EnergyHub

Grid-edge **DERMS**

AN ENTERPRISE PLATFORM BUILT TO MANAGE DERS AT SCALE

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Introduction

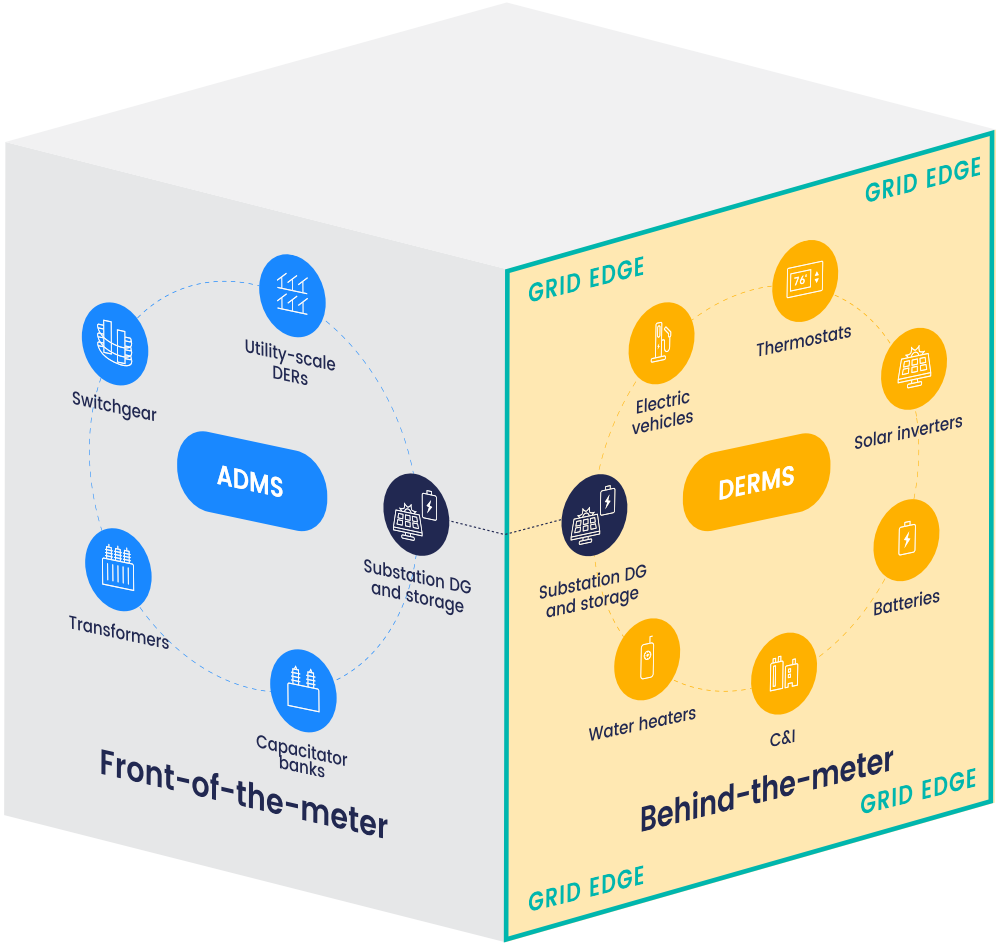
A new phase of distributed energy resource management is on the horizon. A dramatic increase in the uptake of DERs is playing out in parallel with utilities setting aggressive decarbonization goals.

WoodMackenzie estimates that the solar, electric vehicle infrastructure, and residential load management installed base will account for **more than 90 percent of DER capacity installed** between 2016-2025.

The majority of these DERs are being installed by consumers, behind the meter, and are not owned or controlled by the utility.

At the same time, utilities are establishing aggressive goals for 100% decarbonization and are acting on these goals by integrating more renewables into the grid. This influx of renewables is resulting in complex and unprecedented grid conditions.

The flexibility provided by grid-edge DERs can directly mitigate many of the operational issues created by renewables. Large aggregations of DERs can serve as a reliable and cost-effective virtual power resource. When managed intelligently, these aggregations can shift load, quickly balance intermittent renewables, and provide grid operators with new control levers for the distribution network.



Instead of shaping energy generation to meet demand, utilities are starting to think about shaping demand to meet renewable generation. To proactively take advantage of the flexibility provided by DERs to meet these objectives, utilities are implementing innovative DER management strategies. With the majority of new DERs being installed by consumers behind the meter, successful implementation of these strategies requires utilities to deploy a platform that is built to address the unique aspects of working with customer-owned DERs - a grid-edge DERMS. The grid-edge DERMS manages the enormous complexity of acquiring access to customer-owned DERs, integrating with these DERs to enable data flow and control, and making grid service management decisions across diverse portfolios of behind-the-meter, customer-owned DERs.

