# The NYPA Pilot and Results

Optimized Forecasting Solution for Advanced Overhead Line Operations

NYSERDA PON 3770 High Performing Grid







#### *windsim Power* **Pilot Objectives**

- Demonstrate WindSim Power computational fluid dynamics (CFD)-enhanced forecast/real-time transmission line rating system to assess the capacity of existing transmission infrastructure and provide broad awareness.
- Provide real-time and forecasted DLR to improve system planning and operations.
- Assess the benefits of DLR using offline simulations.

### **Pilot Description**

- 70.81 miles 230 kV NYPA Moses-Plattsburgh transmission lines (2 parallel lines)
- 1200 line spans monitored
- Seven line sections
- Weather data:
  - Ambient temperature
  - Solar irradiance
  - Wind speed and direction
- Weather data sources:
  - 10 weather stations
  - 49 virtual weather stations (NOAA HRRR model)
- DLR output:
  - Real-time
  - Forecasted



- Real-time DLR can **identify hotspots for limiting spans**
- We identified capacity increases over static line ratings (SLR) ranging from **2% to 20%**
- The DLR solution also **identified deficits** relative to the SLR
- DLR forecasts are **improved using machine learning (ML)**
- DLR could be used to **reduce wind power curtailment**

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### Real-time DLR can identify hotspots for limiting spans

- Identify most limiting elements in the line (hotspots)
- Two examples:



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#### **DLR for the Moses-Plattsburgh transmission line**



### DLR surplus/deficit over SLR

• Identify surplus/deficit in ampacity of a transmission line relative to static line ratings (SLR)







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### **Pilot Results: forecasted DLR**

- Limiting spans and duration curves are consistent for real-time and forecasted ratings
- In some cases, forecasted ratings tend to be overly optimistic





### **Pilot Results: forecasted DLR**

• Forecasts error is stable for increasing lead times



		nRMSE [%]	nMBE [%]		
FH [h]	Line	Original	Original		
6	DP1	13.40	-0.10		
	MW1	16.80	-7.40		
	MW2	16.40	-7.30		
	PND1	12.80	-1.80		
	RYP2	13.30	-3.20	=	
	WPN1	16.00	-4.70	no	
	WRY2	16.00	-2.00	re	
	Average	14.96	-3.79	ä	
12	DP1	13.60	-0.10	Б.	
	MW1	17.10	-7.80	ρα	
	MW2	16.80	-7.80	- f	
	PND1	13.00	-1.80	re	
	RYP2	13.70	-3.40	ດ	
	WPN1	16.20	-5.00	Ist	
	WRY2	16.10	-2.30	5	
	Average	15.21	-4.03	2	
18	DP1	13.70	-0.40	izo	
	MW1	17.40	-8.20	no	
	MW2	17.20	-8.30		
	PND1	13.20	-2.20		
	RYP2	14.00	-3.60		
	WPN1	16.40	-5.40		
	WRY2	16.20	-2.60		
	Average	15.44	-4.39		

### **Pilot Results: Improving Forecasts**

- ML techniques were used to reduce forecast error and create probabilistic forecasts
- Forecasts were improved by approx. 30%



		nRMSE [%]			nMBE [%]			
FH [h]	Line	Original	ML	Improv	7. Original	ML	Improv	7.
6	DP1	13.40	11.10	2.30	-0.10	1.30	-1.20	
	MW1	16.80	8.90	7.90	-7.40	1.10	6.30	
	MW2	16.40	8.70	7.70	-7.30	0.90	6.40	
	PND1	12.80	10.60	2.20	-1.80	1.80	0.00	
	RYP2	13.30	9.70	3.60	-3.20	1.60	1.60	
	WPN1	16.00	10.00	6.00	-4.70	0.70	4.00	
	WRY2	16.00	11.00	5.00	-2.00	0.70	1.30	
	Average	14.96	10.00	4.96	-3.79	1.16	2.63	
12	DP1	13.60	11.10	2.50	-0.10	1.30	-1.20	
	MW1	17.10	9.00	8.10	-7.80	1.20	6.60	
	MW2	16.80	8.90	7.90	-7.80	1.10	6.70	
	PND1	13.00	10.80	2.20	-1.80	1.90	-0.10	
	RYP2	13.70	9.80	3.90	-3.40	1.60	1.80	
	WPN1	16.20	10.30	5.90	-5.00	0.80	4.20	
_	WRY2	16.10	11.20	4.90	-2.30	0.60	1.70	
	Average	15.21	10.16	5.06	-4.03	1.21	2.81	
	DP1	13.70	11.20	2.50	-0.40	1.40	-1.00	
	MW1	17.40	9.10	8.30	-8.20	1.20	7.00	
	MW2	17.20	8.90	8.30	-8.30	1.00	7.30	
18	PND1	13.20	10.80	2.40	-2.20	1.80	0.40	
	RYP2	14.00	9.90	4.10	-3.60	1.60	2.00	
	WPN1	16.40	10.30	6.10	-5.40	0.90	4.50	
	WRY2	16.20	11.30	4.90	-2.60	0.80	1.80	
	Average	15.44	10.21	5.23	-4.39	1.24	3.14	

2021-10-09 2021-10-13 2021-10-17 2021-10-21 2021-10-25 2021-10-292021-11-01 2021-11-05 2021-11-09

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### **Pilot Results: Line Ratings vs. Wind Output**

- Several wind farms in upstate New York are tied to the Moses-Plattsburg lines
- There is a moderate correlation (~0.5) between DLR and wind power.
- Correlation decreases for lines further away from wind farm.



### **Pilot Results: Reduction of wind power curtailment**

- We looked at DLR values during curtailment periods for the wind farms.
- The figure shows the average increase in DLR relative to SLR during the curtailment for the Clinton wind farm.
- There is at least 8% head room in the lines that could be used to avoid some of the curtailment.



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### **Technical Approach: Meso/Microscale Coupling**



East coordinate (m) **3D** mesoscale model results Resolution: 12 – 3 km



Coupled WindSim model – 100 – 10 m



- WindSim CFD simulation
- **Optional calibration with measurements**
- Allows to transfer weather data from weather stations onto line spans.

#### **Technical Approach: Weather station site selection**

- First step in the project was modelling the terrain in CFD
- Allows to transfer wind speed and direction from reference locations (mesoscale) to every span in the line
- Number of stations and location determined by minimizing hardware while maintaining good DLR accuracy
- Weather stations near hotspots for limiting spans.





### Economic Assessment of DLR Operation in the NYCA

#### Prepared for New York Power Authority (NYPA) & WindSim Power

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