

Impact of the Production Tax Credit on the U.S. Wind Market

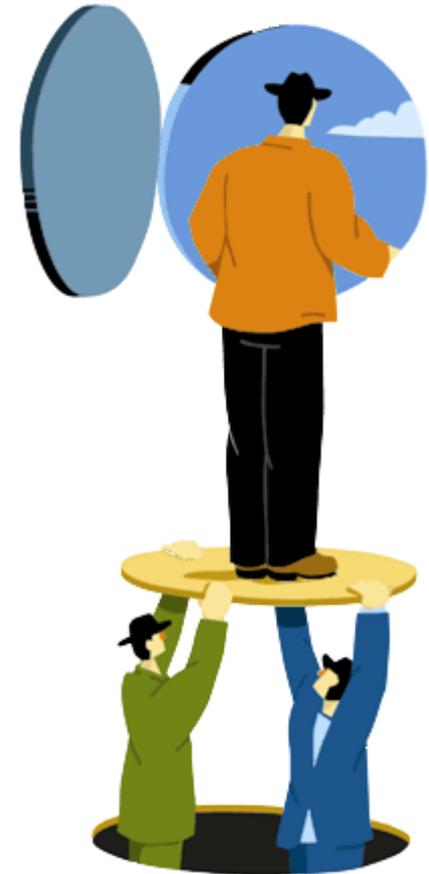
Prepared for the American Wind Energy Association



December 12, 2011

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Content of Report

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December 2011

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1	Executive Summary
2	Wind MW Forecast
3	Wind Jobs Forecast
4	Economic Impact
5	Environmental Impact

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Navigant evaluated the impact of two scenarios of the Production Tax Credit (PTC) on the U.S. wind market through 2016.

Scope of Study

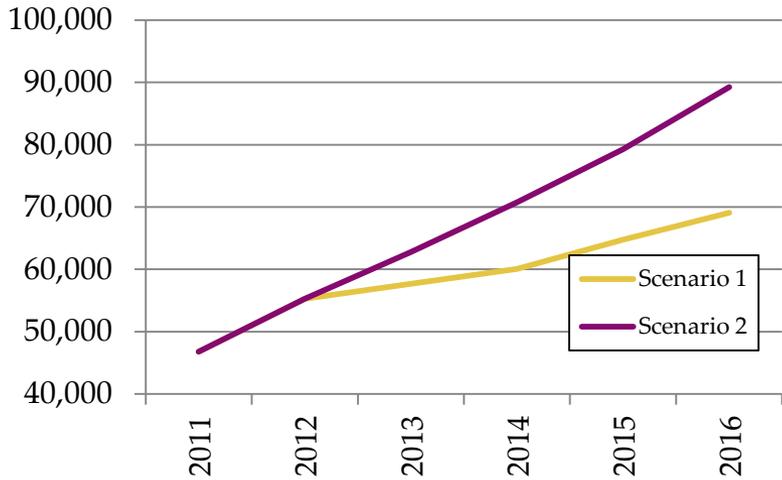
» We evaluated the impact of the following two scenarios:

- Scenario 1: the PTC expires at the end of 2012.
- Scenario 2: the PTC has a four-year extension and expires at the end of 2016.

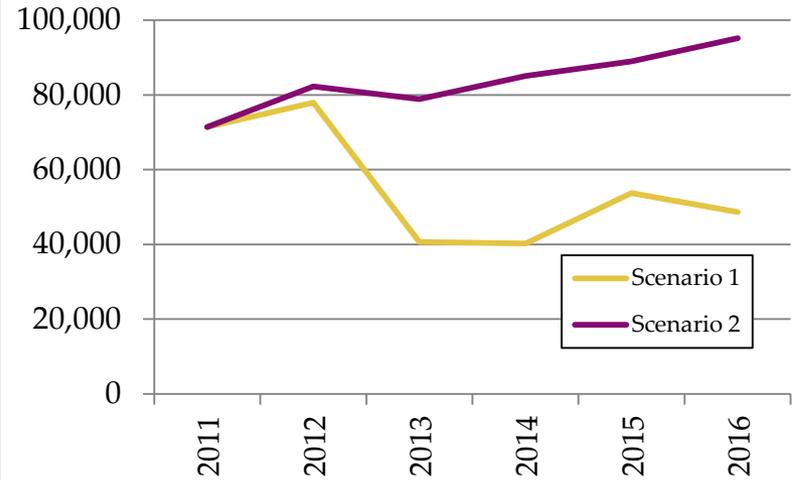
» For each scenario, state and year, we produced a forecast of the following items:

- Wind MW installed
- Wind jobs (direct, indirect, and induced)
 - Manufacturing
 - Construction
 - Operations & Maintenance
- Economic impact
 - Manufacturing investment (direct, indirect, and induced)
 - Construction (direct, indirect, and induced)
 - Other (land lease payments, federal, state, and local taxes)
- Environmental impact

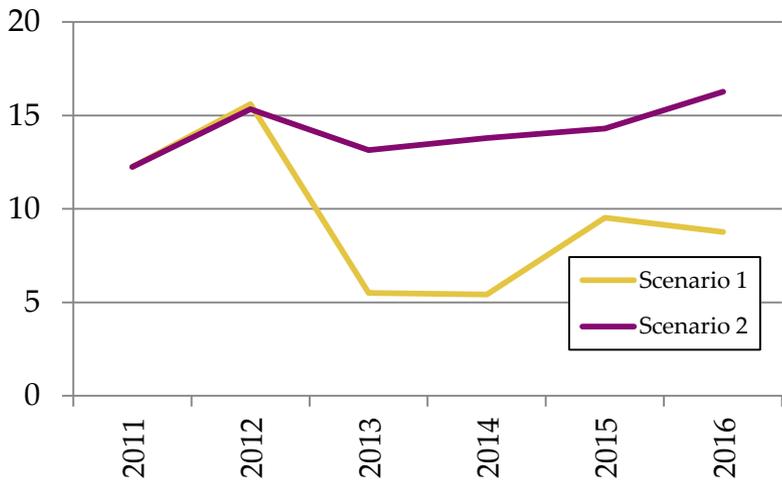
Cumulative Wind Installed [MW]



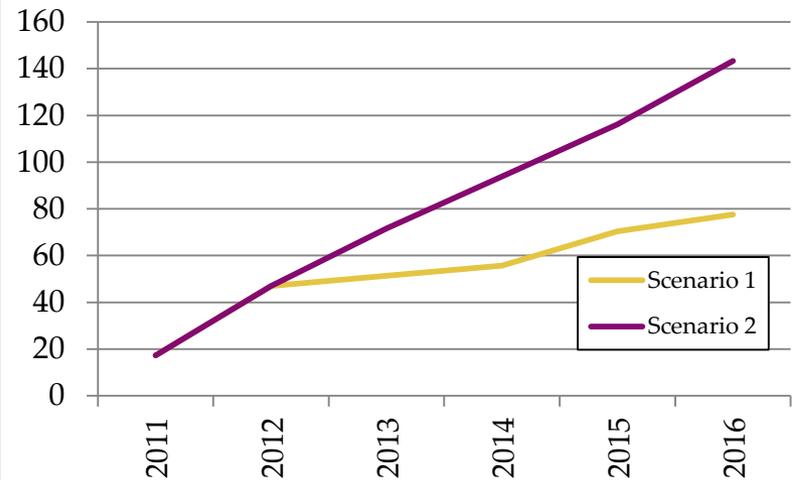
Annual Wind Jobs [FTE]



Annual Wind Investment [\$ B]



CO₂ Emissions Offset by Wind* [Millions of Tons]



* Note: CO₂ emissions reductions are based on high level estimates of emission factors for gas-fired power plants and not a detailed production simulation modeling analysis.

Conclusions

- » With no PTC extension, the U.S. wind market will shrink significantly in 2013.
 - Annual installations will be 2 GW in 2013, down from >8 GW in 2012.
 - Total wind supported jobs will drop by nearly half, from 78,000 in 2012 to 41,000 in 2013.
 - Total wind investment will drop by nearly two-thirds, from \$15.6 billion in 2012 to \$5.5 billion in 2013.
- » With a 4 year PTC extension, the U.S. wind market will grow through 2016.
 - Annual installations will be 8-10 GW through 2016.
 - Total wind supported jobs will grow to 95,000 by 2016.
 - Total wind investment will grow to \$16.3 billion in 2016.

A four year PTC extension will result in an incremental 20 GW installed, 169,000 job-years, and \$28 billion incremental investment through 2016.

Total Impacts on the U.S. Wind Market 2011-2016				
	Scenario →	1	2	2 - 1
New wind installed [GW]		28.8	49	20.2
Total wind job-years [FTE in thousands]		333	502	169
Total wind economic impact [2011\$ in billions]		57	85	28
CO ₂ emissions offset by wind [M short tons]		320	490	170
SO ₂ emissions offset by wind [short tons]		1,560	3,440	1,880
NO _x emissions offset by wind [K short tons]		230	330	100

1	Executive Summary
2	Wind MW Forecast
3	Wind Jobs Forecast
4	Economic Impact
5	Environmental Impact

Navigant used a combination of sources and techniques to develop the wind MW forecast.

