

Energy and Telecommunications Interim Committee

May 2008



Montana Wind Power Variability Study

GENIVAR

Major Funders

- NorthWestern Energy
- Governor's Office of Economic Development
- MATL
- WAPA

Wind Developer Participants

- Chafin
- Gaelectric
- Horizon
- Invenergy
- Naturener
- Oversight Resources
- Wind Hunter

Purpose of Study

- Montana stakeholders interested in an assessment of the magnitude and frequency of change in power output over periods of 10 min to 120 min from geospatially separated wind farms
- The variability stream will be utilized to quantify Control Performance Standard 2 (CPS2) and Operating Transfer Capability (OTC) violations

Purpose of Study

- These results will be correlated with other grid variability factors to predict net influence of wind's variability
- This net influence will assist NorthWestern in forecasting necessary reserves and or mitigating solutions required to maintain balance.

Study Background

- Concept initiated in May 2006
- The total cost should be around \$110K.
- Due to be completed June

Part 1: Wind Power Variability Analysis

➤ Scenario Description

- Historical: Scenario A (for dispatch model validation only)
- Proposed Future Developments:
 - Scenarios were based on projected on-line dates of projects under development, regardless of locations within the state
 - Scenario B: 358MW, includes Scenario A plus at least 3 new projects
 - Scenario C: 741MW, includes Scenario B plus at least 3 new projects
 - Scenario D: 1450MW, includes Scenario C plus at least 3 new projects
- Hypothetical Developments: Scenario E, Scenario F, Scenario G
 - Designed to capture advantage of regional diversity

Hypothetical Scenarios

Region	Scenario E	Scenario F	Scenario G
North West	362.5 MW	625 MW	100 MW
Central	362.5 MW	625 MW	1150 MW
South West	362.5 MW	100 MW	100 MW
North East	362.5 MW	100 MW	100 MW
TOTAL	1450 MW	1450 MW	1450 MW



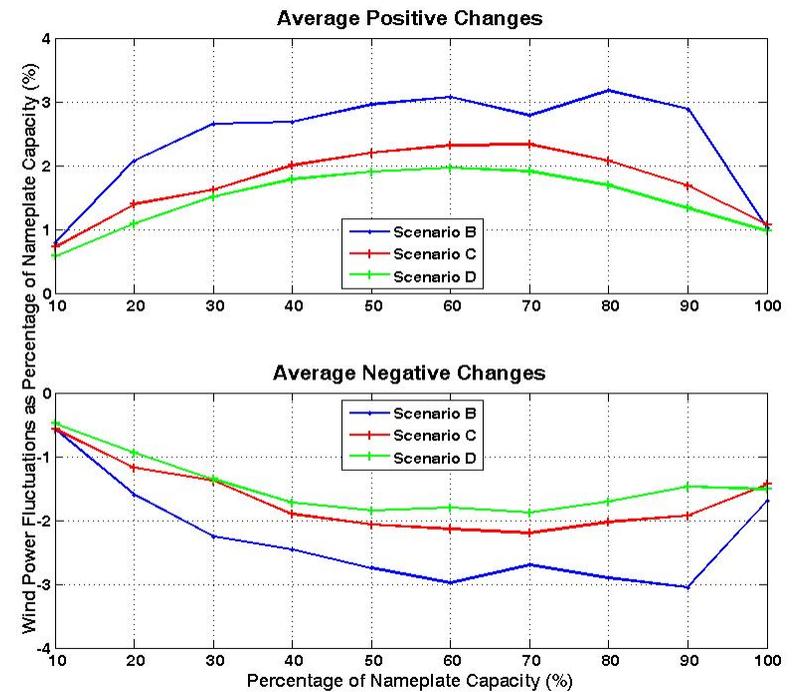
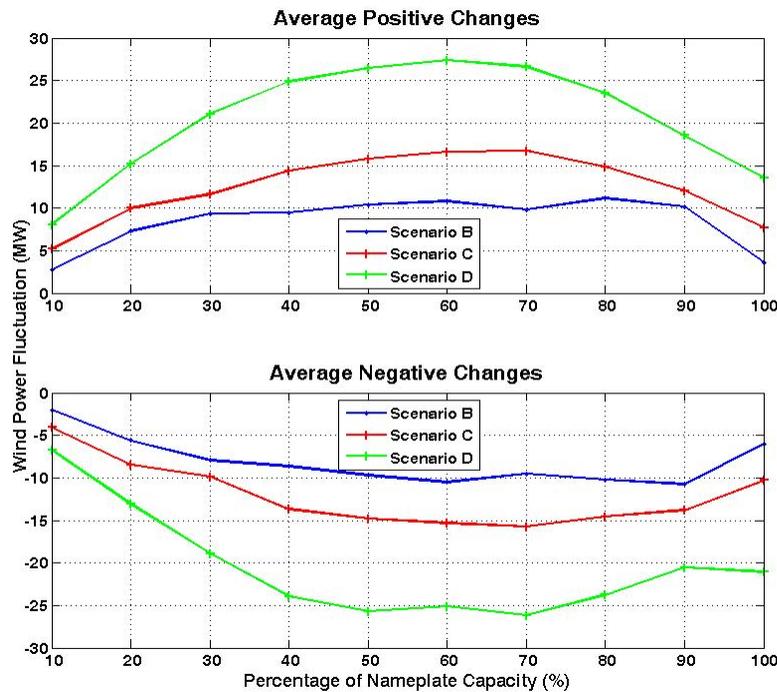
Equivalent capacity to Scenario D

