National Association of State Energy Officials

# NASEO-NARUC Webinar: Grid Investments for FERC Order 2222

January 27, 2022

Photo Courtesy of RL Martin

# About NASEO

- The only national non-profit association for the governor-designated energy officials from each of the 56 states and territories
- Serves as a resource for and about the State Energy Offices through topical committees, regional dialogues, and informational events that facilitate peer learning, best practice sharing, and consensus building
- Advances the interests of the State and Territory Energy Offices before Congress and the Administration
- Learn more at www.naseo.org

# NASEO Programs and Priorities

Buildings

Electricity

Climate

Financing

Workforce

Resilience

Equity

Planning

Innovation

Transportation

Solar

Policy

## ABOUT NARUC

- The National Association of Regulatory Utility Commissioners (NARUC) is a non-profit organization founded in 1889.
- Our Members are the state utility regulatory Commissioners in all 50 states & the territories. FERC & FCC Commissioners are also members. NARUC has Associate Members in over 20 other countries.
- NARUC member agencies regulate electricity, natural gas, telecommunications, and water utilities.

## ABOUT NARUC'S CENTER FOR PARTNERSHIPS & INNOVATION

- Grant-funded team dedicated to providing technical assistance to members.
- CPI identifies emerging challenges and connects state commissions with expertise and strategies to inform their decision making.
- CPI builds relationships, develops resources, and delivers trainings.

Regularly updated CPI fact sheet with recent publications & upcoming events under Quick Links at:

https://www.naruc.org/cpi-1/

**NARUC Center for Partnerships & Innovation**

***Current Activities***

**Recently Released Publications**

- Public Utility Commission Stakeholder Engagement: A Decision-Making Framework (Jan. 2021)
- Private, State, and Federal Funding and Financing Options to Enable Resilient, Affordable, and Clean Microgrids (Jan. 2021)
- User Objectives and Design Options for Microgrids to Deliver Reliability and Resilience, Clean Energy, Energy Savings, and Other Priorities (Jan. 2021)
- Understanding Cybersecurity for the Smart Grid: Questions for Utilities (Dec. 2020)
- Artificial Intelligence for Natural Gas Utilities: A Primer (Oct. 2020)
- Cybersecurity Tabletop Exercise Guide (Oct. 2020)

**Forthcoming Resources**

- NARUC-NASEO Task Force on Comprehensive Electricity Planning Blueprint for State Action and related resources
- A Guide for Public Utility Commissions: Recruiting and Retaining a Cybersecurity Workforce
- Cybersecurity Partnerships and Information Sharing
- Approaches to Economic Development in Decision-Making for Public Utility Commissions
- Regulators' Financial Toolbox on Advanced Metering Infrastructure

**Recent Events**

- Integrated Distribution Systems Planning: NARUC partnered with DOE national laboratories to deliver a virtual training in Oct. 2020 on forecasting, control and automation, metrics, resilience, PUC practices, and more. The next session will be held for Western state officials beginning Feb. 26, 2021. *Contact Dominic*
- NARUC-NASEO Task Force on Comprehensive Electricity Planning. Resources developed by the Task Force will be shared in a virtual workshop on Feb. 11, 2021. Read the Task Force fact sheet. *Contact Danielle*
- National Council on Electricity Policy (NCEP). Presentations from NCEP's December 2020 Annual Meeting are available as well as an updated Transmission and Distribution Resource Catalog. *Contact Kerry*
- Carbon Capture, Utilization and Storage Workshop Webinar Series. Recordings are available from a Western Interstate Energy Board- and NARUC-hosted six-part webinar series in Sept. and Oct. 2020. *Contact Kiera*

**Available Virtual Learning Opportunities**

- Cybersecurity Training for State Regulatory Commissions: NARUC is hosting a virtual cybersecurity training on Feb. 23-25, 2021. *Contact Ashton*
- National Council on Electricity Policy (NCEP). Register for a special session on Exploring Optimization through Benefit-Cost Analysis on Feb. 25, 2021. Learn More about NCEP. *Contact Kerry*
- Emergency Preparedness, Recovery and Resilience Task Force: The EPRR Task Force will meet Feb. 5, 2021 to discuss BRIC funding with FEMA. *Contact Will*
- Commission Staff Surge Calls. NARUC hosts quarterly calls on which commission staff discuss how different states approach emerging issues in electricity policy. The next call will be held in early **Mar., 2021**. Summaries from past calls are available. *Contact Kiera*
- Innovation Webinar Series. NARUC hosts monthly webinars for members and the public. ***Mar. 11:*** Data for the Public Interest: Empowering Energy Equity. ***Apr. 15:*** Initiative on Cybersecurity in Solar Projects. ***May. 13:*** Staffing the Evolving PUC Workforce. Register and find recordings of past events. *Contact Dominic*

**Join us!** NARUC hosts four working groups for members:

- Performance-Based Regulation. *Contact Kerry*
- Electric Vehicles. *Contact Jasmine*
- Microgrids. *Contact Kiera*
- Grid-Interactive Efficient Buildings. *Contact Danielle*

www.naruc.org/cpi

# NASEO NARUC DER Integration and Compensation Initiative

Convene and support state members to understand impact of their decision making related to the connection, operation, and compensation of DERs---within the distribution grid, bulk power system, and wholesale energy markets.

