

Wind Power in Ontario

Quantifying the benefits of geographic diversity
for: IESO Wind Power Standing Committee Jan. 28/09



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Outline

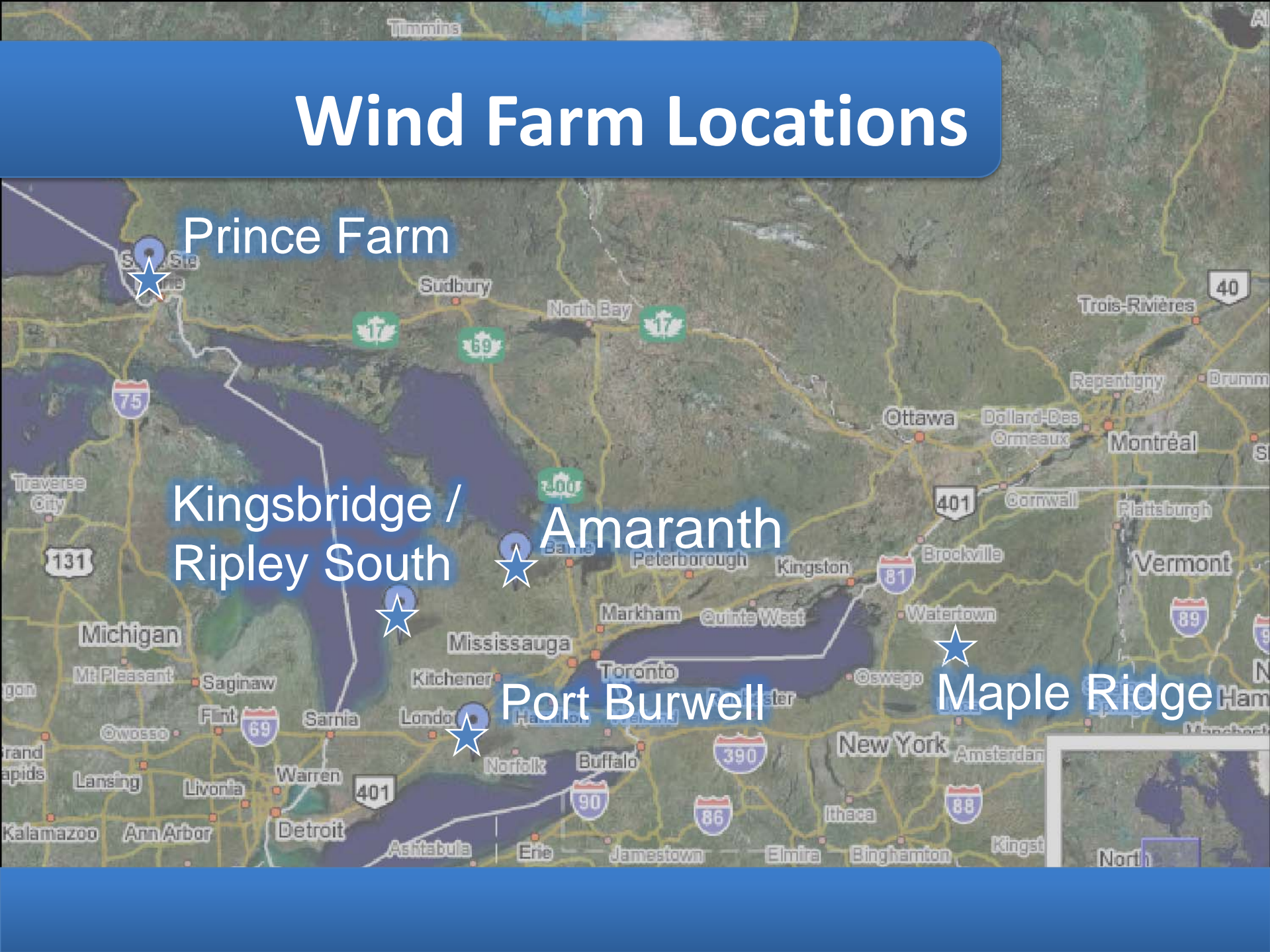
- Introduction
 - Description of Ontario wind fleet
- Purpose
- Methodology
- Results
- Discussion
- Conclusions and Further Research



Wind Farm Locations

A map of the Great Lakes region, specifically focusing on the area around Lake Huron and Lake Erie. The map shows major cities, roads, and water bodies. Five locations are marked with blue stars and labeled with white text: Prince Farm (near Sault Ste. Marie), Kingsbridge / Ripley South (near Sarnia), Amaranth (near Peterborough), Port Burwell (near Port Hope), and Maple Ridge (near Windsor). The map also shows major highways like I-75, I-401, and I-81, and various smaller cities and towns in the region.

