Transmission Optimization with Grid Enhancing Technologies

Principal Investigator: Jake Gentle

Affiliation: Idaho National Laboratory

Team Members: Alexander Abboud, Megan Culler, Christopher Sticht, Chris Duncan, Jesse Reeves

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Acronyms

GETs (Grid Enhancing Technologies)

PFC (Power Flow Control)

DLR (Dynamic Line Rating)

AAR (Ambient Adjusted Rating)

OSW (Offshore Wind)

ISO-NE (Independent System Operator – New England)

INL (Idaho National Laboratory)

CITRC (Critical Infrastructure Test Range Complex)

Project Summary

- Demonstration of Grid Enhancing Technologies (GETs) on the INL Power Grid Testbed at the Critical Infrastructure Test Range Complex (CITRC)
  - Provide an overview of the installation process
  - Compare vendor installations to INL's method
  - Thoroughly document the entire process to ease utility acceptance

- Case study of GETs for Offshore Wind (OSW)
  - Demonstrate how near-term dynamic line rating (DLR) and power flow control (PFC) installs could enable additional grid integration of OSW in ISO-NE region prior to traditional upgrades

The Numbers

- DOE PROGRAM OFFICE:
  OE – Transformer Resilience and Advanced Components (TRAC), TRRI, AGTS

  WETO - SI
- FUNDING OPPORTUNITY:
  XXX
- LOCATION:
  Idaho Falls, ID
- PROJECT TERM:
  04/01/2022 to 09/30/2024
- PROJECT STATUS:
  Ongoing
- AWARD AMOUNT (DOE CONTRIBUTION):
  $1,900,000 [OE] $900,000 [WETO] ?
- AWARDEE CONTRIBUTION (COST SHARE):
  $0
- PARTNERS:
  Telos Energy, EnerNex, WindSim, Ampacimon, POWER Engineers, FERC, NERC, WECC, WAPA, EPRI, BPA, MISO, National Grid, Grid Strategies LLC

Technical Approach

- Installation on the INL Power Grid Testbed at the Critical Infrastructure Test Range Complex

CFA Advantages

- 13.8 kV ‘transmission’ line
- Native load
- Co-located DLR
- Existing loop
- Easy equipment access
- Reconductored longer span for DLR

CFA Challenges

5 MW load to achieve 200A, set peak, demand.

Needed new ground grid

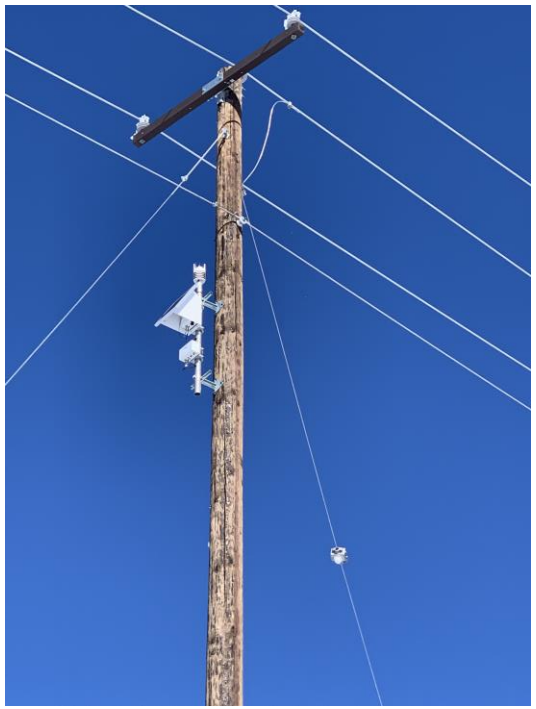
Major overhaul of protection systems on loop for test.

Comm link gap between field unit and rack.

