NAVIGANT RESEARCH

WHITE PAPER

VPPs and DERMSs: Different Sides to the Same Coin

How Alectra Is Building the Business Case for Integration

Commissioned by Enbala

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Research Director

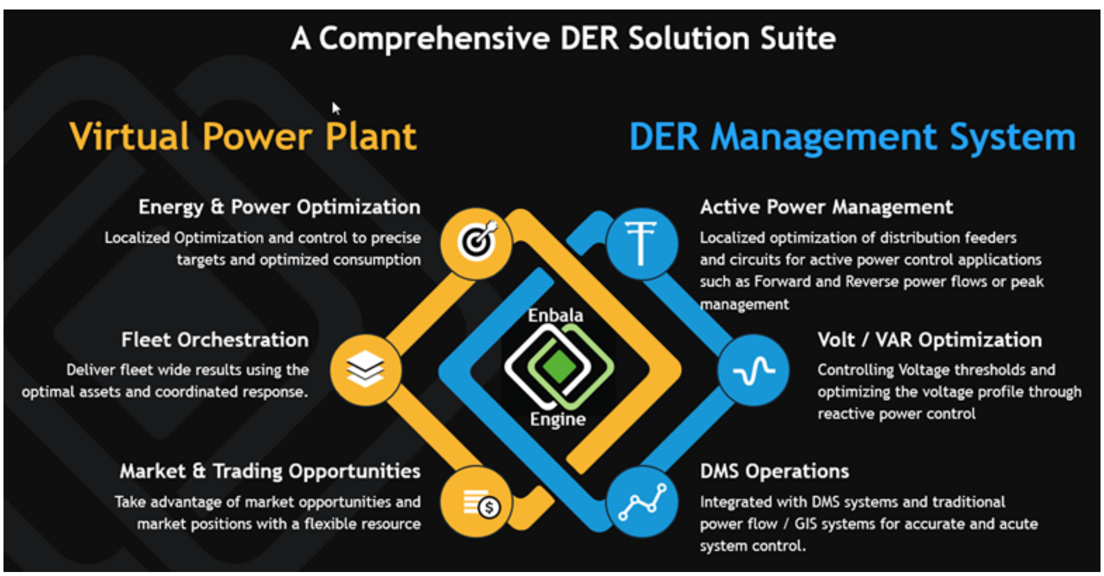
Section 1
VPP AND DERMS: OVERLAP AND KEY DISTINGUISHING FEATURES

1.1 Overview

The purpose of this white paper is to define terms such as virtual power plant (VPP) and distributed energy resources management system (DERMS) and note their similarities and differences. Navigant Research also examines how these two approaches to the management of customer-sited assets might evolve, overlap, and distinguish themselves in the future. The white paper highlights how Alectra, a public utility operating in Ontario, is exploring use cases and applications that piggyback on previous microgrids. It aims to serve as a guide for other software providers and utilities that join this journey toward squeezing the most value out of generation, load, and energy storage for prosumers, utilities, and other grid operators.

While VPPs and DERMSs may have distinguishing features, they are two sides of the same coin. This white paper discusses how combining the capabilities of technology embedded in VPPs and DERMSs may offer the greatest value to all energy ecosystem stakeholders.

Figure 1-1. A VPP and DERMS from Enbala and ABB: Two Sides of the Same Coin



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1.2 Virtual Power Plants

What is a VPP? Though a term appearing with increased frequency when discussing the need for platforms required to gain the most value from deployments of DER, no government or regulatory body has come up with a definitive description. Navigant Research has therefore come up with its own definition:

> *A system that relies upon software and a smart grid to remotely and automatically dispatch retail DER services to a distribution or wholesale market via an aggregation and optimization platform.*

VPPs can help transform formerly passive consumers into active prosumers through the integration and optimization of new technologies such as demand response (DR), solar PV systems, advanced batteries, diesel generators, chillers, smart thermostats, and EVs. Prosumers are transformed into active participants that deliver services tailored to their own needs and preferences while also serving the larger grid.

VPPs can help transform formerly passive consumers into active prosumers through the integration and optimization of new technologies.

One way to think about VPPs is that they can control heterogeneous DER to make the services these resources provide resemble conventional and dispatchable centralized power plants. The term VPP flows from this comparison; it was devised to help utilities and other grid operators understand how advanced software systems incorporating artificial intelligence (AI) algorithms could mimic the same essential services provided by a fossil or nuclear plant, but with a much smaller environmental footprint. VPPs deliver the same services (and more) as a traditional power plant without the shortcomings of a traditional power plant when it comes to land use, air emissions (if new diesel generators are excluded in the aggregation), and waste management concerns.

1.2.1 Energy and Power Optimization

VPPs can provide energy in the form of kilowatt-hours as well as power in the form of kilowatts. The key to the value proposition embedded within VPPs is the ability to optimize and control local DER to precise targets, whether those targets are based on generation, consumption, or energy storage needs or value streams. With the right combination of software and hardware, a VPP can be tuned to deliver what is needed by markets at a specific point in time. It creates a bridge between prosumers and the power grid that interconnects them with retail and wholesale markets.

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1.2.2 Fleet Orchestration

IT and related software bring value to the transportation and lodging markets via new shared resource business models such as Uber, Lyft, Airbnb, and VRBO. These models serve as useful analogies to the VPP. While the underlying assets are vital to the success of Uber or Airbnb, the value they bring to the market is dependent on the concept of smart fleet orchestration. The power of the fleet is much more valuable than the individual components that comprise the fleet—but only if marshaled efficiently by state-of-the-art software scheduling and deployment systems.

1.2.3 Market and Trading Opportunities

The power of markets lies in their ability to capture value that otherwise might be missed by prescriptive regulatory structures unable to provide services in a manner that serves both provider and end-use consumer. VPPs are therefore highly dependent upon utility programs or creatively structured third-party markets that enable buyers and sellers armed with real-time information to engage in mutually beneficial financial transactions. Since VPPs can either grow or shrink depending upon the needs of the real-time market, they offer the most flexible and efficient allocation of energy resources. This, in turn, reduces capital cost outlays and squeezes the most value out of existing DER assets.

