2010 Wind Integration Study

Methodology

April 28, 2010

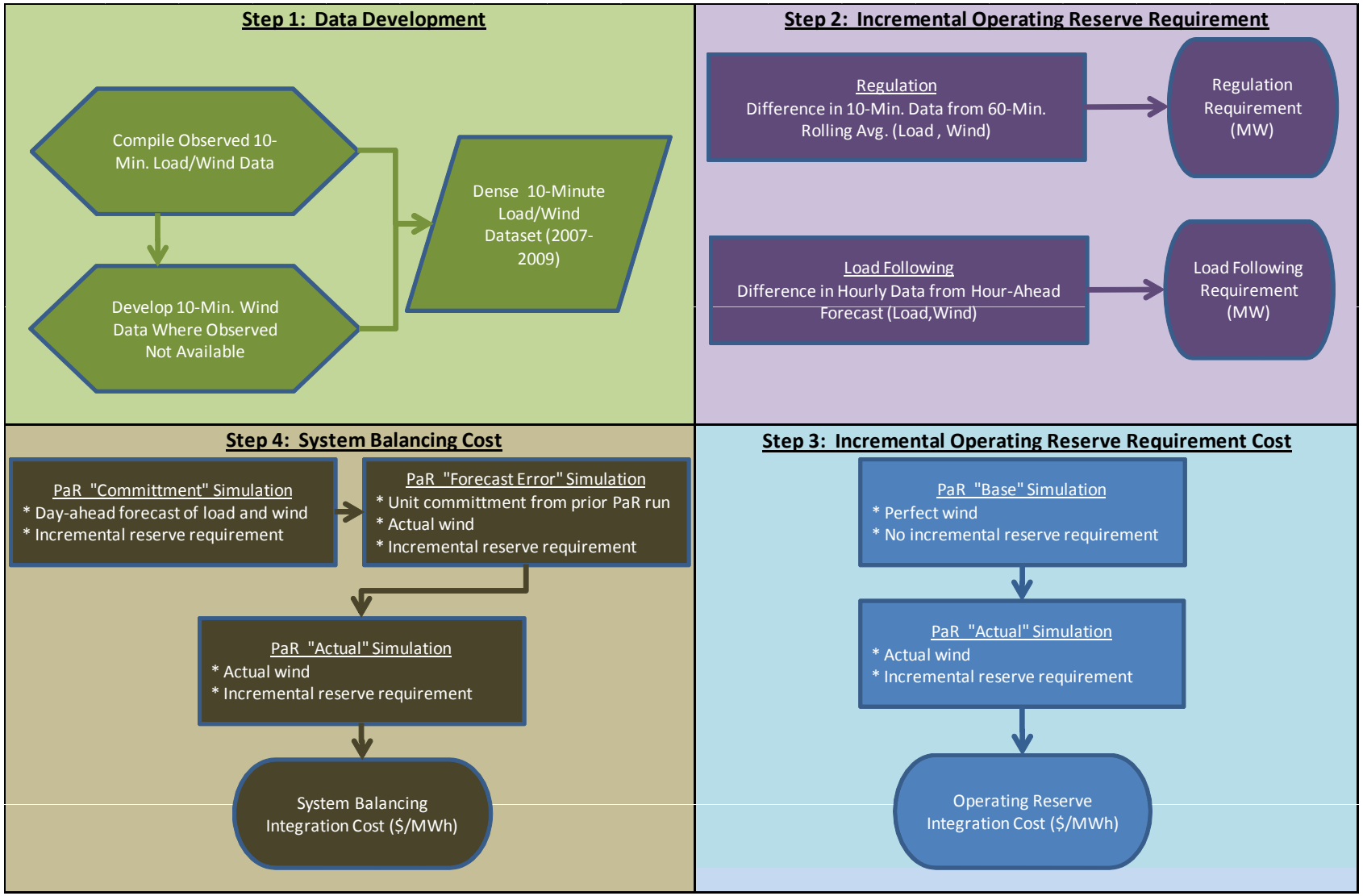
PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

