



# Utility Scale Solar Generation Integration



Hala Ballouz, M.Sc., P.E.

# Overview

- Utility Scale Solar Projects Rising
- Solar, Wind and Load Patterns
- GEMINI 30 MW Solar Photovoltaic Generation Project
- Inverters and Grid Interconnection Requirements
- Developer Concerns or Challenges



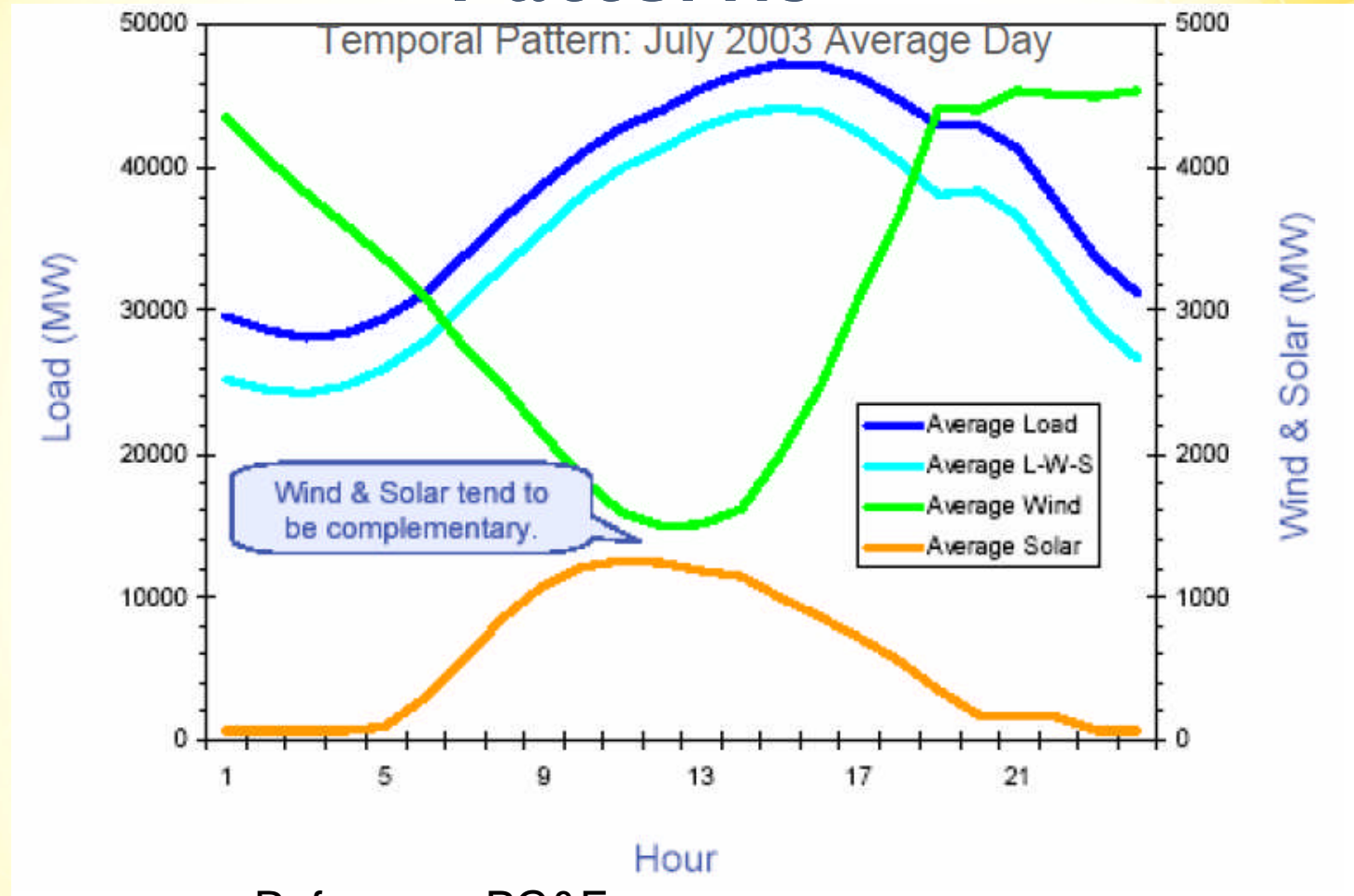
# Large Solar Projects Rising

EPE consulting to Developers:  
Two years ago – No solar related studies  
This past year – more than 30 studies & rising