1.3 DER Management Systems

The Navigant Research definition of a DERMS is revealing, reflecting a utility-centric view of challenges resulting from increased reliance upon DER:

> *A DERMS is a control system that enables optimized control of the grid and DER (to the extent that a utility may be able to dispatch and control DER). To minimize disruptions and the presence of phantom loads, utilities need to manage the grid more proactively. Common use cases include Volt/VAR optimization (VVO), power quality management, and the coordination of DER dispatch (when possible) to support operational needs.*

1.3.1 Active Power Management

Given the diversity of supply, load, and energy storage assets being integrated into power grids today, utilities and grid operators need an active power management system to keep these diverse DER portfolios in balance. This is especially critical to the utility due to its obligation to serve, even though the majority of DER on its system may not be under its direct ownership or control. A state-of-the-art DERMS allows for the localized active power management of distribution feeders

A state-of-the-art DERMS allows for the localized active power management of distribution feeders and circuits.

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and circuits to enable applications such as forward or reverse power flow to occur seamlessly. Active and vigilant power management systems also help address peak power management challenges.

1.3.2 Volt/VAR Optimization

Electricity is a multidimensional product that requires constant fine-tuning—especially as the fleet of DER begins to dominate resource pools. Beginning in 2018, annual centralized power resources began to give way to distributed generation and a more diverse DER mix in terms of total annual capacity additions. This trend will only accelerate over the next decade and beyond. Controlling voltage thresholds through reactive power control is vital to VPPs being able to become fully commercialized. A DERMS solution works together with the VPP vision, ensuring that the vast promise of value embedded within DER is not thwarted by the physics of maintaining a reliable and efficient power grid system. Such fundamental optimization is a cornerstone to the viability of transforming DER from a grid problem with reactive power and voltage concerns into a grid solution set.

1.3.3 Distribution Management System Operations

The components of a DERMS are not completely new. One could view the evolution of the DERMS as a natural outgrowth of a distribution management system (DMS). These systems must be integrated with and encompass traditional power flow and geographic information systems for accurate and acute system control. Despite the complexity of the DER integration puzzle, the goal is to bolster the reliability of the grid, not jeopardize grid performance. DMSs, as well as DR management systems (DRMSs), are moving toward the broader DERMS framework. This is being driven by the shift in the VPP market from separate DR or supply-side VPPs to what Navigant Research has deemed mixed asset VPPs, portfolios mixing together load, generation, electric and thermal assets, and energy storage devices (including the batteries located within EVs).

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Section 2
WHY SHOULD UTILITIES CARE?

2.1 Why It Is Now Possible to Have VPPs and DERMS in One Solution Suite

It is clear VPPs and DERMSs are essentially two different sides of the same coin. Both platforms are designed to aggregate, optimize, and control diverse DER portfolios. VPPs are more focused on the financial value captured by markets whereas DERMSs are more focused on maintaining the physics of the power grid by ensuring that localized voltage and reactive power are marshaled on behalf of grid stability. The ability to flip between a VPP and DERMS solution with the recently released Enbala Engine reflects recent advances in software to reconfigure assets to meet specified goals in real time, shifting priorities between economics, physics, and the large gray area in between. Why is this happening today?

In 2017, Enbala surveyed utilities about both VPPs and DERMs.[1] A follow-up survey completed 1 year later at the start of 2018 revealed some noteworthy trends that reflect an acceleration in DERMS adoption rates. The survey also provided insights into why utilities are moving beyond the silos of DR or advanced DMSs (ADMSs) and are instead seeking broader and more intelligent and comprehensive solution set frameworks. What specific types of programs are utilities deploying to extract value from DER?

Over half of respondents indicated a DERMS pilot.

[1] For more information, see: http://info.enbala.com/dtechsurvey.

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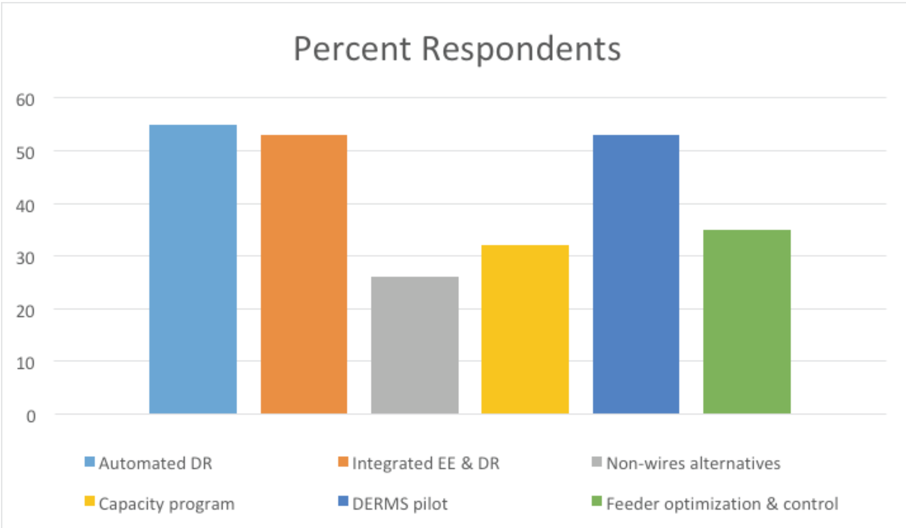
Figure 2-1 provides some clues. Note that over half of respondents indicated a DERMS pilot. In addition, the top use case is automated DR.

Figure 2-1. Types of DER Programs Utility Respondents Are Deploying



(Source: Enbala)

Among the key findings are the following:

- Roughly 25% of the respondents from North America and Europe attending the 2018 DistribuTECH conference indicated that their organization had a DERMS or VPP platform in place, compared to 18% in 2017 (more than half that do not already have a platform said they would be implementing one in the next 36 months).
- This year, 52% of those responding said sustainability/carbon reductions were their top goal, followed by 46% that focused on meeting grid reliability objectives.
- How do utilities measure success? Speed was top choice (21%), followed closely by reliability (19%). Security and flexibility were tied at 10%.
- Regulatory issues remained the top challenge. The costs of DERMSs and VPPs declined in importance in terms of obstacles to near-term deployments.

The survey results reinforce the linkage between VPPs and DERMSs. They also provide clues as to why these two applications should be integrated as markets shift to greater reliance on DER for both primary energy services and the complementary grid services—such as voltage and frequency—necessary to keep the grid in balance.