NARUC and NASEO will provide information, tools, access to experts, and peer sharing opportunities that assist members with FERC Order 2222 implementation in RTO/ISO regions and State oversight of transmission-distribution-customer (TDC) coordination outside of RTO/ISO regions.

**Objectives:**

- Inform key state decision makers
- Raise and evaluate risks and opportunities of different decision options
- Bring different perspectives to the table

**Advisory Group:**

An advisory group of 10 NARUC and NASEO members representing diverse regional perspectives will guide the project.

# Zoom Housekeeping

Zoom Webinar

All participants are muted, and the video is off.

During the presentation, please add questions into the Q&A box or the chat.

# Grid Investments to Support FERC Order 2222

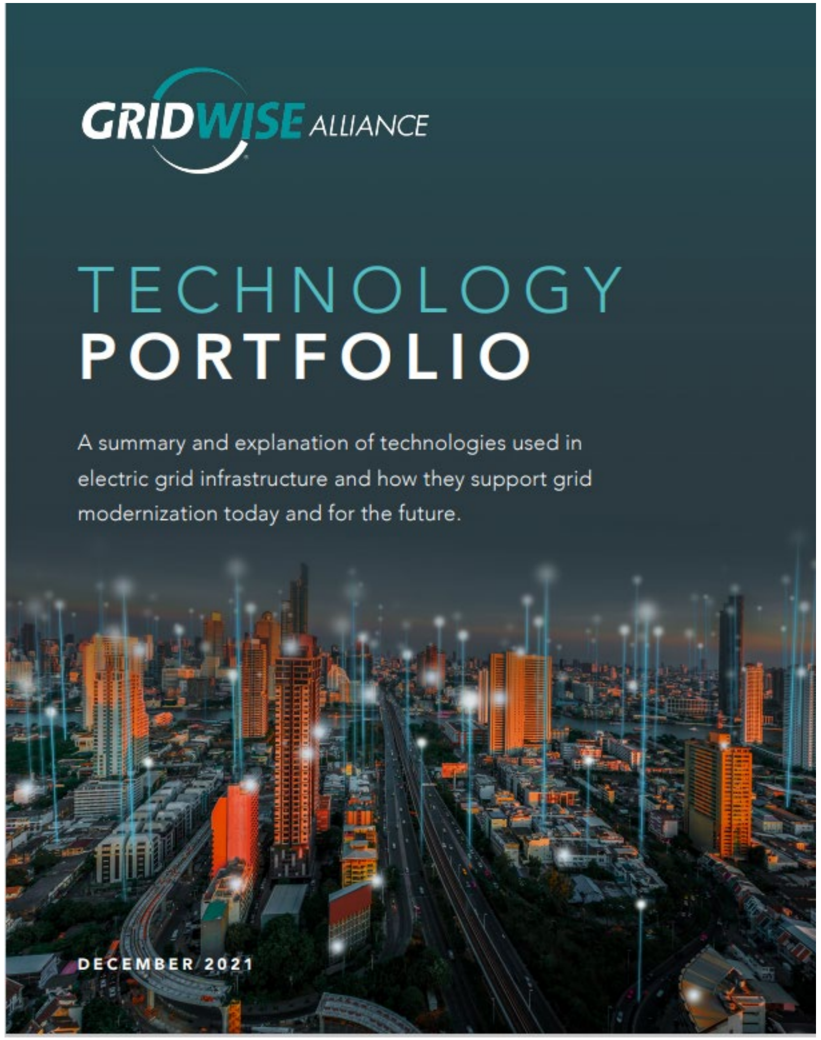
**How Distribution Utilities Will Deploy Grid Technologies to Enable Consumers to Participate in Emerging DER Aggregation Markets**

