Overview

Purpose:
Educate State and Local Policymakers in analysis and assessment of economic development impacts (EDI) from Renewable Energy Projects

Relevant Questions
• How is EDI measured?
• How does NREL think about EDI?
• What can NREL’s JEDI Suite Offer?

Outline
• Definitions and Background
• Accessing and Using NREL’s JEDI models
• Interpreting Modeling Results
• Highlights and Examples from recent NREL Research
• Explaining variability in results
Measuring Economic Development Impacts

General Input Output Methodology

- Aggregated economic data is used to recreate inter-industry transactions throughout the economy
  - This data demonstrates how spending in one industry affects spending in other industries
- From inter-industry transaction data, industry specific multipliers are derived
- Multipliers are used to measure how changes in demand for goods and services in one industry result in changes in demand for goods and services throughout the economy

Input Output Models

- Tools that apply multiplier relationships to evaluate EDI
- Examples: IMPLAN, RIMS II, REMI, IMSET, JEDI etc.
Defining Economic Development Impacts

1. On-site Labor and Professional services

2. Turbine Production and Supply Chain Impacts

3. Induced Impacts (Household purchases due to injection of income)
On-site Labor and Professional Services

Truck drivers, crane operators

Earth moving, cement pouring

Management and support

Construction
Equipment Production and Supply Chain Impacts

Property taxes

Steel mill jobs, parts, services
Photos: E.C. Levy, Inc, Detroit, MI

Financing, banking, accounting

Component manufacturing and sales
Induced Jobs, Services, Materials

Child care, grocery store, clothing, other retail, public transit, new cars, restaurants, medical services
Challenges to modeling Renewables

Renewables represents a new industry
- Not isolated as an industry in conventional I/O tables

Requires detailed knowledge of project costs and industry specific expenditures
- Equipment, Engineering, Labor, Permitting, O&M, etc.

Enter JEDI
- Provides a project basic project recipe for specific RE technologies
- Applies Industry Specific Multipliers derived from IMPLAN
JEDI Model Availability

Current JEDI Models
• Large Wind (>=Class 4)
• Concentrating Solar Power (CSP)
• Dry Mill Corn Ethanol
• Lignocellulosic Ethanol
• Natural Gas (Combined Cycle)
• Coal (Pulverized Coal)

JEDI Under Development
• Photovoltaics (PV) – Residential New & Retrofit, Small and Large Commercial, Utility Scale
• JEDI Hydro – Conventional & MHK
The Job and Economic Development Impact, or JEDI, models are easy-to-use models that analyze the economic impacts of constructing and operating power generation and biofuel plants at the local and state level. First developed to model wind energy development impacts, JEDI has expanded. We now offer models to analyze the job and economic impacts of biofuel plants and concentrating solar power, coal and natural gas power plants.

On this site, you can learn more about JEDI, download the models for free, and get help.

**Downloading the JEDI Models**

Upon acceptance of a required User Agreement, the JEDI models are available to download. To begin downloading a model, select the model below:

**JEDI Wind Energy Model**
- Wind Model rel. W1.09.03e [Excel 672 KB]

**JEDI Biofuels Model**
- Corn Ethanol Model rel. CE1.09.01 [Excel 670 KB]

**JEDI Solar Model**
- CSP Trough Model rel. CSP1.08.02a [Excel 702 KB]

**JEDI Natural Gas Model**
- NGas Model rel. NG1.08.01 [Excel 604 KB]

**JEDI Coal Model**
- Coal Model rel. C1.08.03 [Excel 605 KB]

http://www.nrel.gov/analysis/jedi/
The JEDI Model

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.

JEDI - WIND
Jobs and Economic Development Impact Model

This demonstration model is designed to estimate the statewide economic impacts associated with developing wind power electric generation facilities. The economic impacts identified include annual jobs, earnings, and output for the construction period and once the windfarm is up and running. A user-defined “add-in” location (e.g., county or region) option is also available.

