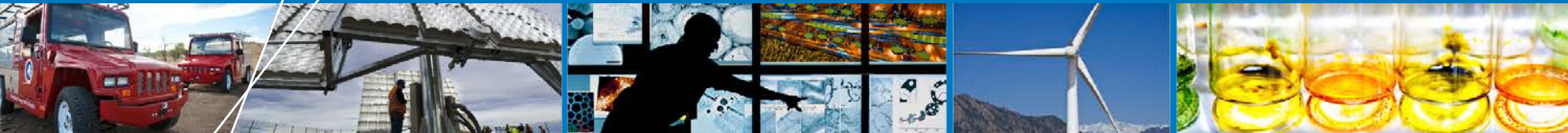


# Jobs and Economic Development Impacts from Small Wind: JEDI Model in the Works



**WINDPOWER 2012**

**Suzanne Tegen**

**June 4, 2012**

**NREL/PR-6A20-55166**

# Overview

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- 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](http://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](http://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).

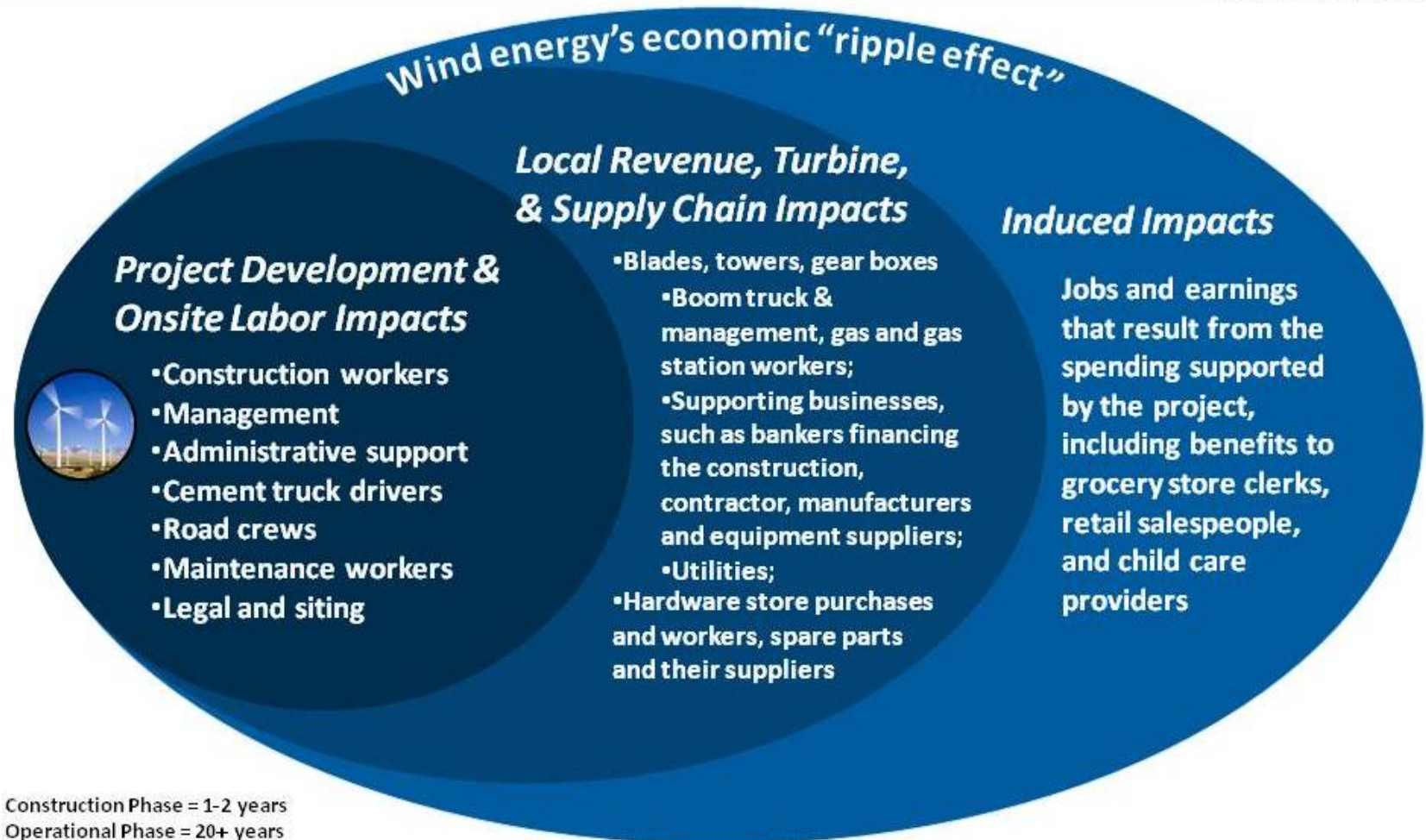


Photo from Jessica Raker, NREL/PIX 14676

# 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 Cross Island Farms, NREL/PIX 19923



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



Photo from istock 947687



Photo by David Parsons, NREL/PIX 05572

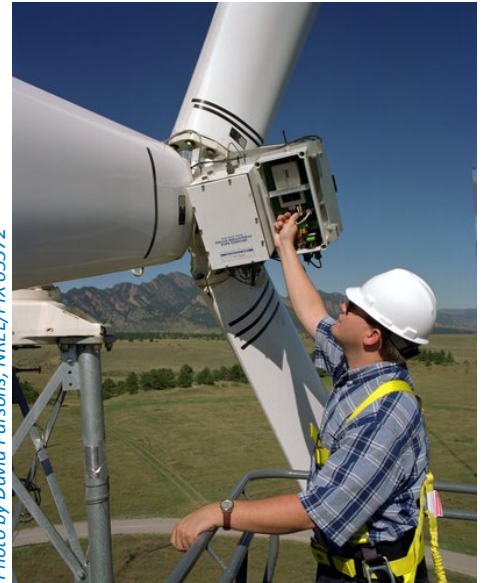


Photo from Northern Power Systems, NREL/PIX 13853



# 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



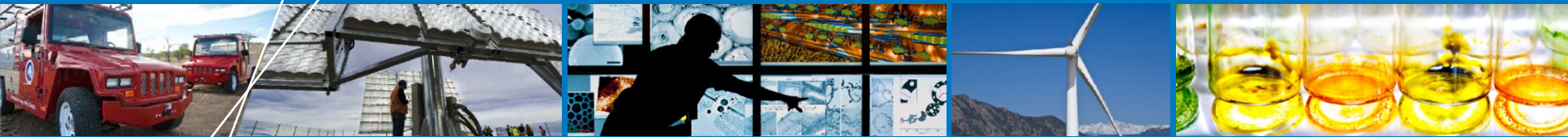
Photo from iStock/8384987

# Induced Impacts



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*





# Using the JEDI Model

# Downloading the JEDI Model

conomic Developm...

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**Jobs & Economic Development Impact Models**

About JEDI

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Interpreting Results

Advanced Users

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Help

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](mailto:JEDIsupport@nrel.gov)

**JEDI Fact Sheet**



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

[www.nrel.gov/analysis/jedi/](http://www.nrel.gov/analysis/jedi/)

# The JEDI Model on Your Screen

|    | A                                                                                                                       | B           | C | D | E | F |
|----|-------------------------------------------------------------------------------------------------------------------------|-------------|---|---|---|---|
| 1  | <b>Small Wind Project Data</b>                                                                                          |             |   |   |   |   |
| 2  |                                                                                                                         |             |   |   |   |   |
| 3  | <b>INSTRUCTIONS:</b> 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 <i>FAQ</i> tab. |             |   |   |   |   |
| 9  | Only those cells with a white background can be changed (accept new values).                                            |             |   |   |   |   |
| 10 |                                                                                                                         |             |   |   |   |   |
| 11 |                                                                                                                         |             |   |   |   |   |
