Opportunities for Solar Development on Wind-Constrained Transmission Systems

Prepared by

clean energy associates

Steve Wiese, Principal
Elisabeth Long, Associate
Benjamin Ryan, Research Assistant
Austin, Texas

Presented at ASES Solar Conference 2010
Technical Session: Evolution of Large Scale PV
May 19, 2010

in partnership with Austin Energy and the U.S. Department of Energy Solar America Cities initiative

AUSTIN ENERGY

SOLAR AMERICA CITIES

This assessment and report was created for Austin Energy with funding from the U.S. Department of Energy's Solar America Cities program.
For more information, see http://www.solaramericacities.energy.gov/.

Presentation Overview

- Objectives and key questions
- Modeling approach
  - Study locations
  - Wind/solar resource regimes
  - Sample analysis
  - PV deployment scenarios
- Findings
  - Estimates of solar value
  - Estimates of energy and economic losses
  - Sensitivity analysis

Study Objectives/Key Questions

Objectives

- Evaluate the opportunity to load both wind and solar generation capacity onto a constrained transmission system while engendering only minimal losses
- Correlate wind, solar and co-located wind/solar generation with system loads and energy prices
- Quantify the economic and energy opportunities and costs associated with pursuing this strategy in two Texas locations

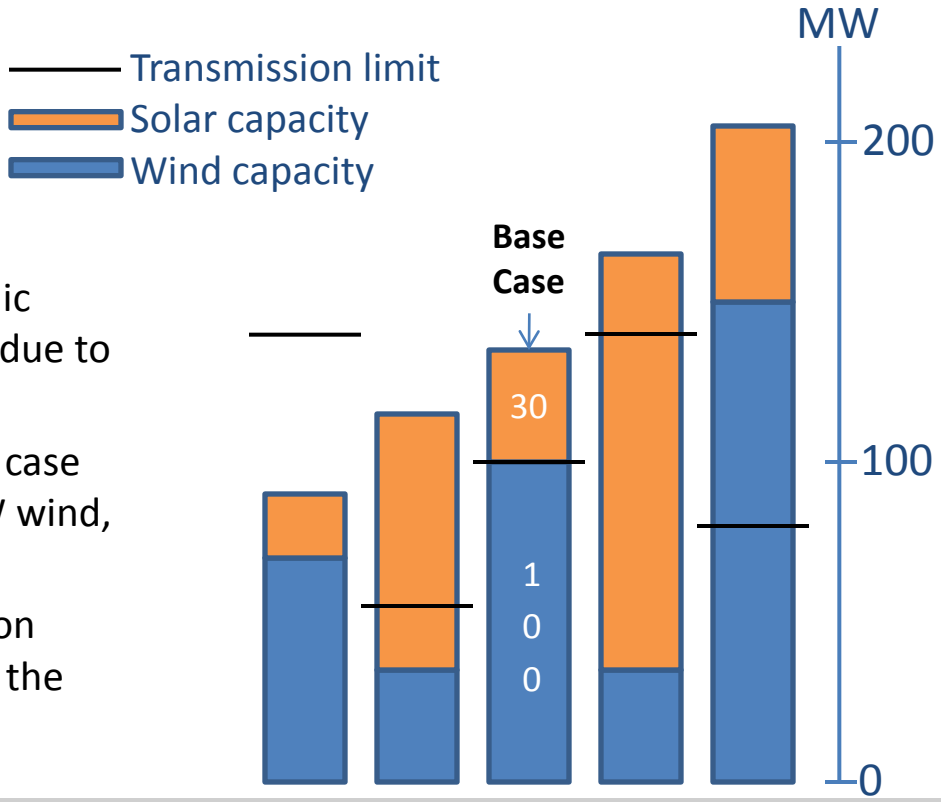
Key questions

- How much solar generating capacity can be reasonably accommodated in locations where transmission is already constrained by existing wind generation?
- Where in Texas does solar/wind co-located generation make the most sense?
- What losses (energy and revenue) can be expected from solar and wind generation operating together in a transmission-constrained environment?

