Guidehouse

Integrated DER: Orchestrating the Grid's Last Mile

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1.0 Arriving at the DER Tipping Point

The global power and utility industry is changing dramatically. In the next 5-10 years, we will further convert to a model where decentralized decision makers manage (platforms of) distributed energy resources (DER). Energy providers, including utilities and others, must accelerate their internal transformation and become the orchestrators of a network of DER platforms that integrate the technology seamlessly into an integrated energy system and broader infrastructure platform. The diversity embedded in these DER (platforms), which are now expanding beyond electrons to molecules due to the integration of energy carriers such as hydrogen through solutions like power-to-gas, is a challenge but also a great opportunity.

1.1 Why iDER?

Navigating the energy transformation requires new approaches to integrating DER into the grid and onsite energy networks to bolster resiliency and foster sustainability. It also requires innovative business models that recognize previously hidden value for both end users and stakeholders across the broader energy system. A fundamental rethink of strategy and planning as well as organization and system operations that embrace DER networks and their underlying technologies will be needed for a successful transformation. The result will be a system better attuned to evolving demand and customer needs and more compatible with a rapidly changing policy and regulatory environment.

In this white paper, we lay out a vision and roadmap to greater realization of integrated DER (iDER), which describes a more dynamic and highly networked system of DER that can coordinate seamlessly with the bulk energy system. For energy providers, iDER represents a platform for ambitious ventures into system orchestration and value creation in the future energy system.

Realizing this vision requires intelligent DER integration that recognizes the need for innovative strategies to deliver increased value to all stakeholders. Key to this integration is better long-term planning and improved interconnection processes. This can support greater visibility of DER, shared control, real-time insights, and interoperability standards. Utilities and other stakeholders need to take a lead role in this emerging Energy Cloud ecosystem to maximize shared value from DER integration, enabling industry transformation to be sustained across the entire value chain.

1.2 Harnessing the Rapid Growth in Diverse DER Portfolios

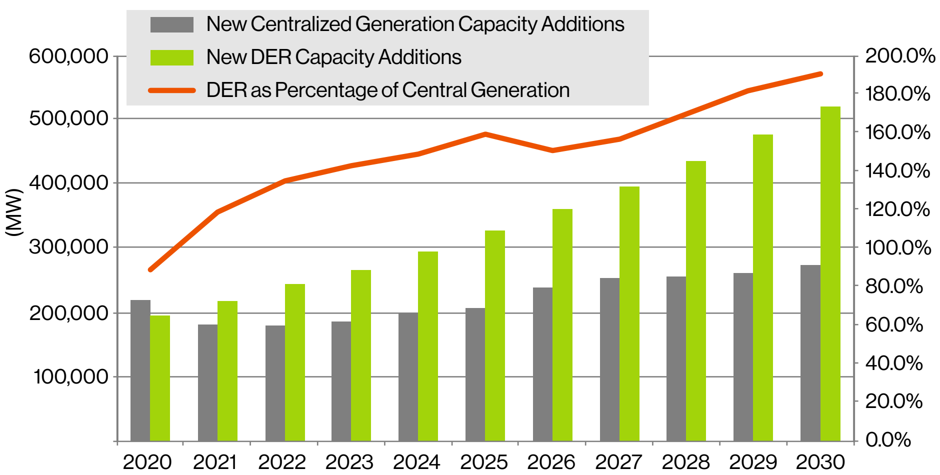
Declining technology costs for key DER assets such as solar photovoltaics (PV) and advanced energy storage systems (ESSs) — as well as business models linked to long-term financing offers — are driving accelerated adoption of smaller, smarter, and cleaner energy systems. The DER assets that underpin this shift can support a variety of mutually shared value propositions in the new energy landscape through value stacking and enhanced prosumer engagement. Combined with advanced management systems and enabling technologies that can integrate diverse DER portfolios into dynamic, optimized aggregations, DER assets once viewed as the most expensive available (such as solar PV) are projected to be the lowest cost options over time.

Increasingly, the capital costs attached to individual DER assets are dipping to grid parity in key global markets. It is already cheaper to build new renewables than to build new coal plants in all major markets. As a result, existing centralized power plants powered by coal and nuclear that once benefited from traditional economies of scale are being retired due to simple economics and stranded asset risk. While the specific responses vary, all global regions are seeing increased prioritization of a more resilient, sustainable, and affordable energy future, with DER a key piece in the future energy system puzzle.

The value of DER assets can only be fully realized if they are integrated into markets, customer sites, and the grid in a way that creates shared value. Most use cases for DER support electrification goals and focus on behind-the-meter (BTM) applications like onsite power generation, but they do not support the larger grid network or incumbent utility suppliers. Still, existing and planned additions of centralized generation around the world greatly influence the proportion of DER technologies that can be accommodated within the existing system. These commitments may crowd out DER capacity additions if demand for energy is lower due to external factors, such as the coronavirus outbreak. These centralized generation systems may also rely on renewable energy such as wind, which would boost the need for a flexible system to manage the load with smaller generators and help balance the variability of output.

Chart 1-1 compares expected new DER capacity additions with centralized generation capacity additions on an annual basis globally. Although many DER assets are deployed as redundant power or backup generation, DER deployments overall — including conventional and renewable distributed generation, flexibility resources, and electric vehicles (EVs) — are expected to keep pace with centralized generation in all regions during the forecast period. This development will likely result in a significant shift in not only grid structures, but also with the trajectory of market evolution, the fate of incumbent market players such as utilities, as well as the ability of consumers to become prosumers.

