

Demand Response and Integration of Renewable Generation Resources

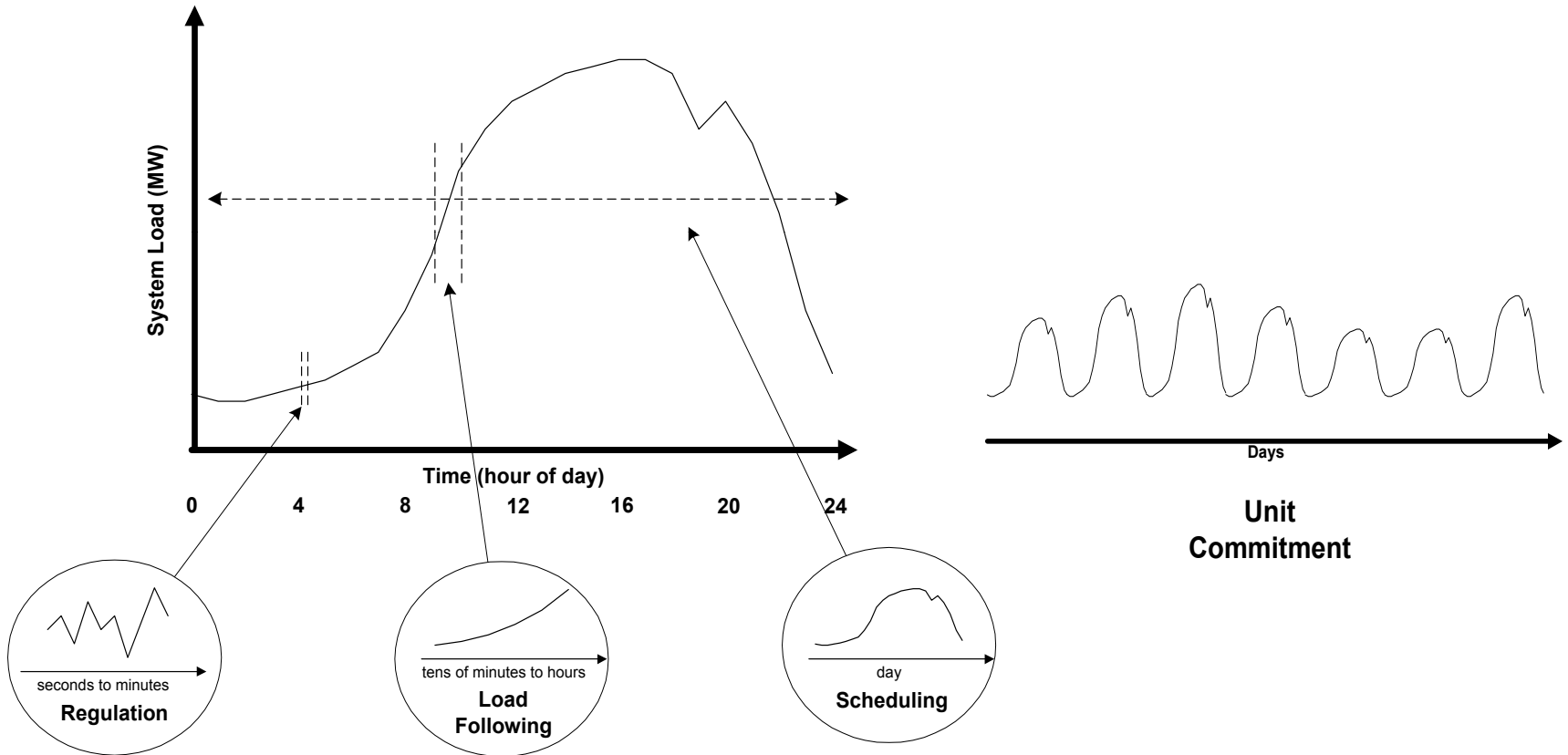
Dr. Steve Isser

*Vice President of Good Company Associates,
Vice Chairman of PLMA*

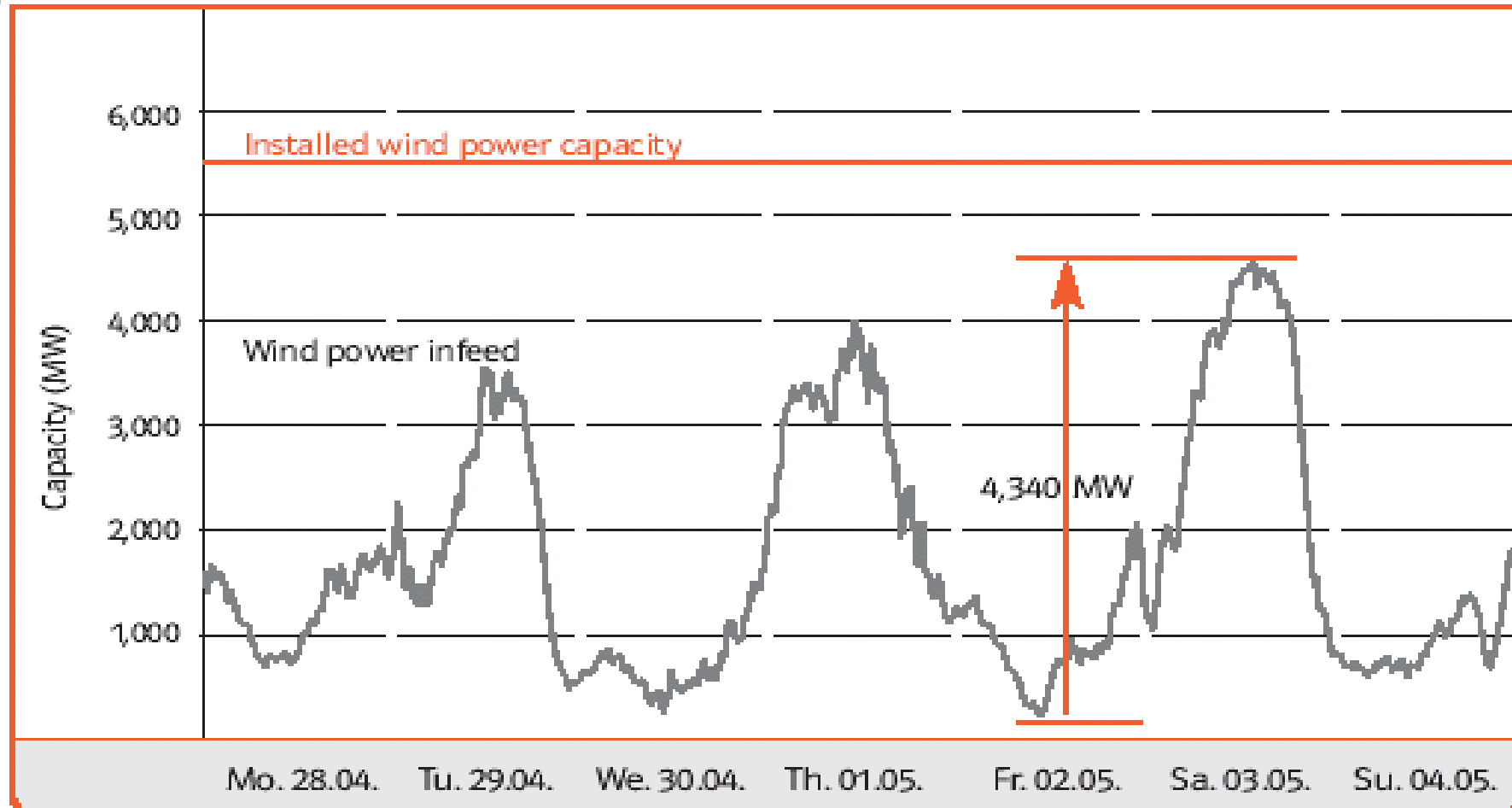
Integrating Renewables is Hot Topic

- Implications of Expansion of Wind
 - Wind generation usually doesn't align with the daily load patterns.
 - Errors in wind generation forecasts can increase the overall uncertainty for unit commitment and scheduling.
 - Operational performance issues are apparent at around 10% of peak capacity level of wind development
 - Mitigation measures include but are not limited to;
 - o *developing wind power forecasting techniques;*
 - o *increasing regulating reserves;*
 - o *increasing transmission reliability margins; and*
 - o *placing constraints on wind power facilities.*
- The need for additional reserves occurs across all time scales, from seconds (regulation) to minutes (spinning or synchronous reserves) to tens of minutes (non-spin reserves) to hours and days.
 - Regulation required for wind grows more slowly than wind capacity because short-run fluctuations are weakly correlated.