Installation of 6 new poles

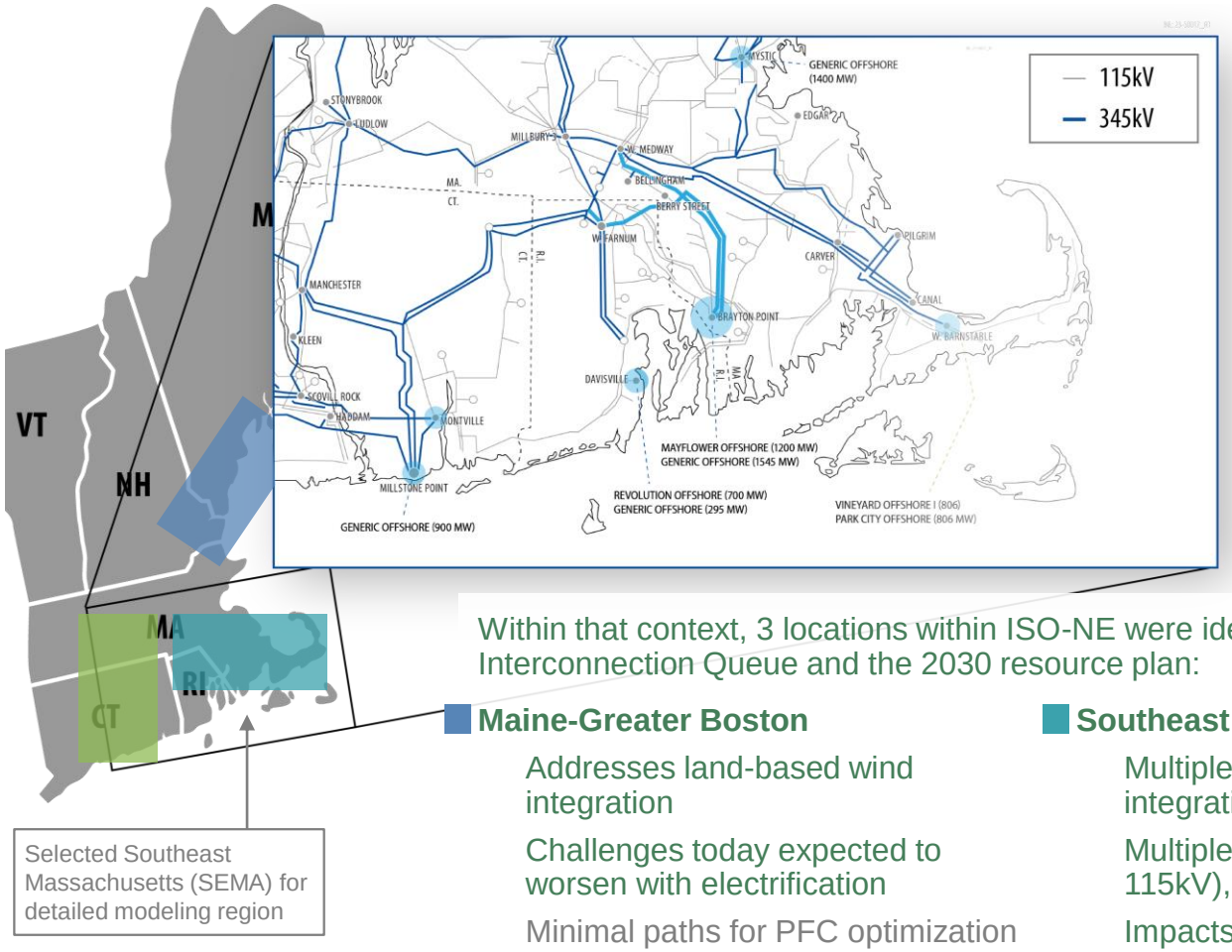
Large Load Bank Rental

Archeological and Environmental impacts



Installed devices

Technical Approach – GETs Model



The 2022 Report to Congress[1] identified six key indicators for GETs value:

1. Wind and Solar Share
2. Renewable Curtailment
3. Transmission Congestion
4. Price Differentials
5. Proposed Transmission
6. Proposed Renewables

Within that context, 3 locations within ISO-NE were identified as potentially well-suited for GETs based on the Interconnection Queue and the 2030 resource plan:

Maine-Greater Boston

- Addresses land-based wind integration
- Challenges today expected to worsen with electrification
- Minimal paths for PFC optimization (Mostly NE/SW)

Southeast Massachusetts (SEMA)

