

CIGRE Grid of the Future 2017

A Non-Contact Sensing Approach for the Measurement of Overhead Conductor Parameters and Dynamic Line Ratings

October 24, 2017

Genscape Inc.
LineVision™

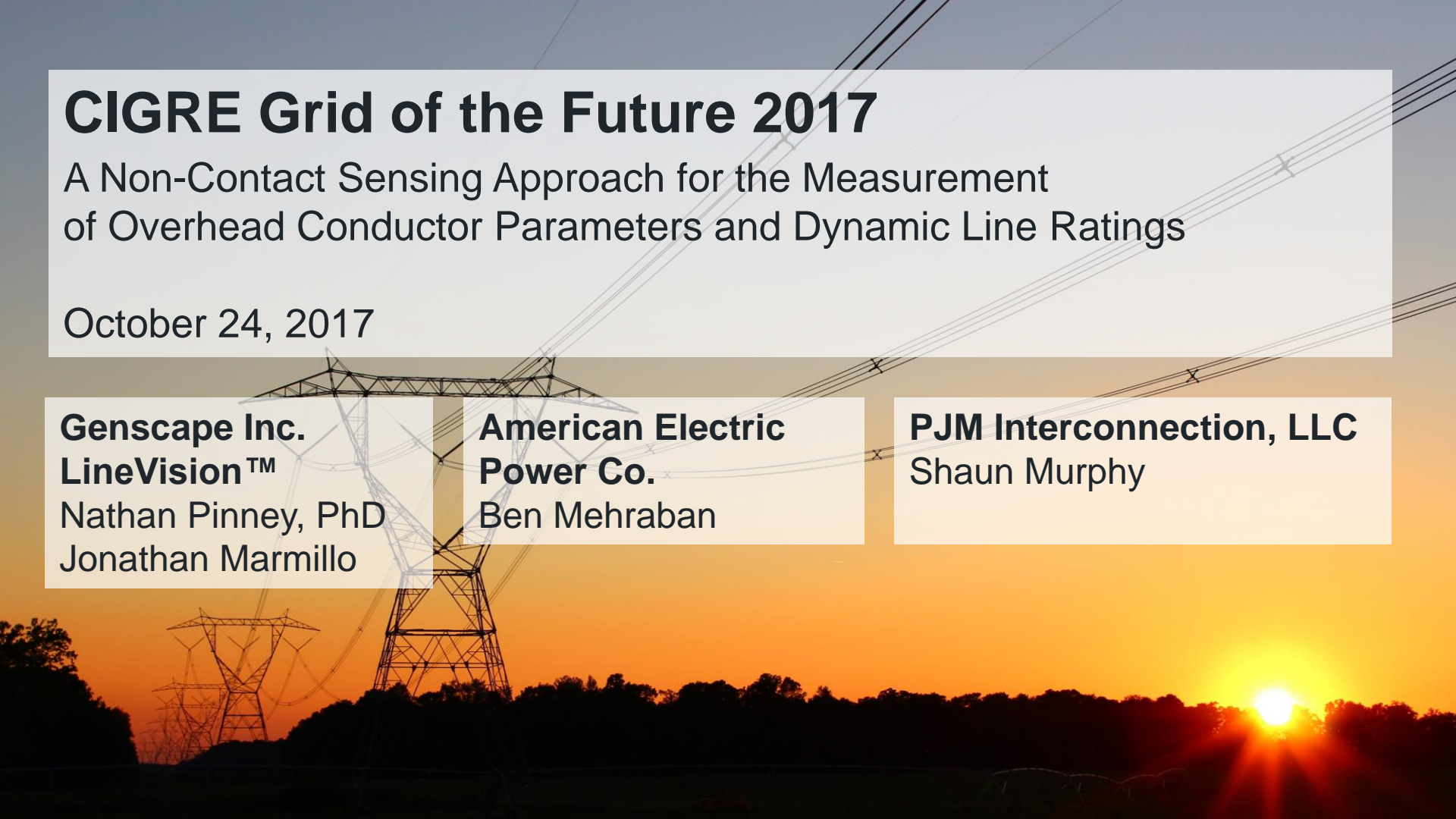
Nathan Pinney, PhD
Jonathan Marmillo

**American Electric
Power Co.**

Ben Mehraban

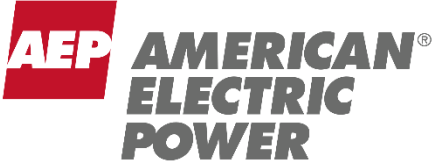



PJM Interconnection, LLC

Shaun Murphy



Oak Ridge National Lab - Dynamic Line Rating Project

AEP, PJM, and Genscape conducted a research project per Oak Ridge National Lab Subcontract 4000148565 to quantify the potential economic impacts of Dynamic Line Ratings.

