Guidehouse

10/6/2025

From Investments to Impact: Proving the Value of Grid Modernization

BILHUDA RASHEED

IEPEC | October 6-8, 2025 | Denver, CO

Urgent Need to Evaluate Grid Modernization, but Methods are Lacking

Utilities are investing over $50B per year in distribution grid modernization, to address:

- Aging infrastructure
- Load growth and peak
- Intermittent resources (e.g., solar, wind)
- Extreme events

Unlike EE and DSM, evaluation methods for grid modernization remain underdeveloped

- Some regulators use ad-hoc methods that are inconsistent across jurisdictions
- Others skip evaluation entirely

Critical Gap

With rising rates and declining reliability, critical gap for regulators and ratepayers:
How do we know grid modernization investments are working?

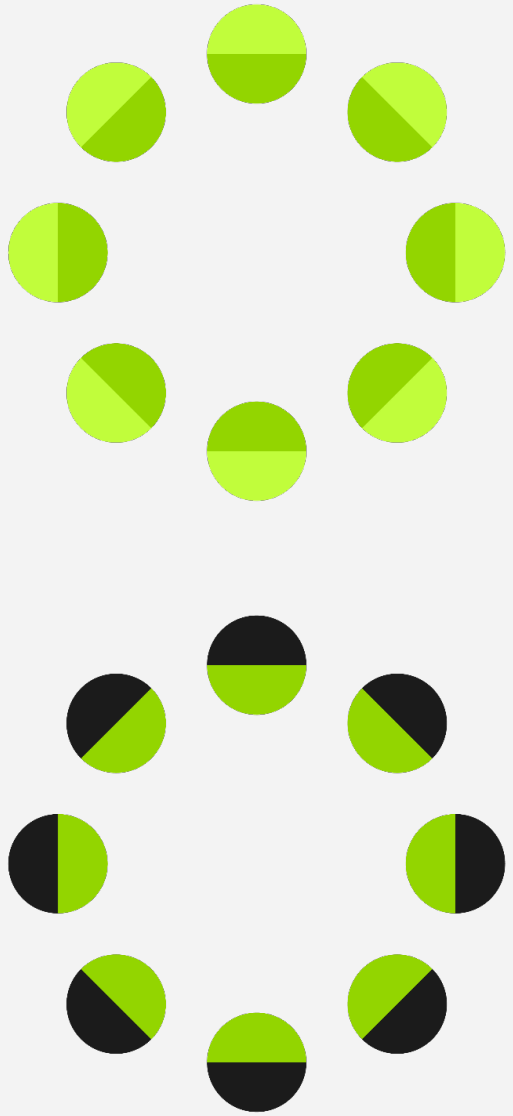
In this talk, you will learn:

Evaluation strategies for grid modernization, including traditional reliability metrics.

Lessons from the evaluation of the Massachusetts Grid Modernization Program (GMP).

The case study methodology to isolate device-level impacts, with example case studies.

Real world guidelines for applying the case study method to evaluate grid modernization investments more broadly.



Grid Modernization Investments Evaluated in Massachusetts

INVESTMENT TYPE	DESCRIPTION
Monitoring and Control (M&C)	Remote near-real-time monitoring of current, voltage and other conditions on distribution circuits and substation devices, and remote-controlled operation of those devices. A common example is SCADA (supervisory control and data acquisition) at field devices, such as reclosers and switches, and substation devices such as breakers or relays.
Advanced Distribution Automation (ADA)	Localized or centralized automation logic that is designed to rapidly isolate a 'fault' to a limited section of a distribution circuit and restore other sections of the circuit via pre-programmed switching and reclosing actions.