- ✓ Technology and Price matured
- ✓ Rapid deployment
- ✓ Daytime peak power matches utility load profile
- ✓ Easier permitting
- Transmission congestion facing wind. Fill in the blanks with Solar?



# Solar, Wind and Load Patterns



Reference: PG&E



## **PSEG Solar Source Projects totaling 29.2 MW to be completed by end of 2010.**

### **Solar at New Jersey**

(September 23, 2009 – Newark, NJ) - PSEG Solar Source today completed the acquisition from juwi solar Inc., of two utility-scale solar projects to be located in **Florida** and **Ohio**

**Abengoa Solar to build the first Solar Thermal installation integrated with a Coal Plant owned by Xcel Energy** developed a third solar project which have a total capacity of

### **Abengoa Solar to build the first Solar Thermal installation integrated with a Coal Plant owned by Xcel Energy**

Denver, August 27, 2009 – Abengoa Solar has been selected by Xcel Energy to build a demonstration parabolic concentrating solar power (CSP) plant near **Grand Junction, Colorado.**

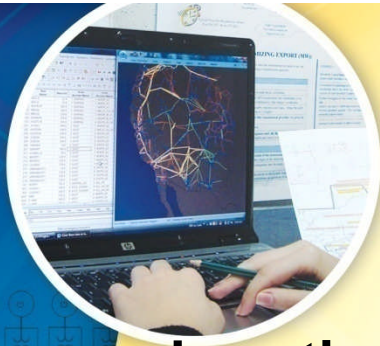
### **New York Times**

### **Gemini Solar to Build Big in Austin**

**Gemini Solar Development** scored its first deal this week, and it's for one of the largest solar photovoltaic plants in the country — a **30-megawatt plant in Austin, Texas**, that's expected to go online by the end of 2010. The unanimous approval of the project by the Austin City Council serves as a clear sign that Gemini's future is a bright one.



# First Large Scale PV Solar Project in Texas



<b>Location</b>	Webberville, Texas
<b>Owner &amp; Developer</b>	Gemini Solar Development Company
<b>Power Purchaser</b>	Austin Energy
<b>Project Size (MW)</b>	34.4 MW dc / <b>30MW</b> ac
<b>Significance</b>	First large-scale PV project proposed in Texas
<b>Module Supplier</b>	Suntech Power Holdings



**Target Completion** 2010

**Project Cost** US \$205 million (estimate)

**Status** Approved by City Council. & signed PPA



# GEMINI

## Webberville Solar Project

Austin Energy was looking for cost-effective solution to meet their solar Renewable Portfolio Standard goals

Previous RFPs too expensive

Why Gemini?