 	<i>Engineering & Field Support</i>
	<i>LineVision DLR System & Installation</i>
	<i>Analysis of DLR's Economic Impact</i>
	<i>Funding, Project Guidance</i>

Project Overview:

AEP's Cook-Olive 345kV transmission line selected

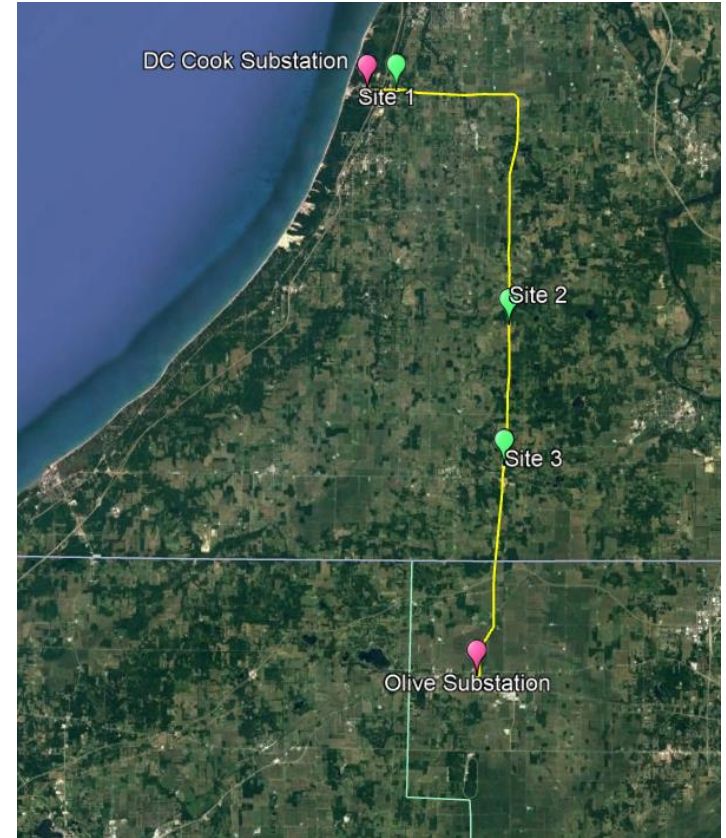
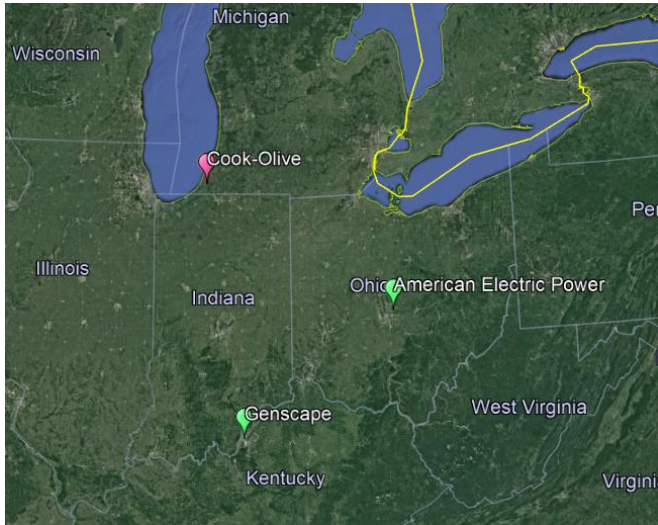
Genscape LineVision™ installed under three (3) spans along the circuit

Line monitoring data was collected between November 2016 – August 2017

PJM is conducting an economic analysis to determine the potential improvements in system and market efficiency by using DLR in operations

