Socioeconomics and Environmental Impacts of Solar and Wind Projects Tied to Renewable Portfolio Standards

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35th USAEE/IAEE North American Conference
Houston, November 14

* PhD Candidate, Professor, and Professor, respectively. This research is funded by NSF Award #1345169 and New Mexico’s Experimental Program to Stimulate Competitive Research (EPSCoR).
INTRODUCTION

• Contributions of climate change on weather events are rising.

• Renewable energy use, as a result, is increasing.

• This research focuses on the economic and environmental impacts of a changing generation portfolio.
INTRODUCTION .cont

• Climate change:
  • Greenhouse gases (GHGs)
  • Health impact
  • Water

• One solution: Renewable energy source
GAPS IN THE LITERATURE

• Previous economic impact studies of constructing and operating RE plants suggest that economic impacts to states are considerable (e.g., Wiser et al., 2015; Barbose et al., 2016).

• Most of these studies:
  • Narrow scope (i.e., plant-level (Slattery et. al, 2011)),
  • Aggregated (e.g., nationwide (Wiser et. al., 2016), or state-specific assessments (e.g., Comings et. al. (2014)).

• Most of the papers in the job comparison literature encounter two problems:
  • They consider number of jobs across different technologies without considering their different efficiency levels.
  • Most studies rely on simulated data.
RESEARCH OBJECTIVE

IMPACTS:

**Economic:**
1. Jobs
2. Economic Output

**Environmental:**
3. Water Use
4. GHG Emissions
The model describes how a one dollar change in final demand would affect the output of given industries.
ANALYTICAL METHOD

➢ Electricity generation:

\[ MWh_{ijs,t} = MW \times cf_{ijs} \times dr \times 8,760 \text{ hrs} \]

➢ GHG:

\[ GHG_{ijs,t} = MWh_{ijs,t} \times cf_{ghg} \]

➢ Water:

\[ H2O_{ijs,t} = MWh_{ijs,t} \times cf_{H2O} \]
We follow the existent normalization approach used in other studies such as Kammen et al. (2004), Sastresa et al. (2010), and Wei et al. (2010).

We apply this roadmap to estimate the potential impact of RES facilities that comply with RPS requirements in New Mexico.
DATA

Data includes:

• Generator characteristics (EIA)
• Solar and wind power plants construction and operation costs and weather data (NREL)
• Generator’s GHG emissions and water usage (EPA)
• County-level input-output multiplier information (Impact Assessment for Planning model (IMPLAN))
New Mexico has substantial generation. The state also has the potential new generation.
GENERATION POTENTIAL

- Coal-Fired 58%
- Natural Gas-Fired 23%
- Other Renewables 19%
## WIND PLANTS

Wind power plant data description

<table>
<thead>
<tr>
<th></th>
<th>Gallegos, Phase 1</th>
<th>El Cabo</th>
<th>Broadview JN</th>
<th>Broadview KW</th>
<th>Grady</th>
<th>Source of data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>County</strong></td>
<td>Union</td>
<td>Torrance</td>
<td>Curry</td>
<td>Curry</td>
<td>Curry</td>
<td>EIA</td>
</tr>
<tr>
<td><strong>Year Operational</strong></td>
<td>2017</td>
<td>2017</td>
<td>2018</td>
<td>2018</td>
<td>2018</td>
<td>EIA</td>
</tr>
<tr>
<td><strong>Nameplate capacity (MW)</strong></td>
<td>180</td>
<td>298</td>
<td>181.7</td>
<td>142.6</td>
<td>200.8</td>
<td>EIA</td>
</tr>
<tr>
<td><strong>Number of turbine</strong></td>
<td>90</td>
<td>142</td>
<td>79</td>
<td>62</td>
<td>251</td>
<td>web search</td>
</tr>
<tr>
<td><strong>Capacity factor</strong></td>
<td>32.83%</td>
<td>34.53%</td>
<td>35.96%</td>
<td>35.71%</td>
<td>35.36%</td>
<td>SAM</td>
</tr>
</tbody>
</table>

- Money value: 2016
- Degradation rate: -1.60%
- Construction period: 2 years
# PV PLANTS

Solar PV power plant data description

<table>
<thead>
<tr>
<th>County</th>
<th>Caprock 1</th>
<th>Aragonne</th>
<th>Alta Luna</th>
<th>Holloman</th>
<th>Los Alamos</th>
<th>Caprock 2</th>
<th>Clean Path</th>
<th>Source of data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quay</td>
<td>Guadalupe</td>
<td>Luna</td>
<td>Otero</td>
<td>Los Alamos</td>
<td>Quay</td>
<td>San Juan</td>
<td>EIA</td>
</tr>
<tr>
<td>Nameplate capacity (MW)</td>
<td>25</td>
<td>40</td>
<td>28.1</td>
<td>5</td>
<td>1</td>
<td>30</td>
<td>70</td>
<td>EIA</td>
</tr>
<tr>
<td>Installed System Cost ($/KWDC)</td>
<td>1,712</td>
<td>1,700</td>
<td>1,712</td>
<td>1,712</td>
<td>1,712</td>
<td>1,700</td>
<td>1,700</td>
<td>PNM</td>
</tr>
<tr>
<td>Operations and Maintenance Cost ($/kW)</td>
<td>27.87</td>
<td>20.95</td>
<td>27.87</td>
<td>27.87</td>
<td>27.87</td>
<td>20.95</td>
<td>20.95</td>
<td>PNM</td>
</tr>
<tr>
<td>Capacity factor</td>
<td>24.92%</td>
<td>26.20%</td>
<td>26.52%</td>
<td>21.07%</td>
<td>25.65%</td>
<td>24.92%</td>
<td>20.61%</td>
<td>SAM</td>
</tr>
</tbody>
</table>