- Bottom-up forecast* – a probabilistic forecast on a project-by-project basis;
- State RPS requirements* – an assessment of each state’s Renewable Portfolio Standard (RPS) and the corresponding off-ramps and degree of compliance;
- Industry interviews* – a consensus forecast of major U.S. wind developers and manufacturers;

	2011	2012	2013	2014	2015	2016
Scenario 1	a		b			
Scenario 2			c			

- The bottom-up forecast was the primary source for 2011-2012 for both scenarios;
- Navigant’s state RPS database was the primary source for Scenario 1 in 2013-2016;
- Industry interviews were the primary sources for Scenario 2 in 2013-2016;

The bottom-up forecast is based on public market data and is adjusted to reflect likely project cancellations and delays.

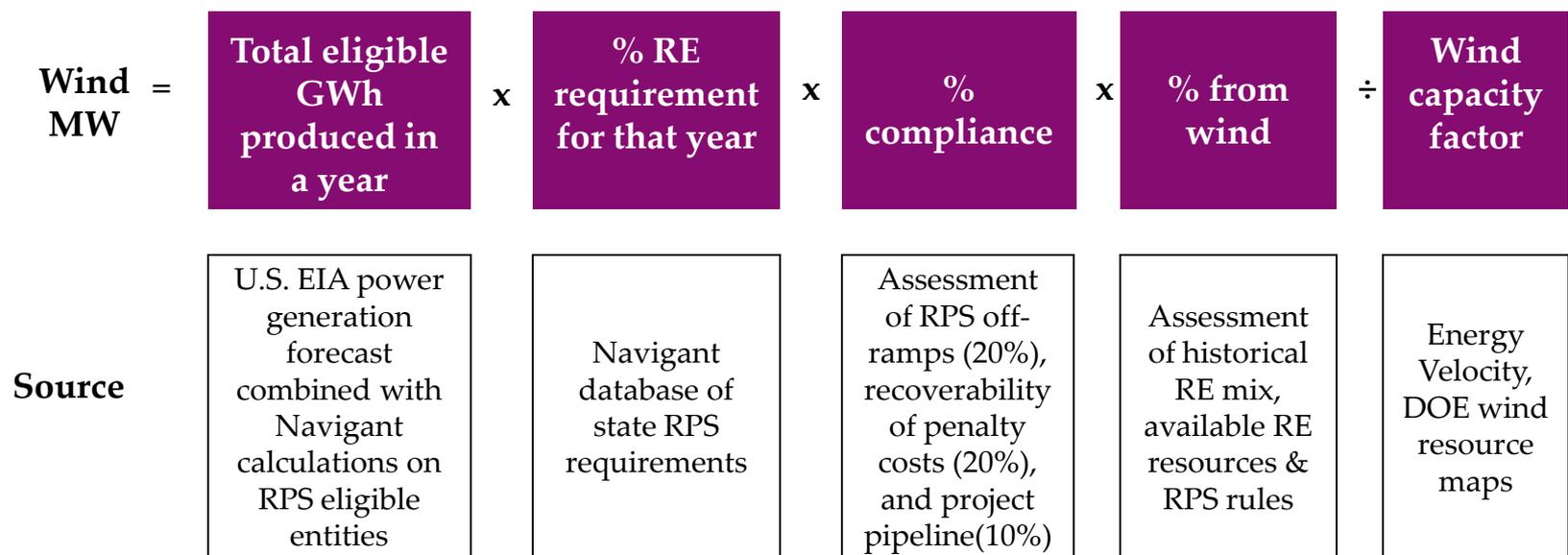
Wind Power Bottom-Up Market Projection Methodology

- Navigant began with Ventyx’s EV Power database of existing and future wind power plants.
- Navigant selected all projects with a Commercial Online Year greater than or equal to 2011.
- Ventyx classifies projects by the following stages of development:
 - Feasibility
 - Proposed
 - Application Pending
 - Permitted
 - Site Preparation
 - Under Construction
 - Testing
 - Operating
- The EV Power database tracks all announced projects without taking into account completion probabilities. As such, it was necessary for Navigant to adjust installed capacity projections by stage-appropriate expected completion factors to account for project cancellations (see 1st table on right).
- The EV Power database forecasts project installations by their stated assumed COD. Given economic and political uncertainty as well as inherent project delays, Navigant applied a series of stage-appropriate phase-in factors to project installed capacity by COD. This methodology accounts for projects that are currently on hold or are expecting delays not reflected in the COD (see 2nd table).

Stage-Based Completion Factors				
Project Stage	Expected Probability of Completion			
	2011	2012	2013	2014
Feasibility	15%	10%	8%	5%
Proposed	30%	20%	15%	10%
App. Pending	50%	40%	30%	20%
Permitted	80%	70%	60%	50%
Site Prep.	90%	90%	90%	90%
Testing	100%	100%	100%	100%
Under Constr.	100%	100%	100%	100%
Operational	100%	100%	100%	100%

Stage-Based Phase-In Factors			
Project Stage	Expected Probability of Completion		
	Stated Yr	Stated Yr +1	Stated Yr +2
Feasibility	0%	33%	67%
Proposed	10%	30%	60%
App. Pending	20%	40%	40%
Permitted	25%	25%	50%
Site Prep.	33%	67%	0%
Testing	60%	40%	0%
Under Constr.	50%	50%	0%
Operational	100%	0%	0%

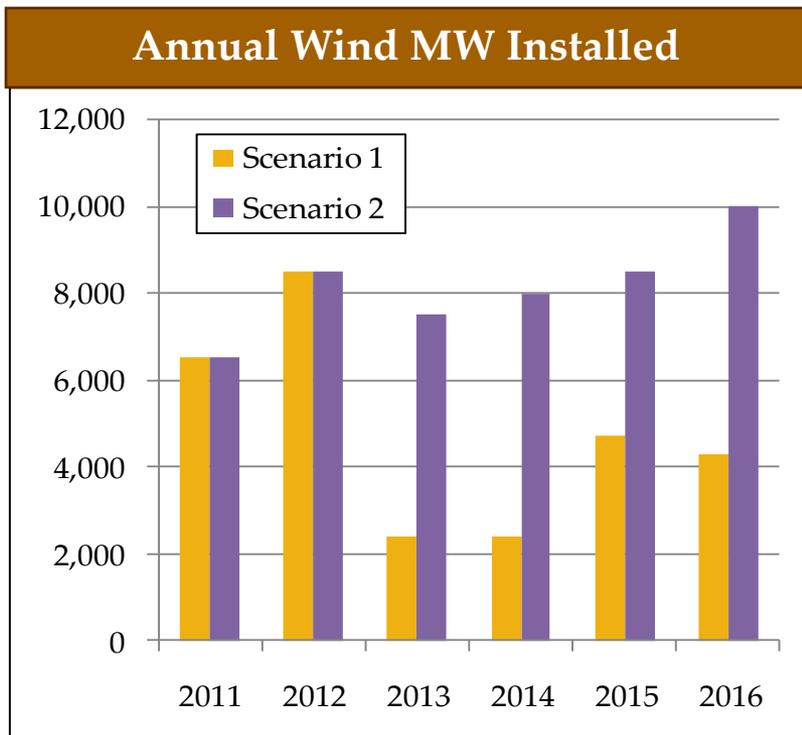
Navigant evaluated a number of factors for each state to determine the RPS-driven MW forecast.



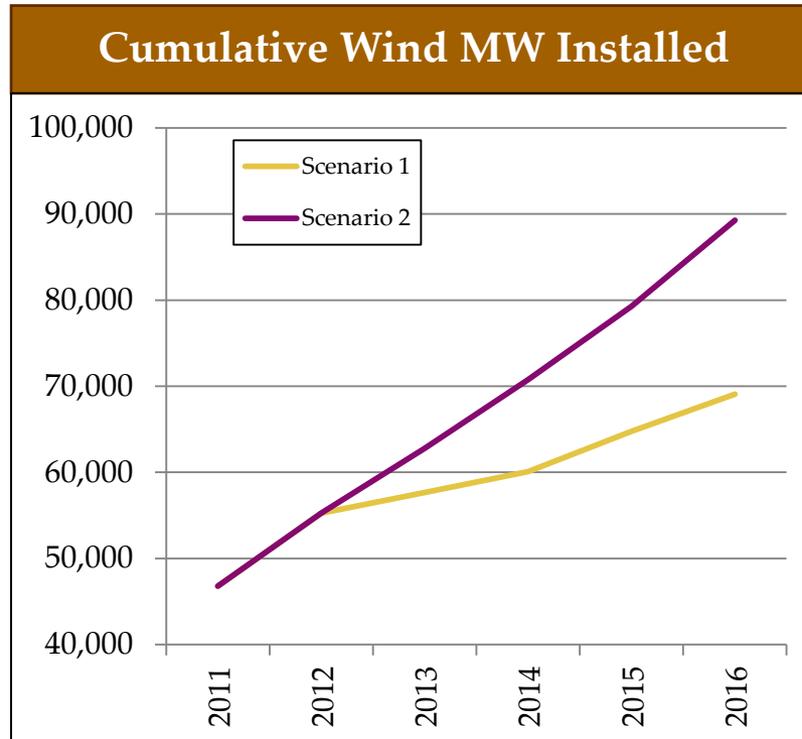
Navigant interviewed 24 leading U.S. wind developers and manufacturers to develop a consensus forecast.