Steps to complete an economic impact analysis:

1. Enter project descriptive data
2. Choose to accept default project cost data (based on project description and average cost data for windfarms) or review and enter new project data.
3. If you accept default values go directly to SUMMARY RESULTS to view and/or print results.
4. If you choose to enter new values make sure to enter an "N" in the designated cell before proceeding.

To begin analysis press Start button

Start
Economic Impact Analysis

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.
## Basic User Inputs

### Wind Farm Project Data

**INSTRUCTIONS:** Begin by entering Project Location (from pull-down list) and other Descriptive Data. After inserting required data press enter (or cursor to the next cell) to continue. Once Descriptive Data is complete, choose "Y" or "N" on Line 24 to continue.

- Choose "Y" to accept Project Cost and Local Share defaults or "N" to review/modify values.
- To utilize new values in analysis you must choose an "N" in "Utilize Model Default Values (below)?" - Line 24
- Additional information is available by pointing to the red triangles located in cell corners and in the FAQ tab.
- Only those cells with a white background can be changed (accept new values).

### Project Descriptive Data

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Location</td>
<td>COLORADO</td>
</tr>
<tr>
<td>Population (only required for County/Region analysis)</td>
<td>2009</td>
</tr>
<tr>
<td>Year of Construction</td>
<td></td>
</tr>
<tr>
<td>Total Project Size - Nameplate Capacity (MW)</td>
<td>100</td>
</tr>
<tr>
<td>Number of Projects (included in Total Project Size)</td>
<td>1</td>
</tr>
<tr>
<td>Turbine Size (KW)</td>
<td>1,500</td>
</tr>
<tr>
<td>Number of Turbines</td>
<td>67</td>
</tr>
<tr>
<td>Installed Project Cost ($/KW)</td>
<td>$2,043</td>
</tr>
<tr>
<td>Operations and Maintenance Cost ($/kW)</td>
<td>$20.00</td>
</tr>
<tr>
<td>Money Value - Current or Constant (Dollar Year)</td>
<td>2008</td>
</tr>
</tbody>
</table>

**Utilize Project Cost Data default values in analysis?**

- Choose "Y" to accept default values below or "N" to over-ride default values and utilize new user defined values as entered below. See FAQ for related topics.

**If desired, default values (in cells below - based on Project Descriptive Data entered above) may be restored by pressing the 'Restore Default Values' button. Note: it is not necessary to restore defaults to incorporate default Project Cost Data in system analysis - simply choose "Y" in cell B24 above.**

Press 'Go To Summary Impacts' Button

- Go To Summary Impacts

Restore Default Values

- Restore Default Values
Basic User Inputs

Wind Farm Project Data

INSTRUCTIONS: Begin by entering Project Location (from pull-down list) and other Descriptive Data. After inserting required data press enter (or cursor to the next cell) to continue. Once Descriptive Data is complete, choose "Y" or "N" on Line 24 to continue.
- Choose "Y" to accept Project Cost and Local Share defaults or "N" to review/modify values.
- To utilize new values in analysis you must choose an "N" in "Utilize Model Default Values (below)?" - Line 24
Additional information is available by pointing to the red triangles located in cell corners and in the FAQ tab. Only those cells with a white background can be changed (accept new values).

The user chooses the state where the project will be located from a drop down menu and provides basic project level information.

The user can then accept the default descriptive data or enter their own project specific data.
### Project Cost Data

#### Construction Costs

<table>
<thead>
<tr>
<th>Equipment Costs</th>
<th>Cost</th>
<th>Cost Per KW</th>
<th>Percent of Total Cost</th>
<th>Local Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbines (excluding blades and towers)</td>
<td>$91,451,104</td>
<td>$915</td>
<td>44.8%</td>
<td>0%</td>
</tr>
<tr>
<td>Blades</td>
<td>$21,409,957</td>
<td>$214</td>
<td>10.5%</td>
<td>0%</td>
</tr>
<tr>
<td>Towers</td>
<td>$23,703,882</td>
<td>$237</td>
<td>11.6%</td>
<td>0%</td>
</tr>
<tr>
<td>Transportation</td>
<td>$18,383,325</td>
<td>$164</td>
<td>8.0%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Equipment Total</strong></td>
<td>$152,928,268</td>
<td>$1,529</td>
<td>74.8%</td>
<td></td>
</tr>
</tbody>
</table>