Wind Farm Locations



A map of the Great Lakes region showing the locations of five wind farms. The farms are marked with blue stars and labeled: Prince Farm (near St. Ignace, Michigan), Kingsbridge / Ripley South (near Kingsbridge, Ontario), Amaranth (near Amaranth, Ontario), Port Burwell (near Port Burwell, Ontario), and Maple Ridge (near Maple Ridge, Ontario). The map includes major cities, highways, and the Great Lakes themselves. A blue banner at the top contains the title 'Wind Farm Locations'.

Prince Farm

Kingsbridge / Ripley South

Amaranth

Port Burwell

Maple Ridge

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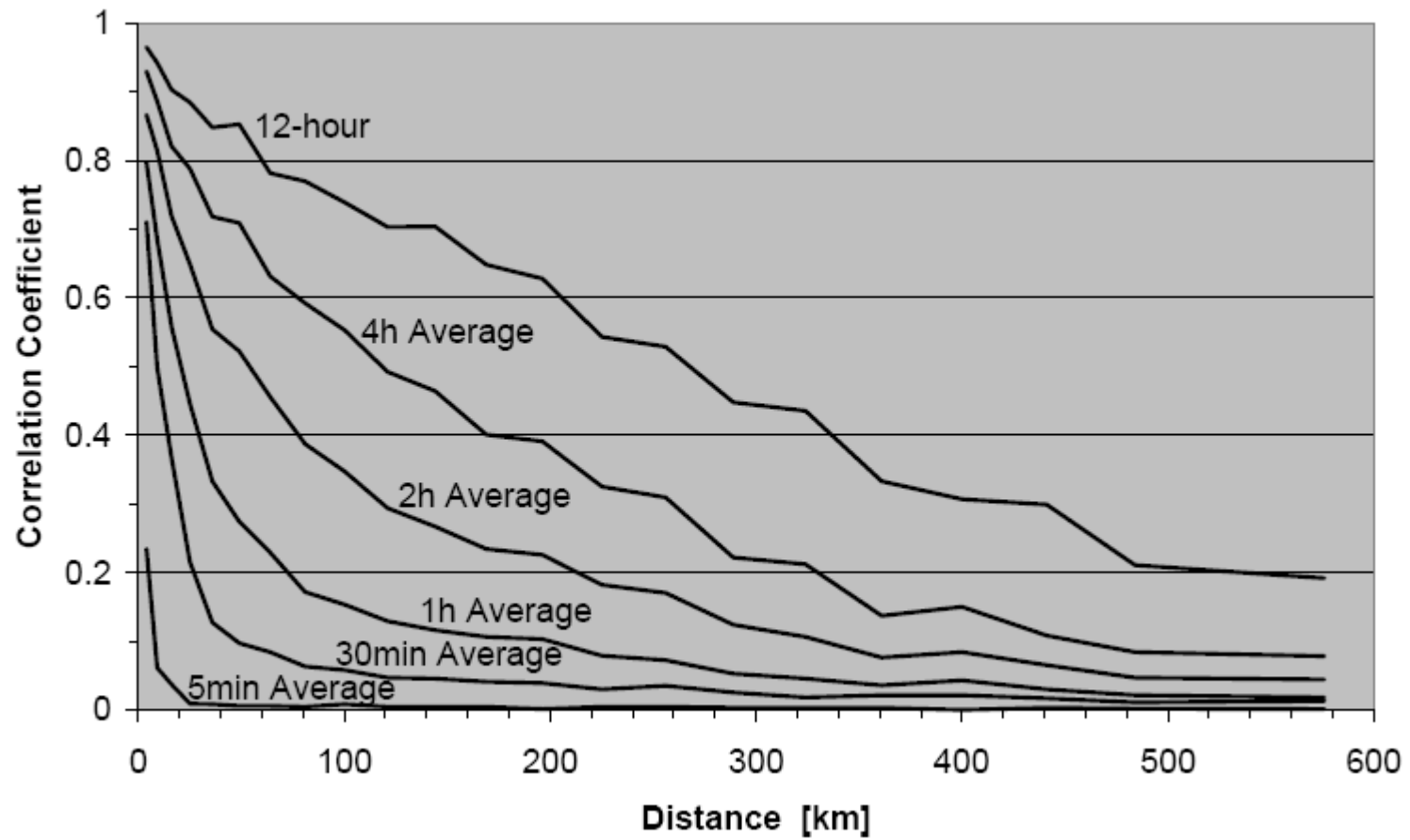
Empirical (Not Modeled) Data