Project Overview: AEP/Genscape/PJM/ORNL Line Monitoring Study

Project Timeline:	October 2016-September 2017
Monitored Line:	Cook-Olive 345kV
Location:	Michigan, Indiana (USA)
No. of Monitored Sites:	3
Approx. Line Length:	25 miles



Site Details

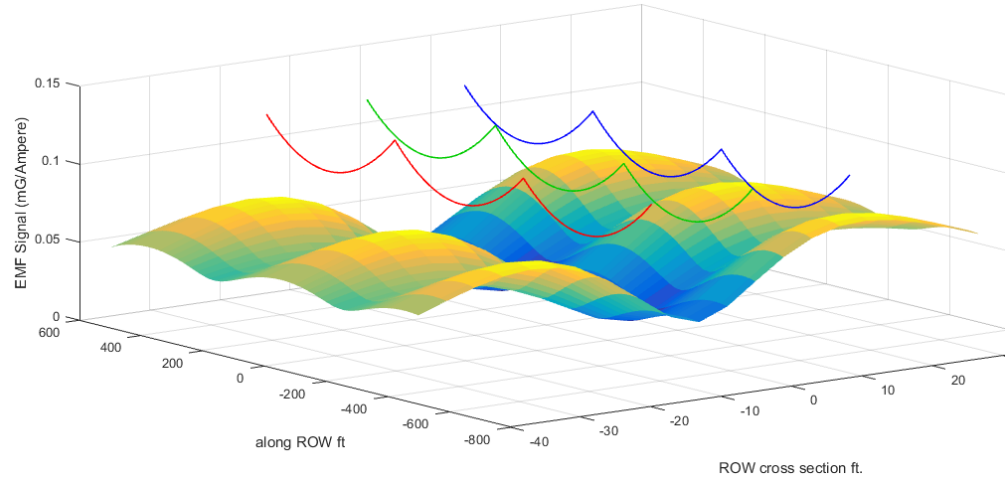
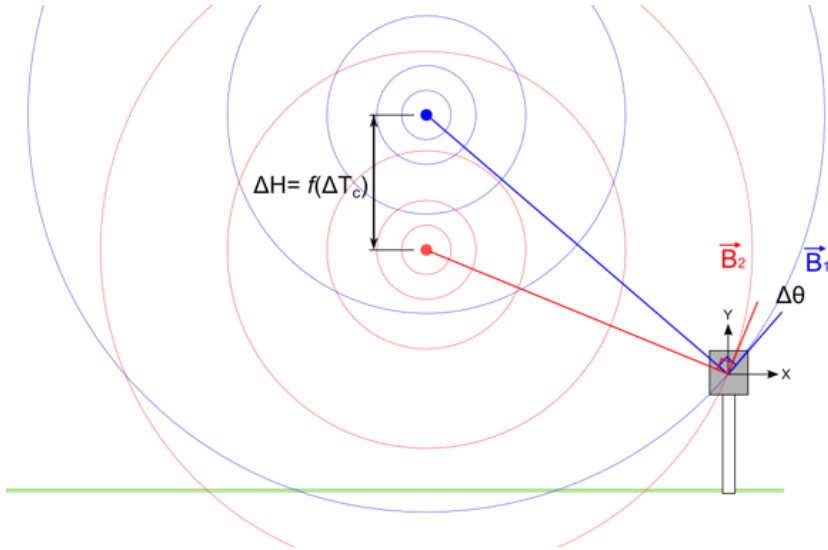


