Clean Line Energy

HVDC: the Key to the Continued Growth of the Wind Industry

Georgia Tech 2011
Introduction to Clean Line Energy
Connecting renewable energy to demand

- Clean Line Energy focuses on building transmission lines to connect renewable resources to load centers.

- Clean Line seeks to develop, own and operate long haul, high voltage direct current (HVDC) transmission lines across the United States, helping solve one of the most vexing challenges to a cleaner energy future.

- Clean Line’s principals, partners and investors bring unique perspective, experience and focus to transmission development along with a track record of success in energy project development.

Strong wind resources

Large demand centers

Integrating large clean energy sources with demand centers
Why Do We Need HVDC Transmission?

Best wind resources are in central spine of the United States away from distant population centers

...with limited access to robust transmission systems
Why HVDC?

- **Efficient**—Due to lower losses, DC is most efficient solution to move large volumes over long distances.
- **Smaller footprint**—Less complex siting because DC requires narrower ROW and lower height than AC.
- **Improved reliability**—Enhances system stability, controls power flows, lowers integration costs in resource area.
- **Technological advances**—Improved HVDC technology will help reduce costs over the long term.
- **Simpler commercial structure**—HVDC enables “toll road” model, but also work in a world of cost-allocated transmission.

<table>
<thead>
<tr>
<th>AC</th>
<th>3000-4000 MW Capacity</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three 500 kV lines</td>
<td></td>
<td>One ± 500kV bipole</td>
</tr>
</tbody>
</table>

Source: ABB
Joint Coordinated System Plan: Identified Seven HVDC Lines to Move Wind Energy to Market

Source: Joint Coordinated System Plan 2008
Clean Line is Developing HVDC Projects to Deliver Renewable Energy to Load Centers
Plains & Eastern Clean Line Delivers Wind Energy from Kansas, Oklahoma and Texas to TVA and the Southeast

Project Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission Capacity</td>
<td>7,000 MW</td>
</tr>
<tr>
<td>Technical Configuration</td>
<td>Two ±600kV bipole transmission lines</td>
</tr>
<tr>
<td>Approximate Length</td>
<td>800 miles</td>
</tr>
<tr>
<td>Target Utilization Rate</td>
<td>50+%</td>
</tr>
<tr>
<td>Approximate Capital Cost</td>
<td>$3.5 billion</td>
</tr>
<tr>
<td>Construction Jobs</td>
<td>10,000</td>
</tr>
<tr>
<td>Operations Jobs</td>
<td>1,000</td>
</tr>
</tbody>
</table>
Plains & Eastern is Pursuing Permits and Siting on State and Federal Levels

State
• Filed for utility certification in OK and AR
  – Corporation Commission’s staff and the Attorney General are supporting Clean Line’s application for utility status
  – Following established precedents, but outcome is not a given and support from wind generators and manufacturers is important
• Plan to obtain Certificate of Environmental Compliance and Public Necessity (CECPN) in Arkansas
  • Contracted Ecology & Environment (E&E) as lead environmental consultant for work on routing, environmental assessment work, and National Environmental Policy Act (NEPA) (including public involvement)

Federal
• Will carry out NEPA Environmental Impact Statement
• Potential partnership with Southwestern Power Administration/DOE under Section 1222 of Energy Policy Act of 2005
The Clean Line Projects Share a Common Rationale

• Connect areas with outstanding renewable resources and low load to areas with weaker renewable resources and higher load: “Wind belt” states cannot absorb enough wind to get to 10% penetration on a national basis. In addition, because of wind’s diurnal profile and variability, it is more difficult to absorb the best resources where they are located.

• Line length of 550-800 miles: This length is long enough to connect separate regions but can keep transmission cost at about $30/MWh.

• HVDC technology: HVDC is the most electrically efficient and cost effective technology to move robust wind resources to load centers.

• Merchant model: Clean Line will fund the development costs of the transmission projects and will sell transmission capacity to wind generators and/or the purchasers of that power.

