



Wind Diversity/Correlation Study (Vancouver Island)

September 2010

Intra-hour Correlation Results

- High intra-hour correlation among wind sites in BPA's control area
 - Wasco, Seven Mile, Goodnoe Hills, and Chinook exhibit a high positive correlation (0.5 to 0.7)
 - Weak, negative correlation to BPA load
- The Vancouver Island site is:
 - Located at the Northern tip of Vancouver Island
 - Uncorrelated on an intra-hour level to Columbia Gorge wind indicating ramping/reserve diversity

2007 data only

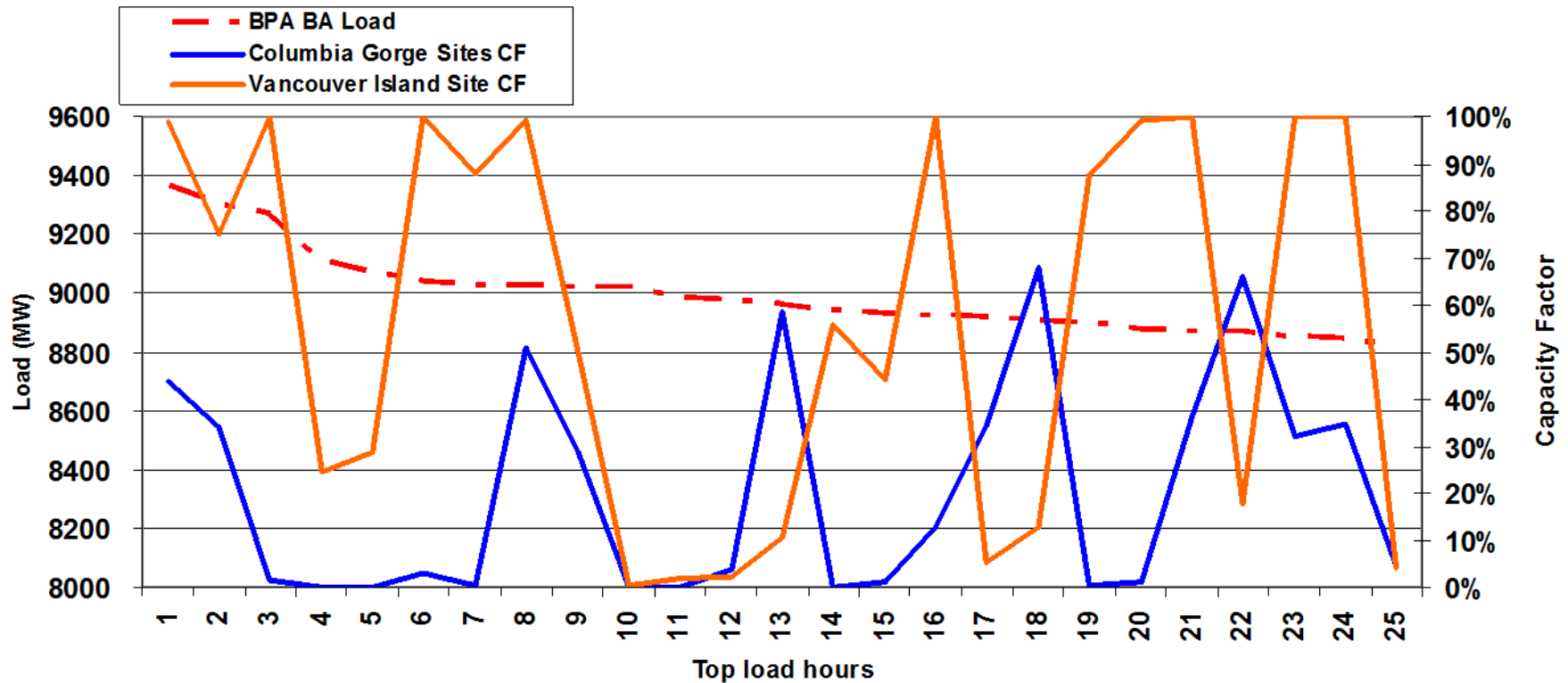
Peak Load Comparison

- Graph plots hourly load data from BPA's control area and simulated hourly generation data from Goodnoe Hills and the Vancouver Island site
- Shows the top 25 peak hourly load periods (all hours in December and January 2007) in BPA's control area and the corresponding generation at each of the wind sites (Based on wind turbine power factor curves)
- In addition to the superior wind potential during peak load periods at the Vancouver Island wind site, simulated wind generation at Goodnoe Hills and Vancouver Island shows diversity during peak periods

2007 data only

Peak Load Hour Capacity Factors

BPA Load Duration Curve Compared to Wind Generation (2007)



