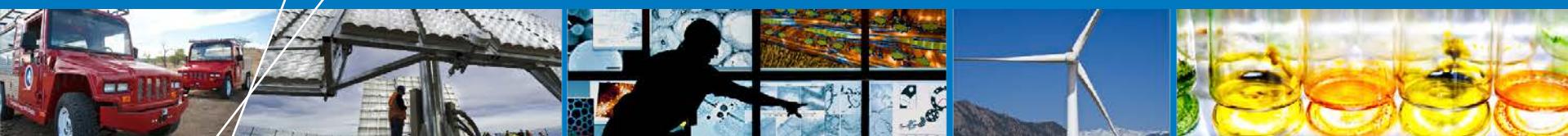


Jobs and Economic Development Impacts from Small Wind: JEDI Model in the Works



WINDPOWER 2012

Suzanne Tegen

June 4, 2012

NREL/PR-6A20-55166

Overview

- NREL's role in economic impact analysis for wind power
- Jobs and Economic Development Impacts (JEDI) models
- JEDI results
- Small wind JEDI specifics
- What we need from you to finish our model.

www.nrel.gov/analysis/jedi

NREL's Economic Impact Analysis for Wind

- **JEDI models**
 - NREL strives to keep JEDI model multipliers updated and consistent. Models, user guides, and reports are peer reviewed, tested, and validated by industry.
- **NREL's roles**
 - Gather cost, employment, tax, & other data
 - Verify with developers, owners, counties
 - Develop & test model
 - Facilitate peer review
 - Issue user guide
 - Publish (www.nrel.gov/analysis/jedi)
 - Manage and maintain models.
- **Other NREL economic impacts analyses**
 - Workforce development
 - National skills assessment
 - Manufacturing and supply chain
 - Analysis (including federal, state, and regional policy and employment)
 - National discussion on renewable energy employment.



Photo by Warren Gretz, NREL/PIX 09636

JEDI Model Availability

- **Current JEDI models**
 - Utility-scale wind
 - Natural gas (combined cycle)
 - Coal (pulverized coal)
 - Marine and hydrokinetic
 - Concentrating solar power
 - Dry mill corn ethanol
 - Lignocellulosic ethanol
 - Photovoltaic.
- **JEDI models under development**
 - Small wind, offshore wind
 - Hydropower (conventional)
 - Natural gas (combined cycle)
 - Transmission
 - Geothermal
 - Biopower
 - Petroleum.



Photo from Sally Wright, Renewable Energy Research Lab - Umass, NREL/PIX15160

JEDI Model Approach

Based on project-specific or default inputs (derived from industry norms), JEDI estimates the number of jobs and economic impacts that could reasonably be supported by a power generation project.

JEDI estimates *gross not net* jobs. For example, JEDI estimates the number of in-state construction jobs from a new wind farm.

Jobs, earnings, and output are distributed across three categories:

- Project Development and Onsite Labor Impacts
- Local Revenue, Turbine, and Supply Chain Impacts
- Induced Impacts.

JEDI model defaults are based on interviews with industry experts and project developers. Economic multipliers within the model are derived from Minnesota IMPLAN Group (Bureau of Economic Analysis, Bureau of Labor Statistics, etc).