Modeling Approach

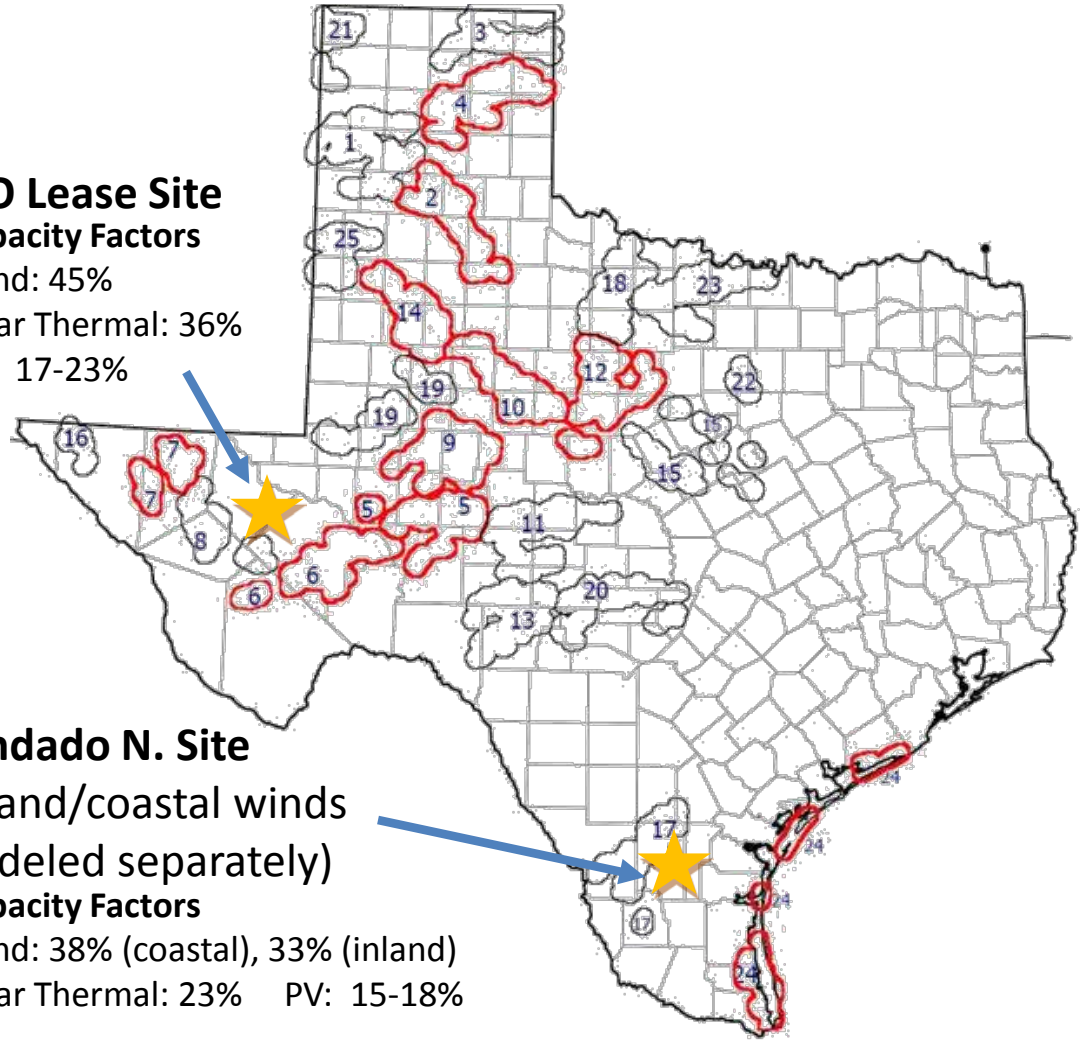
Definition: For the purposes of this study, solar/wind "co-located" generation refers to the presence of solar and wind generating capacity upstream from a transmission constraint. It does not necessarily mean the solar and wind capacity is co-located on the same property or is operated jointly by a single project owner.

