Rhode Island Energy™
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PPL's Dynamic Line Ratings (DLR) System

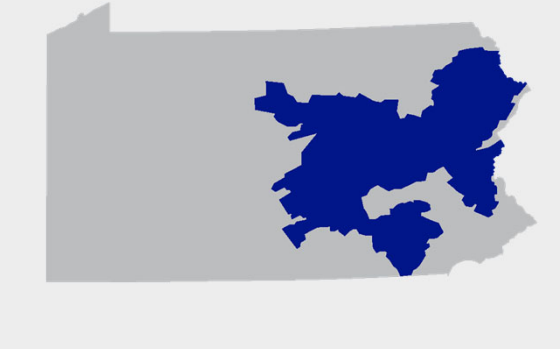
6/18/2025

ISO-NE PAC Meeting

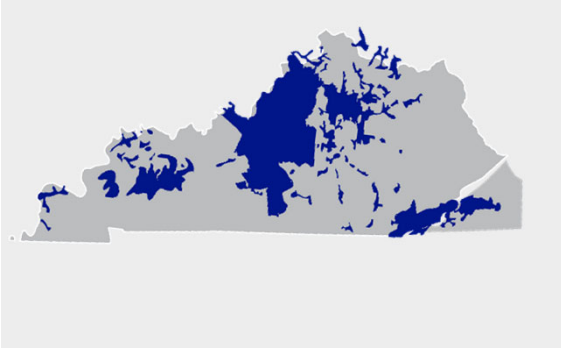
Eric Rosenberger
Principal Engineer – T&S Standards

Where we operate.

PPL Electric Utilities



LG&E KU



Rhode Island Energy™
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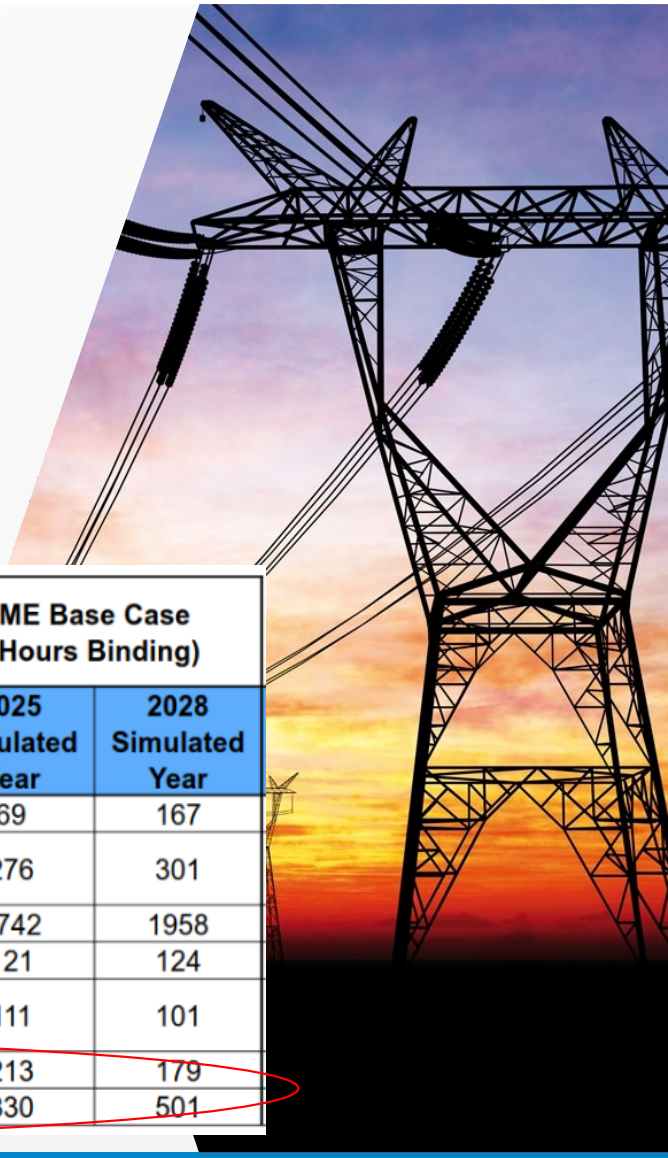
Delivering reliable power to **3.5 million customers**
across **20,600 square miles.**

Background

Original Dynamic Line Ratings Use Case

- 2020 PJM Market Efficiency Case
- $23.5 Million in annual congestion costs projected in 2025
- Harwood to Susquehanna #1 & #2 | 230 kV | ACSS |
- Juniata to Cumberland | 230 kV | ACSR |