| 12 | <b>Project Descriptive Data</b>                                                                                         |             |   |   |   |   |
| 13 | Project Location                                                                                                        | ARIZONA     |   |   |   |   |
| 14 |                                                                                                                         |             |   |   |   |   |
| 15 | Project Sector                                                                                                          | Residential |   |   |   |   |
| 16 | Year of Construction                                                                                                    | 2012        |   |   |   |   |
| 17 | Construction Period (months)                                                                                            |             |   |   |   |   |
| 18 | Turbine Size - DC Nameplate Capacity (KW)                                                                               | 10.0        |   |   |   |   |
| 19 | Number of Turbines Installed                                                                                            |             |   |   |   |   |
| 20 | Total Project Size - DC Nameplate Capacity (KW)                                                                         |             |   |   |   |   |
| 21 | Tower Height (feet)                                                                                                     |             |   |   |   |   |
| 22 | Tower Type                                                                                                              | monopole    |   |   |   |   |
| 23 | System Cost (\$/KW)                                                                                                     | \$6,240     |   |   |   |   |
| 24 | Annual Operations and Maintenance Cost (\$/KW)                                                                          |             |   |   |   |   |
| 25 | Money Value (Dollar Year)                                                                                               | 2012        |   |   |   |   |
| 26 |                                                                                                                         |             |   |   |   |   |
| 27 | Utilize Project Cost Data default values in analysis? Choose                                                            | Y           |   |   |   |   |
| 28 | "Y" to accept default values below or "N" to over-ride                                                                  |             |   |   |   |   |
| 29 | default values and utilize new user defined values as                                                                   |             |   |   |   |   |
| 30 | entered below. See FAQ for related topics.                                                                              |             |   |   |   |   |