**NARUC-NASEO DISCUSSION**

**January 27, 2023**

# About the GridWise Alliance...

AEP AMERICAN ELECTRIC POWER
Anterix
aps
AVEVA
atlantic city electric. An Exelon Company
BEC BANDERA ELECTRIC COOPERATIVE, INC.
BGE An Exelon Company
BLACK & VEATCH
BONNEVILLE POWER ADMINISTRATION
borsetta
California ISO Shaping a Renewed Future
CenterPoint. Energy
COGNITE
ComEd An Exelon Company
conEdison
DELL Technologies
delmarva power. An Exelon Company
DENTONS
DNV
Dominion Energy
DUKE ENERGY.
EPRI ELECTRIC POWER RESEARCH INSTITUTE
ELECTRIQ POWER
Exelon Utilities
EY Building a better working world
FPL.
GE
GW LAW
GRIDBRIGHT The Grid Management Specialists
Hitachi Energy
Guidehouse
IBM
intel
Itron
Krevat Energy Innovations Clean energy. Clean transportation
Landis+Gyr
LINEVISION
MISO
nationalgrid
NEW YORK INDEPENDENT SYSTEM OPERATOR
New York Power Authority
ONCOR
opusone solutions
ORACLE
Pacific Northwest NATIONAL
Pepco Holdings. An Exelon Company
PECO. An Exelon Company
PGE
Qubitekk
Rappahannock Electric Cooperative A Touchstone Energy Cooperative
Schneider Electric
Sentient ENERGY A KOCH ENGINEERED SOLUTIONS COMPANY
SIEMENS energy
TRC
UNITED POWER Your Touchstone Energy Cooperative
Urbint
Utilidata
Van Ness Feldman
VEIR
vermont electric power company VELCO




GWA_GridWiseTechnologyPortfolio_Final.pdf

## DESIRED OUTCOMES

- DECARBONIZED POWER SUPPLY
- AFFORDABLE ENERGY
- BENEFICIAL ELECTRIFICATION
- RELIABLE DELIVERY
- RESILIENT SYSTEM
- CUSTOMER CHOICE

## Functional Areas

- Integrated Planning
- System Visibility
- Real-time Operation
- Consumer & Energy Services Engagement
- Emerging Grid Architecture

## Technology Examples

- Automatic DER interconnections
- Interdependency coplanning
- Integrated distribution and transmission planning
- Synchrophasors
- Advanced distribution management systems
- Volt-Var optimization
- Home energy management
- Distributed energy resource management systems
- Networked microgrids
- Advanced metering infrastructure systems

## Enabling Technologies

- Quantum computing
- Internet of Things
- Physical & cybersecurity protocols
- Open source and data standards
- Blockchain
- Data science
- Machine learning
- Cloud Services

GRIDWISE ALLIANCE

# EXAMPLE TECHNOLOGY | Advanced Metering Infrastructure

## WHAT IT IS?

Advanced metering infrastructure (AMI) refers to a measurement and data collection system that includes a 'smart' meter at the customer site, the communication network transmitting and receiving data to and from the electric service provider, and the management system used by the electric service provider to operate the grid and/or send signals to the customer meter. Fundamentally AMI provides a mechanism for two-way electricity flow and communication on the distribution system.

## WHY IS IT ESSENTIAL FOR A MODERN GRID?

Smart meters are becoming more intelligent and capable of supporting the expansion of distributed energy resources. Technology advances are increasingly allowing AMI systems to work seamlessly with other grid edge devices, such as EV chargers and solar inverters, to maintain grid stability, efficiency, and flexibility. In addition to measuring energy use and voltage, the next generation of AMI systems use machine learning and analytics to respond to anomalies and status changes deeper into the distribution grid in real time to better manage capacity and prevent outages. At the same time they provide energy consumers with the insights to respond to variable pricing programs and incentives and support a decentralized and digitized grid.

An advanced meter is installed at a home.
Source. U.S. DOE. AMI and Customer Systems.

## WHERE IS IT LOCATED?

The foundational component of AMI is the meter. Smart meters are installed at the customer site or where there is an end use requiring electricity from the grid.