Time Scales of Interest



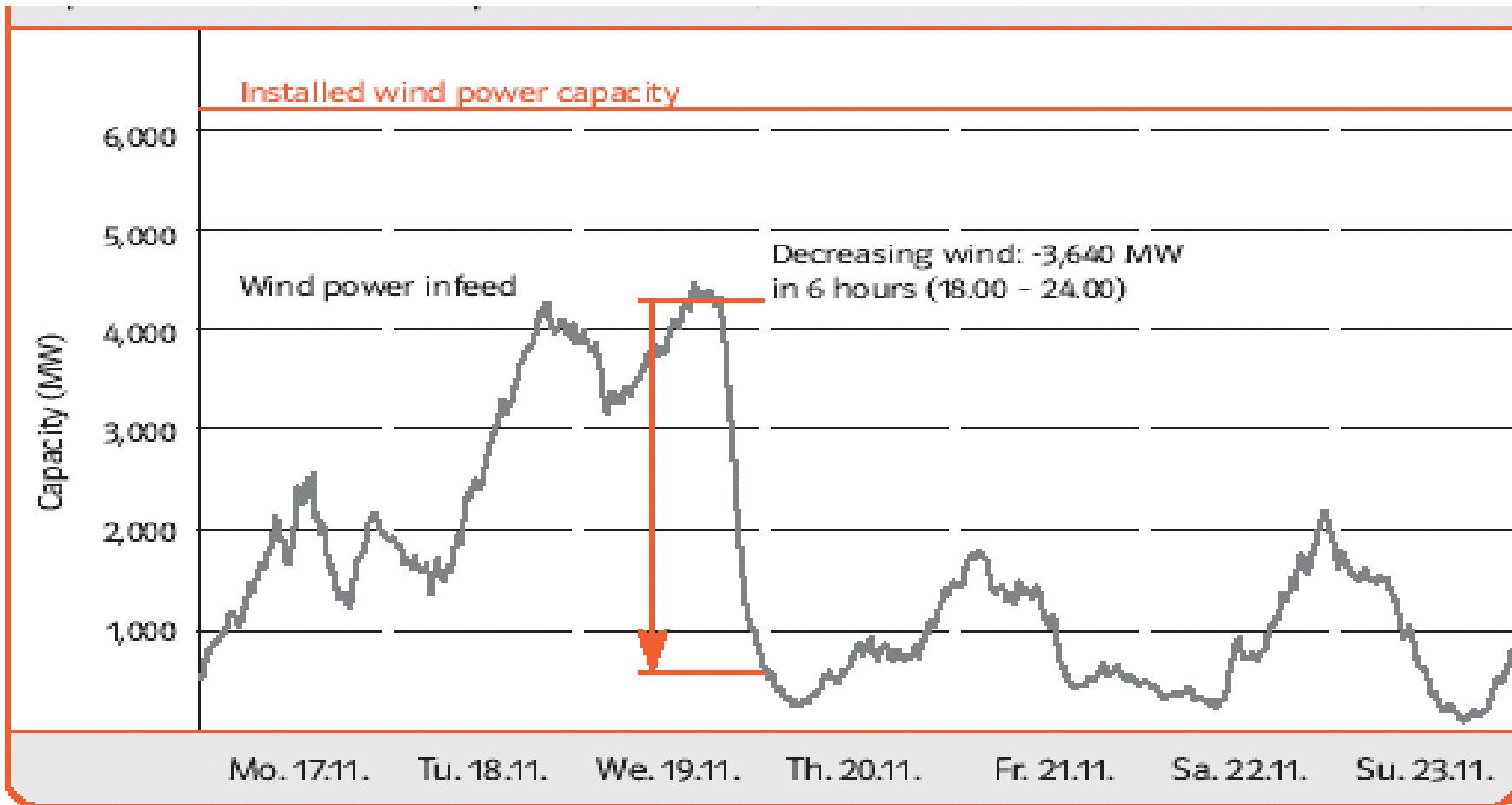
Slow strong fluctuations



Reference: *EON_Netz_Windreport_e_eng.pdf*

Fairly rapid decrease

Winter power infeed E.ON control area 17.11 to 23.11.03



Reference: *EON_Netz_Windreport_e_eng.pdf*

ERCOT Challenge

- 9,621 MW by end of 2008 –
~ 15% of Peak
- 18,000 MW by 2015-2020?
- Current Operational Challenges
 - 15 minute Balancing Energy and Scheduling Challenge
 - Affect on Frequency Control
 - Load/Wind Forecasting Challenge
 - Ancillary Service Requirement Challenge

Putting the February Events into Perspective

- Geographic diversity limit the speed that wind events propagate.
 - February 26, 2008 - three hours to drop 1,500 MW.
 - February 24, 2007 - two hours to drop 1,500 MW.
 - AES Truewind reports that ERCOT can expect:
 - less than one 2,800-MW, 30-minute drop per year - 15,000-MW wind
 - 2-4, 1,300-MW, 30-minute increases or decreases
 - Experience in Other Regions
 - Denmark: 2000 MW (83% of capacity) decrease in 6 hours - 1/8/05
 - Germany: 4000 MW (58% of capacity) decrease in 10 hours – 1/24/04
 - Portugal: 700 MW (60% of capacity) decrease in 8 hours – 6/1/06
 - Spain: 800 MW (7%) increase in 45 minutes
- Conventional generation contingencies require dedicated spinning reserves and immediate response (2300 MW of ERCOT Responsive Reserve Service).
- Multi-hour wind ramps give the system operator time to utilize **load response**, supplemental reserves, or non-spinning reserves.