10.0

2.4

50.0

100.0

Other

Choose Tower Height from dropdown list

Choose Tower Type from dropdown list

**Press 'Go To Summary Impacts' Button**

Go To Summary Impacts

About JEDI Start **ProjectData** SummaryResults User Add-in Location FAQ

# The JEDI Model on Your Screen

|    | A                                                                                                                       | B           | C | D | E | F |
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| 10 |                                                                                                                         |             |   |   |   |   |
| 11 |                                                                                                                         |             |   |   |   |   |
| 12 | <b>Project Descriptive Data</b>                                                                                         |             |   |   |   |   |
| 13 | Project Location                                                                                                        | ARIZONA     |   |   |   |   |
| 14 |                                                                                                                         |             |   |   |   |   |
| 15 | Project Sector                                                                                                          | Residential |   |   |   |   |
| 16 | Year of Construction                                                                                                    | 2012        |   |   |   |   |
| 17 | Construction Period (months)                                                                                            |             |   |   |   |   |
| 18 | Turbine Size - DC Nameplate Capacity (KW)                                                                               | 10.0        |   |   |   |   |
| 19 | Number of Turbines Installed                                                                                            |             |   |   |   |   |
| 20 | Total Project Size - DC Nameplate Capacity (KW)                                                                         |             |   |   |   |   |
| 21 | Tower Height (feet)                                                                                                     |             |   |   |   |   |
| 22 | Tower Type                                                                                                              | monopole    |   |   |   |   |
| 23 | System Cost (\$/KW)                                                                                                     | \$6,240     |   |   |   |   |
| 24 | Annual Operations and Maintenance Cost (\$/KW)                                                                          |             |   |   |   |   |
| 25 | Money Value (Dollar Year)                                                                                               | 2012        |   |   |   |   |

Choose Tower Height from dropdown list

Choose Tower Type from dropdown list

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

About JEDI / Start / **ProjectData** / SummaryResults / User Add-in Location / FAQ

# Detailed User Inputs

## Project Cost Data - Default Values

| Construction Costs                             | Cost                 | Cost Per kW    | Percent of Total Cost | Purchased Locally (%) | Manufactured Locally (%) |
|------------------------------------------------|----------------------|----------------|-----------------------|-----------------------|--------------------------|
| <b>Site Preparation and Erection Materials</b> |                      |                |                       |                       |                          |
| 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%                       |
| <b>Materials Subtotal</b>                      | <b>\$11,661,000</b>  | <b>\$390</b>   | <b>6.1%</b>           |                       |                          |
| <b>Labor</b>                                   |                      |                |                       |                       |                          |
| Trenching and Pipe Installation                | \$4,784,000          | \$160          | 2.5%                  | 100%                  |                          |
| Foundation, Erection, and Electrical           | \$26,999,700         | \$903          | 14.2%                 | 100%                  |                          |
| <b>Labor Subtotal</b>                          | <b>\$31,783,700</b>  | <b>\$1,063</b> | <b>16.7%</b>          |                       |                          |
| <b>Construction Subtotal</b>                   | <b>\$43,444,700</b>  | <b>\$1,453</b> | <b>22.8%</b>          |                       |                          |
| <b>Equipment Costs</b>                         |                      |                |                       |                       |                          |
| 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%                       |
| <b>Equipment Subtotal</b>                      | <b>\$117,686,400</b> | <b>\$3,936</b> | <b>61.7%</b>          |                       |                          |
| <b>Other Balance of System Costs</b>           |                      |                |                       |                       |                          |
| 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%                  |                          |
| <b>Other Subtotal</b>                          | <b>\$18,777,200</b>  | <b>\$628</b>   | <b>9.8%</b>           |                       |                          |
| <b>Subtotal</b>                                | <b>\$179,908,300</b> | <b>\$6,017</b> | <b>94.3%</b>          |                       |                          |
| <b>Sales Tax</b>                               | <b>\$10,845,717</b>  | <b>\$363</b>   | <b>5.7%</b>           | <b>100%</b>           |                          |
| <b>Total</b>                                   | <b>\$190,754,017</b> | <b>\$6,380</b> | <b>100.0%</b>         |                       |                          |