1. **Model development:** Develop and deliver to Austin Energy a flexible model with settable solar and wind nameplate capacity, transmission limit
2. **Model outputs:** Raw energy and economic value produced; energy and value losses due to limits
3. **Base case:** Develop and report on a base case scenario assuming 30 MW solar, 100 MW wind, and 100 MW transmission limit
4. **Sensitivity analysis:** Perform and report on sensitivity analysis on each variable from the base case



clean energy associates

Locations and Wind/Solar Regimes



GLO Lease Site

Capacity Factors

Wind: 45%

Solar Thermal: 36%

PV: 17-23%

Randado N. Site

(inland/coastal winds modeled separately)

Capacity Factors

Wind: 38% (coastal), 33% (inland)

Solar Thermal: 23% PV: 15-18%

3 wind regimes

- GLO Lease Site
  - ERCOT UPLAN at McCamey A bus
- Randado N. Site
  - CREZ 17 (inland)
  - CREZ 24 (coastal)

4 solar technologies

- Solar thermal w/ 6 hours TES
- PV 1-axis tracker
- PV fixed tilt due south
- PV fixed tilt southwest

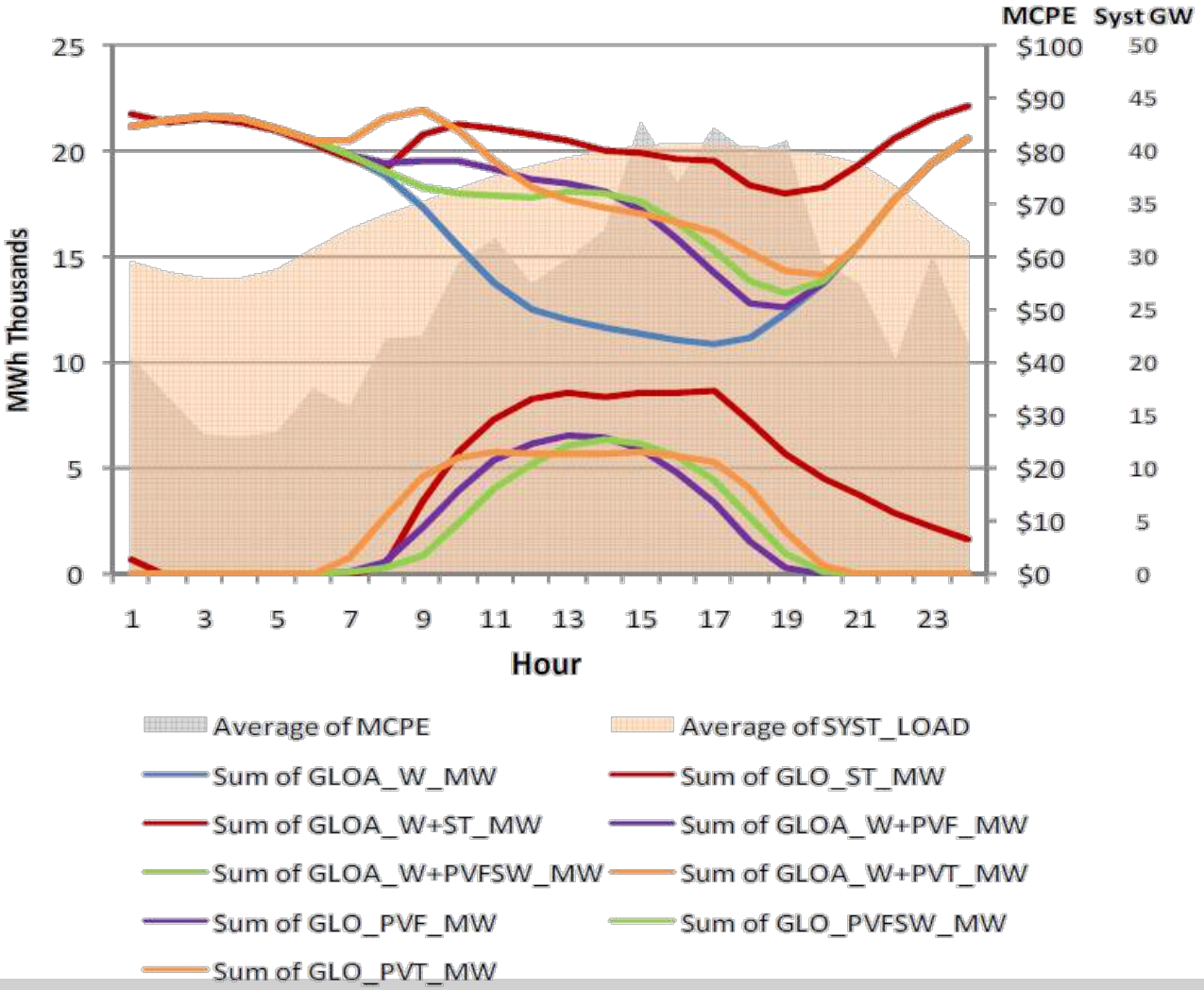
All solar production modeled with NREL's Solar Advisor Model (SAM) with custom UPLAN- or CREZ-matched solar data