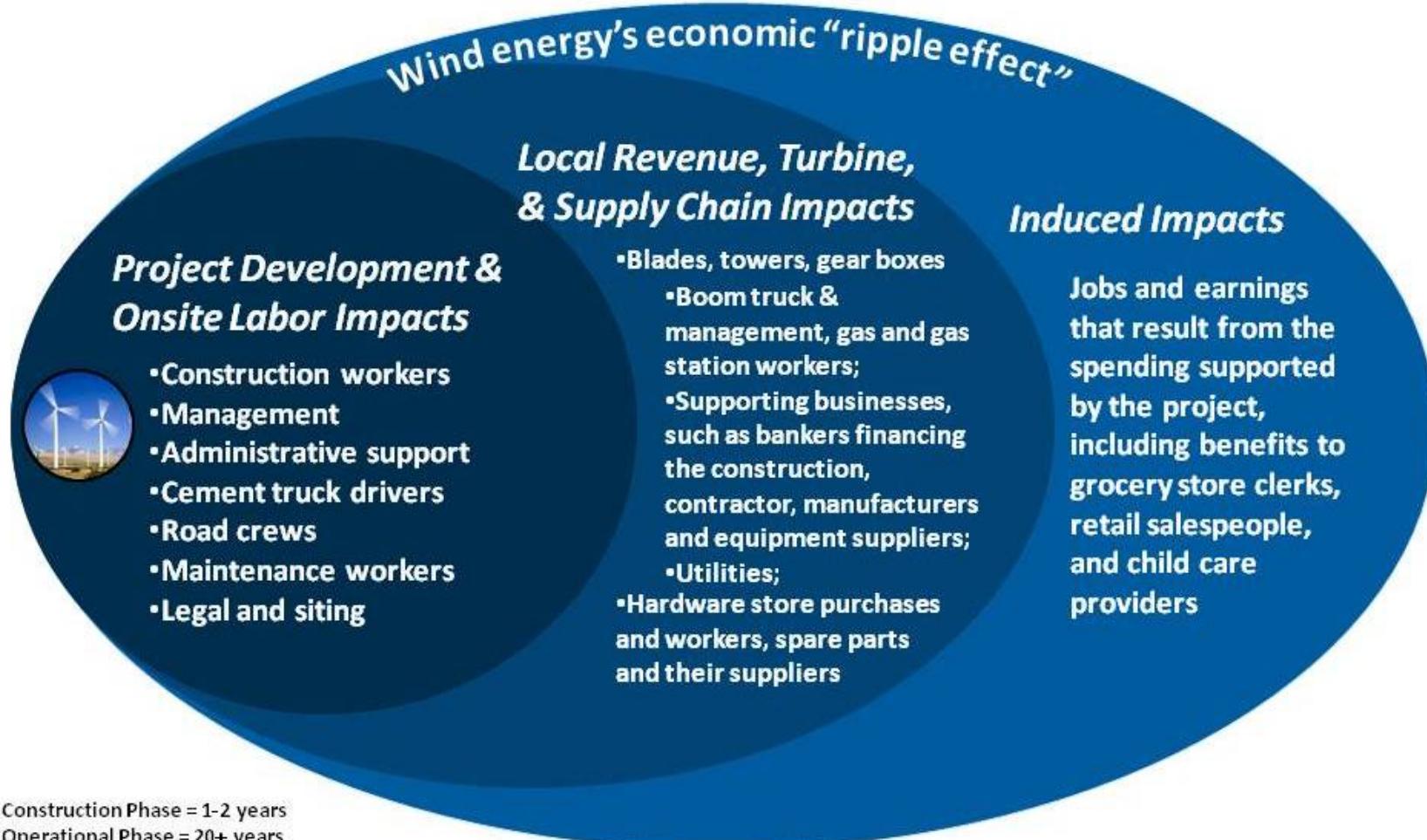


Photo from Jessica Raker, NREL/PIX 14676

Jobs & Economic Impacts from the JEDI Model

Wind Energy's Economic Impact (Large Wind)

JEDI Model Version W1.09.03e



Project Development & Onsite Labor

- **Sample job types**

- Truck driving
- Crane operation, hoisting, rigging
- Earth moving
- Pouring cement
- Management, support
- Siting.



Photo from Stephanie Lively, Boise State University, NREL/PIX 16147



Photo by Northern Power Systems, NREL/PIX 13853



Local Revenues, Turbine, & Supply Chain



Photo by NREL, NREL/PIX 11074



Photo from iStock/5676592



Photo from Clarence Council, NREL/PIX 09091

- Steel mill jobs, parts, services
- Equipment manufacturing & sales
- Blade & tower manufacturers
- Property taxes: financing, banking, accounting.



Photo from iStock/4088468

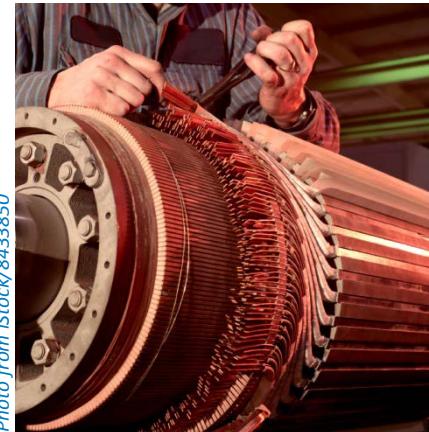


Photo from iStock/8433850



Photo from iStock/7792082



Photo from iStock/8384987

Induced Impacts



Photo from iStock/9774681



Photo from iStock/8783332



Photo from iStock/4363756

Money spent in the local area on goods and services from increased revenue: *sandwich shops, child care, grocery stores, clothing, other retail, public transit, new cars, restaurants, medical services*



