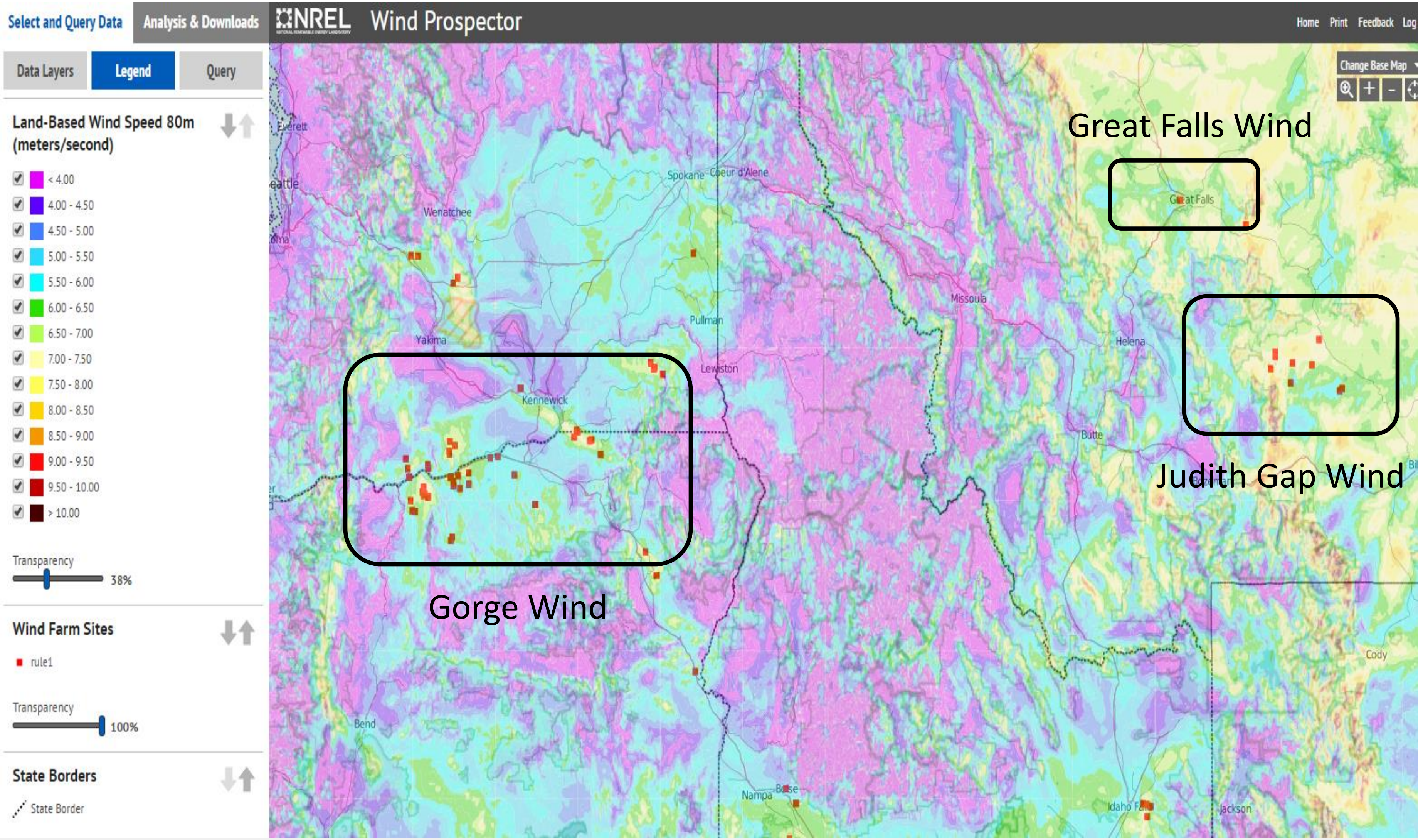
Montana Wind Capacity Contribution



Wind and Transmission Working Group, Sept 22, 2016

Helena, Montana

The Classic ELCC Wind Capacity Study:

1. Take an existing system simulation with an estimated Loss of Load Probability or other reliability metric
2. Add load to the system which will make the system less reliable
3. Add wind generation until the system is back to the same reliability level

Ambiguity gets introduced because of the load. Is the additional load:

- A flat annual block
- Proportional load
- An end-use future forecast load
- Something else

In the Northwest hydro generation can further confuse the study.

- If hydro is re-dispatched, some additional system capacity may be available.
- If integration is done with hydro, some capacity may be held back that should be netted against the capacity contribution.
- Different run-off means capacity contribution is different every combination of wind year and water year.

The Seventh Plan took a unique approach by measuring the **system** capacity contribution of a new resource:

- ASCC = the effective change in the aggregate system capacity when a resource is added to the existing power supply

- The ASCC can be thought of as a resource’s nameplate capacity plus any capacity gained by the hydroelectric system.

Calculating ASCC

1. Start with an inadequate power supply (i.e. LOLP > 5%)

2. Needed Capacity for Adequacy =
Analyze the curtailment record produced by the GENESYS model to determine the exact amount of capacity needed to get 5% LOLP

3. Nameplate Capacity for Adequacy =
Using the GENESYS model, add increments of new resource nameplate capacity until the LOLP gets to 5%

4. ASCC = Needed capacity/Nameplate capacity

Examples of ASCC

- <u>Combustion Turbine</u>
  - Base case is inadequate LOLP = 50%
  - Needed capacity 5,850 MW
  - Nameplate capacity 4,400 MW
  - ASCC = 5,850/4,400 = 1.3

- <u>Energy Efficiency</u>
  - EE capacity for 5% LOLP 4,900 MW
  - ASCC = 5,850/4,900 = 1.2

Associated System Capacity Contribution from the Seventh Power Plan

	Q1	Q2[1]	Q3	Q4
Solar PV[2]	0.26	N/A	0.80	0.42
Geothermal	1.28	N/A	1.02	1.20
Energy Efficiency	1.24	N/A	1.14	1.16
Natural Gas	1.28	N/A	1.02	1.20
Columbia Gorge Wind[2]	0.03	N/A	0.11	0.08

[1]The lack of adequacy issues in Q2 makes the system capacity contribution meaningless.
[2]Within-hour balancing reserves were not adjusted for the solar or wind ASCC analyses

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Judith Gap[2]	0.52	N/A	0.25	0.74
Great Falls[2]	0.63	N/A	0.18	0.40