	CF yr 1	CF yr 2	Developer's CF forecast	Helimax CF forecast
AMARANTH	27.6%	29.9%	33.0%	
KINGSBRIDGE	31.1%	33.9%	31.4%	28%
PRINCEFARM	28.2%	28.1%	32.4%	30%
PTBURWELL	28.6%	26.8%		29%
RIPLEY SOUTH	32.2%			28%
MAPLE RIDGE	25.1%			

Distance Mitigates Variability

- IESO “The geographic diversity of Ontario wind resources, as more sites are commissioned, should mitigate some of the risk associated with wind speed variability.” (18-Month Outlook, January '09 to June '10)
- CanWEA “The more broadly distributed they are, the less likely it becomes that poor wind conditions will affect more than a few facilities at the same time.” (WindVision 2025: Powering Canada's Future, October 20, 2008)

Germany Wind Results (Ernst et.al. '99)



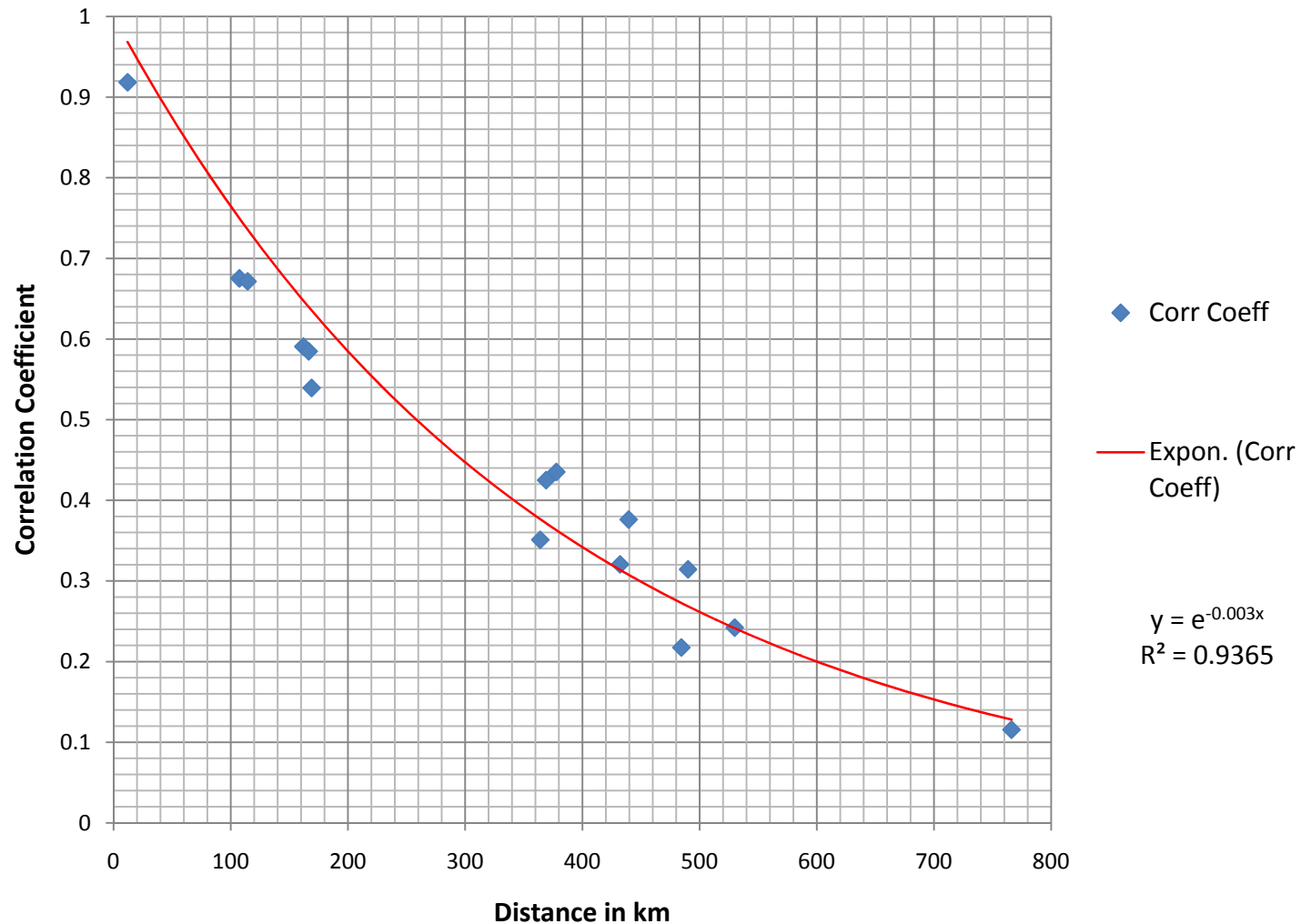
- Our study analyzed up to 32 months of hourly production using IESO and FERC data.