Challenges unique to grid-edge DER management

Managing customer-owned grid-edge DERs at scale comes with a unique set of challenges. Utilities must learn how to manage DERs that are subject to a wide variety of constraints - from the limited evening-only availability of a residential EVSE, to the need to take into account the customer bill impact of behind-the-meter battery control - that make grid-edge assets significantly different from the types of assets utilities typically manage. Everything from the technical capabilities of each type of grid-edge DER to customer comfort concerns to factors such as weather and lifestyle need to be taken into account by utilities. Additionally, the most critical, and often-overlooked problem in working with customer-owned DERs is how to initially form a reliable aggregation of resources from grid-edge DERs and then scale that aggregation. A few key challenges unique to managing grid-edge DERs are as follows:

1. **Lack of visibility -** utilities are often blind to large volumes of DERs that are being adopted by end customers, which prevents the utility from being able to proactively leverage the DER for utility benefit**.**
2. **Forming reliable aggregations of DERs -** in order to access customer-owned assets, platforms need to support the entire customer management lifecycle - including not only enabling control and data flow from DERs via contractual and technical integrations with dozens of DER manufacturers and service providers, but also customer acquisition, enrollment and registration of assets
3. **Diverse communication backhauls and protocols -** classes and brands of DERs use a non-standard set of communication standards and protocols and speak over non-utility networks, lending itself to a complex integration challenge.
4. **Customer preference constraints -** each customer-owned DER comes with its own unique set of constraints and flexibility parameters. Factors such as customer compensation, comfort expectations, device preferences (for example, setting a minimum state of charge of battery for backup, or setting a minimum EV state of charge to minimize range anxiety) need to be taken into account by the utility when making control decisions.
5. **Operational constraints -** Each DER class comes with unique capabilities and operational constraints. For instance, a DER's active and reactive power capability and response time can impact the type and extent of grid services it can provide.
6. **Need to support scale -** the management of all classes DERs requires a platform that is built to handle exponential scale in connected end points and operational complexity - having the ability to potentially manage millions of endpoints.

What is a grid-edge DERMS?

A grid-edge DERMS is a platform that is built to manage all distributed energy resources. EnergyHub's Mercury DERMS is uniquely designed to orchestrate typically unmetered, variable, and customer-constrained DERs into mission-critical, virtual resources at scale for utilities. A grid-edge DERMS transforms the diversity and complexity of utilities' multi-DER portfolio directly into a strength, with widely varying resource profiles complementing each other to deliver a robust, flexible, and virtual resource. The platform allows utilities to centrally manage DER operations from a single pane of glass, allowing them to monitor and optimize DERs in near-real-time to meet various utility objectives. The grid-edge DERMS delivers value across the enterprise - from end-customers to grid operations and market operations. National Grid, a leading utility in the north-east, is managing and growing its DER portfolio of residential batteries, thermostats, C&I sites and aggregators through EnergyHub's Mercury DERMS.

"EnergyHub's fleet [grid-edge] DERMS manages the largest portfolio of customer-owned DERs in the US"
—WoodMackenzie

Arizona Public Service (APS) is one such utility that is leveraging EnergyHub's grid-edge DERMS to build and manage a diverse multi-DER portfolio representing various ownership and deployment models. The platform is managing multiple brands of thermostats, batteries, and community solar to meet their market operations and network management objectives.

The key capabilities of a grid-edge DERMS

A grid-edge DERMS offers a number of features that specifically address the unique operational and ownership aspects of behind the meter grid-edge DERs:

1. Customer-centric resource formation and aggregation

Accessing behind-the-meter DERs requires robust infrastructure to support the DER promotion, adoption, and enrollment lifecycle. This includes software for acquiring and registering customers, and verifying customer and asset eligibility with the utility system of record - the customer information system (CIS). The key components of customer-centric resource formation include:

Customer choice - Integrations with all leading DER vendors allows utilities to enable customer choice, which results in the ability to build larger aggregations.

Customer acquisition - The goal of DER programs is to entice large volumes of customers to make their DER available to the utility. It is imperative that the DERMS platform supports this through robust enrollment infrastructure, supplemented by additional marketing services that focus on engaging and acquiring customers through channels, varying from the consumer app for Wi-Fi thermostats to the point-of-sale for residential energy storage, that customers are most likely to engage with.

Registration and verification - DERMS platforms need to interface with the utility CIS to register the asset and automatically verify the eligibility of the customer or site owner. EnergyHub's proprietary tool, Advanced Enrollment Verification (AEV), interfaces with the utility Customer Information System (CIS) to verify and process customer enrollments for DER programs in real-time.

