GRID MODERNIZATION INITIATIVE PEER REVIEW

GMLC 1.1 – Metrics Analysis

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Sheraton Pentagon City Hotel – Arlington, VA

GMLC1.1: Metrics Analysis
High Level Summary

GRID MODERNIZATION INITIATIVE
U.S. Department of Energy

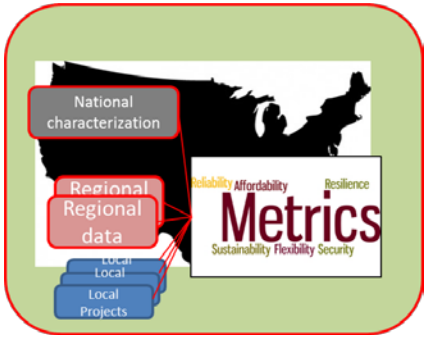
Project Objectives

Work directly with *strategic* stakeholders to confirm the usefulness of *new and enhanced existing* metrics that will guide grid modernization efforts to maintain and improve:

- **Reliability,**
- **Resilience,**
- **Flexibility,**
- **Sustainability,**
- **Affordability, and**
- **Security.**

Expected Outcomes

✓ Definition, Validation, and Adoption of metrics and analysis approaches by leading industry stakeholders and regional partners



Value Proposition

✓ Ensuring that all stakeholders understand how grid modernization investments will affect and benefit them

✓ Audiences: grid modernization technology developers and investors; utility and ISO technology adopters or sponsors; federal, state, and municipal regulatory or oversight authorities; **and electricity consumers** (i.e., the ratepayers)

PROJECT FUNDING			
	FY16 $	FY17$	FY18 $
total	1581	1584	1584

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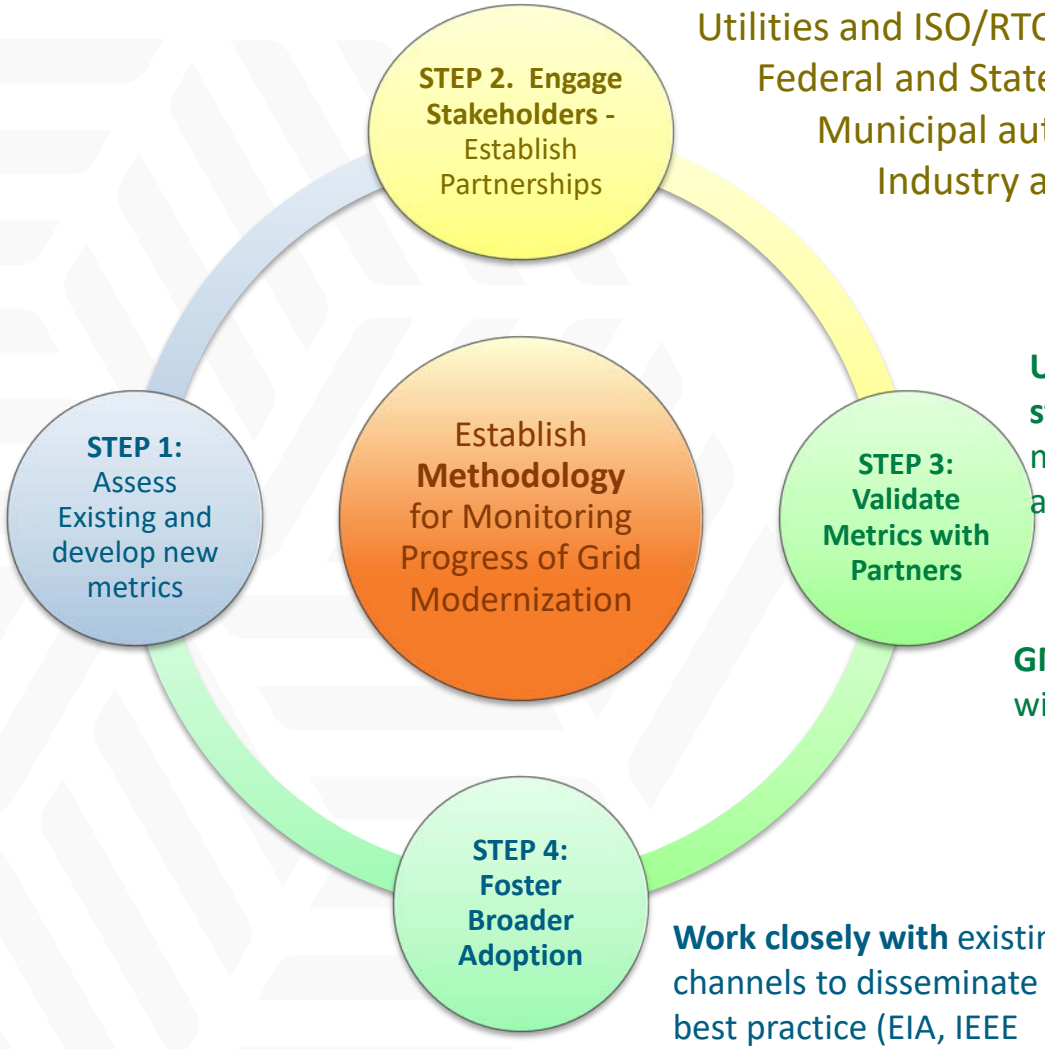
Approach



