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Wind Forecast Error Impacts on Efficiency

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Current Facts

- Currently there is about 400MW of installed wind capacity
  - Capacity expected to be 1100+ MW in 2009
- Wind generators are classified as intermittent generation and must submit a forecast of their hourly energy output
- Wind generation is offered into the market as price-takers (i.e. total forecast energy output is placed at the bottom of the offer stack)

Transition From Pre-Dispatch to Real-Time

- In pre-dispatch the total estimate of wind generation is placed at the bottom of the stack
- However, in real-time, actual tele-metered output from wind generators is used
- Thus, wind forecast error is calculated from the difference between the forecast used in pre-dispatch and the tele-metered values used in real-time

Impact on Efficiency

- Wind forecast error could affect efficiency at 3 different time periods:
  - 1-hour from real-time: scheduling of intertie transactions
  - 3-hours from real-time: SGOL actions
  - day-ahead: DACP commitments
- Wind forecast error may also have offsetting effects on demand forecast error
  - Could lessen or exacerbate the impacts of demand forecast error
  - We will look at this in the analysis for SGOL and DACP impacts

1-Hour Ahead: Impact on Intertie Transactions

- Under forecast of wind generation
  - Could cause expensive imports to be scheduled in pre-dispatch which become uneconomic in real-time
- Over forecast of wind generation
  - In real-time more expensive generation would be scheduled because cheaper imports were not scheduled in pre-dispatch or additional exports were scheduled in pre-dispatch

3-Hour Ahead: Impact on SGOL Actions

- Under forecast of wind generation
  - Could lead to more generators scheduled under SGOL
  - Generators under SGOL would be operating in real-time when cheaper resources could have been used
- Over forecast of wind generation
  - SGOL participating generators would not be scheduled in advance
  - In pre-dispatch more expensive imports would need to be scheduled
  - Or, in real-time more expensive generation would be scheduled