Summary of Survey Questions		
	Developers	Manufacturers
What is your company's view of the 2012-2016 U.S. wind market (in new installed capacity), with and without a PTC extension?	X	X
How many MW per year of wind capacity does your company expect to install in the U.S. in 2013-2016, with and without a PTC extension?	X	
How many people currently work in your company in the U.S.? What is the breakdown by major facility (or state)?		X
Would your company plan to change its manufacturing capacity in the U.S. with a PTC extension? Without a PTC extension? Where, when, and approximately how many people would be employed under each scenario?		X
What is the relationship between MW of wind turbines ordered and employment in your company? In other words, if your volume of business doubled, what percentage increase in employment would result?		X
For the U.S. wind market, what is the approximate combined market share for <i>domestic</i> manufacturers in your equipment segment (e.g., blades)? How do you expect that percentage to change between now and 2016, both with and without a PTC extension?		X

The PTC has an impact of an incremental 5-6 GW of installed capacity during each year of the extension.



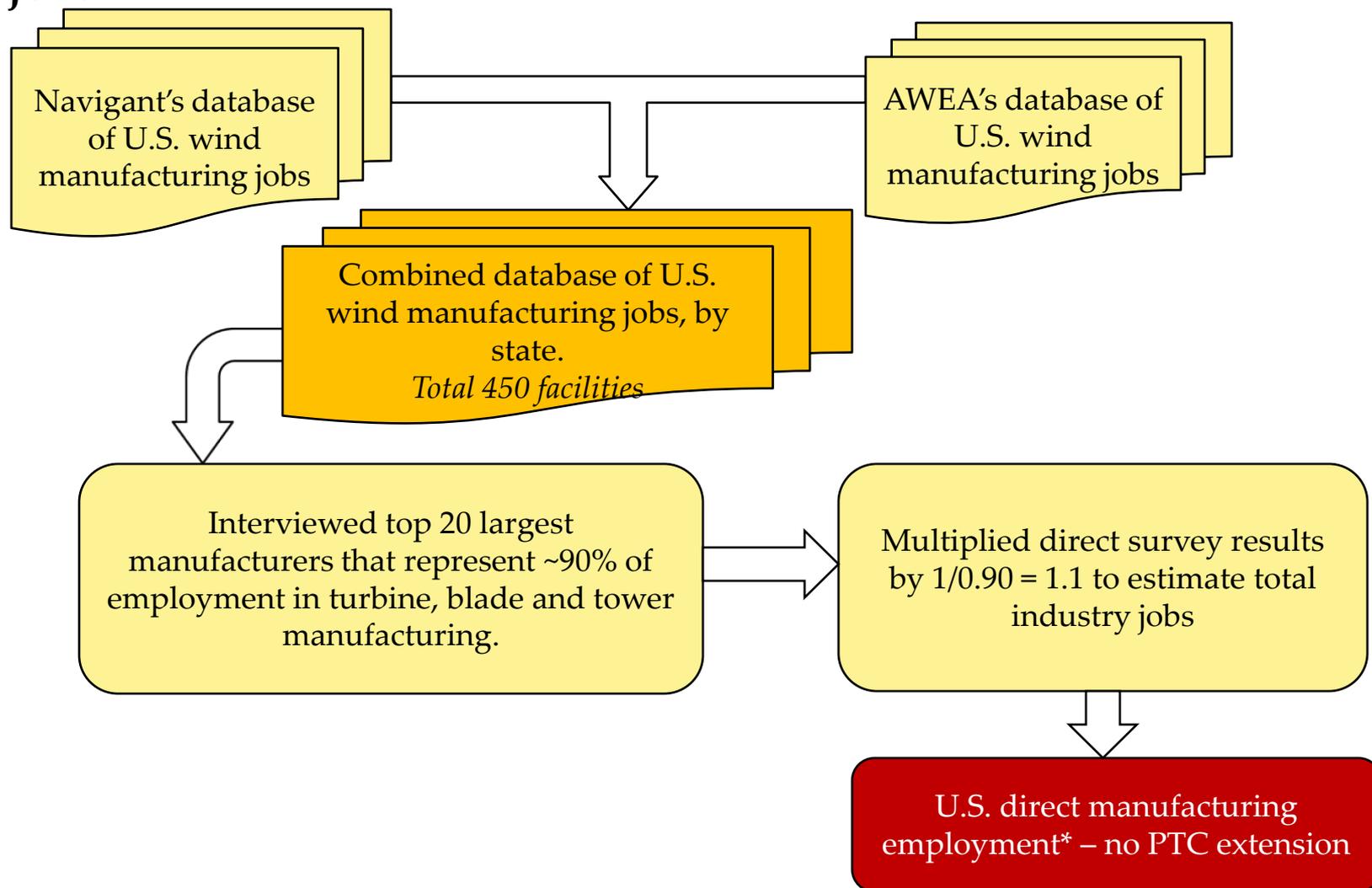
Source: Navigant, December 2011



Source: Navigant, December 2011

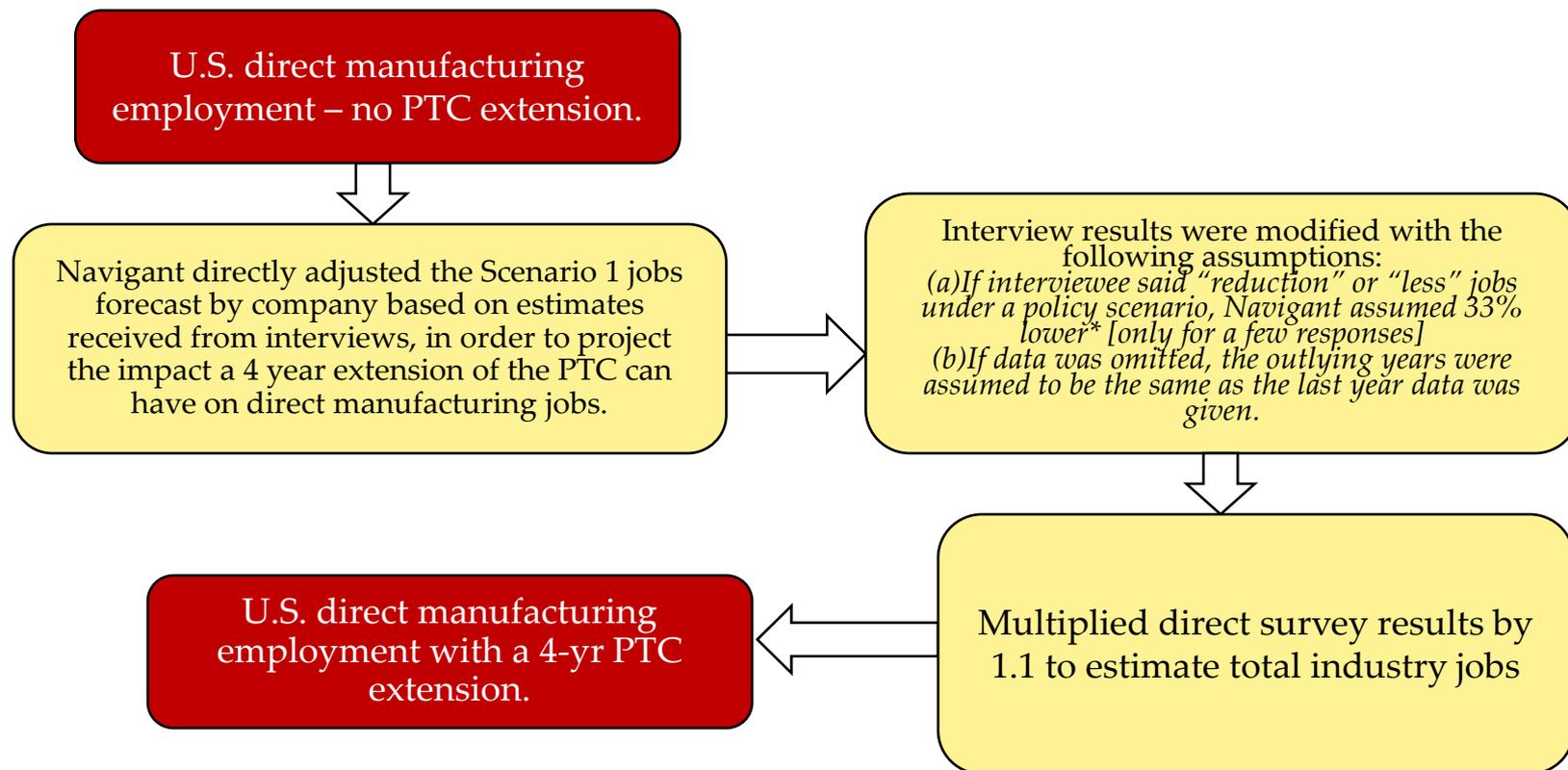
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Navigant developed a bottom-up forecast of U.S. wind manufacturing jobs.