Utilities and ISO/RTOs
Federal and State regulators,
Municipal authorities,
Industry associations

Work closely with existing channels (EPA, EIA, IEEE standards, EPRI, EPA)

Collaborate with GMLC Portfolio researchers

Utilities and key stakeholders will test metrics for self-assessment

GMLC Regional Partners will apply metrics

Work closely with existing channels to disseminate best practice (EIA, IEEE standards, EPRI EPA)

GMLC1.1: Metrics Analysis
Approach

- **Formation of a strong lab team with senior staff**
  - **Joe Eto,** LBNL, Reliability lead, and +1

  - **Vanessa Vargas**, SNL and James **Kavicky**, ANL: Resilience leads

  - **Tom Edmunds**, LLNL: flexibility lead

  - **Garvin Heath**, NREL: Sustainability lead

  - **Dave Anderson**, PNNL: Affordability lead

  - **Steve Folga**, ANL: Security Lead

  - **Monisha Shah, Gian Porro**, NREL, stakeholder leads [e]

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Accomplishments to Date

- **Working partnerships**:
  - Reliability: NERC, APPA, ERCOT
  - Resilience: NOLA, 100 Resilient Cities
  - Flexibility: ERCOT, CAISO
  - Sustainability: EIA, EPA, ERCOT, PG&E, MN-PUC
  - Affordability: SCE, WA State UTC
  - Security: EEI, ComEd , Idaho Falls Power, SCE
- **Uptake of proposed metrics**
  - **EIA: submitted modifications to Form 861 and CBECS to reflect small DG generators** (May, 2018)
  - **APPA: ICE Calculator integrated into eReliability Tracker** (Dec., 2017)
  - **NOLA: building microgrid based on SNL's consequence-based approach and testing ANL's approach** (Nov., 2017)
- **Publications and information dissemination**
  - **Living document: Metrics Analysis: Reference Document, v2.1, May 2017**
  - *(Sustainability) Journal paper: CO_2 emission estimates from U.S. electricity: Potential for underestimation as grid modernizes* (submitted to Energy & Environmental Science, 8/14/18)
  - *(Resilience) Journal paper*: Development of Grid Resilience Metrics (submitted to IEEE Transaction on Industrial Informatics on Resilience in Energy Industries, 4/30/2018)
  - 3 technical reports:
    - Flexibility[1]
    - Affordability[2]
    - Resilience
- **Technical Workshops:** EPRI, CEC, SCE, FERC, IEEE-PES, WI-PUC, Smart Grid Northwest

[1] Edmunds, Thomas, Omar Alzaabi, and Andrew Mills, Flexibility Metrics to Support Grid Planning and Operations, *LLNL-CONF-738350, Siebel Energy Institute Future Markets Workshop*, Washington, DC, July 26, 2017.
[2] Anderson, David. 2018. *Electricity Affordability Metrics for the US*, National webinar of the Clean Energy States Alliance. June 14, 2018. PNNL-SA-135678.

