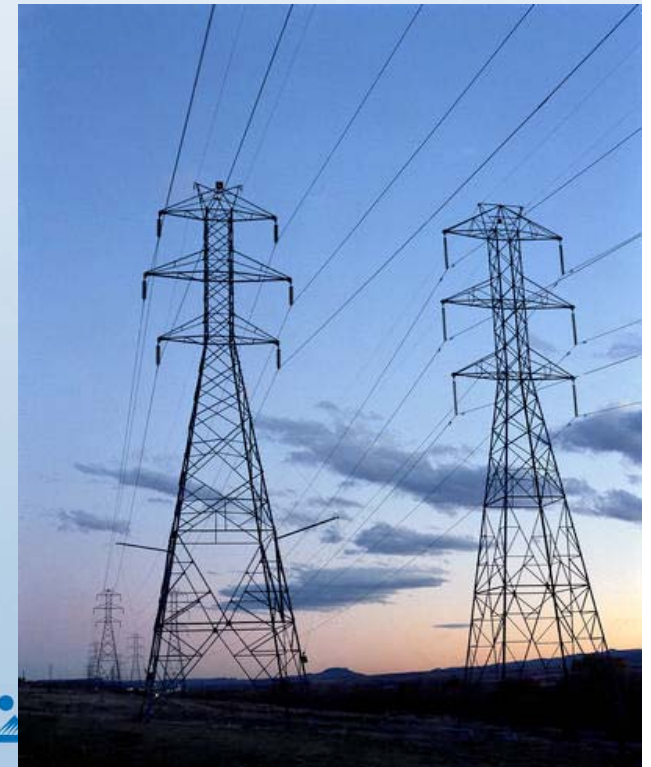


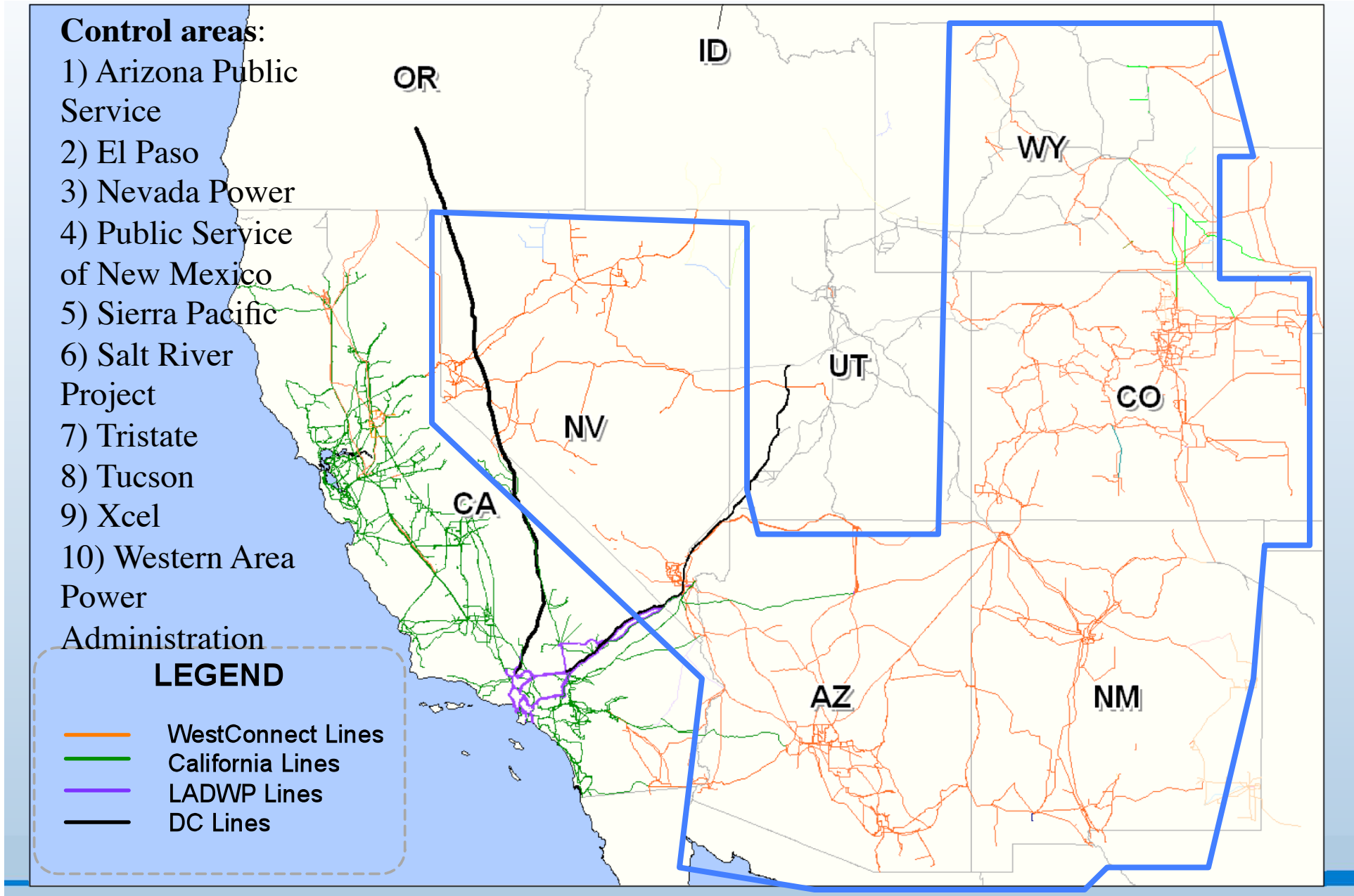


# Western Wind and Solar Integration Study Update

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**National Renewable Energy Laboratory**  
**UWIG Spring Workshop, April 17, 2008**



# Study Footprint (WestConnect outside of California)



# 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?

# High Renewables Basecase 2017

	Wind	Solar PV	Concentrating Solar Power	Total
Study footprint (WestConnect)	30% by energy	1.5%	3.5%	35%
	28,256 MW	2472 MW	2884 MW	33,613 MW
Rest of WECC	20%	0.9%	2.1%	23%
	36,767 MW	2895 MW	3378 MW	43,040 MW
Total	65,023 MW	5368 MW	6262 MW	76,654 MW