# Detailed User Inputs

## Project Cost Data - Default Values

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| Tower wiring kit                               | \$0           | \$0         | 0.0%                  | 0%                    | 0%                       |
| Materials Subtotal                             | \$11,661,000  | \$390       | 6.1%                  |                       |                          |
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| Labor Subtotal                                 |               |             | 16.7%                 |                       |                          |
| Construction Subtotal                          |               |             | 22.8%                 |                       |                          |
| <b>Equipment Costs</b>                         |               |             |                       |                       |                          |
| Turbine                                        |               |             | 49.8%                 | 0%                    | 0%                       |
| Tower                                          |               |             | 11.9%                 | 0%                    | 0%                       |
| Special Tooling (bolts, wrenches)              |               |             | 0.0%                  | 75%                   | 0%                       |
| Equipment Subtotal                             |               |             | 61.7%                 |                       |                          |
| <b>Other Balance of System Costs</b>           |               |             |                       |                       |                          |
| 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%                  |                          |
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| 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%                |                       |                          |

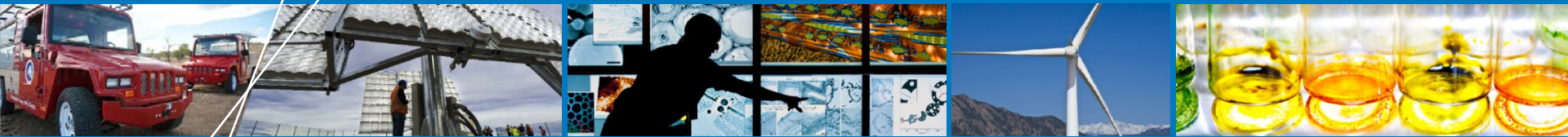
Line item cost inputs are shown here. In addition to **construction** cost inputs, default values are provided for **operating and maintenance** and **financial** parameters or the users can enter their own project-specific data.