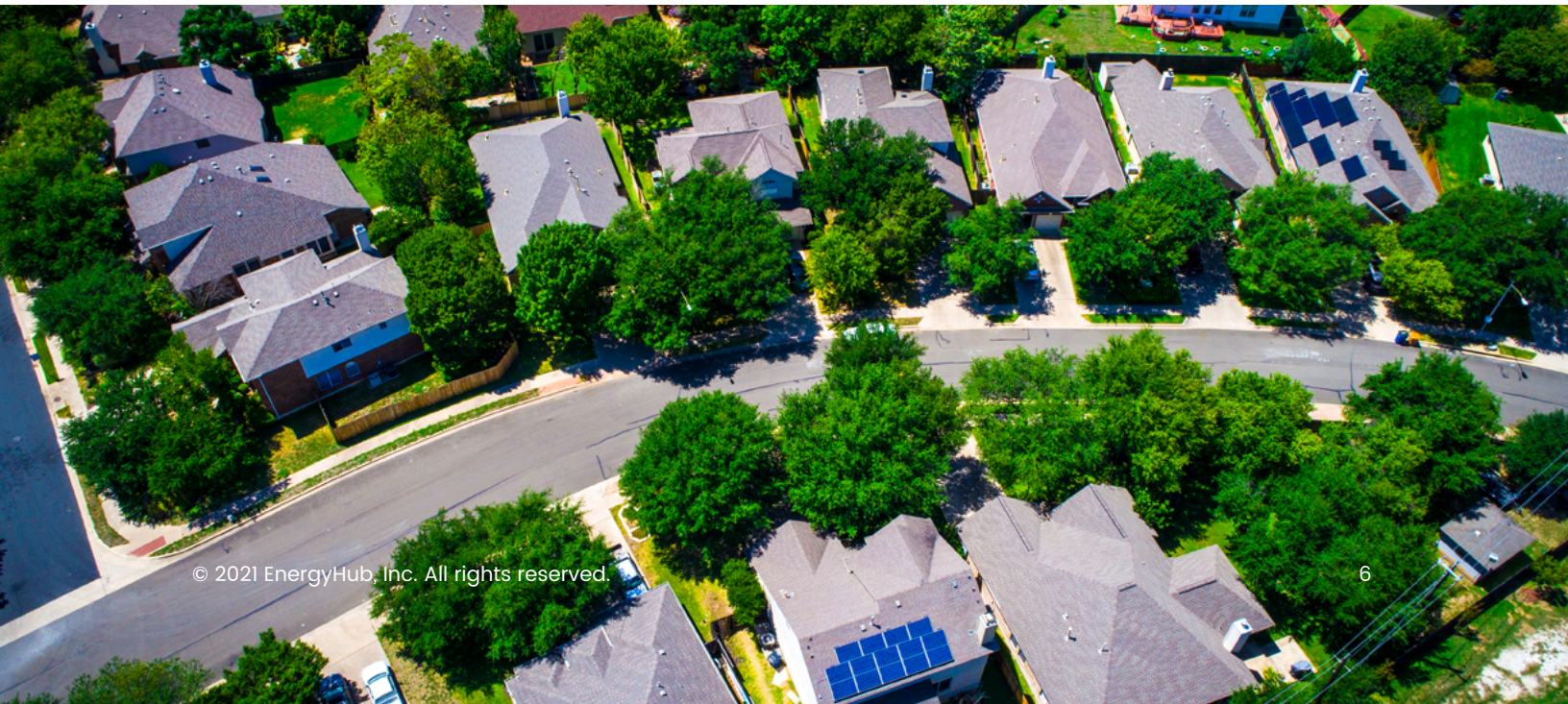
At a west coast utility, AEV supported the rapid enrollment of **over 45,000 devices** within a week.

2. Multi-objective optimization

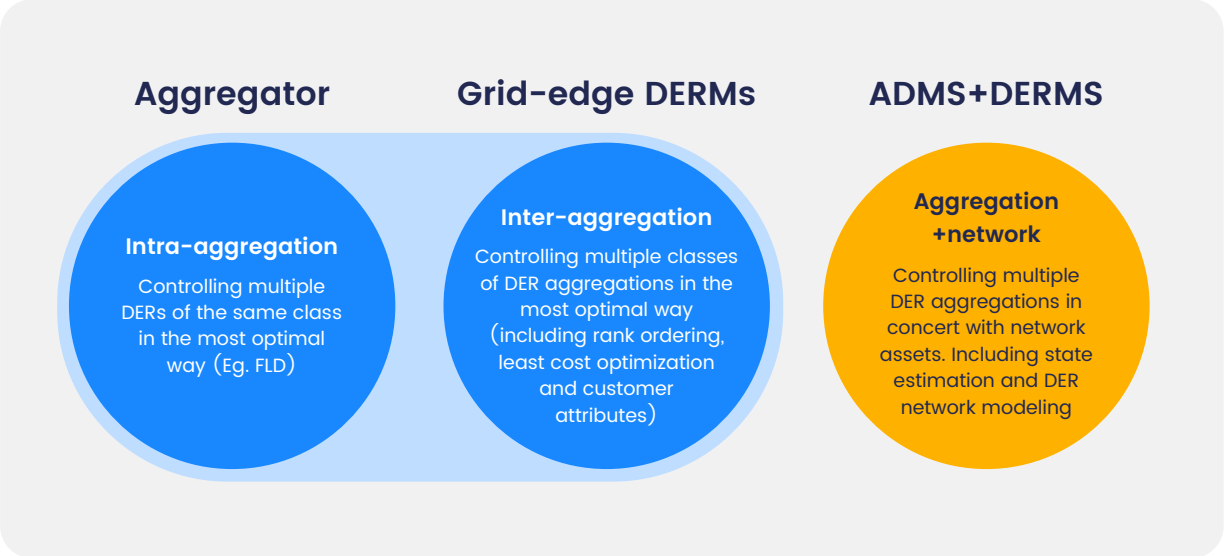
Different DER classes and brands come with unique capabilities and operational constraints. The grid-edge DERMS takes into consideration DER-specific attributes before determining which assets are best suited to provide the requested service. The platform then autonomously co-optimizes the control levers of these DERs to provide on-demand and in some cases, proactive, services. The platform's AI-enabled control optimization framework intelligently operationalizes DERs to ensure that utilities achieve desired outcomes while taking into consideration the operational, financial, and customer constraints associated with each individual (and cohorts of) DER(s). The platform is built on a multi-layer optimization framework for DER control that enables three types of DER optimization strategies:

> **Intra-DER optimization -** intelligently controlling a large volume of DERs of the same type, in the most optimal manner. EnergyHub's Firm Load Dispatch is a data-driven functionality for optimizing the load shape during a demand response event. The result is a grid service that behaves like generation, guaranteed to achieve a load reduction target while maintaining the desired load shape. This allows utilities to pursue aggressive load shed targets without jeopardizing customer satisfaction.

Multiple utilities such as Eversource, APS, and National Grid are **leveraging Firm Load Dispatch to maximize the load shed** from large aggregations of thermostats.



Inter-DER optimization – intelligently controlling multiple classes of DER aggregations simultaneously in the most optimal way. This includes accounting for asset- and class-specific flexibility. EnergyHub's optimization models conduct Monte Carlo simulations of potential load curves of available DERs based on available control parameters, and using that state space, conducts a stochastic optimization technique to identify the optimal control strategy.



DER-network optimization (with integration with an ADMS) – discussed in the following section.

3. Grid-edge situational awareness

The grid-edge DERMS also provides visibility of behind the meter assets that utilities are blind to. The platform can identify, monitor and forecast DERs at user-defined levels of spatial and temporal granularity. This fills in holes in utility network models by providing operational data from areas of the network that have historically otherwise been invisible to grid operators.

Alongside this visibility, the grid-edge DERMS also provides recurring DER capacity and net load forecasts at any level of the network hierarchy. These features include:

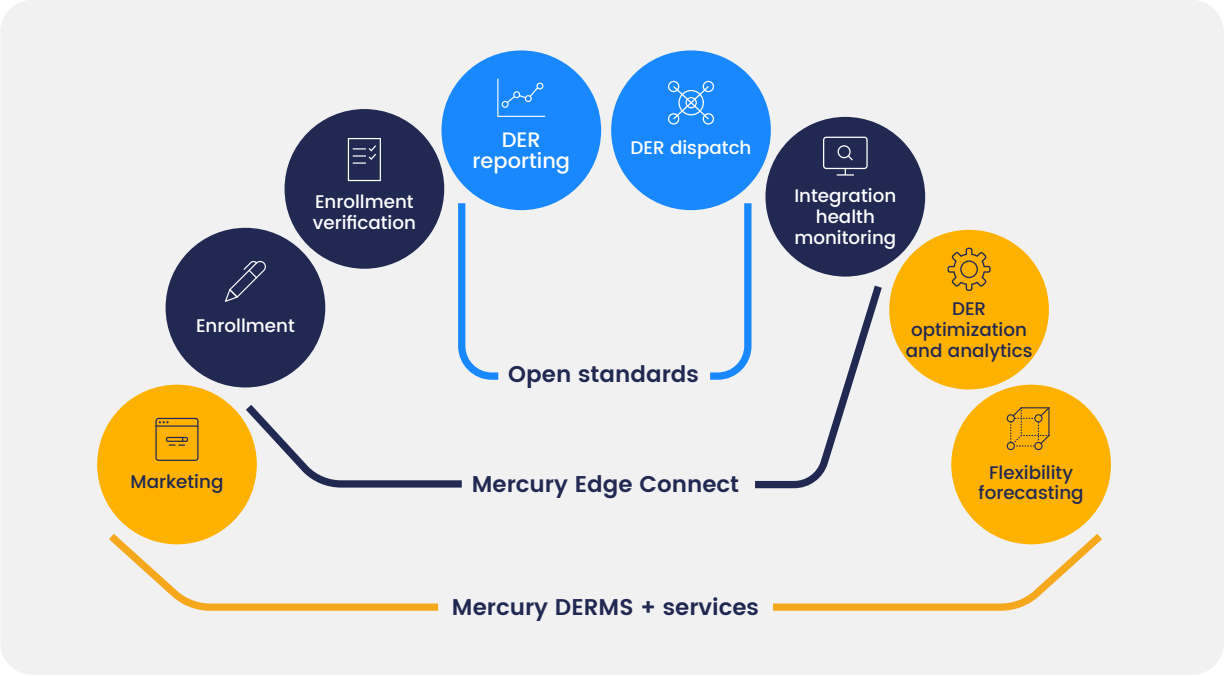
DER identification and monitoring	Fundamental information such as asset connectivity, operating mode, location, real-time load, and available or forecasted capacity becomes critical as customer adoption of DERs increases across the system.
DER flexibility forecast	Flexibility forecasts display forecasted load reduction for connected DERs, giving utility operators continual insight on expected, aggregated resource availability. Flexibility forecasts equip utility operators with the ability to assess available load reduction capabilities over a given timeframe.
DER load forecast	Load forecasts equip utility operators with the ability to view forecasted load across DERs under management to accurately predict load activity and enable data-driven insight and decision-making.