# Tasks

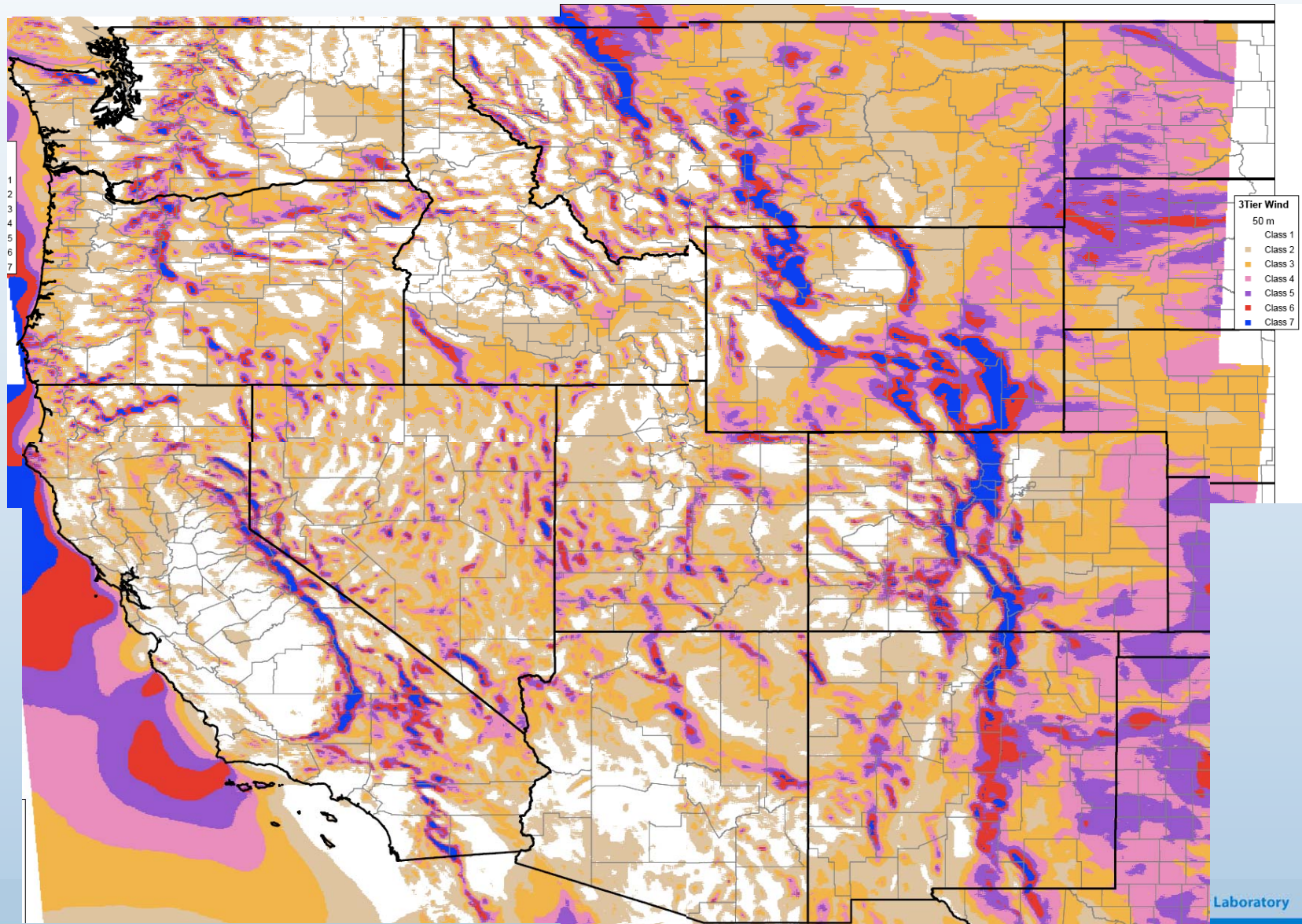
- Stakeholder Meeting
- Data Collection
  - Wind and solar mesoscale modeling (3TIER)
  - Utility load, generator, transmission data
- Preliminary Analysis
  - Extensive statistical analysis with various options for wind/solar sites and transmission
- Scenario Development
  - In-state vs out-of-state 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

# Mesomodeled Wind Data for Western US

- 3TIER generates historical wind data by running a Numerical Weather Prediction Model using physical conservation equations that ‘recreate the weather’ for 2004-6.
- They sampled the weather at a 1 arc-minute (~2km) spatial and 10 minute temporal resolution, and at 5 hub heights (10, 20, 50, 100, 200m).
- Based on a limited number of actual tower measurements for that time period, they did a sophisticated adjustment of (MOS-corrected) the model so that the data more accurately reflects actual wind speed measurements.
- Validation reports comparing the model wind speed results to actual data will be produced by 3TIER when their modeling is complete.
- 3TIER used SCORE-lite to convert wind speed to power output, assuming a Vestas V90 3 MW turbine at 100m hub height. Each grid point can hold 10 turbines or a 30 MW wind plant. The SCORE-lite process applies a probability distribution function to the manufacturer’s power curve to replicate actual wind farm output.
- 3TIER produced hourly forecasts for day-ahead wind power output for the 30,000 selected sites.