[1]The lack of adequacy issues in Q2 makes the system capacity contribution meaningless.
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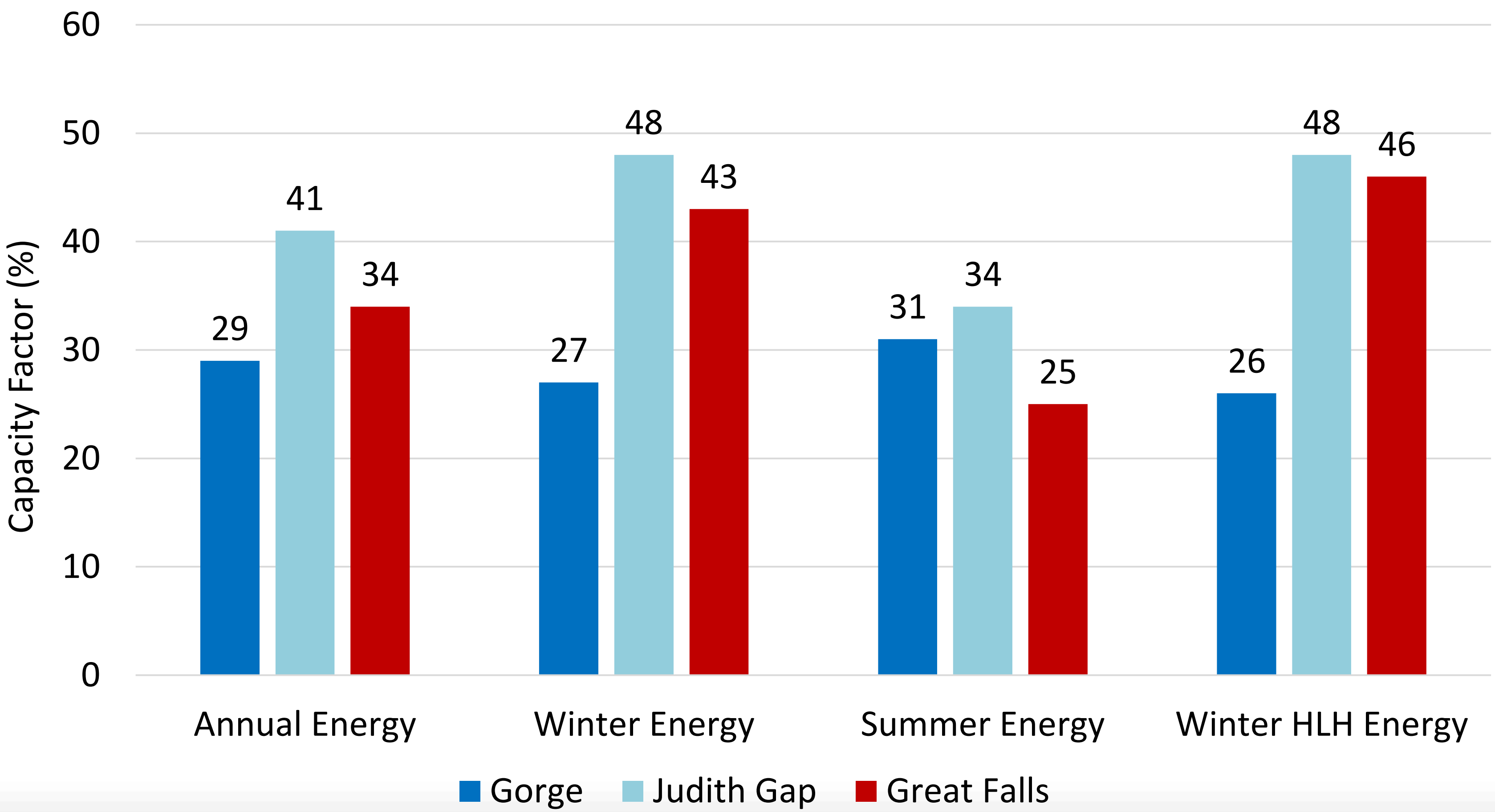
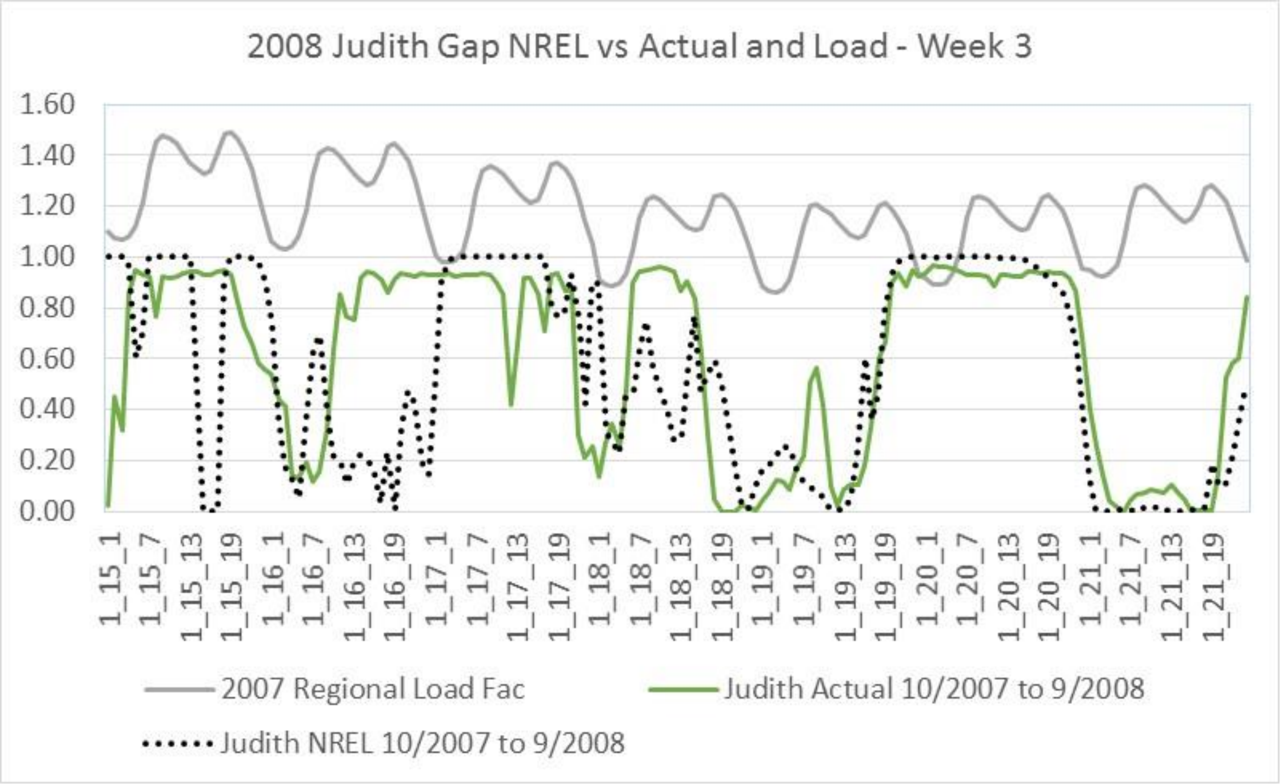
Caveats and Notes

- 7th power plan methods and assumptions
- No additional within-hour balancing reserves were added
- Very small sample size for Montana wind
- Staff to revisit ASCC methodology (7th power plan action item)