2020/21 RTEP Market Efficiency Window Eligible Energy Market Congestion Drivers* (Posted 03-05-2021)				ME Base Case (Annual Congestion $million)		ME Base Case (Hours Binding)	
FG#	Constraint	FROM AREA	TO AREA	2025 Simulated Year	2028 Simulated Year	2025 Simulated Year	2028 Simulated Year
ME-1	Kammer North to Natrium 138 kV	AEP	AEP	$ 2.02	$ 6.56	69	167
ME-3	Junction to French's Mill 138 kV	APS	APS	$ 9.18	$ 11.97	276	301
ME-4	Yukon to AA2-161 Tap 138 kV	APS	APS	$ 4.36	$ 5.16	1742	1958
ME-5	Charlottesville to Proffit Rd Del Pt 230 kV	DOM	DOM	$ 3.76	$ 4.96	121	124
ME-6	Plymouth Meeting to Whitpain 230 kV	PECO	PECO	$ 3.33	$ 4.09	111	101
ME-7	Cumberland to Juniata 230 kV***	PLGRP	PLGRP	$ 9.00	$ 6.61	213	179
ME-8	Harwood to Susquehanna 230 kV***	PLGRP	PLGRP	$ 14.49	$ 8.69	830	501

Solutions Considered

Reconductor

Rebuild

Dynamic Line Rating

Time to Implement	2 – 3 Years	3 – 5 Years	~1 Year
Downtime	Extended Outages	Extended Outages	No Outages
Cost	$0.5 M per mile	$2 - 3 M per mile	< $1 M
Est Capacity Benefit	+ 34%	+ 106%	+ 10 – 30%

What is DLR?

DLR is a system of installed line sensors used to measure conductor and environmental real-time data to determine a real-time rating instead of assumed condition values

Existing Line Ratings

Assumes:

- Wind speed
- Ambient temperature
- Solar radiation

2 Seasons (Summer & Winter) (Planning)

Ambient Adjusted (Operations)

- Conservatively calculates ratings

Dynamic Line Ratings

Measures:

- Wind speed
- Ambient temperature
- Conductor temperature
- Conductor sag

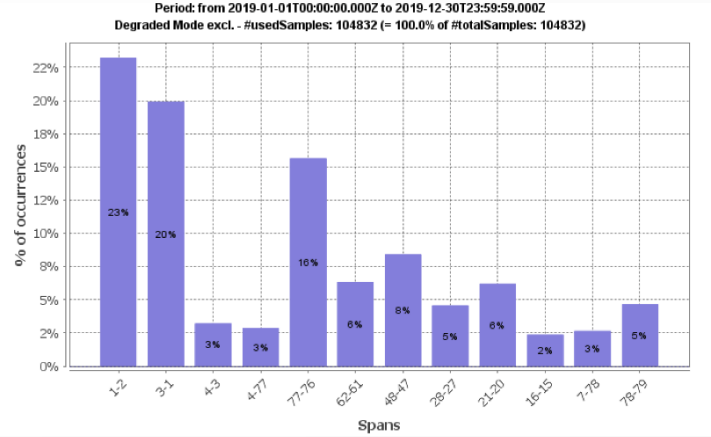
Provides Accurate Real-Time Ratings

Allows for Forecasted Rating

- Measures Conductor Health

Target Span Identification

1 Critical Span Distribution From DLR Simulation



2 Required Span Selection Rules

- Orientation between spans changes more than 15°
  - → To capture variability in wind direction
- Distance is greater than 10 km
- Conductor or number of sub-conductor change
- Span safety concerns
- Utility span data identifies high risk span(s)

