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EXECUTIVE SUMMARY

# Turning Behind-the-Meter DERs into Grid Assets: Opportunities, Challenges, and Principles for Success

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T&D World Webinar:
Turning Behind-the-Meter DERs Into Grid Assets

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## KEY TAKEAWAYS

- Due to advances in technology, the DER landscape is evolving rapidly in terms of price, performance, and resulting adoption.
- EV growth brings opportunities for and challenges to electricity infrastructure.
- There are five core principles for successful DER management.
- When applying machine learning, AI, and automation in the DER management space, most work will fall under artificial narrow intelligence.
- Guardrails are in development for AI risk management.
- Itron focuses on six themes in its approach to DER management.

# Turning Behind-the-Meter DERs into Grid Assets: Opportunities, Challenges, and Principles for Success

## OVERVIEW

Distributed energy resources (DER) adoption is growing exponentially. Utilities are already rethinking how they procure power and operate the grid to prepare for continued rapid growth in the industry. Integrating DERs at scale will require the adoption of an array of new and fundamentally different technologies, significantly altering the utility-customer relationship.

When considering DER management solutions, there are five core principles to follow for success, including automation and flexibility, which are key requirements for utilities designing grid operation solutions for the future. These principles focus on the solution architecture, customer choice, security, the grid's future state, and automation.

Itron's approach to DER management emphasizes open standards, security first, flexible connectivity, distributed intelligence, multiple approaches to ADMS integration, and auditable ANI.

## CONTEXT

Mike Ting discussed challenges created by high DER adoption, the five core principles for successful DER management, how automation can be applied to support DER adoption today and moving forward, and Itron's approach to DER management.

## KEY TAKEAWAYS

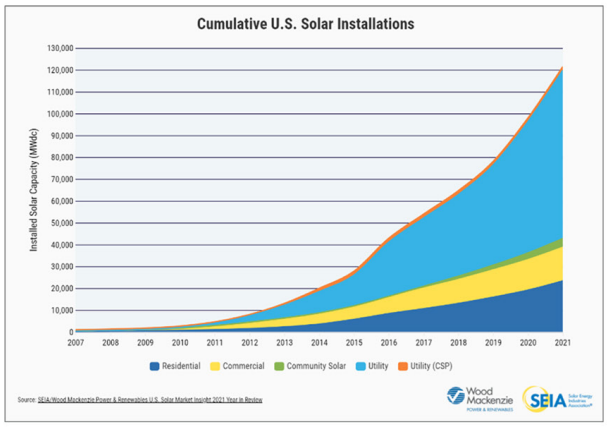
**Due to advances in technology, the DER landscape is evolving rapidly in terms of price, performance, and resulting adoption.**

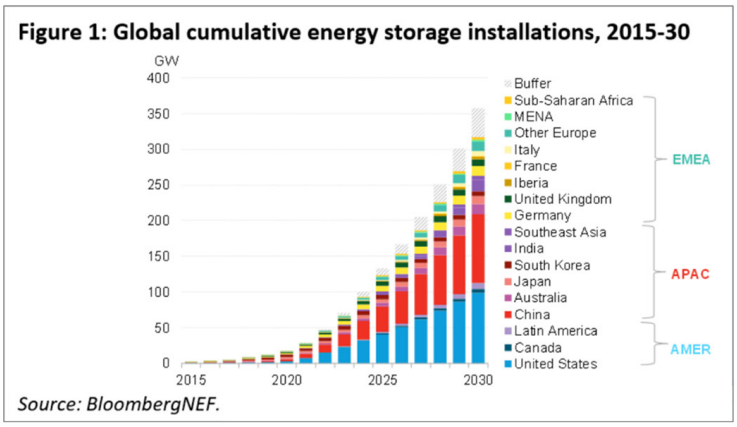
Improvements in performance, coupled with a decrease in price, have led to growth in the DER market. Since 2007, the U.S. has experienced nonlinear growth in solar installations, while global energy storage installations have risen steadily since 2015 and are projected to increase exponentially in the decade ahead.

Transportation electrification is also entering a phase of explosive growth, with automotive original equipment manufacturers (OEMs) worldwide committing to and/or making investments in electric vehicle (EV) manufacturing. Forecasted EV market growth in the next decade is likewise expected to grow exponentially.