clean energy associates

Sample Analysis – GLO Lease Site

Average Annual Wind, Solar and Combined Production by Hour

Base Case



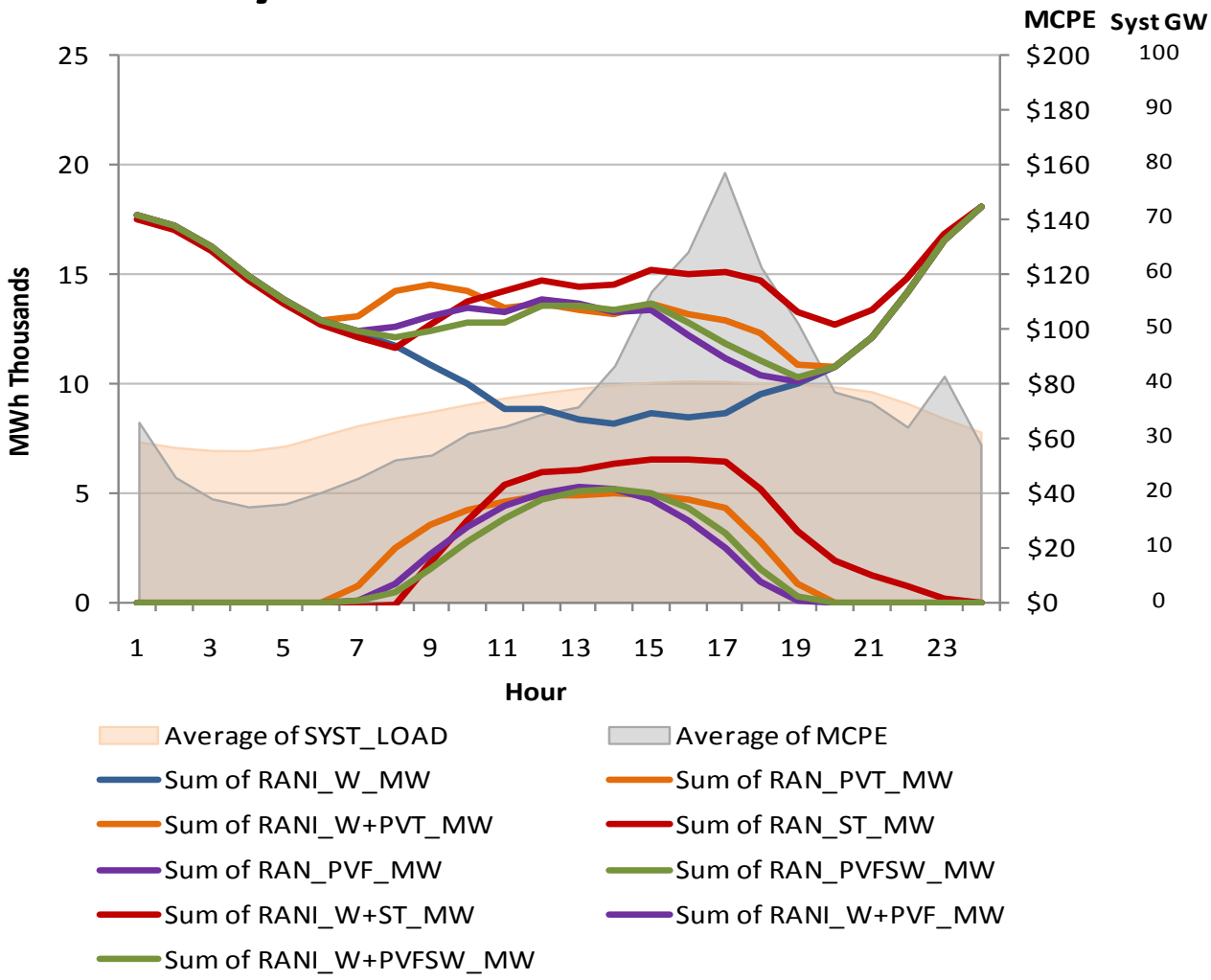
clean energy associates

Sample Analysis – Randado N. Site

Inland (CREZ 17) Winds

Average Annual Wind, Solar and Combined Production by Hour

Base Case



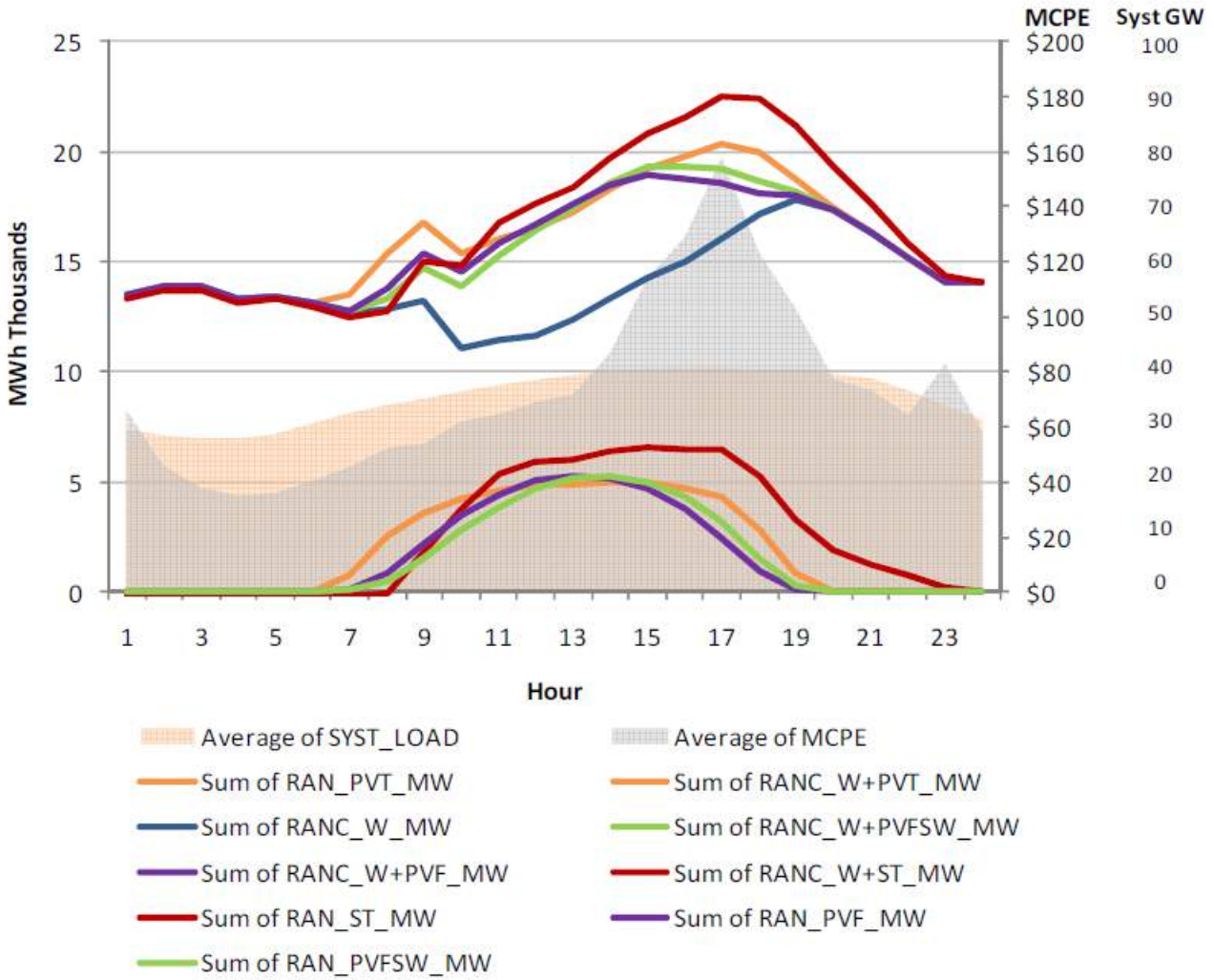
clean energy associates

Sample Analysis – Randado N. Site

Coastal (CREZ 24) Winds

Average Annual Wind, Solar and Combined Production by Hou

