Wind Energy Workforce Development & Jobs

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DOE/NREL Wind Energy Workforce Efforts

- WINDEXchange
- Wind for Schools
- DOE Collegiate Wind Competition
- North American Wind Energy Academy
- NREL student internships
- Wind Career Map
- Research and reports.

COLLEGIATE WIND COMPETITION
U.S. DEPARTMENT OF ENERGY

Design and build a wind turbine
Deliver a market-based business plan
Test turbine performance

The Collegiate Wind Competition engages tomorrow’s wind industry workforce to tackle pressing wind technology and deployment challenges.

wind.energy.gov/windcompetition
One Segment of Jobs in the 2012 Wind Industry

Subset of the Workforce Captured in Our Survey
(~46,000 Workers)

- Wind Technicians: 25%
- Engineers: 18%
- Trade Workers and Specialists: 12%
- Construction Laborers: 9%
- Admin/Clerical: 7%
- Management: 7%
- Accounting/Finance: 7%
- Scientists: 3%
- Education & Training: 3%
- Assembly Workers: 3%
- Development Management: 3%
- Supply Chain Management: 3%
- Salespeople: 3%
- Transportation/Logistics: 3%
- Resource Assessment/Surveying: 3%
- Legal: 3%
- Government regulatory workers: 3%

Manufacturing jobs include some from the following categories: trade workers, assembly workers, supply chain management, salespeople, transportation, and some admin/clerical—approximately 25%.
Jobs Estimations are based on Leventhal and Tegen 2012 report, AWEA jobs data, and DOE *Wind Vision* scenarios for 2030 (380,000 total jobs) and 2050 (600,000 total jobs). Jobs are estimated based on percentages, which causes similar jobs numbers in different categories.

<table>
<thead>
<tr>
<th>Job</th>
<th>2015</th>
<th>2030</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind Energy Technician</td>
<td>21,250</td>
<td>95,000</td>
<td>150,000</td>
</tr>
<tr>
<td>Engineer</td>
<td>15,300</td>
<td>68,400</td>
<td>108,000</td>
</tr>
<tr>
<td>Trade Worker</td>
<td>10,200</td>
<td>45,600</td>
<td>72,000</td>
</tr>
<tr>
<td>Construction Labor</td>
<td>7,650</td>
<td>34,200</td>
<td>54,000</td>
</tr>
<tr>
<td>Admin/Clerical</td>
<td>5,950</td>
<td>26,600</td>
<td>42,000</td>
</tr>
<tr>
<td>Management</td>
<td>5,950</td>
<td>26,600</td>
<td>42,000</td>
</tr>
<tr>
<td>Accounting/Finance</td>
<td>2,550</td>
<td>11,400</td>
<td>18,000</td>
</tr>
<tr>
<td>Scientist</td>
<td>2,550</td>
<td>11,400</td>
<td>18,000</td>
</tr>
<tr>
<td>Education/Training</td>
<td>2,550</td>
<td>11,400</td>
<td>18,000</td>
</tr>
<tr>
<td>Assembly Worker</td>
<td>2,550</td>
<td>11,400</td>
<td>18,000</td>
</tr>
<tr>
<td>Development Management</td>
<td>2,550</td>
<td>11,400</td>
<td>18,000</td>
</tr>
<tr>
<td>Supply Chain Management</td>
<td>1,700</td>
<td>7,600</td>
<td>12,000</td>
</tr>
<tr>
<td>Salesperson</td>
<td>1,700</td>
<td>7,600</td>
<td>12,000</td>
</tr>
<tr>
<td>Transportation/Logistics</td>
<td>1,700</td>
<td>7,600</td>
<td>12,000</td>
</tr>
<tr>
<td>Resource Assessment/Surveyor</td>
<td>850</td>
<td>3,800</td>
<td>6,000</td>
</tr>
<tr>
<td>Legal Professionals</td>
<td>850</td>
<td>3,800</td>
<td>6,000</td>
</tr>
</tbody>
</table>
This wind career map explores an expanding universe of wind energy occupations, describing diverse jobs across the industry, charting possible progression between them, and identifying the high-quality training necessary to do them well.