# 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.

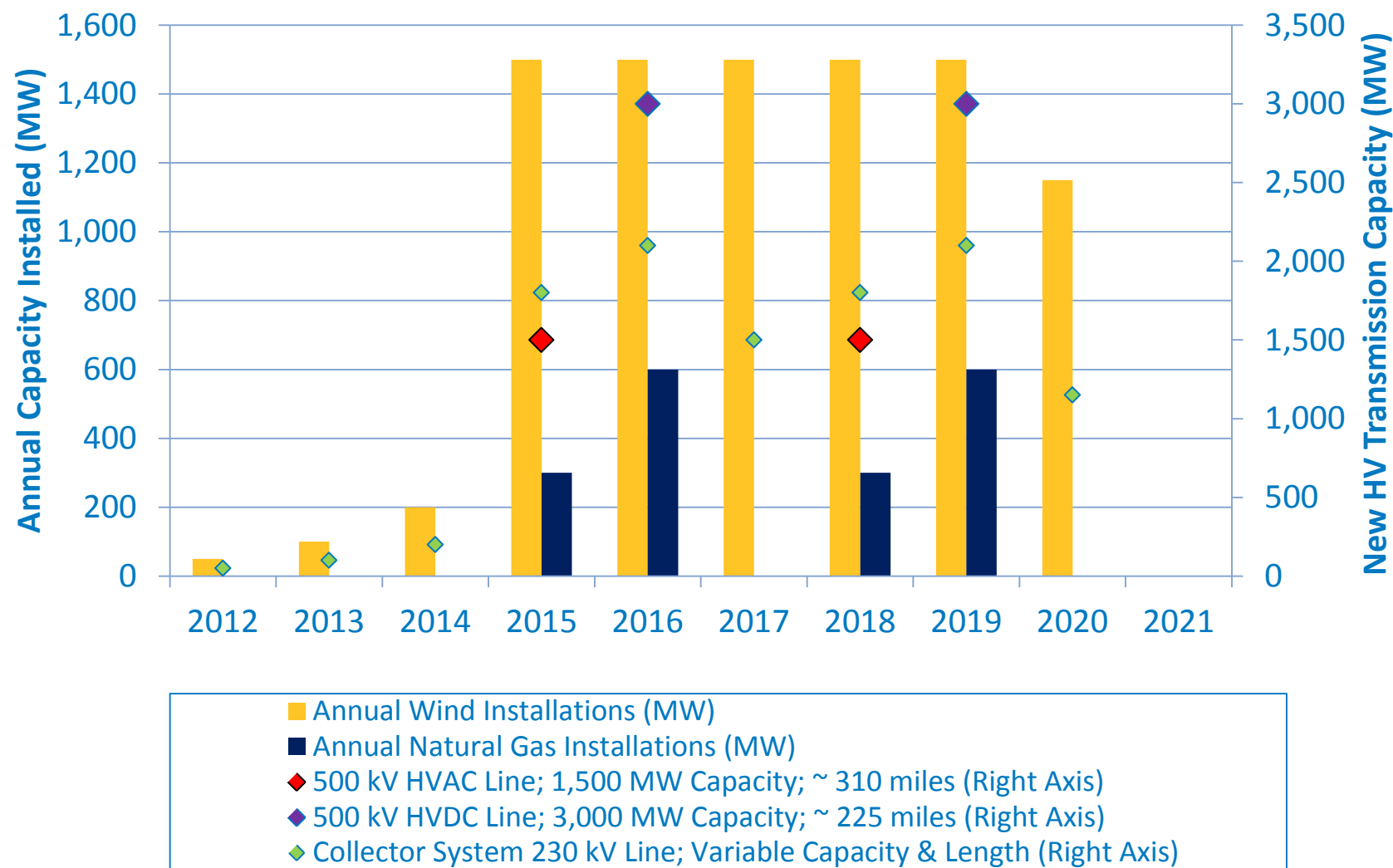


*Photo from First Wind, NREL/PIX 16738*