Base Case



clean energy associates

Summary Findings - Base Case

Base case limited annual solar value

Wind +	GLO Lease Site	Randado N. Site - Coastal	Randado N. Site - Inland
Solar thermal	$6,692,552	$6,307,415	$7,094,690
PV tracker	$3,970,710	$4,467,989	$4,715,764
PV fixed S	$3,116,110	$3,500,772	$3,610,628
PV fixed SW	$3,185,196	$3,715,711	$3,866,563

- Solar value generally correlates positively with generator capacity factors
  - Exception: PV fixed SW earns higher value than PV fixed S despite lower total production
- Randado N. Site benefits from high South MCPE levels in 2008
- Solar paired with inland wind at Randado N. Site earns greater value than solar paired with coastal wind.
  - High positive correlation of coastal wind, solar and MCPE leads to losses at peak.

Summary Findings - Base Case

Value Loss < MWh Loss

Value Loss > MWh Loss

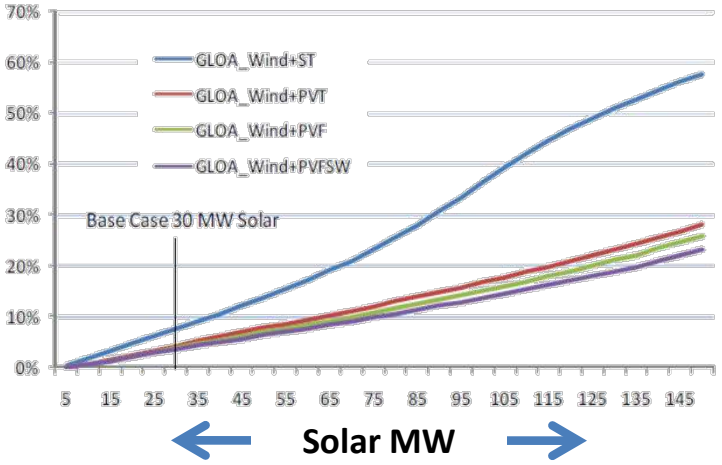
Base case energy and economic value losses at each site