2.1.1 Access to Full Library of DER Assets

The Enbala Engine, which sits between prosumer and utility DER and the utility grid management system, is based on an upgraded architecture that continues to evolve and

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allows for the aggregation and optimization of a much wider pool of assets to be included in VPPs over time. Enbala, like many other vendors, started its VPP journey by focusing on larger commercial and industrial (C&I) customers, for which large loads were more easily manipulated. However, the company realized that to continue growing, it had to go downmarket to reach further into the available pool of smaller but still valuable potential VPP assets. These assets ran the full gamut of common DER, including everything from smart thermostats to air conditioners to HVAC systems to pool pumps. Each of these devices represent a potential solution to energy cost management as well as overall grid reliability.

Being able to tap the full library of available DER assets translates into a more robust VPP solution and a fuller realization of the logic behind the mixed asset VPP business model. Nevertheless, as VPP portfolios grow in complexity and diversity, they also pose increased challenges to the distribution utilities whose grid underpins the VPP value proposition. VPPs alone cannot solve the DER integration challenges facing the energy ecosystem today. While markets may help unpack previously unrealized value in DER assets, there needs to be a parallel effort to ensure that the physics of electricity exchanges are respected and responded to in real time.

2.1.2 Seamless Conversion between VPP and DERMS Configurations

The ability to seamlessly switch back and forth between economic optimization and granular optimization of the physics of electricity offers tremendous synergy. This ability is the focus of the VPP versus the more granular and localized control of DER assets necessary for grid stability under a DERMS. As global energy markets increasingly rely upon DER assets to provide the fundamentals of energy and capacity—as well as the finer adjustments revolving around voltage and reactive power—the need for tighter integration between economics and physics will grow. The electric utility industry has been plagued by a siloed approach to grid challenges in the past. In the future, prosumers offering assets that can be harnessed for grid services must be synced with the ability of utility grid operators to have visibility and control of the same assets to meet their obligation to serve requirements.

> *VPPs can be characterized as being more focused on economics, but they also address grid stability issues.*
>
> *With DERMSs, a more nuanced perspective is necessary, requiring a full connectivity model with visibility into the fine details.*

VPPs can be characterized as being more focused on economics, but they also address grid stability issues such as frequency. In contrast to a DERMS, the VPP control architecture is less granular. Since frequency can be

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addressed with resources located over a wider geography, it is well matched to VPP portfolio optimization capabilities. With the VPP, there is less concern where the DER are specifically located. With DERMSs, a more nuanced perspective is necessary, requiring a full connectivity model with visibility into the fine details of each unique grid topology.

2.1.3 Increased Ability to Integrate with Legacy Utility SCADA and ADMS Solutions

Shifting to a focus on DERMS, utilities also need to squeeze as much value as possible out of their own legacy assets. These assets include control and automation technologies ranging from SCADA systems to ADMSs. Such systems often form the foundation for utilities to manage the assets that interconnect with their distribution and transmission systems.

The primary function of a SCADA system is to leverage computers, network data communications, and a graphical user interface for high level management of generation and load on the utility grid. However, over time, SCADA systems have expanded their reach to also help supervise peripheral devices such as programmable logic controllers that are embedded in a variety of control products, including self-sustaining systems such as microgrids.

The primary function of an ADMS is to integrate SCADA technology with other information management systems to enable greater automated control for more efficient distribution energy-related services. As the distribution grid evolves into a platform to enable a greater variety of interconnected assets to perform both the most basic and more exotic grid services, the fundamentals of ADMSs represent a permutation of acronyms. Each pertains to a more specific set of grid services; for example, a DRMS is focused on DR. The DERMS is just the latest example of this continued evolution to broaden the eligible assets and resulting grid services possible through software optimization. DERMSs offer a broader suite of aggregated DER aligned with the vision of pushing the mixed asset VPP model, consisting of generation, load, and energy storage assets, into the forefront. These systems will become the new industry norm for efficient power supply management.

2.2 Top-Down (DERMSs) and Bottom-Up (VPPs)

Utilities like hierarchy. It should therefore come as no surprise that the ADMSs they deploy take a top-down view on controls. These systems typically provide a snapshot in time every 15 minutes. Aggregators partnering with prosumers, on the other hand, lean toward a more bottom-up perspective. One could also consider this a more distributed controls paradigm. The VPP typically needs to reoptimize DER every few seconds.

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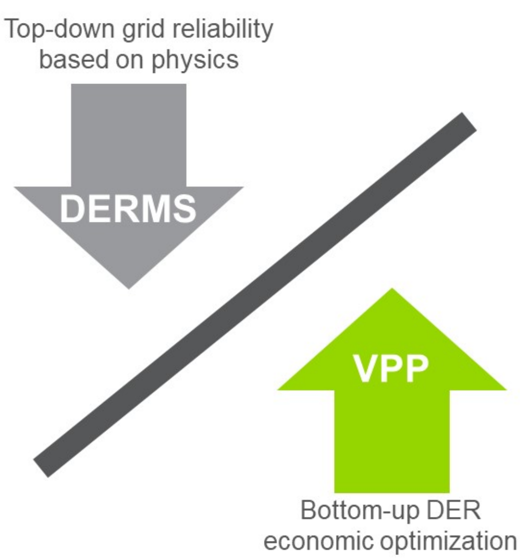
Blending the VPP and DERMS insights allows a grid operator to go into the dark places on any distribution feeder.

Is there a way to reconcile these two different approaches to reduce cost and extract more value while also maintaining the utmost in superior grid reliability? This is the question that Enbala and ABB set out to answer in a collaboration designed to bridge the gap between VPP and DERMS perspectives. The way to accomplish this goal is through a thorough topology synchronization. An ADMS starts with a computer model that replicates the grid topology of any segment of the distribution grid. This top-down perspective can be a starting point when configuring a DERMS solution. If one then layers the real-time updates possible with the VPP software, a grid operator can optimize the system based on reality. Furthermore, blending the VPP and DERMS insights allows a grid operator to go into the dark places on any distribution feeder where there were no sensors or data available in the past. What the Enbala Engine represents is a fine-tuning knob that can make adjustments based on real-time grid status measurements.

Figure 2-2. Top-Down and Bottom-Up Control Strategies Merge with VPP-DERMS Hybrid



(Source: Navigant Research)

Today, the top-down perspective dominates grid management. Yet, at some point in the future, there could be a flip toward a more distributed platform flowing from the need to manage the increasing growth and diversity of DER. In the interim, concepts such as AI and machine learning augment static models of grid topology fundamental to DERMSs, setting the stage for real-time optimization with VPPs.