Pacific Power | Rocky Mountain Power | PacifiCorp Energy

2010 Wind Integration Study: Schedule Updates

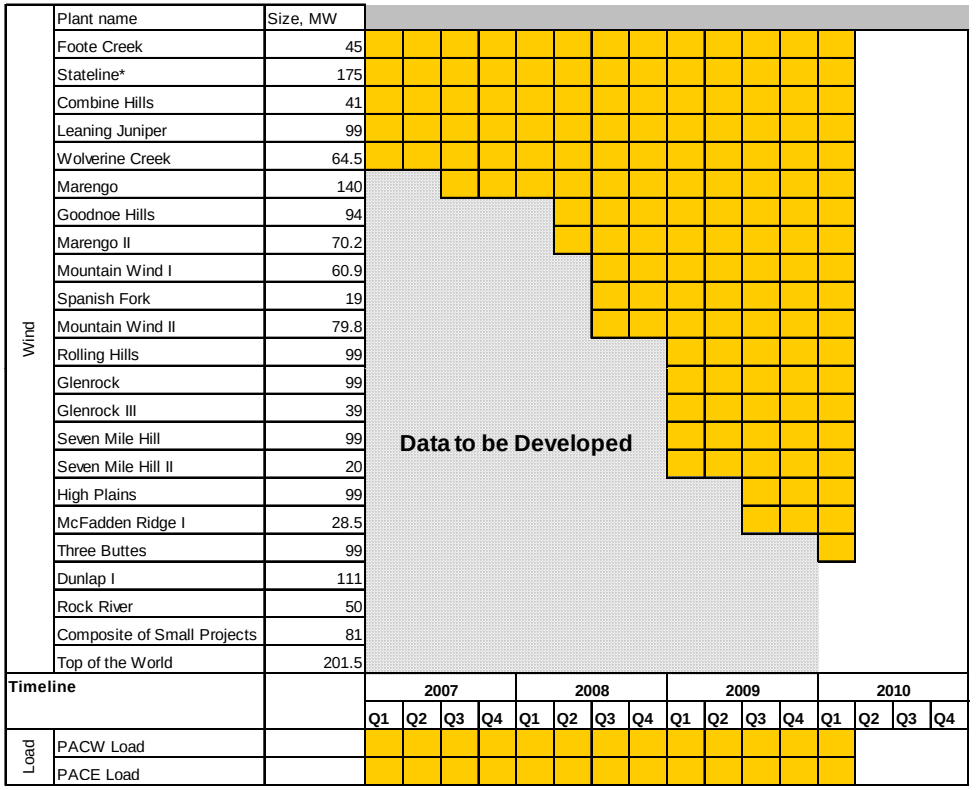
Step	Date(s)	Status
Review of other wind integration cost studies	On-going	On-going
Inventory of data	February 8, 2010	Complete
Initial public input meeting	February 16, 2010	Complete
Draft of study design/concept	February 26, 2010	Complete
Stakeholder comments on draft study design/concept	March 12, 2010	Complete
Finalize selection of technical advisor	March 2010	Complete
White paper on methodology	April 16, 2010	Complete
Presentation of methodology	April 28, 2010	Scheduled
Stakeholder comments on methodology	May 5, 2010	Pending
Methodology finalized	May 12, 2010	Pending
Progress conference calls	May 2010 and June 2010	To be scheduled
Draft results	July 9, 2010	To be scheduled
Draft results public workshop	July 12, 2010 – July 16, 2010	To be scheduled
Written comments on draft results	July 23, 2010	Pending
Finalize study	August 2, 2010	Pending

