IPC Wind Integration Analysis

Public Stakeholder Meeting

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Agenda

- Introduction of consulting team
- Summary of methodology
- Overview of tasks

Consulting Team

- PLEXOS Solutions – Utility System Simulation
  - Dr. Tao Guo -- Project Manager, Simulation Expert
  - Dr. Guingjuan Liu – Modeler
  - Eric Toolson -- Advisor
- 3TIER – Wind Data
  - Dr. Scott Eichelberger – Meteorologist
  - Corey Rhodes -- Analyst
- Tulane University – Uncertainty Analyses
  - Dr. Anjali Sheffrin -- Economist

Methodology Overview – 8 steps

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1. Define base case and assumptions
2. Develop base case model
3. Determine operational violation status for base case
4. Develop incremental wind cases
5. Determine operational violation status for incremental wind cases
6. Determine resources to eliminate operational degradation
7. Compute wind integration cost
8. Develop report

Task 1 -- Determine base case definition and assumptions

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- Discussion Items
  - Base year – 2017
    - Langly Gulch power plant and Boardman-Hemingway transmission line are online
    - Best to focus on single year and model it in great detail, rather than several years in less detail and accuracy
  - Hydro model
    - Cascading model with storage and seasonal efficiencies
    - Capable of producing energy and all four AS
  - Ancillary services
    - Spin, non-spin
    - Reg-up, reg-down

Base case definition (continued)

- Treatment of net imports
  - Focus on IPC system, not WECC
  - Two markets – firm and non-firm
    - Energy only
    - Hourly prices
    - Subject to transmission limits

Task 2 -- Develop base case

- Discussion Items:
  - Base case data from IPC existing resource planning tool
  - Enhanced data for
    - Hydro – optimize hydro output subject to constraints (no profiles)
    - Reg-up and reg-load (system requirements, units and capacity range, ramp rates)
    - Stochastic modeling of wind and load

Task 3 -- Determine operational violation status for base case

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- Parameters to be evaluated
  - Unserved energy
  - Overgeneration
  - Non-spin
  - Spin
  - Reg-up
  - Reg-down

Operational violations (continued)