Wind Site Characteristics

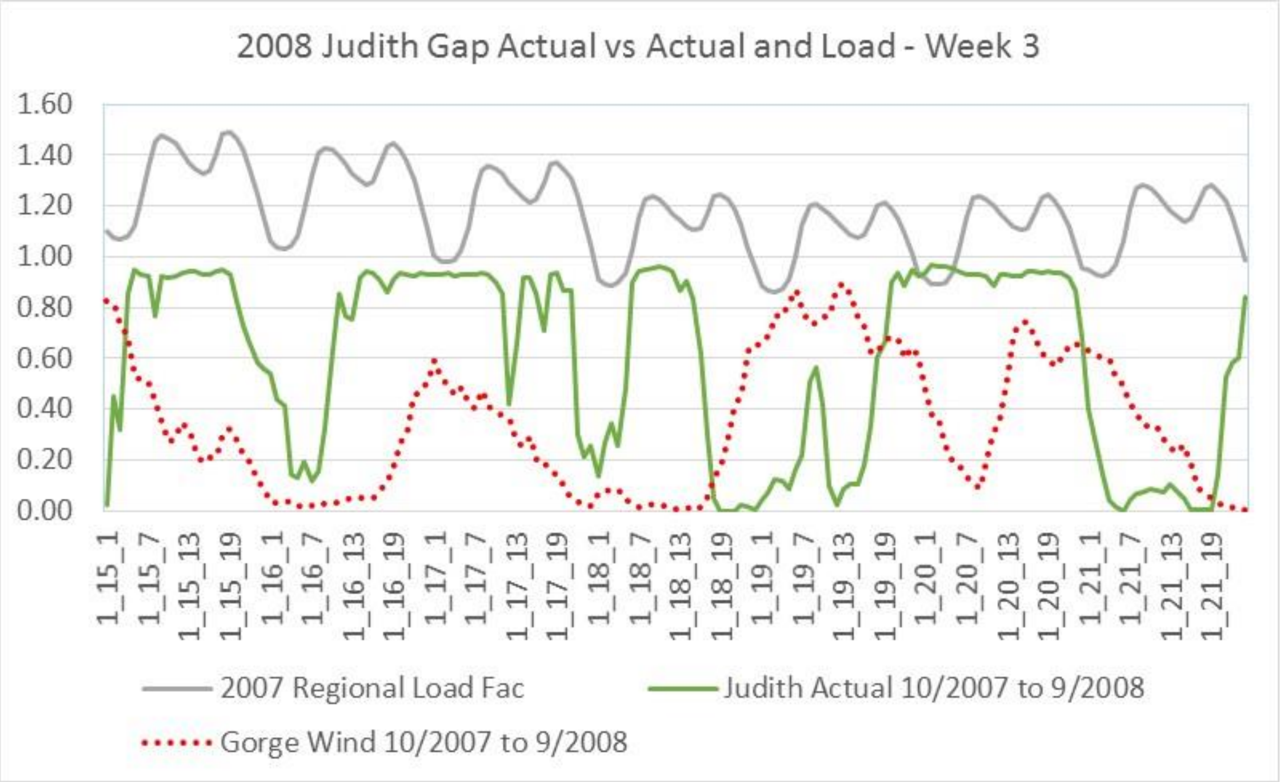


Actual vs Simulated Wind CF
Judith Gap – January 2008 Week 3

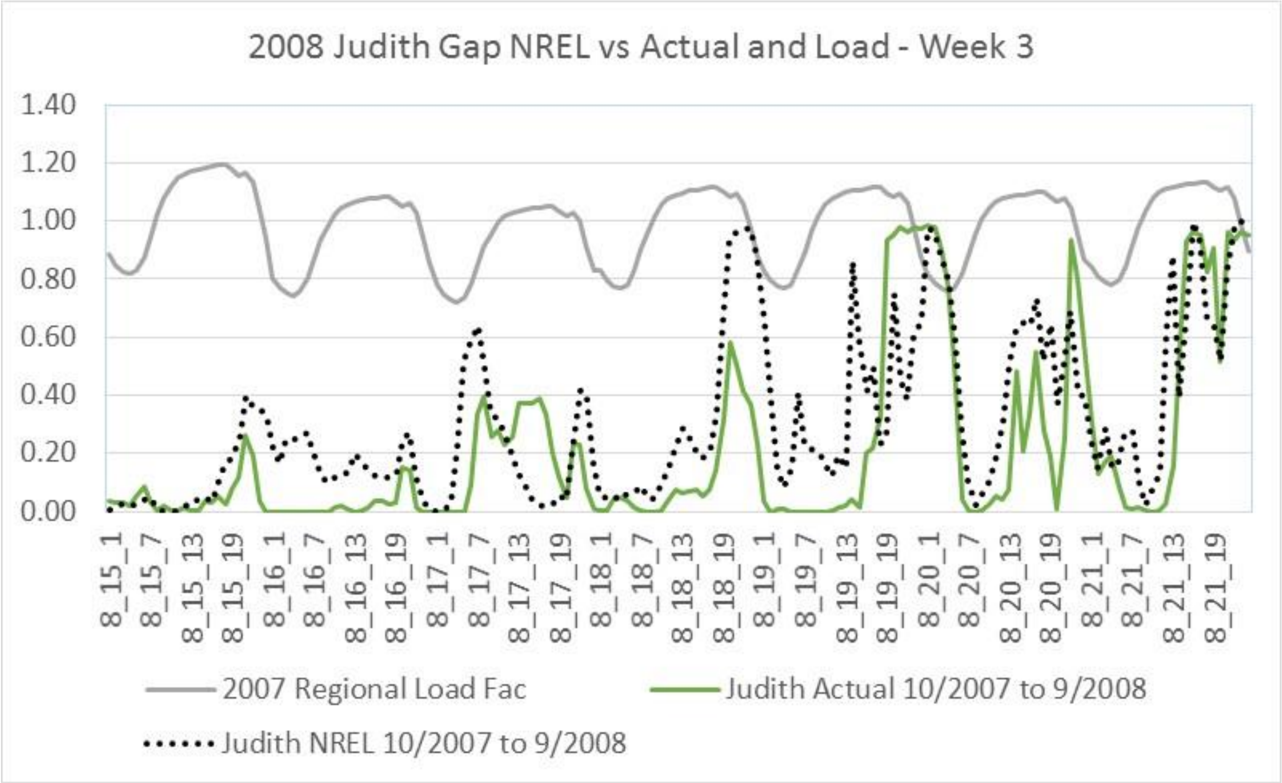


Northwest **Power** and **Conservation** Council

Judith Gap vs Gorge Wind CF
January 2008 Week 3



Actual vs Simulated Wind CF
Judith Gap – August 2008 Week 3



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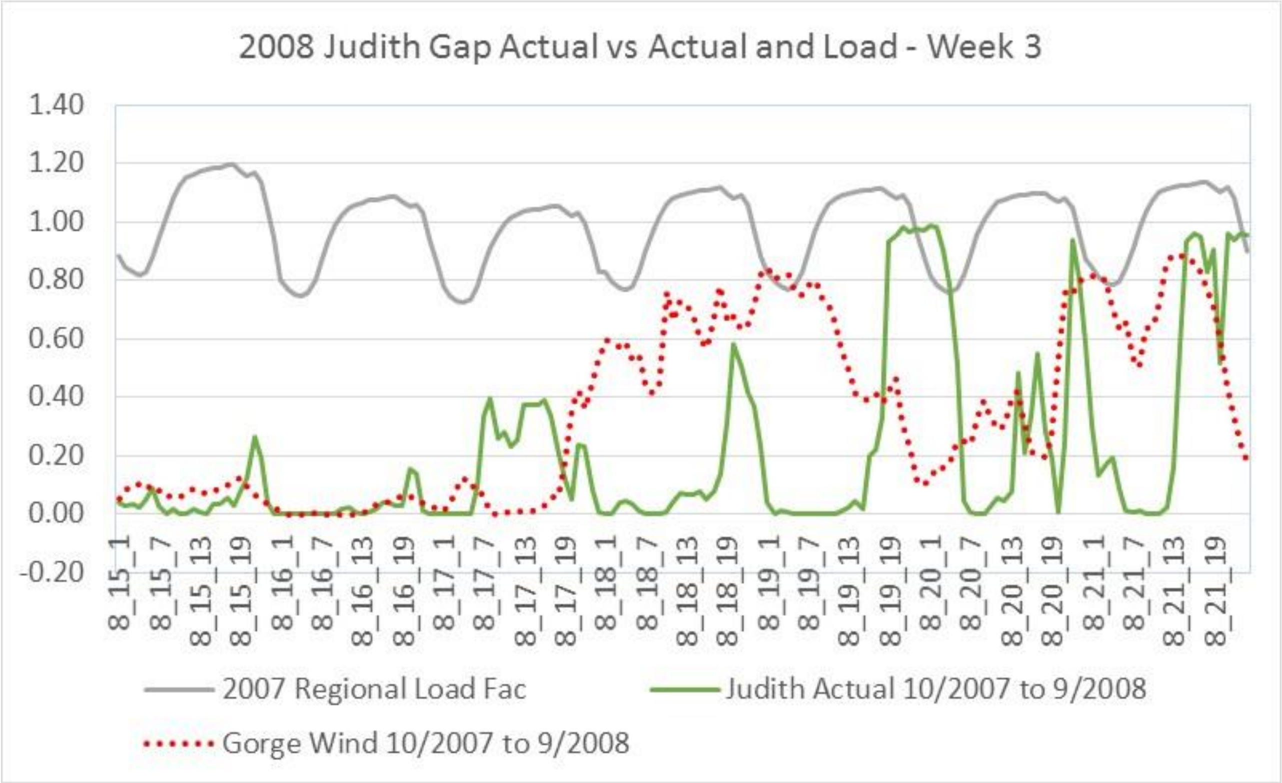