Parameters analyzed:

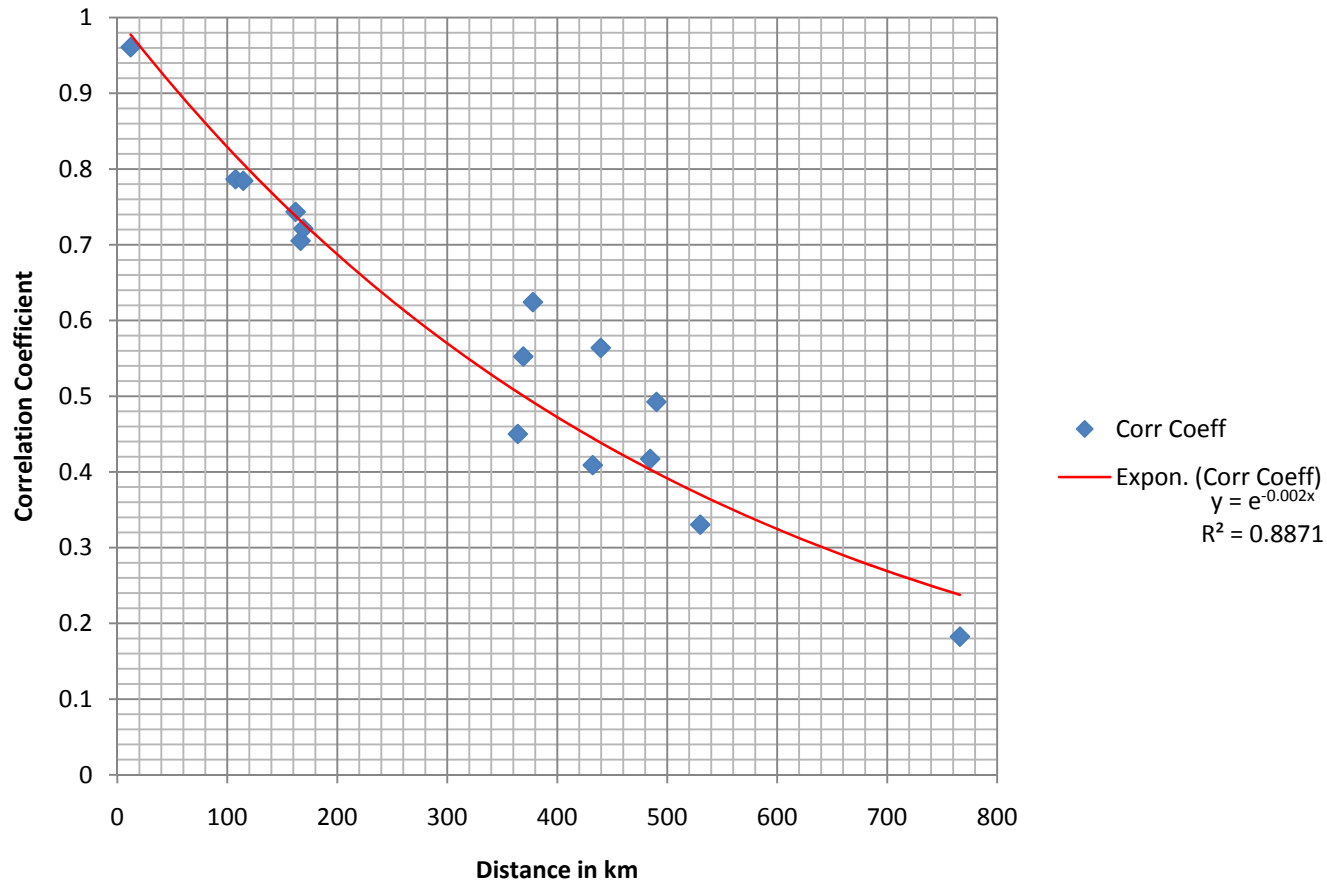
- Performance & variability
- Correlation between stations (hourly and daily)
 - Correlations by season and then seasonal results averaged

- Spot checked 5 minute results for a few days
- Winter temperature vs. wind output correlation considered
- 95% CI for correlations
- Haversine formula for distance