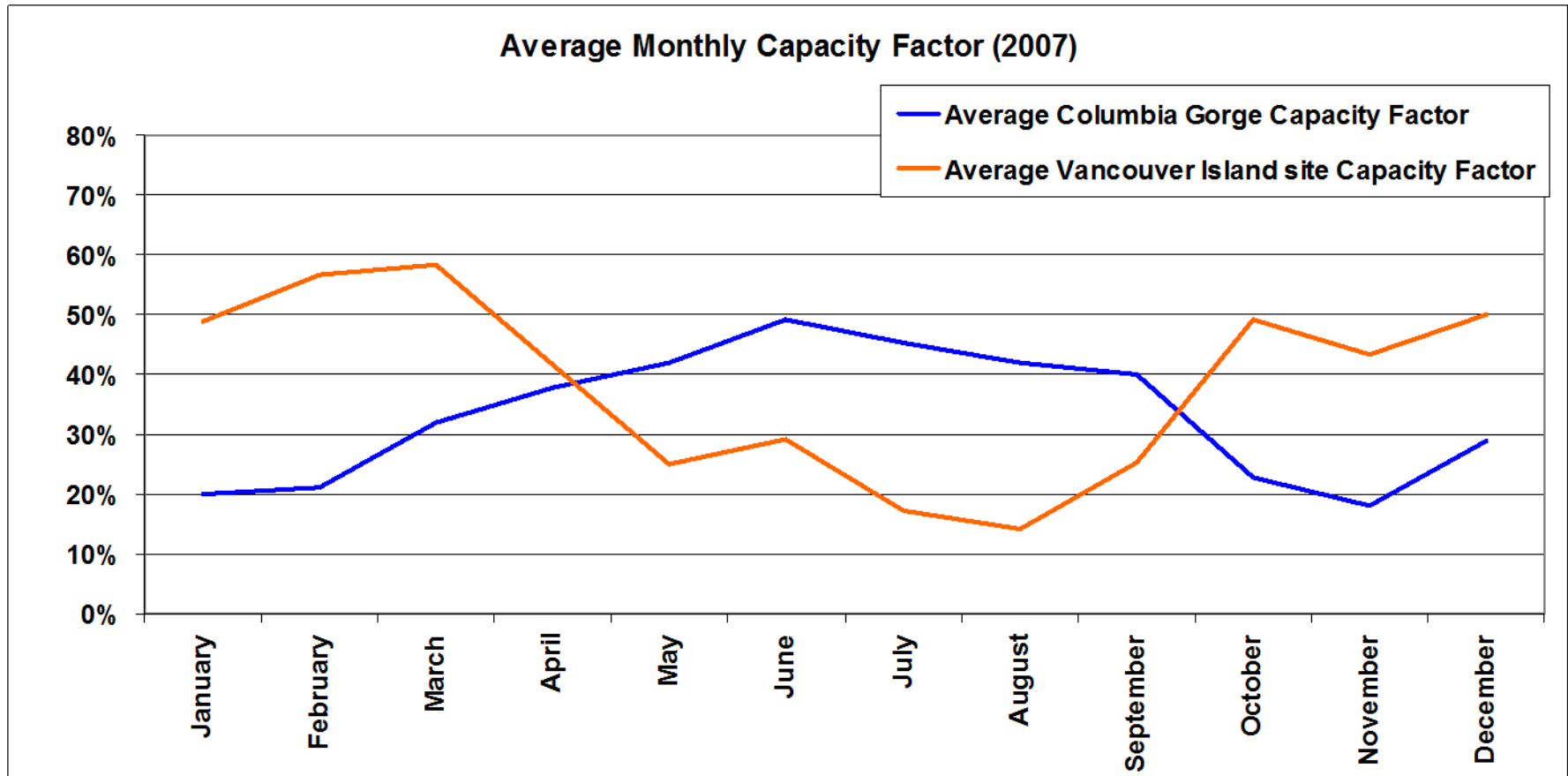
2007 data only

Peak Load Capacity Factors

Vancouver Island wind diversity results		
Top Load hours	Average Columbia Gorge Capacity Factor	Average Vancouver Island site Capacity Factor
10	16%	66%
20	17%	54%
50	24%	52%
100	22%	51%
200	20%	46%
300	20%	48%
400	21%	47%
500	21%	47%
1000	21%	44%
2500	26%	40%
8760	33%	38%