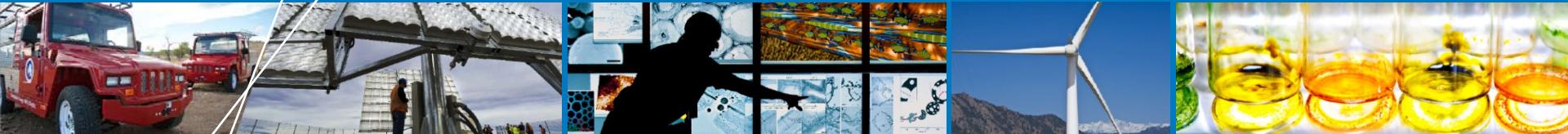
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Photo from iStock/8007815



Photo from iStock/8913075



Using the JEDI Model

Downloading the JEDI Model

The screenshot shows the homepage of the National Renewable Energy Laboratory's (NREL) Jobs & Economic Development Impact Models (JEDI) website. The header features the NREL logo and the tagline "Innovation for Our Energy Future". The main navigation menu includes links for "ABOUT NREL", "SCIENCE & TECHNOLOGY", "TECHNOLOGY TRANSFER", "APPLYING TECHNOLOGIES", and "LEARNING ABOUT RENEWABLES". A secondary navigation bar below the main menu includes "Energy Analysis", "Jobs & Economic Development Impact Models" (which is highlighted in a brown box), and "More Search Options / Site Map". The central content area is titled "About JEDI" and describes the JEDI models as user-friendly tools for estimating economic impacts. It mentions their initial development for wind power and subsequent expansion to other energy sources like solar, biofuels, coal, and natural gas. Below this, a section titled "Contact" provides an email address for questions. To the right, there is a "JEDI Fact Sheet" PDF document (444 KB) which includes images of wind turbines and a power plant.

National Renewable Energy Laboratory
Innovation for Our Energy Future

ABOUT NREL **SCIENCE & TECHNOLOGY** **TECHNOLOGY TRANSFER** **APPLYING TECHNOLOGIES** **LEARNING ABOUT RENEWABLES**

Energy Analysis **Jobs & Economic Development Impact Models** More Search Options **Search** Site Map

About JEDI

The Jobs and Economic Development Impact (JEDI) models are user-friendly tools that estimate the economic impacts of constructing and operating power generation and biofuel plants at the local and state levels. First developed by NREL's [Wind Powering America](#) program to model wind energy impacts, JEDI has been expanded to analyze concentrating solar power, biofuels, coal and natural gas power plants.

On this site, you can [download](#) the models for free, learn more about how JEDI [works](#), understand the [output](#), and get [answers](#) to questions about using the model.

Contact

For questions regarding the JEDI models or model updates, please contact: JEDIsupport@nrel.gov

JEDI Fact Sheet

(PDF 444 KB)
[Download Acrobat Reader](#)

www.nrel.gov/analysis/jedi/

The JEDI Model on Your Screen

	A	B	C	D	E	F
1	Small Wind Project Data					
2						
3	INSTRUCTIONS: Begin by entering Project Location (from pull-down list) and other System Descriptive Data.					
4	After inserting required data press enter (or cursor to the next cell) to continue.					
5	Once Descriptive Data is complete, enter "Y" or "N" on Line 27 to continue.					
6	Enter "Y" to accept System Cost and Local Share defaults or "N" to review/modify values.					
7	To utilize new values in analysis choose "N" in "Utilize Project Cost Data default values analysis?" - Line 27.					
8	Additional information is available by pointing to the red triangles located in cell corners and in the FAQ tab.					
9	Only those cells with a white background can be changed (accept new values).					
10						
11						
12	Project Descriptive Data					
13	Project Location					
14	ARIZONA					
15	Project Sector					
16	Residential					
17	Year of Construction					
18	2012					
19	Construction Period (months)					
20	Turbine Size - DC Nameplate Capacity (KW)					
21	10.0					
22	Number of Turbines Installed					
23	2.4					
24	Total Project Size - DC Nameplate Capacity (KW)					
25	10.0					
26	Tower Height (feet)					
27	50.0					
28	100.0					
29	Other					
30	Choose Tower Height from dropdown list					
31	Tower Type					
32	Monopole					
33	Choose Tower Type from dropdown list					
34	System Cost (\$/KW)					
35	\$6,240					
36	Annual Operations and Maintenance Cost (\$/KW)					
37	2012					
38	Money Value (Dollar Year)					
39						
40						
41	Utilize Project Cost Data default values in analysis? Choose					
42	"Y" to accept default values below or "N" to over-ride					
43	default values and utilize new user defined values as					
44	entered below. See FAQ for related topics.					
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25	10.0					
	Choose Tower Height from dropdown list					
	Tower Height (feet)					
	Choose Tower Type from dropdown list					
	Tower Type					
	Monopole					
	\$6,240					
	System Cost (\$/KW)					
	\$6,240					
	Annual Operations and Maintenance Cost (\$/KW)					
	2012					
	Money Value (Dollar Year)					
	The models contain state multipliers, but county or regional multipliers					
	can be acquired and input into the model to carry out analysis on entities					
	other than states					
	Press 'Go To Summary Impacts' Button					
	Go To Summary Impacts					