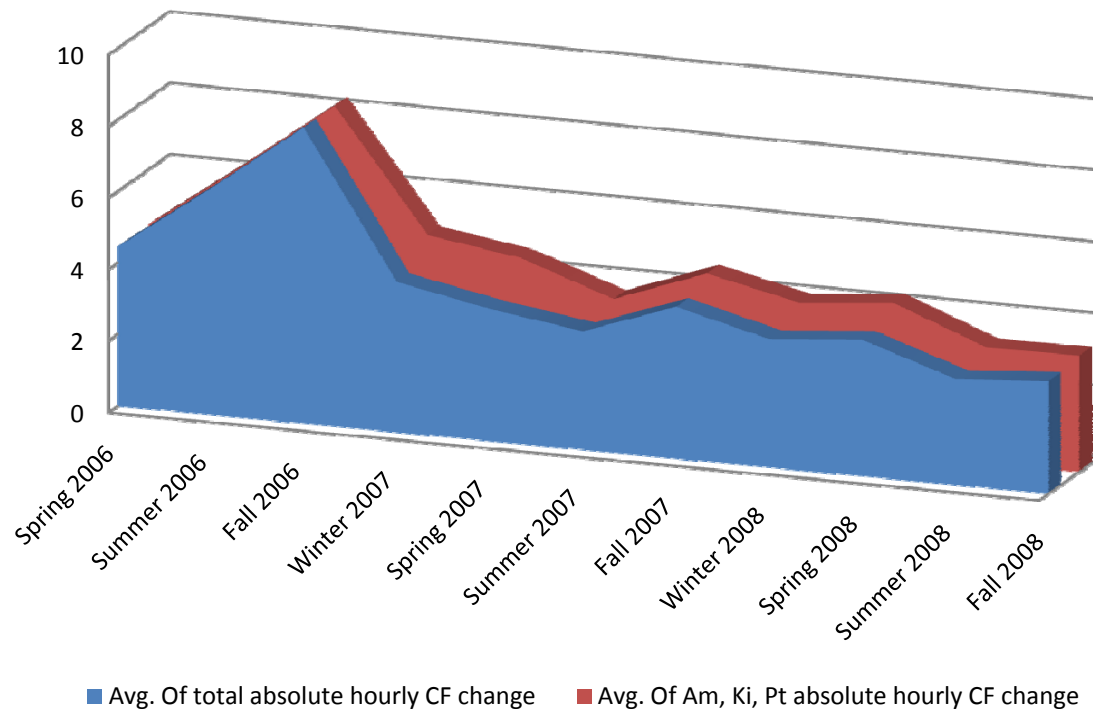
Ontario Correlation vs. Distance (Hourly)



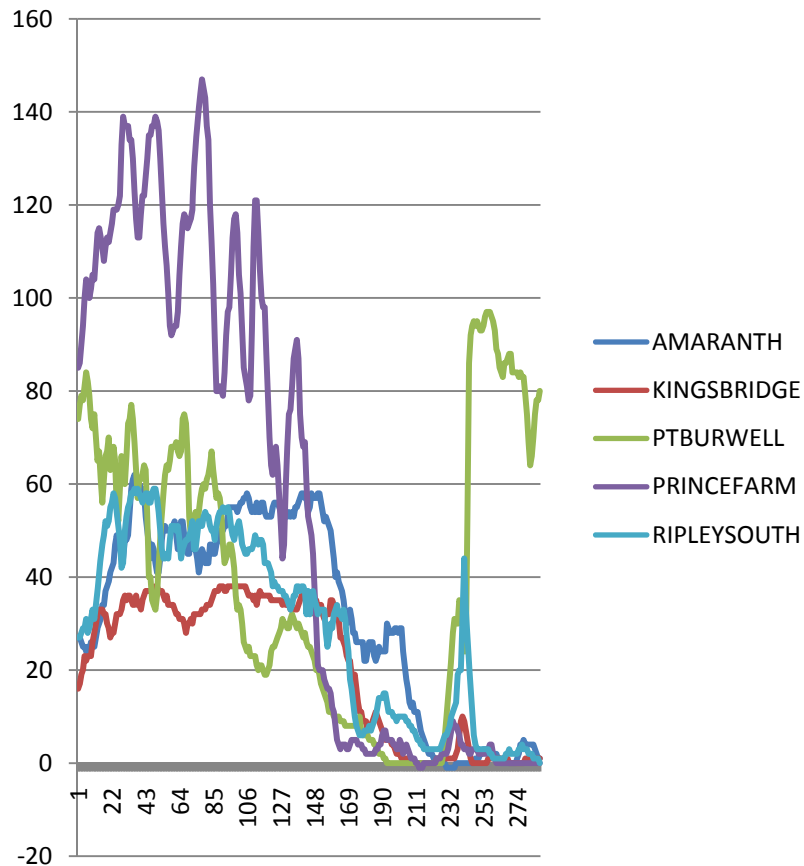
Ontario Correlation vs. Distance (Daily)