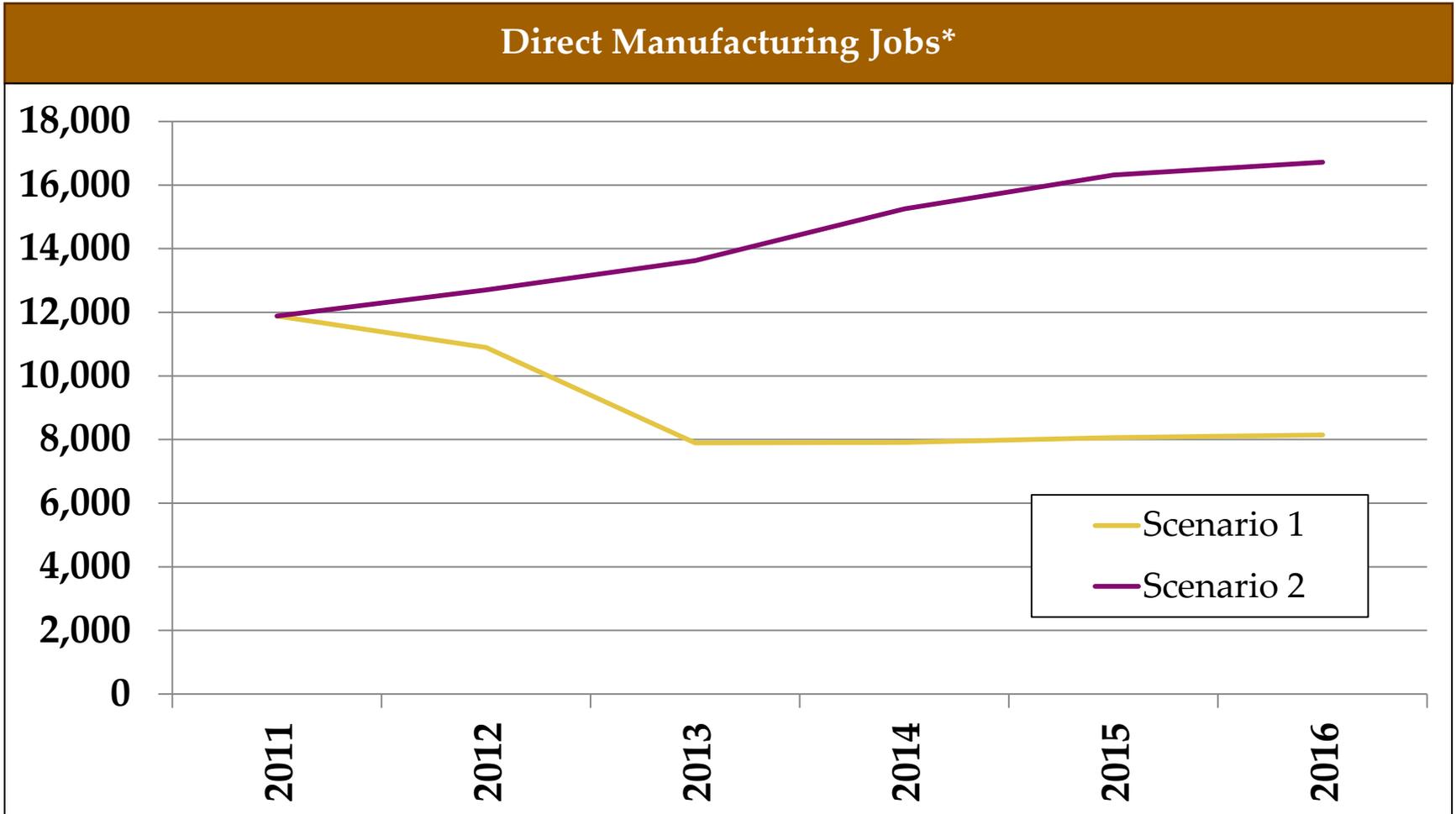
*Note: Navigant defines direct manufacturing as manufacturing of turbines, blades and towers. All other components are considered indirect manufacturing.

Navigant adjusted Scenario 1 manufacturing employment numbers based on key interviews with manufacturing companies.



*Note: Turbine manufacturer responses ranged from 13% - 33%; blade manufacturers from 42-47%; tower manufacturers from 38-58%.

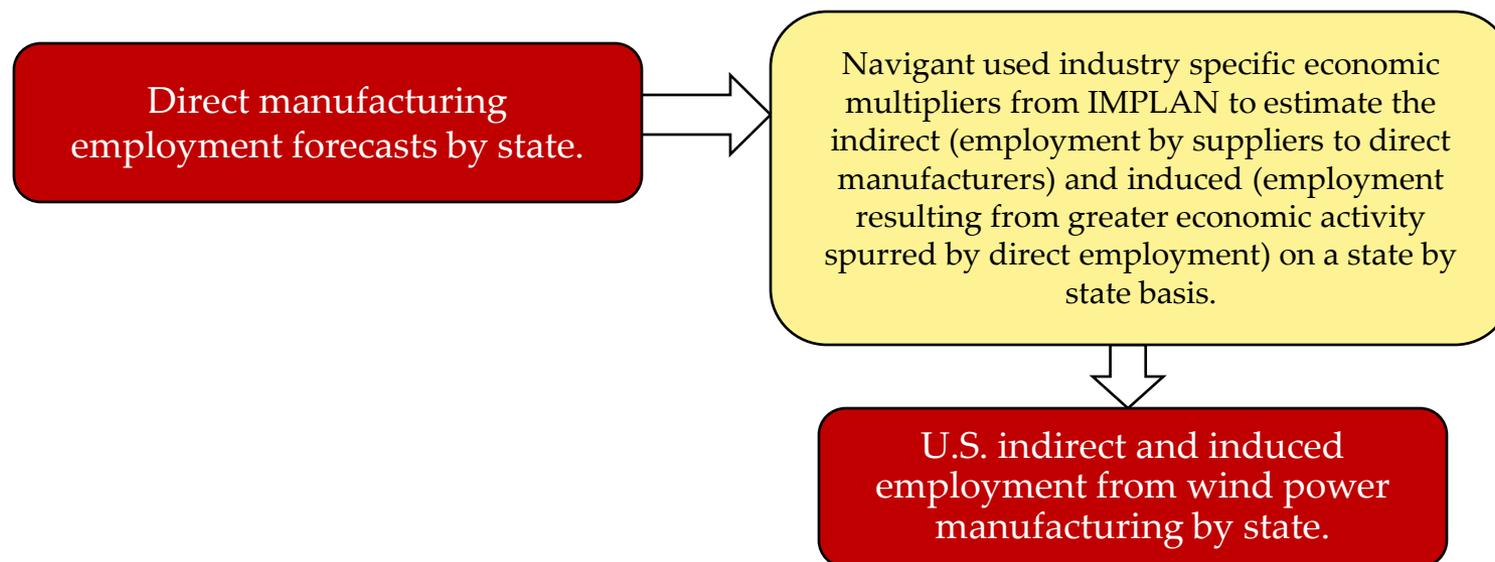
With no PTC extension, wind direct manufacturing jobs are projected to decline by 1/3; a 4 year extension could increase jobs by 1/3.



Source: Navigant, December 2011

*Note: Navigant defines direct manufacturing as manufacturing of turbines, blades and towers. All other components are considered indirect manufacturing.

Navigant calculated each scenario's indirect and induced manufacturing jobs by using economic multipliers.



Notes:

1. Source: IMPLAN

With a 4 year PTC extension, the wind industry will peak at 46,000 manufacturing jobs, or about 24,000 jobs more than without a PTC extension.

Wind Manufacturing Jobs [FTE in thousands]							
Scenario	'11	'12	'13	'14	'15	'16	'11-16
Direct Jobs							
1	12	11	8	8	8	8	55
2	12	13	14	15	16	17	87
2 - 1	0	1	6	7	8	9	31
Indirect Jobs							
1	10	10	7	7	7	7	48
2	10	11	12	13	14	15	75
2 - 1	0	2	5	6	7	7	27
Induced Jobs							
1	11	10	7	7	7	7	49
2	11	11	12	14	15	15	78
2 - 1	0	2	5	7	7	8	29
Total Wind Manufacturing Jobs							
1	33	30	22	22	22	23	152
2	33	35	38	42	45	46	239
2 - 1	0	5	16	20	23	24	88

Navigant used NREL's Wind Jobs & Economic Development Impact (JEDI) model to assess labor impacts of installation and operation.

Navigant's Use of the JEDI¹ Model

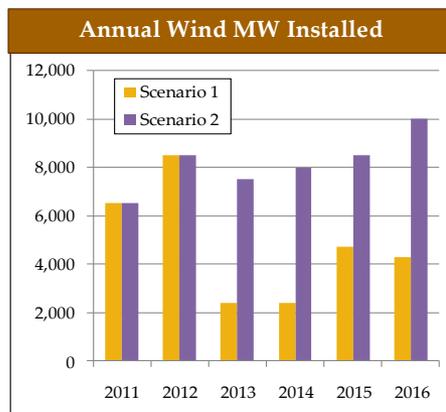
- » The wind JEDI model was developed for the U.S. Department of Energy to analyze the economic benefits of constructing and operating wind power plants.
- » JEDI contains wind power manufacturing and construction labor intensity data and then uses IMPLAN modeling software to project indirect and induced economic impacts. More information on IMPLAN modeling software can be found at <http://www.implan.com/>.
- » Navigant conducted JEDI runs for each year 2011-2016 for the United States using the state-by-state wind new installations for construction jobs and state-by-state cumulative installations for operations jobs.

