2011 Integrated Resource Plan

2010 Wind Integration Study

Draft Study Design

February 26, 2010

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

Pacific Power | Rocky Mountain Power | PacifiCorp Energy

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Introduction

2010 Wind Integration Study: Process Updates

- Given feedback from the February 16, 2010 public input meeting, the Company is pursuing a number of enhancements to the wind integration study process
- The Company intends to procure the services of a technical advisor to assist with the study in the following areas
  - Methodology and study design
  - Involvement in stakeholder conference calls and public input meetings
  - Development of coincident wind and load data
  - Technical advice during implementation
  - Technical review of the final evaluation and findings
- To allow for the involvement of a technical advisor in supporting study design, issuance of a second draft has been incorporated into the schedule
- Increased opportunities for stakeholder involvement
  - Written comments on the initial draft design will be shared with stakeholders (but for those comments submitted with a preference to remain confidential)
  - A stakeholder conference call will be scheduled to facilitate discussion on a second draft study design
  - Periodic conference calls will be scheduled to report progress and gather further feedback
  - A public input meeting will be scheduled to facilitate discussion on the draft study findings

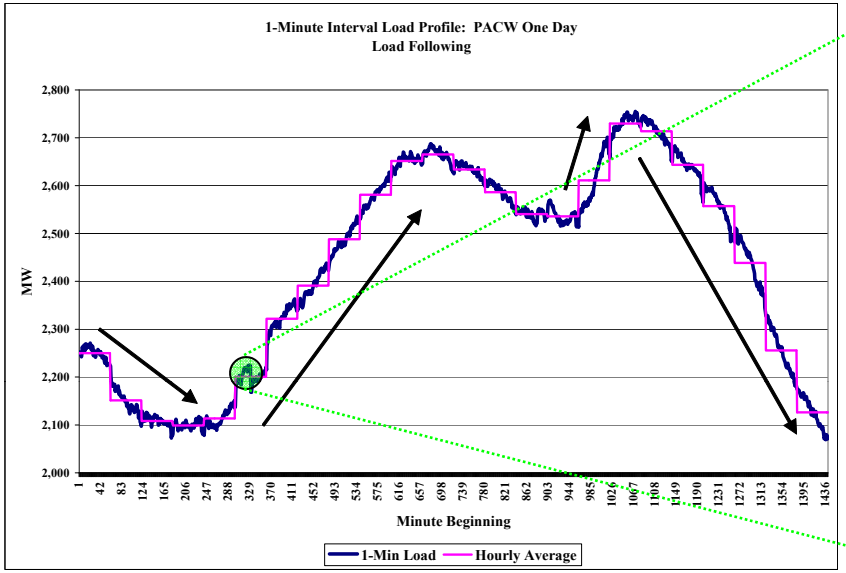
2010 Wind Integration Study: Schedule Updates

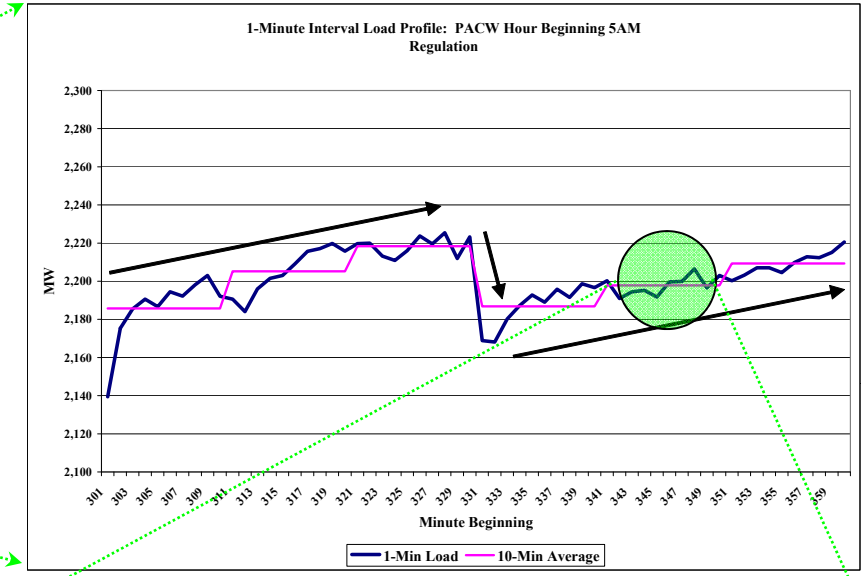
Step	Date(s)	Status
Review of other wind integration cost studies	On-going	On-going
Inventory of data	February 8, 2010	Complete
Initial public input meeting	February 16, 2010	Complete
Draft of study design	February 26, 2010	Complete
Written comments on first draft study design	March 12, 2010	Pending
Finalize selection of technical advisor	March 2010	Pending
Stakeholder conference call on study design (stakeholder feedback and design updates)	April 1, 2010 – April 9, 2010	To be scheduled
Final study design (to include responses to stakeholder feedback)	April 21, 2010 – April 28, 2010	To be scheduled
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

