The Texas Competitive Renewable Energy Zone Process

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September 2017
Presentation Objectives

• Understand the transmission planning process for the Texas Competitive Renewable Energy Zone project

• Understand the technical considerations for planning the Texas Competitive Renewable Energy Zone project

• Understand how stakeholders worked together to successfully implement the Texas Competitive Renewable Energy Zone plan
The Texas Legislature restructured the Texas electric market in 1999 and assigned the Electric Reliability Council of Texas (ERCOT) four primary responsibilities:

• **System Reliability**
• **Competitive Wholesale Market**
• **Open Access to Transmission**
• **Competitive Retail Market**

ERCOT is a nonprofit organization and regulated by the Public Utility Commission of Texas (PUCT), with oversight by the Texas Legislature.

ERCOT is not a market participant and does not own generation or transmission/distribution wires.
Texas Competitive Model

- Generating units are owned by privately owned companies
  - Except for municipal and cooperative units
- Compete in ERCOT market to serve load
  - Market is overseen by PUCT.

- Transmission and distribution lines and related facilities are owned and operated by regulated utilities.
  - Utilities are regulated by PUCT.

- Consumer’s electric load is served by competitive retailers.
  - Except in municipal and cooperative utility areas
The ERCOT Region

The interconnected electrical system serving most of Texas, with limited external connections

- 90% of Texas electric load; 75% of Texas land
- 71,110 MW peak, August 11, 2016
- More than 46,500 miles of transmission lines
- 16,022 MW wind generation record (instantaneous), December 25, 2016
- 570+ generation units
ERCOT Installed Capacity (1999-2017)

Wind and solar values are based on nameplate capacity (not adjusted for peak capacity contribution)
Windy West Texas

Windy, Less Populated

Majority of Population

Texas Annual Average Wind Speed at 80 m

Which came first?

Transmission is built for generation once the generator is committed to build.

Generators will build once the transmission has been committed to be built.
2003 – The McCamey Plan

In 2003 McCamey had 755 MW of wind generation but an export limit of 400 MW

Phase 1 (Immediate): Local 138 kV and voltage support improvements

Phase 2 (1500 MW): New McCamey-Twin Buttes 345 kV line

Phase 3 (2000 MW): New McCamey-Odessa 345 kV line
2005 – Texas Senate Bill 20

• 2005 Texas Legislature
• Public Utility Commission of Texas (PUCT), with consultation from ERCOT shall:
  – Designate “Competitive Renewable Energy Zones” (CREZ)
    • Competitive – generation in ERCOT competes
    • Renewable Energy – mainly wind (solar not competitive in 2005)
    • Zones – areas with high renewable potential
  – Develop a transmission plan to deliver renewable power from CREZ to consumers
  – Etc.
• SB 20 did not specify how many MWs or where
The Zones

2006: ERCOT contracted with AWS Truepower to determine best wind resource zones in Texas

2007: PUCT identified five CREZs based on preliminary transmission analysis and wind developer interest
**Late 2007**

- PUCT asked ERCOT to develop CREZ Transmission Optimization Study (CTOS)
  - MW levels based on wind generation developer interest

<table>
<thead>
<tr>
<th>Location</th>
<th>Scenario 1 (MW)</th>
<th>Scenario 2 (MW)</th>
<th>Scenario 3 (MW)</th>
<th>Scenario 4 (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panhandle A</td>
<td>1,422</td>
<td>3,191</td>
<td>4,960</td>
<td>6,660</td>
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<tr>
<td>Panhandle B</td>
<td>1,067</td>
<td>2,393</td>
<td>3,270</td>
<td>0</td>
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<td>McCamey</td>
<td>829</td>
<td>1,859</td>
<td>2,890</td>
<td>3,190</td>
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<tr>
<td>Central</td>
<td>1,358</td>
<td>3,047</td>
<td>4,735</td>
<td>5,615</td>
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<tr>
<td>Central West</td>
<td>474</td>
<td>1,063</td>
<td>1,651</td>
<td>2,051</td>
</tr>
<tr>
<td><strong>Total CREZ Wind Capacity</strong></td>
<td><strong>5,150</strong></td>
<td><strong>11,553</strong></td>
<td><strong>17,956</strong></td>
<td><strong>17,516</strong></td>
</tr>
</tbody>
</table>
ERCOT Study Approach