Chart 1-1. Centralized vs. DER Annual Capacity Additions, World Markets: 2020-2030



Source: Guidehouse Insights

By 2030, new DER capacity additions will be nearly twice the capacity on an annual basis as centralized generation systems. For conventional utility industry paradigms, this trend would be significantly problematic. However, if DER can be orchestrated by market participants at scale, these assets can enhance the value of energy and power infrastructure across the value chain and activate a broader stakeholder ecosystem that creates and receives value in dynamic markets.

The shift away from centralized generation requires integration platforms that can aggregate, organize, optimize, schedule, and settle rapid-fire transactions that are necessary to keep the grid in balance. Advances in power electronics enable DER assets to resolve grid impacts issues through smart inverters and direct current (DC) networks. Advanced software that enables greater control and interoperability across heterogeneous grid elements is key to the success of fully realizing the increased value of iDER. Nurtured by artificial intelligence

(AI) and machine-learning algorithms, iDER solutions may serve different stakeholders. However, these solutions are also aimed at a common purpose: supporting a more nimble, sustainable, and customer-centric energy future — what Guidehouse refers to as the Energy Cloud.[1]

1.3 Launching an iDER Strategy

This white paper maps out recommended steps stakeholders should take over the next 5 years to accelerate an iDER strategy. The transition to widespread reliance on iDER may take a decade in some regional markets, while the need is imminent in other markets. Several regional markets are charting their course given their resource base, pace of regulatory reform, and leadership.

As one reference, consider New York State in 2040. If current DER and renewable energy deployment trends continue, it is possible New York could feature:

- 100,000 buildings offering flexible demand response (DR) loads
- 5,000 MW of distributed energy storage devices deployed behind and in front of the meter
- 9,000 MW of offshore wind
- 250,000 solar plus storage systems installed at residences
- 100,000 EVs plugged into distribution networks

That future is very different from the world we live in today. AI, machine learning, blockchain, and transactive energy, which are deployed across numerous use cases spanning multiple industries, will be critical in orchestrating these diverse fleets of DER. This orchestration will no longer be solely top-down — it will shift to be increasingly decentralized, autonomous, and more importantly, aggregated. The only way to meet the sustainability, affordability, and decarbonization goals set forth by public and private sectors is to reinvent utilities and allow for better orchestration of flexible loads, generators, and energy storage to deliver value across the entire Energy Cloud ecosystem. Stakeholders that move now to embrace iDER will be better prepared to reap the rewards sooner.

Starting in Section 2 of this white paper, **Harnessing iDER Value**, we explore valuing DER assets, the shifting relationship among stakeholders, and linkages with adjacent infrastructure markets. Section 3: **Future iDER Scenarios** explores two scenarios for iDER evolution and the energy market impacts. Section 4: **Preparing for Accelerated iDER** outlines Guidehouse's recommendations for fast-tracking iDER strategies and embracing ubiquitous iDER. Finally, the white paper concludes with Section 5: **Launching iDER**.

2.0 Harnessing iDER Value

2.1 What Does True iDER Look Like?

The value of DER assets is not fully recognized today regardless of where it is deployed. As DER assets continue to grow in number and installed capacity and integrated in ways to create value, strategic investments will need to be guided by a roadmap. This white paper describes fundamental principles that should guide future investments and innovation. In short, the rules of the game need to be clearly articulated so utilities and the rest of the Energy Cloud ecosystem can more effectively coordinate. Instead of viewing iDER from opposite sides of the spectrum, there is significant common ground that can facilitate coopetition among stakeholders. It will be critical to establish markets where value can not only be created but shared in a transparent and economically efficient manner.

The precise mechanics of iDER will vary across regions, market segments, and specific applications. Some high-level rules of engagement can inform strategy, paving the way to a more sustainable, affordable, and resilient infrastructure future. Leading with an initial focus on electricity, this roadmap will need to be expansive, flexible, adaptive, and financially sound. To meet these goals, four critical industry shifts are described in the following sections.

2.1.1 Smash Through Internal Utility Siloes

Most utilities are built around bureaucratic structures that foster expertise and specialization while maintaining a cohesion centered around a common purpose. In large organizations, balancing the need for uber specialists and big idea generalists is difficult, especially during a time of extreme change. Just as energy resources options were historically addressed in siloes — separating, for example, supply and demand — the teams addressing these two sides of the energy balance ledger need to be increasingly integrated at any organization or company.

In some ways, there is even greater demand for specialists today given the increase in evolving DER technologies and sheer volume of data required to manage a complex grid. Not only do supply and demand experts need to be brought together, but distribution and transmission systems will require tighter coordination and integration.

It will be difficult for utilities and other market players to successfully navigate this transition to a more integrated energy future without reforms to internal organizations that traditionally leaned toward siloed solutions. New skill sets and capabilities will also be valued in an Energy Cloud future. Internal dynamics need to reflect external outcomes. As solutions initially aimed to solve electricity issues expand to other adjacent infrastructure needs (including heating, cooling, mobility, and water), cross-purpose teams seeking out integration synergies will become only more crucial.