2007 data only

Vancouver Island - Average Monthly Capacity Factors



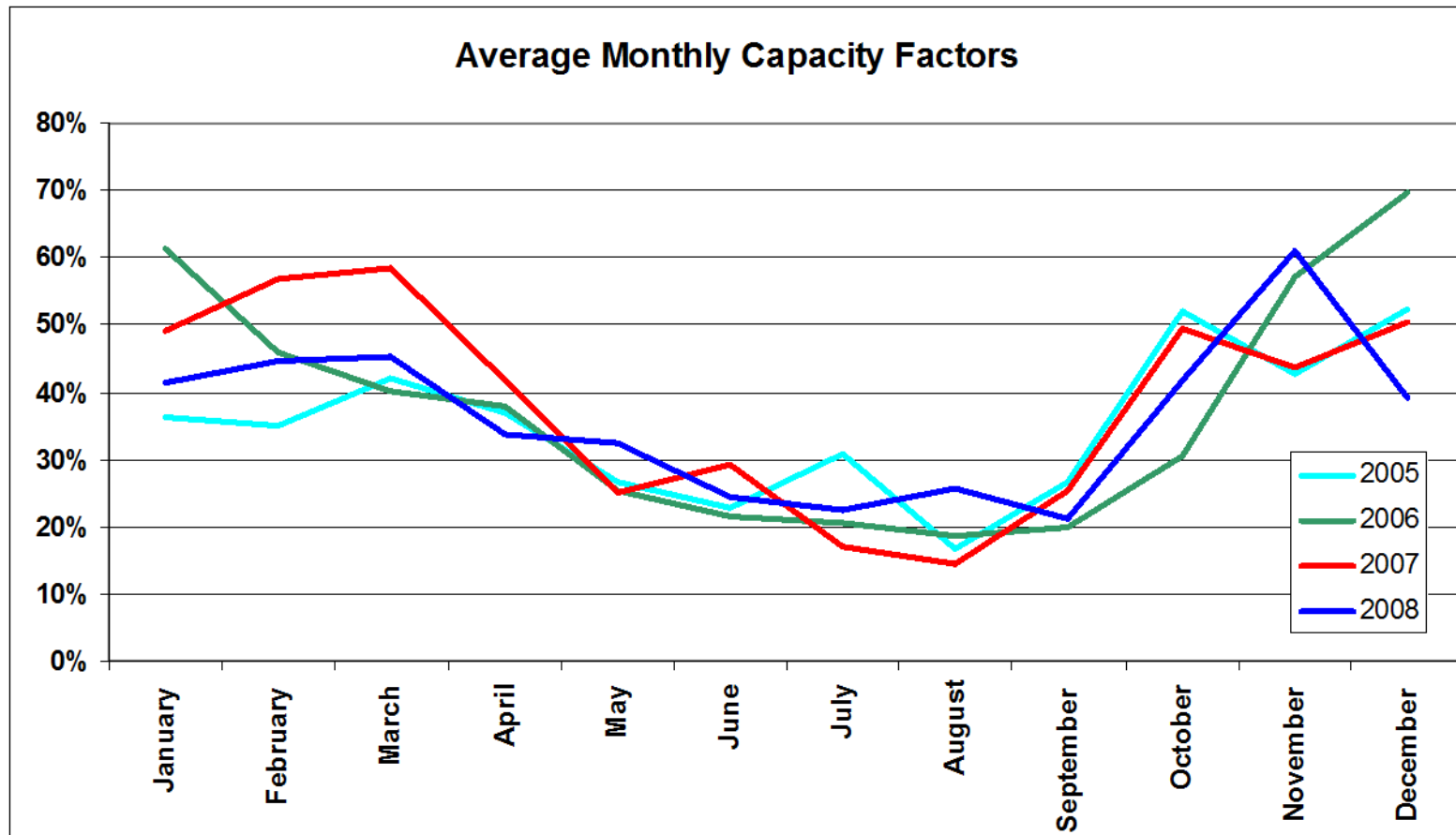
2007 data only

Vancouver Island - Average Monthly Capacity Factors

Vancouver Island wind diversity results			
Month	Average Monthly BPA Control Area Load (MW)	Average Columbia Gorge Capacity Factor	Average Vancouver Island site Capacity Factor
January	6621	20%	49%
February	6102	21%	57%
March	5655	32%	58%
April	5782	38%	42%
May	5708	42%	25%
June	5783	49%	29%
July	6079	45%	17%
August	5757	42%	14%
September	5388	40%	25%
October	5561	23%	49%
November	6186	18%	43%
December	7314	29%	50%