These three markets alone (solar, energy storage, and EV) are projected to grow roughly 30% per year.

**Figure 1: The DER landscape is evolving rapidly—customer adoption is growing non-linearly**
*Recorded solar (left) and projected energy storage (right) growth*



# Turning Behind-the-Meter DERs into Grid Assets: Opportunities, Challenges, and Principles for Success

## EV growth brings opportunities for and challenges to electricity infrastructure.

Transportation electrification is one of the more significant revenue opportunities for utilities, with the potential for terawatt hours of additional demand.

But along with the opportunities related to additional demand are significant challenges. The increase in EV charging will have a large impact on the low- and medium-voltage distribution grid. Physical assets, such as secondary distribution transformers, are projected to experience a decrease of expected service life, particularly those in residential neighborhoods.

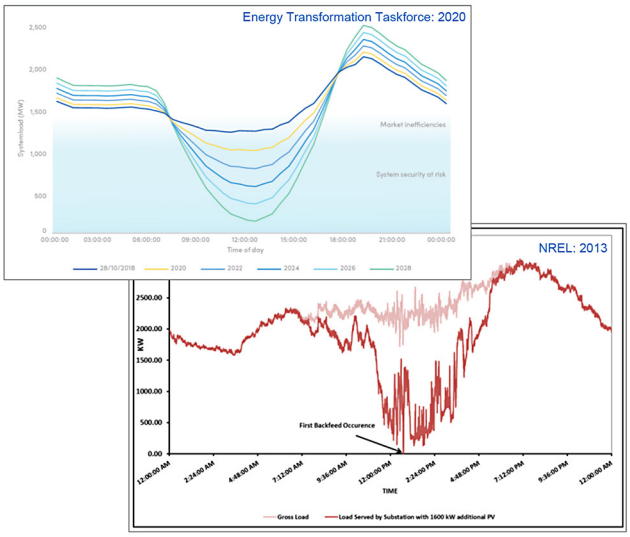
IEEE estimated that every Level 2 (L2) charger installed on a residential transformer will result in a 10% reduction in service life, further decreasing exponentially with every L2 charger added. Although rare in the current environment, when EV adoption is clustered, increased load can cause long duration overloads, resulting in overheating and catastrophic failures. This can also occur in other grid assets that are subject to various forms of overloading and stressing from additional EV charging loads—even primary feeders, due to heavy load such as truck fleet charging.

Assuming a 30% penetration of EVs in five or six years, as has been estimated, to build out the grid to accommodate uncontrolled charging the forecasted incremental CapEx over today's spending rate is estimated between $765 million and $2.6 billion for a mid-sized utility. For investor-owned utilities (IOUs), this can negatively impact net revenue growth.

> The CapEx required to build out the grid to accommodate uncontrolled charging is massive.
>
> *Mike Ting, Itron*

High photovoltaic (PV) adoption, as well, can create significant changes in the bulk power system, particularly in how low-voltage (LV) distribution grids behave and are operated.

**Figure 2: Impact of high penetration of behind-the-meter PV**
*(top: bulk power system, bottom: LV distribution grid)*




Bulk power systems will experience a "duck curve," with a marked increase in solar generation during midday hours, while system demand peaks typically occur in the late afternoon, resulting in steep and expensive ramp rates to meet the evening peak.

On the distribution side, reverse power flow is a risk in systems not built to handle high DER adoption, as they were built based on distribution planning assumptions from several decades ago.

In addition to the ways DERs interact with the distribution grid, DER adoption also impacts the utility-customer relationship in four key ways.