3 Final Span Selection

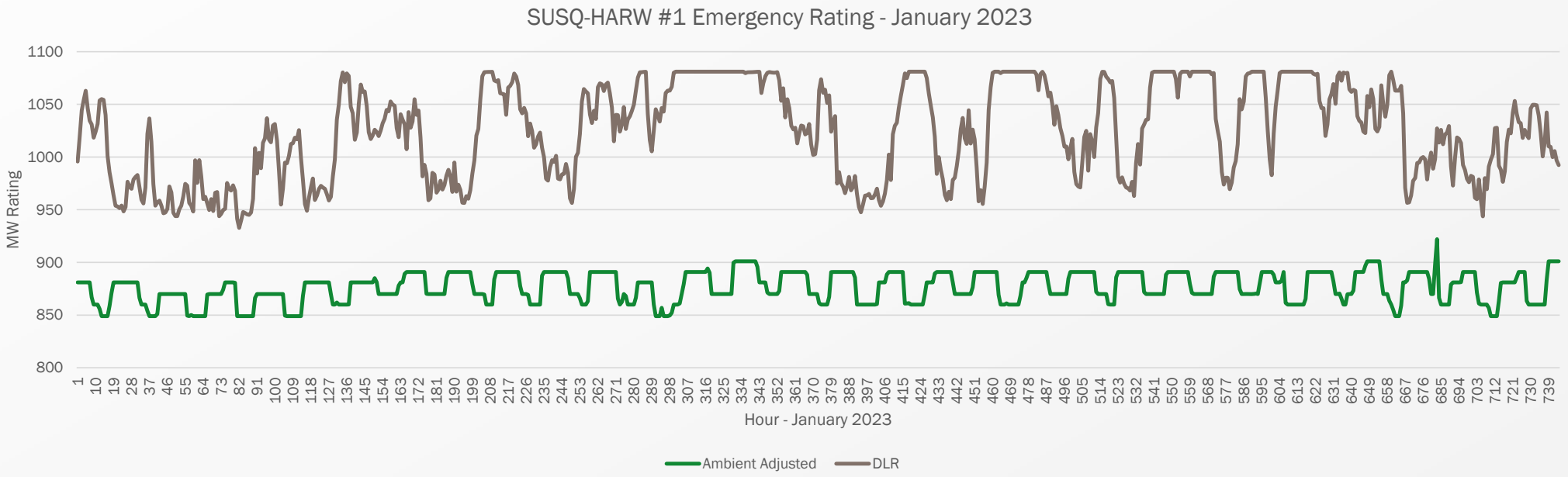
4 Installation

- One phase per identified span
- Sensor mounted 5 – 10% of the total span length from either tower
- Live Line Installation Via Helicopter and from ground
- Mounting procedure is 5 - 10 minutes per sensor

SUSQ-HARW In-Service Results

SUSQ-HARW #1 & #2 (ACSS) Fully in-service in December 2022:

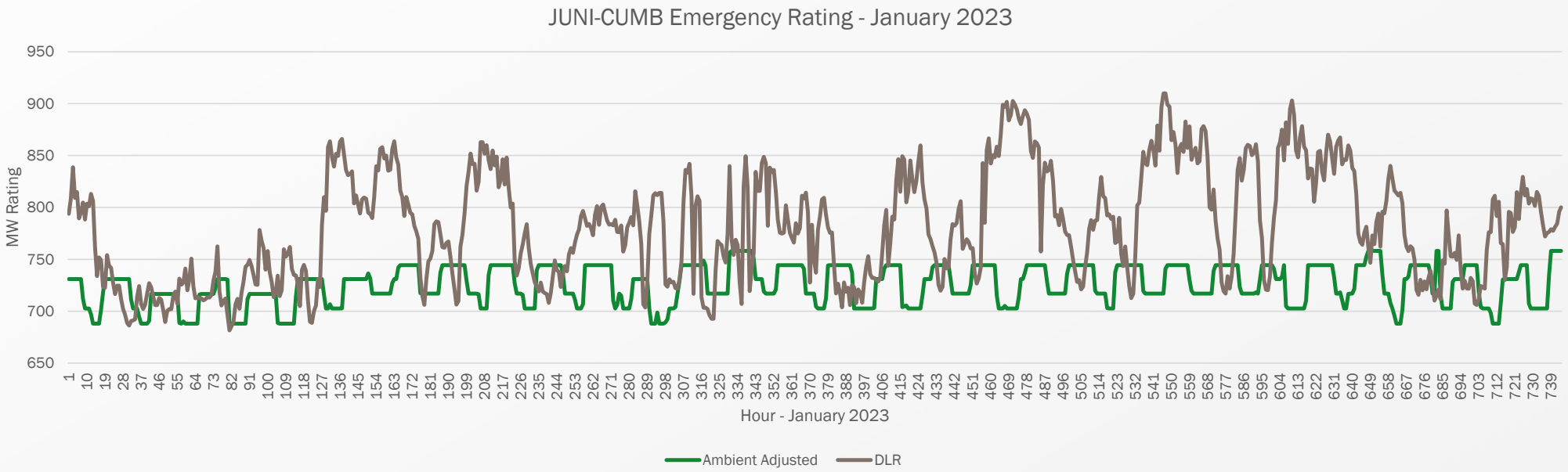
- ~17% Average Normal Rating Increase (2023)
- ~16.5% Average Emergency Rating Increase (2023)
- Congestion drop from ~$2 million to ~$0 for winter 2021-22 to 2022-23