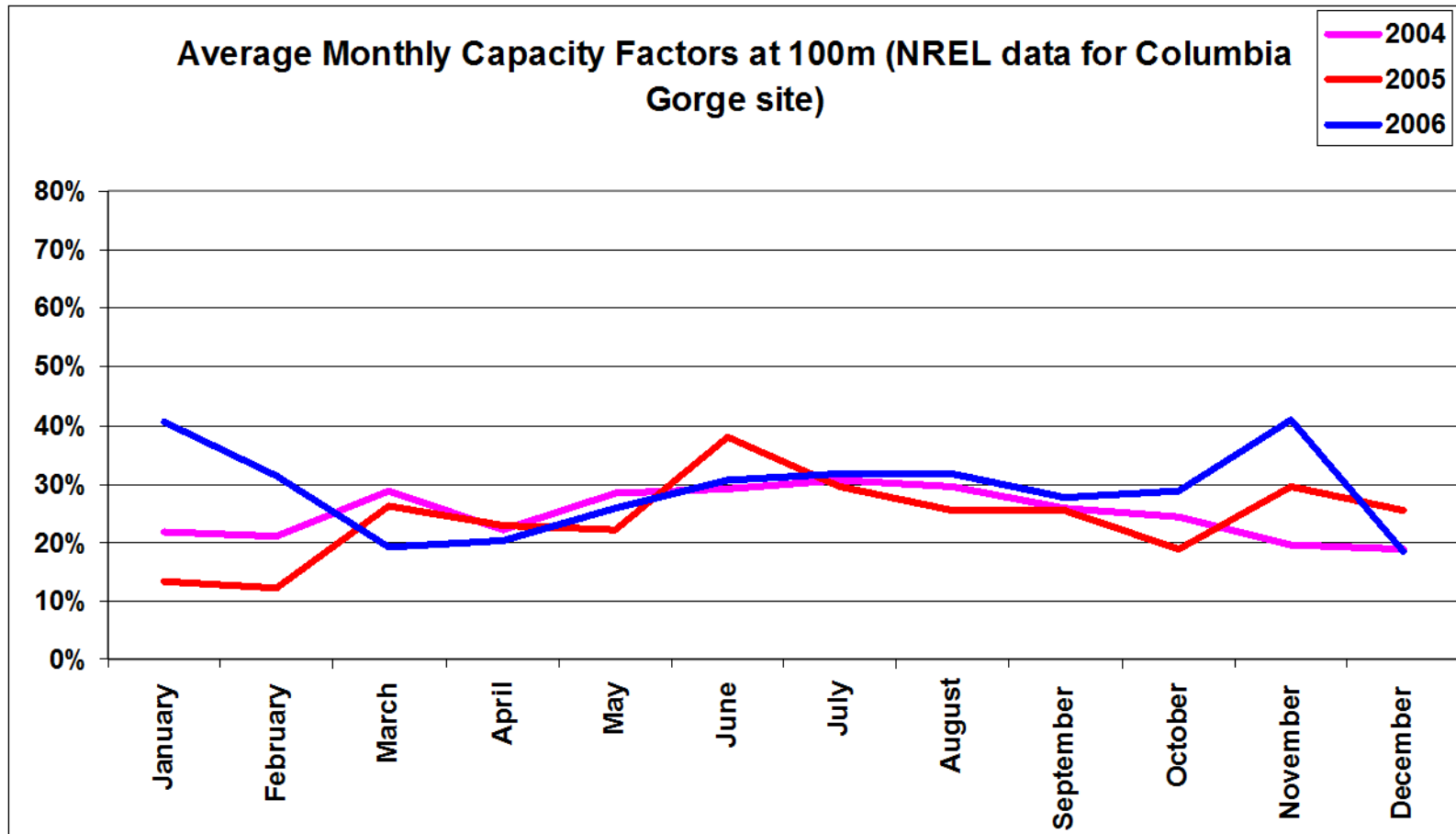
2007 data only

Vancouver Island - Average Monthly Capacity Factors (Vendor-provided data)