The ability of the grid-edge DERMS to drill down to any level of grid hierarchy allows the utility to develop customized device aggregations allowing for localized and targeted grid services.

4. Repeatable DER integration approach

Integrating with DER vendors rapidly, and with full functionality supported, can be a bottleneck for utilities looking to scale DER portfolios. Many DER vendors use custom APIs to allow integration with their devices, slowing and complicating integration with a DERMS platform. Open standards are limited in functionality and do not address functionality like device enrollment that are crucial to accessing a behind-the-meter resource. In order for utilities to unify the management of grid-edge DERs, it is imperative that the grid-edge DERMS support an integration approach that addresses the unique nature of customer-owned DERs, and is extensible to any class of DERs.

EnergyHub's Mercury Edge Connect (MEC) is a scalable integration framework that supports integrating DERs of all classes and brands with the Mercury DERMS platform, allowing utilities to broaden the portfolio of DERs they support and scale their DER programs faster. MEC supplements the base functionality provided by open standards and protocols like OpenADR and SEP2.0 to enable end-to-end integration and the resource formation process, including enrollment and registration.



Mercury Edge Connect provides utilities:

- a standardized integration model for all classes of DERs
- faster vendor integrations
- standardized access to DERs (data and control) and
- visibility into DER(s) health

5. Robust infrastructure built to handle scale

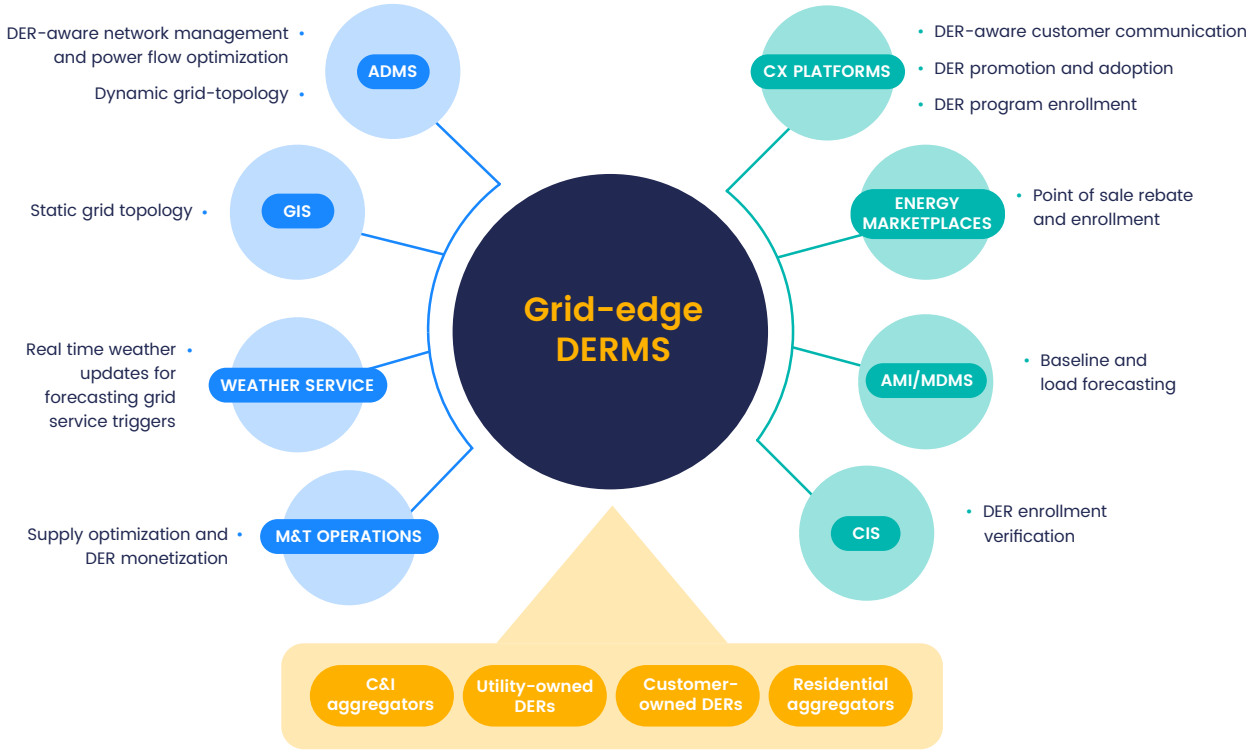
DER deployments are expected to continue to scale in terms of number of DERs, capacity represented, and grid services configured, as the requirements of utilities expand in the future. There are more than 14 million connected thermostats, 2 million solar installations, and 1.5 million EVs deployed today in the United States, and over 350 GW of load flexibility[1] is expected to come online by 2025, representing millions of endpoints. It is imperative that the platform that manages grid-edge DERs performs reliably at scale. EnergyHub's grid-edge DERMS manages millions of end points and has been proven to support DER scale and complexity reliably.

