



# Western Wind and Solar Integration Study

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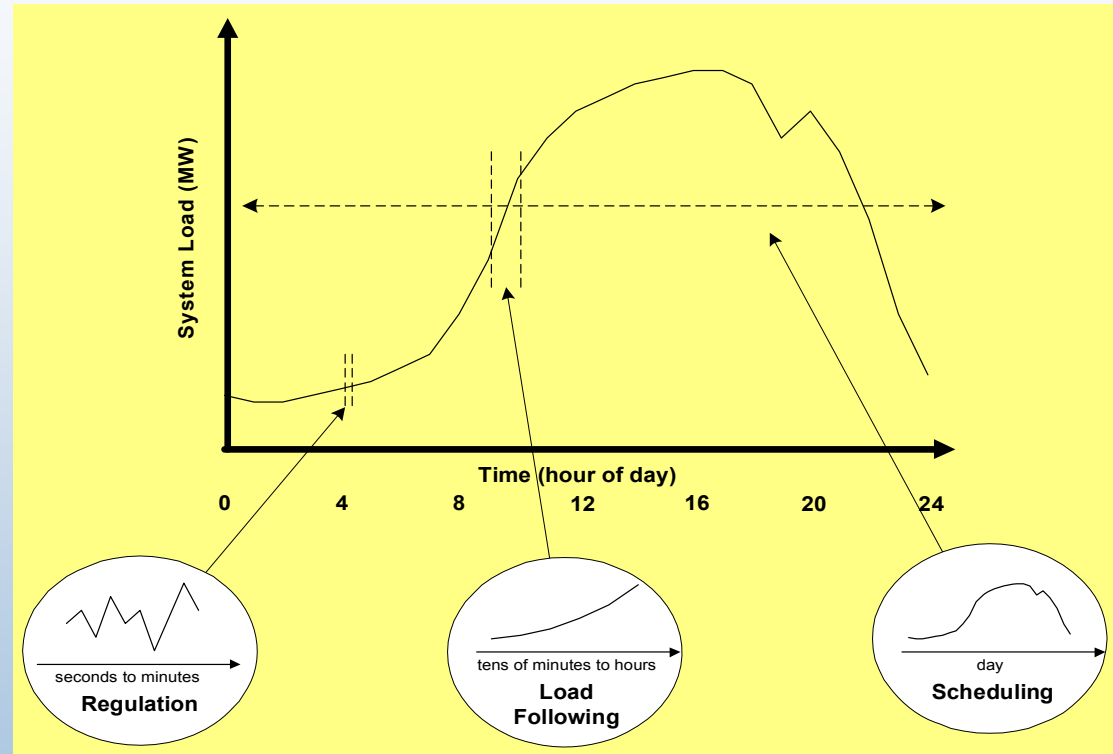


# Systems Integration: a DOE/NREL Priority

- 20% Wind Vision
  - Start to examine the operating impacts of 20% wind vision
- Conduct regional studies to look at effects of larger balancing areas and feed into transmission planning
  - Western US - southwest and mountain
  - Eastern US - excluding southeast
- Generate consistent time-series wind dataset.

# Integration Study - Key Tasks

- Evaluate operating impacts and associated costs:
  - Regulation
  - Load Following
  - Unit Commitment
- Evaluate reliability impacts:
  - Effective Load Carrying Capability/Loss of Load Probability