## HOW MATURE IS THE TECHNOLOGY?

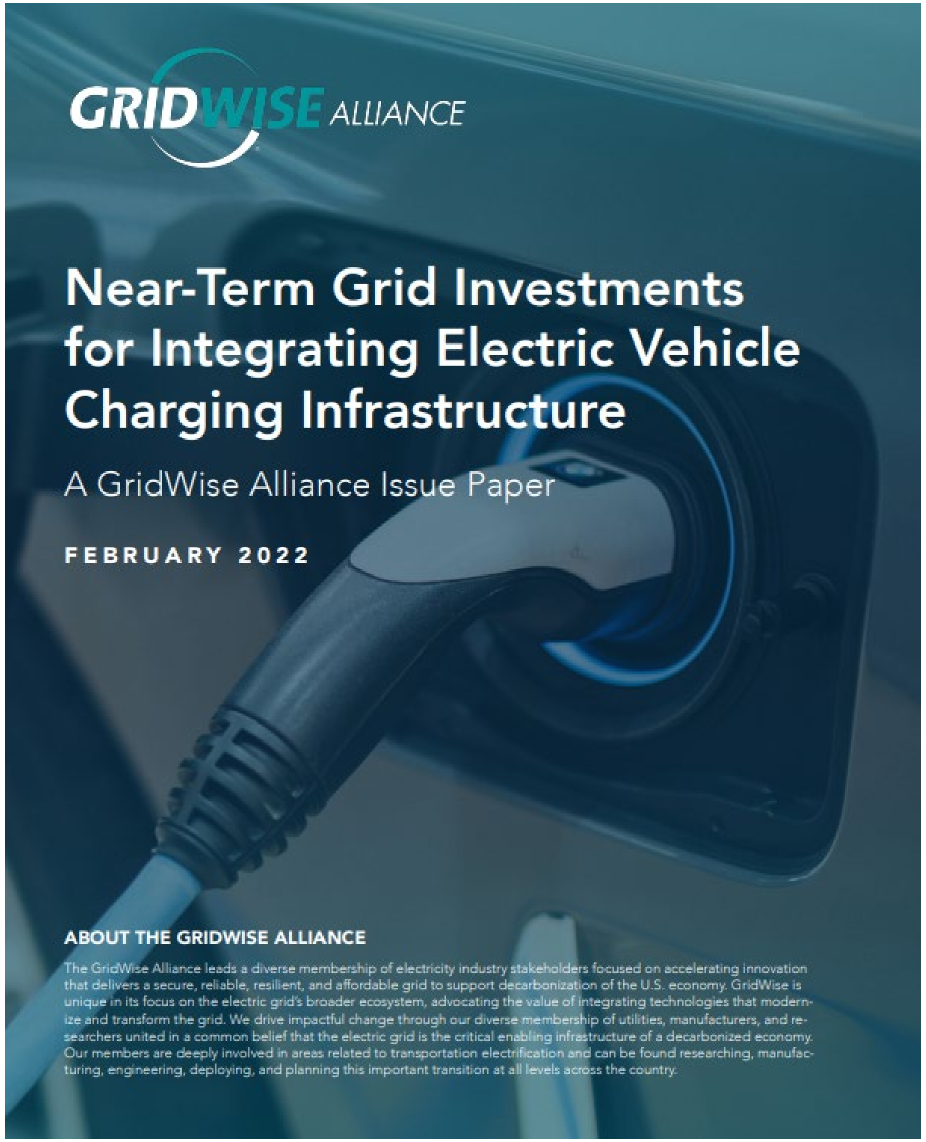
**Widely deployed** | The Smart Grid Investment Grant (SGIG) Program invested more than $5 billion in the deployment of AMI and customer systems in 2009. This funding supported widespread deployment of AMI. Today more than half of all states have achieved a rollout greater than 50% and about 60 investor-owned utilities have fully deployed smart meters.

## EXAMPLE: CASE STUDY

Supported by the Smart Grid Investment Grant (SGIG), Pepco installed over 277,000 smart meters in the Washington, DC territory through 2013. Benefits realized as a result of the AMI deployment significant include utility and customer savings and reliability improvements. See the project description and report for more information.

## FOR MORE INFORMATION

- U.S. DOE. Modern Distribution Grid (DSPx). Volume II. November 2019.
- U.S. DOE. Advanced Metering Infrastructure and Customer Systems. September 2016.
- New Mexico Grid Modernization Advisory Group. Draft Whitepaper: Investment in Advanced Meter Infrastructure. January 2021.



GRIDWISE ALLIANCE

# Near-Term Grid Investments for Integrating Electric Vehicle Charging Infrastructure

A GridWise Alliance Issue Paper

FEBRUARY 2022

**ABOUT THE GRIDWISE ALLIANCE**

The GridWise Alliance leads a diverse membership of electricity industry stakeholders focused on accelerating innovation that delivers a secure, reliable, resilient, and affordable grid to support decarbonization of the U.S. economy. GridWise is unique in its focus on the electric grid's broader ecosystem, advocating the value of integrating technologies that modernize and transform the grid. We drive impactful change through our diverse membership of utilities, manufacturers, and researchers united in a common belief that the electric grid is the critical enabling infrastructure of a decarbonized economy. Our members are deeply involved in areas related to transportation electrification and can be found researching, manufacturing, engineering, deploying, and planning this important transition at all levels across the country.