[1] https://www.woodmac.com/news/editorial/der-growth-united-states/

A grid-edge DERMS within the utility's holistic DERMS vision

As the only enterprise platform that is built to bridge the gap between customer-owned assets and utility operations, the grid-edge DERMS plays a unique role in facilitating the interaction between other utility enterprise platforms and behind-the-meter DERs.

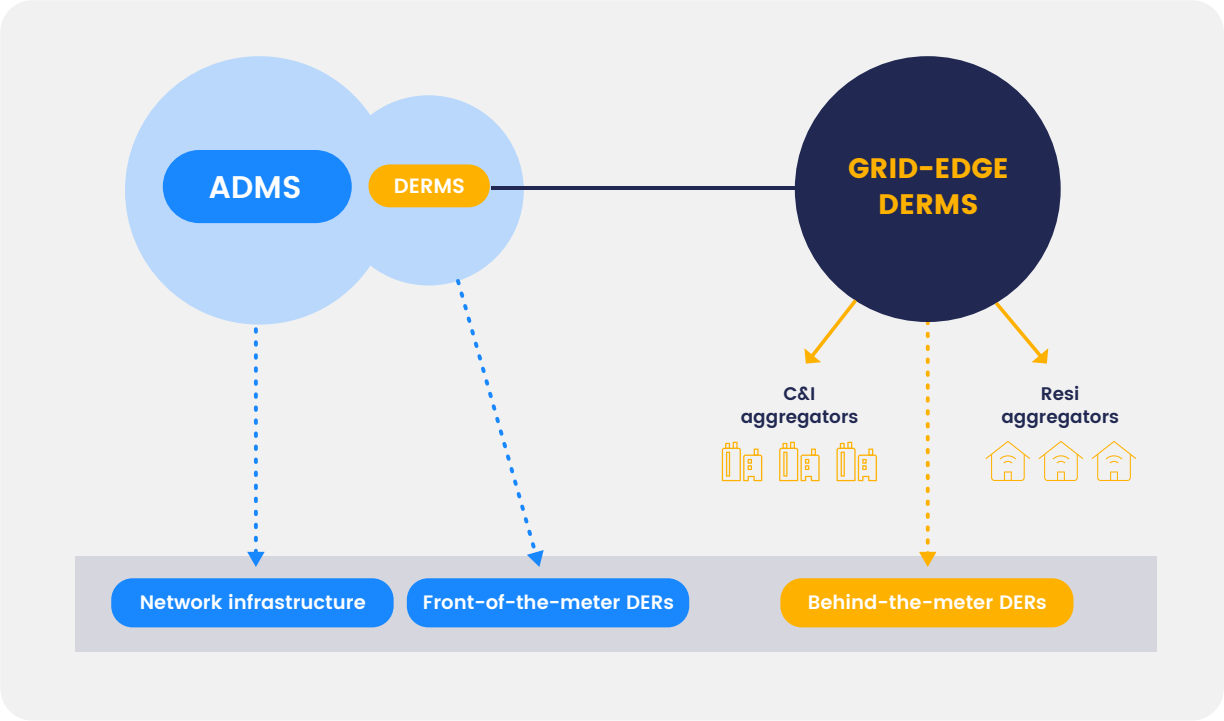
The grid-edge DERMS can integrate with complementary distribution management and market operations systems, enabling a system-of-systems approach to implementing a holistic DERMS vision. In addition to integrating with the distribution management and market operations systems, the grid-edge DERMS platform can integrate with the MDMS, the CIS, and the GIS to leverage DER data for program measurement and verification, settlement calculations, enrollment verification, and grid topology data.



Integrating with an ADMS to bring DERs into the control room

The grid-edge DERMS can provide valuable support to the utility's grid management goals through an integration with the network management platform or ADMS. Integrating the ADMS and the grid-edge DERMS allows each platform to play to their respective symbiotic strengths, providing crucial visibility and control of DERs to grid operators and empowering them to make informed and timely grid management decisions using data from grid-edge DERs that are otherwise not accessible to the ADMS or the grid operator.

As utility DER portfolios reach a level of scale that is significant to grid operators, EnergyHub's grid-edge DERMS can **integrate with the utility ADMS** - allowing grid operators to reach behind-the-meter to assets for **localized grid services and enhanced situational awareness**.



Interaction between the DERMS and the ADMS can take several different forms, depending on the granularity of visibility, control and the nature of information flows between the two systems required to meet utility needs.