Source: NREL's JEDI model can be found at <http://www.nrel.gov/analysis/jedi/>

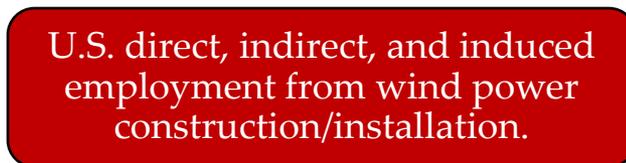
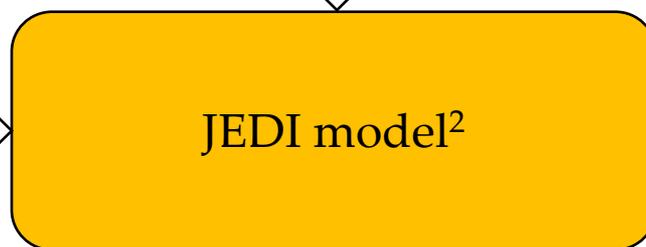
Notes:

1. The JEDI model used for this study is "Release Number: W1.10.03"
2. MRG & Associates provided national multipliers from the most recently available (2007) IMPLAN data. The multipliers cover employment, earnings, output, and personal consumption expenditure (PCE) patterns.

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



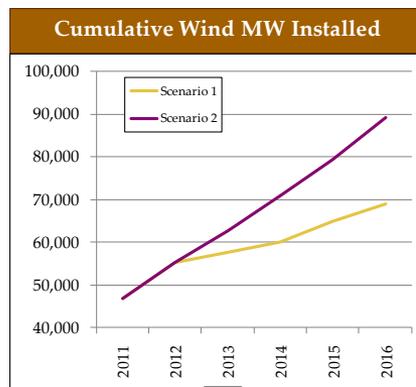
Year	Total Installed Costs \$/kW ¹	
	Scenario 1	Scenario 2
2011	1,758	1,758
2012	1,722	1,687
2013	1,688	1,620
2014	1,654	1,555
2015	1,621	1,493
2016	1,589	1,433



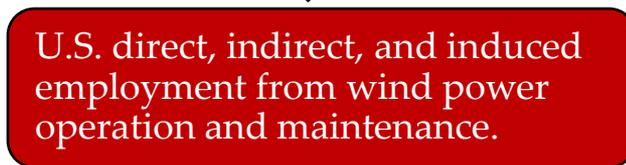
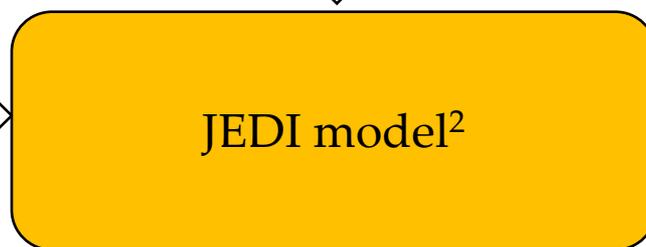
Notes:

1. Total installed cost estimates are in 2011\$ 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.

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



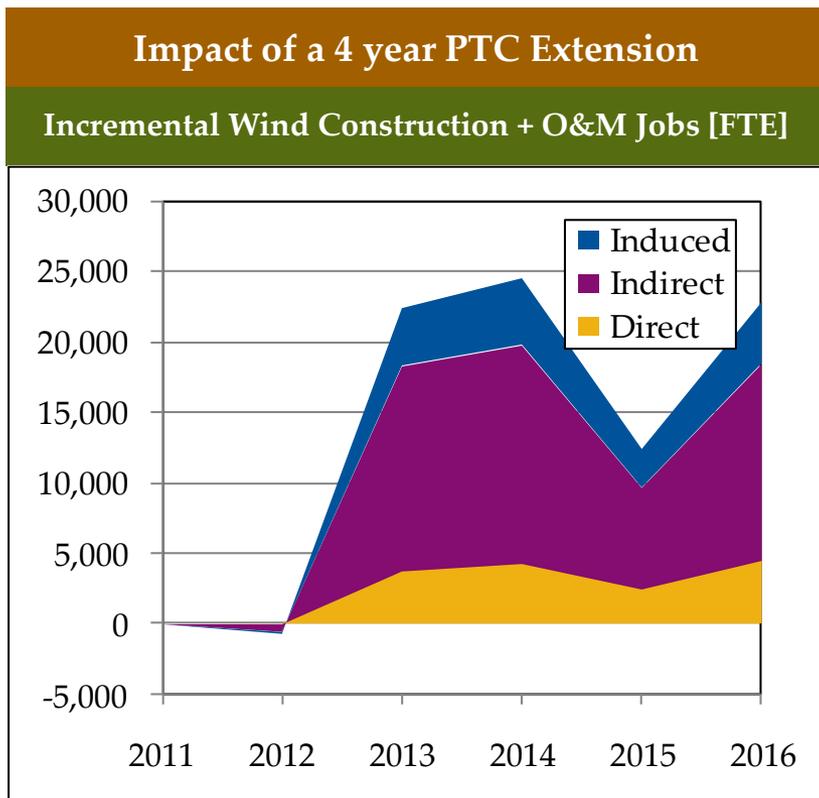
Year	Total Installed Costs \$/kW ¹	
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2016	1,589	1,433



Notes:

1. Total installed cost estimates are in 2011\$ and internally developed by Navigant. They are adjusted for each state using the JEDI locational adjustment factors.
2. Navigant ran the JEDI model for the new O&M jobs added in a given year and added those to the previously created O&M jobs.

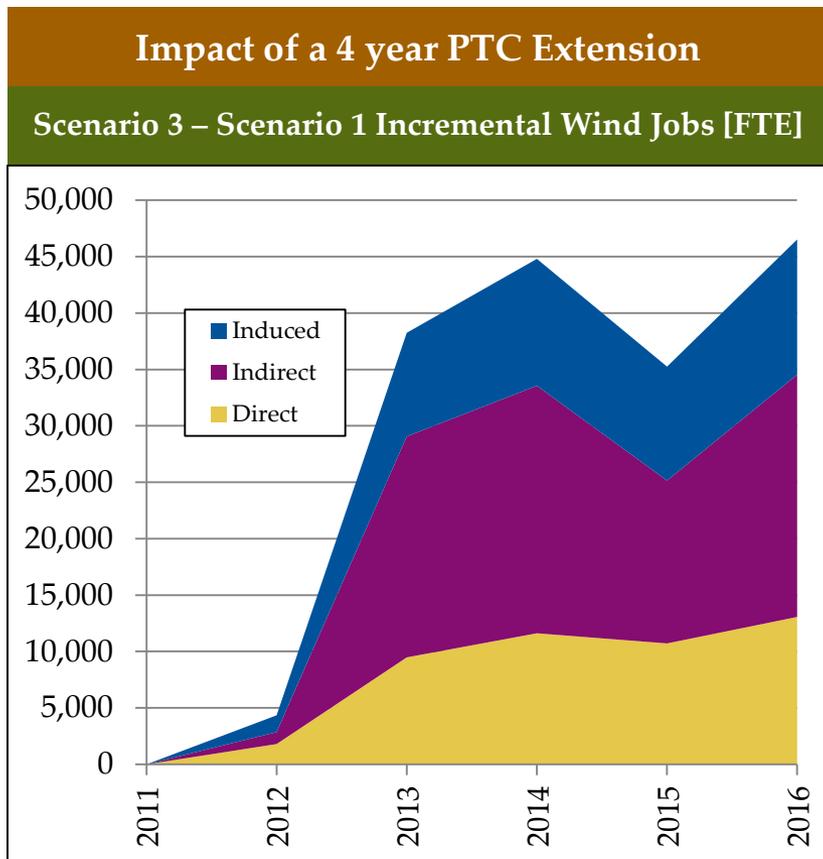
With a 4 year PTC extension, total wind construction and O&M jobs will peak at 49,000 in 2016, compared to 26,000 with no extension.



Source: Navigant, December 2011

Wind Construction and O&M Jobs [FTE in thousands]							
Scenario	'11	'12	'13	'14	'15	'16	'11-'16 [Job-Years]
Direct Jobs							
1	7	8	4	4	7	6	36
2	7	8	8	9	9	11	52
2-1	0	0	4	5	2	5	16
Indirect Jobs							
1	24	30	10	10	18	14	106
2	24	29	25	25	25	28	156
2-1	0	-1	15	16	7	14	51
Induced Jobs							
1	8	10	4	4	7	6	39
2	8	10	9	9	9	10	55
2-1	0	0	4	5	3	4	16
Total Wind Construction and O&M Jobs							
1	39	48	19	18	31	26	181
2	39	47	41	43	44	49	263
2-1	0	-1	22	24	12	23	80

With a 4 year PTC extension, total wind employment will peak at 95,000 jobs in 2016, compared to 49,000 jobs with no PTC extension.