**Other investments (e.g., Communications, VVO, ADMS) not covered in this paper.*

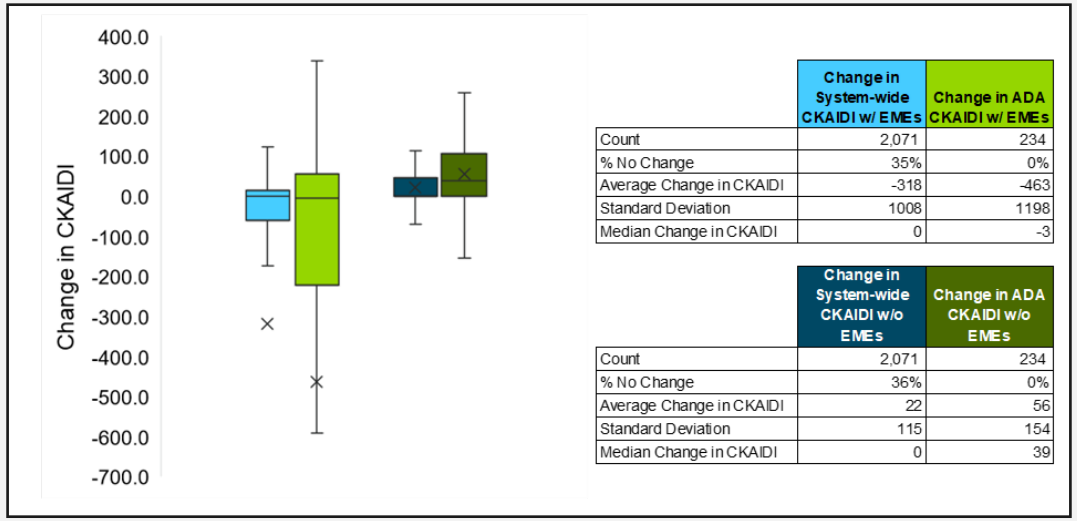
State-Approved Reliability Metrics

Massachusetts DPU requires use of SAIDI- and SAIFI-based metrics for evaluation

METRIC	DESCRIPTION	TRACKING
CKAIDI	Compares the experience of customers on ADA-enabled and M&C-enabled circuits to the prior three-year average for the same circuits. Provides insight into how ADA or M&C can reduce the duration of outages.	• Circuit-level SAIDI (CKAIDI) for the program year • Three-year average SAIDI (CKAIDI) for 2015, 2016, and 2017 (baseline) • Comparison of current year SAIDI with the three-year average: AVERAGE(CKAIDI 2015, CKAIDI 2016, CKAIDI 2017) – Program Year CKAIDI. • If result > 0 → positive impact
CKAIFI	Compares the experience of customers on ADA-enabled and M&C-enabled circuits to the prior three-year average for the same circuit. Provides insight into how ADA or M&C can reduce the frequency of outages.	• Circuit-level SAIFI (CKAIFI) for the program year • Three-year average SAIFI (CKAIFI) for 2015, 2016, and 2017 (baseline) • Comparison of current year SAIFI with the three-year average: AVERAGE(CKAIFI 2015, CKAIFI 2016, CKAIFI 2017) – Program Year CKAIFI. • If result > 0 → positive impact

Challenges of Using SAIDI and SAIFI for Massachusetts Grid Mod Evaluation

1. **Large variability and small sample sizes** made first three years' results statistically inconclusive.
2. **Attribution challenge**: multiple overlapping drivers affect reliability
3. **Control group challenge:** system-wide circuits already had modernization technology.
4. **Non-reliability benefits** (e.g., situational awareness, emergency response, power quality) not captured.



	Change in System-wide CKAIDI w/ EMEs	Change in ADA CKAIDI w/ EMEs
Count	2,071	234
% No Change	35%	0%
Average Change in CKAIDI	-318	-463
Standard Deviation	1008	1198
Median Change in CKAIDI	0	-3

	Change in System-wide CKAIDI w/o EMEs	Change in ADA CKAIDI w/o EMEs
Count	2,071	234
% No Change	36%	0%
Average Change in CKAIDI	22	56
Standard Deviation	115	154
Median Change in CKAIDI	0	39

Circuit SAIDI (CKAIDI) metric performance results in PY2021 for one participating utility. EME = excludable major events. Change in CKAIDI greater than zero indicates positive impact. (Web URL)

The Case Study Approach

Case studies are a targeted evaluation method that select a random sample of grid modernization devices and trace how each was used to address specific challenges or achieve desired outcomes.

Methodology

- Compare the **observed scenario** (where the device was present and operated) with a **counterfactual scenario** (what would have happened without the device).
- Quantify benefits such as **avoided customer minutes of interruption (CMI),** faster emergency response, avoided overloads, or deferred costs.
- Capture instances where **devices mis-operated or failed to operate**, highlighting opportunities for improvement.

Advantages

- Directly attribute outcomes to specific investments, **overcoming the limitations of traditional reliability metrics** (which are confounded by weather, other programs, and system-wide changes).
- Can be performed **within a year of device deployment**, unlike statistical methods that require years of data.
- Applicable to **pilots and small deployments** where sample sizes are limited.