# NREL's JEDI Results

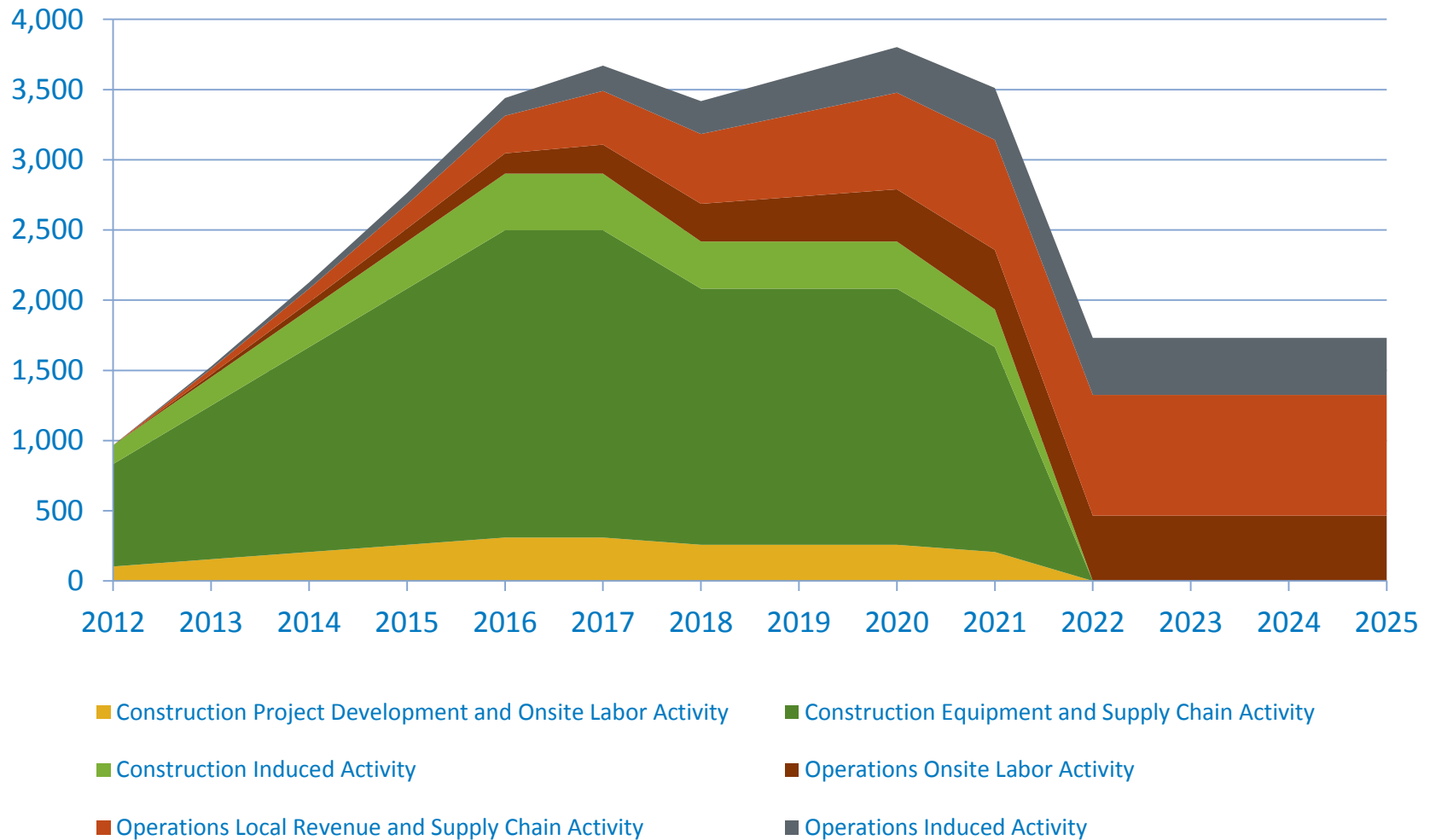
# Sample JEDI Results: Wyoming Infrastructure Authority: Deployment (2012 – 2021)