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Accomplishments to Date

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Reliability

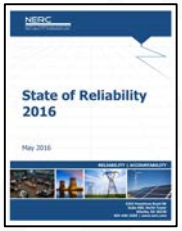
Lead: Joe Eto (LBNL)

Value: new metrics for reliability value-based planning and bulk power system assessment

New metrics for distribution that capture the economic cost of interruptions to customers

AMERICAN PUBLIC POWER ASSOCIATION
Powering Strong Communities

eliabilityTracker



New metrics for system impacts using North American Electric Reliability Corporation transmission/generation availability data

New probabilistic transmission planning metrics

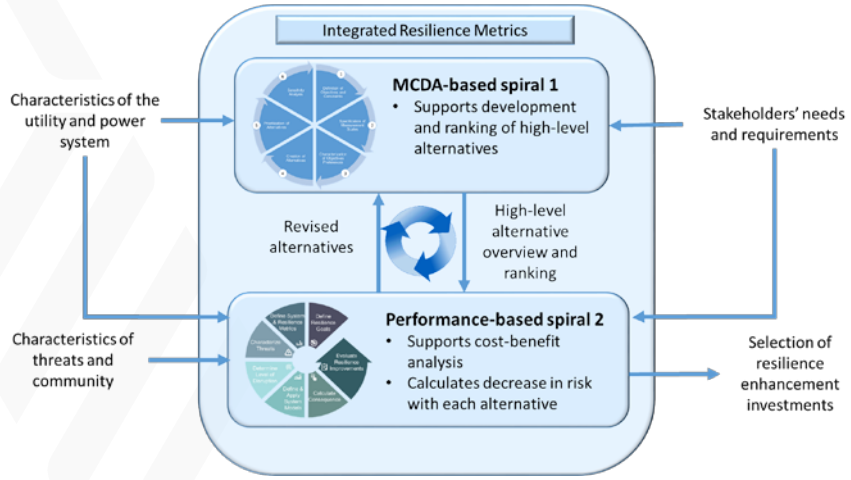
Accomplishments Year 1+2:

- APPA has incorporated ICE Calculator into eReliability Tracker (Dec., 2917)
- Membership in NERC Performance Analysis Subcommittee (responsible for preparing Annual State of Reliability report), (Jan., 2018)
- Demonstration prob. transmission planning metrics with ERCOT in progress

Resilience

Leads: Vanessa Vargas (SNL)
Jim Kavicky (ANL)

Value: create new metrics/process for resilience investment.



Accomplishments Year 1+2:

- Developed and documented performance-based resilience metric design for electric power infrastructure (2017)
- Document the methodologies and differences between performance-based and attribute-based approach (April, 2018)
- Engaged stakeholders and provided decision support in New Orleans (Nov., 2017)
- Designed economic metrics (performance based) to evaluate local resilience benefits
- Developed initial MCDA survey mechanism (March, 2018)

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Accomplishments to Date

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Flexibility

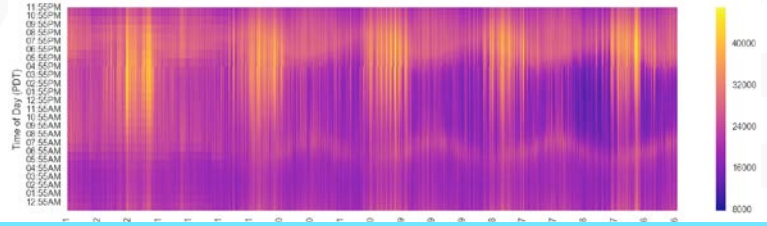
Lead: Tom Edmunds(LLNL)

Value: Develop and demonstrate usefulness of new flexibility metrics

Developed large set of candidate metrics that represent network properties of flexibility and lack of flexibility, engaging stakeholders to identify most useful metrics

Lagging indicators
- Requires statistical analysis of market and grid conditions to reveal curtailments, loss of load, or other economic impacts caused by insufficient flexibility.