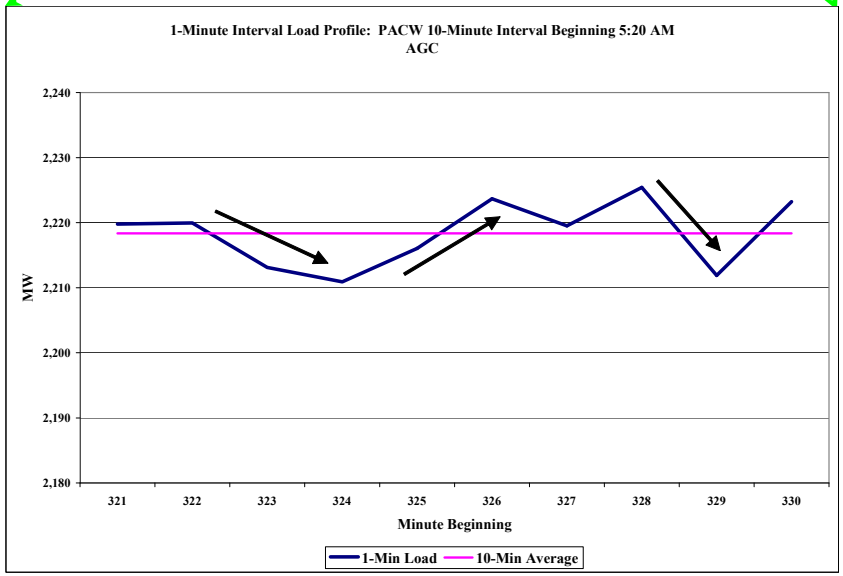
Key Concepts: Wind Integration Components

- Incremental reserves (intra-hour)
  - Operationally, incremental reserves are required to account for wind variability, and these incremental reserves come with a cost
  - Incremental reserve volumes are driven by both short-term variability (1- to 10-minutes) and hour-to-hour variability ("forecast" error)
  - From a study design perspective, intra-hour integration costs are estimated in two steps
    1. Statistically estimate incremental reserve requirements
    2. Compute the costs associated with incremental reserves
- System balancing (inter-hour)
  - System balancing costs are real and occur in different time scales (day-ahead and hour-ahead)

Key Concepts: Differentiation Among Reserve Types







- AGC, Regulation and Load Following reserves are *incremental* to contingency reserves
- Reserves for each are allocated to specific resources to establish a reserve "credit"
  - Load following = both AGC and non-AGC units that can be used to follow longer term trends in system fluctuations (40-minutes to hourly)
  - Regulation = on-line capacity on AGC responsive to changes in system fluctuations (1-minute to 10-minutes)
  - AGC = responsive to short duration (seconds to 1-minute) changes in system fluctuations

Intra-Hour Analysis:
Incremental Reserve Requirement

Incremental Reserve Requirement: Overview

- Data development
- Develop hour-ahead forecast “rules”
- Quantify the variance from forecast
- Apply a CPSII performance-based reliability metric to establish regulation and load following reserve requirements for load alone
- Apply the same CPSII performance-based reliability metric to establish regulation and load following reserve requirements for load net of wind
- Calculate the incremental amount of regulation and load following reserves by netting the load alone requirement against the load net wind requirement