JUNI-CUMB In-Service Results

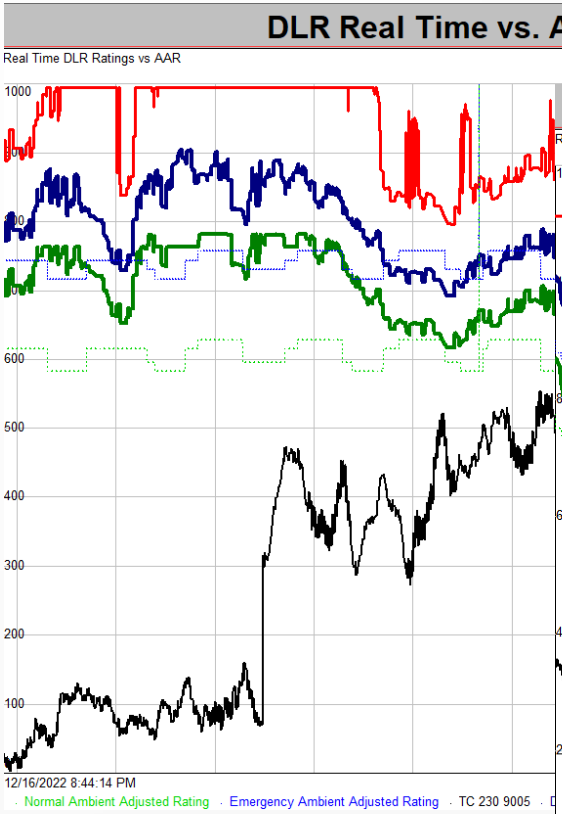
JUNI-CUMB (ACSR) Fully in-service in October 2022:

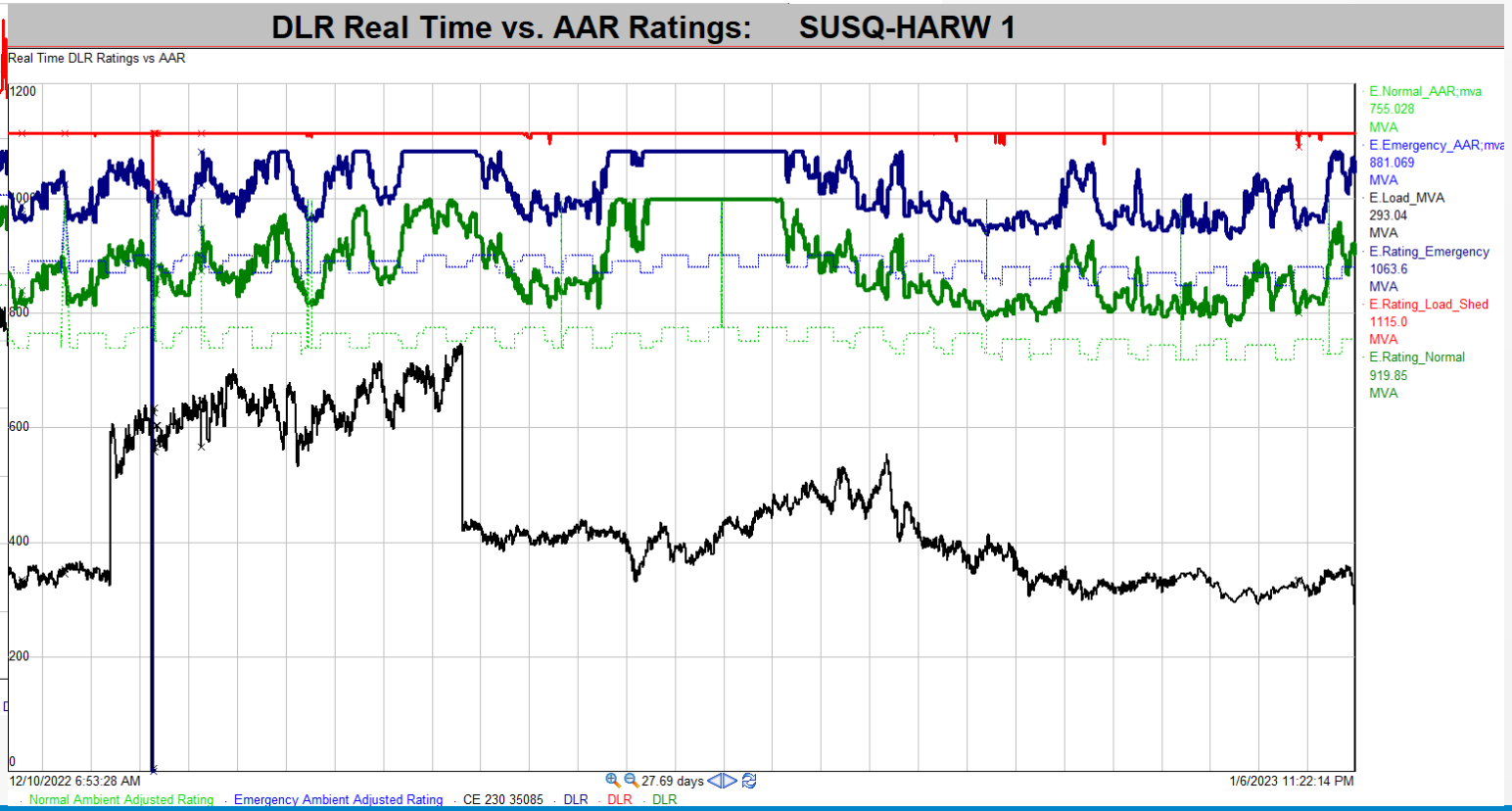
- ~17% Average Normal Rating Increase (2023)
- ~8.5% Average Emergency Rating Increase (2023)
- Congestion drop from >$60 million to ~$1.6 Million for winter 2021-22 to 2022-23