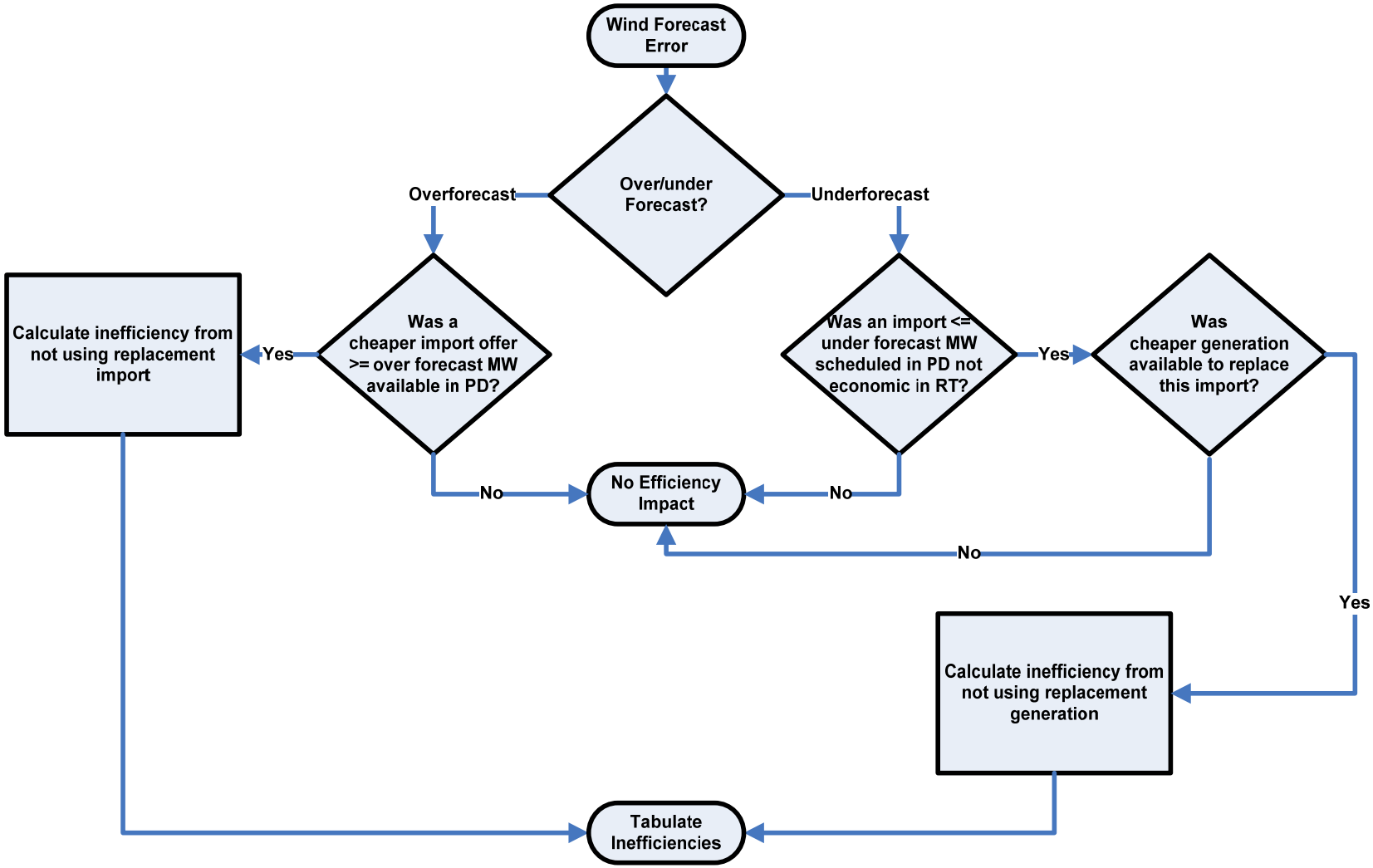
Day-Ahead: Impact on DACP Commitments

- Under forecast of wind generation
  - Over-commitment of imports and generators could occur
  - Cheaper resources could be available in real-time
- Over forecast of wind generation
  - Some imports and generation would not be committed in DACP
  - In pre-dispatch more expensive imports would need to be scheduled
  - Or, in real-time more expensive generation would be scheduled

1-Hour Ahead Accuracy of Wind Forecast (2007)

- Under forecast frequency of 42%
  - 39MW average underforecast
- Over forecast frequency of 58%
  - 35MW average overforecast

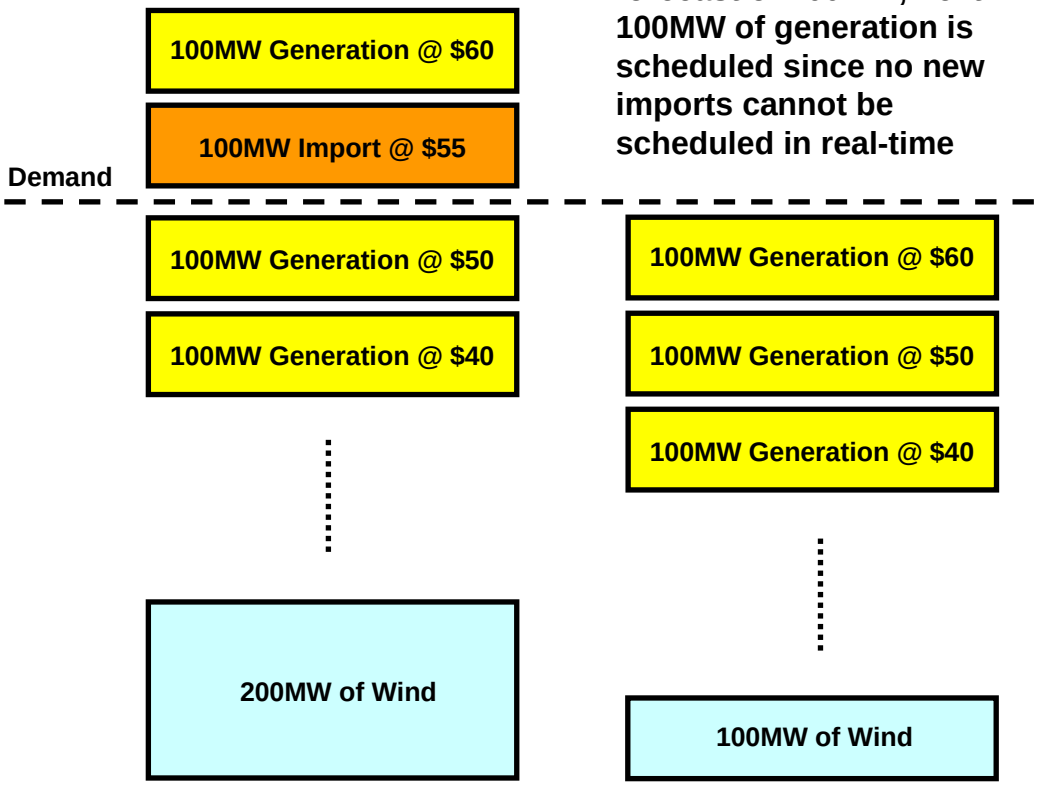
Capturing Efficiency Impact Due to 1-Hour Ahead Wind Forecast Error