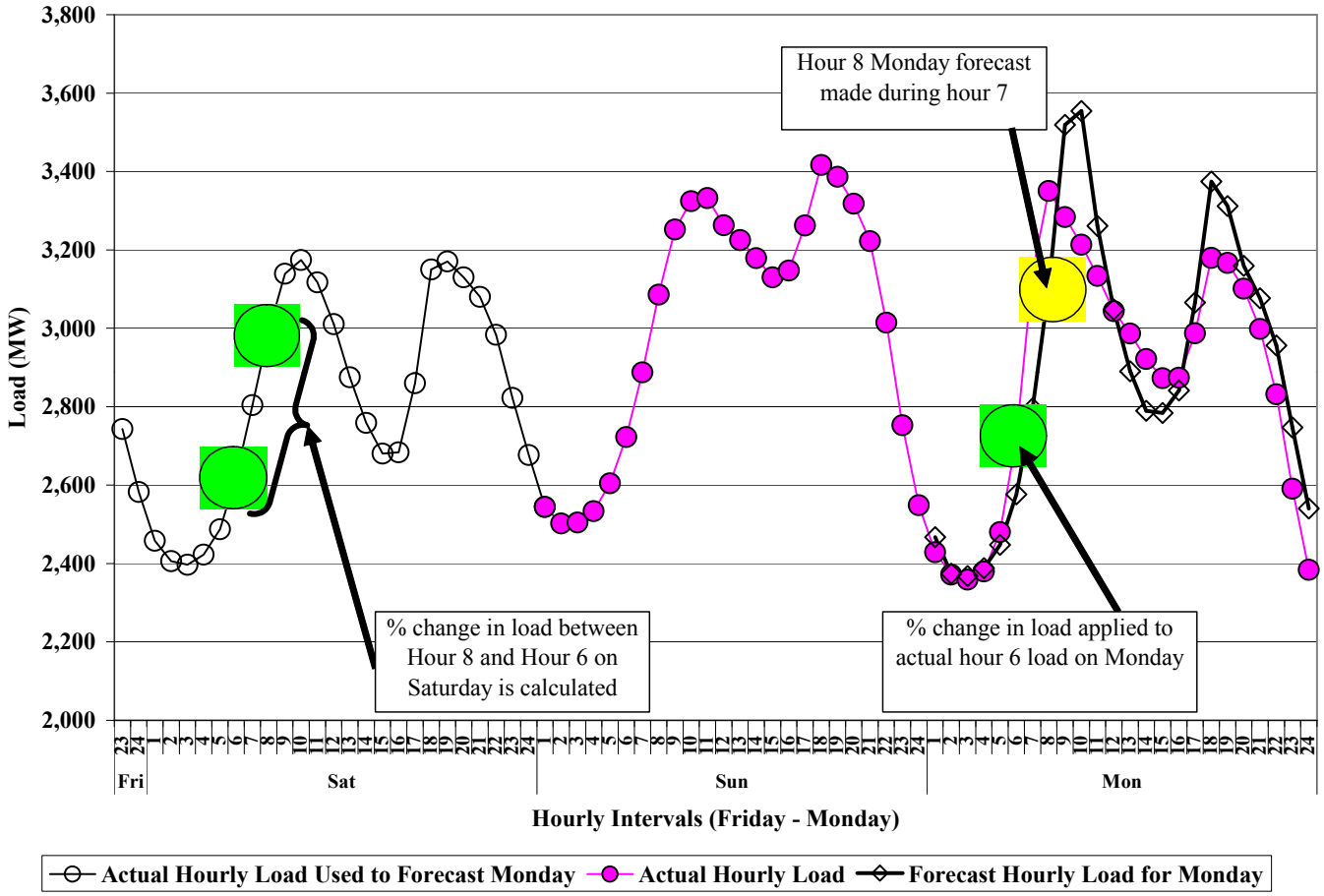
Incremental Reserve Requirement: Data Development

- Data needs
  - Target a sample size containing two to three years of a coincident load and wind data
  - 10-minute interval granularity
  - Applicable to existing resources (owned and contracted) and future resources
- The technical advisor will play an active role in developing the data required for the study
  - Consideration of NREL data
    - Test how well these data compare to observed metered data where available
    - Test correlations among sites
  - Consideration of observed metered data
    - Observed meter data are preferable
    - However, data gaps will need to be addressed
  - Develop or inform approach for wind profiles applicable to future resources

Incremental Reserve Requirement: Hour Ahead Forecast "Rules"

