Wind Development in Texas

Workshop on Renewable Energy

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Why Renewables?

- Global climate change
- Carbon emissions limits and/or taxes
- Green power marketing programs
- Declining costs
- Public support
Renewable Technologies

Solar

Geothermal

Hydro

Biomass

Wind

Wave

Tidal
Factors Influencing Renewable Development in Texas

- Legislative mandate
- Abundant renewable resources
- Favorable transmission treatment
- Public acceptance
- Improved Economics of Renewable Resources (wind)
Legislative Mandate: The Texas Electric Choice Act

In 1999, Senate Bill 7, enacted by the Texas Legislature, brought retail choice to the Texas electric industry effective January 1, 2002.

This comprehensive restructuring included a Renewable Portfolio Standard (RPS).
25 States (+D.C.) with an RPS

Additional renewable energy “goals” established in IA, VT, VA, MO, ND, and ME
Texas’ First RPS

![Chart showing the comparison between required and actual MW from 2002 to 2009. The chart highlights that the actual MW significantly exceeded the required MW, particularly in the year 2007.]
2nd Texas RPS (5,000 MW by January 1, 2015)
### Renewable Technologies in Texas

#### Renewable Generating Capacity Installed in Texas (MW)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Existing</th>
<th>New</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass</td>
<td>-</td>
<td>12.2</td>
<td>12.2</td>
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<tr>
<td>Hydro</td>
<td>197.0</td>
<td>10.3</td>
<td>207.3</td>
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<tr>
<td>Landfill Gas</td>
<td>6.3</td>
<td>54.3</td>
<td>60.6</td>
</tr>
<tr>
<td>Solar</td>
<td>-</td>
<td>1.2</td>
<td>1.2</td>
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<tr>
<td>Wind</td>
<td>115.8</td>
<td>3,823.3</td>
<td>3,939.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>319.1</strong></td>
<td><strong>3,901.3</strong></td>
<td><strong>4,220.4</strong></td>
</tr>
</tbody>
</table>

As of July 31, 2007
Wind is the renewable resource of choice in Texas because:

- Readily available
- Low cost (competitive with gas-fueled generation)
- Publicly accepted
- Short development and construction time (12 months or less)
Economic Factors Favorable to Wind

- Continuation of Federal Production Tax Credits
- Increasing economies of scale
- No fuel costs
- Natural gas price increases
- Other economic benefits
  - Jobs creation
  - Property taxes
Wind Resource Map of Texas

The Panhandle contains the state’s greatest expanse with high quality winds. Well-exposed locations atop the caprock and hilltops experience particularly attractive wind speeds. As in all locations throughout the state, determination of areas appropriate for development must include consideration of environmental and social factors as well as technical viability.

South of Galveston, the Texas coast experiences consistent, strong seabreezes that may prove suitable for commercial development.

Source: NREL
Wind Energy Potential

400,000 MW or roughly 5 times the total generating capacity currently in Texas!
Installed Wind Capacity in the U.S.
### Texas Wind Farms