Detailed User Inputs

Project Cost Data - Default Values

	Cost	Cost Per kW	Percent of Total Cost	Purchased Locally (%)	Manufactured Locally (%)
Construction Costs					
Site Preparation and Erection Materials					
Foundation Materials (concrete, rebar, etc.)	\$7,176,000	\$240	3.8%	100%	50%
Electrical (wire, conduit, etc.)	\$4,485,000	\$150	2.4%	0%	0%
Tower wiring kit	\$0	\$0	0.0%	0%	0%
Materials Subtotal	\$11,661,000	\$390	6.1%		
Labor					
Trenching and Pipe Installation	\$4,784,000	\$160	2.5%	100%	
Foundation, Erection, and Electrical	\$26,999,700	\$903	14.2%	100%	
Labor Subtotal	\$31,783,700	\$1,063	16.7%		
Construction Subtotal	\$43,444,700	\$1,453	22.8%		
Equipment Costs					
Turbine	\$94,962,400	\$3,176	49.8%	0%	0%
Tower	\$22,724,000	\$760	11.9%	0%	0%
Special Tooling (bolts, wrenches)	\$0	\$0	0.0%	75%	0%
Equipment Subtotal	\$117,686,400	\$3,936	61.7%		
Other Balance of System Costs					
Bird Flight Diverters	\$0	\$0	0.0%	0%	0%
Tower Raising Kit	\$0	\$0	0.0%	0%	0%
Batteries, Controllers and Misc. Electrical	\$0	\$0	0.0%	0%	0%
Buildings/Sheds/Fencing	\$5,382,000	\$180	2.8%	100%	
Shipping Freight	\$5,980,000	\$200	3.1%	0%	
Professional Services	\$7,176,000	\$240	3.8%	0%	
Site Permits/Fees	\$239,200	\$8	0.1%	100%	
Other Subtotal	\$18,777,200	\$628	9.8%		
Subtotal	\$179,908,300	\$6,017	94.3%		
Sales Tax	\$10,845,717	\$363	5.7%	100%	
Total	\$190,754,017	\$6,380	100.0%		

Detailed User Inputs

Project Cost Data - Default Values

Construction Costs

Site Preparation and Erection Materials

Foundation Materials (concrete, rebar, etc.)

Cost	Cost Per kW	Percent of Total Cost	Purchased Locally (%)	Manufactured Locally (%)
------	-------------	-----------------------	-----------------------	--------------------------

\$7,176,000

\$240

3.8%

100%

50%

Electrical (wire, conduit, etc.)

\$4,485,000

\$150

2.4%

0%

0%

Tower wiring kit

\$0

\$0

0.0%

0%

0%

Materials Subtotal

\$11,661,000

\$390

6.1%

Labor

Trenching and Pipe Installation

\$4,784,000

\$160

2.5%

100%

Foundation, Erection, and Electrical

\$26,999,700

\$903

14.2%

100%

Labor Subtotal

16.7%

22.8%

Construction Subtotal

Equipment Costs

Turbine

49.8%

0%

0%

Tower

11.9%

0%

0%

Special Tooling (bolts, wrenches)

0.0%

75%

0%

Equipment Subtotal

61.7%

Other Balance of System Costs

Bird Flight Diverters

0.0%

0%

0%

Tower Raising Kit

0.0%

0%

0%

Batteries, Controllers and Misc. Electrical

0.0%

0%

0%

Buildings/Sheds/Fencing

2.8%

100%

Shipping Freight

3.1%

0%

Professional Services

3.8%

0%

Site Permits/Fees

0.1%

100%

Other Subtotal

9.8%

Subtotal

94.3%

Sales Tax

5.7%

100%

Total

100.0%

Line item cost inputs are shown here. In addition to **construction** cost inputs, default values are provided for **operating and maintenance** and **financial** parameters or the users can enter their own project-specific data.