Wind Jobs

Mouse over the career map at the left to explore wind industry related jobs in Project Development; Component Manufacturing; Construction; Operations; and Education, Training, & Research. Or select a multi-sector career route below.

Selected Cross-Sector Routes

- Technician >> Training Manager

FAQ
This wind career map explores an expanding universe of wind energy occupations, describing diverse jobs across the industry, charting possible progression between them, and identifying the high-quality training necessary to do them well.

**Logistician**

**Job Description:** Logisticians analyze and coordinate an organization's supply chain—the system that moves a product from supplier to consumer. They manage the entire life cycle of a product, which includes how a product is acquired, distributed, allocated, and delivered.

**Career transitions are related to experience and education.** Although an associate's degree may be sufficient for some logistician jobs, a bachelor's degree is typically required for most positions. Industry certification and work experience in a related field can be helpful for jobseekers.

**Routes To Advancement:**

- **Buyer** - This advance typically
No cost, input-output tool to estimate gross employment and economic impacts that result from new power generation

JEDI default inputs are from developers and industry experts, based on existing projects.

User input can be minimal with defaults or be very detailed for more precise results.
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

www.nrel.gov/analysis/jedi
Which Technologies Have JEDI Models?

- Land-based wind
- Distributed wind
- Offshore wind
- Natural gas (combined cycle)
- Coal (pulverized coal)
- Marine and hydrokinetic
- Concentrating solar power
- Dry mill corn ethanol
- Lignocellulosic ethanol
- Solar photovoltaic
- Hydropower
- Transmission
- Geothermal
- Biopower
- Petroleum refining.
Wind Power Sizes & Applications

Small (≤100 kW)
Homes
Farms
Remote applications (e.g., water pumping, telecom sites, ice making)
Distributed power

Photo from Bergey Windpower Co. Inc., NREL 02102

Mid-scale (100–1,000 kW)
Village power
Hybrid systems
Distributed power

Photo from Tjaden Farms, NREL 13764

Large, land-based (1–3 MW)
Utility-scale wind farms
Large distributed power

Photo from Native Energy Inc., NREL 7593

Large, offshore (3–7 MW)
Utility-scale wind farms, shallow coastal waters
One U.S. installation

Photo from HC Sorensen, NREL 17855
Between 2013-2015, 14,300 kW of distributed wind were installed in Nebraska.
Why Economic Impact Modeling?

- People care about jobs!
- Evaluate potential scenarios – current or future
- Inform communities, decision-makers
- Assist businesses
  - Evaluate economic development efforts
- Assist government
  - Representing public interest
  - Planning and evaluating
  - Community development.
Who Uses the JEDI Models?

- Governments
  - Public utility commissions
  - State or governors’ energy offices
  - Many federal agencies, including BLM, Treasury, DOE, USDA
    - National laboratories
- State, county, domestic and international analysts
- Developers and others in industry
- Universities/students
- Consultants
- Stakeholders
- Economic development groups
- Consumer advocates.
Sample job types

- Truck driving
- Crane operation, hoisting, rigging
- Earth moving
- Pouring cement
- Management, support
- Siting.
Local Revenues, Turbine, Module, & Supply Chain Impacts

- Steel mill jobs, parts, services
- Equipment manufacturing and sales
- Blade and tower manufacturers
- Property taxes, financing, banking, accounting.
Induced Impacts

Money spent in the local area on goods and services from increased revenue, including: *hotels, sandwich shops, grocery stores, clothing, other retail, public transit, cars, restaurants, and medical services.*
## Typical Results from a 100-MW Wind Project

### Onsite Jobs

- **60-80 construction jobs**
- **5-7 operations & maintenance jobs**

### Increased Local Revenues

- **Land lease payments:**
  - 3%-6% of gross project revenue (occasionally higher based on region)

- **Local property tax revenue:**
  - $500,000 - $1+ million per year

### Local Benefits

- Stimulate local industry (concrete, roads, environmental, siting, legal)
- Stimulate local manufacturing in some cases

*Jobs are listed as full-time equivalents*
JEDI Strengths & Weaknesses

• **Strengths**
  
  o Widely accepted
  
  o Utilized and trusted by private companies, international organizations, and government agencies in the United States at the federal, state, and local levels
  
  o Can use available data from many different sources
  
  o Can give detailed sector-specific impact information.