Conclusions

- Higher annual energy generation, especially in winter – helps increase ASCC

- Montana wind correlates better with timing of regional winter peak load

Next Steps

- Update study with additional data and continue to add data as available

- Investigate other potentially promising sites in Montana

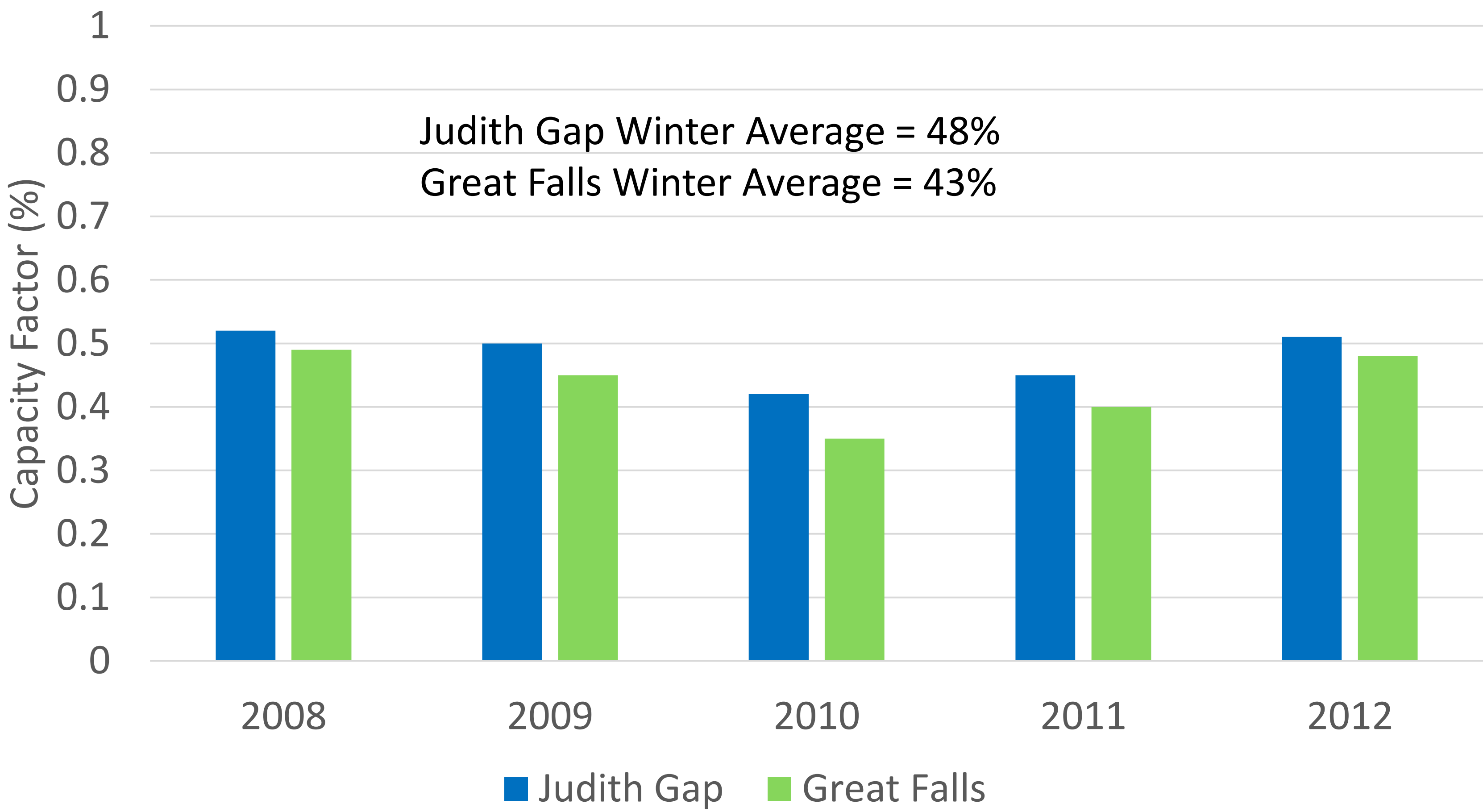
Additional Slides

Wind Site Characteristics

	Average Values			
Wind Site	Annual Energy (% of NP)	Winter Energy (% of NP)	Summer Energy (% of NP)	Winter HLH[1] Energy (% of NP)
Gorge	29%	27%	31%	26%
Judith Gap	41%	48%	34%	48%
Great Falls	34%	43%	25%	46%

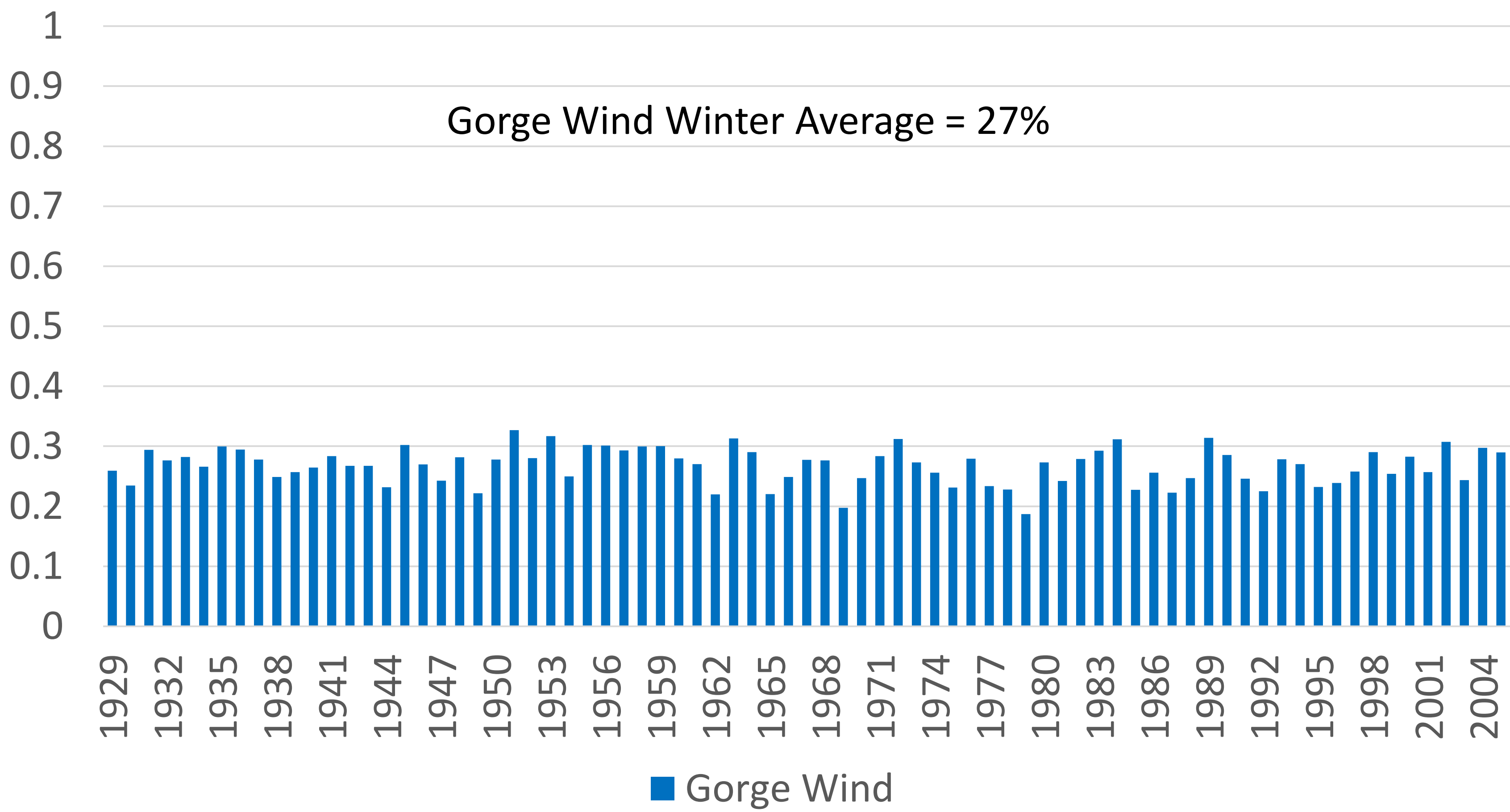
[1]HLH = High Load Hours, in this case from 7am to 6pm all days.