[GWA_22_NearTermGridInvestmentsEVChargingInfra_Final.pdf (gridwise.org)]

## Real-time Operation

**BACKGROUND**

At both the transmission and distribution level, the grid needs systems and technologies that can act automatically on system data and deliver the increased load associated with growing EV adoption. Electric vehicles will be a source of two-way power flow on the grid once vehicle-to-grid functionality is implemented and upgrades will need to occur at the substation level and throughout the system to prepare the grid for this reverse power flow. Several technologies available today can monitor and respond to grid conditions, especially important as EVs continually connect and disconnect from the grid, and are capable of immediately correcting operational problems related to voltage, current, frequency, and outages.

| NEAR-TERM INVESTMENT NEED | REASONING |
|---|---|
| Voltage regulation technologies | Voltage regulation technologies offer greater visibility and control into real-time, localized usage of electric load. Electric load and quality fluctuate during EV charging or when vehicle-based stored energy is passed back to the grid. Proper siting of this technology allows the utility insights into the behaviors and patterns of an EV charging station while managing power quality. Smart inverters are one example of a voltage regulation technology, though they also provide other services including frequency regulation and DC-AC current conversion. Another type of voltage regulation technology is volt-VAR regulation, which regulates and optimizes power flow on the distribution system. |
| Energy storage systems | Energy storage, when co-located with EV charging infrastructure, could play a role in mitigating peak electricity demand of highway charging stations and ultimately lower the cost of charging for consumers. It may not be necessary to have storage at all charging sites however, so supporting early planning efforts around charging infrastructure and technology needs is important. |
| Distributed energy resource management systems (DERMS) | DERMS can both monitor and control DERs placed throughout the distribution system, such as EVs. At minimum, DERMS provide a way to make the load from EVs visible to the broader system. Fully implemented DERMS will be a key component to supporting advanced vehicle-to-grid functionality. |

# Next Tech Portfolio White Paper: Grid Investments to Enhance Resilience

SEC. 40101. PREVENTING OUTAGES AND ENHANCING THE RESILIENCE OF THE ELECTRIC GRID

Funding can be used for:

(A) weatherization technologies and equipment;
(B) fire-resistant technologies and fire prevention systems;
(C) monitoring and control technologies;
(D) the undergrounding of electrical equipment;
(E) utility pole management;
(F) the relocation of power lines or the reconductoring of power lines with low-sag, advanced conductors;
(G) vegetation and fuel-load management;
(H) the use or construction of distributed energy resources for enhancing system adaptive capacity during disruptive events, including— (i) microgrids; and (ii) battery-storage subcomponents;
(I) adaptive protection technologies;
(J) advanced modeling technologies;
(K) hardening of power lines, facilities, substations, of other systems; and
(L) the replacement of old overhead conductors and underground cables.

# Grid Investments to Support FERC Order 2222

## How Distribution Utilities Will Deploy Grid Technologies to Enable Consumers to Participate in Emerging DER Aggregation Markets

**White Paper Draft Outline**

- What is DER aggregation?
- What is FERC Order No. 2222?
  - Metering and Telemetry requirement
- What grid technologies will enable participation in wholesale markets?
  - Description of how DER aggregation physically happens, how market signals are conveyed, etc.
  - Technology one-pagers
- Other considerations

# Key FERC 2222 Requirements & Their Implications

1. Prohibits double-counting & double-rewarding DERs for same response:
   - LSE must provide ISO with wholesale energy market 1) load forecast & 2) demand bid that are <u>net</u> of aggregated DERs
   - Much more sophisticated forecasting algorithms
   - Communications w/ aggregators re bids offered & accepted
2. DER participation in ISO markets is at wholesale prices, so:
   - Adjusted retail bills, net of aggregated DERs

# Key FERC 2222 Requirements & Their Implications (cont.)

3. Items 1 & 2, together, likely require:
   - Submeters for distributed generation & storage
   - Estimated response by AMI-based M&V algorithms for demand response & EVs
4. Capacity market rules require DERs to bid into wholesale energy market
   - DERs can't offer to commit same capacity in both wholesale market & distribution level
   - Inhibits utility from <u>relying</u> on them to provide local, distribution services
   - Cannot locally re-dispatch DERs with bids not accepted at wholesale w/o disrupting LSE load forecast & bid quantities