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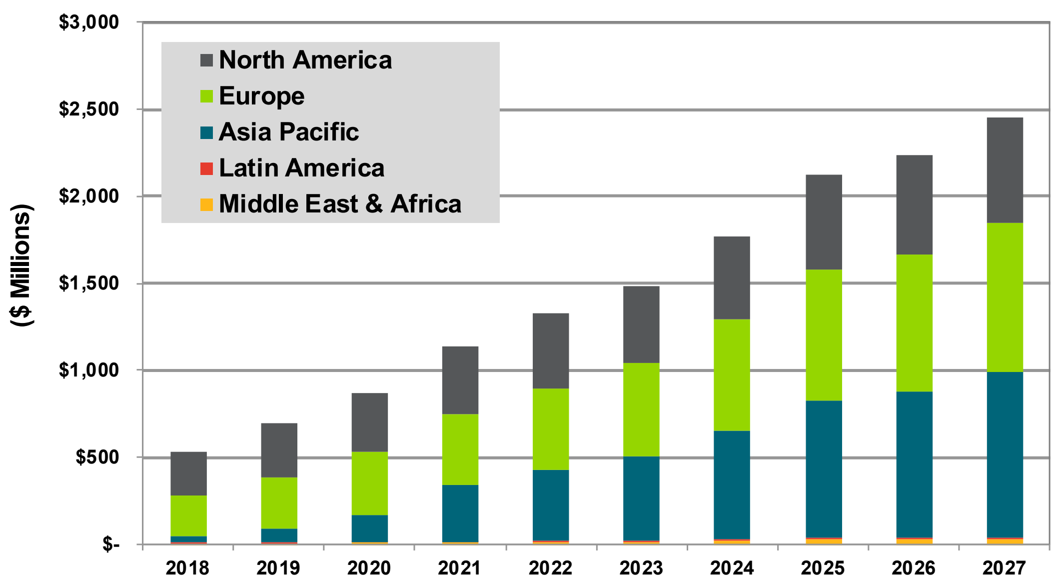
Section 3
THE EVOLVING DER SOLUTION SET LANDSCAPE

3.1 What Is the Size of the VPP Market?

There are many ways to measure the size of the VPP market. Historically, Navigant Research has taken a narrow view on the sizing of the market, particularly on definitional issues as it pertains to DR, arguably the most mature segment in the VPP market in North America. Navigant Research only counts DR capacity, for example, that is automated and capable of quick response to a signal from a grid operator. Several vendors tout the size of their DR portfolios as being VPPs, but in many cases, the majority of capacity is not responsive to real-time grid dynamics.

Furthermore, Navigant Research does not count the capital investment embedded in the assets aggregated into a VPP. These assets are usually legacy systems not owned by the VPP aggregator. The emergence of energy storage providers, whereby the VPP piggybacks on new deployments, has changed this dynamic. Yet, to compare on a level playing field across all VPP vendors, the market is sized by the most vital enabling technologies: software, telemetry, and device controls. Software represents the largest investment category. Chart 3-1 shows that the global market for VPPs is estimated at more than $500 million in 2018. By 2027, annual implementation spending is expected to grow to almost $2.5 billion.

Chart 3-1. Annual Software, Telemetry, and Device Control VPP Implementation Spending by Region, World Markets: 2018-2027



(Source: Navigant Research)

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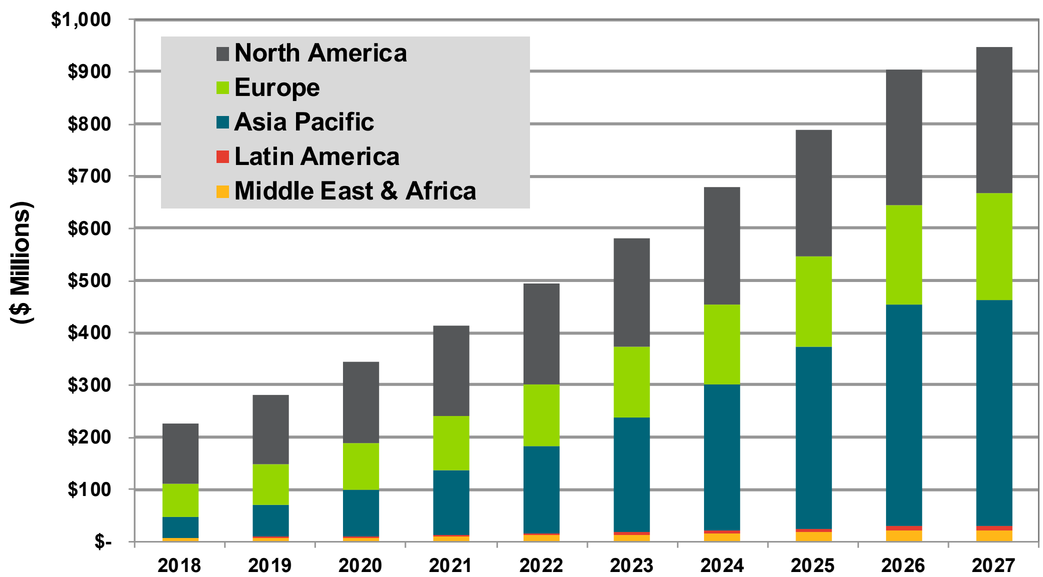
3.2 What Is the Size of the DERMS Market?

The DERMS market is less nebulous than the VPP market, but also less mature. It is more of an evolutionary path, with DERMSs representing the latest twist in utility-led control platforms such as DRMSs and the ADMS platform. As the pool of customer-owned behind-the-meter (BTM) DER grows and diversifies, utilities are looking for broader control platforms that can scale over time and do not represent siloed dead ends.

Although VPPs tend to focus on BTM DER being orchestrated into solutions by third parties paid to solve utility supply challenges, DERMSs may or may not control BTM assets. More likely than not, DERMSs will expand the reach of utilities to more directly address control issues on their distribution systems, no matter what entity owns the assets. And while VPPs tend to look upstream to the transmission system and wholesale markets for value exchanges, DERMSs make sure that the physics of the distribution grid is accounted for when DER are being used to solve transmission-level needs. Note that the DERMS market is considerably smaller than the VPP market. Global DERMS implementation spending is estimated at $226.3 million in 2018. It is expected to increase to $946.6 million annually by 2027 at a compound annual growth rate (CAGR) of 19.8%.