\$5,900,000

\$200

\$240

\$6,017

\$363

\$6,380

\$10,845,717

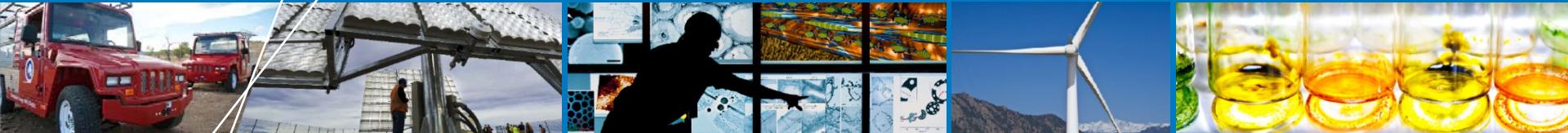
\$190,754,017

JEDI Model Caveats

- Not a precise forecast but an estimate of overall economic impacts
- Inputs need your context!
- Project size
- Gross jobs vs. net jobs
- Local sourcing levels have significant impact
- Full-time equivalent (FTE) jobs.

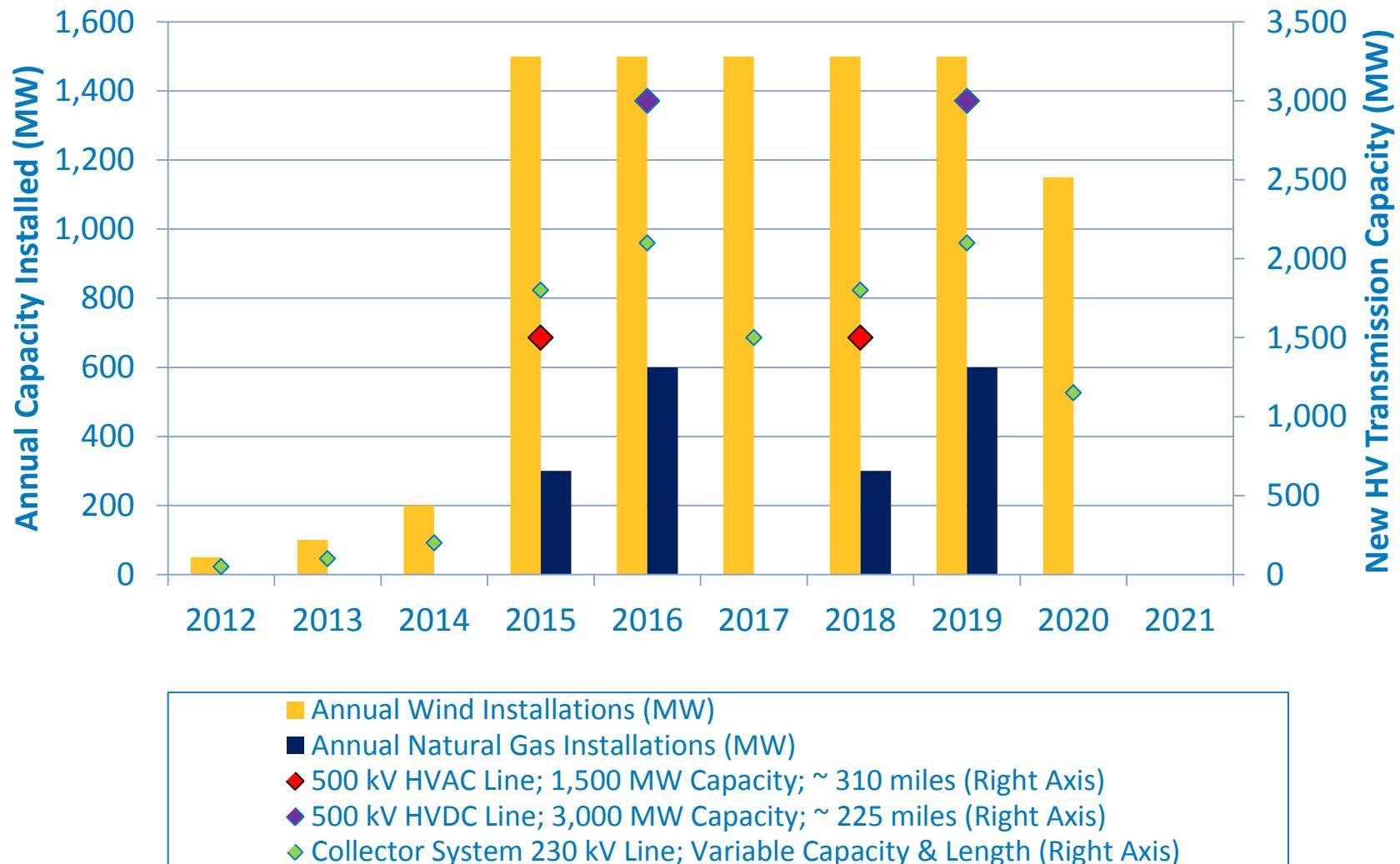


Photo from First Wind, NREL/PIX 16738



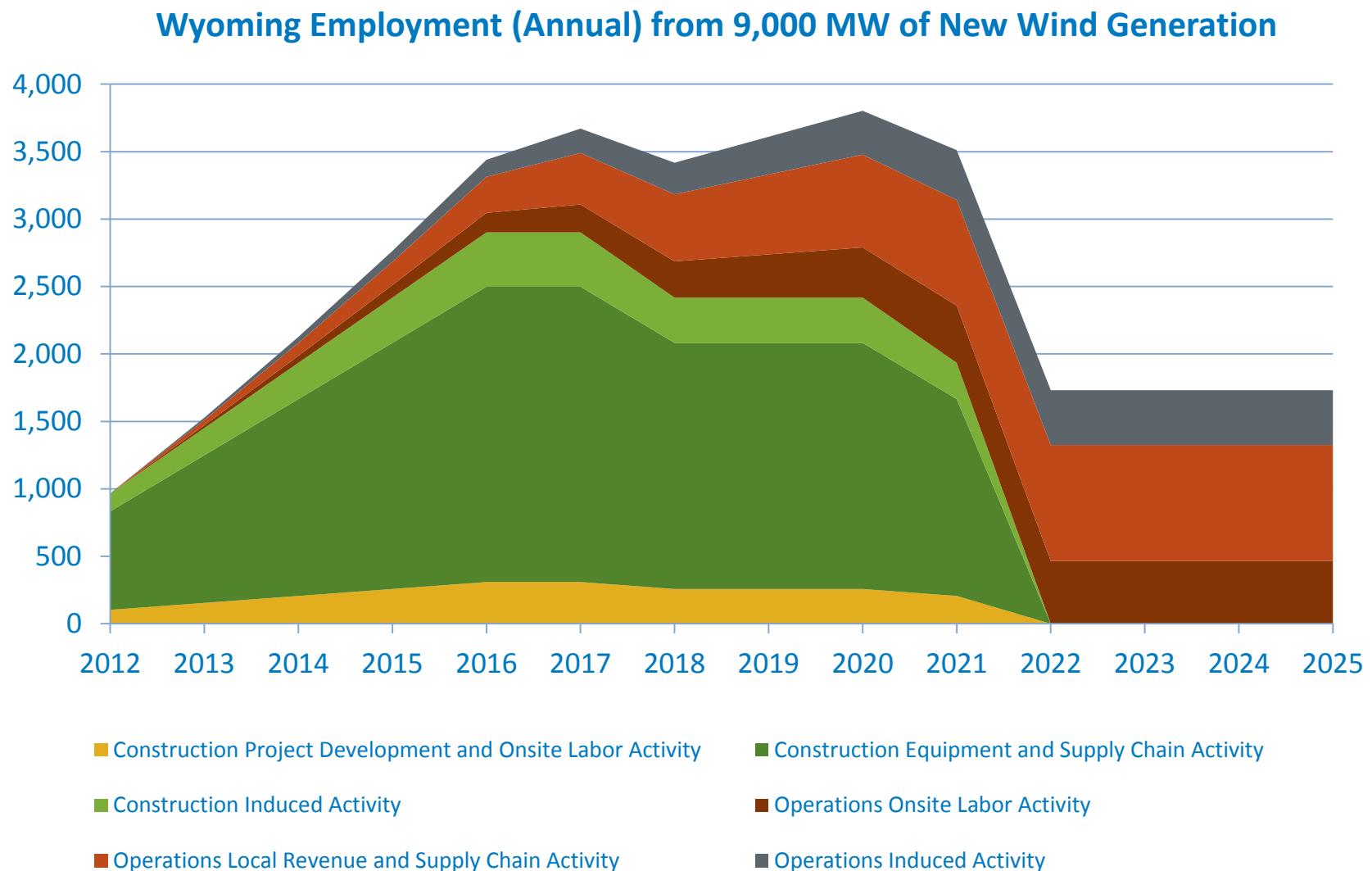
NREL's JEDI Results