Absolute Hourly CF Delta

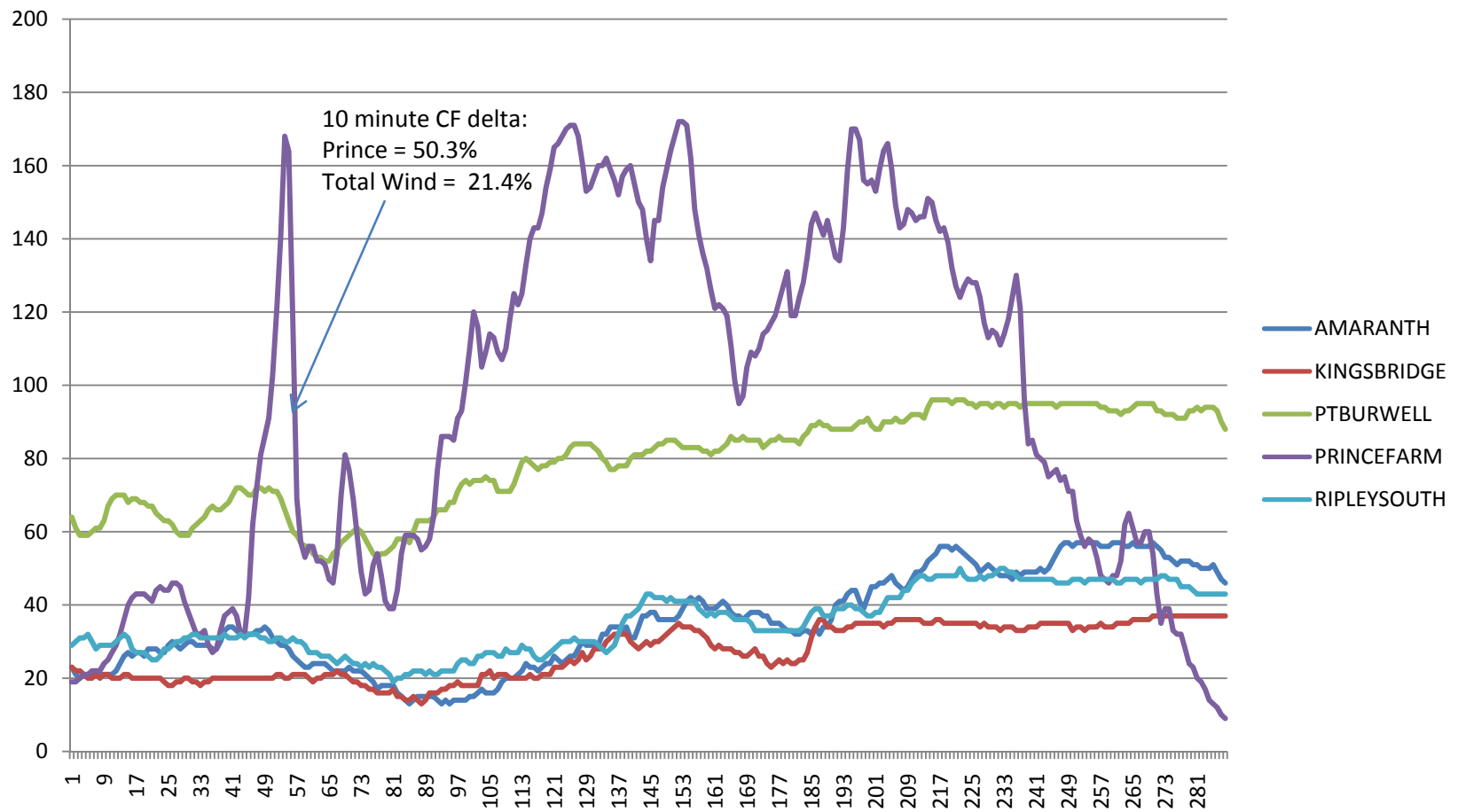


Sometimes Distance Doesn't Help (@ 5 min resolution)