TYPICAL CLEAN LINE PROJECT SCHEDULE

JANUARY 2010 KICKOFF
2010 - 2013 PUBLIC OUTREACH, REGULATORY APPROVAL, SITING PERMITTING AND BEGIN LAND ACQUISITION
2013-2014 SECURE CUSTOMERS AND FINALIZE LAND ACQUISITION
2014-2016 CONSTRUCTION

CLEAN LINE ENERGY PARTNERS
Wind Energy Coming of Age
Wind Energy is the Most Cost-Effective Form of Renewable Energy even when paired with transmission
With a 45% NCF, Delivered Price Could be $51-56/MWh

Cost of Delivered Wind

- PPA Price ($1700/kw, 45% NCF)
- Tariff Cost
- Loss Cost
- Curtailment Cost
- Estimated Delivered Cost Plains and Eastern
- Grain Belt Savings from Lower Line Length
- Estimated Delivered Cost Grain Belt

$/MWh

Source: Clean Line Energy
## Cost Competitiveness

<table>
<thead>
<tr>
<th></th>
<th>Fixed Cost</th>
<th>Fuel Cost</th>
<th>Total Cost</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind in high class II site</td>
<td>30-40</td>
<td>0</td>
<td>30-40</td>
<td>Typical resource in IA, OK, KS, TX, eastern NM</td>
</tr>
<tr>
<td>Wind in low class II site</td>
<td>50-60</td>
<td>0</td>
<td>50-60</td>
<td>Typical resource in IN, IL</td>
</tr>
<tr>
<td>Clean Line delivered product</td>
<td>55-70</td>
<td>0</td>
<td>55-70</td>
<td>Includes $25-30/MWh of transmission</td>
</tr>
<tr>
<td>Gas combined cycle</td>
<td>15</td>
<td>50</td>
<td>65</td>
<td>Based on 7,000 heat rate, $6/mmBTU real ($7 nominal)</td>
</tr>
<tr>
<td>Wind in class III site</td>
<td>65-75</td>
<td>0</td>
<td>70-80</td>
<td>Typical resource in OH, NY, CA</td>
</tr>
<tr>
<td>Nuclear</td>
<td>80-120</td>
<td>5</td>
<td>85-125</td>
<td>Costs are highly uncertain</td>
</tr>
<tr>
<td>Solar PV</td>
<td>110-130</td>
<td>0</td>
<td>110-130</td>
<td>Costs are declining, but have a long way to fall</td>
</tr>
<tr>
<td>Solar thermal</td>
<td>120-150</td>
<td>0</td>
<td>120-150</td>
<td></td>
</tr>
</tbody>
</table>

Source: EIA, Clean Line
### Integration Costs

- 3 scenarios:
  - Scenario 1: 7,000 MW delivered to TVA
  - Scenario 2: 3,500 MW delivered to TVA
  - Scenario 3: 3,500 MW to TVA; 3,500 MW to neighboring balancing areas (Southern Company, Duke Energy, Entergy)

- 3 times the standard deviation of the variations of net load (load minus wind) represents ramps occurring approximately 24 times every year

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Net Load 3 Sigma Variation MW w/o Wind</th>
<th>Net Load 3 Sigma Variation MW w/Wind</th>
<th>Additional Net Load Variation MW</th>
<th>Additional Net Load Variation % of Peak Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1</td>
<td>2326</td>
<td>3307</td>
<td>981</td>
<td>2.9%</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>2326</td>
<td>2658</td>
<td>332</td>
<td>1.0%</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>4989</td>
<td>5210</td>
<td>220</td>
<td>0.3%</td>
</tr>
</tbody>
</table>

Source: AWS
1 What’s Working in Favor of HVDC

- PROVEN TECHNOLOGY
- PUBLIC ACCEPTANCE AT THE LOCAL LEVEL
- PLENTY OF FINANCING
- PROVEN TECHNOLOGY
- ADEQUATE WIND RESOURCES
- FERC’S NEGOTIATED RATE STRUCTURE
- NO CURTAILMENT DUE TO CONGESTION
Issues That Are a Challenge

- Antiquated State Siting Laws
- No Federal Siting Laws
- Lack of Federal Leadership
- Lack of Rules Around HVDC Interconnection
- Incumbents Sandbox
- Integration Concerns by Utilities
- Lack of Motivation by DOE