Example: 1-Hr Ahead Over forecast Inefficiency Calculation

Over forecast Scenario

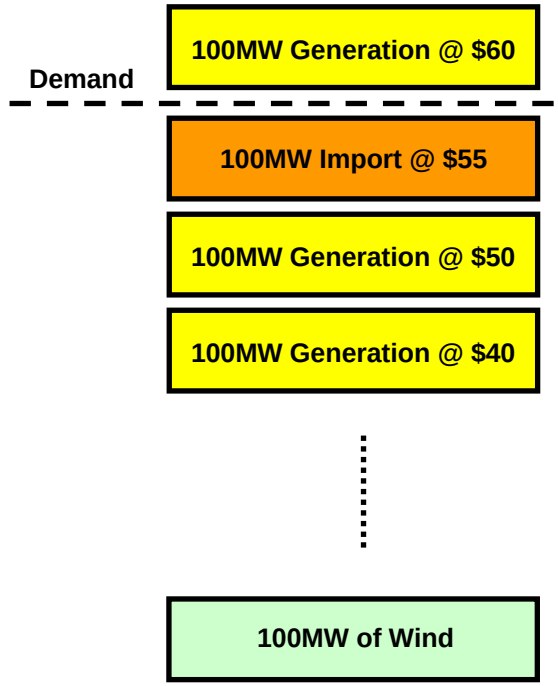
In Pre-dispatch – Forecast of 100 MW of wind



Real-time – Only 100MW of wind available, over forecast of 100MW, next 100MW of generation is scheduled since no new imports cannot be scheduled in real-time

Correct Forecast Scenario

If there wasn't a wind forecast error, the import at $55 would have been scheduled in pre-dispatch. Thus, the inefficiency reduced is:
($60 - $55) / MW x 100MW = $500