1. Guidehouse, Energy Cloud 4.0: Capturing Business Value through Disruptive Energy Platforms, 1Q 2018, https://guidehouseinsights.com/reports/creating-an-agile-energy-cloud-platform.

2.1.2 Build Bridges Between Retail and Wholesale Markets

With the right combination of software and hardware, iDER platforms such as virtual power plants (VPPs) can be tuned to deliver value to markets at a specific point in time.

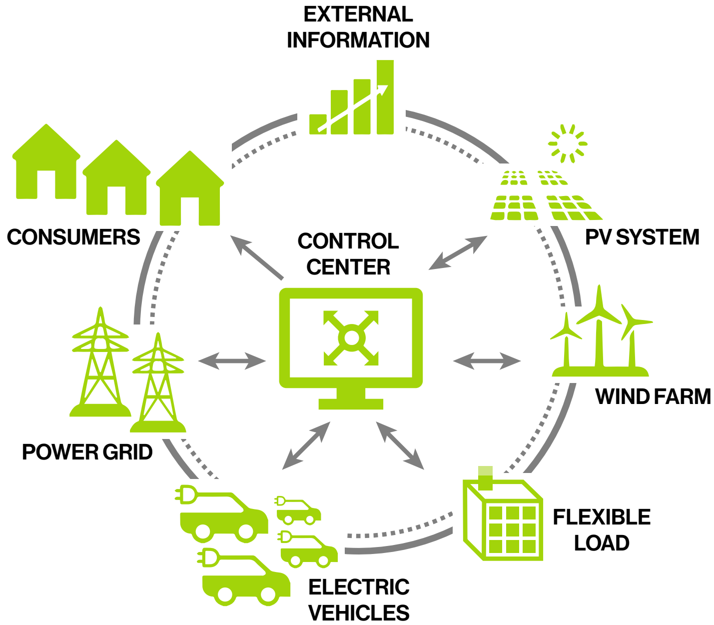
VPPs, a system that relies on software and a smart grid to remotely and automatically dispatch iDER services to a distribution or wholesale market via an aggregation and optimization platform, can aggregate heterogeneous DER to make the services these resources provide resemble conventional and dispatchable 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 AI algorithms could mimic the same essential services provided by a fossil or nuclear plant. VPPs deliver the same services (and more) as a traditional power plant without the liabilities associated with land use, air emissions, waste management, and stranded asset risk.

> VPPs rely on software and a smart grid to remotely and automatically dispatch iDER services to a distribution or wholesale market via an aggregation and optimization platform.

At the same time, VPPs help transform formerly passive consumers into active prosumers through the integration and optimization of the full gamut of available DER assets. Prosumers are active participants that deliver services tailored to their own needs and preferences while also serving the larger grid.

The key value of a VPP is building bridges between prosumers and the power grid that links retail and wholesale markets. This bridge can help resolve grid-balancing challenges with both BTM and front-of-the-meter (FTM) resources. At the same time, VPPs integrate supply, demand, and storage into temporary iDER portfolios that meet the real-time needs of markets. As the world shifts to greater reliance on iDER to meet new demand and related grid services, all potential DER assets need to be accounted for and optimized. Without bridging retail and wholesale markets with distribution and transmission systems, the promise of iDER falls short.

Figure 2-1. Virtual Power Plants



Source: Guidehouse Insights

2.1.3 Develop Tools to Mitigate Grid Reliability Challenges Linked to DER

VPPs harness iDER to maximize economic value. While VPPs can resolve frequency regulation challenges on grid networks, the primary drivers behind this iDER framework remain releasing economic value from DER assets. That value cannot be sustained unless the underlying multidimensional physics of electricity are maintained and balanced in real time.

Despite their diminishing role in managing the entire electricity and natural gas supply chain, utilities historical obligation to serve is still in place. Without direct ownership of many of the assets that integrate into their distribution and transmission networks, utilities are focusing on how to best reinvent themselves. A major focus during this change is contributing to iDER management on the distribution system, the part of the grid that touches most customers directly and where DER assets typically integrate with the larger grid network.

The emergence of DER management systems (DERMS) is driven by utilities' need to maintain overall reliability. Utilities are in a tight spot because they increasingly do not own the assets they will be depending on to maintain the reliability of the grid. There is an urgent need from the market for utilities to still play a key role by using new tools to transform iDER concepts into a practical reality and continue to maintain the security and reliability of the system. Orchestrating such large fleets of assets owned by multiple parties could introduce a massive system vulnerability, if not managed properly. If cybersecurity is baked into these control systems, the grid could become more secure, not less, due to the lack of a single point of failure.

The Guidehouse definition of DERMS is as follows: "A software control system typically deployed by utilities to optimize DER assets and maintain the reliability of the distribution system through use cases such as active power management, voltage issues, and other services that support utility operational needs."

Utilities and other grid operators use DERMS to manage individual DER assets into a single integrated system. Rather than relying on proprietary communication protocols for each vendor and device, DERMS use common protocol standards to centrally administer all DER assets located on a utility network. This construct saves the operator from having to manipulate multiple systems from multiple vendors for multiple device types, which would make the management of DER almost untenable from a staffing and operational position.