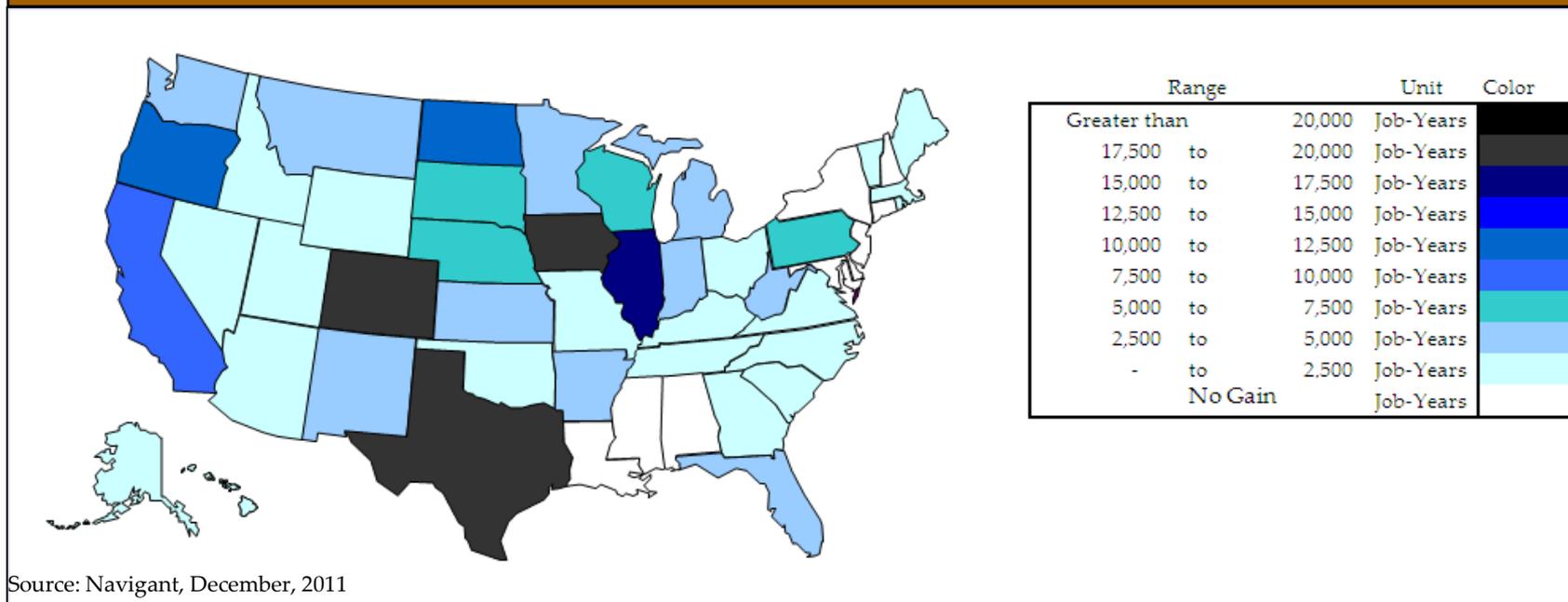
Source: Navigant, December 2011

Total Wind Jobs [FTE in thousands]							
Scenario	'11	'12	'13	'14	'15	'16	'11-'16 [job-years]
Direct Jobs							
1	19	19	12	12	15	14	91
2	19	21	22	24	26	27	139
2-1	0	2	9	12	11	13	47
Indirect Jobs							
1	34	39	17	16	25	21	152
2	34	40	36	38	39	43	230
2-1	0	1	20	22	14	21	78
Induced Jobs							
1	19	20	12	11	14	13	89
2	19	21	21	23	24	25	133
2-1	0	1	9	11	10	12	43
Total Wind Jobs							
1	71	78	41	40	54	49	333
2	71	82	79	85	89	95	501
2-1	0	4	38	45	35	47	169

Although an annual analysis is shown, the employment impacts of a PTC expiration will vary by month, beginning immediately and increasing throughout 2012. The effects are already evident in the upstream segments of the value chain as developers scale back activities.

Wind power's geographically diverse manufacturing base spreads employment impacts around the country.

Cumulative (2011 to 2016) Employment Impact of 4 Year PTC Extension [Job-Years]^{1,2}

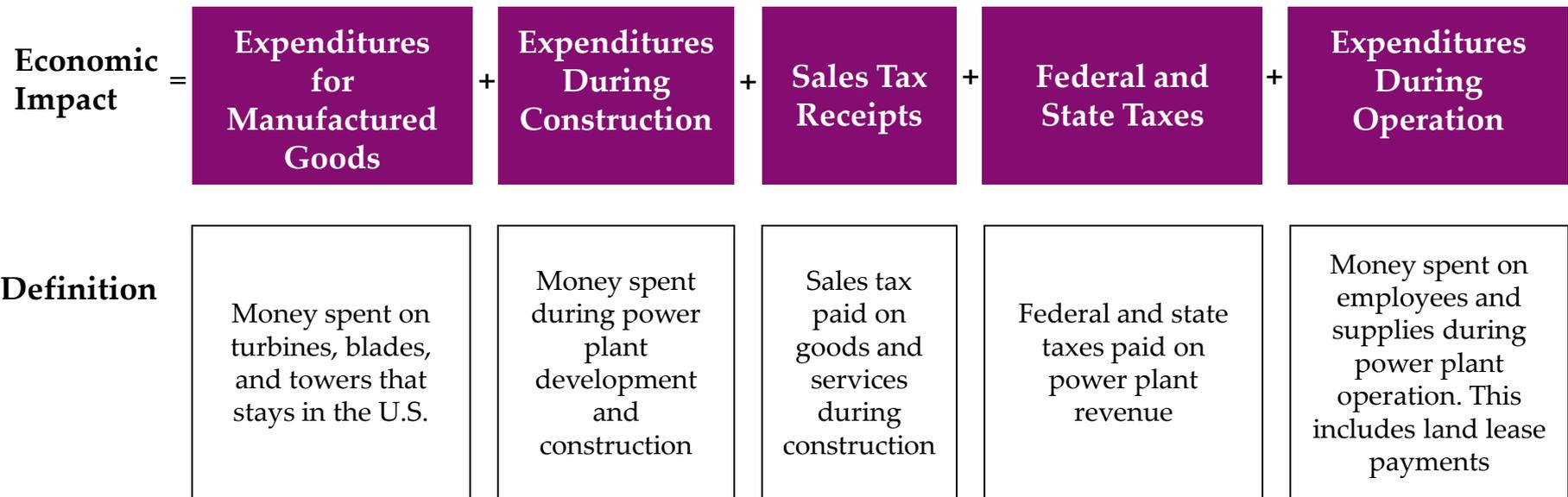


Notes:

1. Employment impacts include direct, indirect, and induced jobs.
2. Plot shows the incremental cumulative increase in employment with a 4 year PTC extension relative to no extension.

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Navigant analyzed the full economic impact of manufacturing, constructing, and operating wind power plants.



The amount of manufacturing done in the U.S., and the resulting revenue, varies by scenario.

$$\text{Economic Impact} = \text{Expenditures for Manufactured Goods} + \text{Expenditures During Construction} + \text{Sales Tax Receipts} + \text{Federal and State Taxes} + \text{Expenditures During Operation}$$

» Navigant calculated the impact of money spent on turbines, blades and towers.

» Given that not all turbines, blades, and towers are installed in the U.S., Navigant assessed current and future domestic content under each scenario.

- Navigant used manufacturer interviews and its internal market knowledge to estimate current and future domestic content.
- Without an extension of the PTC, some manufacturers would close, and the remaining need would likely be filled by products manufactured outside of the U.S.
- With a 4 year extension providing a stable project pipeline, some international manufacturers might move operations to the U.S., thus increasing domestic content.
- Navigant's assumptions are shown below.

	Domestic Content Assumptions					
	Turbines		Blades		Tower	
	2011	2016	2011	2016	2011	2016
Scenario 1	50%	50%	55%	50%	65%	55%
Scenario 2	50%	61%	55%	63%	65%	71%

» In each year of analysis, Navigant took the amount spent on each component* and multiplied it by the domestic assumption to arrive at the impact.

» Navigant then used investment multipliers from IMPLAN to calculate indirect and induced impacts.

*Notes: Navigant assumed turbines are ~45% of installed cost, blades are 11% and towers 12%.

Navigant used NREL's JEDI model to estimate the expenditures during construction and operation.

$$\text{Economic Impact} = \text{Expenditures for Manufactured Goods} + \text{Expenditures During Construction} + \text{Sales Tax Receipts} + \text{Federal and State Taxes} + \text{Expenditures During Operation}$$

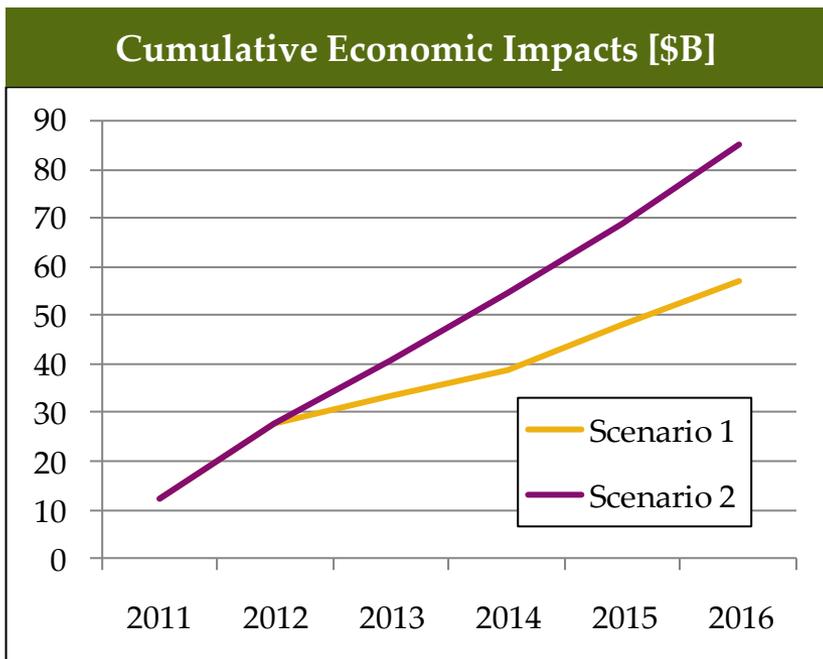
- » In addition to calculating employment impacts, the JEDI model tracks expenditures during construction and operation.
 - Navigant used the same % local assumptions as for the employment analysis.
 - JEDI uses IMPLAN multipliers to calculate the indirect and induced impact during construction and during the subsequent 25 years of operation.
- » JEDI also captures the local benefits of land lease payments and property taxes during operation.
 - For property taxes, Navigant used a simplifying assumption of 1% of assessed value. In reality, property taxes rates and assessment rules vary widely from state to state and county to county, but this is taken as an average value across the U.S.
 - Navigant assumed \$6,000/turbine/year for land lease payments. This is a typical national average paid to land owners.