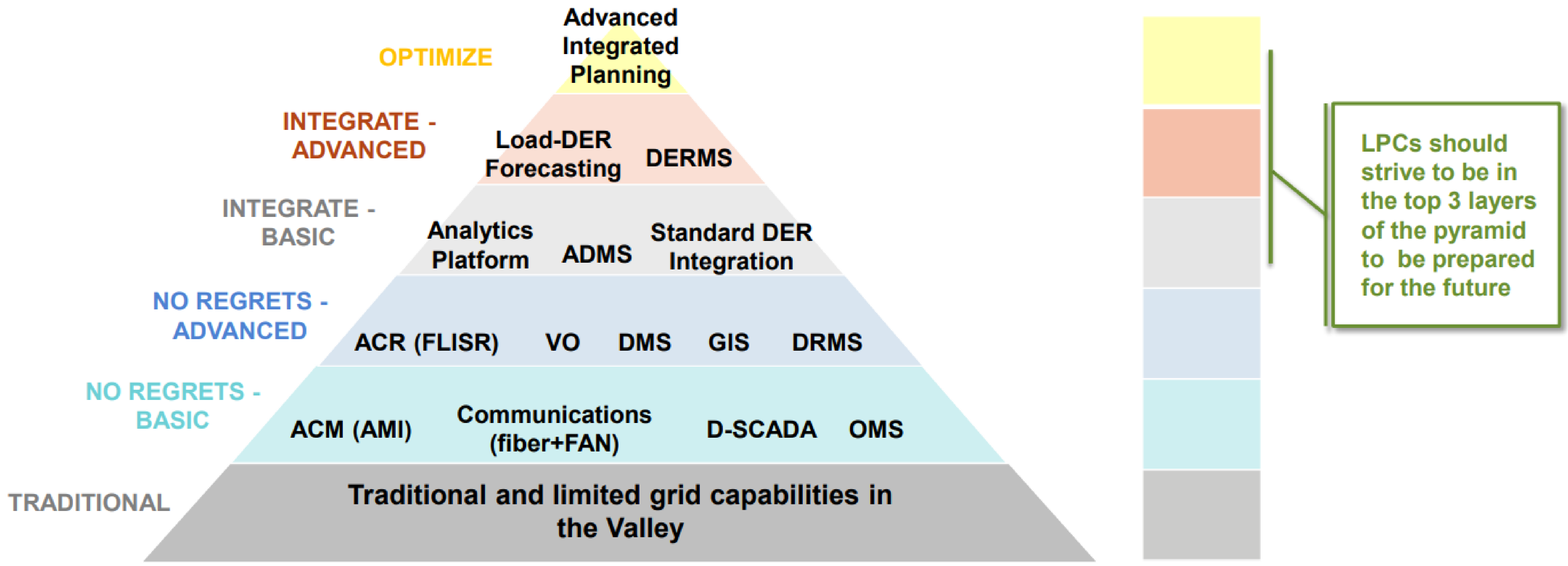
# Accommodating High Penetrations of DERs and Using Them to Provide Distribution Services is Technically Complex

- Requires much more sophisticated, real-time analysis of impacts & mitigation strategies

- Significant utility investment in advanced smart grid apps will be needed

# LPC Capabilities Pyramid: Where are We Now?

Each layer can build on the capabilities from the layer underneath: LPCs should move up over time.




Credit: Tennessee Valley Authority

# Grid Technologies and Capabilities

| Capabilities (Technology) | Deployed By | Rationale for Capability |
|---|---|---|
| **Advanced Integrated Planning** | Distribution Utility | Needed (eventually) to evaluate and leverage impact of DERs on distribution infrastructure planning, both in terms of avoided infrastructure as well as needed investments – to take full advantage of DERs and manage DER impacts |
| **Load-DER Forecasting** | Distribution Utility | LSE needs advanced load forecast that is gross (not net) of aggregated DERs, because including them in LSE demand bid is double counting (and double rewarding) with aggregator bid into wholesale energy market – both prohibited by FERC 2222 (immediate need) |
| **DER Management System (DERMS)** | Aggregator | Platform to dispatch each individual DER (immediate need by aggregator, but not utility)<br>Utility will (eventually) need to integrate its own platform with the aggregators' in order to use DERs for distribution-level services |
| **Analytics Platform** | Distribution Utility | Needed to optimize use of DERs for supplying distribution-level services; fed by data and applications from ADMS (see below) |
| **Advanced Distribution Management System (ADMS)** | Distribution Utility | ADMS is needed (eventually, as penetrations and impacts become significant) to host applications needed to 1) collect data and evaluate and mitigate DER impacts on power flows, and 2) utilize DERs for distribution benefits. Examples include:<br>• GIS (see below)<br>• real-time use of AMI and DER submeter data to estimate DER loads and reductions<br>• distribution sensor data collection/management & state estimation to support various apps, e.g.<br>- DERMS dispatch of DERs for distribution services (see above)<br>- fault location, isolation, and reconfiguration (FLSIR; see below)<br>- voltage optimization (VO; see below) |