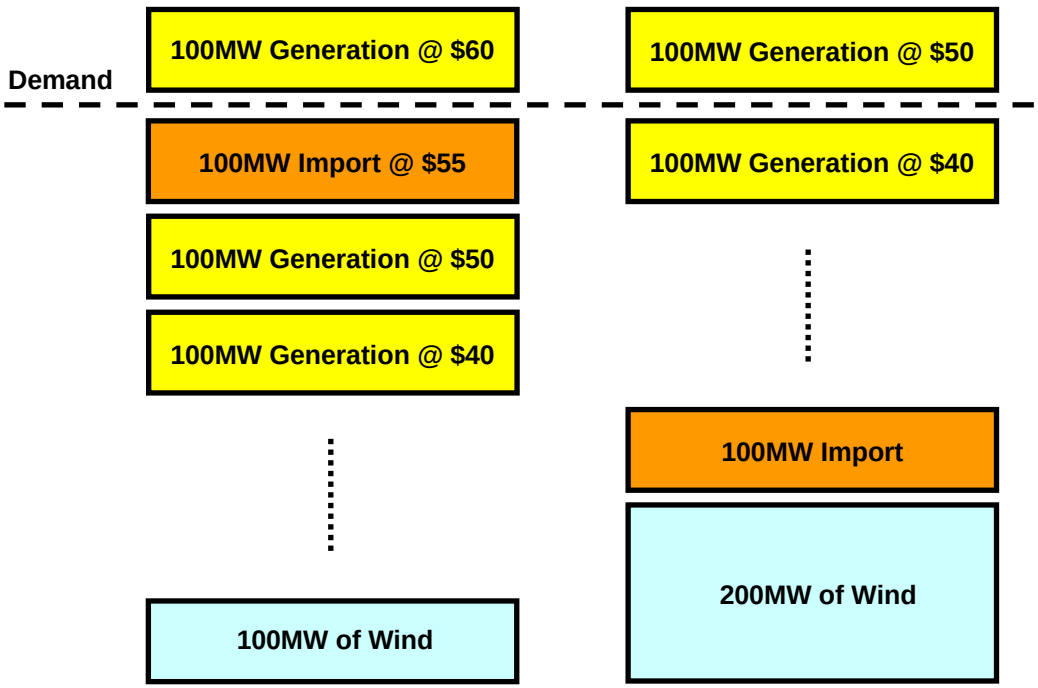


Example: 1-Hr Ahead Under forecast Inefficiency Calculation

Under forecast Scenario

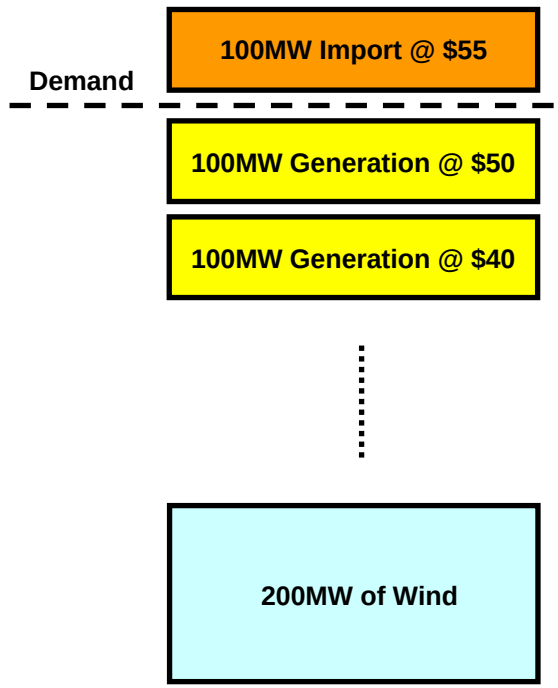
In Pre-dispatch – Forecast of 100 MW of wind

Real-time – 200MW of wind available, under forecast of 100MW, the 100MW of import moves to the bottom of the stack and the 100MW of generation at $50 is not scheduled



Correct Forecast Scenario

If there wasn't a wind forecast error, the import at $55 would never have been scheduled in pre-dispatch. Thus, the inefficiency reduced is: ($55 - $50) / MW x 100MW = $500



1-Hour Ahead Wind Forecast Errors 2007 Costs of Inefficiencies

- Inefficiencies occur when the most economic set of resources are not used to satisfy demand
- Annual costs of inefficiencies
  - Due to over forecast: $186k
  - Due to under forecast: $25k

Projection of Inefficiencies in 2009 Due to Wind Forecast Error

- If we assume that the forecast error percentages remain the same in 2009 we could expect the annual costs of inefficiencies to increase
  - Due to over forecast: $866K
  - Due to under forecast: $37K

Comments on Price Impact

- Over forecast of wind can put upward pressure on the real-time price because in the transition from pre-dispatch to real-time, the amounts of MWs (priced at -$2000) from wind decreases in the real-time stack
  - More expensive resource in the stack gets dispatched
- Conversely, under forecast of wind can put downward pressure on the real-time price because in the transition from pre-dispatch to real-time, the amounts of MWs (priced at -$2000) from wind increases in the real-time stack
  - More expensive resource in the stack can get backed down

Wind Forecast and Demand Forecast Errors

Combination of Forecast Errors	Under forecast of Wind Generation	Over forecast of Wind Generation
Under forecast of Demand	Could lessen potential efficiency impacts from under forecast of demand ✓ (Unless under forecast of wind far exceeds under forecast of demand)	Could further contribute to not committing cheaper resources in SGOL and DACP and/or scheduling of less expensive imports in pre-dispatch ✗
Over forecast of Demand	Could further contribute ✗ to the over-commitment in SGOL and DACP and/or scheduling of more expensive imports in pre-dispatch	Could lessen potential efficiency impacts from underforecast of demand ✓ (Unless under forecast of wind far exceeds under forecast of demand)

3-Hour Ahead Accuracy of Wind Forecast (2007)

- Under forecast frequency of 46%
  - 49MW average under forecast
- Over forecast frequency of 54%
  - 45MW average over forecast

Possible Wind Forecast Error Impact on SGOL Decisions

- We will only look for occurrences when there is a demand overforecast and wind under forecast
  - Leading to possible over-commitment in SGOL
- For the time being we will not look at when there is a demand under forecast and wind over forecast

SGOL Commitments in 2007

- SGOL GCG paid out on average about once per day
- Less than a third ~107 of these SGOL events occurred when there was an demand over forecast and wind under forecast in the 3-hour ahead time frame
- Of the 107 SGOL events, how many were over-commitments and how many were contributed by wind underforecast?

Possible Wind Forecast Error Impact on DACP Commitments

- We will only look for occurrences when there is a demand over forecast and wind underforecast
  - Leading to possible over-commitment in DACP
- For the time being we will not look at when there is a demand under forecast and wind over forecast

Day-Ahead Accuracy of Wind Forecast (2007)

- Under forecast frequency of 45%
  - 83MW average under forecast
- Over forecast frequency of 55%
  - 59MW average over forecast

DACP Commitments in 2007

- DACP GCG paid out on average twice daily
- Just over a third of these DACP commitments (~275) occurred when there was an demand overforecast and wind under forecast in the day-ahead time frame
- Of the 275 DACP commitments events, how many were overcommitments and how many were contributed by wind under forecast?