#### Balance of Plant

<table>
<thead>
<tr>
<th>Balance of Plant</th>
<th>Cost</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction (concrete, rebar, equip, roads and site prep)</td>
<td>$22,098,135</td>
<td>$221</td>
<td>10.8%</td>
<td>90%</td>
</tr>
<tr>
<td>Transformer</td>
<td>$2,499,757</td>
<td>$25</td>
<td>1.2%</td>
<td>0%</td>
</tr>
<tr>
<td>Electrical (drop cable, wire, )</td>
<td>$2,634,913</td>
<td>$26</td>
<td>1.3%</td>
<td>100%</td>
</tr>
<tr>
<td>HV line extension</td>
<td>$4,813,107</td>
<td>$48</td>
<td>2.4%</td>
<td>70%</td>
</tr>
<tr>
<td>Materials Subtotal</td>
<td>$32,045,912</td>
<td>$320</td>
<td>15.7%</td>
<td></td>
</tr>
<tr>
<td>Foundation</td>
<td>$1,266,243</td>
<td>$13</td>
<td>0.6%</td>
<td>95%</td>
</tr>
<tr>
<td>Erection</td>
<td>$1,434,200</td>
<td>$14</td>
<td>0.7%</td>
<td>75%</td>
</tr>
<tr>
<td>Electrical</td>
<td>$2,090,061</td>
<td>$21</td>
<td>1.0%</td>
<td>70%</td>
</tr>
<tr>
<td>Management/Supervision</td>
<td>$1,084,537</td>
<td>$11</td>
<td>0.5%</td>
<td>0%</td>
</tr>
<tr>
<td>Misc.</td>
<td>$7,762,202</td>
<td>$78</td>
<td>3.8%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>Labor Subtotal</strong></td>
<td>$13,637,243</td>
<td>$136</td>
<td>6.7%</td>
<td></td>
</tr>
</tbody>
</table>

#### Development/Other Costs

<table>
<thead>
<tr>
<th>Development/Other Costs</th>
<th>Cost</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HV Sub/Interconnection</td>
<td>$1,518,720</td>
<td>$15</td>
<td>0.7%</td>
<td>90%</td>
</tr>
<tr>
<td>Labor</td>
<td>$485,214</td>
<td>$5</td>
<td>0.2%</td>
<td>10%</td>
</tr>
<tr>
<td>Engineering</td>
<td>$2,066,598</td>
<td>$21</td>
<td>1.0%</td>
<td>0%</td>
</tr>
<tr>
<td>Legal Services</td>
<td>$1,126,296</td>
<td>$11</td>
<td>0.6%</td>
<td>100%</td>
</tr>
<tr>
<td>Land Easements</td>
<td>$0</td>
<td>$0</td>
<td>0.0%</td>
<td>100%</td>
</tr>
<tr>
<td>Site Certificate/Permitting</td>
<td>$526,983</td>
<td>$5</td>
<td>0.3%</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Development/Other Subtotal</strong></td>
<td>$5,703,811</td>
<td>$57</td>
<td>2.8%</td>
<td></td>
</tr>
<tr>
<td><strong>Balance of Plant Total</strong></td>
<td>$51,386,966</td>
<td>$514</td>
<td>25.2%</td>
<td></td>
</tr>
</tbody>
</table>
Detailed User Inputs

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 user can choose to enter their own project specific data.