# Grid Technologies and Capabilities

| Standard DER Integration | Distribution Utility | Offline interconnection studies are the primary tool used (today) for gensets, solar, batteries. Note that demand response and EV charging do not require such studies (today). |
|---|---|---|
| ACR??? Fault location, isolation, & reconfiguration (FLSIR) | Distribution Utility | Advanced capabilities beyond standard FLISR needed (as DER penetrations increase) to:<br>• assess and account for DER contributions to fault currents (mid-term)<br>• take advantage of DER capabilities to assist with outage management (eventually) |
| Voltage Optimization VO | Distribution Utility | Needed to manage voltages within service limits due to power injections (gensets, PV), withdrawals for charging (batteries & EVs), sudden load switching (demand response, EVs) |
| Distribution Management System (DMS) | Distribution Utility | Foundational capability for remote management and sensing of substations (needed as foundation for ADMS; see above) |
| GIS | Distribution Utility | GIS capabilities (eventually) must include ability to locate DERs on network |
| DRMS | Distribution Utility | (Included in aggregator's DERMS; not needed by utility other than to coordinate use of its own demand response assets with aggregated DERs) |
| DER submetering | Distribution Utility | FERC 2222 likely requires separate meter for distributed generation and storage |
| Advanced Retail Billing | Distribution Utility | Retail bills must be adjusted for net of wholesale market participation of aggregated DERs to avoid double rewarding (based on submetering and demand response M&V algorithms) |
| ACM??? Automated Metering Infrastructure (AMI) | Distribution Utility | • Interval customer net load data needed to assemble LSE forecasts adjusted for DERs (immediate)<br>• (Eventually) Higher bandwidth needed to support real-time acquisition of total and DER submeter data for real-time applications (see ADMS, above) |
| Communications (fiber+FAN) | Distribution Utility | Foundational capability for comms with ISO, substations, aggregators |
| D-SCADA | Distribution Utility | Foundational capability for DRMS, ADMS |
| OMS | | N/A (unrelated to DER aggregations) |
| Traditional and limited | | |

# Questions & Suggestions

# Background Slides

# EXAMPLE TECHNOLOGY | Advanced Metering Infrastructure

## WHAT IT IS?

Advanced metering infrastructure (AMI) refers to a measurement and data collection system that includes a 'smart' meter at the customer site, the communication network transmitting and receiving data to and from the electric service provider, and the management system used by the electric service provider to operate the grid and/or send signals to the customer meter. Fundamentally AMI provides a mechanism for two-way electricity flow and communication on the distribution system.

## WHY IS IT ESSENTIAL FOR A MODERN GRID?

Smart meters are becoming more intelligent and capable of supporting the expansion of distributed energy resources. Technology advances are increasingly allowing AMI systems to work seamlessly with other grid edge devices, such as EV chargers and solar inverters, to maintain grid stability, efficiency, and flexibility. In addition to measuring energy use and voltage, the next generation of AMI systems use machine learning and analytics to respond to anomalies and status changes deeper into the distribution grid in real time to better manage capacity and prevent outages. At the same time they provide energy consumers with the insights to respond to variable pricing programs and incentives and support a decentralized and digitized grid.

An advanced meter is installed at a home.
Source. U.S. DOE. AMI and Customer Systems.

## WHERE IS IT LOCATED?

The foundational component of AMI is the meter. Smart meters are installed at the customer site or where there is an end use requiring electricity from the grid.

## HOW MATURE IS THE TECHNOLOGY?

**Widely deployed** | The Smart Grid Investment Grant (SGIG) Program invested more than $5 billion in the deployment of AMI and customer systems in 2009. This funding supported widespread deployment of AMI. Today more than half of all states have achieved a rollout greater than 50% and about 60 investor-owned utilities have fully deployed smart meters.

## EXAMPLE: CASE STUDY

Supported by the Smart Grid Investment Grant (SGIG), Pepco installed over 277,000 smart meters in the Washington, DC territory through 2013. Benefits realized as a result of the AMI deployment significant include utility and customer savings and reliability improvements. See the project description and report for more information.

## FOR MORE INFORMATION

- U.S. DOE. Modern Distribution Grid (DSPx). Volume II. November 2019.
- U.S. DOE. Advanced Metering Infrastructure and Customer Systems. September 2016.
- New Mexico Grid Modernization Advisory Group. Draft Whitepaper: Investment in Advanced Meter Infrastructure. January 2021.

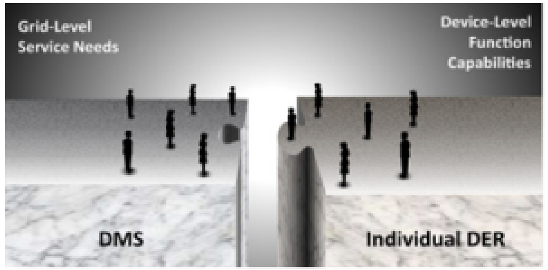
**EXAMPLE TECHNOLOGY** | Distributed Energy Resource Management Systems

## WHAT IT IS?

Distributed Energy Resource Management System (DERMS) is a software solution that incorporates a range of operations including asset repository, forecasting, and dispatch. It is particularly useful for adjusting the production and/or consumption levels of disparate DER directly or through an aggregator. DERMS connect individual distributed energy resources (DERs) and help to aggregate and optimize their operation based on grid conditions and feedback from the distribution management system (DMS).