Variation in Winter[1] Wind Energy Judith Gap and Great Falls



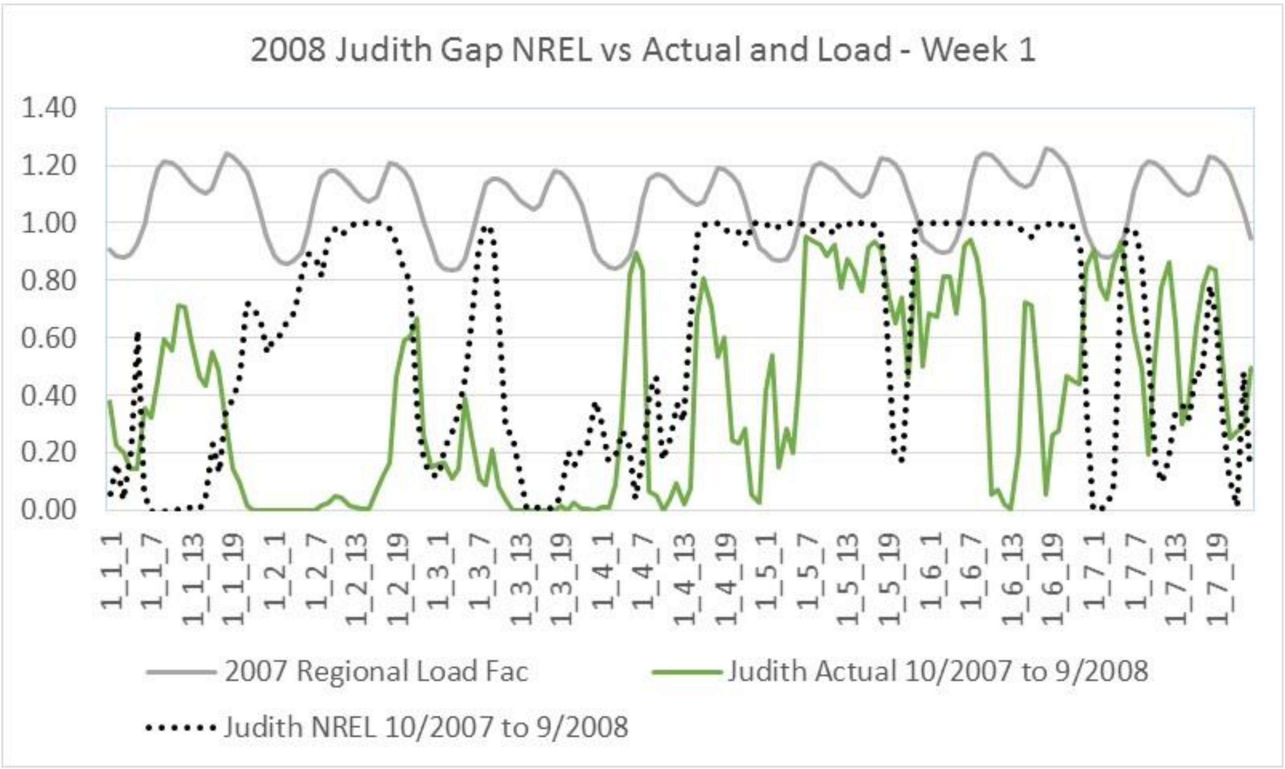
[1]Winter months from October through March

Variation in Winter[1] Wind Energy Gorge Wind

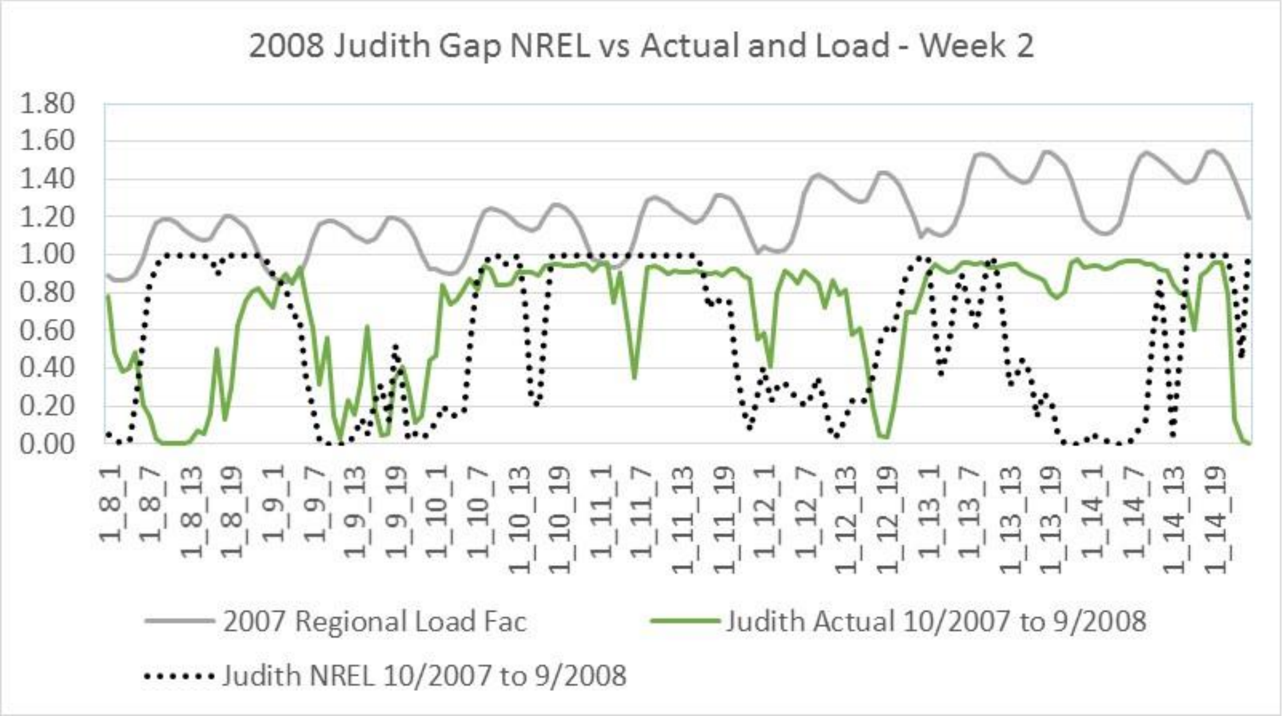


[1]Winter months from October through March

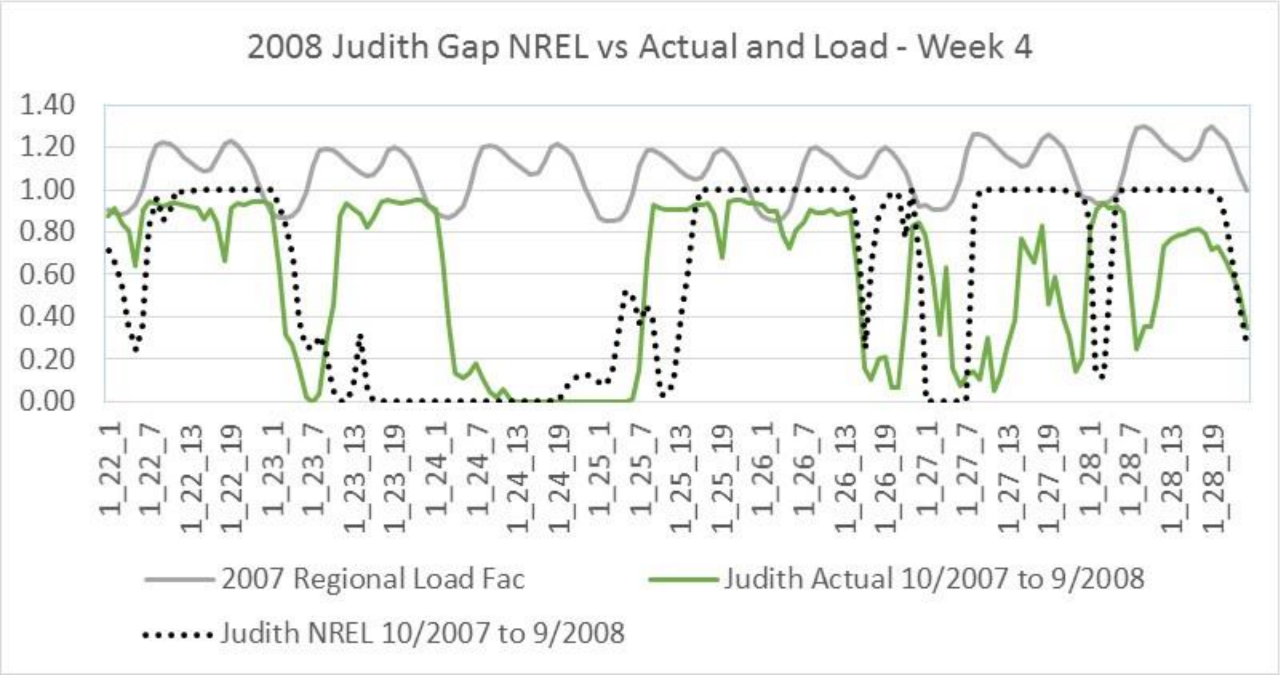
Actual vs Simulated Wind CF
Judith Gap – January 2008 Week 1