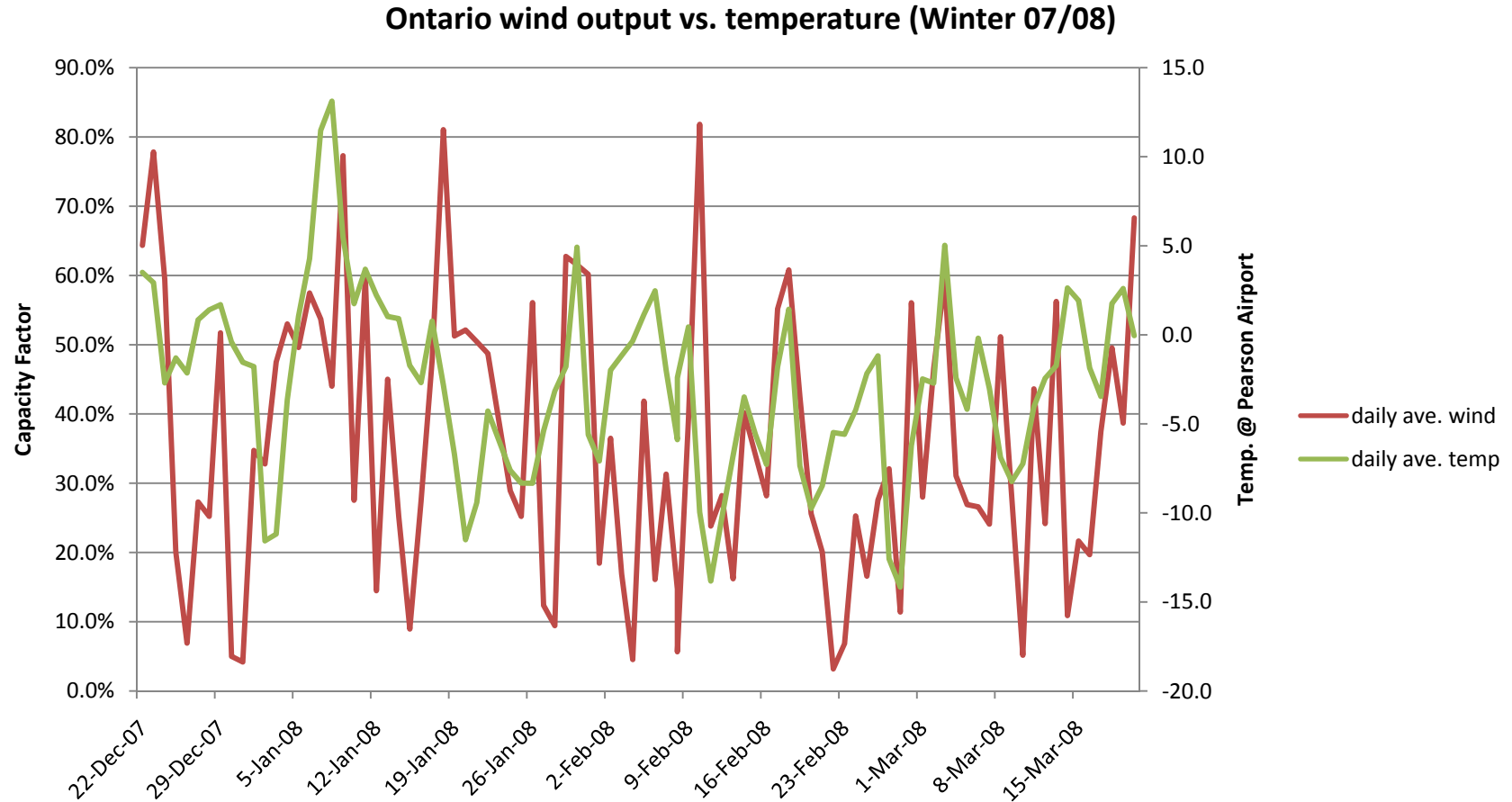


	Amaranth	Kings bridge	Pt Burwell	Prince
Kings bridge	94%			
Pt Burwell	-13%	2%		
Prince	73%	82%	31%	
Rip South	85%	93%	13%	90%