- Money value: 2016
- Degradation rate: -0.50%
- Construction period: 1 year
<table>
<thead>
<tr>
<th>Type</th>
<th>Plant</th>
<th>Construction</th>
<th>O&amp;M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Direct</td>
<td>Indirect</td>
</tr>
<tr>
<td>Wind</td>
<td>Gallegos</td>
<td>171.5</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>El Cabo</td>
<td>350.5</td>
<td>42.5</td>
</tr>
<tr>
<td></td>
<td>Broadview JN</td>
<td>169</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Broadview KW</td>
<td>133</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Grady</td>
<td>104</td>
<td>15</td>
</tr>
<tr>
<td>Solar PV</td>
<td>Caprock 1</td>
<td>73</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Caprock 2</td>
<td>84</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Aragonne</td>
<td>115</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Alta Luna</td>
<td>66</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Holloman</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Los Alamos</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Clean Path</td>
<td>149</td>
<td>31</td>
</tr>
</tbody>
</table>
Statewide total FTE jobs by 12 proposed renewable plants.

- Solar PV:
  - Construction Jobs: 172
  - Cummulative Operating and Maintenance Jobs: 57
  - Average Jobs per Year: 814

- Wind:
  - Construction Jobs: 126
  - Cummulative Operating and Maintenance Jobs: 814
  - Average Jobs per Year: 2,898
Statewide total economic impact by 12 proposed renewable plants.

- **Construction Output**
  - Solar PV: $80, $20
  - Wind: $295, $98

- **Operating and Maintenance Output**
  - Solar PV: $142, $5
  - Wind: $20

- **Annual Output**
  - Wind: $542
JOB COMPARISON, SOLAR PV VS. WIND

Average and range of direct employment multiplier (coefficient) for solar PV and wind potential new additional facilities in New Mexico.

<table>
<thead>
<tr>
<th>Job-Years/Gwh</th>
<th>Solar PV</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# JOB COMPARISON, RE VS. COAL-FIRED JOBS

<table>
<thead>
<tr>
<th>PLANT</th>
<th>Lifetime</th>
<th>MWp</th>
<th>Yrs to complete project</th>
<th>FTE Const. Direct Jobs</th>
<th>FTE O&amp;M Direct Jobs</th>
<th>Cap Factor</th>
<th>Average employment over life of facility person-yrs/GWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tech</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>O&amp;M</td>
</tr>
<tr>
<td>PV Total</td>
<td>25</td>
<td>199</td>
<td>1</td>
<td>502</td>
<td>43</td>
<td>24%</td>
<td>0.10</td>
</tr>
<tr>
<td>Wind Total</td>
<td>25</td>
<td>1003</td>
<td>2</td>
<td>927</td>
<td>88</td>
<td>35%</td>
<td>0.03</td>
</tr>
<tr>
<td>Coal (SJGS)</td>
<td>45</td>
<td>1,848</td>
<td>0</td>
<td>0</td>
<td>280</td>
<td>76%</td>
<td>0.02</td>
</tr>
<tr>
<td>Coal &amp; mining NM (SJGS)</td>
<td>45</td>
<td>1,848</td>
<td>0</td>
<td>0</td>
<td>630</td>
<td>76%</td>
<td>0.05</td>
</tr>
</tbody>
</table>
CONCLUSION

• An analysis of twelve potential renewable energy projects, constituting nearly 1,202 MW of power capacity finds:
  • 7,384 job-years over their lifetimes (2015 to 2043)
  • 72% of jobs in wind generation plants
• Economic output
  • $375 million construction
  • $683 million O&M
• Considering the size of plant, or number of plants to replace an equivalent amount of coal-fired generation, we estimate:
  • 4.2 times more people to run a solar plant.
  • 1.2 times more people to operate a wind plant.
The generation of these 12 renewable generating projects, if a replacement for coal-fired generation would

- Save 44 billion gallon of water (1.4 times as much water used by residents in Albuquerque metro area in 2013)
- Avoid 81 million tons of greenhouse gases (the equivalent of 174 million miles driven by an average passenger vehicle).
AVOIDED EMISSIONS

Avoided emissions of thousands miles driven by an average passenger vehicle.

- **Solar PV**: 25,045
- **Wind**: 148,975

Miles driven by an average passenger vehicle
POLICY IMPLICATIONS

• There are large differences in county populations across the US. Thus, counties will experience variations in impact.

• For instance, 20 jobs in a county with small population (e.g., Union county, NM) will have a higher impact than in another county with a large population (e.g., San Juan county, NM).
Thank You!

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