LineVision monitor array at installation Site 1 of 3



LineVision monitor array at installation Site 3 of 3

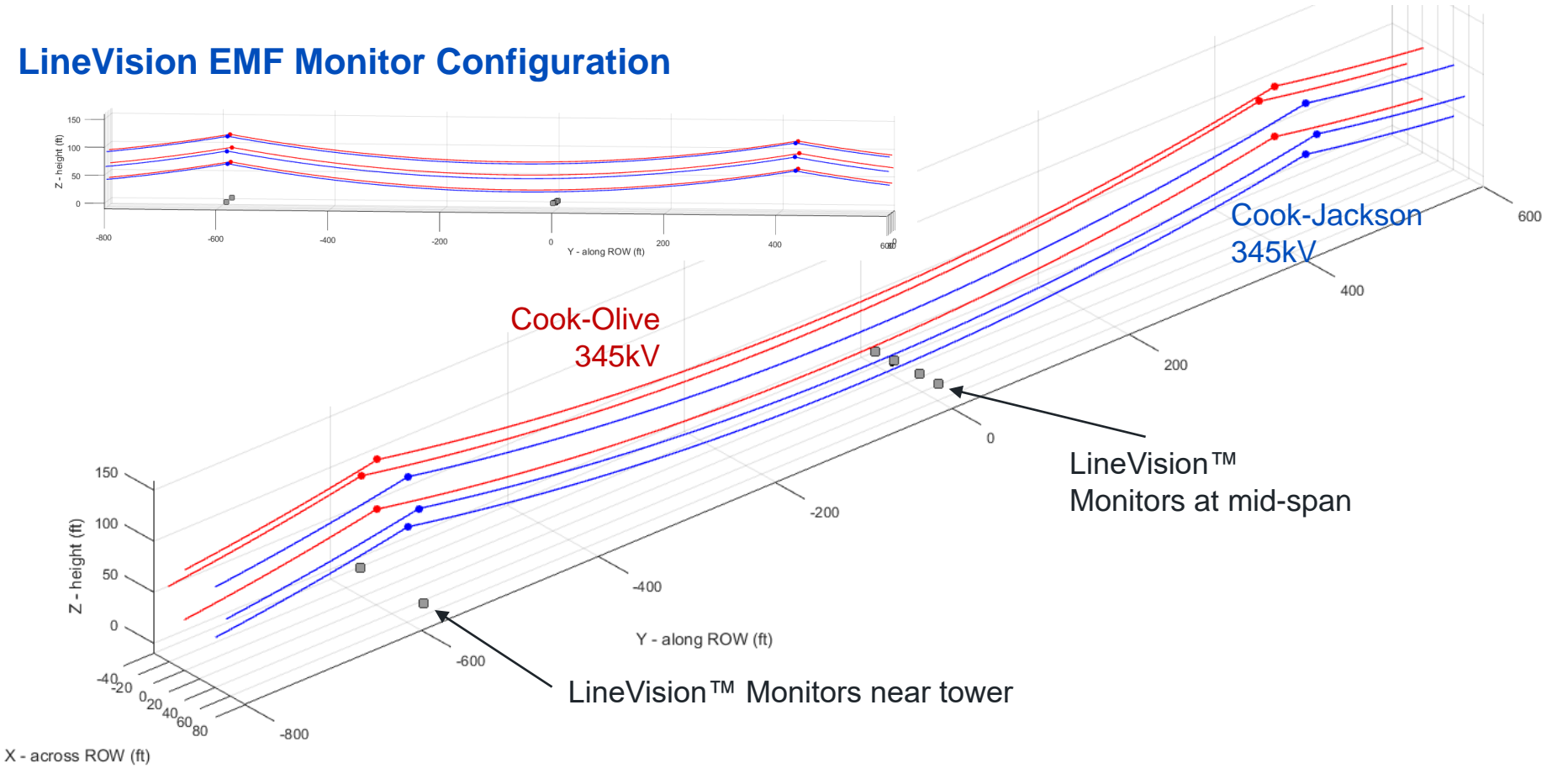
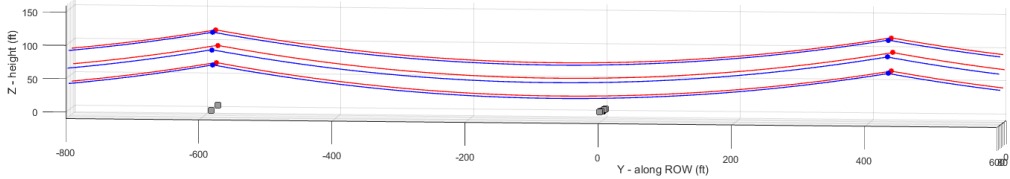
LineVision™: Non-Contact Clearance and Temperature Monitoring



Principle of Operation:

- Measure AC magnetic (B) field amplitude, phase and vector orientation in several locations
- Determine conductor clearance/sag by adjusting circuit-geometry EMF model to agree with sensor data
- Determine conductor temperature based on sag/temperature analysis
- Over time: Adjust sag/temperature coefficients based on as-built observations

LineVision EMF Monitor Configuration

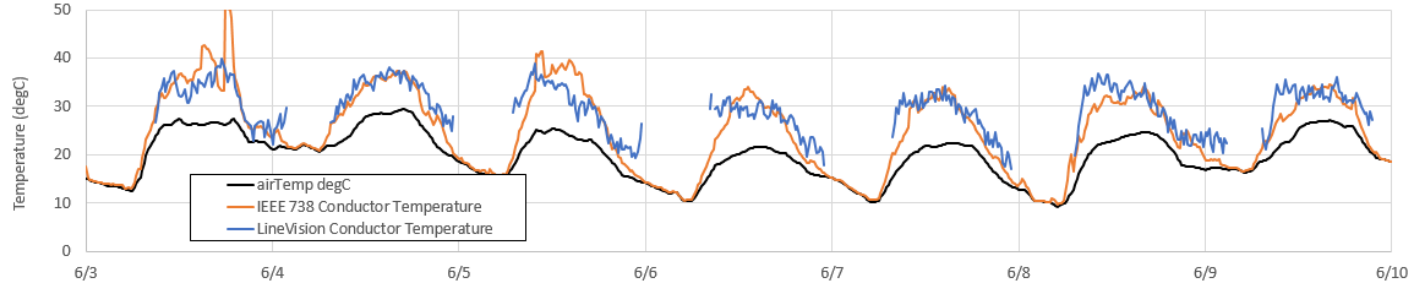


LineVision EMF Monitoring: Monitored Loading/Current vs. SCADA

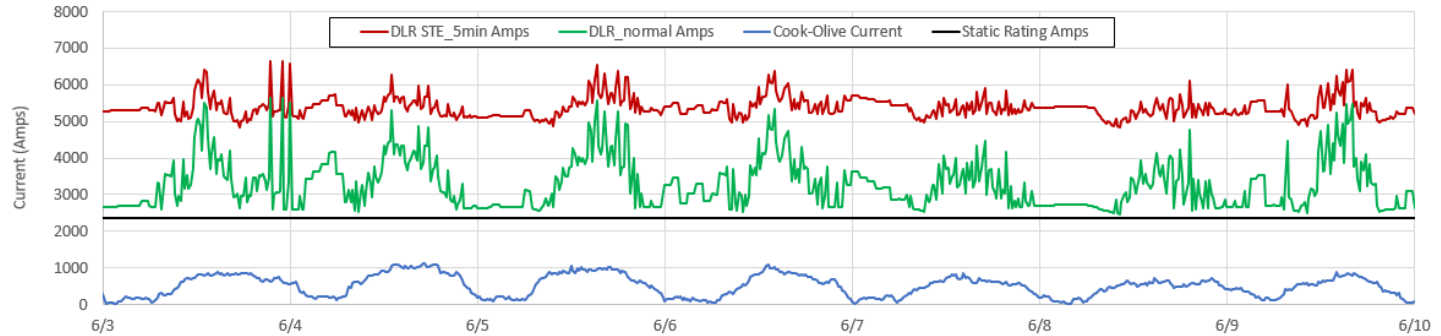


Line Monitoring from the Real-Time Operations perspective

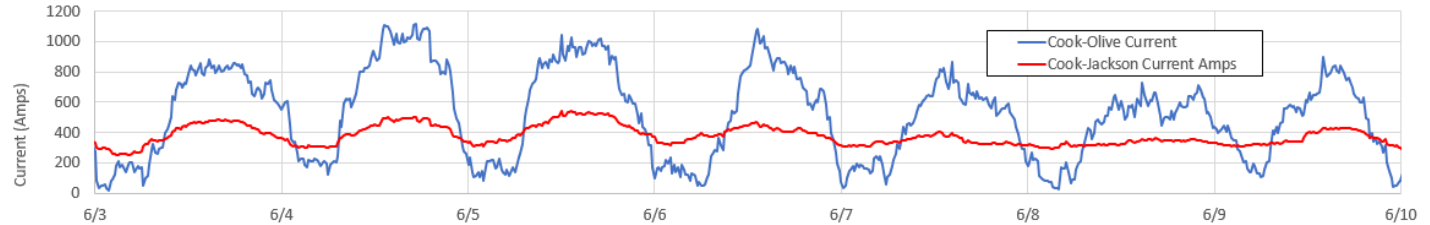
When current loading is high on Cook-Olive, LineVision provides an accurate reading of conductor clearance and temperature.