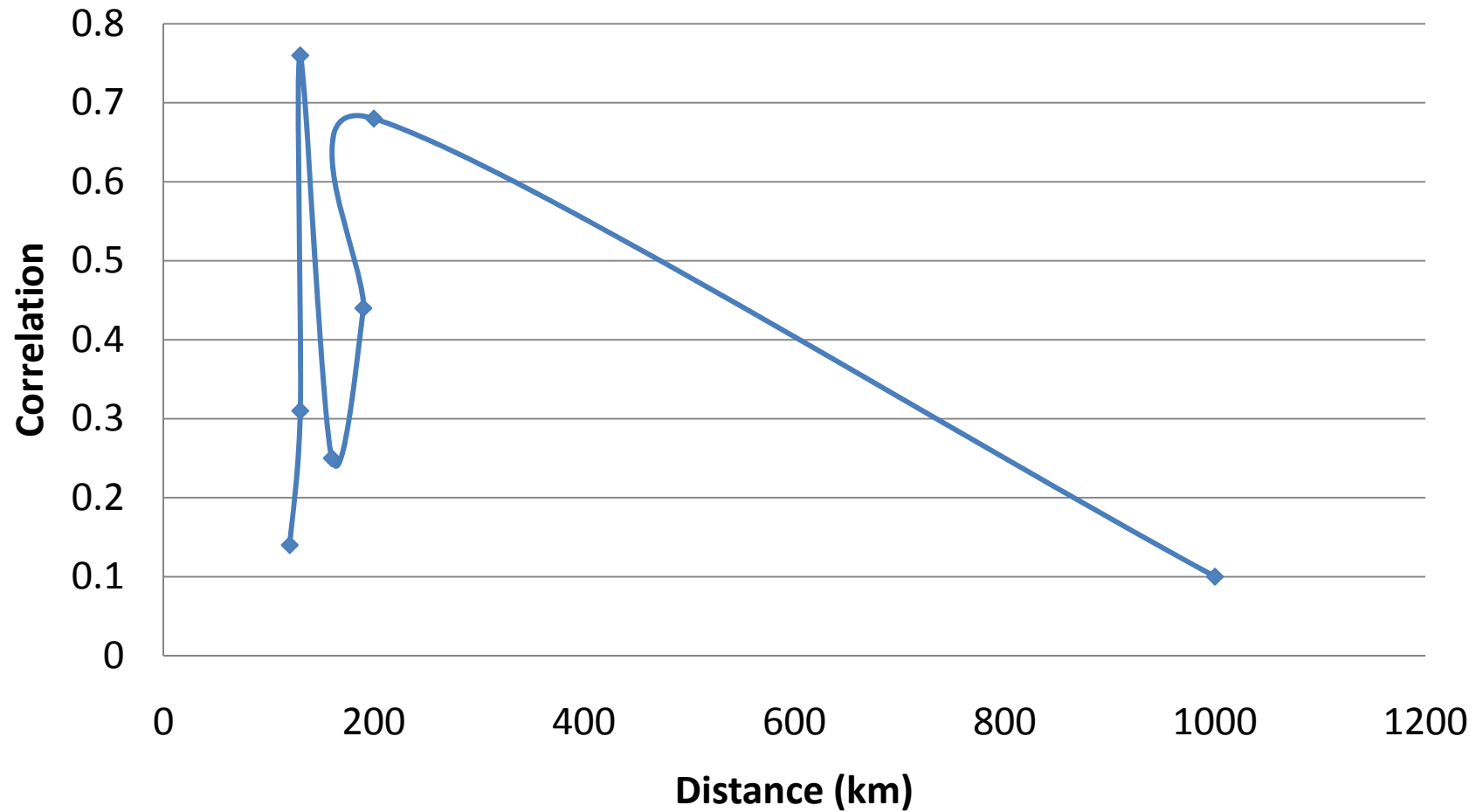
When Bigger is Not Better



Winter: Warm = Windy (so far)



GE (2006) correlations by distance (10 minute data over one year)



Benefits of Distance

- Approximately 250 km drops the hourly corr. coeff. to 50%, and 350 km drops the daily corr. to 50%.
- Adding a distant wind farm fills the valleys of average output and drops st. dev. a little but also increases the peaks of output. If output swings or peaks are challenging the system, distance doesn't help.

Implications of Distance Benefits

- Location diversity does not solve variability, but it does reduce the impacts for a given fleet size.
- No matter how far apart they are, wind farms in Ontario east of Wawa will be positively correlated.
- Allowing concentrated wind development, either by co-locating (e.g. Ripley South, Melancthon II, Enbridge 1, Essex/Chatham region) or large size, reduces the total wind capacity the system can accommodate.

Wind's Costs and Benefits

- When considering wind's consumer impacts, incremental transmission, energy storage, ramping generation requirement, and grid reliability service costs (e.g. AGC, OR) are insignificant at low capacity but rise in significance as capacity rises.

Further Research

- Analysis addressing potential reliability issues should be undertaken using actuals
- GE's 2006 study provides guidance but not assurance
- Martin Lodyga's research (Nov 5th WPSC) identified 10 minute deltas as an area of interest
- Methodology: include high resolution data (start with 5 minute) and logs, troll for extreme event days (e.g. UBG, reverse ramps)

Data Requirements for Research

- IESO can promote research by providing access to 5 minute data for selected days
- Build on the success of hourly data release
- 5 minute data is not competitively interesting, no confidentiality concerns should arise