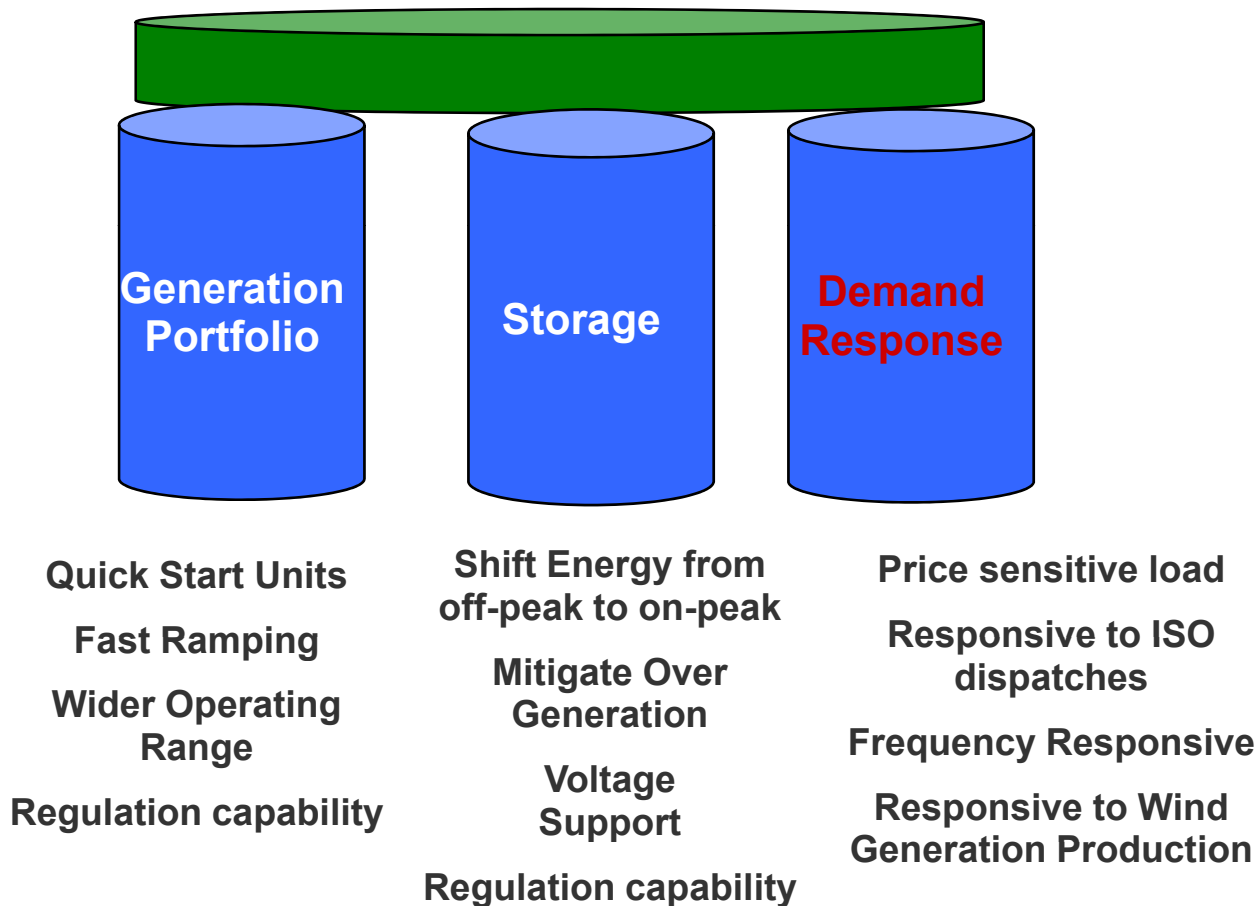
Project Costs of Wind Integration

Date	Study	Wind Penetration %	Regulation Cost (\$/MWh)	Load Following Cost (\$/MWh)	Unit Commitment Cost (\$/MWh)	Gas Supply Cost (\$/MWh)	Total Cost Impact (\$/MWh)
2005	Pacificorp	20%		1.60	3.00		4.60
April 06	XCEL-PSCo	15%	0.20		3.32	1.45	4.97
Nov 06	MN/MISO	25-35%	0.15		4.26		4.41
Feb 07	GE/PIER	20%	0.69				
March 07	Avista	20%	1.67	1.79	2.69	na	6.65
Sept 07	Arizona	10%	0.31	2.32	0.93	na	3.56

Role of Load Management and Demand Response

- Load Management
 - Load shifting to wind peak periods avoids curtailment, negative prices
 - Allows more economic operation of baseload units with wind
- Demand Response
 - Provide ancillary services
 - Provide ramping capability, mix of quick start generation and DR? No startup, no load, fuel costs with DR.
- More Study is Needed, little has been done up to Now

CAISO Considers DR One of the Three Legs of Renewable Energy Integration



CAISO's Demand Response Proposal

1. Price Sensitive load - Bid into Day-Ahead markets to reduce peak load.
2. Interruptible Load – Loads willing to be curtail under emergency conditions.
3. Frequency sensitive load – Load that is responsive due to a drop in system frequency.
4. Load that curtails based on availability of excess wind generation production.

Goals of NERC Report on Integrating Variable Resources

- Raise awareness/understanding of characteristics of variable resources
- Investigate changes required to traditional approaches used by system planners and operators. For example:
 - Ensure adequate supply during all periods
 - Technical/Interconnection Requirements
 - Transmission Planning
 - Scheduling & Dispatch
 - Diversity & Ancillary services
 - Demand Side Resources & Storage technologies
- Integration of Variable Generation Task Force (IVGTF)
 - Final Report, December 2008, Open Meeting Jan 2009
 - Need to take action and give input

Cost Effective Wind in the Northwest

A14a: Characterize **demand-side**, power generation, storage and other options for augmenting system flexibility (Forum - 2008)

A14b: Improve understanding of tradeoff between competing uses of system flexibility