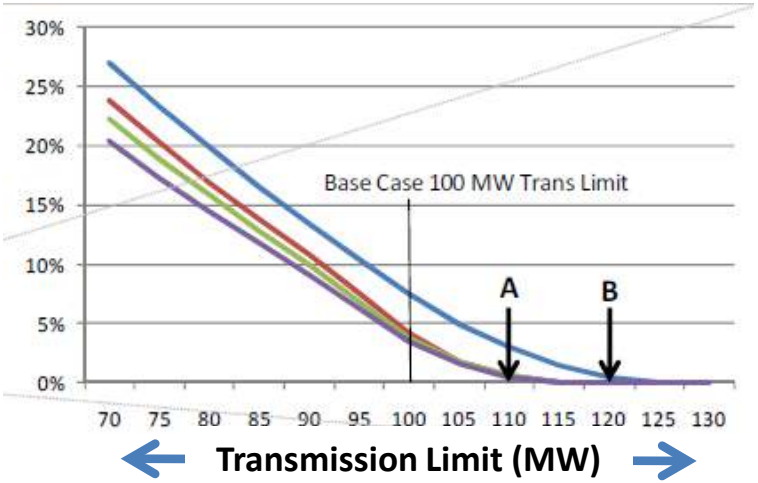
Wind +	GLO Lease Site		Randado N. Site - Coastal		Randado N. Site - Inland	
	% Solar MWh Lost	% Solar Value Lost	% Solar MWh Lost	% Solar Value Lost	% Solar MWh Lost	% Solar Value Lost
Solar thermal	7.5%	5.7%	11.2%	14.7%	3.9%	4.1%
PV tracker	4.2%	3.2%	4.9%	6.6%	1.7%	1.4%
PV fixed S	3.8%	2.8%	3.7%	4.4%	1.7%	1.4%
PV fixed SW	3.5%	2.2%	3.9%	5.2%	1.7%	1.3%

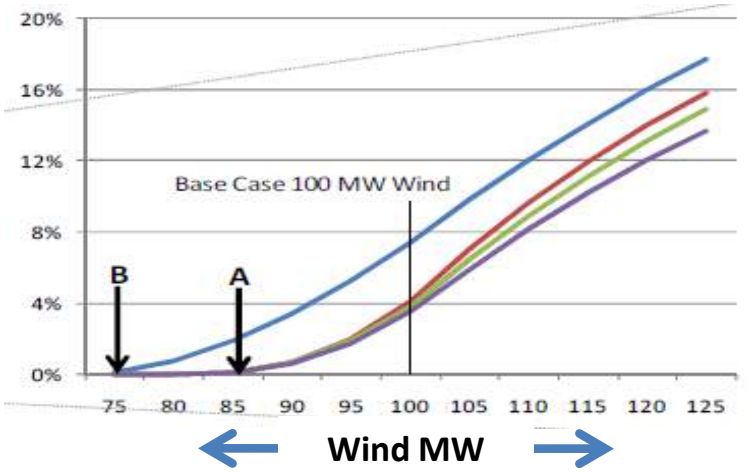
- All losses accrue to the solar generator in the base case
- Solar losses generally correlate positively with generator capacity factors
  - Exception: Randado Coastal/PV fixed SW - PV peaks in late afternoon along with wind
- GLO Lease Site economic losses are lower than MWh losses (lost solar MWh tend to occur during periods when prices are relatively low)
- Randado N. Coastal is opposite, indicating lost solar MWh tend to occur during periods when prices are relatively high
- Randado N. Inland losses are mixed

Sensitivity of Results

- Solar losses increase as constraints are tightened (+ solar, + wind, - transmission limit)
- Solar losses at GLO Lease Site are:
  - Less than 1% at 30 MW solar, 1000 MW wind, and 1000 MW transmission limit
  - 18-22% at 30-150 MW solar, 1500 MW wind, and 1000 MW transmission limit







clean energy associates

Conclusions

- Base case study is a start, findings may be useful in evaluating strategies for co-locating solar and wind resources on the grid.
- Location-specific conclusions
  - The GLO Lease Site has the greatest wind and solar production capability but lower MCPE levels in ERCOT's west zone reduce overall value
  - Solar paired with coastal wind regime at the Randado N. Site generates significant overall energy but carries a higher risk of loss due to curtailment
  - The best outcomes for solar generation occur where solar production is strongly negatively correlated to wind, and strongly positively correlated to price and/or peak loads
- Solar energy losses range from **1.7% to 11.2%** in the base case; economic losses range from **1.3% to 14.7%**. Losses at the GLO Lease Site are **less than 1%** at 30 MW solar, 1000 MW wind, and 1000 MW transmission limit.
- Solar generation can be reasonably accommodated within transmission systems already constrained by existing wind generation while experiencing minimal energy and economic losses.

Steven M. Wiese, Principal
steve.wiese@cleanenergyassociates.com
512-323-6629