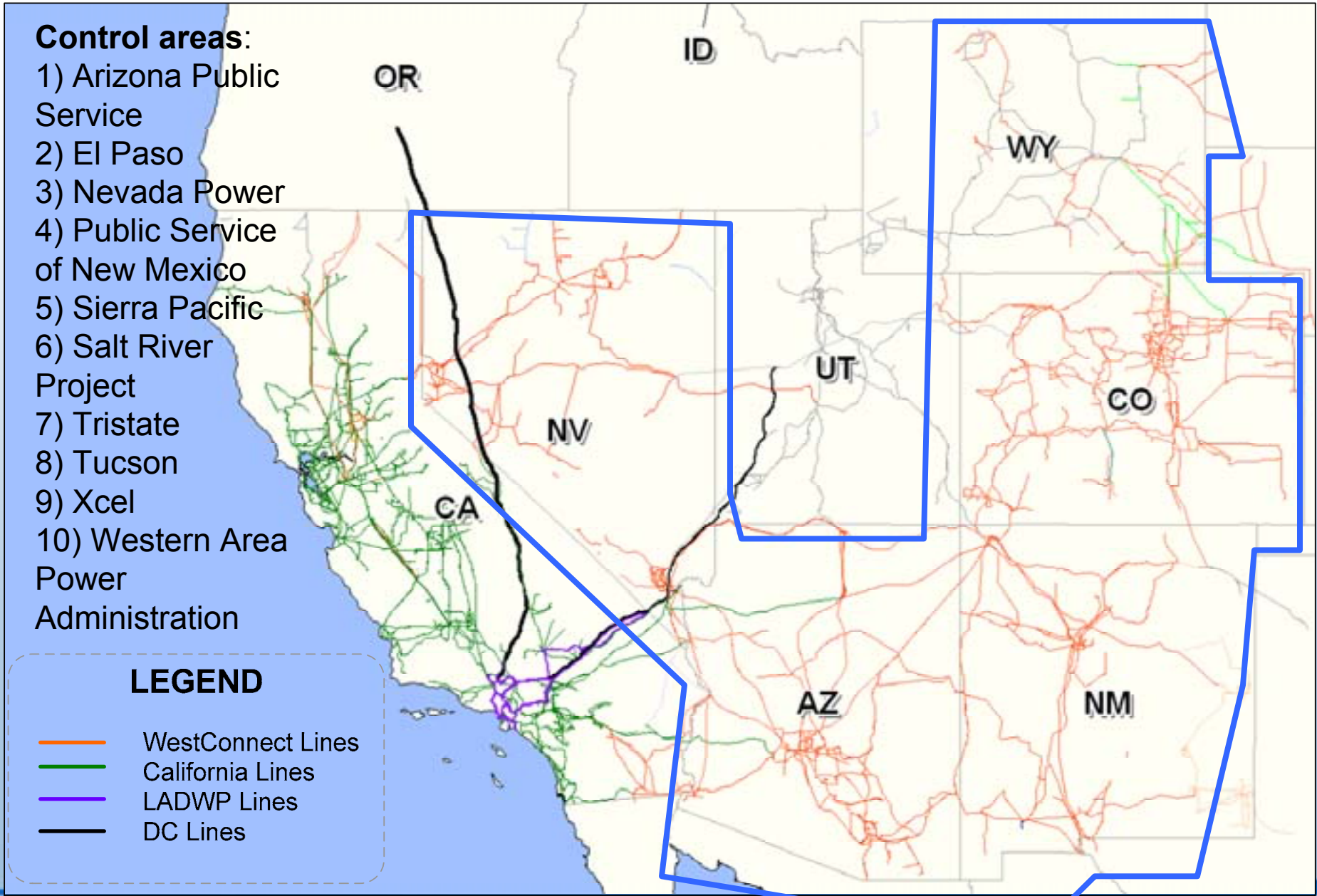
# Study Footprint (WestConnect outside of California)

## Control areas:

- 1) Arizona Public Service
- 2) El Paso
- 3) Nevada Power
- 4) Public Service of New Mexico
- 5) Sierra Pacific
- 6) Salt River Project
- 7) Tristate
- 8) Tucson
- 9) Xcel
- 10) Western Area Power Administration

## LEGEND

- WestConnect Lines
- California Lines
- LADWP Lines
- DC Lines





# Western Wind and Solar Integration Study - Overview

To support multi-state interests in understanding the **operating and cost impacts** due to the **variability and uncertainty** of wind, PV, and concentrating solar power (CSP) on the grid.

- How can utilities manage the incremental variability and uncertainty of wind and solar? Examine 20% and 30% wind penetration by energy in 2017
- Do geographically diverse wind/solar resources reduce variability and increase transmission utilization? Feeds into WECC and WestConnect transmission planning
- How do local wind/solar resources compare to out-of-state resources in terms of load correlation or cost?
- How can hydro help with wind/solar integration?
- The role and value of wind forecasting
- Can balancing area cooperation help manage the variability? Virtual Control Area study.
- How do wind and solar contribute to reliability and capacity value?