Study Flow Chart



Data Development

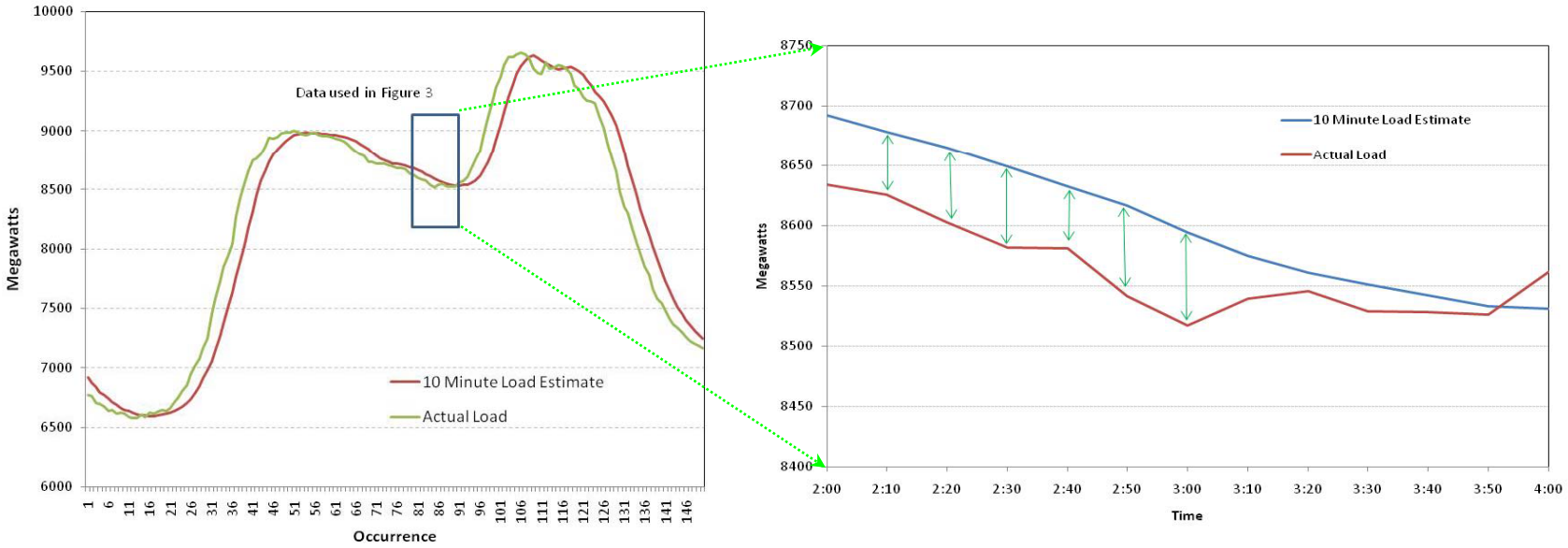
- Actual wind generation and load data will drive the wind integration study
- Missing wind generation data will be developed by The Brattle Group to produce a dense and concurrent data series over the period 2007 to 2009
- Developed wind data will maintain correlations derived off of actual wind data



Development of Wind Generation Data

- The data for wind sites can be segmented into three categories
  - Full data sites, where actual data is available for the entire initial term (2007 – 2009)
  - Partial data sites, where actual data is available for a portion of the initial term
  - No data sites, where no actual generation data is available over the initial term
- The Brattle Group will produce data for partial data and no data sites (pp. 4-5 of white paper)
  - Partial data sites
    - An econometric model will be developed that will quantify the relationships between full data and partial data sites
  - No data sites
    - An econometric model will be developed using data from full data sites as a dependent variable with explanatory/independent variables coming from distributed lags of another full data wind site in a different area
  - The econometric models for both partial data and no data sites will include variables for stochastic noise

Defining Incremental Regulation and Load Following Reserves for this Study



- Regulation and load following reserves are allocated to specific resources with operational flexibility, which serves as a reserve credit used to meet a reserve requirement
  - Regulation = on-line capacity responsive to changes in system fluctuations (1-minute to 10-minute)
  - Load following = flexible generation units that can be used to follow longer term trends in system fluctuations (40-minutes to hourly)
- Regulation and Load Following reserves are *incremental* to contingency reserves