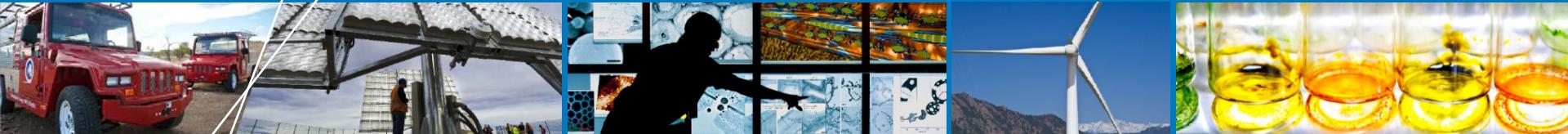
Sample JEDI Results: Wyoming Infrastructure Authority: Deployment (2012 – 2021)



Source: Lantz and Tegen, 2011.

Wyoming: Base Case for New Wind over Time





Small Wind JEDI Specifics

Small Wind JEDI Model

- Four turbine size categories:
 - 0+ kW – 2.4 kW
 - 2.5 kW – 10 kW
 - 10.1 kW – 50 kW
 - 50.1 kW – 100 kW.
- Costs vary by size, and users should add project-specific information.
- Supply chain and manufacturing jobs and impacts vary by size and by state (depending on multipliers).