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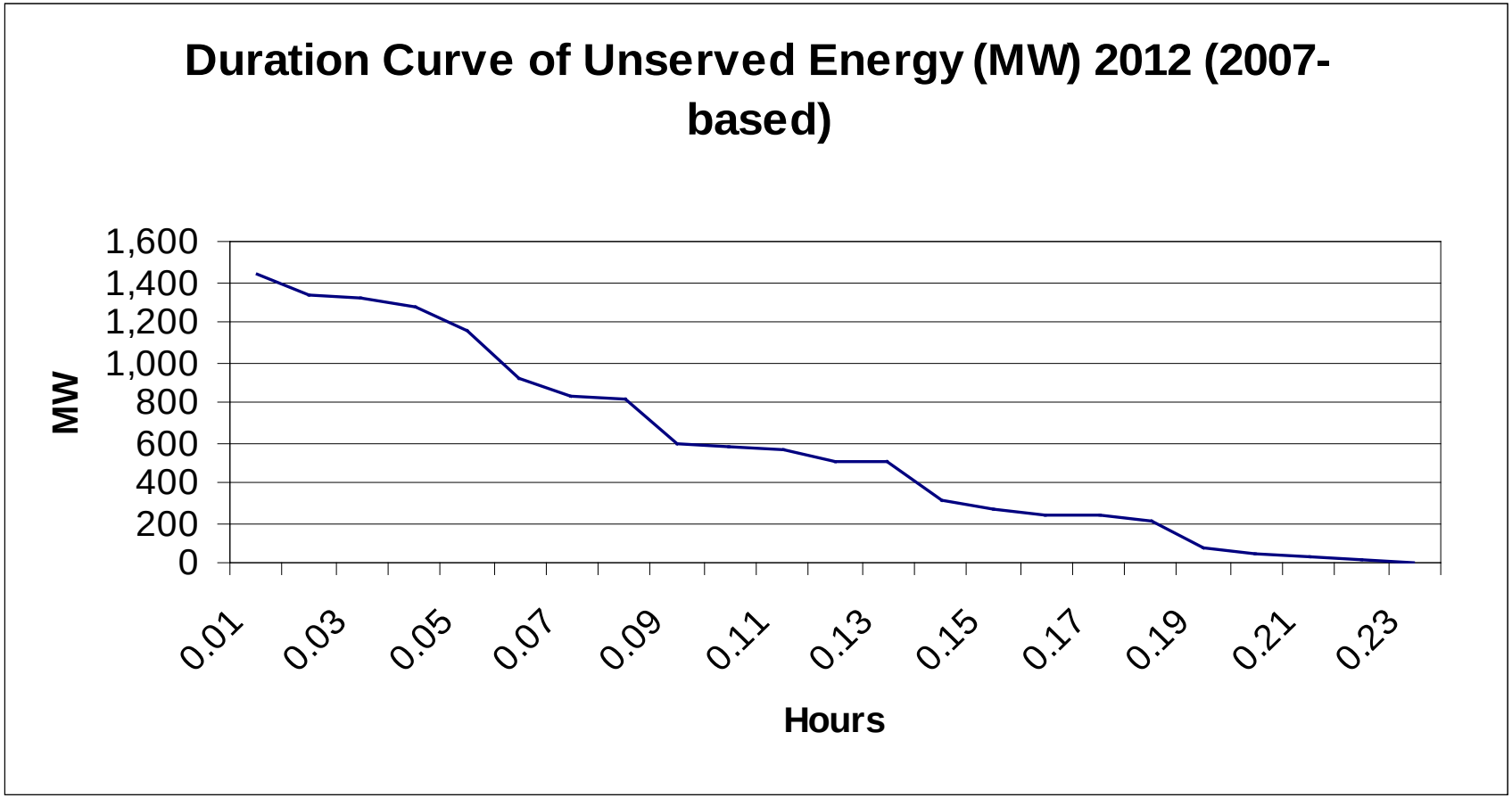
- How will operating violations be determined?
  - Hourly simulations
    - Model DA and RT
    - DA modeled stochastically
      - 100 iterations (i.e. years)
      - Incorporate wind and load uncertainty
        - DA commitment based on load and wind forecasts
    - RT modeled deterministically against actuals
      - RT re-commitment may be limited to quick-start units
      - Initial RT based on hourly time-step

Operational violations (continued)



Operational violations (continued)

- 10-minute simulations
  - Days that have greatest probability of operating violations will be evaluated on 10-minute basis
  - Commitment for day locked in from DA hourly runs (except for quick-start units)
  - 10-minute simulations for all 24 hours
  - 100 different commitments for each selected day, but only one actual 10-minute pattern

Operational violations (continued)

- Need to establish violation penalty costs
- CAISO working example
  - Penalty costs for violations
    - Unserved energy -- $6,500/MWh
    - Dump -- $6,000/MWh
    - Spin -- $3,250/MWh
    - Reg-Up –- $2,500/MWh
    - Reg-Down -- $2,500/MWh
    - Non-Spin -- $2,000/MWh

Task 4 -- Develop incremental wind cases

- Subject to time constraints:
  - 400 MW incremental
  - 800 MW " "
  - 1200 MW " "
  - 1600 MW " "
- How will cases be developed?
  - Based on projected expansion

Task 5 -- Operational violations for incremental wind cases

- Same process as Task 3 for different levels of wind resources
- Will also run 10-minute simulations on those periods identified in base case as most interesting

Task 6 -- Determine resources to eliminate operational degradation

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- Identify resource options for remediation
  - Increased reserves
  - Increased flexibility (aero vs. industrial CT)
  - Increased capacity
- Incrementally add identified resources
- Develop package of least-cost resource options for each wind case
  - So that violations are no greater than base case

Task 7 -- Compute wind integration cost

- For each level of incremental wind:
  - Case 1a -- Treat wind initially as a flat monthly resource without increased capacity or reserve requirements
  - Case 1b – Model wind with its variability and increased capacity or reserve requirements
  - Difference in production costs divided by total wind generation is wind integration cost

Task 8 – Develop report

- Develop outline and responsibilities in first two weeks
- Compile report as tasks are completed
- 48-hour review is recommended

Summary

- Relative benefits of proposed methodology
  - Very detailed and accurate modeling of IPC system
    - Hydro modeling
    - Multi-area
    - Reg-up and reg-down
  - Least-cost solution employed to mitigate any operational degradations