	56	56	56	56	56	56	56	56	56	56
Georgia	0	0	0	0	0	0	0	0	0	25	27	42	44	46	47	49	51	55	58	62	65
Florida	0	0	0	0	0	0	0	0	0	30	32	50	53	55	57	60	62	66	70	75	79
Southeast Region	20	221	245	266	288	303	324	345	368	402	425	459	476	492	509	526	542	570	599	629	660

$M (2015) LOW COST REDUCTION Scenario under Analysis																					
State	2020	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
North Carolina	8	115	127	113	123	90	95	65	69	159	168	212	220	228	236	244	252	266	279	294	308
South Carolina	7	0	0	0	0	30	32	20	21	96	103	100	104	108	112	117	121	128	136	144	152
Virginia	5	107	119	154	167	185	198	261	279	93	96	56	56	56	56	56	56	56	56	56	56
Georgia	0	0	0	0	0	0	0	0	0	25	27	42	44	46	48	50	51	55	58	62	66
Florida	0	0	0	0	0	0	0	0	0	30	32	51	53	55	57	60	62	66	70	75	80
Southeast Region	20	222	246	268	290	305	325	346	369	403	426	460	476	493	510	526	543	571	600	630	662

NAVIGANT ENERGY