• **Weaknesses**
  
  o Only gross, not net; What about coal mining jobs that could be lost if new natural gas plant comes online?
  
  o Assumes infinite supply of inputs and successful project
  
  o Assumes fixed prices; does not consider changes in electric rates, wages, or taxes.
The Wind Vision Report

Key Findings

- **Wind energy is available nationwide.** The *Wind Vision Report* shows that wind can be a viable source of renewable electricity in all 50 states by 2050.

- **Wind energy supports a strong domestic supply chain.** Wind has the potential to support more than 600,000 jobs in manufacturing, installation, maintenance, and supporting services by 2050.

- **Wind energy is affordable.** As wind generation agreements typically provide 20-year fixed pricing, the electric utility sector is anticipated to be less sensitive to volatility in natural gas and coal fuel prices with more wind. By reducing national vulnerability to price spikes and supply disruptions with long-term pricing, wind is anticipated to save consumers $280 billion by 2050.

- **Wind energy preserves water resources.** By 2050, wind energy can save 260 billion gallons of water—the equivalent to roughly 400,000 Olympic-size swimming pools—that would have been used by the electric power sector.

- **Wind energy deployment increases community revenues.** Local communities will be able to collect additional tax revenue from land lease payments and property taxes, reaching $3.2 billion annually by 2050.

- **Wind energy reduces air pollution.** In 2013, operating wind energy capacity avoided the emission of more than 250,000 metric tons of air pollutants, which include sulfur dioxide, nitric oxide, nitrogen dioxide, and particulate matter. By 2050, wind energy could avoid the emission of 12.3 gigatonnes of greenhouse gases.

http://energy.gov/eere/wind/wind-vision
Wind Vision Scenario Tool

Wind Vision Study Scenario Viewer

Study Selection: Study Baseline
Fuel Selection: Low Central High
Wind Selection: Low Central High
Selected Scenario(s): Study Central

Generation (2040):
Land-based Wind (TWh)

Net Present Values (2013-50, 3% discount):
- Electricity System Costs (billion 2013$)
  - Biomass Fuel: 21
  - Conventional Capital: 245
  - Conventional Fuel: 2,237
  - Conventional O&M: 918
  - Renewable Capital: 663
  - Renewable O&M: 360
  - Storage: 27
  - Transmission - Cumulative: 70

http://en.openei.org/apps/wv_viewer/
## Wind Vision Scenario Benefits, Costs, Impacts

### The Potential of 35% of the Country’s Electricity Coming from Wind Energy by 2050

<table>
<thead>
<tr>
<th>Costs</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>$149 Billion [3%] savings</td>
<td>$108 Billion savings; 22,000 lives saved</td>
</tr>
</tbody>
</table>

### Additional Impacts

<table>
<thead>
<tr>
<th>Energy Diversity</th>
<th>Jobs</th>
<th>Local Revenues</th>
<th>Land Use</th>
<th>Public Acceptance and Wildlife</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity prices 20% less sensitive</td>
<td>- 600,000 gross jobs</td>
<td>$1.0 Billion/year in land leases</td>
<td>1.5% area of contiguous US</td>
<td>Responsible siting; Optimizing coexistence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$3.2 Billion/year in tax payments</td>
<td>Less than 1/3 area occupied by golf courses in US today</td>
<td></td>
</tr>
</tbody>
</table>

The Wind Vision Study Scenario results in modest increases in electricity cost in the near- and mid-term (<1% price increase), but in the long term electricity costs savings of 2% are achieved by 2050.
Jobs from the Wind Vision Scenario

Note: Existing job estimates for 2012 and 2013 utilized American Wind Energy Association data for on-site and supply chain jobs and then the JEDl model to estimate the additional induced jobs.