When loading is low, especially relative to Cook-Jackson, the conductor clearance is difficult to resolve.



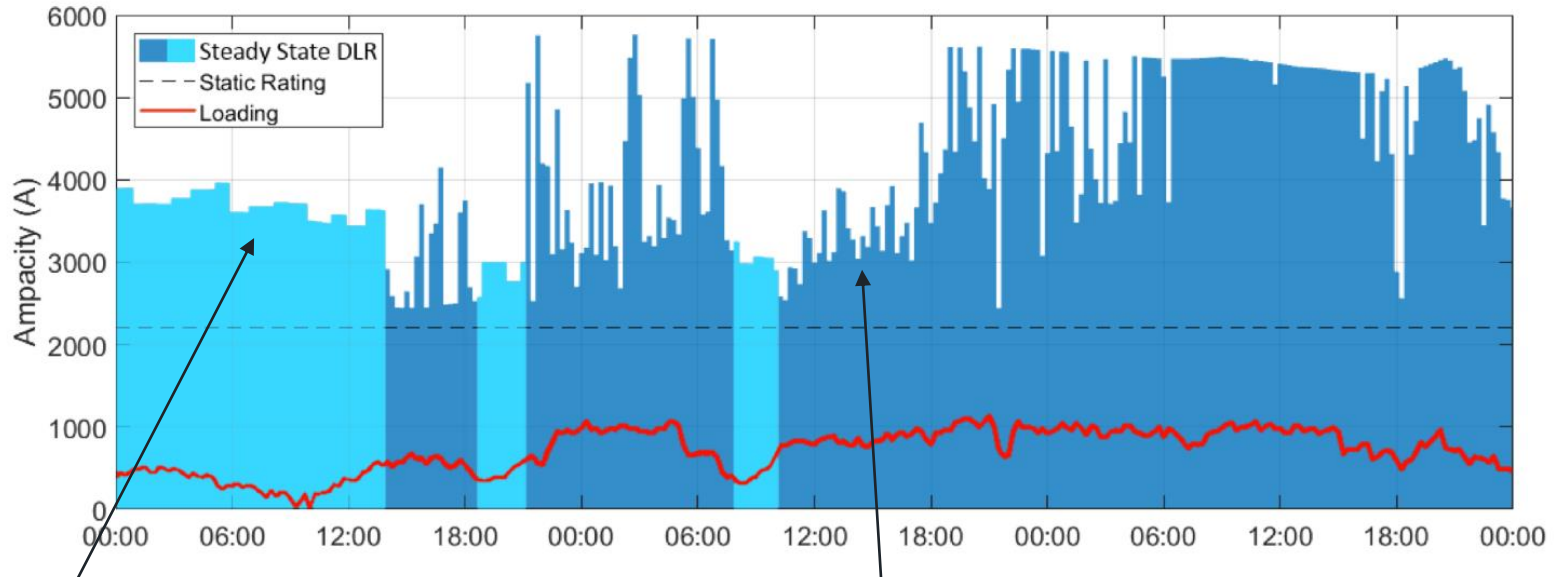
Dynamic Line Ratings are calculated in either case.



DLRs are very favorable relative to static ratings, and 5-min STE ratings are even higher.

Weather Model Backup Operation

When EMF sensor data is insufficient to determine sag/temperature, NOAA-based weather data is used to compute an adjusted rating based on interpolated wind speed, temperature, sunlight, etc.