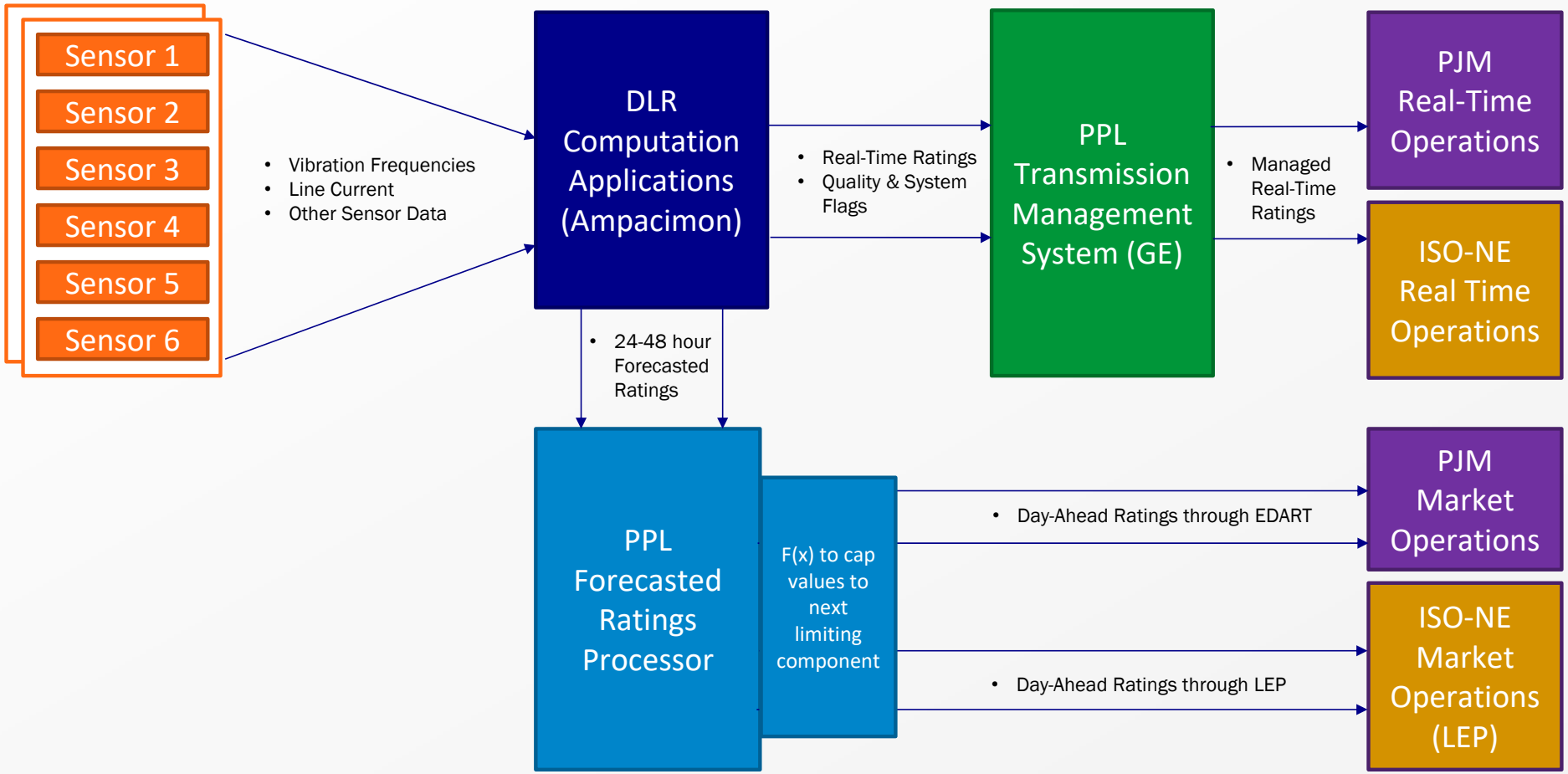
Real Time DLR In Action

December 2022 Polar Vortex





Ratings Data Flow



NERC Standards Considerations

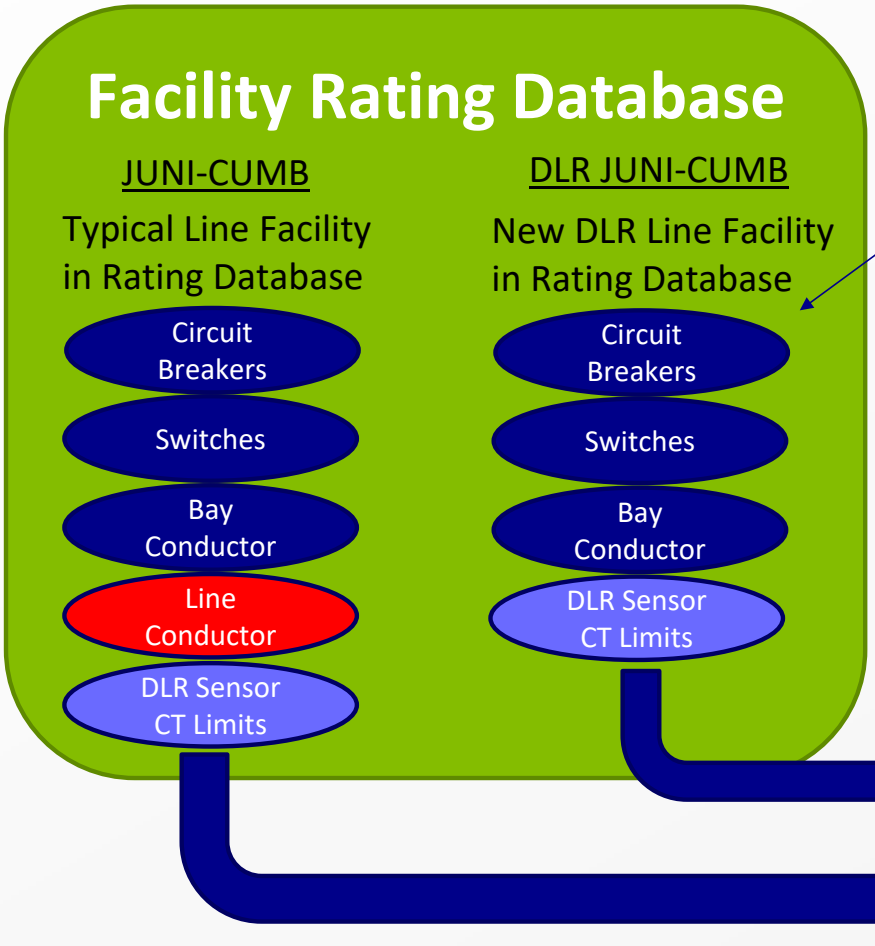
CIP Standards:

- CIP-002: System Categorization
- CIP-005: Electronic Security Perimeters
- CIP-006: Physical Security

PRC-023 – Relay Loadability

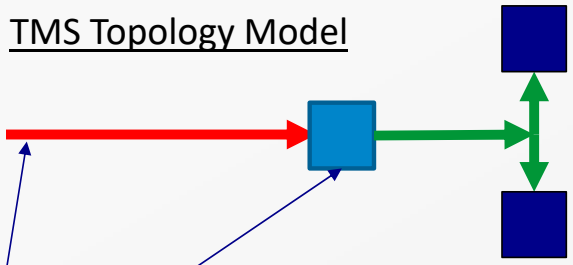
FAC-008 – Ratings Methodology

FAC-008 Operations Considerations



A duplicated line facility is created when DLR is applied to a line. The line conductor ratings are removed in this facility since the ratings will be dynamic