Local share values allow the user to adjust the percentage of local labor that is used in the project.
# Results Summary

## Wind Farm - Project Data Summary based on model default values

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Location</strong></td>
<td>COLORADO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Year of Construction</strong></td>
<td>2009</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Project Size - Nameplate Capacity (MW)</strong></td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Number of Projects (included in total)</strong></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Turbine Size (KW)</strong></td>
<td>1500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Number of Turbines</strong></td>
<td>67</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Installed Project Cost ($/KW)</strong></td>
<td>$2,043</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Annual O&amp;M Cost ($/KW)</strong></td>
<td>$20.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Money Value (Dollar Year)</strong></td>
<td>2008</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Installed Project Cost</strong></td>
<td>$204,315,234</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Local Spending</strong></td>
<td>$36,581,782</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Annual Operational Expenses</strong></td>
<td>$33,598,101</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Direct Operating and Maintenance Costs</strong></td>
<td>$2,000,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Local Spending</strong></td>
<td>$697,527</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Other Annual Costs</strong></td>
<td>$31,598,101</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Local Spending</strong></td>
<td>$869,090</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Debt and Equity Payments</strong></td>
<td>$0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Property Taxes</strong></td>
<td>$567,590</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Land Lease</strong></td>
<td>$301,500</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Local Economic Impacts - Summary Results

<table>
<thead>
<tr>
<th></th>
<th>Jobs</th>
<th>Earnings</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>During construction period</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Development and Onsite Labor Impacts</td>
<td>67</td>
<td>$4.2</td>
<td>$4.9</td>
</tr>
<tr>
<td>Construction and Interconnection Labor</td>
<td>60</td>
<td>$3.8</td>
<td></td>
</tr>
<tr>
<td>Construction Related Services</td>
<td>7</td>
<td>$0.5</td>
<td></td>
</tr>
<tr>
<td>Turbine and Supply Chain Impacts</td>
<td>306</td>
<td>$12.0</td>
<td>$41.5</td>
</tr>
<tr>
<td>Induced Impacts</td>
<td>122</td>
<td>$4.3</td>
<td>$14.6</td>
</tr>
<tr>
<td><strong>Total Impacts</strong></td>
<td>495</td>
<td>$20.5</td>
<td>$61.0</td>
</tr>
</tbody>
</table>

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>During operating years (annual)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onsite Labor Impacts</td>
<td>6</td>
<td>$0.4</td>
<td>$0.4</td>
</tr>
<tr>
<td>Local Revenue and Supply Chain Impacts</td>
<td>8</td>
<td>$0.3</td>
<td>$1.7</td>
</tr>
<tr>
<td>Induced Impacts</td>
<td>7</td>
<td>$0.2</td>
<td>$0.8</td>
</tr>
<tr>
<td><strong>Total Impacts</strong></td>
<td>20</td>
<td>$1.0</td>
<td>$2.0</td>
</tr>
</tbody>
</table>
JEDI then estimates the annual economic impact on jobs earnings and output during facility construction and operation.
Interpreting the Results

• JEDI reports jobs as *full time equivalents* or 2,080 hour units
  • Projects may take more or less than a year to complete, in these cases construction can be adjusted to reflect the impact during the actual period of construction
    • Example: JEDI reports 100 Construction period jobs. This could be 25 workers supported for 4 years or 200 workers supported for 6 months.
  • Operations period impacts are also FTE’s but because they are reported as annual impacts you can interpret these as long-term jobs

• Earnings reflect the actual salaries acquired by laborers

• Output is the sum value of all goods and services provided at each layer of the supply chain
  • Example: For a wind turbine it is the cost of the iron ore, plus the cost of the rolled steel, plus the cost of the assembly, plus the cost of the final project
  • This is in contrast to metrics like GDP or GSP which reflect only the sum of the value added (i.e. sale price less material input prices) or the market value of *final goods and services*

• JEDI Analyses are a measure of Gross Economic Impacts
Jobs and Economic Impacts from the JEDI Model