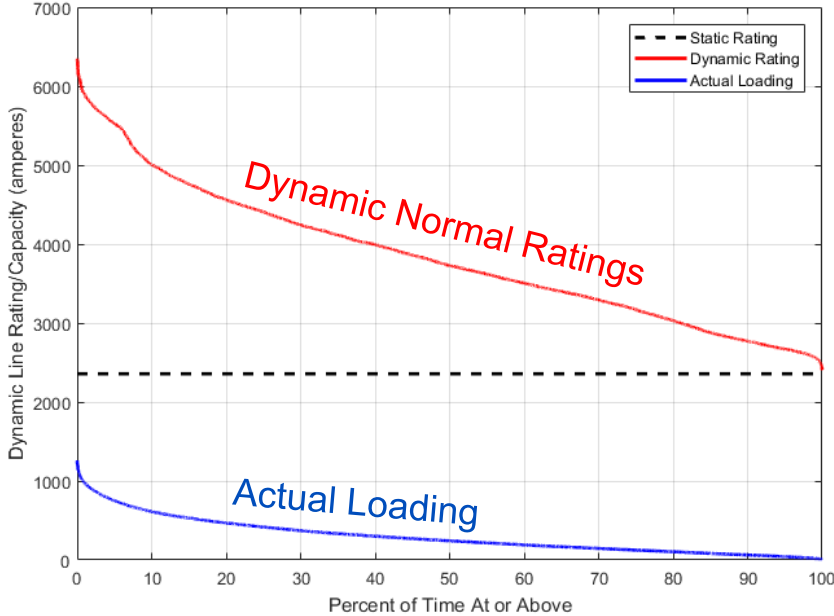
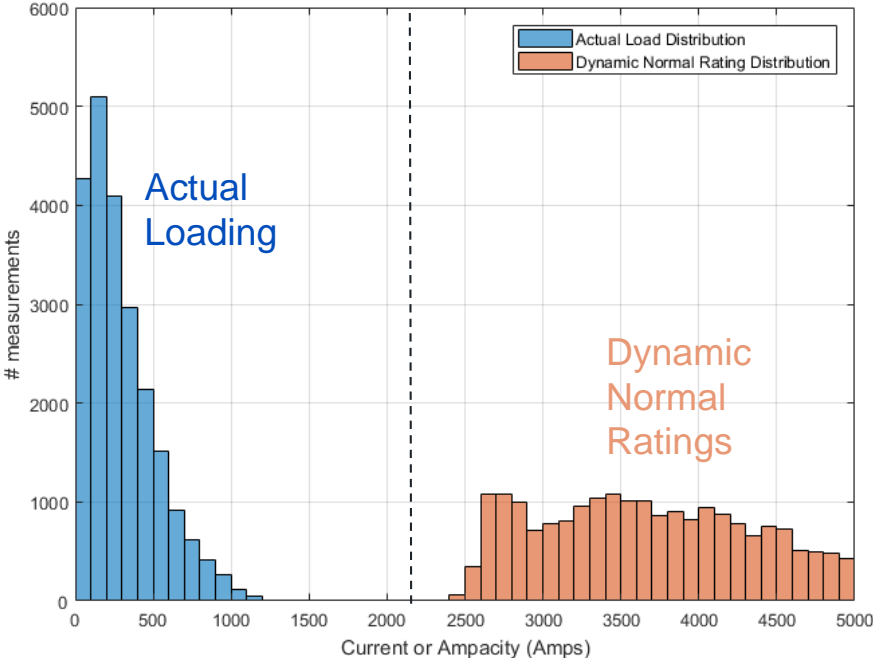