In WestConnect		Wind:	30%	Solar:	5%				
		Total		Wind		Concentrated Solar		Solar PV	
Annual Growth		Capacity (MW)	Energy (GWh)	Capacity (MW)	Energy (GWh)	Capacity (MW)	Energy (GWh)	Capacity (MW)	Energy (GWh)
4%	2005	20,995	63,129	17,649	54,111	1,802	6,313	1,544	2,706
	2017	33,613	101,072	28,256	86,633	2,884	10,107	2,472	4,332
Outside WestConnect		Wind:	20%	Solar:	3%				
		Total		Wind		Concentrated Solar		Solar PV	
Annual Growth		Capacity (MW)	Energy (GWh)	Capacity (MW)	Energy (GWh)	Capacity (MW)	Energy (GWh)	Capacity (MW)	Energy (GWh)
2%	2005	33,937	102,218	28,991	88,885	2,664	9,333	2,283	4,000
	2017	43,040	129,637	36,767	112,728	3,378	11,836	2,895	5,073
Total		Total		Wind		Concentrated Solar		Solar PV	
		Capacity (MW)	Energy (GWh)	Capacity (MW)	Energy (GWh)	Capacity (MW)	Energy (GWh)	Capacity (MW)	Energy (GWh)
	2005	54,932	165,347	46,639	142,996	4,465	15,646	3,827	6,705
	2017	76,654	230,709	65,023	199,361	6,262	21,944	5,368	9,404

### Assumptions

Wind Capacity Factor	35%
Concentrated Solar Capacity Factor	40%
Solar PV Capacity Factor	20%
Portion Solar met with PV	30%
Wind requirement in WestConnect	30%
Solar requirement in WestConnect	5%
Wind requirement outside WestConnect	20%
Solar requirement outside WestConnect	3%
2005 In WestConnect retail Energy (GWh)	180,370
2005 outside WestConnect retail Energy (GWh)	444,426
Annual energy growth rate in WestConnect	4%
Annual energy growth rate outside WestConnect	2%
Study year	2017