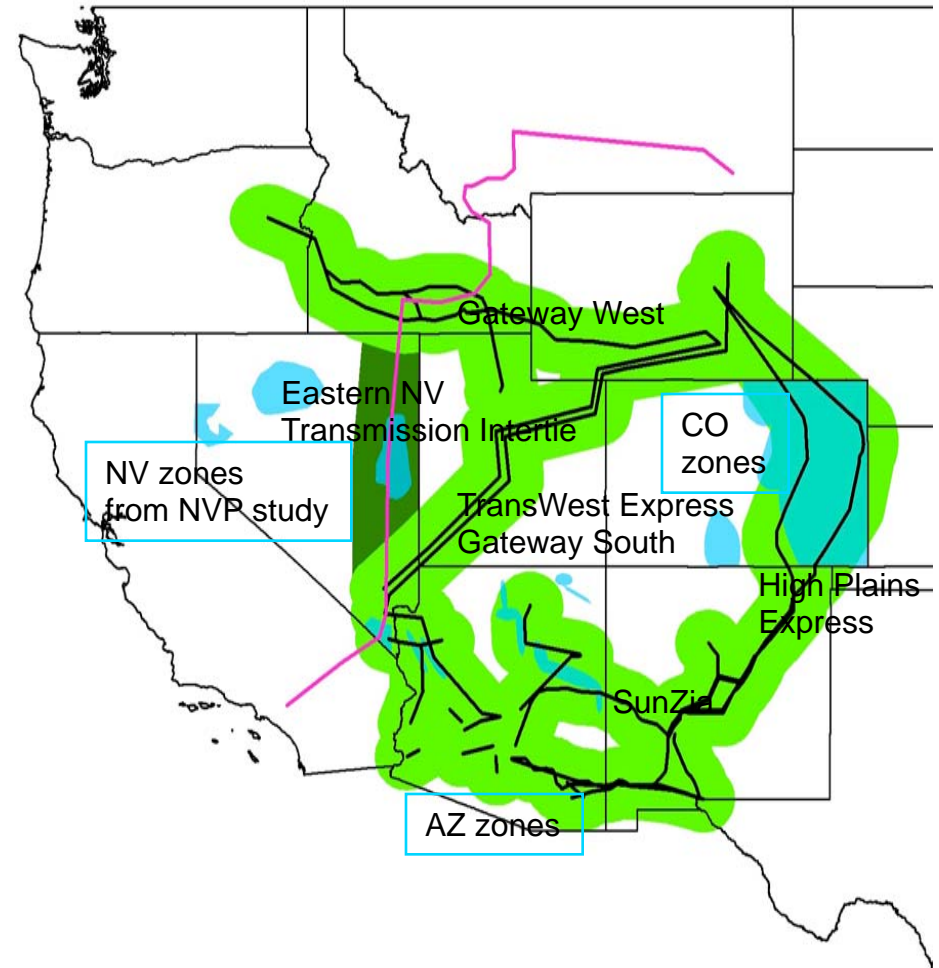


# Average Wind Power Density 2006



# Site selection

- 3TIER downselected from 1.2M to 30,000 points so that we could work with something reasonable in the WWSIS.
  - Exclusions - recreation, urban, forests, slopes, high elevation, etc. (NREL)
  - Preselected sites - existing or planned wind plants (Platts database/NREL)
  - Transmission corridors or zones (200 GW) - based on proposed new transmission and initial zone information (excl new NV zones)
  - Load correlation (250 GW) - best diurnal correlation with Westconnect load
  - Best resource (450 GW) - best wind power density
  - Additional sites added in to help validate model results