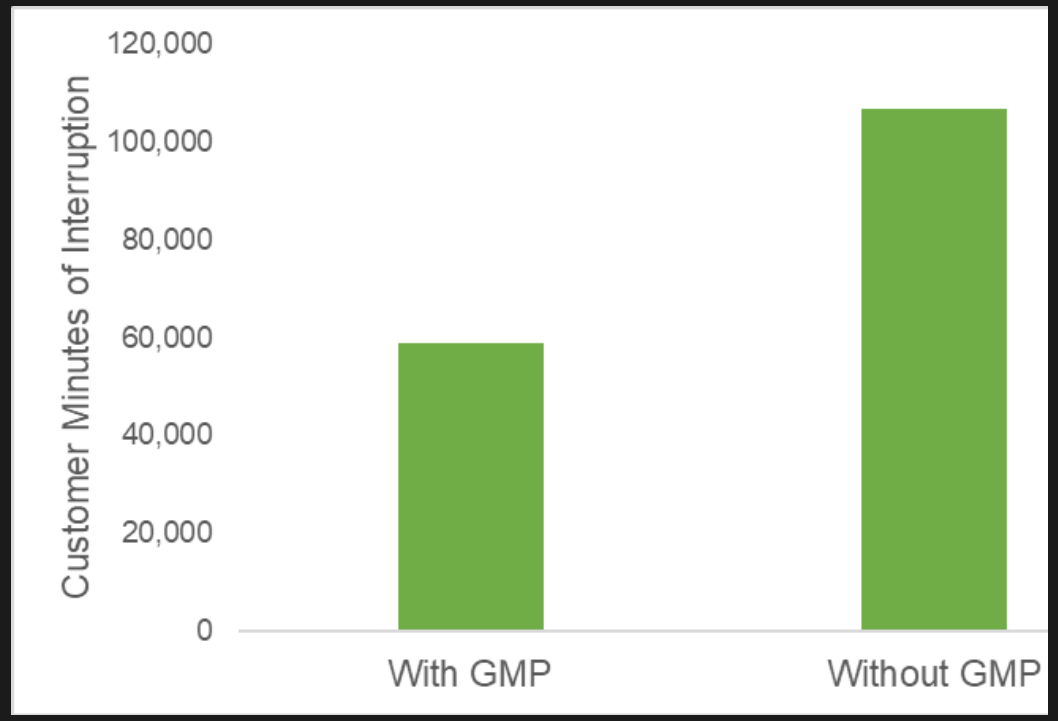
CASE STUDY 1

Underground Fault Detection Reduces Outage Time

- In one case, the utility replaced legacy underground switches with modern, remotely operable devices. Previously, crews manually inspected manholes to locate faults—delaying restoration. In 2022, after an underground fault, fault was automatically isolated to a section of the circuit.
- SCADA alerts helped indicate the location of the fault and remote switching further minimized the outage footprint
- **Result: 40% reduction in customer minutes of interruption (CMI)**
- **Recommendation:** Program switches to isolate faults more precisely and reduce impact further

A scan of all ADA operations at a utility in 2023 and 2024 indicated over 90% operations were successful in reducing outage duration.

Benefit of ADA for Customer Reliability



CASE STUDY 2

Emergency Response

Faster Storm Response

- During a storm in 2024, a broken tree caused live overhead wires to fall on top of a fire truck.
- Before Grid Mod, crews would have had to travel to the site to manually deenergize the live wires.
- With SCADA investment, the utility was able to remotely deenergize the wires and quickly make the area safe

Faster Fire Response

- In 2023, a pole-top device caught fire on a Massachusetts circuit.
- Thanks to SCADA integration, the system sent an alarm within seconds to the utility's dispatch center.
- Crews were already en route when the fire department called, enabling a rapid and coordinated response.