# Tasks

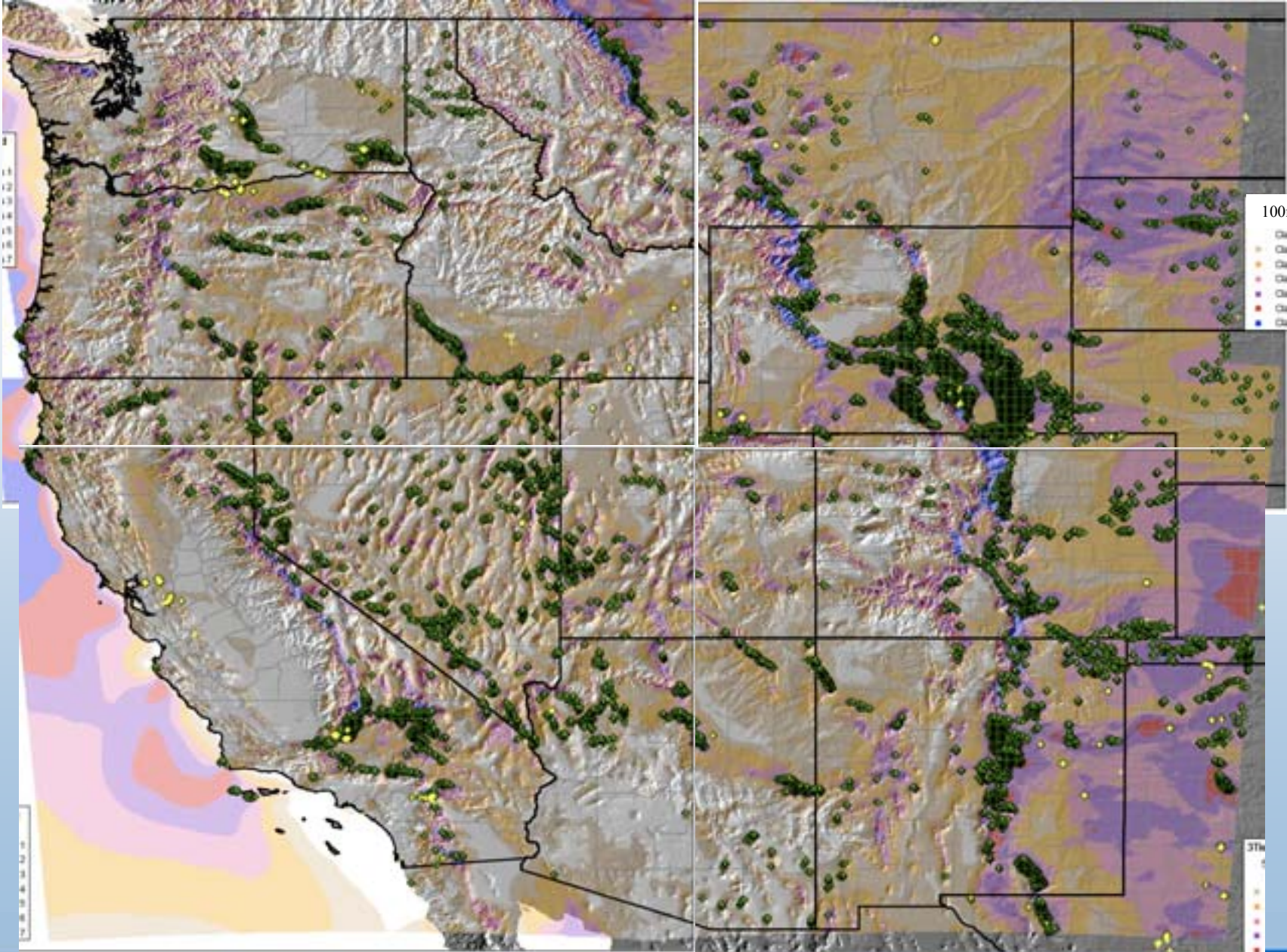
- Stakeholder Meeting
- Data Collection
  - Wind and solar mesoscale modeling (3Tier)
  - Utility load, generator, transmission data
- **Preliminary Analysis**
  - **Extensive statistical analysis with various options for wind/solar sites and transmission**
- Scenario Development
  - In-state vs. out-of-state resources
  - Geographically diverse resources
  - Mega projects
  - Best correlated with load
- Run Scenarios
  - Examine costs due to regulation, load following, unit commitment
  - “Dives” to investigate issues such as Hoover
  - Examine mitigation strategies/options
  - Determine contributions to reliability and capacity value
- Draft and Final Report.

# Wind and Solar Modeling

- 3TIER running wind mesoscale model for western US
  - 10-minute intervals for 2004-2006
  - 1 arc-minute resolution (approx 2-km x 2-km grid)
  - Wind speed data - 5 hub heights for entire western US
  - Wind plant output data – 100-m hub height, 10 x 3-MW Vestas turbines incl. statistical variation in output, selected 30,544 grid points (900 GW) to model; web interface to be developed in summer
- Perez of SUNY ran solar model for US
  - 1-hour intervals for 2004-2006, 10-km grid, direct normal and global insolation
  - PV plant output by NSRDB weather station site (150 sites for western US) using template of different orientations and tracking
  - Concentrating Solar Power (CSP) plant output - parabolic trough plants with 6 hours thermal storage.



# Site Selection



# Schedule

Kickoff Stakeholder Meeting	May '07
Data Collection	Jun-Dec '07
Wind/solar mesoscale modeling	Oct '07-May '08
Preliminary Analysis	Mar-Jul '08
Prelim. results stakeholder mtg.	Aug '08
Production Cost Modeling	Aug '08-May '09
Interim Technical Results mtg.	Dec '08
Draft report	May '09
Draft results Stakeholder mtg.	Jun '09
Final Report	Jul '09

# Contact Information

- Western Wind and Solar Integration Study
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