Navigant calculated the impact of sales tax paid during construction and federal and state taxes during operation.

$$\text{Economic Impact} = \text{Expenditures for Manufactured Goods} + \text{Expenditures During Construction} + \text{Sales Tax Receipts} + \text{Federal and State Taxes} + \text{Expenditures During Operation}$$

- » During construction, the plant developer pays sales tax on goods and services.
 - Navigant collected state level data on sales tax from the Federation of Tax Administrators (www.taxadmin.org)
 - For each year of analysis, Navigant calculated the sales tax returns for installations in that year.
- » During operation, plant owners pay federal and state taxes on the income from power sales.
 - Navigant also used Federation of Tax data on state corporate income tax rates.
 - To calculate income,
 - Navigant used an estimated power sale price based upon the local Levelized Cost of Electricity, which is in turn influenced by local capacity factor and installed cost.
 - The power sale price was multiplied by annual generation, to get revenue.
 - Navigant then assumed income was ~10% of revenue, and applied the taxes to this income.

A 4 year PTC extension would likely spur \$28 billion more in economic activity over the base case.

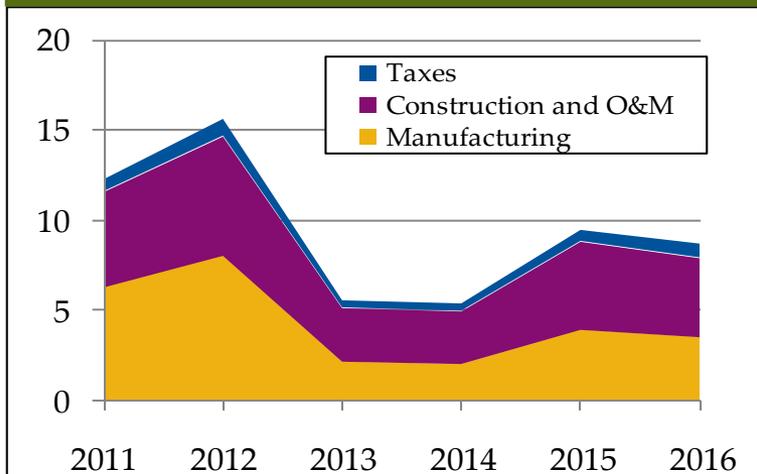


Source: Navigant, December 2011

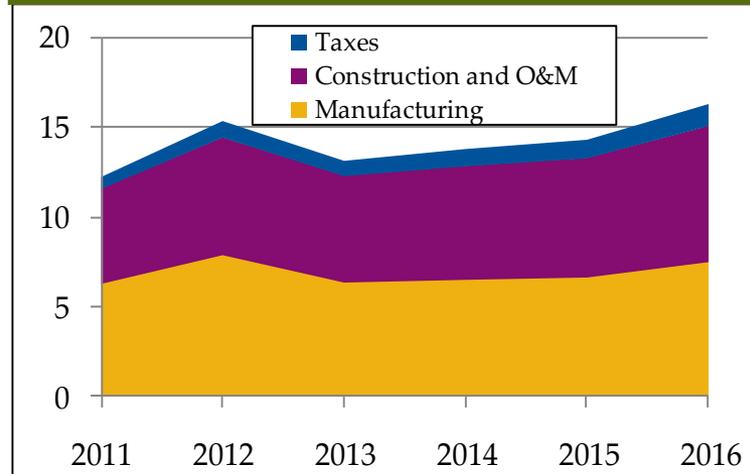
Economic Impact of Wind Power [\$B]							
Scenario	'11	'12	'13	'14	'15	'16	'11-'16
Manufacturing							
1	6.3	8.0	2.1	2.0	3.9	3.5	25.8
2	6.3	7.9	6.3	6.5	6.6	7.5	41.1
2-1	0.0	-0.2	4.2	4.5	2.7	4.0	15.2
Construction and Operation							
1	5.3	6.7	3.0	2.9	4.9	4.4	27.2
2	5.3	6.6	6.0	6.3	6.7	7.6	38.5
2-1	0.0	-0.1	3.0	3.4	1.7	3.2	11.2
Sales, Federal and State Taxes							
1	0.7	0.9	0.4	0.4	0.7	0.8	3.9
2	0.7	0.9	0.8	0.9	1.0	1.2	5.5
2-1	0.0	0.0	0.4	0.6	0.3	0.4	1.7
Total Economic Impact							
1	12.3	15.6	5.5	5.3	9.5	8.7	56.9
2	12.3	15.3	13.1	13.8	14.3	16.3	85.1
2-1	0.0	-0.3	7.6	8.5	4.8	7.6	28.2

Annual U.S. Wind Investment [2011\$ in billions]

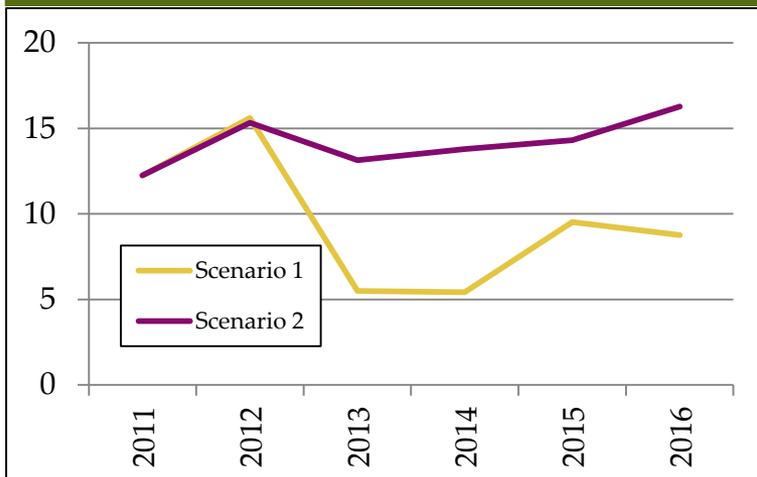
Scenario 1



Scenario 2



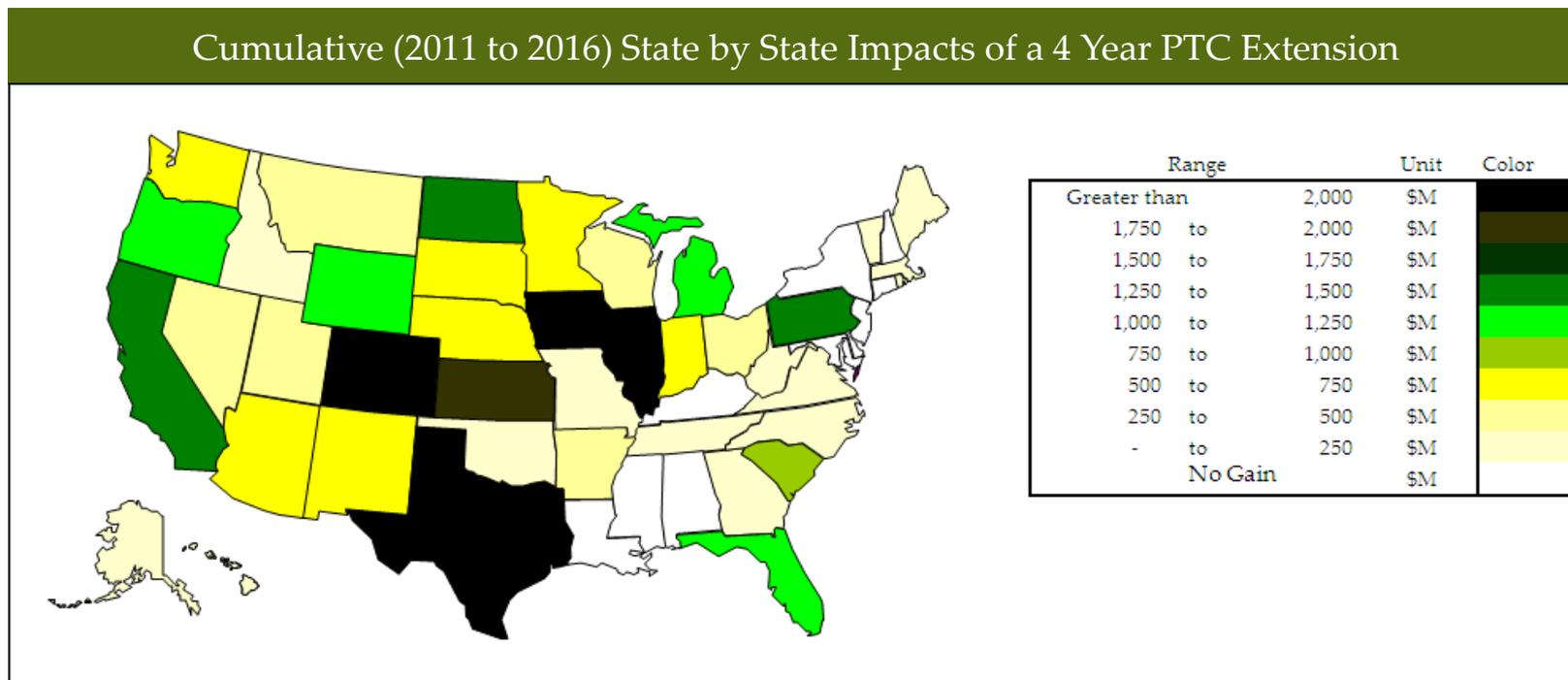
Comparison



Source: Navigant, December 2011

- Investment in the U.S. wind market has averaged \$15-20 billion/year since 2008
- Investment will continue at roughly these levels with a 4-year PTC extension
- Investment will be reduced to roughly half of historical levels without a PTC extension

States with a combination of wind component manufacturing and strong wind resources would benefit from the most investment.