Figure 3-45. Wind-related gross employment estimates, including on-site, supply chain, and induced jobs: 2012–2050
For more information, please visit our website at www.nrel.gov.

JEDI www.nrel.gov/analysis/jedi
DOE Wind Vision http://energy.gov/eere/wind/wind-vision

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Additional Information
Results presented over two phases:

- **Construction**
  - Result is calculated over construction period, regardless of how long it takes to build the project
  - Example: JEDI reports an impact of 600 jobs. This is an annual average of 300 if it takes 2 years to build the project

- **Operating**
  - Annual, ongoing results
  - Example: JEDI reports 25 jobs. This means that year after year, there will be 25 FTE jobs supporting the project.
JEDI Results Are Reported in Three Categories

• **Jobs (FTEs)**
  - Number of people working the equivalent of 40-hour weeks, 2080 hours/year

• **Earnings**
  - Income from work
  - Includes wages, salaries, employer-provided supplements (retirement, health)

• **Gross output**
  - Measure of total economic activity
  - Revenue plus expenditures on inputs
  - Not the same as GDP
Interpreting Results & Model Limitations

- JEDI results are gross, not net.
- JEDI does not factor in far-reaching impacts from development such as changes in utility rates, greenhouse gas emissions, property values, or public health.
- Input-output models cannot estimate impacts from supply-side changes such as technological improvements, price changes, or changes in taxes/subsidies.
- JEDI doesn’t evaluate a project’s feasibility or profitability.
- NREL is not responsible for how the model is used or applied or how the results are interpreted.
• Build project development and operation scenarios
  o Scenarios contain project parameters, expenditures, and other characteristics.
  o Scenarios can be based on default data, or a model user can supply detailed project information.
• Feed project scenario into an input-output model to estimate impacts
  o We use the IMPLAN model.
  o User has ability to change I-O data to represent different geographies or models such as RIMS II.
Input-Output Models

• Snapshot of the relationships between sectors of an economy at a single point in time:
  o Industries, labor, households, capital, investments, government, imports/exports
• Expenditures in an economy
  o Inputs: goods/services from other industries; payments for labor, capital, taxes, imports
  o Outputs: goods/services to other industries, households, and governments, exports
• Captures feedback within a region; i.e., an increase in demand for electricity might increase demand for locally manufactured turbines, which will further increase demand for electricity.
• Size and cost of the project
  o Higher costs often result in increased impact for construction and O&M
• Size and diversity of the local economy
  o Level of analysis
  o Multiplier effect
• Developer preferences
  o Local share/local purchase coefficient
• Magnitude and allocation of project revenues
  o E.g., community wind.
Various studies have validated the JEDI model outputs. One example: USDA and DOE worked together on an econometric study.

*Economic Development from Wind Power: An Empirical Analysis of Impacts to Counties*

The findings of this work indicate that, on average, there is an approximately $36,000-per-megawatt impact on county-level personal income resulting from wind power installations between 2000 and 2008. For this sample, this translates to a median increase in total personal income of 0.65% for those counties with wind power development (with an increase of 0.1% and 2.6% at the 25\textsuperscript{th} and 75\textsuperscript{th} percentiles, respectively) when compared to initial income levels in 2000.

Total Installed Wind Power Capacity from 2000 to 2008 in the Counties in the 12 State Study Area

Source: Jason Brown (USDA) et al. 2011.
Summary of the JEDI Model

- The JEDI tool provides a user-friendly, free platform to carry out economic impacts analysis for renewable energy projects.
- Acquiring as much project-specific information as possible is critical—the more accurate the inputs, the better the outputs.
- Individual projects vary in key aspects that affect economic development to state and local regions.
  - In extreme cases (i.e., local turbine manufacturing), impacts to a state or local region may be 5 to 10 times different.
- Analyzing jobs and economic impacts is an important task, especially in today’s economic and political climate.
  - It is not, however, the sole metric upon which we can/should evaluate renewable energy projects.
- General questions: jedisupport@nrel.gov