TMS Topology Model



These are used as next most limiting component ratings to limit any ratings received from DLR

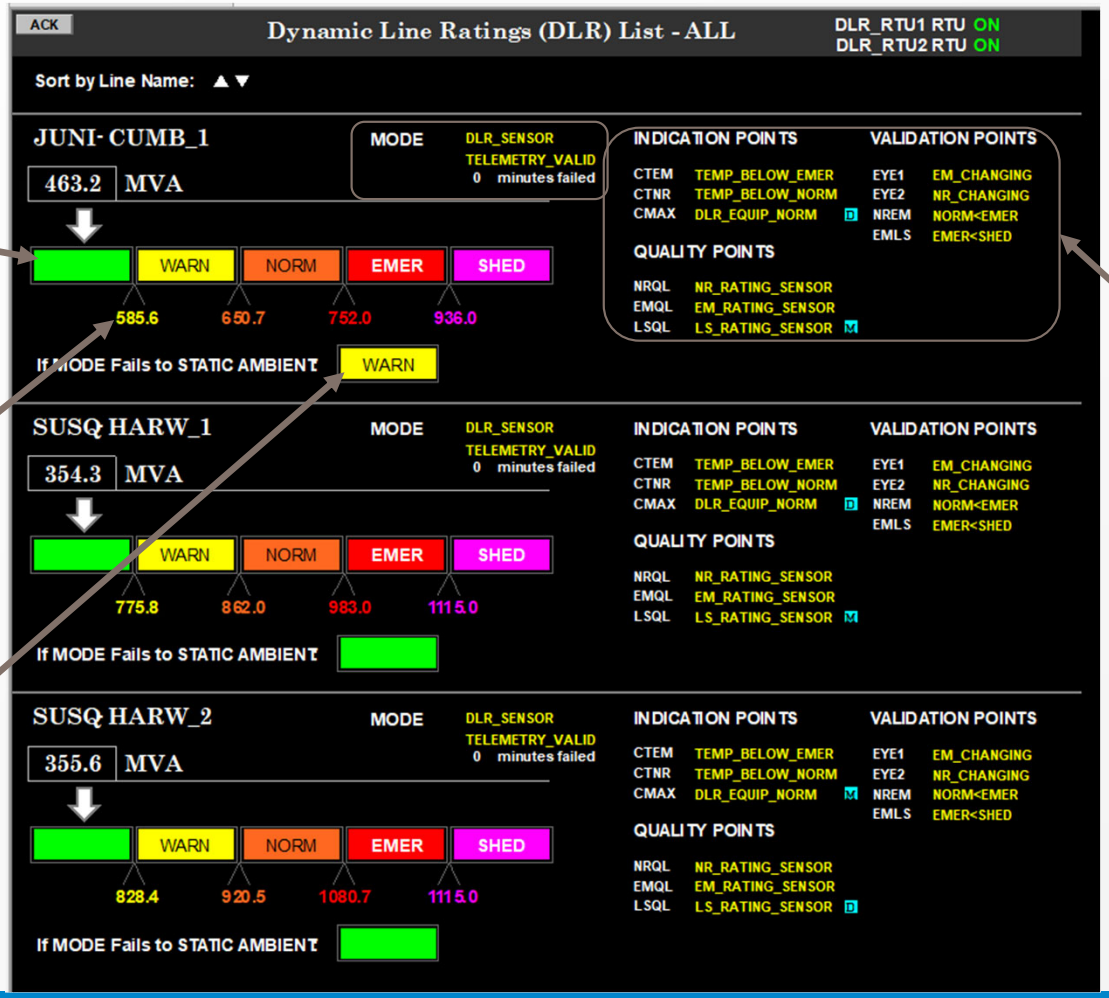
These ratings are used as backup ratings for the case if DLR fails