- Multiple Offshore Wind (OSW) integration points
- Multiple paths, voltages (345 & 115kV), orientations (N/S, E/W)
- Impacts both New England and New York power systems

Eastern Connecticut (ECT)

- Single OSW landing spot
- Multiple 345kV paths
- Impacts both New England and New York power systems

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[1] https://www.energy.gov/sites/default/files/2022-04/Grid%20Enhancing%20Technologies%20-%20A%20Case%20Study%20on%20Ratepayer%20Impact%20-%20February%202022%20CLEAN%20as%20of%20032322.pdf

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Accomplishments

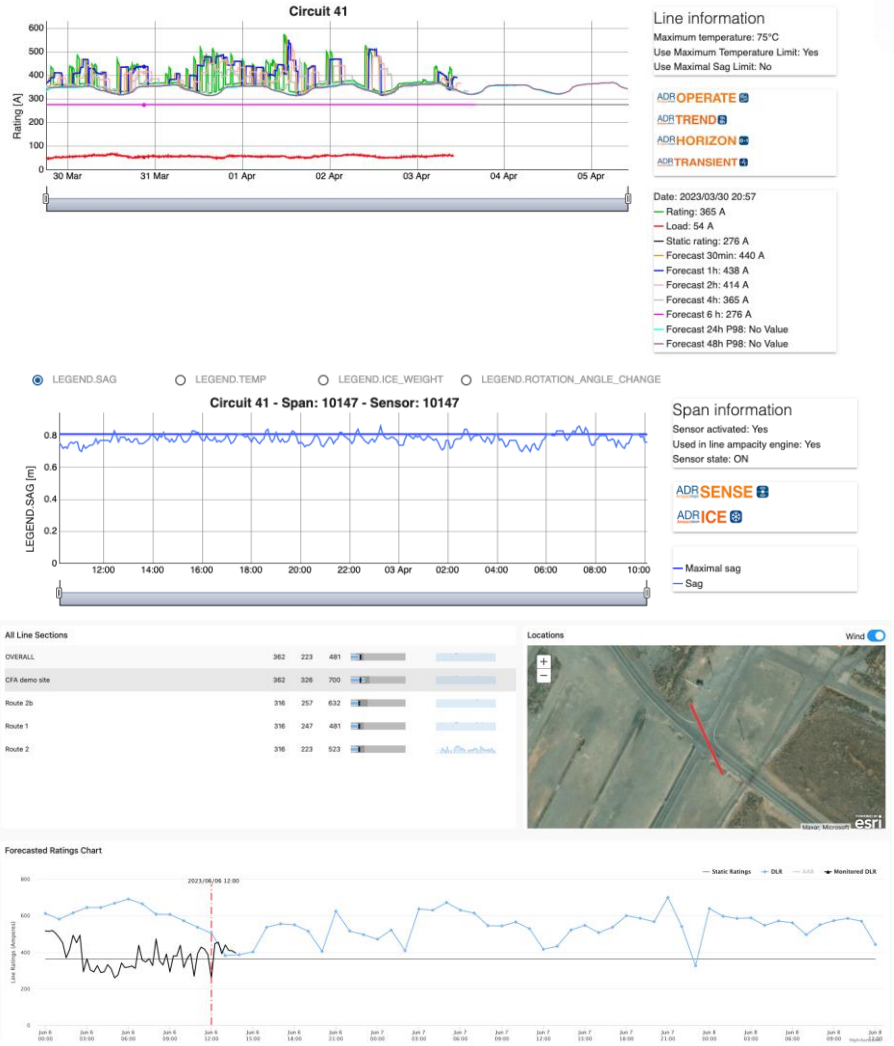
- Installation on the INL Power Grid Testbed at the Critical Infrastructure Test Range Complex

DLR Vendor 1

- Online dashboard access provided
  - allows for AAR, and forecasted DLR at 1-2-4-6-24-48 hour intervals
- Installation completed
  - Load sensor working and reporting + validated with INL instruments
  - Sag measurement appears to be reporting fine
  - Temperature measurement needs continued calibration