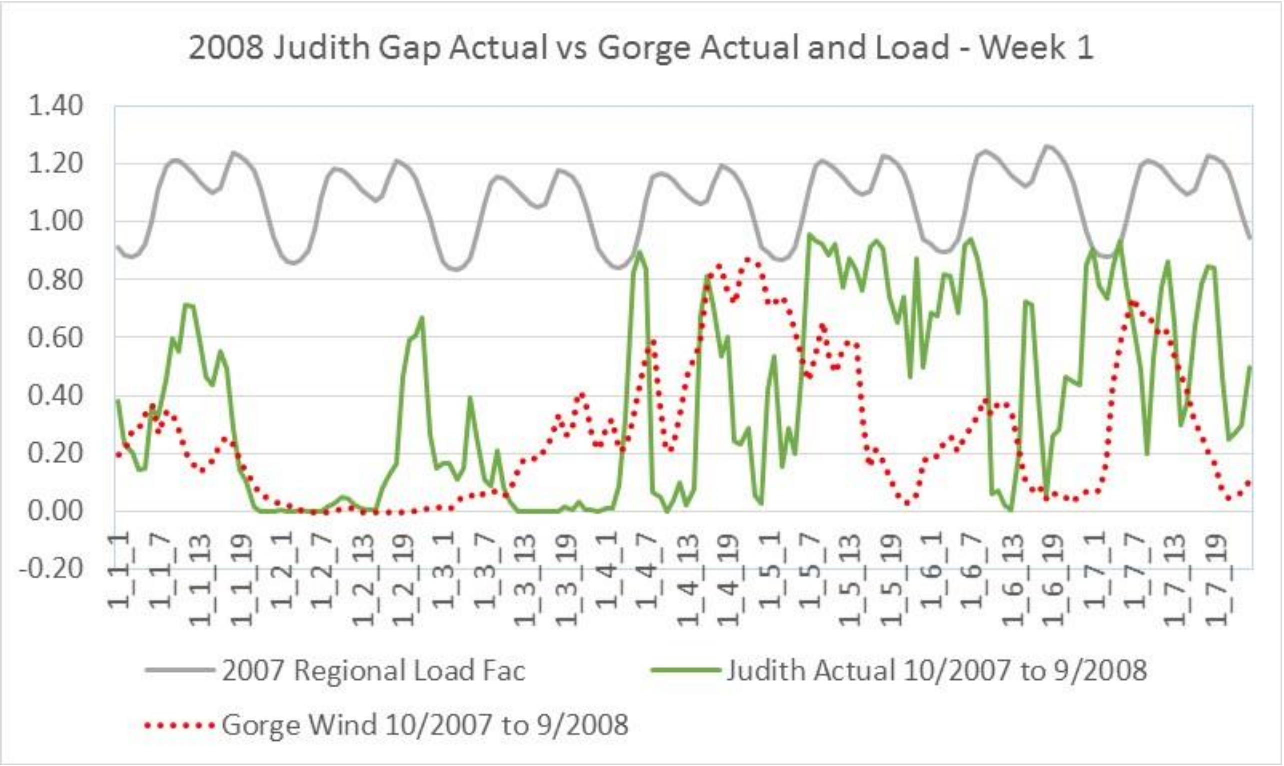
Actual vs Simulated Wind CF
Judith Gap – January 2008 Week 2