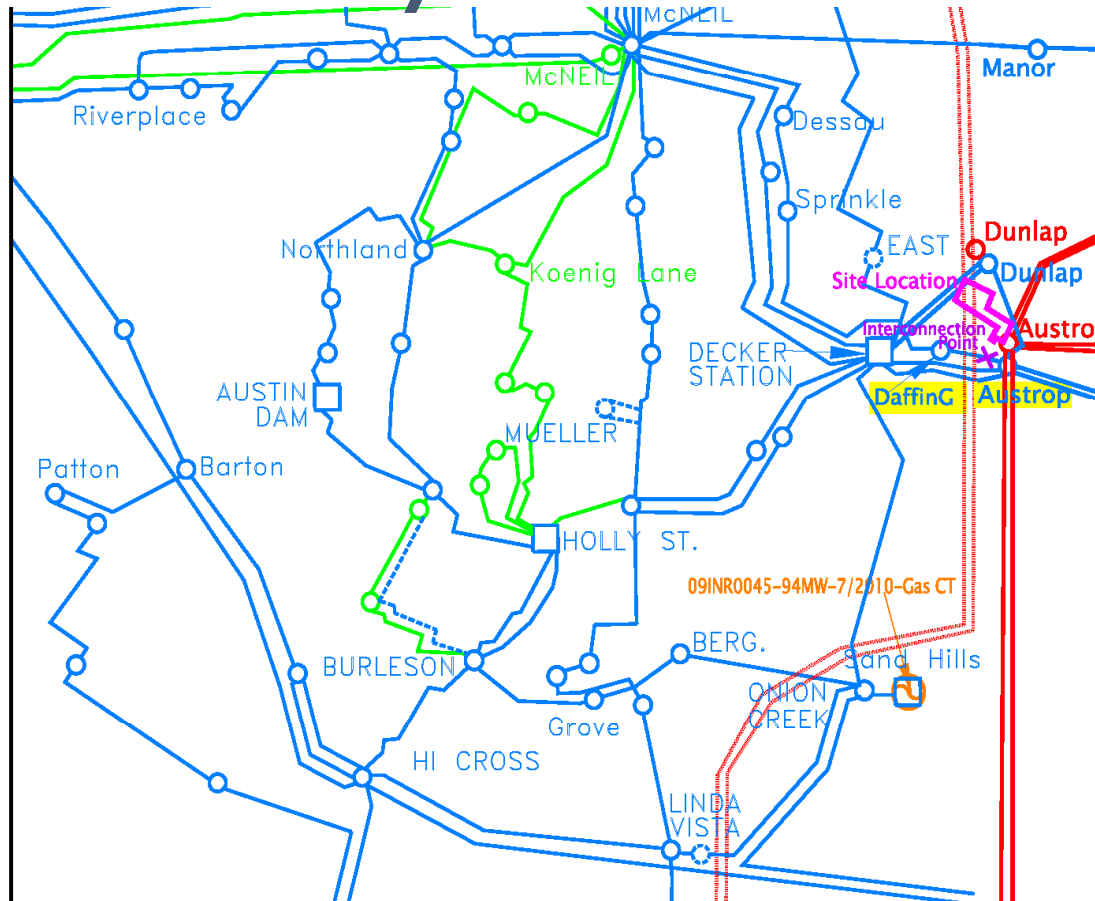
Competitive Price

Track record

Visibility to solar PV technology



# GEMINI 30 MW Solar City of Austin



<b>LEGEND</b> 345 KV Existing 230 KV ERCOT Proposed 138 KV ERCOT Under Study 115 KV Change Of Ownership 69 KV		<b>ERCOT CREZ Proposed Transmission</b> Double Circuit 345 KV Single Circuit 345 KV Add second Circuit to Existing 345 KV Structure Add second Circuit to Existing 138 KV Structure Single Circuit 138 KV Wind Power Collection Point New 345 KV Substation New 345 KV Substation with 345/138KV Transformer		<b>EPE ELECTRIC POWER ENGINEERS, INC.</b> 13326 200 West Highway 6, Suite 610 Waco, Texas 76712 Office: 254-368-8676 Fax: 666-379-3635 Email: hballouz@epeconsulting.com				<table border="1"> <thead> <tr> <th>DATE</th> <th>REVISIONS</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </tbody> </table>		DATE	REVISIONS																					<b>GEMINI SOLAR DEVELOPMENT CO. LLC</b> GEMINI AE SOLAR- 30MW PROJECT - SITE MAP <b>EPE ELECTRIC POWER ENGINEERS, INC.</b> WACO, TEXAS FILENAME: Webberville SiteMap.dwg   DWN BY: E.P.E.   DATE: 7/8/09	
DATE	REVISIONS																																



# Grid Interconnection Requirements

Most inverters available are compliant with:

- IEEE STD 1547 (Recommended Practices for Interconnecting Distributed Resources)
- IEEE STD 929 (Recommended Practice for Utility Interface of PV Systems).
- IEEE 519 -1992.