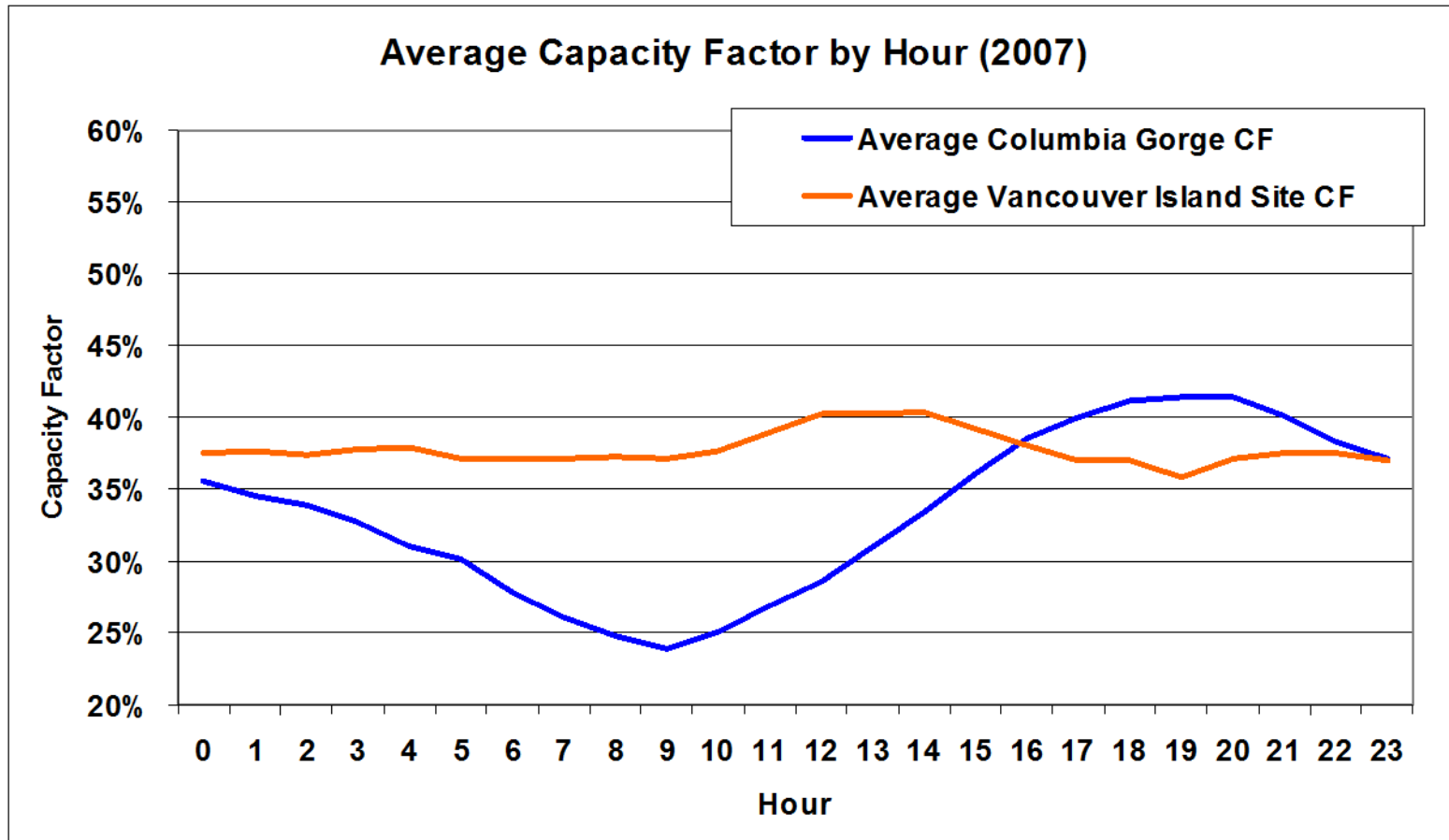
2005 - 2008 data

CG - Average Monthly Capacity Factors (NREL data)