Actual vs Simulated Wind CF
Judith Gap – January 2008 Week 4

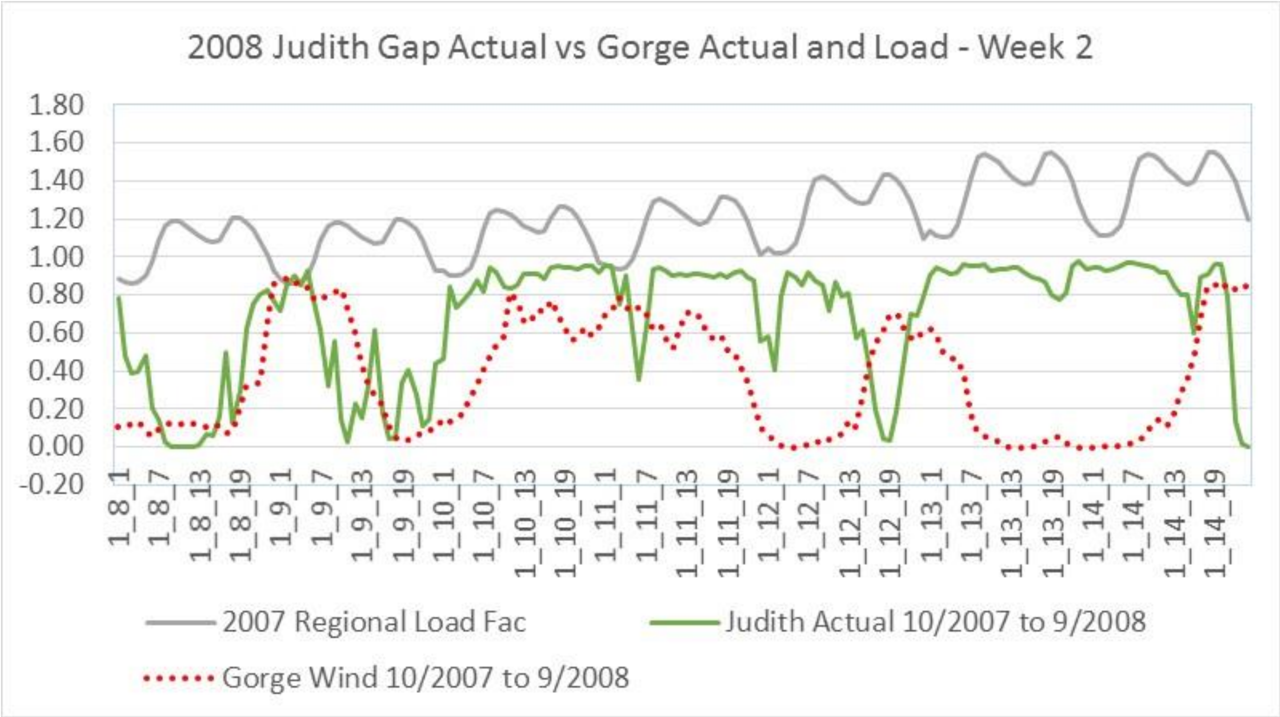


Judith Gap vs Gorge Wind CF
January 2008 Week 1

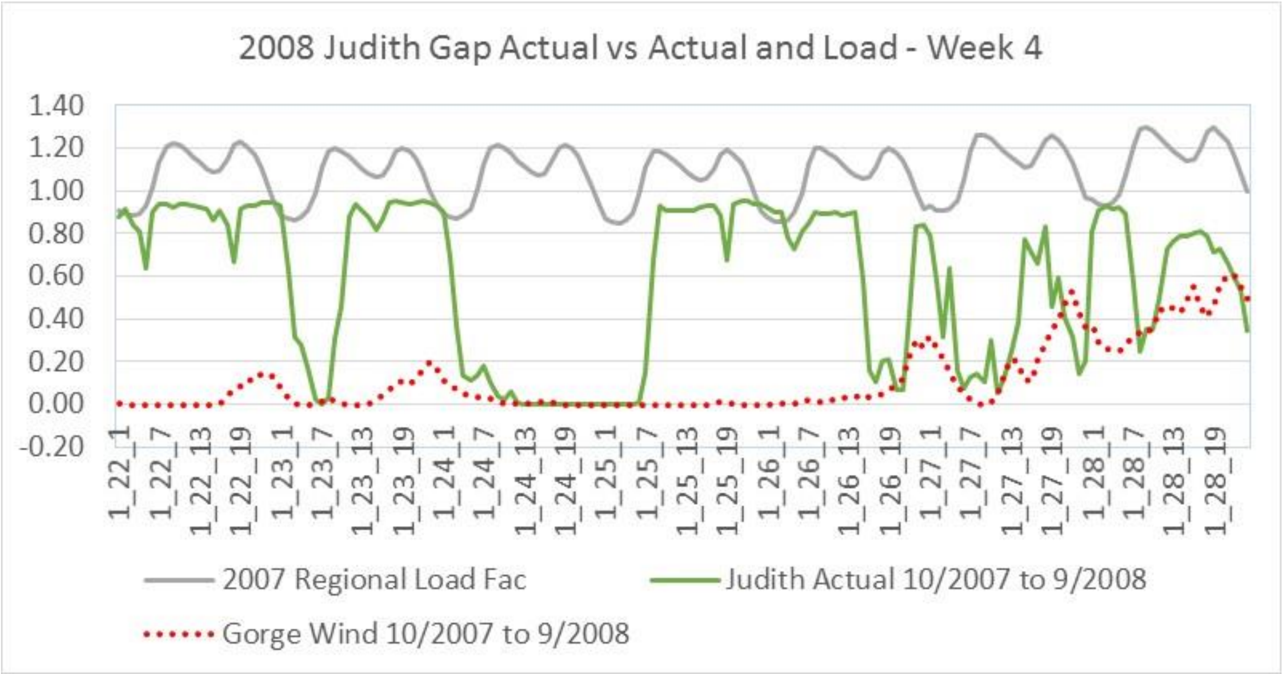


Judith Gap vs Gorge Wind CF

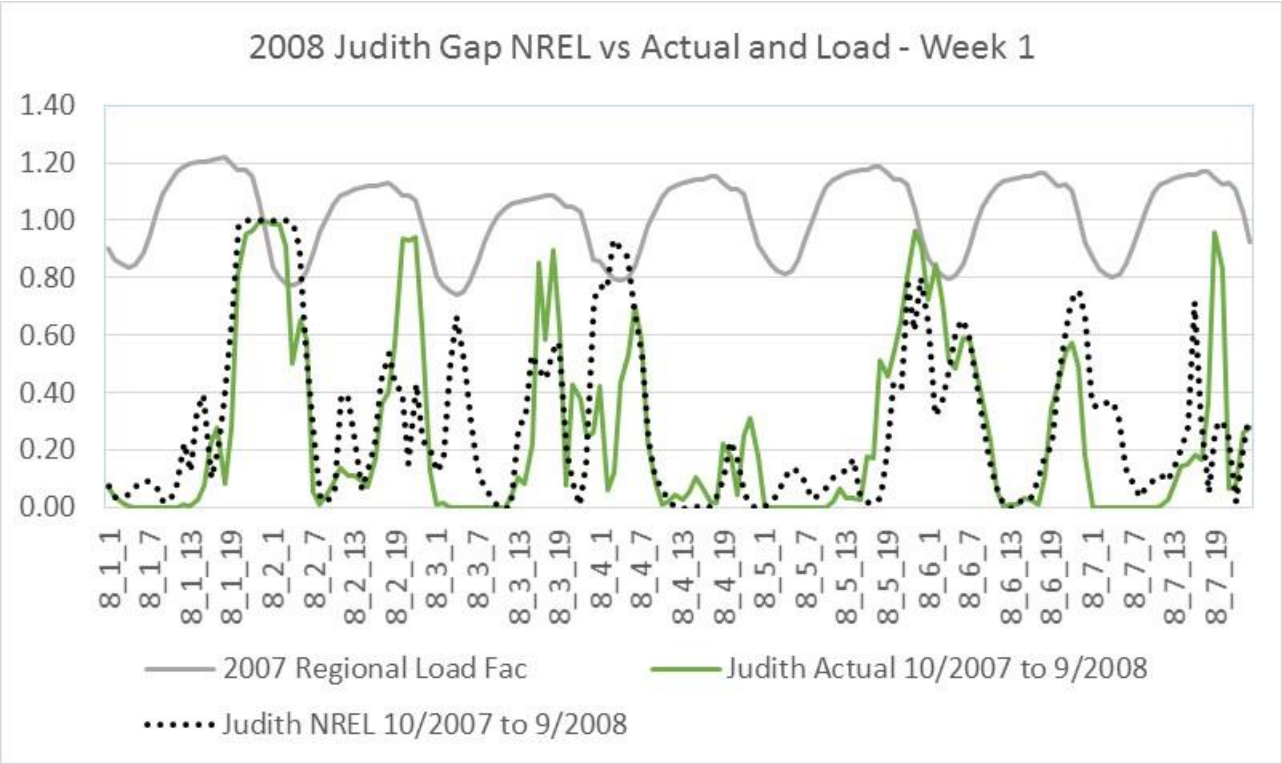
January 2008 Week 2



Judith Gap vs Gorge Wind CF
January 2008 Week 4



Actual vs Simulated Wind CF
Judith Gap – August 2008 Week 1



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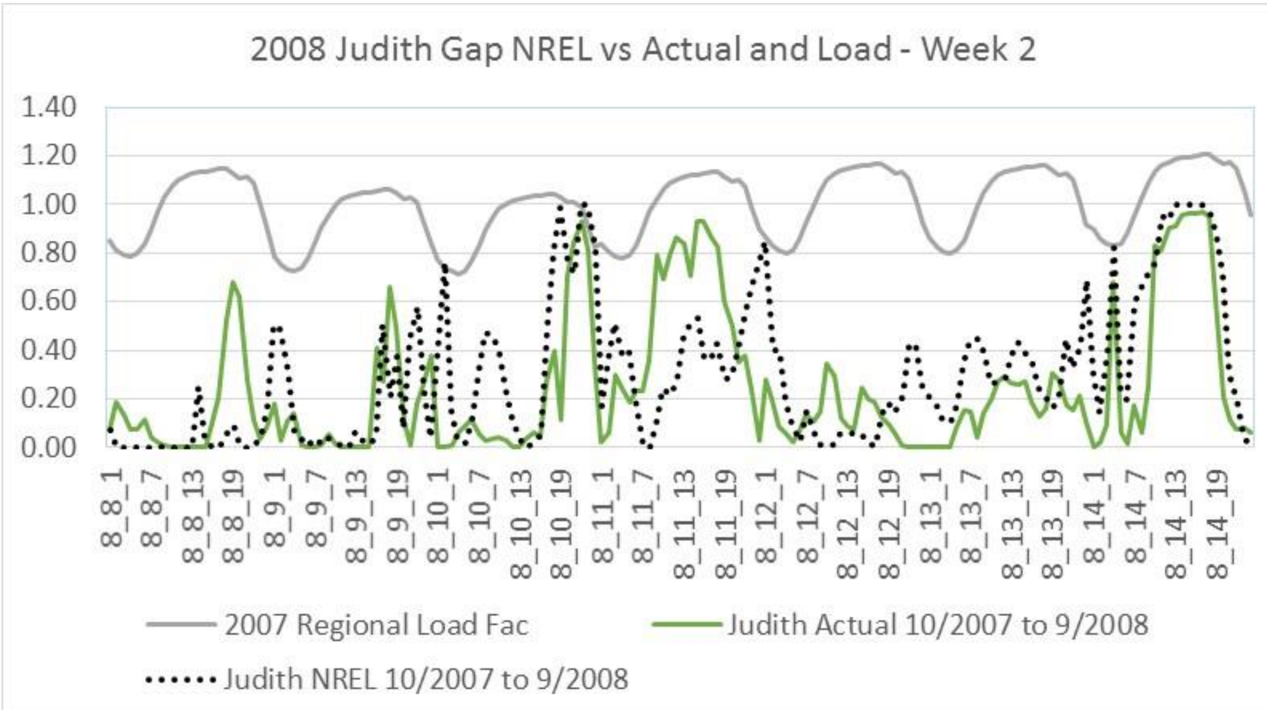
Judith Gap – August 2008 Week 2