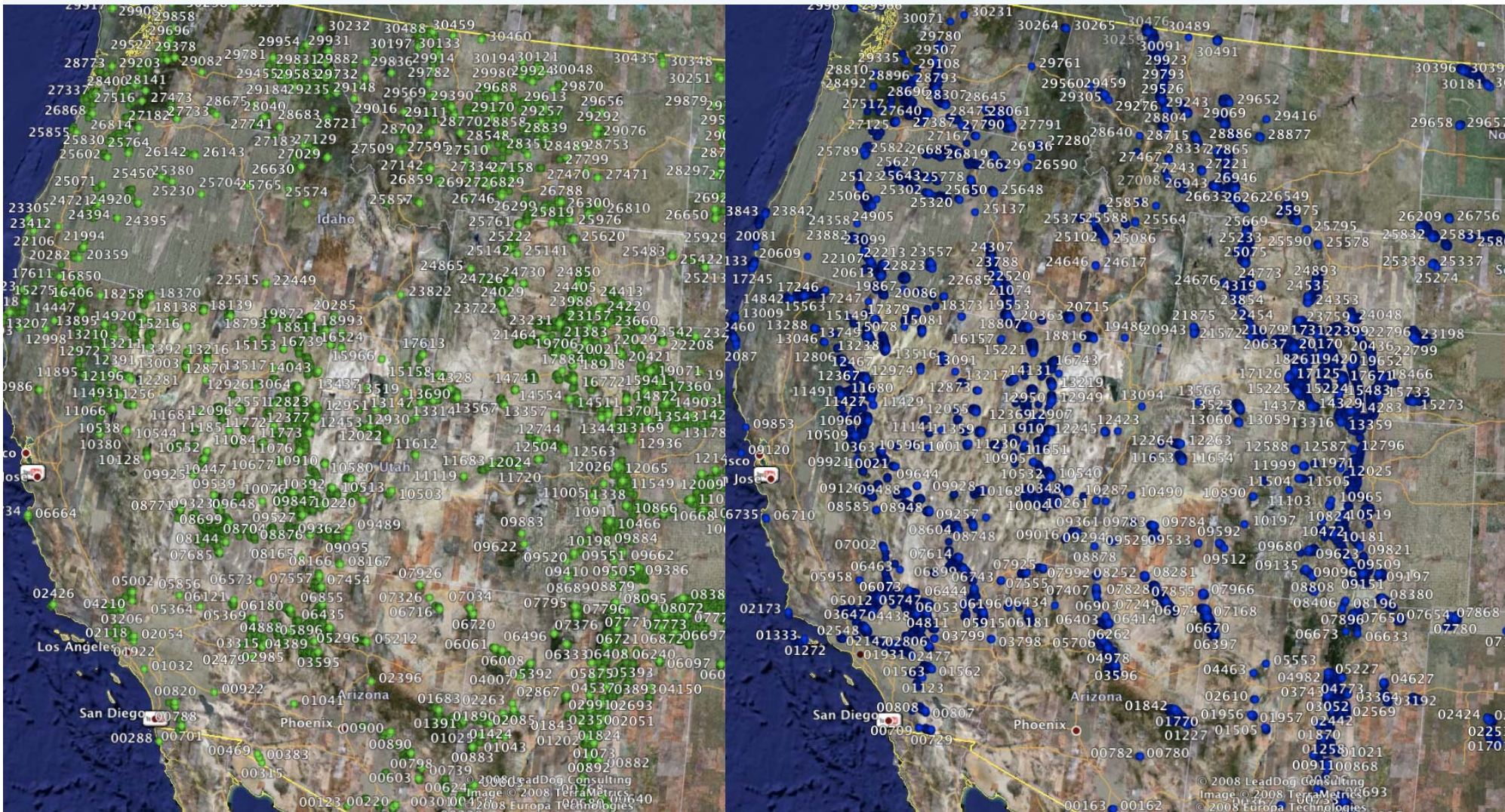






# Load correlated

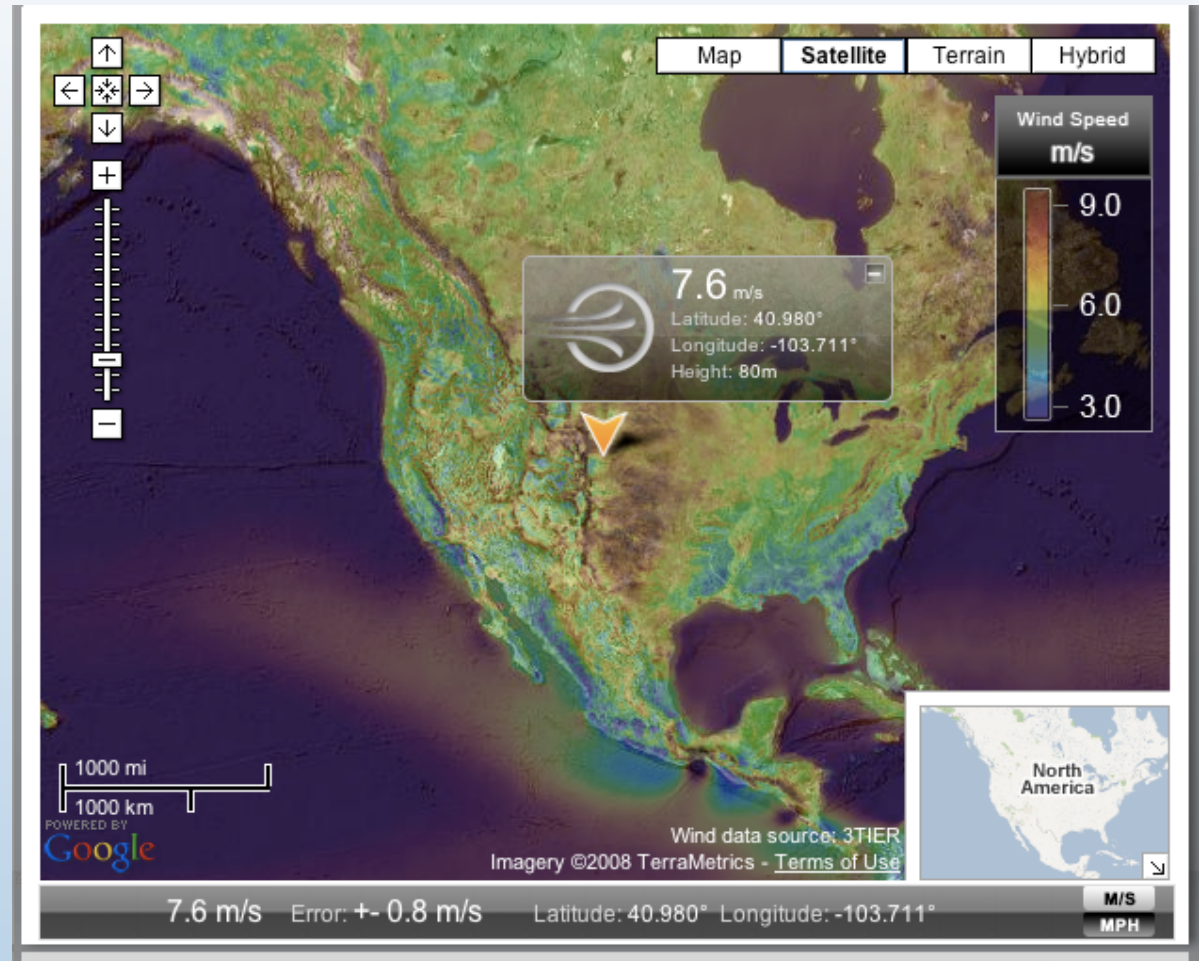
# Best resource





# Web-based interface for wind data

- Similar to 3TIER's FirstLook ->
- Click on site and download 10 minute wind speed and wind power output data stream for selected periods
- Planned release in summer to be accompanied by webinars explaining use of database



# Solar Modeling

- Perez of SUNY ran solar model for US
  - 1 hour intervals for 2004-2006, 10km 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
  - Limitations in resolution, especially temporal resolution, driving subhourly PV output analysis



# 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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