## WHY IS IT ESSENTIAL FOR A MODERN GRID?

An increasing number of DERs are rapidly connecting to the grid, and ways to manage individual DERs is critical to operating and monitoring the grid. DERMS monitor and control DERs placed throughout the distribution system, from the substation to the individual home or device and provide a way to connect individual DERs to the broader system.




The gap addressed by DERMS.
Source. EPRI. Understanding DERMS.

## WHERE IS IT LOCATED?

DERMS software is typically in a centralized utility real-time operations center.

## HOW MATURE IS THE TECHNOLOGY?

**Ready for scaling** | Standardization efforts are underway by research groups, and as of 2021 there have been a number of larger scale utility RFPs in the multi-million dollar range for rolling out non-pilot DERMS.

## EXAMPLE: PILOT PROGRAM

Pacific Gas & Electric completed a pilot program in San Jose in 2019 with DERMS software. Funded by the Electric Program Investment Charge (EPIC) charge, it connected two aggregator platforms and includes up to 150 residential and 10 commercial customers with solar arrays and energy storage systems. See PGE's EPIC 2018 Annual Report, for more information.

## FOR MORE INFORMATION

- U.S. DOE. Modern Distribution Grid (DSPx), Volume II. November 2019.
- Electric Power Research Institute. Understanding DERMS. July 2018.

# EXAMPLE TECHNOLOGY | Advanced Distribution Management System

## WHAT IT IS?

An advanced distribution management system (ADMS) is a software platform that digitizes and integrates numerous utility operational and monitoring systems including SCADA systems, outage management systems (OMS), existing distribution management systems (DMS), and workforce management and data visualization. It provides a comprehensive digital representation of the condition of the distribution network and supports optimal management of DERs and integration with utility tools for billing and data collection.

## WHY IS IT ESSENTIAL FOR A MODERN GRID?

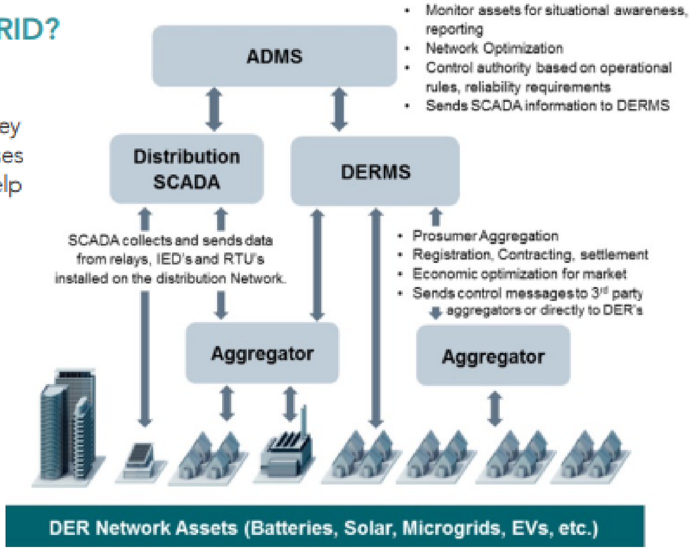
With the increase in DERs connecting the the grid, from solar PV to electric vehicles, ADMS systems are considered increasingly essential to the future of the utility business. They support a utility in transitioning from manual, paper processes to digitized, automatic process that use real-time data to help better integrate renewables and improve grid efficiency.

## WHERE IS IT LOCATED?

ADMS is not a physical entity but a software platform that is installed and run from a utility control center.

## HOW MATURE IS THE TECHNOLOGY?

**Mid-stage development, ready for scaling** |
While early pilots of ADMS date back over a decade, the technology is still evolving and is only lightly adopted. Research into ADMS systems by national laboratories is underway and vendors continue to develop products for adoption by utilities.




ADMS has a complete view of the operating network.
Source: Powergrid International.

## EXAMPLE: RESEARCH TEST BED

For several years now, the National Renewable Energy Laboratory (NREL) has operated a test bed to serve as a vendor-neutral evalutation platform for advanced grid controls implemented on ADMS platforms. Multiple use cases have gone through evaluation, and it continues to research ADMS capabilities. See more on this effort here.

## FOR MORE INFORMATION

- U.S. DOE. Voices of Experience: Insights into Advanced Distribution Management Systems. 2015.
- National Renewable Energy Laboratory. Advanced Distribution Management Systems. 2020.
- U.S. DOE. Advanced Distribution Management Systems Testbed Development. 2020.