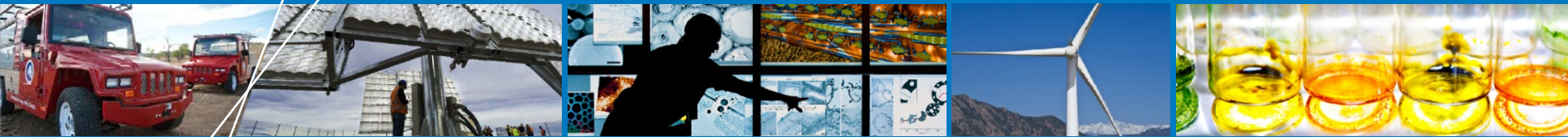


Source: Lantz and Tegen, 2011.

# Wyoming: Base Case for New Wind over Time

Wyoming Employment (Annual) from 9,000 MW of New Wind Generation





# 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

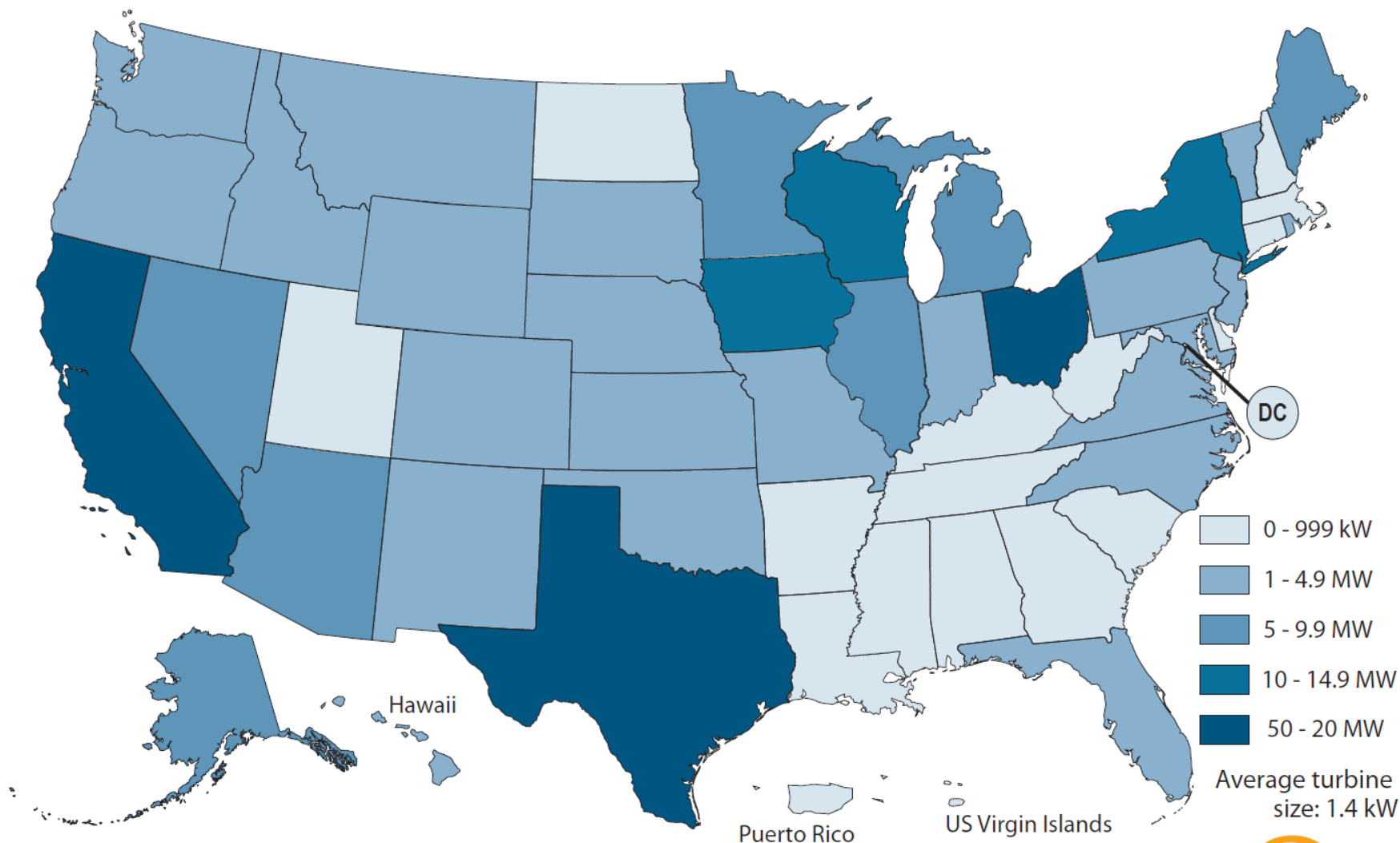
|                          | Up to 2.4 kW       | 2.5 -10 kW         | 10.1 – 50 kW | 50.1 – 100 kW      |
|--------------------------|--------------------|--------------------|--------------|--------------------|
| Installed Capital Cost   | \$6000 - \$6400/kW | \$6000 - \$6300/kW | ~\$6,000/kW  | \$5000 - \$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    |

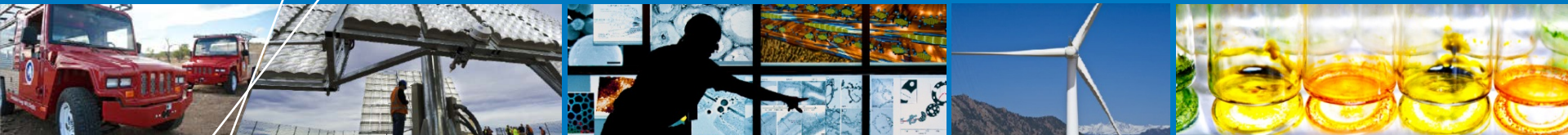
# 2011 Year End Small Wind Turbine Capacity

Turbines up to 100 kW Cumulative Installations and Sales



Approximately 151,000 small wind turbines totaling 205 MW as of 12/31/2011





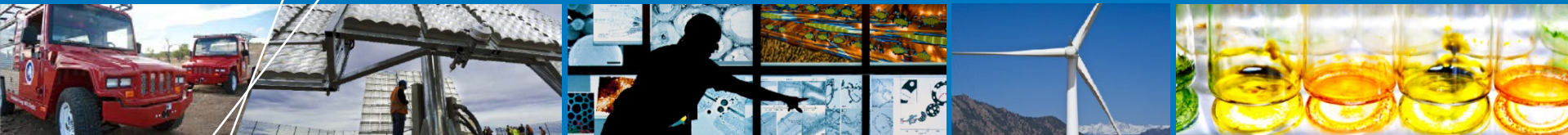
# Your Input Is Needed: Improve the Small Wind JEDI Model

# 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.