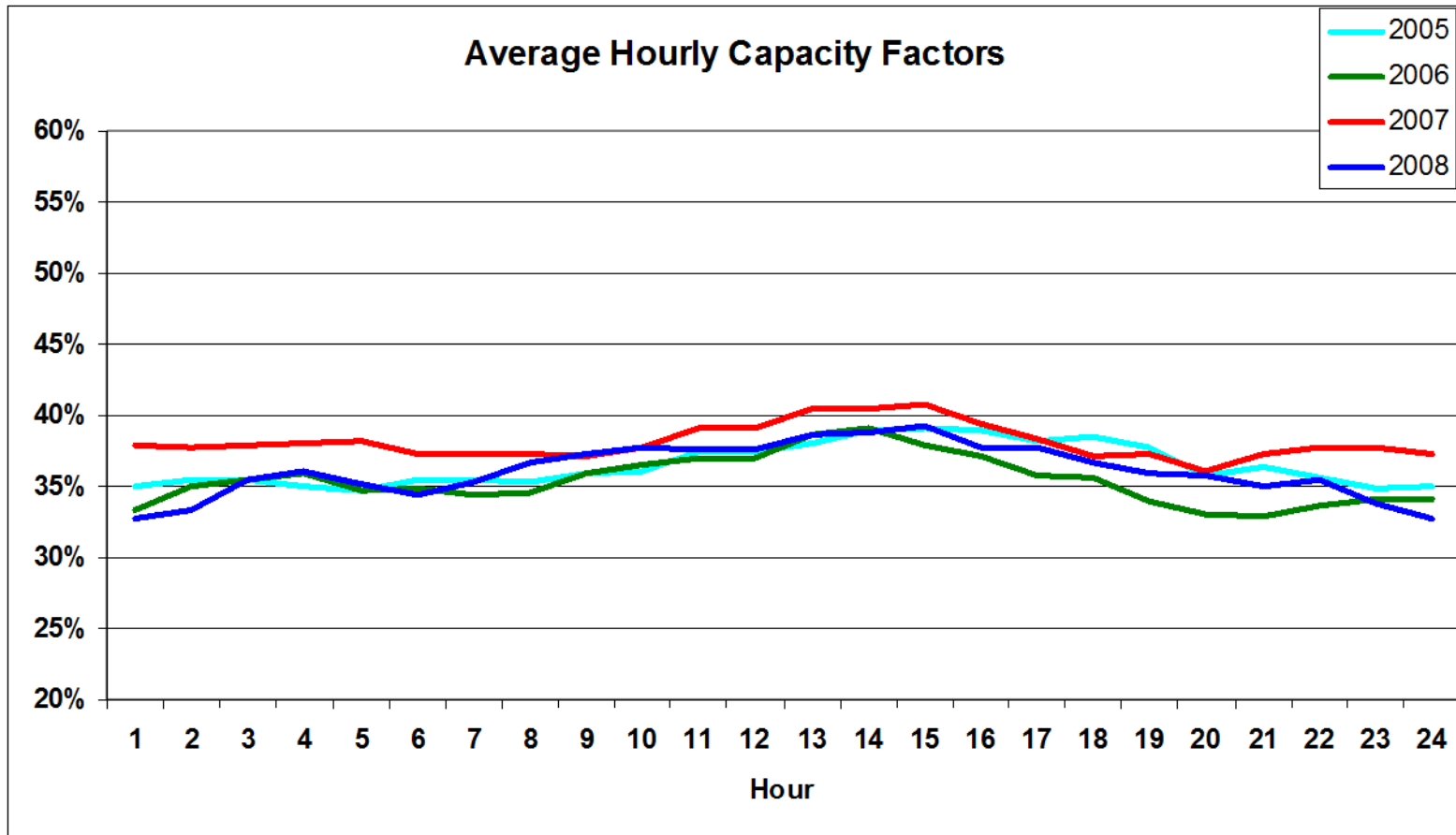
2004 - 2006 data only

Vancouver Island - Average Hourly Capacity Factors



2007 data only

Vancouver Island - Average Hourly Capacity Factors (Vendor-provided data)



2005 - 2008 data

Methodology Check

- Use of Columbia Gorge sample data is favorable in order to preserve the comparability of the two data sets.
- Descriptive statistics of actual Gorge wind generation for the entire fleet in 2007 compares closely with the method of converting wind speeds to generation.
- Lower actual wind fleet capacity factor results from considering station service and station maintenance.

Fleet Capacity Factor		Columbia Gorge Sample Capacity Factor	
Mean	0.30144258	Mean	0.33316895
Standard Error	0.003022446	Standard Error	0.003152862
Median	0.208	Median	0.26
Mode	-0.005	Mode	0
Standard Deviation	0.282885402	Standard Deviation	0.295091679
Sample Variance	0.080024151	Sample Variance	0.087079099
Kurtosis	-1.058074041	Kurtosis	-0.980746462
Skewness	0.56964745	Skewness	0.555994974

2007 data

Conclusions

- Correlation of ten-minute Vancouver Island wind site data from 2007 shows no correlation to Columbia Gorge wind data for the same period indicating some intra-hour diversity benefit.
- Average monthly pattern of Vancouver Island site in 2007 indicates 40 to 66% capacity factors during BPA's top load hours in 2007.
- Average monthly and diurnal wind pattern of Vancouver Island site for 2007 is complementary to the Gorge's average annual and diurnal wind pattern for 2007.
- Vancouver Island wind data maintains a similar monthly and diurnal wind shape for years 2005 through 2008.
- Sampled and converted Columbia Gorge public wind data compares closely to actual 2007 generation data which indicates conversion method is reasonable.

Next Steps

- Intra-hour diversity benefits require further exploration.
- NREL mesoscale model wind data for Vancouver Island is not available. Additional data may be analyzed to determine the representativeness of the Vancouver Island data.
- **The Vancouver Island wind capacity factor analysis is based on a single wind data point. An actual fleet of generators would produce a monthly average capacity factor shape that is flatter as a result of temporal diversity.**