Network-DER optimization use cases can range from point-in-time, event-based interactions to dynamic, closed-loop intelligent processes. These include:

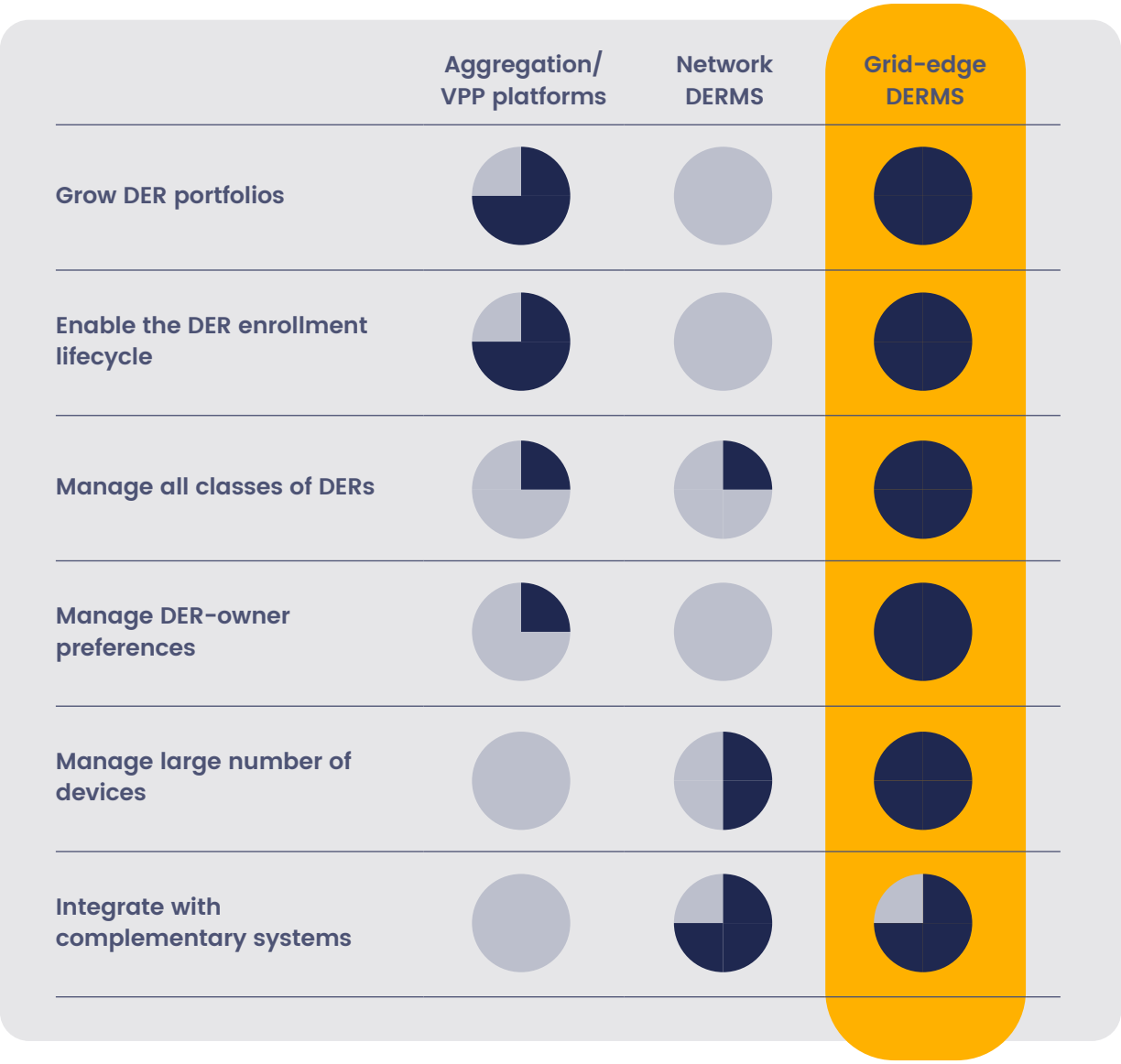
1. **Situational awareness:** The grid-edge DERMS can improve situational awareness and state estimation of the ADMS by providing real-time and forecasted data of individual DERs, or aggregations of DERs, across distribution network hierarchy. Localized capacity forecasts, for instance, can help inform grid services that the ADMS may request from the DERMS.

2. **Event-based grid services:** The grid-edge DERMS can be called by the ADMS for specific, mission critical grid-service requests from DERs in an open-loop, event-based fashion. For instance, the ADMS can request a certain level of load relief at a specific node and time. In response, the grid-edge DERMS will orchestrate the asset(s) best suited to provide the service by taking into account each of their operational characteristics and constraints.

3. **Complete nodal integration:** This configuration refers to an ideal state of maximal integration between the two systems. In it, the ADMS both incorporates nodal voltage and power measurements provided by the grid-edge DERMS in its state estimation, and includes grid-edge DERMS provided local capacity forecasts in its power flow optimization.