Chart 3-2. Annual DERMS Technology Implementation Spending by Region, World Markets: 2018-2027



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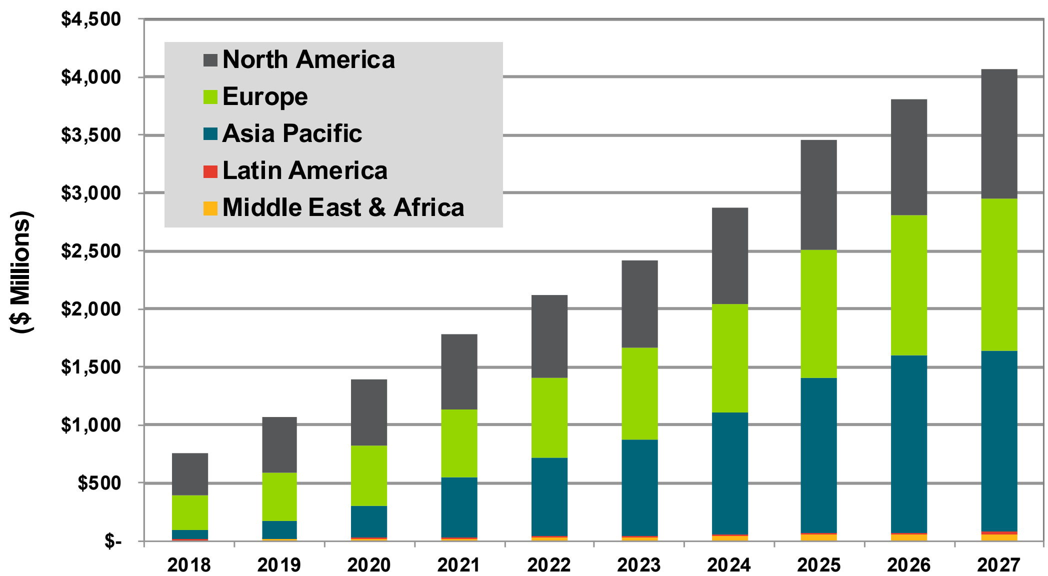
3.3 What Would a Market Integrating the Two Platforms Look Like?

The new VPP-DERMS solution would compete for a share of the market portrayed in both previous forecasts presented, which looked at each platform separately. The beauty of the new offering is that it can provide the basis for both VPP and DERMS applications.

How could such integration increase the overall market for DER aggregation, optimization, and precise control? One could just add up the two forecasts. But Navigant Research believes that simple calculation would underrepresent the overall market. Assuming others follow Enbala's approach, Chart 3-3 represents a synergy scenario. It incorporates some of the assumptions behind what Navigant Research has deemed an "aggressive Energy Cloud scenario."[2]

Chart 3-3. Annual Combined VPP-DERMS Implementation Spending by Region, Synergy Scenario, World Markets: 2018-2027



(Source: Navigant Research)

This is an optimistic view. Yet, all industry forecasts on solar PV were wrong, grossly underestimating cost declines, which reduced projected uptake. Similar underestimations of cost declines and market uptake seem to be happening with energy storage. The fact that DER will represent 3 times as much capacity as centralized generation by the end of 2027 underscores the challenge for grid operators. They will need to address and control

[2] Navigant Research, *Defining the Digital Future of Utilities*, 2Q 2017, www.navigantresearch.com/research/defining-the-digital-future-of-utilities.

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much larger pools of much smaller assets to keep the grid in balance. This suggests that both VPP and DERMS solutions will become necessary to address market and reliability issues in the years to come.

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Section 4
UTILITY CASE STUDY: ALECTRA

4.1 Alectra's Incremental Steps toward DERMS

Alectra, the second largest municipal utility in North America, was the first utility to develop a microgrid offering for its customers. It developed a small commercial-scale microgrid and then a utility-scale microgrid, the latter at its own headquarters at CityView in Vaughan, Ontario. This utility-scale microgrid integrates a variety of DER while also featuring the ability to island, if necessary, to maintain reliability at a site that includes Alectra's center of operations. Quite small in scale in terms of loads and installed capacity, the diversity of DER initially incorporated into the microgrid is one of the most significant achievements of the project:

- 17 kW of SunPower solar PV modules and 1.8 kW of small wind utilizing a single Southwest WindPower turbine, both systems integrated into the microgrid by Enviro-Energy Technologies
- 35 kW of natural gas-fired generation from a Caterpillar engine, integrated into the microgrid via an Eaton manufactured automatic transfer switch
- 23 kWh lead-acid battery manufactured by Surrette
- 5 kWh Li-ion battery manufactured by China Aviation (now decommissioned)
- 12 kWh Durathon sodium nickel chloride battery manufactured by GE (now decommissioned)
- SMA battery inverter
- 5 kW solar carport developed by renewz with Silfab Ontario solar PV panels
- 14.4 kW EV charger manufactured by Eaton and integrated by renewz, the first vehicle-to-grid deployment in North America
- Four 7.2 kW EV chargers
- A 14 kW controllable load bank with 1.8 kW steps

GE Digital Energy provided the microgrid system controller. The D400 microgrid controller is based on a supervisory control architecture that can monitor and track load, generation, and energy storage within the microgrid in both grid-connected and islanding operations modes. Other components, in particular the SMA battery inverter set and a smart panel, synchronize the microgrid to the Alectra distribution network. The GE D400 sends a signal to these devices to either connect or disconnect, with the objective to determine the capability of the integrated system to work together under a range of operating scenarios, including synchronization. This mix of control technologies will address any voltage,

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frequency, or phase angle issues that arise from managing the diversity of resources integrated into the system, each providing a relatively large share of total system capacity.

Alectra realizes that it had to build the business case to provincial regulators about why ratepayer investments in control of BTM assets provided value to all distribution network ecosystem stakeholders.