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Capacity (MW)</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Kunitz</td>
<td>45</td>
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<tr>
<td>2</td>
<td>Big Spring Wind Farm</td>
<td>34</td>
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<tr>
<td>3</td>
<td>Southwest Mesa</td>
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<tr>
<td>4</td>
<td>Delaware Mountain Wind Farm</td>
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<tr>
<td>5</td>
<td>West Texas Project</td>
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<tr>
<td>6</td>
<td>Hueco Mountain Wind Ranch</td>
<td>1</td>
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<tr>
<td>7</td>
<td>Indian Mesa</td>
<td>83</td>
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<tr>
<td>8</td>
<td>Woodward Mountain Ranch</td>
<td>160</td>
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<tr>
<td>9</td>
<td>Trent Mesa</td>
<td>150</td>
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<td>10</td>
<td>Desert Sky</td>
<td>161</td>
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<td>11</td>
<td>King Mountain Wind Ranch</td>
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<tr>
<td>12</td>
<td>Llano Estacado Wind Ranch</td>
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<td>13</td>
<td>Sweetwater Wind Power</td>
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<td>14</td>
<td>Green Mtn. Energy Wind Farm at Brazos</td>
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<tr>
<td>15</td>
<td>Aeolius Wind</td>
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<tr>
<td>16</td>
<td>Callahan Divide Wind Farm</td>
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<td>17</td>
<td>Sweetwater Wind Power II</td>
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<td>18</td>
<td>Buffalo Gap Wind Farm</td>
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<td>19</td>
<td>Horse Hollow Wind Farm</td>
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<td>20</td>
<td>John Deere (3 Community-Owned Projects)</td>
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<td>21</td>
<td>Sweetwater Wind Power III</td>
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<td>22</td>
<td>Horse Hollow Wind Farm II</td>
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<td>23</td>
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<tr>
<td>24</td>
<td>Horse Hollow Wind Farm IV</td>
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<td>25</td>
<td>Red Canyon 1</td>
<td>84</td>
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<td>26</td>
<td>Forest Creek Wind Farm</td>
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<td>Wolfe Flats Wind Farm</td>
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<td>Camp Springs</td>
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<td>29</td>
<td>Mesquite Wind Farm</td>
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<td>33</td>
<td>Post Oak Wind</td>
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<td>34</td>
<td>Capricorn Ridge Wind Farm 1</td>
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<tr>
<td>35</td>
<td>Capricorn Ridge Wind Farm 2</td>
<td>150</td>
</tr>
</tbody>
</table>

Total 4,366

Map as of 9-30-2007
Wind Turbine Nomenclature

Typical Parameters:
- Hub Height = 80 meters
- Rotor Diameter = 88 meters
- Swept Area = 6,082 sq. meters
- Cut-in Windspeed = 4 m/s
- Rated Windspeed = 14 m/s
- Cut-out Windspeed = 25 m/s

Drawing of the rotor and blades of a wind turbine, courtesy of ESN
Comparative Heights of the Wind Turbines

- **Suzlon S88 (2.1 MW)**
  - Total Height: 133 meters (433 feet)
  - Rotor Diameter: 88 meters (289 feet)
  - Hub Height: 80 meters (263 ft)

- **Statue of Liberty**
  - Total Height: 89 meters (290 feet)
  - Rotor Diameter: 47 meters (154 feet)
  - Hub Height: 65 meters (213 ft)

- **Carter 300 (300 kW)**
  - Total Height: 200 feet
  - Rotor Diameter: 79 feet
  - Hub Height: 160 ft

- **Vestas V47 (660 kW)**
  - Total Height: 133 meters (433 feet)
  - Rotor Diameter: 88 meters (289 feet)
  - Hub Height: 80 meters (263 ft)
Wind Turbine Technology Today

- Several well-established global manufacturers
  - Mitsubishi (Japan)
  - Suzlon (India)
  - GE (US)
  - Siemens (Germany)
  - Vestas (Denmark)
  - Gamesa (Spain)

- Typical wind turbine specifications
  - Capacity: 2 to 3 MW (net)
  - Hub Height: 80 to 90 meters
  - Rotor Diameter: 90 to 100 meters

- Typical costs: $1,500/kW to $2,000/kW
Tomorrow’s Wind Turbine Technology

New Innovations
- New blade designs for low wind speeds
- Smaller turbine weights/fewer lifts (e.g., two-blade design)
- Improved bearings and gearboxes

Larger Turbine Sizes
- Next generation 3+ MW
- 7.5 MW design being developed
- Up to 10 MW possible
Texas Offshore Wind Project

Galveston Off-Shore Wind
Announced in October, 2005
Located off-shore (Galveston Island)
Located on leased state-owned land (managed by the Texas General Land Office)
150 MW capacity
- 3 MW turbines (50)
- 260’ Hub Height (80 meters)
- 250’ Rotor Diameter
Commercial Operation Date: TBD
Location

Galveston Island

Site

10.36 miles

Boundary of Texas lands
Favorable Transmission Treatment

- Texas’ Postage Stamp Transmission Rate
  - Developer only pays for connection to the grid
  - Grid upgrades paid for by all users of the transmission system (Postage stamp rate)
  - Low hurdle for market entry
- ERCOT not subject to FERC regulation
- Development of additional transmission infrastructure through Competitive Renewable Energy Zones (CREZs)
Issues Facing Wind Generation