The DERMS umbrella is broad, and its purview and capabilities to support iDER on the grid-edge will only grow over time. As more diverse DER assets populate regional grids, utilities and grid operators will require constant fine-tuning to deliver reliable electricity and other energy services. One of the challenges DER poses to the electricity system is the diversity and sheer number of DER assets that will be present on the grid in the future. For this reason, DERMS need to be capable of forecasting and optimizing millions of DER assets and processing high volumes of data in near real time.

Case in Point:

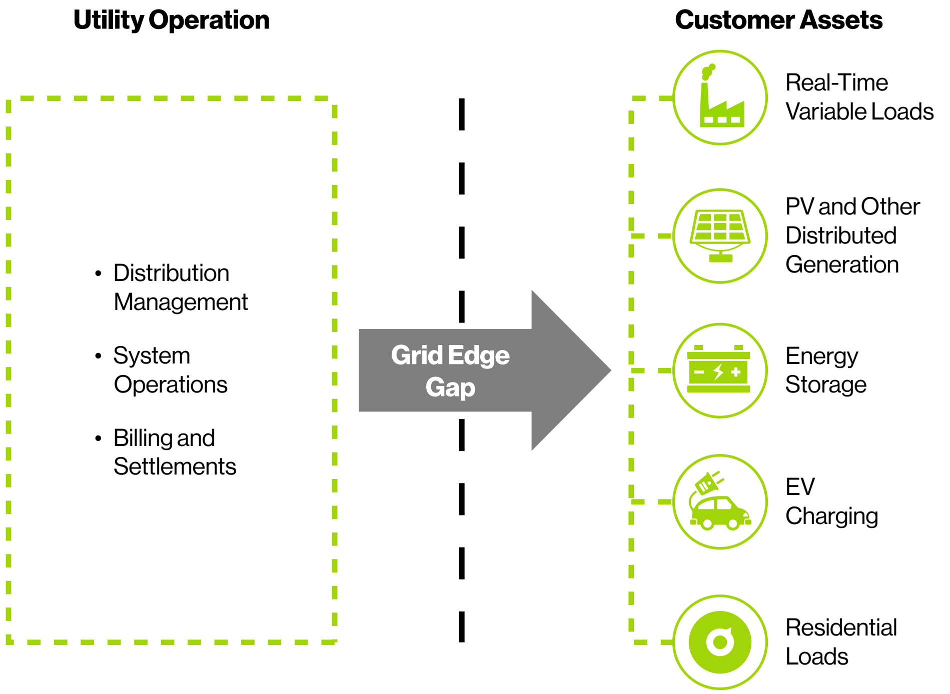
AGL Energy (AGL) is expanding into the VPP market by aggregating the battery systems of 1,000 households with rooftop solar PV in Adelaide, South Australia. The VPP, totaling 5 MW in capacity, will optimize DER coordination to maximize the overall benefits across utility customers, wholesale markets (energy and ancillary), and network service value streams. While not the largest VPP in terms of capacity or customer number, it is among the most sophisticated due to the variety of vendor assets (three kinds of batteries) involved and grid services rendered.

Almost 25% of homes located within AGL's service territory (1.7 million prosumers) feature rooftop solar PV systems, illustrating the scope of potential assets available to include in VPPs. AGL launched two separate offers to the residential sector for this VPP project:

- $1,000 upfront payment toward the cost of a battery system (in addition to a government grant of up to $6,000) for residents who are intent on joining the VPP.
- Ability to earn an additional $280 over the first 12 months by joining the VPP program and agreeing to provide grid services when called upon. This deduction from their electricity bills consists of a $100 sign-on bonus and a quarterly $45 payment.

DERMS is a software control system typically deployed by utilities to optimize DER assets and maintain the reliability of the distribution system through use cases such as active power management, voltage issues, and other services that support utility operational needs.

Figure 2-2. DERMS Designed to Close the Grid-Edge Gap



Source: Guidehouse Insights

2.1.4 Boost Resiliency via Microgrids to Extract More Value from DER

While both VPPs and DERMS are iDER strategies that can help bolster reliability, a microgrid's primary domain is resiliency.

Guidehouse defines a microgrid as a distribution network that incorporates a variety of potential DER assets that can be optimized and aggregated into a single system to balance loads and generation. In addition, microgrids are capable of islanding in the event of a grid outage — whether planned (e.g., a DR call) or unplanned (e.g., hurricane, wildfire, or earthquake) — regardless of whether it is connected to a traditional utility power grid or not.

> A microgrid is a distribution network that incorporates a variety of potential DER assets that can be optimized and aggregated into a single system to balance loads and generation. Microgrids are capable of islanding, connected to a traditional utility power grid or not.

The majority of microgrids remain retrofits to existing DER installations. Historically, resiliency has been provided by backup diesel generators, often only tapped when the power grid fails — and these operations were often limited by air emissions regulations. A typical microgrid would leverage these assets into a defined network with boundaries that can be self-sustaining through a combination of DER assets; these assets would operate in parallel to the grid during normal operations but be able to disconnect and continue providing reliable energy services without compromising regional and local air quality regulations. A microgrid offers the following iDER services:

- Respond to emergencies
- Optimize cost and carbon reductions
- Serve as a platform for other infrastructure needs

Case in Point:

In 2012, over 250,000 Montgomery County, Maryland residents and 71 county facilities were without power for multiple days due to a severe storm. Coupled with aging infrastructure (some of which dates back half a century), this had the county looking at options for upgrades that could bolster its resilience in light of increasing extreme weather events.