**ERCOT requirements are more stringent than IEEE STD 1547 and IEEE STD 929**



# ERCOT Interconnection Requirements

- ERCOT presently does not have protocols uniquely for utility scale solar facilities.
- Both solar and wind are classified as non synchronous.
- What requirements should the solar project inverters comply with?



# ERCOT Interconnection Requirements

- Low voltage ride-through (LVRT) for wind
- Reactive power support at +/-95%
- Over and under frequency ride-through
- Operate continuously from 90% - 110% of nominal voltage.



# Satcon PV PowerGate 500 kW



## Standard Compliance:

- UL1741, CSA 107.1-01
- **IEEE 1547**, IEEE C62.41.2, IEEE C62.45, IEEE
- C37.90.1, IEEE C37.90.2



# Satcon PowerGate Plus 500kW Inverter Voltage Settings

Voltage Range (% $V_{NOMINAL}$ )	ERCOT Delay to Trip for Wind Generation	Satcon
$110\% < V$	Generator Discretion	<b>In Compliance</b> – Adjustable trip time between .16s and 1.00s
$90\% \leq V \leq 110\%$	No automatic tripping (Continuous operation)	<b>In Compliance</b> – Continuous operation from 88% to 110%
$50\% \leq V < 90\%$	1.1s to 1.75s	<b>In Compliance</b> – Adjustable up to 2.00s
$20\% \leq V < 50\%$	.5s to 1.1s	<b>Trips after .16s</b>
$0 < V < 20\%$	.15 to .5s	<b>Trips instantly</b>
$V = 0$	.15s	<b>Trips instantly</b>

Source: PowerGate Plus Installation, Operation, and Maintenance Guide & ERCOT Operating Guides Section 3.1.4

# Satcon PowerGate Plus 500kW Inverter Frequency Specifications



Frequency Range (Hz)	ERCOT Delay to Trip	Satcon
$60.5 < f$	Generator responsibility	<b>In Compliance</b> – adjustable trip time between .10s and .16s
$59.4 < f \leq 60.5$	No automatic tripping (Continuous operation)	<b>In Compliance</b> - will operate with the grid frequency between 59.3-60.5Hz as default setting
$58.4 < f \leq 59.4$	Not less than 9 minutes	<b>can only ride-through for 5 minutes (300 seconds)</b>
$58.0 < f \leq 58.4$	Not less than 30 seconds	<b>In Compliance</b> - 0.16 seconds (adjustable, max 300 sec) down to 57 Hz.
$57.5 < f \leq 58.0$	Not less than 2 seconds	<b>In Compliance</b> - 0.16 seconds (adjustable, max 300 sec) down to 57 Hz.
$f \leq 57.5$	No time delay required	<b>In Compliance</b> – Instant tripping at 57 Hz