- Timing of Production
- Impact on Grid Operations
- Transmission Congestion
- Environmental and Social Impacts
Timing of Production

Wind Farm Production (MWh)

Projected vs. Actual

Month

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Summer Peak Month Coincidence

Average Hourly Profiles - August 2000

TXU Load

Wind Project Output

Capacity Value at Peak = 10.9%

20,993 MW

3.7 MW
Settlement Interval Production

February 2003

Note: Settlement Interval = 15 minutes
Impact on Grid Operations

- Voltage support
- Reactive compensation
- Responsive Reserves
- Grid Stability
Environmental and Social Impacts

- Avian and bat issues
- Radar interference
- Aesthetics
- Not In My Backyard (NIMBY)
Transmission Congestion

- Location of resource in relation to load
- Existing infrastructure
- Time required to construct new transmission facilities
Transmission Congestion

Local Transmission Congestion (138 and 69 kV)
(g) The commission, after consultation with each appropriate independent organization, electric reliability council, or regional transmission organization:

1) **shall designate competitive renewable energy zones** throughout this state in areas in which renewable energy resources and suitable land areas are sufficient to develop generating capacity from renewable energy technologies;

2) **shall develop a plan** to construct transmission capacity necessary to deliver to electric customers, in a manner that is most beneficial and cost-effective to the customers, the electric output from renewable energy technologies in the competitive renewable energy zones; and

3) **shall consider the level of financial commitment by generators** for each competitive renewable energy zone in determining whether to designate an area as a competitive renewable energy zone and whether to grant a certificate of convenience and necessity.

Section 39.904 of the Public Utility Regulatory Act
ERCOT Report on CREZs

Published in Dec. 2006, the study shows significant potential for wind development in Texas

- 2,508 MW in-service
- 4,850 MW to be in-service by 2007
- 17,000 MW have requested interconnection analysis

Examined 4 areas (10 zones):

- Gulf Coast
- McCamey
- Central-western Texas
- Texas Panhandle
Results

- Wind Capacity in CREZs ranged from 1,000 MW to 4,600 MW
- Capital costs for transmission upgrades ranged from $15 million to $1.5 billion
- Annual production cost savings ranged from $112 million to $587 million
- Annual capacity factors of wind generation in CREZs ranged from 37.0% to 43.3%
Major Issues:

- Definition of a CREZ (boundaries, sufficiency of renewable resources, level of financial commitment by developers, etc.)

- Number of CREZs

- Major transmission improvements necessary within a designated CREZ (i.e., beneficial and cost-effective)

- Implications (if any) on jurisdiction of the PUCT and FERC in relation to designating a zone as a CREZ in the Southwest Power Pool (SPP) region of Texas
Potential CREZs

17 parties nominated 17 of the 25 zones developed by ERCOT.

The zones most often nominated as CREZs were:

- Zone 2
- Zone 10
- Zone 4
- Zone 9

No Gulf Coast Zone was nominated.
In its Interim Order, the Commission:

- Designated 5 CREZs
- Ordered ERCOT to complete its CREZ Transmission Optimization Study within 6 months (04-01-2008)
  - Study to consider 4 scenarios for each CREZ
  - Total wind capacity varies from 5,000 to 18,000 MW
  - Develop transmission plan for each scenario
- Requires any generators located in Zone 1 (which is part of the designated Zone 2A) and Zone 4 to obtain approval from FERC before interconnecting with the ERCOT grid.
The Commission designated the following 5 CREZs:
1. A combination of Zones 1, 2 and Motley County (referred to as Zone 2A),
2. Zone 4,
3. Zone 5 and 6 together,
4. A combination of Zones 9, 10 and the area between those zones (referred to as Zone 9A)
5. Zone 19
Established a new rulemaking project (Project No. 34560) related to selection of transmission service providers for CREZs and other special projects.

Established a new rulemaking project (Project No. 34577) related to overdevelopment within CREZs (i.e., “piling on”).
Questions?