**Figure 3: The utility-customer relationship will evolve into a two-way relationship**

**RATES**

» TOU, CPP, RTP
» GPC charges

**EXPECTATIONS**

» Ease-of-use
» Fast response
» Trusted advisor

**PRIVACY**

» PII protection
» Data rights

**CONTROL**

» Frequency/magnitude
» Compensation/value
» Opt-out provisions
» Guarantees of service

- **Rates.** Customer-owned assets behind the meter will change the core financial relationship, moving away from flat rates into time-differentiated rates or dynamic rates such as critical-peak pricing and real-time pricing. As DERs can push surplus generation back to the grid, infrastructure costs associated with customers who use DERs is higher than those who don't. Introducing cross-subsidies between PV owners and non-PV owners is a consideration for rate structures moving forward.
- **Customer expectations** are changing rapidly. DER adopters expect a service that is quick and easy to use, and they prefer an interactive response, with utilities acting as trusted advisors on not only how to pay their bill and set up an account, but also how to operate DERs, where to buy them, how to commission them, and so forth.
- **Privacy** and personally identifiable information (PII) protection has always been a concern, and that is even more so in the DER-centric future. Green Button was an important first step in data rights, but DER-driven energy solutions will require deeper and more comprehensive data-sharing solutions for the market to function efficiently and competitively.
- **Control.** Program designs will have to change to accommodate a higher frequency of control and a move away from legacy demand-response relationships. The increase in frequency of control will affect terms of compensation, value proposition to customers, opt-out provisions, personal preferences, and guarantees of service. For reliability, it will be critical to have load flexibility established and maintained.

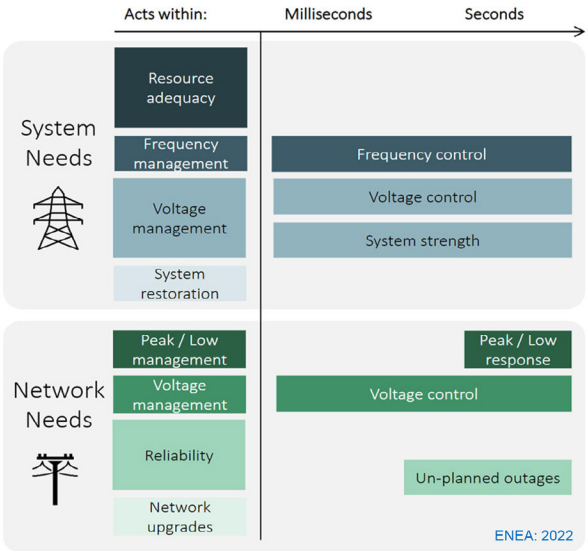
> Customers—particularly DER adopters—tend to be pretty tech-savvy. In general, that's their demographic, at least today. And with that, their expectations of utility service are different from the past. They expect a smartphone-like experience . . . that is a significant paradigm shift from the utility customer relationship.
>
> *Mike Ting, Itron*

**There are five core principles for successful DER management:**

1. **Solution architecture** matters in terms of total system latency and interoperability. Certain grid services like voltage and frequency regulation require total system latency—the time between the originating signal and the control—to be in the sub-second to sub-minuterange. Frequency regulation markets are highly valuable, but for DERs to provide advanced grid services with low latencies requires a distributed computing or grid edge intelligence architecture.

   From an interoperability point of view, distributed energy resource management system (DERMS) platforms need to integrate with many different utility systems, including advanced metering infrastructure (AMI), SCADA, outage management system (OMS), customer information system (CIS), billing, and advanced distribution management services (ADMS) systems. ADMS integration, in particular, is key to providing low voltage grid services. Designing for interoperability is a requirement, especially as the systems evolve and change over the long term.

**Figure 4: System and network needs of utility services**




2. **Supporting customer choice** by making it easy for customers to onboard, connect, and manage their own devices is important to overall customer satisfaction and customer retention. Throwing up barriers, particularly in a highly dynamic environment, is counter to success with the DER market. Customer choice is critical.

3. **Security and high availability;** cyber threats and the impact of hacking are significant concerns for any business, but especially for utilities. Behind-the-meter DERs are frequently connected through a customer's WiFi, which is by nature not highly secure. Additionally, piggybacking on customer WiFi connections also creates availability issues as access to those connections is unreliable. Establishing alternate paths to DER connectivity, particularly over the AMI network, which is built around industrial IoT standards, provides high security, as well as low bandwidth and high availability required to established higher reliability of the flexible load resource.

4. **Consider the future** state of the grid, especially in terms of convergence. Over the long term, managed EV charging will need to merge with the legacy set of demand-response programs such as thermostat programs, water heater programs, large commercial and industrial programs, and so on, to become one large resource pool. Utilities should plan ahead to ensure as smooth and painless a convergence process as possible in terms of both customer experience and utility operations.