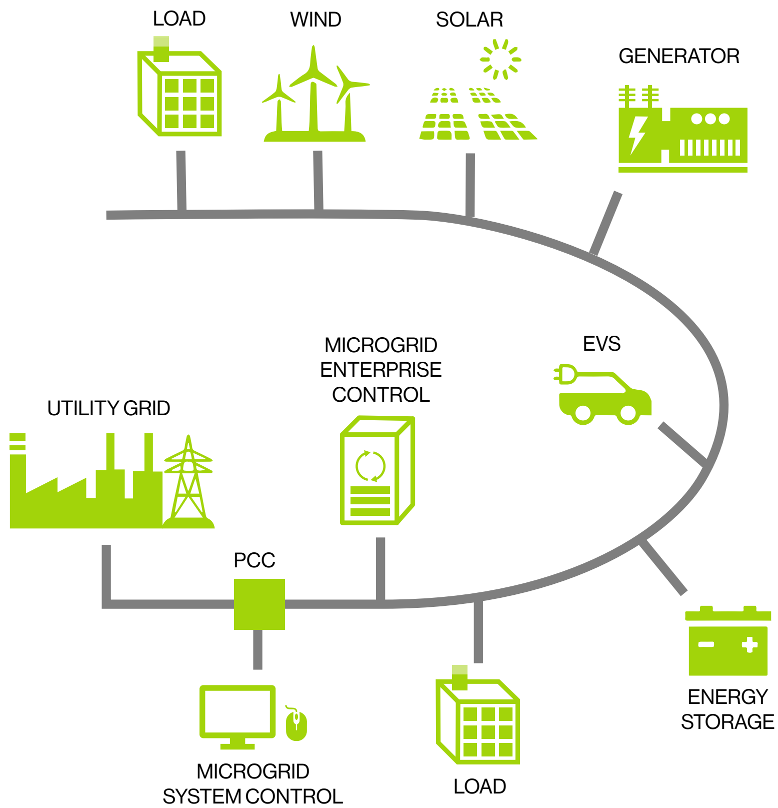
Montgomery County achieved carbon neutrality in 2016 but was still seeking greater efficiency and resilience. In 2017, the county set an aggressive goal of an 80% reduction in greenhouse gases by 2027 and a 100% reduction by 2035.

To help comply with these interconnected targets, the local government moved forward with two microgrids in 2017. These microgrids help Montgomery County meet its policy goals to dramatically increase resiliency, efficiency, and sustainability without exposing the local government to large capital expenses. Solar PV and natural gas and diesel generators allow the county's critical facilities to operate independently of the electrical grid, ensuring uninterrupted public services during emergencies. The microgrid also includes a combined heat and power system, which saves energy by using waste heat from onsite power generation to heat buildings and to provide chilled water via absorption chilling.

The project was funded through an energy as a service arrangement that put the risk of performance on Schneider Electric, which provided electrical infrastructure that would have otherwise cost the county over $4 million. The investor was Duke Energy Renewables.

Figure 2-3 is a simplified diagram highlighting the components that may be integrated into a single microgrid. Note that the enabling technologies featured for a microgrid focus on different forms of distributed generation (DG) but also include energy storage, loads (such as a building's HVAC system or a factory's manufacturing process), and EVs. Though resiliency through islanding is its distinctive feature, microgrids can respond to decarbonization goals by shrinking carbon emissions from backup fossil generators while extracting value from DER when the larger utility grid goes down. In this latter scenario, one could argue this is when DER assets can provide the highest value.

Figure 2-3. iDER Platform: Microgrids as Climate Change Mitigation Strategy



Source: Guidehouse Insights

2.2 Value of DER Assets Multiplies When Integrated in the Right Way

The value of DER assets is typically measured by the capital expense attached to their purchase. However, the value of each asset to the commonly shared power grid grows exponentially if integrated with other DER assets in a smart and nimble way, even as the capital cost declines. One could argue this is the best of both worlds: lower cost but better value. With the right markets and platforms, a well-designed iDER strategy can provide electricity, power, and grid services, along with supporting clean mobility, smart homes, and other infrastructure needs. Markets do not currently account for all of these values because regulatory structures still lean toward siloed valuations.

For example, markets also do not recognize the value of resiliency provided by microgrids despite this being their primary value proposition. Provided one deploys a reliable control system for the microgrid, the more diverse the DER pool, the more resilient and valuable that microgrid becomes. For VPPs, a similar argument can be made, though the focus of integration is less on economic efficiency and the ability to effectively deliver grid services such as frequency regulation. With DERMS, an inverse relationship exists with DER. In this case, the greater the DER diversity, the more difficult the task of maintaining the physical security of any grid. Yet, the need for DERMS also builds the business case for iDER.

While iDER concepts like VPPs and microgrids are not mutually exclusive, over time, distinctions among different iDER strategies will be shaped by nuanced business models and customer application priorities. Today, each of these early iDER strategies have three primary functions in common that are necessary to harvest the most value from DER portfolios:

- **Forecasts** on demand, weather, market prices, and other factors all shape the viability and value of iDER aggregations. Key to extracting maximum value are real-time adjustments to generation, load, and energy storage to sync up with current weather patterns affecting resource availability, fluctuations in other available resources, and other market conditions.
- **Real-time monitoring** is also vital to ongoing operations, economics, and the reliable delivery of energy and grid services. While the degree to which monitoring is critical for any specific iDER service will vary, situational awareness often drives the ability to deliver on the terms of a contract.
- **Optimized dispatch** is the core driver behind iDER. This is where the most value is created, both at the prosumer site and in distribution and transmission markets. While market structures create and limit the value delivered, optimized dispatch is where the performance of an iDER will be determined.