A15: Develop planning framework to optimize tradeoffs

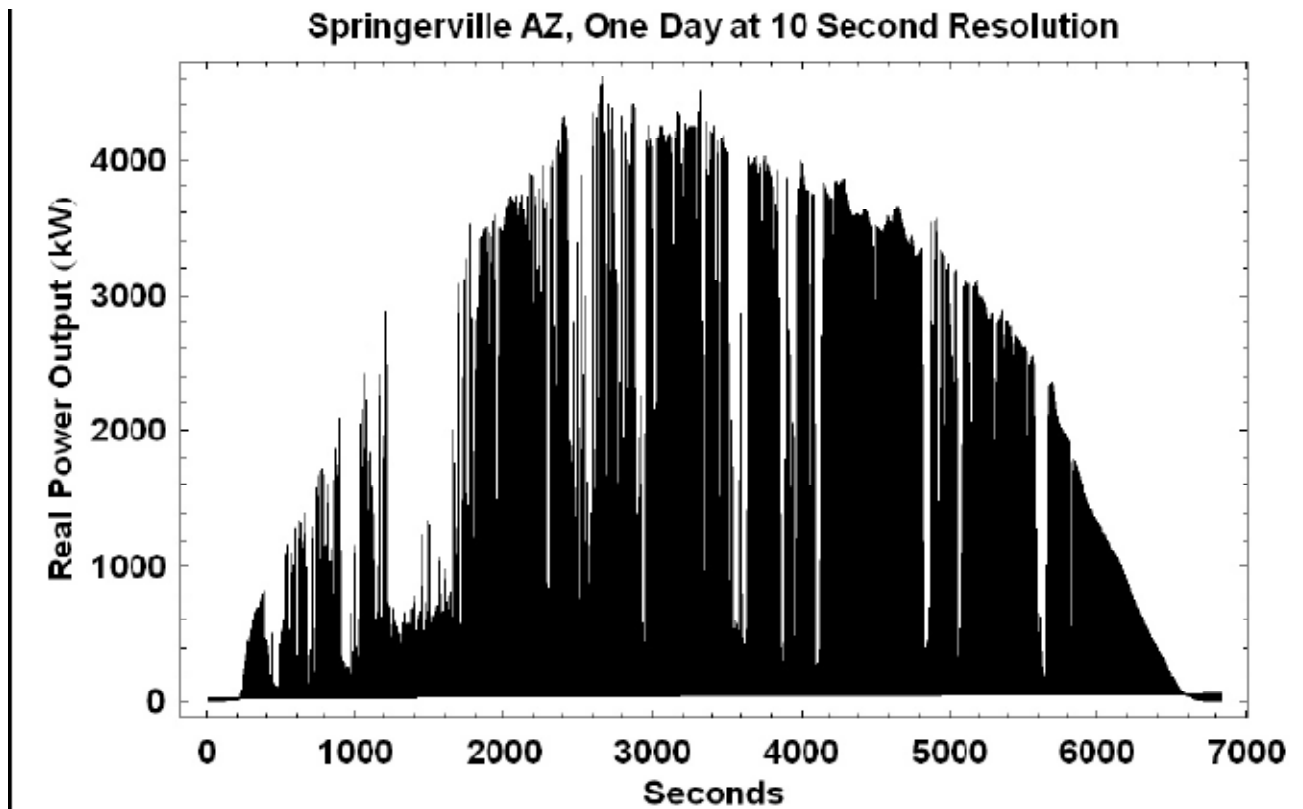
- costs of augmenting system flexibility
- (NPCC - Sixth Power Plan)

RTP and Wind Integration

- Real-time pricing (RTP) may help alleviate wind curtailment issues by:
 - Flattening load peaks and reducing the number of ramp constrained units during shoulder periods
 - Increasing off-peak and overnight loads to reduce the impact of thermal generator minimum load constraints
 - Using locational prices to increase demand in a region with wind resource available but exports constrained
- Modeled the extent to which RTP would increase wind utilization - RTP:
 - Results in increases in wind utilization
 - Can be effective if applied to only C&I customers - e.g. 62% of load in Texas in 2005
- RTP can alter the load pattern, reduce binding generator and transmission constraints, and increase wind generation

Problems with Solar

- Solar generation also exhibits intermittency.



Problems With Solar

- Solar peaks around noon, system peaks around 6 PM in ERCOT
- Large solar penetration will encroach on base load, not provide sufficient peak load
- Same problem as wind in the morning, either curtail solar or use more shoulder and peaking units
- Same solution as wind, LM and Storage to shift load to peak solar output