1,000 MW of New Wind Power in Illinois

**Wind energy’s economic “ripple effect”**

**Direct and Indirect Impacts**

- **Landowner Revenue:**
  - $3 million/year

- **Local Property Taxes:**
  - $6.9 million/year

- **Construction Phase:**
  - 3,577 jobs
  - $471.5 million to local economies

- **Operational Phase:**
  - 120 jobs/year
  - $21.9 million/yr to local economies

**Induced Impacts**

- **Construction Phase:**
  - 1,394 jobs
  - $165.2 million to local economies

- **Operational Phase:**
  - 80 jobs/year
  - $9.5 million/year to local economies

**Totals**

- **Construction Phase:**
  - 4,971 jobs
  - $636.7 million to local economies

- **Operational Phase:**
  - 200 jobs/year
  - $31.5 million/year to local economies

Construction Phase = 1-2 years
Operational Phase = 20+ years
JEDI at Work: Employment Impacts from construction over time

Construction Period Jobs Added to the Nebraska Labor Force from Building 7,800 MW of Wind Power

- CBED High
- CBED Low
- Trad High
- Trad Low

Short-term Job Additions

- 0
- 1,000
- 2,000
- 3,000
- 4,000
- 5,000
- 6,000
- 7,000
- 8,000

JEDI at Work: Comparing Completed Community Wind Projects and other Retrospective Analyses

- Ratio of Construction Period Impacts: **2.3 – 3.1 : 1**
- Ratio of Operations Period Impacts: **1.5 – 1.8 : 1**

![Bar Chart](chart.png)

- Blue bar: Average of Projects Analyzed Here
- Orange bar: Colorado 1000 MW Average (Reategui 2008)
- Gray bar: Iowa 1000 MW Average (Reategui forthcoming)
JEDI at Work: Comparing Community Wind to Absentee Wind during Operations

Note: Values shown here represent the ratio of community wind to a hypothetical “average” absentee wind project. The ratio of impacts is interpreted as the value shown to one (e.g., 2.8 : 1).
Total economic impacts from energy equivalent wind and coal in Colorado

- **CO Wind 43% Cf (991 MW)**
  - Landowner revenue
  - Property taxes
  - Coal mining & transport
  - Operations
  - Construction

- **CO Wind 35% Cf (1328 MW)**
  - Landowner revenue
  - Property taxes
  - Coal mining & transport
  - Operations
  - Construction

- **CO Coal (500 MW, 55% in-state coal)**
  - Landowner revenue
  - Property taxes
  - Coal mining & transport
  - Operations
  - Construction

- **CO Coal (500 MW, 0% in-state coal)**
  - Landowner revenue
  - Property taxes
  - Coal mining & transport
  - Operations
  - Construction

Millions of dollars
JEDI at Work: Potential Jobs Impacts During Construction Assuming 80% In-state Manufacturing

Preliminary Results

Jobs supported by 1000MW of Wind projects in IA During Construction period

- Research Results: ~2,250 jobs
  - 600
  - 1,100
  - 550

- Assuming 80% Manufacturing: ~12,480 jobs
  - 680
  - 4,050
  - 7,750
Explaining variability in economic development impacts

- Size and cost of the project
  - Higher costs often results in increased impact for both construction and O&M

- Size and diversity of the local economy
  - Level of analysis
  - Multiplier effect

- Developer preferences and contractor / equipment availability
  - Goods and services
  - *Turbine manufacturing*

- Magnitude and allocation of project revenues
Conclusions

• Analyzing Jobs and Economic Impacts is an important task, and even more so in today’s economic and political climate
  • It is not however, the sole metric upon which we can/should evaluate renewable energy projects
• The JEDI tool provides a user friendly platform to carry out economic impacts analysis for renewable energy projects
• 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.
• Acquiring as much project specific information as possible is critical
• NREL can provide answers to general questions regarding the JEDI models at jedisupport@nrel.gov
Thank You

Eric Lantz and Gail Mosey
Strategic Energy Analysis Center
National Renewable Energy Laboratory
http://www.nrel.gov/analysis/

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