TMS Operator Display

Current line loading

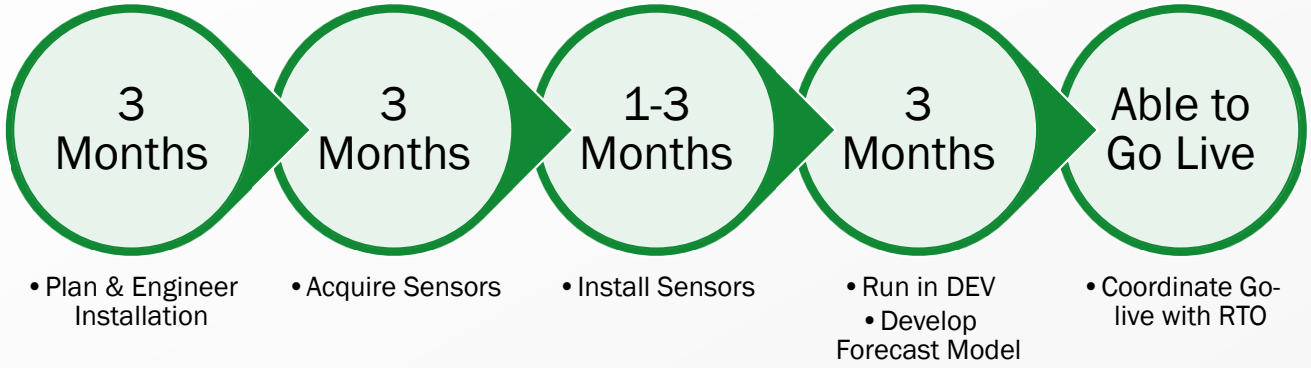
Current real-time ratings

Rating Zone if DLR goes down

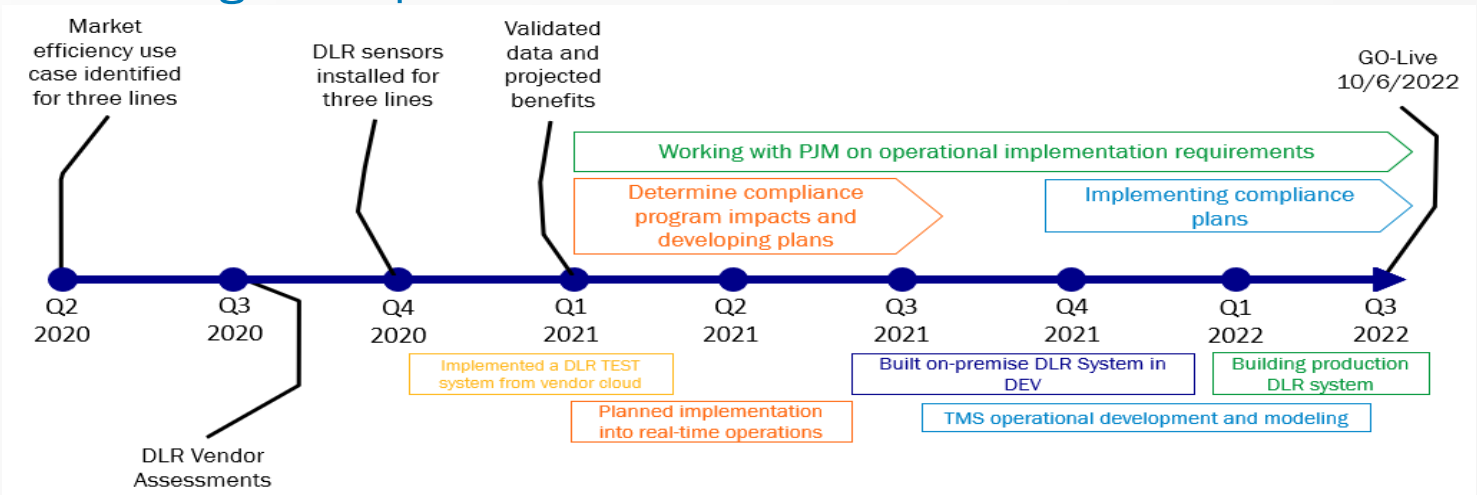


Various DLR indication, validation, and quality points for situational awareness

DLR Implementation Timeline



Original Implementation with PPL's EMS and PJM



Application Plan for RIE

- DLR installed and operating in a Development environment for the following RIE lines:
  - 1870, 1870N, 1870S and 1870S_2
  - H17, H17_S
  - 328
- FERC 881 upgrades needed within ISO-NE before these lines can be operated to DLR in real time and day ahead markets
- After FERC 881 upgrades are completed, RIE will evaluate integrating DLRs with ISO-NE Operations.

Questions?

Photo of some of the DLR team members: from left, Andrew Henry, Horst Lehmann, Bill Elko, and Eric Rosenberger