This utility-scale microgrid was focused on the internal optimization of these assets to create a reliable optimization network. As Alectra looks out into the future, however, it realizes that it had to build the business case to provincial regulators about why ratepayer investments in control of BTM assets provided value to all distribution network ecosystem stakeholders, including those with DER and those without. Rather than engage in theoretical models and lengthy discussions, Alectra elected to take steps toward first making its microgrid a VPP by demonstrating the use case of automated DR. (As noted in the recent Enbala survey,[3] this is the No. 1 use case utilities are experimenting with today.) “We wanted to get our hands dirty with DERMS,” said Vikram Singh, Alectra’s director of advanced planning. “We believe this is a real market,” said Singh, “but it is also fraught with uncertainty. We want to learn about the capability of vendors in a practical way, so we’re are doing an incremental walk-up to the end goal of DERMS.” The utility is moving forward with three different use cases exploring the intersection of VPP and DERMS frameworks with an existing microgrid as a starting point, then branching out to other DER outside of the confines of the utility-scale microgrid.

[3] For more information, see: http://info.enbala.com/2018survey.

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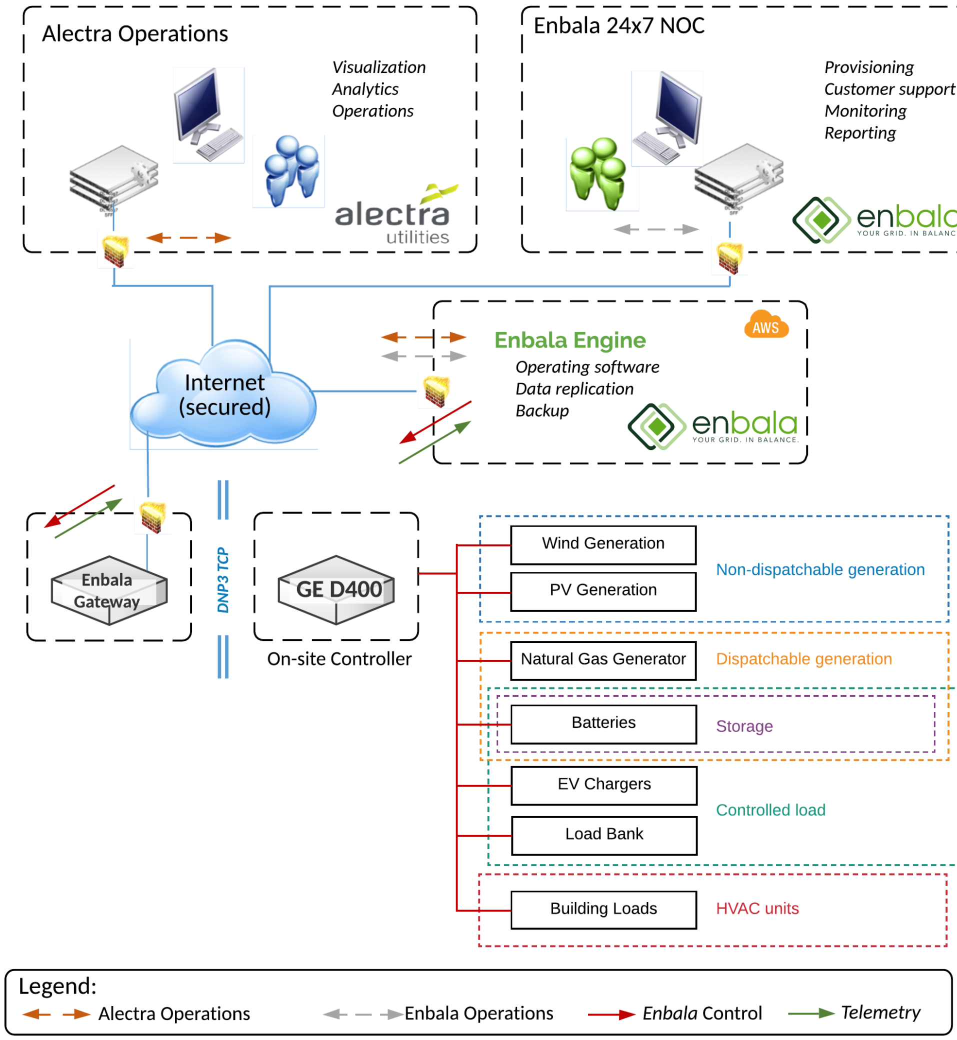
Figure 4-1. System Architecture for Microgrid-VPP-DERMS at Alectra Headquarters



(Source: Enbala)

Alectra is auditioning vendors to help it on its journey toward utility integration of its utility-scale microgrid with broader VPP and DERMS applications. It wanted to find out how easy it was to integrate devices from a variety of manufacturers and control platforms that might overlap.

The first use case to be demonstrated with the Enbala software upgrades is a sophisticated orchestration of different DER ranging from load banks, batteries, building loads, and even EV chargers to perform grid services such as automated DR. The question to be answered was this: When onsite demand is changed, how quickly can BTM

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assets drop down in response? While the GE controls platform optimizes these assets for internal equilibrium during normal operations, the Enbala software will be layered on top to interact with the grid and provide value upstream. This new software layer validates that the assets—generation, load, stationary, and mobile storage devices—could provide value beyond the confines of the microgrid.

The main objective of the DERMS application in this project, however, is to optimally coordinate the DER to meet a specified real and reactive power setpoint at the microgrid's point of common coupling, despite the intermittency in generation and passive loads. This demonstration of technical capabilities could then be translated more broadly to provide any ancillary services when called upon by an independent system operator.

This accomplishment with the DERMS sets the stage for the utility to explore additional DERMS applications, such as stabilizing fluctuations in voltage often concentrated in localized sections of distribution feeders. "We don't want to deal with individual customer behind-the-meter assets; we'd rather use advanced software algorithms and concepts such as AI to optimize an entire DER fleet," said Vikram Singh of Alectra. The microgrid in this pilot project can be considered a microcosm of what Alectra sees happening to its entire distribution system with increased proliferation of DER.

"We don't want to deal with individual customer behind-the-meter assets; we'd rather use advanced software algorithms and concepts such as AI to optimize an entire DER fleet."

– Vikram Singh of Alectra

4.2 Moving from Microgrid to VPP via Offsite EV Integration

The next phase of the VPP-DERMS pilot will reach outside the microgrid. It will integrate offsite EVs, building automation systems, solar carports, and Li-ion batteries into the VPP to mitigate potential demand charge costs increases for the host site—Alectra's head office at Derry Road in Burlington, Ontario—while paving the way for the provision of grid services to Ontario's Independent Electricity System Operator (IESO.) The Enbala Engine will be able to provide peak demand management, tariff management, and demand charge management by configuring peak demand parameters associated with each EV asset. Enbala's prediction model relies upon IESO monthly, weekly, and day-ahead system forecasts—as well as real-time weather data—to create day-ahead and long-term forecasts of IESO hourly Ontario energy prices.

