Economic Development from Gigawatt-Scale Wind Deployment in Wyoming

Analysis Performed by NREL for the Wyoming Infrastructure Authority

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Presentation Overview

- Project context
- Definitions & caveats
- Deployment scenario
- Modeling inputs
- Results
- Conclusions
The Crux

Source: NASA (http://www.nasa.gov/)
Wyoming Transmission Projects

Transmission Projects under development in Wyoming

- Wyoming-Colorado Interie
- Energy Gateway (West & South)
- TransWest Express
- High Plains Express
- Zephyr
- Overland Transmission

Routes shown are for illustrative purposes only & will be finalized following the permitting and siting process

Source: WIA
Role and Scope of the NREL Study

• Building and siting new power generation and infrastructure, especially to serve out-of-state load, can be challenging.

• Decisions are best made with a full understanding of how a given project (or set of projects) will affect Wyoming and its communities.

• Jobs and economic development are variables that are important to state policymakers, local policymakers, and residents.

• This study considers the question: What if? 
  
  *If deployment of new transmission allows for significant new power generation, what level of jobs and economic activity might result?*
The JEDI Analysis Tools

Currently public
- Utility-Scale Wind
- Natural Gas
- Coal
- Geothermal
- Ethanol
- Solar (CSP, PV)

In process
- Transmission
- Water
- Biopower
- Offshore, Small Wind

JEDI is used by industry, government, academics, advocates, consultants, and others.

Jobs and Economic Development Impacts (JEDI) Model
Economic Development at Multiple Levels

1. On-site labor and professional services

2. Equipment production and supply chain

3. Induced economic activity (household purchases due to injection of income)
JEDI Caveats

• Results are an estimate, not a precise forecast.

• Results are not a measure of project profitability or viability.

• Results report *gross jobs* as opposed to *net jobs*.

• Assumptions around local sourcing and procurement are fundamental in determining local economic activity.
  • Sensitivity scenarios are included in this analysis.

• Jobs are reported as Full-Time Equivalent (FTE) jobs.

Photo from First Wind, NREL/PIX16738
# Infrastructure Portfolio for WIA

<table>
<thead>
<tr>
<th>Infrastructure Type</th>
<th>Units Installed</th>
<th>Total Installed Cost</th>
<th>Annual Operating Expenditures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wind Generation</strong></td>
<td>9,000 MW</td>
<td>$18 billion</td>
<td>$225 million</td>
</tr>
<tr>
<td><strong>Natural Gas Generation</strong></td>
<td>1,800 MW</td>
<td>$2.3 billion</td>
<td>$42 million</td>
</tr>
<tr>
<td><strong>500-kV HVDC Transmission Line</strong></td>
<td>2</td>
<td>$2.2 billion</td>
<td>$60 million</td>
</tr>
<tr>
<td><strong>500-kV HVAC Transmission Line</strong></td>
<td>2</td>
<td>$1.3 billion</td>
<td>$35 million</td>
</tr>
<tr>
<td><strong>230-kV HVAC Collector System</strong></td>
<td>Multiple</td>
<td>$660 million</td>
<td>$17 million</td>
</tr>
</tbody>
</table>
Infrastructure Deployment (2012 – 2021)

- **Annual Wind Installations (MW)**
- **Annual Natural Gas Installations (MW)**
- **500 kV HVAC Line; 1,500 MW Capacity; ~ 310 miles (Right Axis)**
- **500 kV HVDC Line; 3,000 MW Capacity; ~ 225 miles (Right Axis)**
- **Collector System 230 kV Line; Variable Capacity & Length (Right Axis)**

- **New HV Transmission Capacity (MW)**
## Basic Inputs

<table>
<thead>
<tr>
<th>Installed Cost</th>
<th>Annual O&amp;M Cost</th>
<th>Land Lease ($/MW) (Annualized NPV)</th>
<th>Property Tax ($/MW) (Annualized NPV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2,000/kW</td>
<td>$25/kW</td>
<td>$6,025</td>
<td>$6,080</td>
</tr>
</tbody>
</table>

### Installed Wind Power (MW)

- **2012**: 0 MW
- **2013**: 100 MW
- **2014**: 200 MW
- **2015**: 1,000 MW
- **2016**: 1,400 MW
- **2017**: 1,600 MW
- **2018**: 1,600 MW
- **2019**: 1,600 MW
- **2020**: 1,200 MW
- **2021**: 0 MW
## Sample Detailed Inputs