- All default inputs and assumptions come from recent projects and industry interviews.
- NREL is requesting more data on current projects to help populate and validate the Small Wind JEDI model.

Preliminary Small Wind Inputs and Outputs

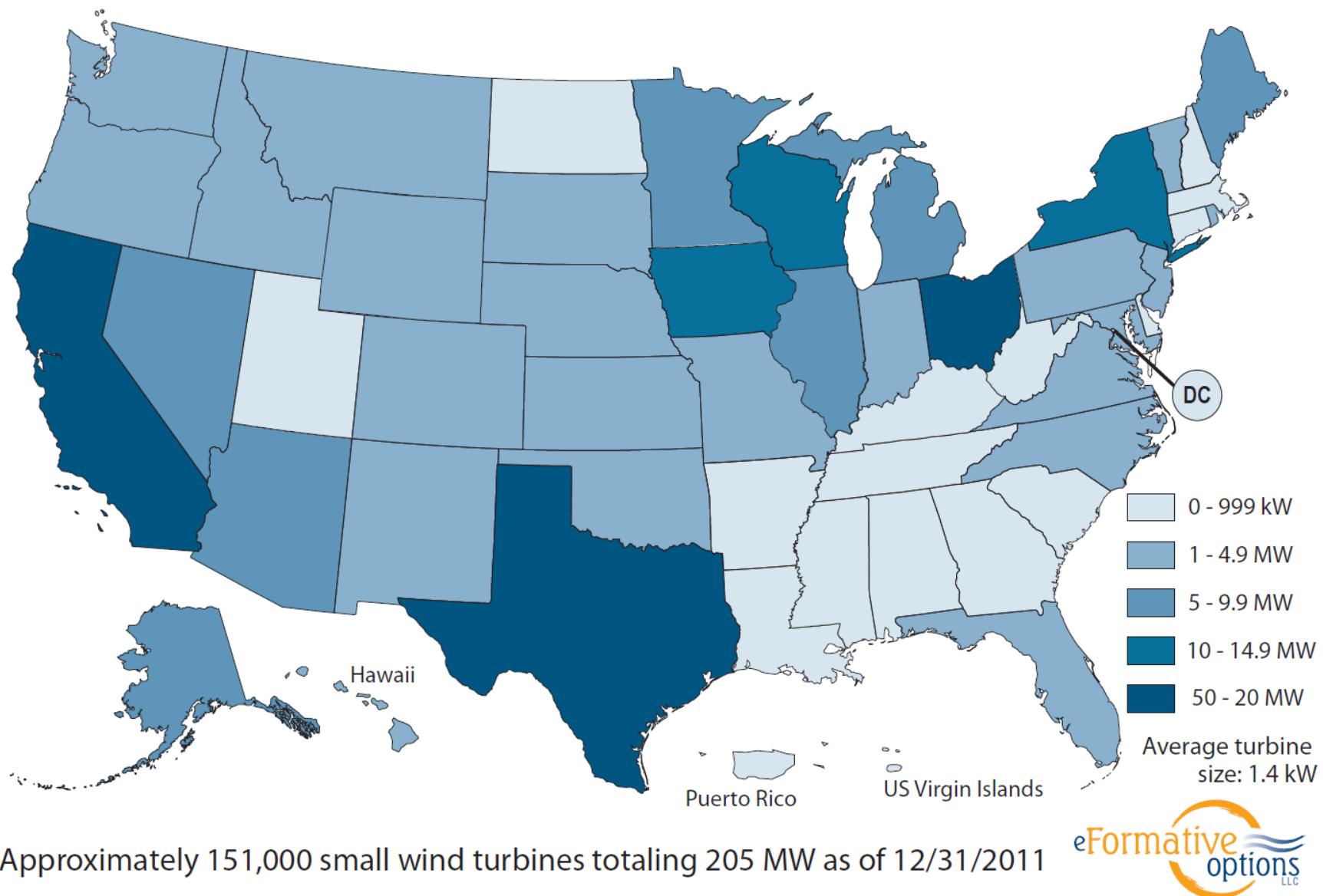
	Up to 2.4 kW	2.5 -10 kW	10.1 – 50 kW	50.1 – 100 kW
Installed Capital Cost	\$6000 - \$6400/kW	\$6000 - \$6300/kW	~\$6,000/kW	\$5000 - \$5400/kW
Operations & Maintenance	Need data	~\$10/kW	~\$50/kW	\$20-\$25/kW