While iDER concepts like VPPs and microgrids are not mutually exclusive, over time, distinctions among different iDER strategies will be shaped by nuanced business models and customer application priorities.

Figure 2 4. iDER Balances Forecasts with Asset Optimization Enabled by Real-Time Monitoring

FORECASTING

A DERMS must be able to accurately forecast in real-time how much generation and peak load reduction would be available under a given DER program, all the way down to the level of individual customer assets.

These forecasts need to be calculated at different lead times and at different levels of aggregation.

MONITORING

Real-time monitoring of a large number of DER becomes critically important as:

- More DER are interconnected to the system
- More customer loads are otherwise hidden from system operates (phantom load)

Real-time monitoring improves situational awareness and increases operational visibility, leading to greater efficiency.

CONTINOUS DISPATCH AND OPTIMIZATION

DERMS need to look at opportunities to provide value at three different levels at any point in time:

- BTM self-consumption
- Distribution grid level
- Transmission grid level

To do this, a DERMS need to understand:

- Local supply and demand needs
- The tariffs customers face
- The markets or utility programs in which DER can participate

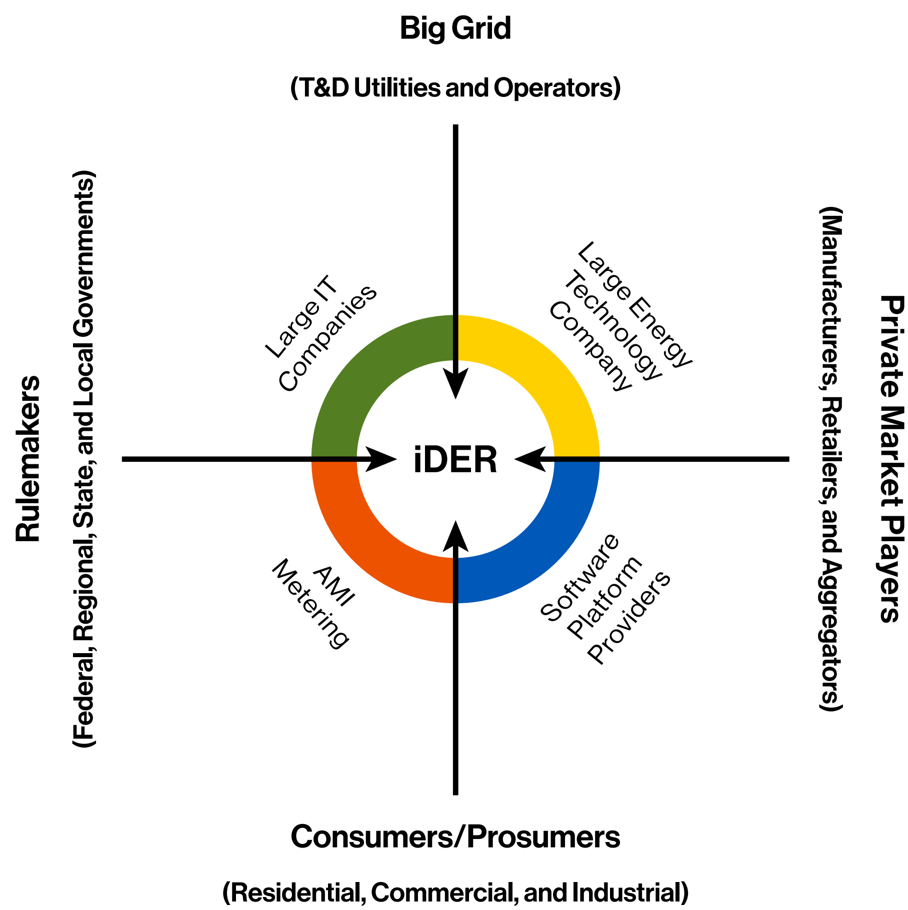
Source: Guidehouse Insights

Case in Point:

Green Mountain Power of Vermont is showing how an investor-owned utility can partner with the private sector to deliver clean backup power to its customers. The utility is partnering with Tesla to substitute lithium ion batteries for traditional grid modernization installations in a Resilient Home pilot program. The utility is embracing the prosumer concept of bring your own devices, making it the center of its iDER strategy. With a goal of 100% renewable energy by 2030, this pilot program, which the utility hopes to rollout across its entire customer base, was started with 1,000 Resilient Homes and then expanded to 2,000 homes. The utility is comparing flat fees to more dynamic pricing as well as direct deployments versus third-party installations. During a major storm in late 2019 that caused widespread power outages, homes featuring the Tesla Powerwall and other batteries kept the lights on, with batteries offering an average of 9 hours — and as many as 82 hours — of backup power. The utility is now seeking regulatory approval for a permanent storage tariff that would allow complete home backup power for roughly $50 per month.