Primary Study Tools:
1. Production Cost Modeling
   • Objective: <2% Annual Wind Curtailment
2. Stability Analysis
Early Maps
Early Maps
Narrowing Options

CTOS

- Incremental 345-kV Network
- Incremental 765-kV Network
- HVDC to Load Centers
- Isolated 345-kV Network
- 345-kV Hub-and-Spoke
- Low Impedance Wind-to-Load Loop

Best Ideas

Hybrid Approach

ERCOT Issued CTOS Report April 2, 2008
2008

• The PUCT selected Scenario 2
  – Accommodate 18.5 GW of wind
  – $6.8 Billion
  – ~3,600 circuit miles 345 kV transmission

• What still needed to be decided
  – Who (Transmission Service Providers) would build the CREZ lines
  – Reactive needs
  – Subsynchronous Resonance
  – Staging
2009 – PUCT Selects Transmission Providers
2010-2013

• 2010: Follow-up reactive compensation and stability studies

• 2010-2013: Construction
  – Goal was to have all facilities in-service by December 31, 2013
    • It nearly happened!
Technical Lessons Learned

• Weak grid
  – Inverter based generation needs a strong synchronous signal

• Stability
  – Stability became the most limiting factor
  – Recommend begin stability analysis early in the process if incorporating large amounts of generation and/or if transferring over a long distance

• Grid code
  – Modern turbines and inverters can support grid needs
  – It can be difficult to retrofit after installed

• Economic curtailment
  – It is not economically optimal to plan for 100% wind generation output
Policy-Related Lessons Learned

- Successful integration of >19 GW of wind generation
  - Eliminated transmission bottleneck issues that could have delayed wind generation development
  - Operating reliably and efficiently
    - In 2016 ERCOT had its lowest ever average wholesale price of electricity ($24.62/MWh)
    - Low prices attributed to low natural gas prices and abundance of low-cost renewable energy (and other factors)
- Transmission provider competition
  - Incented TSPs to complete construction on time
  - Can be challenging in operational coordination
- Stakeholder collaboration
  - Would not have been successful without participation from a broad cross section of stakeholders
Wind Generation Capacity Today

ERCOT Wind Installations by Year (through August 1, 2017)

- Cumulative MW Installed
- Cumulative Planned (Signed Interconnection Agreement with Financial Security)
- IA Signed - No Financial Security

2009: 17% wind curtailment
2014: 0.5% wind curtailment

YEAR | Cumulative MW Installed | Cumulative Planned | IA Signed - No Financial Security
-----|--------------------------|-------------------|-------------------------
2000 | 116 MW                   |                   |                         
2001 | 816 MW                   |                   |                         
2002 | 977 MW                   |                   |                         
2003 | 1,173 MW                 |                   |                         
2004 | 1,385 MW                 |                   |                         
2005 | 1,854 MW                 |                   |                         
2006 | 2,875 MW                 |                   |                         
2007 | 4,785 MW                 | 8,005 MW          |                         
2008 | 8,916 MW                 | 9,400 MW          |                         
2009 | 9,604 MW                 | 10,407 MW         |                         
2010 | 11,065 MW                | 12,470 MW         |                         
2011 | 12,674 MW                | 15,764 MW         |                         
2012 | 15,604 MW                | 200 MW            |                         
2013 | 19,512 MW                | 1,965 MW          |                         
2014 | 21,677 MW                | 26,845 MW         |                         
2015 | 21,677 MW                | 26,845 MW         |                         
2016 | 29,014 MW                | 29,014 MW         |                         
2017 | 29,014 MW                | 29,014 MW         |                         
2018 | 29,014 MW                | 29,014 MW         |                         
2019 | 29,014 MW                | 29,014 MW         |                         
2020 | 29,014 MW                | 29,014 MW         |                         

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