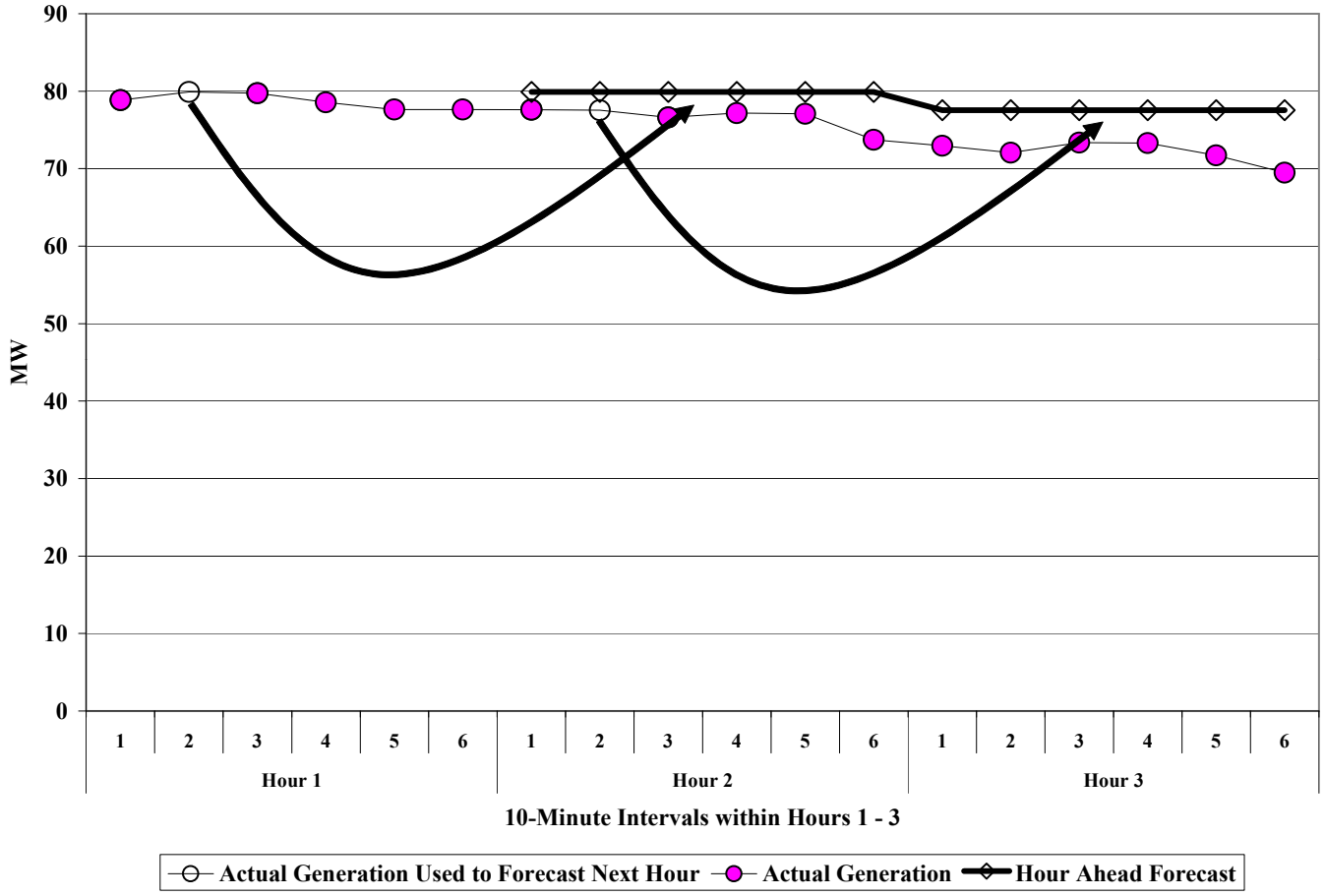
- To evaluate intra-hour variability, there must be some expectation or forecast against which actual load and wind data can be compared
- In order to replicate the hourly similar-day load forecast and the hourly wind forecasting method (persistence) used in the Company real time operation, model "rules" will be established
- Hourly similar day load forecast rule
  - Prior like-day (weekday/Saturday or Sunday/holiday) load profiles will be used to estimate a retrospective next hour load forecast
  - The percent change in load between the forecast hour and two hours prior to the forecast hour in the prior like-day will be applied to the actual observed load from two hours prior to the forecast hour on the forecast day
  - Applied independently to the east and west balancing areas of PacifiCorp's system
- Hourly persistence wind forecast rule
  - A persistence forecast is currently used to establish hour-ahead expectations for wind generation
  - The observed generation level from 40-minutes prior to the forecast hour will be used to establish the hour-ahead forecast
  - Applied independently to the east and west balancing areas of PacifiCorp's system

Incremental Reserve Requirement: Conceptual Application of Load Forecast "Rule"



- The forecast for hour 8 on Monday is made during hour 7 on Monday (hour ahead forecast)
- The hour 8 Monday forecast is based upon the rate of change between hour 8 on the preceding Saturday and hour 6 on the preceding Saturday
- The rate of change for like hours on Saturday are applied to observed hourly load data from hour 6 on Monday
- Similar day profiles will be used to estimate hour ahead load forecasts (i.e. in the example above, so long as Tuesday is not a NERC holiday, the profile for Monday would be used to estimate the load forecast; if Tuesday were a NERC holiday, Sunday would be used to estimate the load forecast)

Incremental Reserve Requirement: Conceptual Application of Wind Forecast "Rule"



- The forecast for hour 2 is based upon the observed generation level at 20-minutes after hour 1
- Likewise, the forecast for hour 3 is based upon the observed generation level at 20-minutes after hour 2