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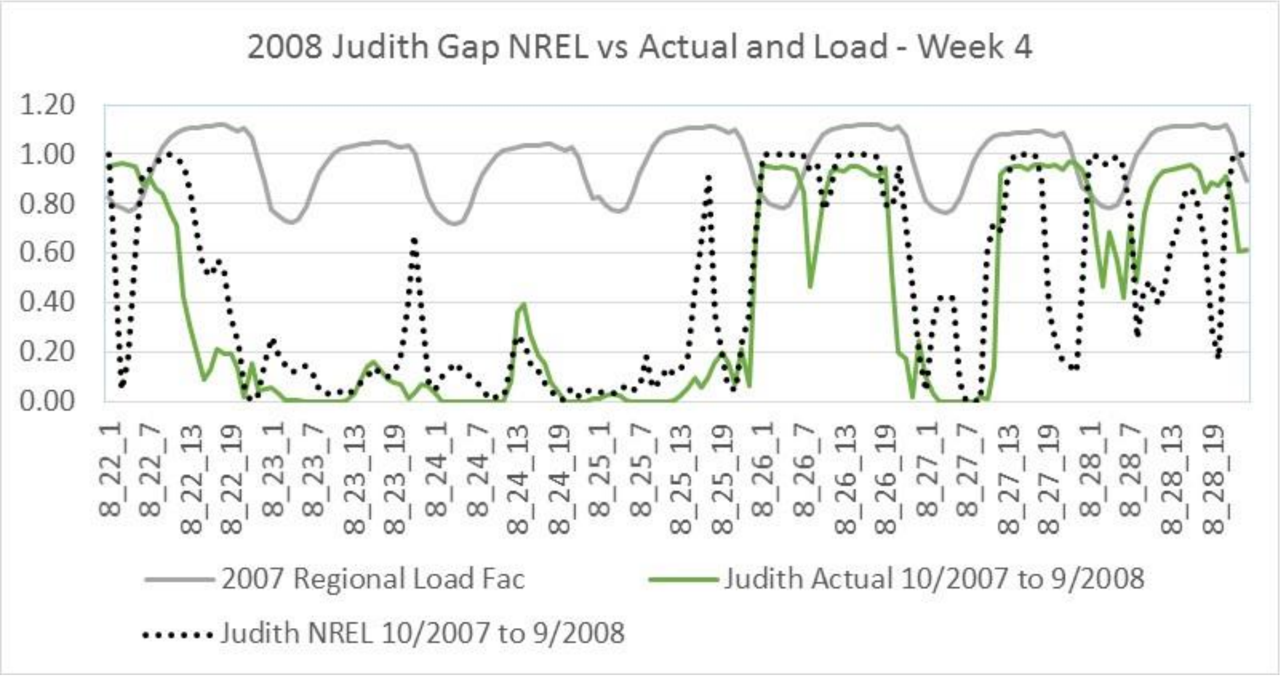

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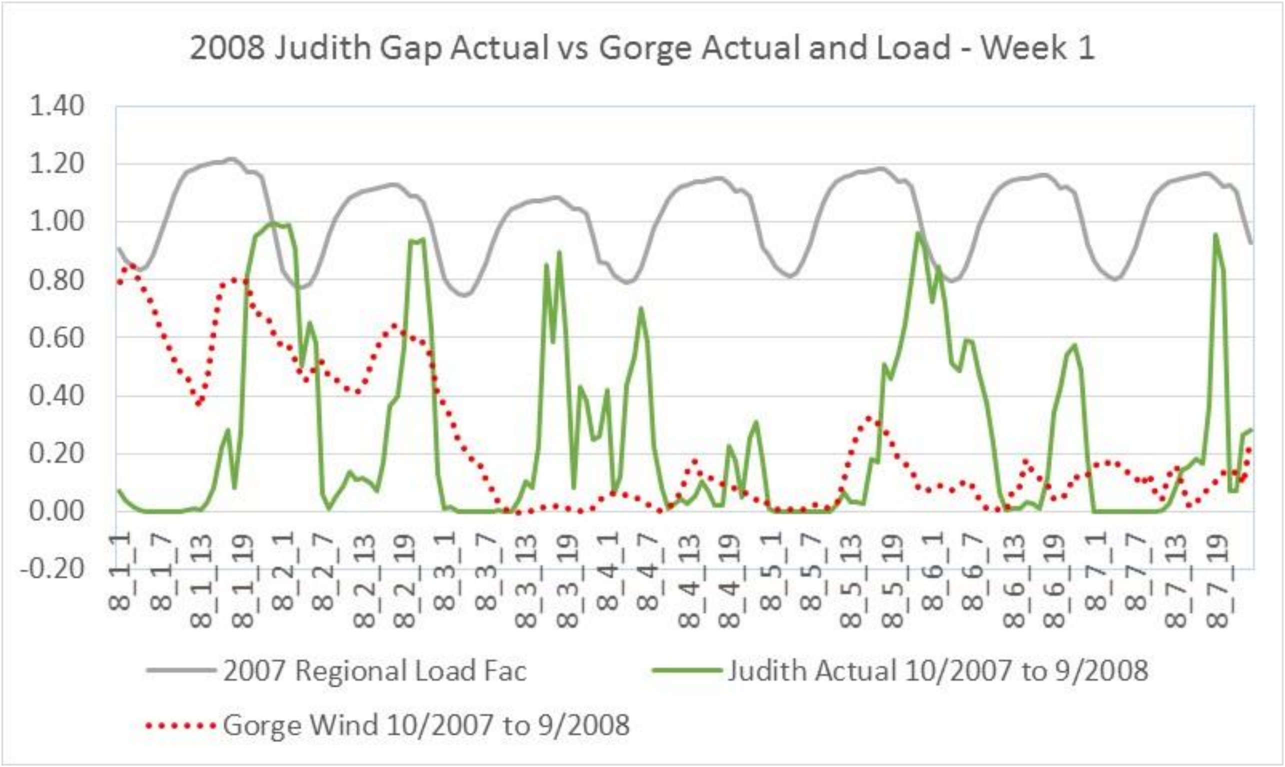
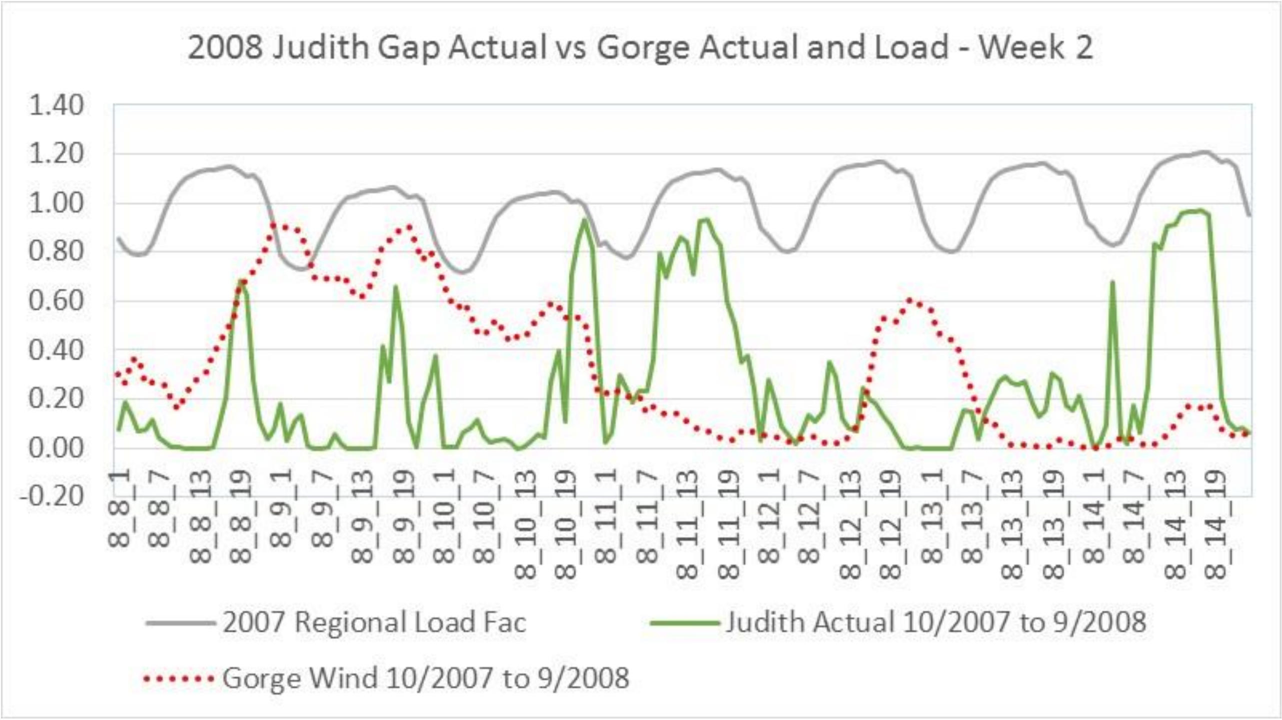
August 2008 Week 1



Judith Gap vs Gorge Wind CF
August 2008 Week 2



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Judith Gap vs Gorge Wind CF
August 2008 Week 4