Along with automated DR, this VPP can tap the diverse pool of assets (in two different locations) in the microgrid and the offsite EV charging station to provide regulation services. It can respond to small moment-to-moment fluctuations in frequency in the regional distribution grid. Utilities will increasingly find DER devices being sold to their

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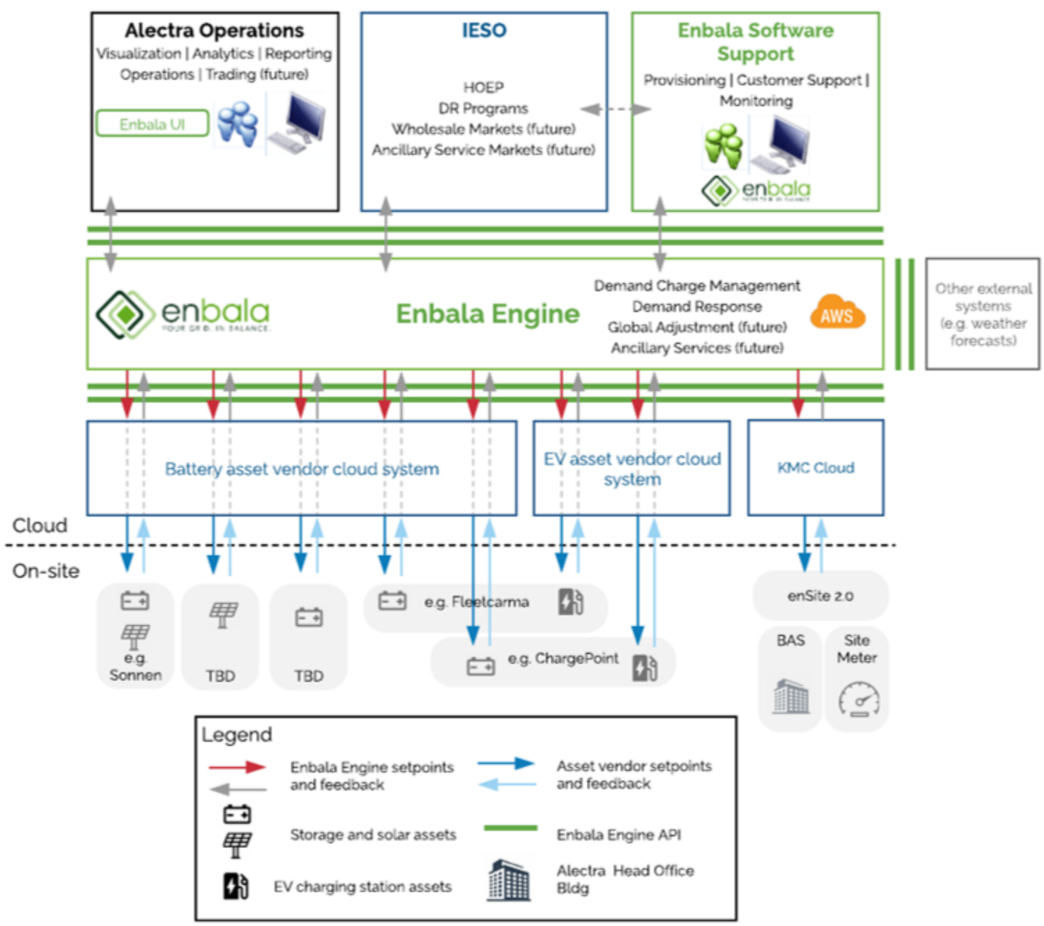
customers from a variety of vendors. The approach being validated in this phase two project is the ability to rely upon a cloud-to-cloud application programming interface integration of devices. Such devices include battery systems offered by Sunverge and sonnen, two market leaders in the residential solar + storage market. Future challenges will also include the integration of additional solar inverters and solutions from various EV supply equipment providers.

Among the challenges facing utilities moving toward the VPP model is this: What if an asset associated with two or more VPPs is simultaneously optimizing to deliver multiple grid services? The Enbala Engine can perform cross-service analysis to dispatch assets that will offer the most value for both the prosumer and the host distribution utility. The parallel VPP will then reconfigure its DER portfolio to call upon alternative assets to deliver the requested grid services to meet any market signal or contractual obligation.

Figure 4-2. Demonstrating the Optimization of DER via the Energy Cloud



(Source: Enbala)

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4.3 The Utility Rate Base Question

Many utilities in North America have struggled to make the business case to regulators for rate-basing investments in platforms that aggregate, control, and optimize BTM assets. For example, many proposed utility microgrids that were intended to be financed with ratepayer funds in the US have been rejected by state regulators. Recently, however, Commonwealth Edison was successful after a campaign that lasted more than 4 years. The funding will allow two adjacent microgrids to coordinate their operations, essentially creating a VPP.

Many utilities in North America have struggled to make the business case to regulators for rate-basing investments in platforms that aggregate, control, and optimize BTM assets.

Alectra will soon explore how to quantify the business case for non-wires alternatives and whether substituting DER in lieu of traditional, often expensive, distribution system upgrades makes economic sense. The utility is evaluating municipalities within its service territory where the customer demographics and energy growth forecasts could serve as an initial proving ground for how such alternative investments may be practically integrated with its existing operational systems.

In such regions, Alectra wants to explore how DER optimization via VPPs and DERMSs could mitigate the peak demand growth with prosumer assets. The company's success with its Power.House project—whereby 20 solar + storage systems were deployed in specific locations most beneficial to Alectra—is helping to inform its strategy for the utility's DER expansion initiatives moving forward. By partnering with software and hardware vendors across the industry, Alectra is seeking to expand its Power.House pilot to quantify the system benefits from the fleet optimization of a higher penetration of customer-sited loads and generating assets. These BTM assets can displace more traditional utility upgrades only if Alectra integrates prosumer assets into its control and communications architecture, including the utility's SCADA system. That is the only way for this potential fleet to provide power factor correction, frequency regulation, and capital deferral benefits to the utility and its ratepayers. The aim of this third VPP/DERMS project is to implement such an IT/OT integration strategy.