DLR Vendor 2

- Online dashboard access provided
  - Allows for actual DLR and forecasted 48 hour DLR
  - Provides direct weather data with API
- Installation completed
  - Reporting weather data and ampacity separately
  - Vendor wants some additional calibration tests on pole proximity



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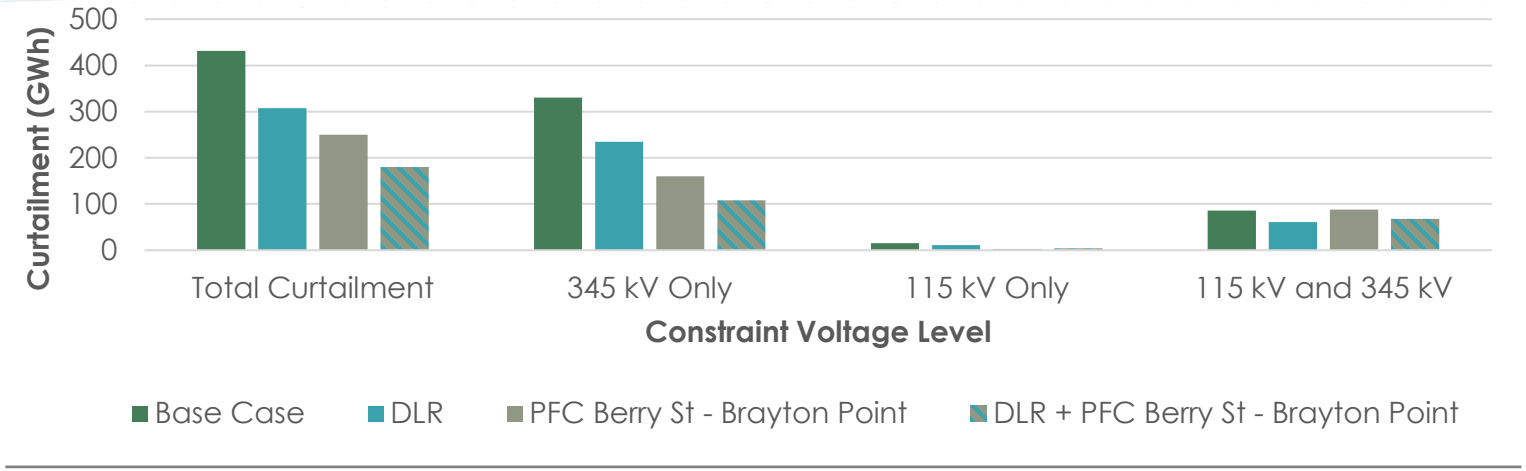
Accomplishments - GETs Model