Light blue: weather data-based rating

Dark blue: Sensor-data based rating

Dynamic Line Rating Distributions

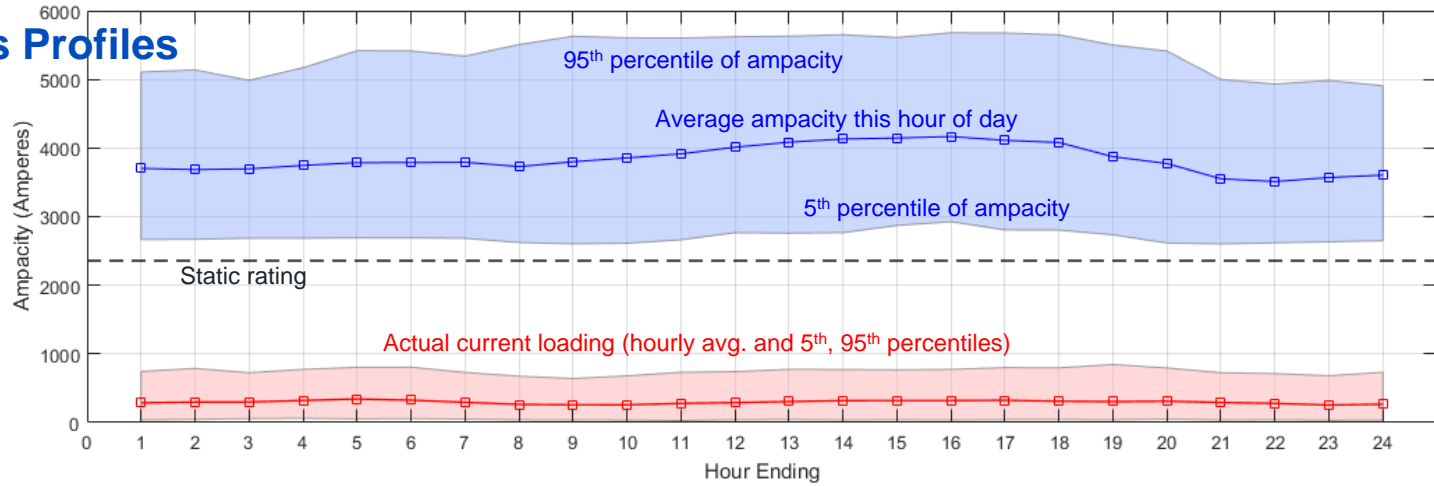
(same data, two different views)



Time-of-Day Ratings Profiles

DLRs typically peak in mid-afternoon.

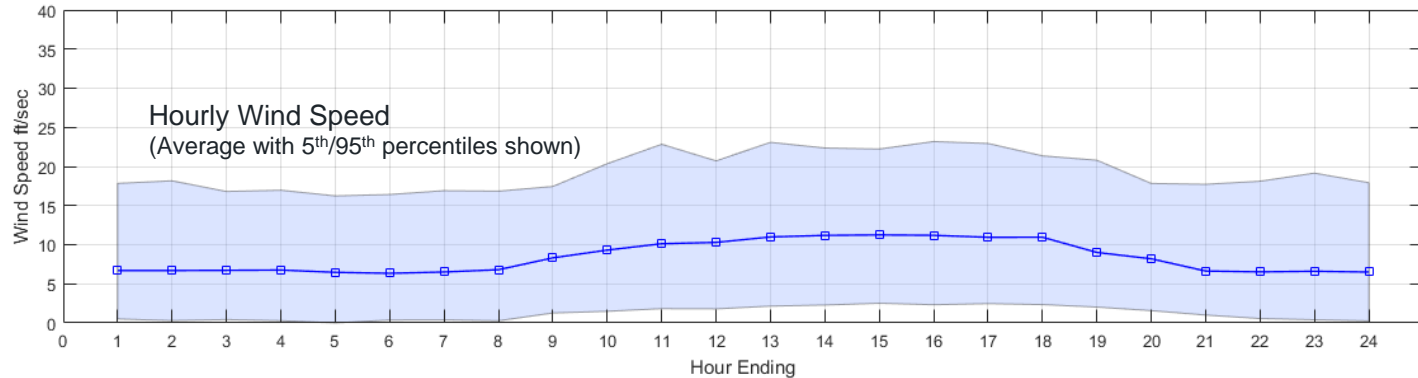
DLRs are lowest in early AM hours.



DLR hourly trends reflect average wind speed distributions:

-Calm in the early AM

-Windy in the afternoon



Conclusions and Future Work

- Line monitoring data reveals significant additional current capacity on monitored lines, similar results are expected for all lines in similar geographic areas.
- Consistent low loading on Cook-Olive 345kV has consequences for monitoring/DLR:
 - Few temperature extremes; conductor is near ambient temperature much of the time
 - Little potential economic benefit from DLR; AEP's 345kV network is not congested
- Non-contact monitoring allows for rapid installation with no outages or live-line work.
- **Next steps:**
 - PJM to perform economic analysis using scaled DLRs to evaluate market impacts of monitoring on a more-congested line
 - Second monitoring phase on a lower-voltage, more heavily-loaded line

Questions?

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