Leading indicators
- Requires production cost simulations with weather and other uncertainties to design for sufficient flexibility.
- Use production cost models to examine tradeoffs between different sources of flexibility.



Accomplishments Year 1+2:
- Reduced 23 metrics down to 5 essentials (Feb. 2018)
- Wrote software to visualize data and reveal trends with 5-years of CAISO & ERCOT data (Jul. 2018)
- Presentations to CAISO & ERCOT (Nov., 2017, Apr., 2018)

Sustainability

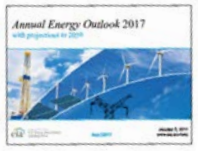
Lead: Garvin Heath (NREL)

Value: Identify needed improvements to GHG and water metrics and reporting

Evaluated current federal data products' ability to track changes in electric-sector CO_2 emissions that may result from future grid modernization; identified coverage gaps for certain energy sources anticipated to grow.

Completed survey of available water scarcity metrics.

Engaged with EIA and other stakeholders to improve federal data products' ability to track changes in electric-sector CO_2 emissions from distributed generation (DG).



EIA: AEO

EPA: eGRID

EIA: MER

EPA: GHGRP

Accomplishments Year 1+2:
- EIA survey teams are changing forms to better capture DG penetration in manufacturing (MECS), commercial (CBECS) and utility systems (861) (May, 2018)
- Demonstrated need for new *Relative Water Risk* metric (Jan, 2018)

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Accomplishments to Date

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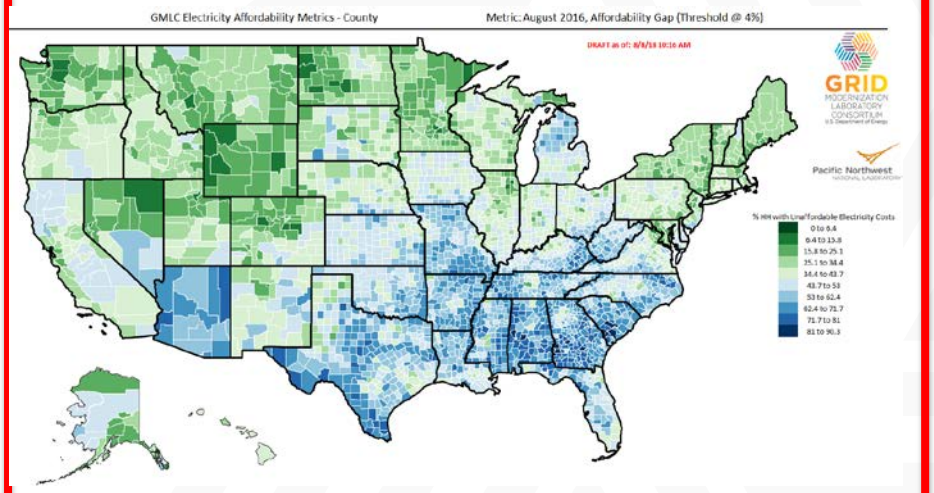
Affordability

Lead: Dave Anderson (PNNL)

Value: Establish new metrics based on electricity cost burden on consumers



Accomplishments Year 1+2:

- Electricity cost-burden metrics published (May, 2017)
- Alaska use case completed (May, 2018)
- National affordability dashboard (Jun., 2018)
- Macro affordability metrics developed (Apr., 2018)
- Continued engagement with data partners