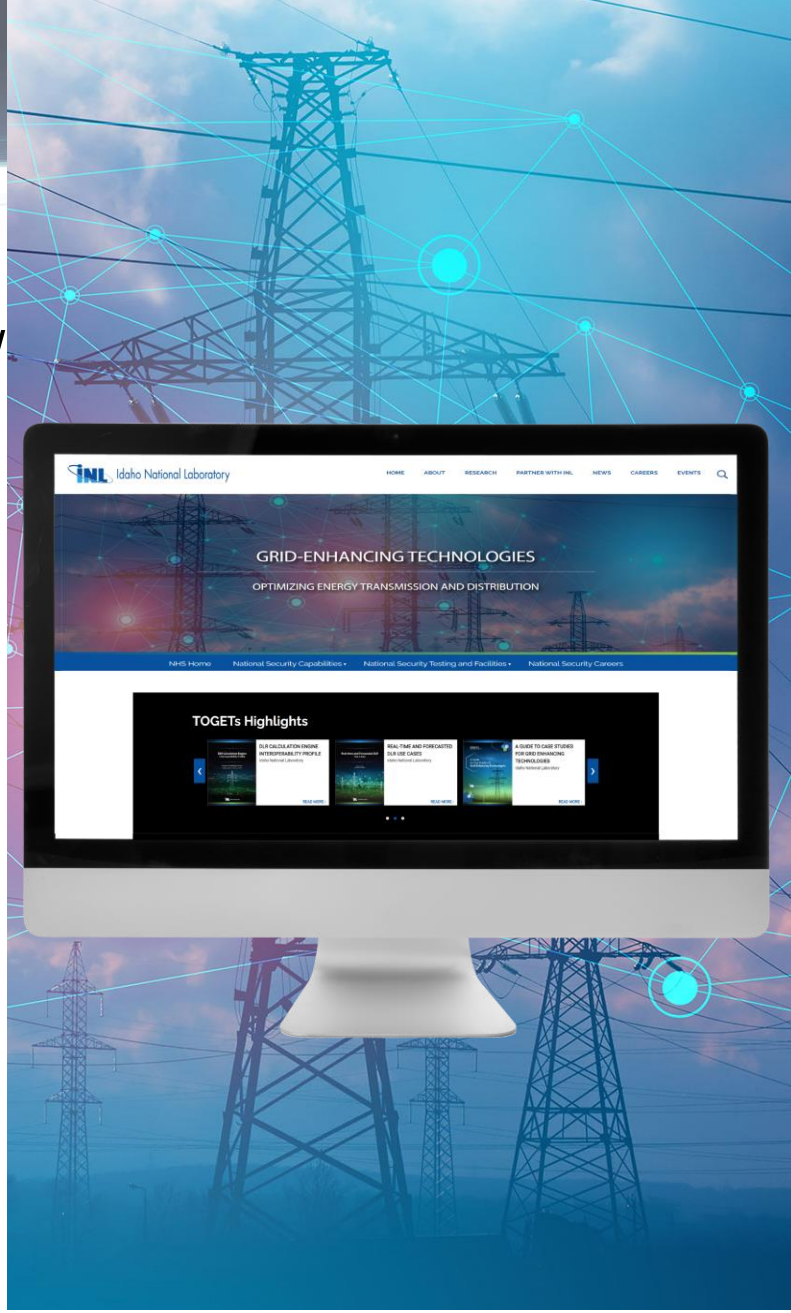
DLR and PFC work together to mitigate congestion and improve system costs:

- DLR (on its own) on the 345kV portion of the Brayton Point substation significantly but not fully mitigates the 345kV Brayton Point export path congestion.
- The main value provided by an additional PFC is to shift power flow from the 345kV to the 115kV Brayton Point export paths in cases when DLR cannot fully mitigate the 345 Brayton Point export path congestion.
- There are still some hours where even with DLR, both the 115kV and 345kV export paths out of Brayton Point substation are congested – adding a PFC does not mitigate congestion in these hours.

TOGETs Publications and Longer Catalogue of Relevant Info

- GETs website - inl.gov/national-security/grid-enhancing-technologies/
  - Background
  - Variety of products
    - Guide to Case Studies for GETs
    - Real-time and Forecasted DLR Use Cases
    - DLR Forecast Time Frames
    - Interoperability Profile
  - Related Information

- DLR website – inl.gov/national-security/dynamic-line-rating/
  - Last 10-15 years of DLR R&D
  - Overview of DLR
  - Technical Articles and Papers



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Timeline

- Risks to mitigate include site location alternatives and vendor procurements
  - Negotiations with DOE on extension of project due to supply chain/delivery issues