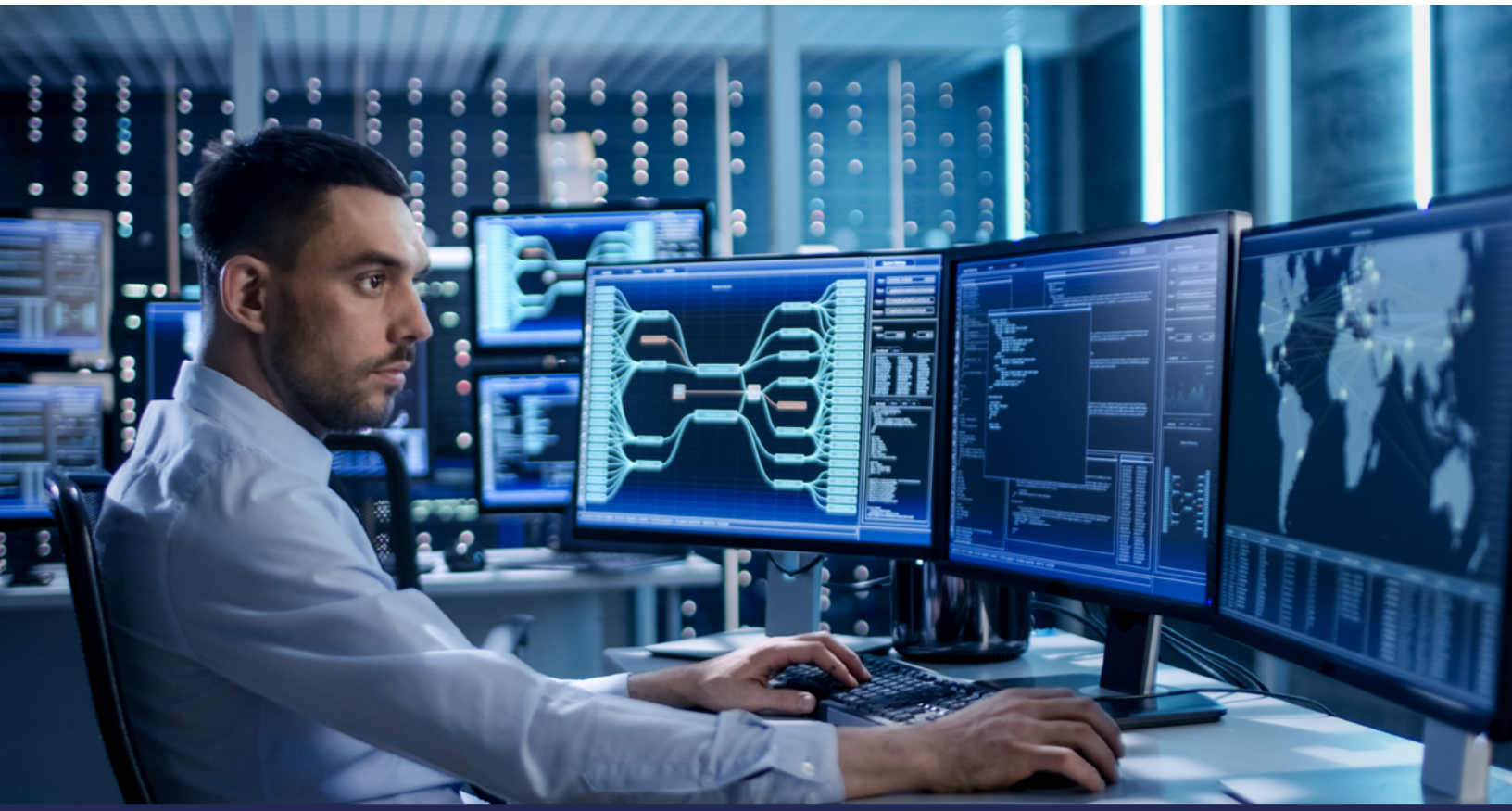
Conclusion

The market for DERMS platforms is complex - vendors provide varying capabilities to serve a diverse set of utility objectives. While some vendors provide ADMS platforms that integrate with DERs, others provide siloed aggregation platforms that integrate with a single class of DERs. Neither of these are suitable for managing behind-the-meter, grid-edge DERs across the entire utility enterprise. ADMS platforms that have DER control capability can access only those DERs that are utility-owned or front-of-the-meter, ignoring DERs that are customer-constrained and behind-the-meter. Siloed, single-class DER management platforms do not provide the breadth of control across DER classes that is vital for an integrated DER management strategy.



A grid-edge DERMS is crucial to effectively reach behind the meter and tap into assets owned by end customers or utilities to provide localized grid services and a robust suite of analytics back to the control room. As DER deployments reach a scale that is significant to grid operations teams, the grid-edge DERMS should integrate with complementary utility systems to allow grid and market teams to leverage the flexibility of DER as a resource.

The unique capability of EnergyHub's grid-edge DERMS to be customer-centric, scalable, and manage multiple DER classes, makes it a critical element of fully integrated, holistic utility planning and operations.



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