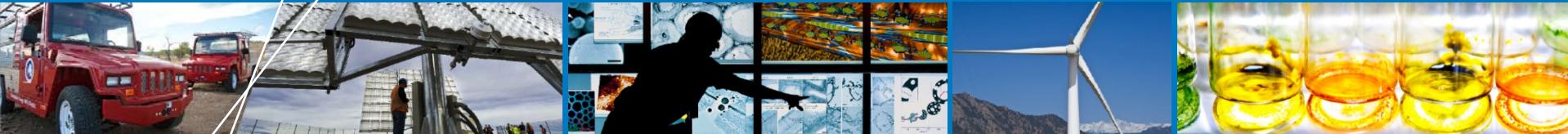
Preliminary model runs indicate small wind supports more jobs per MW than large/utility-scale wind. These JEDI model results are based on the preliminary model and will change as the model is updated.

	Large-Scale FTE	Small Wind FTE
Construction	60-70 jobs/100 MW	Up to 550 jobs/100 MW
Operations	6-7 jobs/100 MW	~ 8-25 jobs/100 MW

2011 Year End Small Wind Turbine Capacity

Turbines up to 100 kW Cumulative Installations and Sales





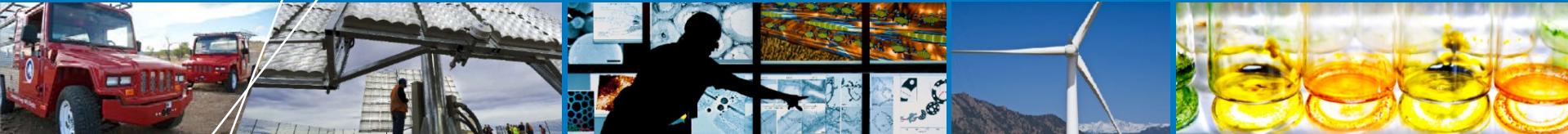
**Your Input Is Needed: Improve the
Small Wind JEDI Model**

Please Contact Me with Comments

- **Data on turbines between <1 - 100 kW**
 - Siting/development cost and labor
 - Site preparation cost and labor
 - Capital cost and labor
 - Installation cost and labor
 - Operations and maintenance cost and labor.
- **Cost and labor ranges may be provided instead of a dollar amount.**
- **We will not release company or project-specific data.**



Photo by Frank Oteri, NREL/PIX 18440



Thank you
Suzanne .Tegen@nrel.gov

This work was supported by the U.S. Department of Energy under Contract No. DE-AC36-08-GO28308 with the National Renewable Energy Laboratory.