Conclusion

- **Impact of proposed development scenarios to variability**
 - **Variability in terms of magnitude increases with increased capacity: the 95 percentile value of 10-minute positive fluctuations for Scenario B, Scenario C, and Scenario D are 25.1MW, 38.7MW, and 60.7MW respectively**
 - **Variability in terms of percentage capacity decreases with increased capacity: the 95 percentile value of 10-minute positive fluctuations for Scenario B, Scenario C, and Scenario D are 7.1%, 5.4%, and 4.4% respectively**
- **Impact of hypothetical geospatial diversity to variability**
 - **Variability in terms of magnitude decreases with increased diversity: the 95 percentile value of 10-minute positive fluctuations for Scenario E, Scenario F, and Scenario G are 63.51MW, 73.9MW, and 84.6MW respectively**

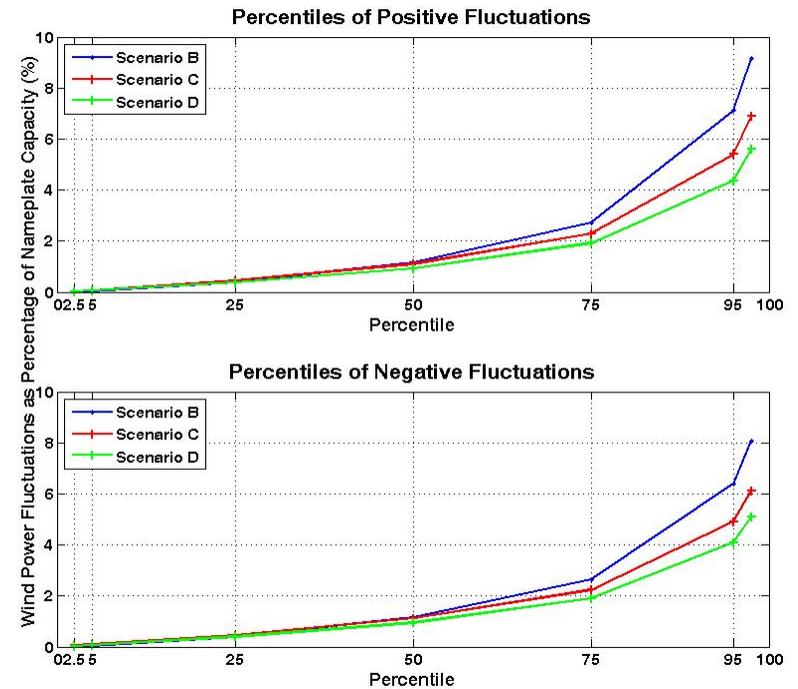
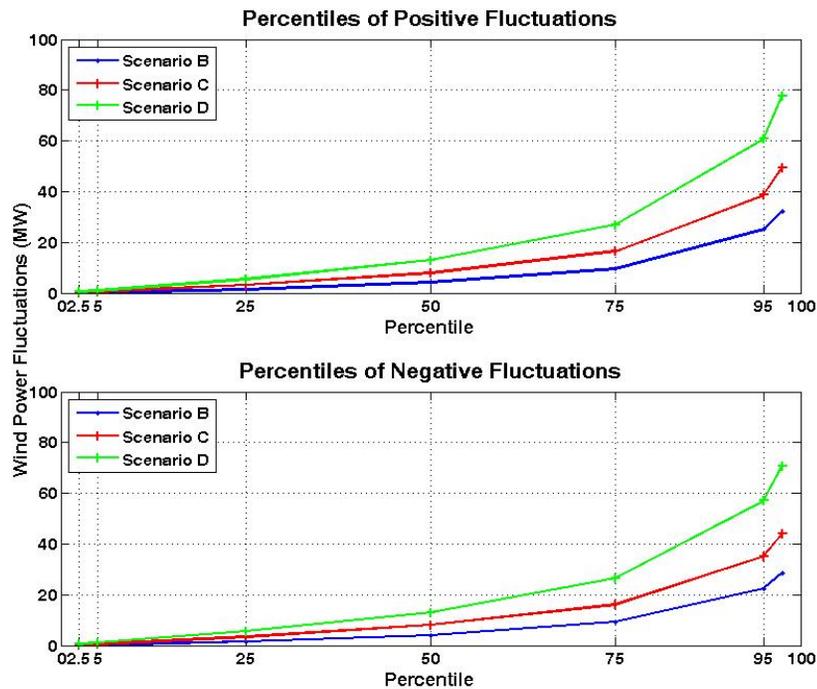
Part 1: Wind Power Variability Analysis