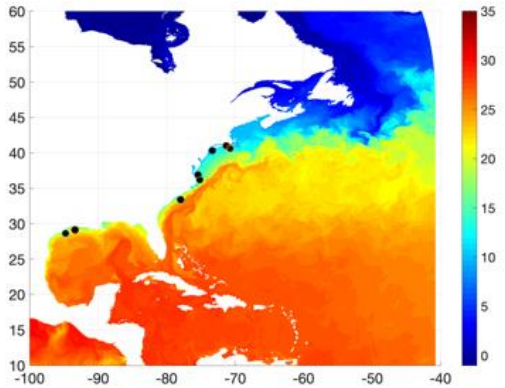
Milestone Name/Description	Criteria	End Date	Type	Completion
1.3 FY22 Q3: INL will compile information on case studies previously performed by utilities and reach out to them to gauge their willingness to share data in support of the cost estimate guide. A letter report to DOE WETO and OE will be provided outlining case studies/pilot documentation received to date.	External Report (flipbook)	12/9/2022	Quarterly Progress Measure (Regular)	100%
3.1 FY22 Q4: Field testing of PFCs and Dynamic Line Rating monitoring, modeling, and forecasting of line ratings. INL will host DOE OE and WETO, as well as Task Force members, for on-site demonstration. A letter report of findings to date will be prepared. **3.2 FY23 Q1: Identify, evaluate, and document integration challenges, including data models, communication shortfalls, secure implementation requirements, and the techniques used to overcome them (i.e., gap analysis). Release external lab report of this together with Task 3.1 information.** **3.3 FY23 Q2: Identify requirements, conventions/standards, etc. relevant for industry- wide integration of GETs technologies for operations.** **3.4 FY23 Q4: Document behavior of GETs under intended operating scenarios and unexpected or extreme operating scenarios (informed by Task Force) to inform resilience evaluation of GETs in real-world operation. Prepare letter report to DOE.**	GETs Demonstration Progress/letter reports + External Report	-	Annual Milestone (Regular)	75%
2.1 FY23 Q1: Expand the methodology for identifying the best practices, dependent upon the case restrictions of GETs (DLR, PFC, DTR) alongside traditional transmission upgrades (conductor coating, reconductoring, new build, voltage uprating), and non-wire alternatives (energy storage, demand response, V2X) identified in previous OE report. (Use case documents)	Letter report	6/30/2023 planned	Quarterly Progress Measure (Regular)	90%
2.2 FY23 Q2 Develop passive cost estimate guide. Work with the Task Force and industry to develop a set of passive cost estimates to help planners consider the GETs technologies as viable transmission system upgrades.	Letter report	6/30/2023 planned	Quarterly Progress Measure (Regular)	98%

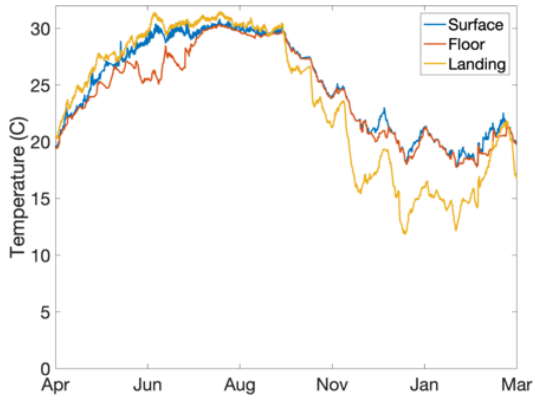
Impact/Commercialization

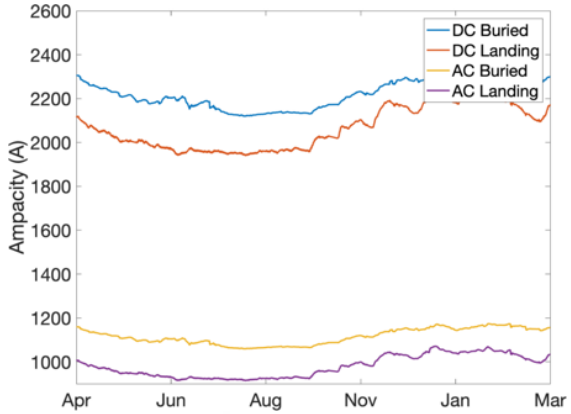
- Documentation
  - DLR Calculation Engine Interoperability Profile
  - Real-Time and Forecasted DLR Use Cases
  - DLR Forecast Time Frames
  - A Guide to Case Studies for Grid Enhancing Technologies
- List of innovations
  - Unique PLEXOS-TARA coupling shows how DLR and PFCs can be incorporated together into power flow modeling to assess impacts
- IP status
  - Interoperability Profile software copyright
- ESIG Webinar on power flow modeling
- Conference presentations/panels: EEI, IEEE PES, CIGRE GOTF
- Integration of DLR into the NAERM platform

Future Work

- Document the performance of the two DLR devices
- Document the modeling approach to allow for utilities to adapt PFCs onto their systems
- Document differences across various terrains for AAR vs. DLR including conductor maximum temperature exceedance in relation to FERC 881
- Examine potential for subsea cable rating increases as a function of sea temperature







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THANK YOU

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