Notes:

1. Investment impacts include direct, indirect, and induced investment.
2. Plot shows the incremental cumulative increase in investment with a 4 year PTC extension relative to no extension.

A four year PTC extension could result in a 87% return on investment for U.S. taxpayers.

Return on 4 Year PTC Extension

- Extending the PTC 4 years can be viewed as an investment by U.S. taxpayers.
 - The investment is tax credits over the life of wind plants
 - The returns are both in the form of taxes on revenue and the investment spurred by manufacturing, construction and operation of the plants.
- Navigant calculated return of investment of a 4 year extension using the following inputs:
 - Investment: tax credits for wind plants installed from 2013 to 2016.
 - Returns: manufacturing investment, expenditures during construction, land lease payments over the life of the plants out to 2021, operating expenditures and federal and state taxes on income from power sales.
- The PTC extension would cost ~\$13.6B*, but result in ~\$25.6B in investment and tax revenue.
 - Return on investment = $(\text{sum of benefits})/(\text{sum of costs})-1 = \$25.6\text{B}/\$13.6\text{B}-1 = 87\%$
- This calculation excludes indirect and induced investment.

* Estimated revenue affects of the revenue provisions contained in S.1220, 'The Fulfilling U.S. Energy Leadership (Fuel) Act of 2011', fiscal years 2012-2021, as scored by the Joint Committee on Taxation. The Act includes a 4-year extension of the PTC for wind, hydro, biomass, and geothermal, so \$13.6 billion slightly overstates the cost of an extension for wind only.

1	Executive Summary
2	Wind MW Forecast
3	Wind Jobs Forecast
4	Economic Impact
5	Environmental Impact

Navigant assessed the amount of pollutants offset by wind plants built as a result of a 4 year PTC extension.

Methodology

- Navigant assessed the impact of wind plants offsetting the following pollutants:
 - CO₂
 - SO₂
 - NO_x
- Navigant used its MW projections and typical state level wind capacity factors to calculate annual wind generation on a state by state bases.
- Generation was then multiplied by typical state level emissions factors, to arrive at total offset emissions.

Navigant used electricity generation and emissions data from the U.S. EIA to calculate state-specific emission factors for CO₂, SO₂, and NO_x.

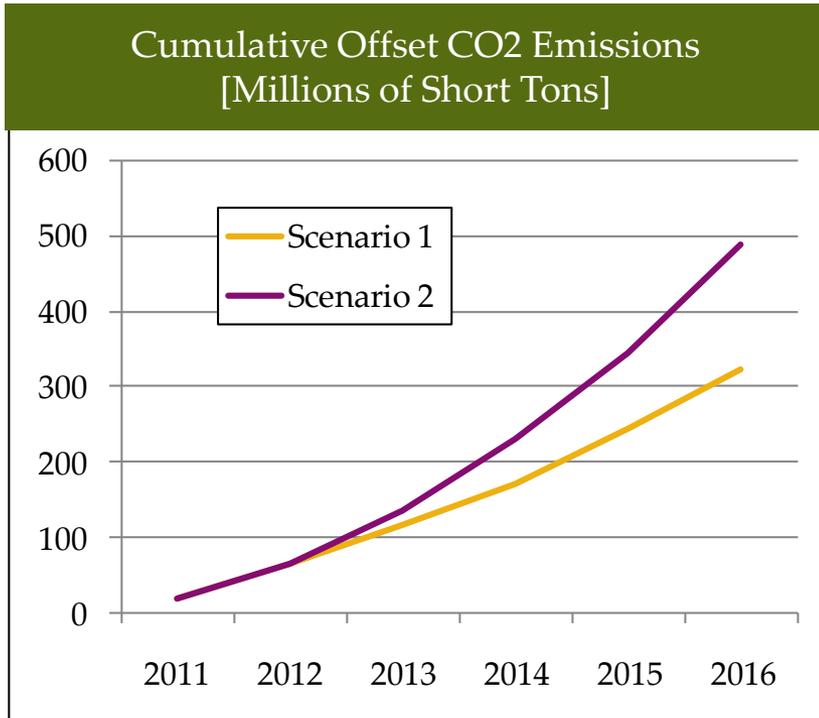
Emissions Assumptions*

- Data source:
 - Net electricity generation and emissions estimates are reported by each state to the Energy Information Administration. 2009 data is the most recently available.
 - Data is disaggregated by each state, fuel source, and type of generator (e.g., utility, independent power producer).
 - Navigant calculations exclude combined heat and power systems that are not owned by utilities or IPPs. Such distributed generation resources are unlikely to curtail generation due to added wind capacity.
- Navigant based emission factors on natural gas-fueled generators only.
 - Marginal wind capacity additions will likely replace intermediate natural gas generation, not coal-fired baseload or renewable energy.
 - Hawaii's emission factors are based on petroleum-fueled generation (the majority of its electrical capacity). Hawaii has no natural gas generators.
- Navigant applied state-specific emission factors to the forecast wind capacity additions to estimate emissions offsets under each of the three scenarios.

* Note: these projections are based on high level estimates of emission factors for gas-fired power plants and not a detailed production simulation modeling analysis.

Source: U.S. Energy Information Administration, 2011. Available at: http://www.eia.gov/cneaf/electricity/epa/epa_sprdshts.html.

Extending the PTC 4 years could result in displacement of CO₂ emitting generating units over the period of study.



Source: Navigant, December 2011

Note: these projections are based on high level estimates of emission factors for gas-fired power plants and not a detailed production simulation modeling analysis.

Emissions Offset by Wind Plants							
Scenario	'11	'12	'13	'14	'15	'16	'11-'16
CO ₂ [Millions of Short Tons]							
1	17	47	51	56	72	79	320
2	17	47	72	94	116	143	490
2 - 1	0	0	20	38	44	64	170
SO ₂ [Short Tons]							
1	113	244	263	281	316	351	1,570
2	113	244	673	735	798	872	3,440
2 - 1	0	0	409	454	482	521	1,870
NO _x [Thousands of Short Tons]							
1	15	34	38	42	47	53	230
2	15	34	45	60	77	94	330
2 - 1	0	0	7	18	29	41	100

Conclusions

» With no PTC extension, the U.S. wind market will shrink significantly in 2013.

- Annual installations will be 2-4 GW beginning in 2013, down from >8 GW in 2012.
- Total wind supported jobs will drop by nearly half, from 78,000 in 2012 to 41,000 in 2013.
- Total wind investment will drop by nearly two-thirds, from \$15.6 billion in 2012 to \$5.5 billion in 2013.

» With a 4 year PTC extension, the U.S. wind market will grow through 2016.

- Annual installations will be 8-10 GW through 2016.
- Total wind supported jobs will grow to 95,000 by 2016.
- Total wind investment will grow to \$16.3 billion in 2016.

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Wind power manufacturing and installation requires a wide variety of skill sets and educational backgrounds.

Manufacturing Jobs

» Manufacturing

- Factory worker
- Technician
- Metal working
- Material handler
- Factory supervisor
- Quality assurance
- Manufacturing engineer
- Manufacturing manager

» Design

- Mechanical engineer
- Electrical engineer

» Administrative and support

- Director
- Purchasing agent
- Health and safety officer
- Accountant
- Administrative assistant
- Information technology professional

Installation Jobs

» Installation

- General contractor
- Shift supervisor
- Foreman
- Heavy construction

» Design

- Mechanical engineer
- Civil engineer
- Electrical engineer

» Administrative and support

- Health and safety officer
- Accountant
- Administrative assistant
- Information technology professional

Key Definitions

FTE: Full time equivalent. Equals employment of one person for a year, or multiple people contributing enough hours to equal one person being employed for a year.

Job-Years: One job-year is equal to 1,960 hours (40 hours per week, 49 weeks per year). This can be one person employed for 1,960 hours, two people for 980 hours each, etc.

Direct Impacts: Represent the initial change in final demand for the industry sector in question. Direct impacts describe the changes in economic activity for sectors that first experience a change in demand because of a project, policy decision, or some other stimuli.

Indirect Impacts: Represent the response as supplying industries increase output in order to accommodate the initial change in final demand. These indirect beneficiaries will then spend money for supplies and services, which results in another round of indirect spending.

Induced Impacts: Generated by the spending of households who benefit from the additional wages and business income they earn through all of the direct and indirect activity. The increase in income, in effect, increases the purchasing power of households.