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Section 5
CONCLUSION: THREE KEY TAKEAWAYS

5.1 New DER Solutions Are Necessary Due to Market Growth

Navigant Research forecasts that more DER capacity will come online than centralized generation globally in 2018. This is a watershed moment in the history of electricity. The gap between distributed resources—different forms of generation, load, and storage—and centralized fossil and nuclear capacity will only widen over time.

The gap between distributed resources—different forms of generation, load, and storage—and centralized fossil and nuclear capacity will only widen over time.

What this means is that without adaptive, self-learning, and nimble aggregation and optimization platforms, these disparate resources could create chaos on the utility grid. Both financial innovation via third-party VPPs and precise utility management and control will be necessary to squeeze the most value out of DER assets. Can prosumers lower their bills and carbon footprints while also providing value to the distribution utility? Rather than relying upon centralized fossil generators to keep the system in balance, just the right mix of DER (organized as a fleet) can manage the frequency, voltage, and other nuanced aspects related to the physics governing the reliability of the grid. Microgrids, VPPs, and DERMSs will all play a role in this transformation.

5.2 New Products and Services Designed for Utility Priorities

Vendors around the world are offering new products and services designed to make sense out of an emerging energy landscape that continues to evolve over time. This is an incremental journey. Defining the roles of hardware, software, and middleware in this new market is being supported by rapid innovation in the IT/OT space. Concepts such as Internet of Things and transactive energy are quickly being adapted and adopted to serve even more sophisticated relationships between consumers, prosumers, utilities, legacy providers, and regulators. The recognition that staying connected to the larger utility network may be a better deal than abandoning the grid to achieve total self-sufficiency through grid deflection is an argument that utilities such as Alectra are seeking to articulate and validate.

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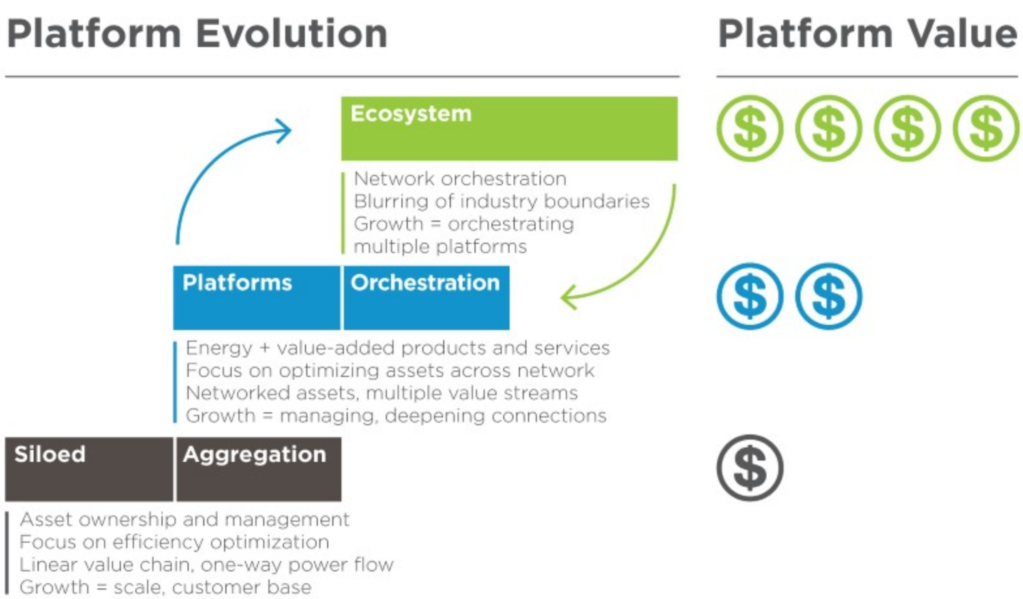
5.3 Merging of VPPs and DERMSs Offers Synergy Solution

The ability to seamlessly switch between VPP and DERM applications synergistically grows the market for DER management beyond what would be possible if these platforms were developed in silos. Platforms have power. Aggregation allows for the creation of multiple value streams.

Ownership has always been posited as the best form of control. Yet, economic models are shifting. Today, direct ownership is less important when looking to create value than the scheduling and orchestration of these assets, the fundamental premise behind the concept of the Energy Cloud. Think Uber, Lyft, Airbnb, and VRBO. Navigant Research believes an Energy Cloud is emerging where software will increasingly be called upon to hold the larger grid network together. Software will blur boundaries between the roles of each market player, which will benefit all stakeholders, including those without their own DER assets. This flexibility, in turn, will also benefit the environment. At one point in time, an asset may be part of a microgrid. At another time, it may be a part of a VPP and then a DERMS. Software enables the repurposing of DER assets to fulfill their most valuable function in real time.

Figure 5-1. Energy Cloud Value Creation: VPP-DERMS Solutions Moving toward Ecosystem Approach



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In the end, the growth in VPPs and DERMSs—and platforms that combine these two applications—points to an evolution that underlies an emerging Energy Cloud.[4] The key to value creation starts with moving from silos to broader orchestrations of networks enabled by new platforms. The platforms being created today via partnerships between vendors and utilities will enable a diversity of services that will only blur boundaries that once separated consumers from prosumers, and C&I customers from utilities. In this new Energy Cloud paradigm, each stakeholder is part of a common solution ecosystem.

The key to value creation starts with moving from siloes to broader orchestrations of networks enabled by new platforms.

[4] Navigant Consulting, Inc., *Energy Cloud 4.0*, 1Q 2018, www.navigantresearch.com/research/energy-cloud-4-0.

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Section 6

ACRONYM AND ABBREVIATION LIST

ADMS .... Advanced Distribution Management System

AI .... Artificial Intelligence

BTM .... Behind-the-Meter

C&I .... Commercial and Industrial

CAGR .... Compound Annual Growth Rate

DER .... Distributed Energy Resources

DERMS .... Distributed Energy Resources Management System

DMS .... Distribution Management System

DR .... Demand Response

EE .... Energy Efficiency

EV .... Electric Vehicle

GE .... General Electric

IESO .... Independent Electricity System Operator

IT .... Information Technology

kW .... Kilowatt

Li-ion .... Lithium Ion

OT .... Operational Technology

PV .... Photovoltaics

SCADA .... Supervisory Control and Data Acquisition

US .... United States

VAR .... Volt-Ampere Reactive

VPP .... Virtual Power Plant

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Section 7

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Section 8
TABLE OF CHARTS AND FIGURES

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