The three principles outlined are high-level descriptions of key functions critical to the full realization of iDER. Incorporating all three functions maximizes value across the Energy Cloud stakeholder landscape. The players involved in this rich web of innovation are diverse, each representing a different side but all participating in transactions that tap the once-hidden value embedded in DER assets. Through forecasting, continuous monitoring, and dispatch, these assets provide bidirectional value exchanges while supporting onsite and big grid needs.

Figure 2-5. iDER Increases Value Across the Energy Cloud Stakeholder Landscape



Source: Guidehouse Insights

2.2.1 Linking iDER to Global Infrastructure Trends

The decarbonization of the global energy sector is gaining significant traction and iDER will play a significant role in shifting investment away from fossil-based centralized generation. One could argue iDER is part of a broader grid modernization movement. It is the next iteration of trends that originated with public investments in advanced metering infrastructure during the Great Recession a decade ago. Advanced metering infrastructure (AMI) was the first step to increasing situational awareness on power grids.

Reducing overall demand for electricity through creative demand side management is also fundamental to sustainability and economic savings goals. Many of the solutions deployed as part of a broader iDER platform — including VPPs, DERMS, and microgrids — are multipurpose, offering benefits to other emerging Energy Cloud infrastructure needs such as Building-to-Grid[2] and Transportation-to-Grid.[3]

While the focus of iDER is on electricity, the integration of molecules into the system, and non-energy services delivered across iDER platforms, many of the concepts, business models, and integration principles apply to a wider swath of public and private infrastructure. Deeper integration will be necessary across infrastructure needs, with smart cities perhaps emerging as the ultimate example of how coordination and integration boost value and economic and environmental advances for multiple stakeholders.

2.2.2 Clean Mobility Technologies as iDER Enabler

The projected growth in plug-in EVs (PEVs), like other DER assets, offers both challenges and opportunities to distribution utilities. If not managed in an intelligent way, these PEVs can pose a severe threat to overall grid reliability. If aggregated and optimized with smart controls, they can offer diverse grid services as part of an iDER solution.

The addition of PEVs to the iDER solution mix is important because a tipping point is steadily approaching for PEVs to become mainstream consumer offerings. By 2030, government vehicle fuel efficiency regulations combined with continued development of advanced battery chemistries and manufacturing capacity are likely to make PEVs cheaper to purchase than liquid or gaseous fuel-powered vehicles. For the electric power sector, this growth is a boon, but a boon that requires active iDER management. While basic load growth is good for the sector, the uneven distribution of that growth within a specific location or at a specific time of day will need to be managed.

Vehicle grid integration (VGI) enables PEVs to participate in grid-balancing schemes as generation or demand assets for grid operators; it also allows PEVs to perform similar balancing options for smaller subsets of the grid, including microgrids and VPPs. PEVs may do so by modulating the rate of power at which its battery is charged, known as V1G (unidirectional VGI) or by providing power back to the grid, known as vehicle-to-grid (V2G). In practical terms, the difference between the two is that V2G enables PEVs to participate in grid services to a greater extent than V1G systems do. The key to realizing the potential for VGI and V2G resources to be tapped as part of an iDER strategy revolves around technology advances and creation of viable markets. Use cases for both V1G and V2G as gateways to add value to microgrids and VPPs include the following:

- Reduce negative impacts of EV charging loads on grid stability
- Provide frequency regulation and voltage support for power grids
- Enable mobile energy storage devices as a grid-balancing resource

2. Guidehouse, Building-to-Grid: Industry Transformation for Flexible, Integrated, Value-Generating Resources, 4Q 2019, https://guidehouse.com/insights/energy/2019/building-to-grid.

3. Guidehouse, Transportation-to-Grid: New Business Models to Capture Value in the Energy Cloud, 3Q 2019, https://guidehouse.com/insights/energy/2019/transportation-to-grid.