5. **Automation** that leverages artificial intelligence and machine learning is a must. Both the technology and the paradigm around grid operations need to change to accommodate DER adoption.

### When applying machine learning, AI, and automation in the DER management space, most work will fall under artificial narrow intelligence.

There are three categories of AI: artificial super intelligence (ASI), artificial general intelligence (AGI), and artificial narrow intelligence (ANI). Artificial super intelligence is futuristic and highly theoretical, and is often conceptualized in movies. In artificial general intelligence, a collection of sensors can learn limited contextual situations and mimic reasoning regarding a problem to solve for it, such as in military drones. However, ASI and AGI are not areas of focus for utilities when designing and developing an intelligent grid.

Artificial narrow Intelligence is based on expert systems with clear rules and logic, with distinct, narrow boundaries around the environments and tasks that ANI is applied to. In the DER management space, ML and AI are applied as ANI concepts. For example, automated EV recharging is a use case for ANI. In a managed EV charging scenario, where the objective is to protect a transformer by limiting EV charging load for a specific period and a specific neighborhood, the decision variables and constraints are based on very controlled, intentional actions.

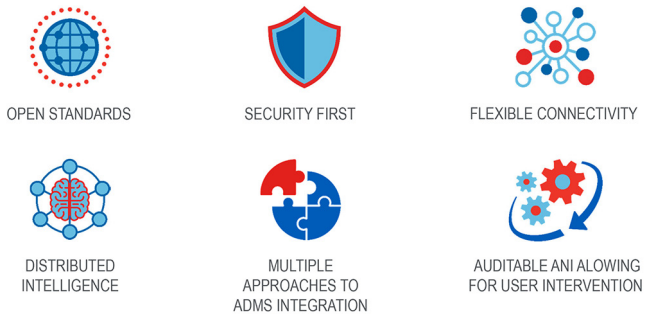
### Guardrails are in development for AI risk management.

At the federal level, the National Institute of Standards and Technology (NIST) has developed a risk-management framework for AI. These guardrails are intended to protect stakeholders from the worst unintended consequences of AI. Although voluntary, Itron takes this risk-management framework seriously and is participating in collaborative engagements made available by the federal government. The development of guardrails for AI is an ongoing and growing effort, both nationally and internationally.

### Itron focuses on six themes in its approach to DER management.

Six themes are core to Itron's DER management solutions:

**Figure 5: Itron's approach to DER management**




- **Embrace open standards.** Itron is heavily invested in open standards to support customer choice and a "Bring Your Own Device" principle.
- **Security first.** Itron develops its modules around North American Electric Reliability Corporation (NERC) CIP compliance. Itron architects solutions for NERC CIP compliance from the ground up.
- **Flexible connectivity.** Itron meets customers where they are, whether that means having to leverage customer WiFi or go direct cellular, with the goal of moving customers to AMI network connectivity over the long term for security and availability.
- Itron is invested in and committed to **distributed intelligence**. Itron was the first company to bring to market smart meters with their own onboard Linux processors and sensors to enable high-frequency sensing at the edge. In addition, onboard processing apps can be written by third parties and downloaded over the air to Itron meters. In the DER management space, Itron is developing solutions to provide connectivity via the meter directly and apps that help do real-time DER management.

- **Multiple approaches to ADMS integration.** Itron offers a DI app that mimics a distributed network protocol (DNP3) endpoint as an option to bring in DERs into ADMS systems without having to go through a complicated custom back-office integration.
- **Auditable ANI that allows for user intervention.** Itron creates implementations of AI where all methods are transparent and auditable that accommodate phase gates as needed.

## ADDITIONAL INFORMATION

Itron enables utilities and cities to better manage energy and water. To learn more, visit www.itron.com/na

## BIOGRAPHY

**Mike Ting**

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Mike Ting is a Senior Product Manager in Itron's Distributed Energy Management team. Mike oversees Itron's strategies and product roadmaps related to DER management solutions that leverage Itron's networks and distributed intelligence technologies. Prior to his product management role, Mike spent 20+ years in public and private sector research and consulting to utilities, government agencies, and other stakeholders related to energy efficiency, demand response, and energy policy, including stops at the International Energy Agency and Lawrence Berkeley National Laboratory.



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