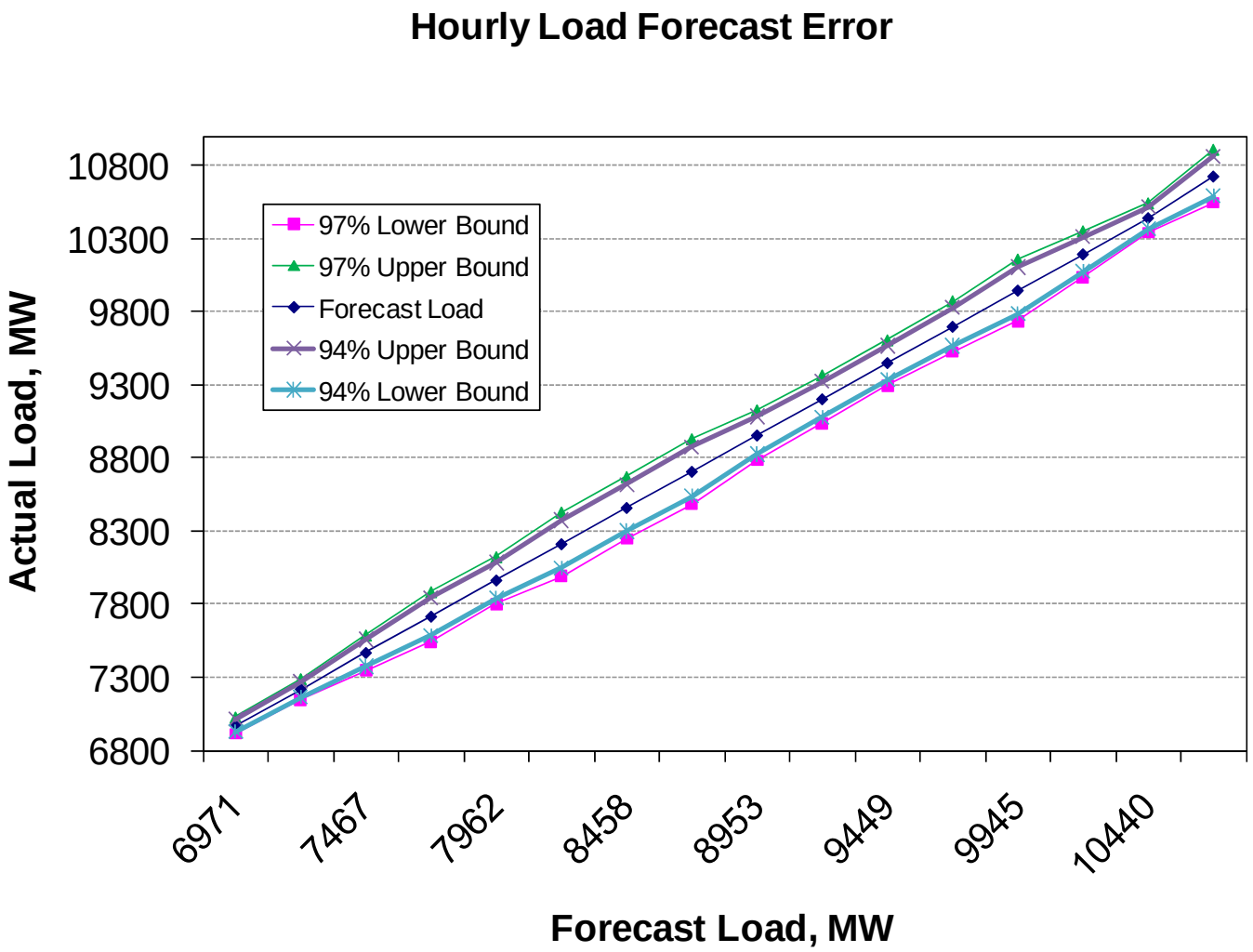
Estimating Regulation Reserve Requirement

- Calculate the difference between a 60-minute rolling average and actual data recorded at 10-minute intervals
  - Load
  - Wind
- Calculate the standard deviation of differences and identify any seasonal trends
  - Load (σ_{load})
  - Wind (σ_{wind})
- Calculation of the regulation requirement assumes that fast variations in load are not correlated with fast variations in wind generation