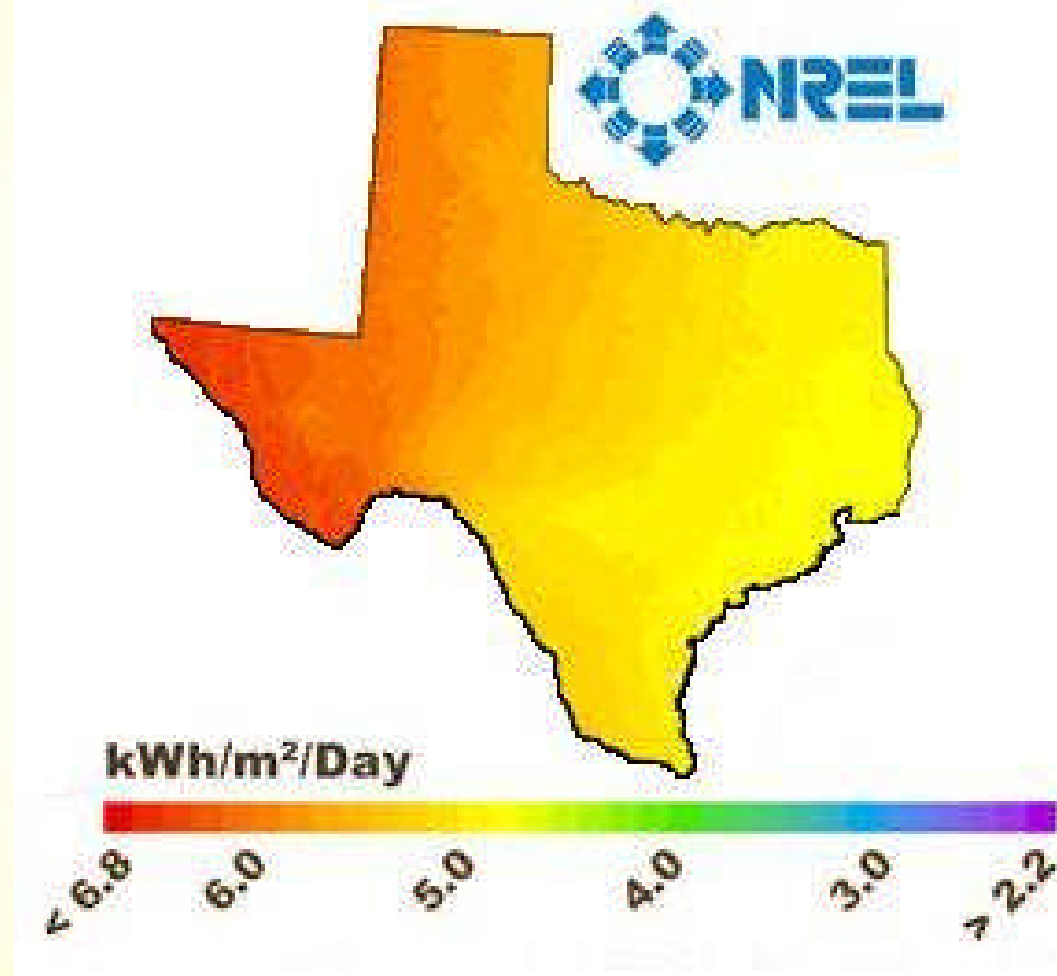
Source: PowerGate Plus Installation, Operation, and Maintenance Guide

# Technical Challenges

- The need for enhanced interconnection procedures and standards to address reactive power control, voltage and frequency ride-through
- Work on the inverter side to lessen the power quality impacts and improve voltage and frequency compliance.



# Solar PV Resources in Texas



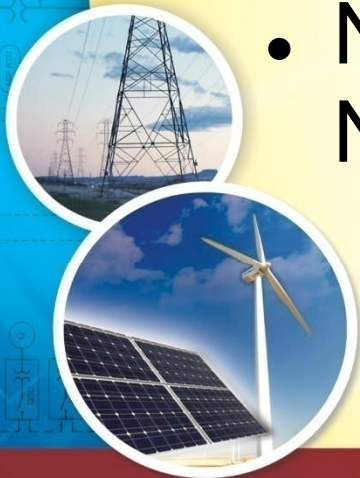
# Call for Solar Generation

- Requests for Proposals for PPA rising targeting Solar projects
- Solar in West Texas?
- Utilities call for PPA, do they care about location of project on the grid?



# Other Challenges for Solar Developers

- “The biggest ERCOT challenge to solar are similar to other generation on the lack of firm transmission rights. That adds an extra variable of risk over a 25 year asset investment life.”
- Negative Node Pricing and impact of Nodal market on future prices



# Studies Required

- To show what actually happens on grids with large penetration of solar
- What can be done at the solar inverter to improve quality and grid compliance.
- ERCOT: Adding significant amounts of Solar generation in West Texas.



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