Incremental Reserve Requirement: Estimation of Load Following

- Calculate the hourly variance between forecast load and actual load
  - To be done independently for the east and west balancing areas
- Calculate the hourly variance between forecast load net wind and actual load net wind
  - To be done independently for the east and west balancing areas
  - To be done at varying wind penetration levels
- Produce distributions of hourly variance from forecast for load alone and again for load net wind
- Statistically estimate the amount of load following reserves required to maintain a CPSII reliability score (tied to historical performance) using the distributions of observed hourly variance from forecast
- Calculate the incremental load following reserves by netting the load alone requirement against the load net wind requirement

Incremental Reserve Requirement: Estimation of Regulation Reserves

- Calculate the 10-minute variance from forecast for load alone and then again for load net wind
  - To be done independently for the east and west balancing areas
  - To be done at varying wind penetration levels
- Produce hourly distributions of 10-minute variance from forecast for load alone and again for load net wind
- Statistically estimate the amount of regulation reserves required to maintain a CPSII reliability score (tied to historical performance) using the distributions of observed hourly variance from forecast
- Calculate the incremental regulating reserves by netting the load alone requirement against the load net wind requirement

Intra-Hour Analysis:
Incremental Reserve Cost

Incremental Reserve Cost: Overview

- Configure the Planning and Risk (PaR) production cost simulation model with regulation and load following reserve requirements based only upon load variability
- Configure PaR with regulation and load following reserve requirements based upon load net of wind variability
- Calculate the change in system costs between the two PaR simulations (load and load net wind)
- Calculate the cost of incremental reserves by dividing the change in system costs by the volume of wind on the system

Incremental Reserve Cost: Load Only PaR Simulation

- PaR will be configured with regulation and load following requirements as required to maintain system reliability accounting for variations in system load
  - Inputs will be differentiated among the east and west balancing areas and consistent with the hourly load used to develop the incremental reserve requirement
- Given that the reserve requirements are inclusive of incremental volumes to account for only load variability, the variability in wind generation will be removed from the PaR simulation
  - Hourly varying wind profiles will be converted into daily flat energy blocks
  - Even though the wind profiles will be altered to isolate system variability due to load, the total amount of energy produced by wind does not change
- The units selected to hold reserves will be optimized endogenously by PaR
  - The physical attributes of system resources will define the amount and type of reserves that can be held by any given unit at any given point in time

Incremental Reserve Cost: Load Net Wind PaR Simulation

- PaR will be configured with regulation and load following requirements as required to maintain system reliability accounting for variations in both system load and system wind generation
  - Inputs will be differentiated among the east and west balancing areas
- Given that the reserve requirements are inclusive of incremental volumes to account for wind variability, the variability in wind generation will be maintained in the PaR simulation
  - Hour-to-hour variability in wind profiles will be maintained in PaR
  - The total amount of energy produced by wind will be identical to the energy production levels in the load only PaR simulation
- The units selected to hold reserves will be optimized endogenously by PaR as done in the load only simulation

Incremental Reserve Cost: Estimation of Intra-hour Wind Integration Costs

- The difference in total system costs between the two PaR simulations (load only and load net wind) will be calculated
- The difference in total system costs will be divided by the total amount of wind energy at various wind penetration levels
- Costs will be identified over time and differentiated among the east and west balancing areas

Inter-hour Analysis:
System Balancing Cost

System Balancing Cost: Conceptual Approach

- The Company is investigating use of a production cost simulation approach in estimating inter-hour wind integration costs
- The approach requires that a baseline simulation be completed that allows for unit commitment and dispatch with perfect foresight (no change in load or wind generation from day-ahead to real time)
- A second simulation is then completed in which unit commitment is established under an uncertain day-ahead forecast for load and wind, but dispatch choices are made against actual load and wind conditions
- The change in system costs between the two scenarios are representative of system balancing integration costs
- The Company continues to explore the feasibility of such an approach using PaR
- Additional details on how this approach will be implemented with PaR will be made available prior to finalizing the study design

Additional Information

Additional Information

- Wind penetration scenarios
  - The wind penetration “baseline” will be based upon existing owned or contracted resources
  - Incremental wind penetration levels will be developed prior to finalizing the study design
- A number of sensitivities will be considered throughout the design and implementation phases of the study
  - Market prices
  - Future thermal resources available for holding reserves
  - The number and types of sensitivities considered will need to be prioritized to maintain schedule

Comments

- Comments can be submitted to the IRP mailbox at: IRP@PacifiCorp.com
- If you prefer that your comments not be shared with other stakeholders, please specify accordingly with your submittals