Estimating Load Following Reserve Requirement

- Calculate the difference between an hour-ahead forecast and actual hourly average data (per P. 9 of the white paper)
  - Hour ahead load forecast will be estimated using hour to hour changes from prior, similar load-shape days
    - Prior week load profile hour-on-hour change applied to prior hour actual observed load
    - Preceding Sundays will be used for all NERC holidays
  - Hour ahead wind forecast will be estimated assuming persistence
    - Next hour wind forecast will be based upon actual generation at 20-minutes past the hour in the previous hour
- Differences between forecast and actual will be culled into bins by load magnitude (see sample figure on next slide)
  - Percentile equivalent of historical CPS2 performance will be sampled above and below the median of each bin and adjusted downward for PacifiCorp's L_{10} standard
    - Using the percentile equivalent of historical CPS2 performance removes the need to assume normality in the distribution of errors
  - Probabilities will be implied by the number of observations in each bin, and averaging the volumetric load following requirement over a given period will be done via integration
- Calculation of the load following requirement assumes that hour-to-hour variability in load are not correlated with hour-to-hour variability in wind generation

Load Following Reserves Scaled by CPS2 Score



Incremental Reserve Allocation

Reserve Service	Spinning Operating Reserve	Non-Spinning Operating Reserve
Regulation	4 * (Regulation$_{10Min}$)	0
Load Following	0.5*(Load Following Reserves)	0.5*(Load Following Reserves)
Contingency	0.5*(5% of Hydro + 7% of Thermal generation output)	0.5*(5% of Hydro + 7% of Thermal generation output)
Total	Sum of the above	Sum of the above

- Reserves for regulation and load following will be developed for each scenario and summed
  - The multiplier on regulation is consistent with previous studies
    - Idaho Power wind integration study used 5*Regulation Requirement (smaller balancing authority area)
    - Eastern Interconnect Wind Integration Study used 3*Regulation Requirement (large balancing authority area)
  - The regulation requirement multiplier of 4 “splits the difference” (larger balancing area than Idaho Power, smaller balancing area than that assumed in the Eastern Interconnect study)
  - Disposition of Load Following Reserves as Spinning and Non-Spinning is under review
- Contingency reserves remain unchanged among wind penetration scenarios
  - Driven by event risk
  - WECC requirements

Wind Penetration Scenarios

Representative Timing	Baseline	EOY 2007	EOY 2009	EOY 2011
Installed Wind Capacity	0	400	1400	1750
Wind Penetration	0%	3%	10%	12%

- Scenarios are consistent with the most recent Integrated Resource Plan.
  - Wind plant placement in production cost runs and data densification will reflect system geography.
  - Initial Term (2007-09) load and wind generation data will be applied to 2011-13 forward price curves in production cost modeling.
- System hydro and thermal asset profiles remain unchanged
  - No new additions contemplated to PacifiCorp portfolio
  - Production cost models to reflect operational practice
- Distant future calculation will be developed
  - Would include scheduled additions to PacifiCorp portfolio
  - Production cost models to reflect operational practice

Production Cost Modeling: PaR Simulations

PaR Simulation	Forward Term	Load	Wind	Incremental Reserves	Day-Ahead Forecast Error
1	2011 - 2013	Initial Term - Actual	Initial Term - Perfect Shape	None	None
2	2011 - 2013	Initial Term - Actual	Initial Term - Actual	Yes	None
3	2011 - 2013	Initial Term - Day Ahead Forecast	Initial Term - Day Ahead Forecast	Yes	None
4	2011 - 2013	Initial Term - Actual	Initial Term - Actual	Yes	Yes (Commitment from PaR Simulation 3)

Operating Reserve Integration Costs = system costs from PaR simulation 2 less system costs from PaR simulation 1.
System Balancing Integration Costs = system costs from PaR simulation 4 less system costs from PaR simulation 2.