Security

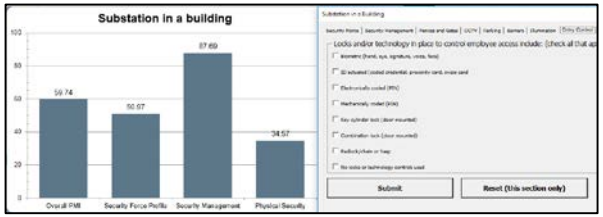
Lead: Steve Folga (ANL)

Value: Spur electric industry adoption of DHS Protective Measures Indices (PMI) for physical security metrics

Physical Security Metric:

- Measures the ability of electric sector to resist to disruptive events such as man-made attacks, etc.
- Accounts for existing protective measures at electric assets and their relative importance
- PMI approach has been applied by DHS at over 600 electric facilities
- PMI approach has been modified for use by Public Safety Canada and European Commission

Defines "security" as reducing the risk to critical infrastructure by physical means or defense cyber measures to intrusions, attacks, or the effects of natural or manmade disasters (PPD 21)



Accomplishments Year 1+2:

- Developed survey methodology for Protective Measurement Index (PMI) for physical security based on DHS data (Nov. 2016)
- Endorsed by DHS and utilities (ComEd, Idaho) (Feb., 2017)
- Completing initial version of survey tool (Excel) with dashboard capability (*June, 2018)*
- Continuing outreach to EEI and electric sector

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Institutionalization Pathways

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Reliability

Pathway: utility adoption
- Metrics: ICE calculator adopted in eReliability Tracker

Resilience

Pathway: city/utility adoption
- Metrics: adoption by NOLA to built Microgrids
- broad information dissemination through “100 Resilient Cities”

Flexibility

Pathway: adoption by RTOs
- Retrospective metrics: through publishing in IEEE
- Prospective metrics: by working with ISOs

Sustainability

Pathway: Data Collection Agency
- Metrics: GHG Emissions of DERs
- Adoption into EIA End-use (MECS and CBECS) and Utility Surveys (EIA-861)

Affordability

Pathway: State Energy Offices
- Dashboard offered by Energy offices

Security

Pathway: Utility Adoption
- Metrics: Physical Security Attributes
- PMI Dashboard offered by EEI to Member Utilities

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Next Steps and Future Plans

- Remainder of year 3 activities (expected end March 30, 2019)
  - Completing existing tools in all metrics areas
  - Transition of the Reference Document to more accessible document for targeted audience:
    - Into several documents with extended EXECUTIVE SUMMARY
    - Individual Metric subject discussions
    - Appendices with work products
  - Institutionalizing proposed metrics with
    - EIA: commercial buildings survey (CBECS): DG enhancements
    - CEC
    - EEI
    - IEEE
- Discussion with DOE on potential new/continued Metrics project with potential objectives
  - Enhance existing activities
  - Applying comprehensive set of metrics with partners to measure grid modernization progress

GMLC1.1: Metrics Analysis
Mapping Metrics to Decisions and Stakeholders

- Motivation
  - Improve understanding of the metrics being used to inform decision-making in the electric sector (e.g., capacity investment, retirement, operations, policy, regulatory RD&D)
  - Complements to-date stakeholder approach
  - Use to inform Year 3 work plans and longer-term DOE metrics and valuation activities
- Approach
  - Elicit directly from representative stakeholders: metrics of most interest in their decision-making (leverage GMLC1.2.4: valuation framework development)
  - Mine from publicly-available proceedings and identify set of metric used
- Initial Findings (*to be updated by August 27*)
  - Several decision frameworks (e.g., NY REV) document a diverse set of benefit and cost metrics to inform a variety of decisions —– *may not always be applied in practice*
  - *More variation in breadth occurs in case- or proceeding-specific examples examined to date*
  - ***Reliability and affordability metrics are commonly in use; sustainability (environmental, economic) appear less frequently; resilience still uncommon***
  - Continuing to extend literature review to cover a broader range of situations – e.g., performance regulation, transmission capacity investment, allocation of stranded costs associated with asset retirement