➤ Results: Proposed Scenarios, 10-minute model



Part 1: Wind Power Variability Analysis

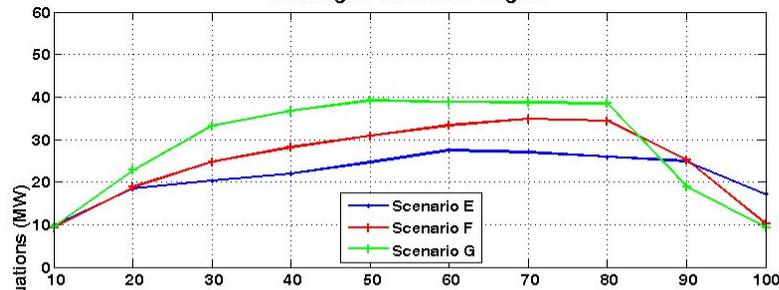
➤ Results: Proposed Scenarios, 10-minute model



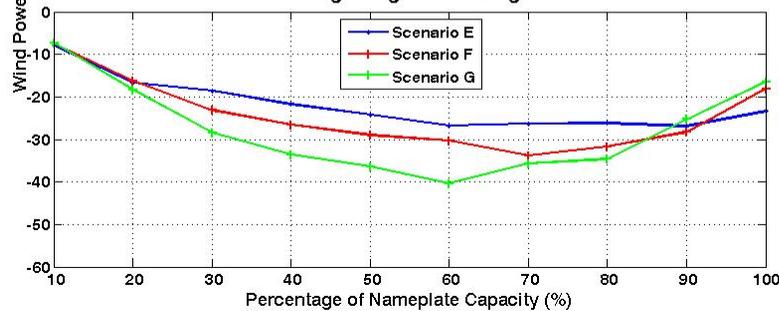
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➤ Results: Hypothetical Scenarios, 10-minute model

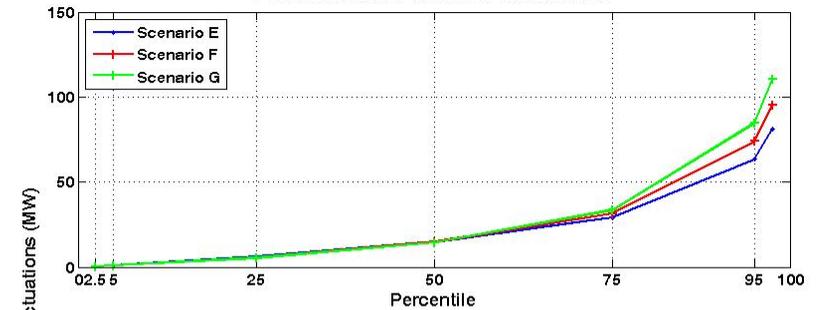
Average Positive Changes



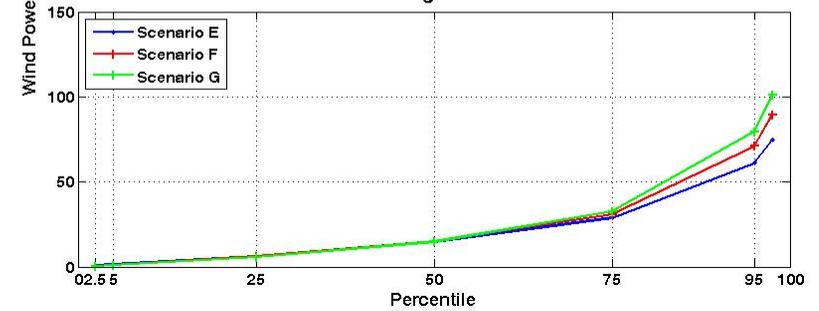
Average Negative Changes



Percentiles of Positive Fluctuations



Percentiles of Negative Fluctuations



Why Develop Montana Wind?

- **Greatest Wind Resource in the US** - 116,000 MW potential
- **Climate Change** – no GHG's
- **National Energy Security** – increasing demand for electricity, further increased by ideas for more electrification of the transportation system (PHEV's)
- **Economic Development** – Judith Gap doubled local tax base plus efforts are underway to bring wind turbine manufacturing and R&D to the state (Fuhrlander/Chafin and Vestas)



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Infrastructure
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