<table>
<thead>
<tr>
<th>Wind Construction Parameters</th>
<th>Percentage of Total Installed Cost</th>
<th>Wyoming Local Purchase Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Base Case</td>
</tr>
<tr>
<td>Turbine nacelle &amp; drive train</td>
<td>43%</td>
<td></td>
</tr>
<tr>
<td>Blades</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td><strong>Towers</strong></td>
<td>11%</td>
<td>0%</td>
</tr>
<tr>
<td>Transportation</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>General site materials</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Transformer</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Electrical equipment</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>HV line extension</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Foundation labor</td>
<td>&lt;1%</td>
<td></td>
</tr>
<tr>
<td>Turbine erection</td>
<td>1%</td>
<td>20%</td>
</tr>
<tr>
<td>Electrical craft labor</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td><strong>Management/supervision</strong></td>
<td>&lt;1%</td>
<td>10%</td>
</tr>
<tr>
<td>Misc.</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Substation/interconnection materials</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Substation/interconnection labor</td>
<td>&lt;1%</td>
<td></td>
</tr>
<tr>
<td>Engineering</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Legal services</td>
<td>1%</td>
<td>70%</td>
</tr>
<tr>
<td>Land easements</td>
<td>&lt;1%</td>
<td></td>
</tr>
<tr>
<td>Site certificate/permitting</td>
<td>&lt;1%</td>
<td></td>
</tr>
<tr>
<td>Sales tax</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100%</td>
<td>16%</td>
</tr>
</tbody>
</table>
Results
Base Case Employment Over Time and by Infrastructure Type
# Wind Base Case Results

<table>
<thead>
<tr>
<th>Construction (Average Annual over 10 years)</th>
<th>Total Jobs</th>
<th>Earnings($M)</th>
<th>Output ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Development and Onsite Labor</td>
<td>230</td>
<td>$14</td>
<td>$19</td>
</tr>
<tr>
<td>Equipment and Supply Chain Activity</td>
<td>1,600</td>
<td>$77</td>
<td>$210</td>
</tr>
<tr>
<td>Induced Activity</td>
<td>300</td>
<td>$11</td>
<td>$37</td>
</tr>
<tr>
<td>Total</td>
<td>2,200</td>
<td>$100</td>
<td>$270</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operations (Annual for 20 Years)</th>
<th>Total Jobs</th>
<th>Earnings($M)</th>
<th>Output ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onsite Labor</td>
<td>470</td>
<td>$27</td>
<td>$27</td>
</tr>
<tr>
<td>Local Revenue and Supply Chain Activity</td>
<td>860</td>
<td>$35</td>
<td>$220</td>
</tr>
<tr>
<td>Induced Activity</td>
<td>400</td>
<td>$14</td>
<td>$48</td>
</tr>
<tr>
<td>Total</td>
<td>1,700</td>
<td>$76</td>
<td>$290</td>
</tr>
</tbody>
</table>
Wind Power Sensitivities

Low scenario: project management during construction all out-of-state and only 20% of legal services provided by Wyoming firms.

High scenario: 50% of towers manufactured in Wyoming, 75% of tower erection labor in-state (instead of 20%), and 20% of project management during construction based in Wyoming.
Wind Direct Payments to Government and Landowners

The chart illustrates the direct payments made to government and landowners from 2012 to 2025. The payments are broken down by type of tax and revenue source.

- **Sales Tax - construction**
- **Sales Tax - operations**
- **Property tax**
- **Generation tax**
- **Landowner revenue**

The chart shows a gradual increase in direct payments over the years, with some peaks in specific years.

- In 2012, the payments are minimal, with a slight increase in 2014 and 2015.
- From 2016 to 2025, there is a steady increase in payments, with a significant rise in 2020 and 2021.

The data reflects the growth and development of wind energy projects and their associated financial benefits to various stakeholders.
Conclusions

• Averaged over the duration of the construction period, 4,000 to 5,900 workers per year are employed as a result of construction-related economic activity.
  • Wages and benefits average $200 million - $330 million per year during construction.
  • Wind = 45% of construction-period employment

• Ongoing operation of this infrastructure is estimated to employ 2,300 - 2,600 Wyoming workers for at least 20 years.
  • Wages and benefits average $100 million - $120 million per year during operations.
  • Wind = 70% of operations period employment
  • Wind land leases = $54 million per year
  • Wind property tax = $55 million per year

• Economic output peaks at $1.2 billion in 2016 and $1.4 billion in 2019 before settling to about $380 million per year during operations-only years.
  • Wind = $450 million per year between 2014 and 2020 (Construction-period average = $270 million)
  • Wind = $290 million per year each year of operations (75%)

• Total Wyoming economic activity from these investments is expected to be ~$12 billion - $15 billion (construction plus 20 years of operations).
  • Wind = $8 billion to $10 billion
  • Wind manufacturing could drive these values higher.
Thank you

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