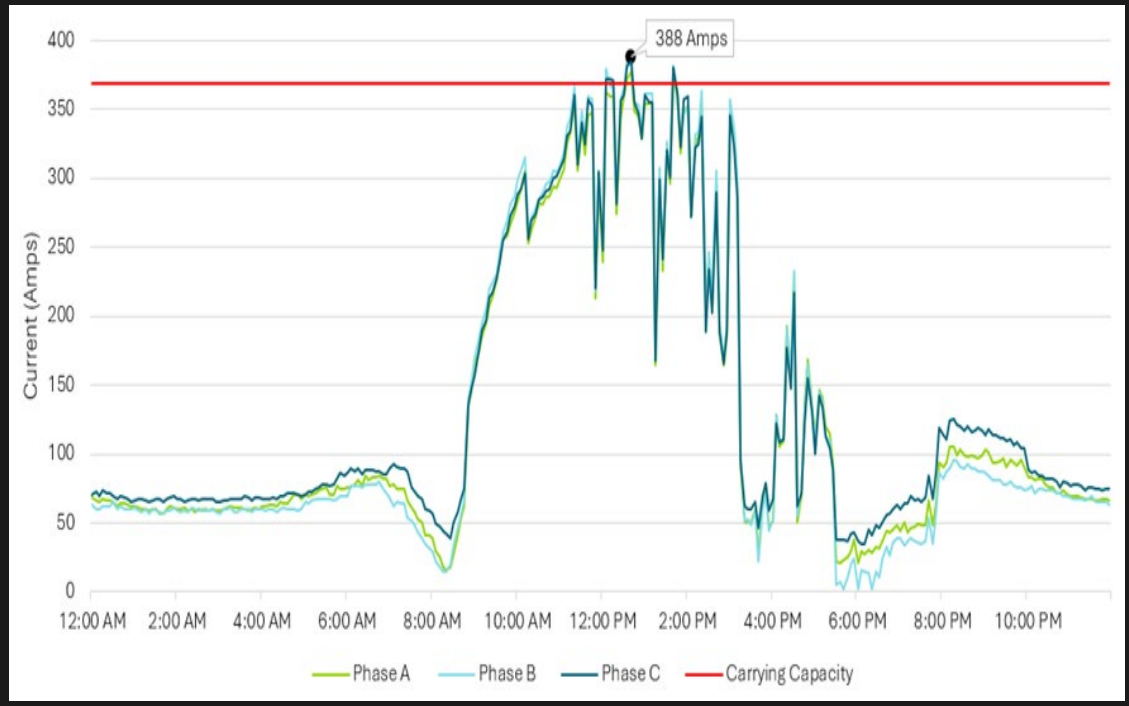
CASE STUDY 3

Avoiding Overloads and Deferring Capital Costs

- For one circuit (see Figure), M&C data showed the actual load being served ***exceeded*** the feeder peak load recorded on the books of the utility's planning department.
  - Overloads if gone undetected can cause equipment damage or outages.
- For another circuit, M&C data showed the actual load was ***lower*** than the official load on the books for one of the three phases.

Key information: costly upgrades were planned on this circuit and they were deferred with better information.

M&C Data



How Case Studies Can Benefit Regulators and Utilities

Prove reliability impacts

By quantifying avoided customer interruption minutes from specific investments.

Deliver actionable results

Within about a year of device commissioning—faster than SAIDI/SAIFI methods, which require years of data.

Provide comparison for pilots

Suitable for pilots and small deployments where statistical methods aren't feasible.

Reveal non-reliability benefits

Such as improved situational awareness and operational efficiency.

Capture lessons and opportunity

Enable regulators and utilities to assess both benefits and improvement opportunities, capturing lessons learned.

Applying Case Studies to Evaluate Broader Grid Modernization Investments

Case study methodology can be streamlined and scaled to apply to large grid modernization deployments

1. **Scan outage records** (or data mine device operation records) to estimate the percentage of successful versus unsuccessful operations

2. For each successful operation, **assign pre-defined estimates** of CMI savings
   - For example, assume the first automatic step of an ADA restoration would have taken as long as, and impacted as many customers as, the second (longer) step of restoration

3. Automated and AI-driven approaches can **further accelerate analysis**.
   - For instance, screen M&C device records for voltage or current violations, such as readings outside normal bounds or exceeding circuit capacity

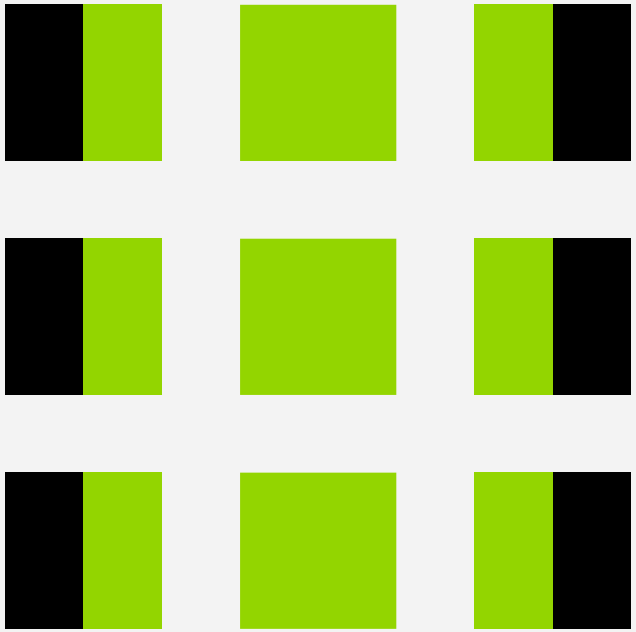
Guidehouse

Contact:

Bilhuda Rasheed

bilhuda.rasheed@guidehouse.com

(609)-968-1169



outwit complexity™