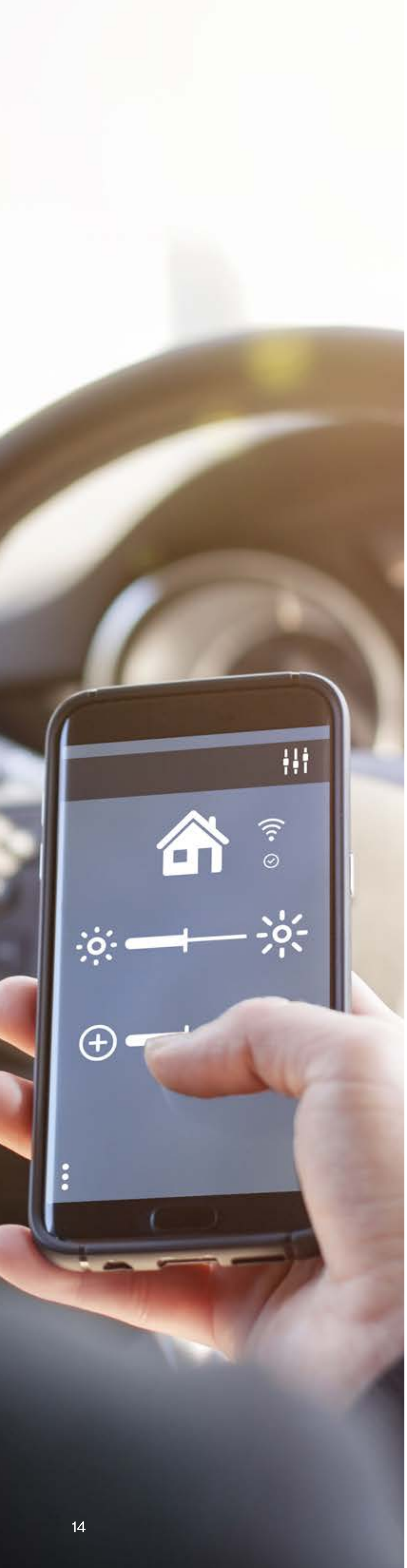
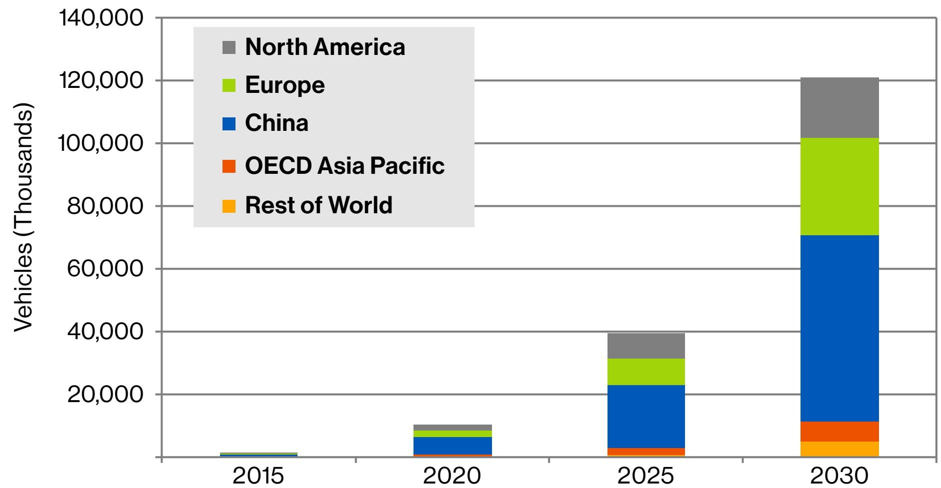


Chart 2-1. PEV Population by Region, World Markets: 2015-2030



Source: Guidehouse Insights

The exponential growth in PEVs between 2015 and 2030 reveal the growing linkages between mobility and electricity infrastructure. These linkages will pose challenges to existing grids not designed to accommodate such loads populating the grid, both at the residential level and at private and public campuses. The promise underscoring iDER is transforming what was viewed as a challenge into an opportunity — in this case, using EV batteries and charging infrastructure as DER assets that can provide resiliency as temporary stationary storage, modulate loads by serving as DR, or serve as an asset to provide frequency regulation services via a VPP aggregation.

Case in Point:

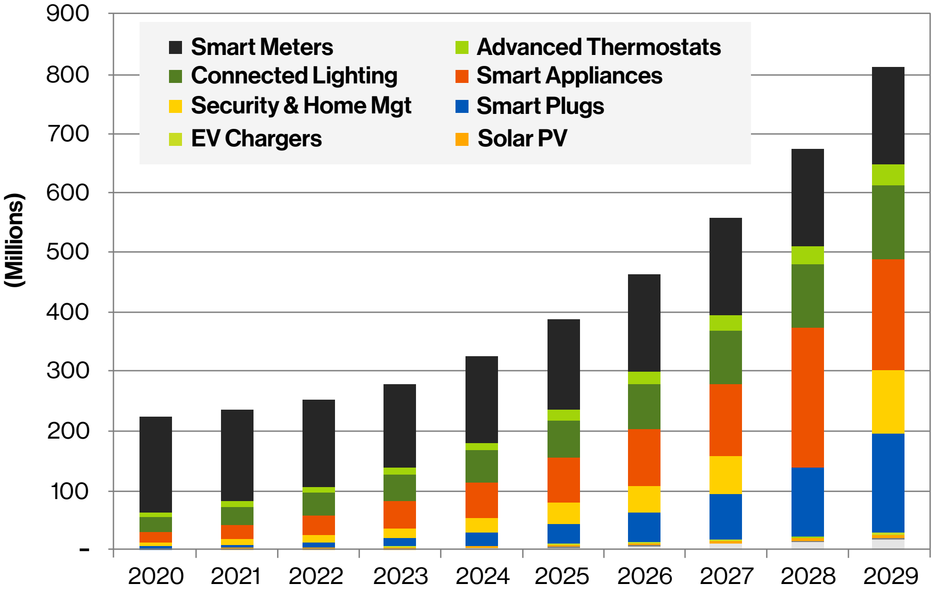
One of the largest iDER experiments in the world is at Jeju Island in South Korea. Commenced in 2009, the deployment and optimization of PEVs is one critical aspect of the research, which is exploring the nexus between smart transportation, smart electricity services, and smart grid. The PEVs, and their ability to provide grid support, are being managed by recognizing the state of charge of the mobile batteries and the market-responsive behavior of the PEV aggregators. The lessons learned from these tests are to be incorporated as Jeju Island seeks 100% carbon-free energy by 2030. The PEV population is forecast to reach 371,000 by 2030, supported by 75,513 charging stations. These PEV fleets are a crucial and integral part of the project's strategy to address the variability of wind and solar energy as all fossil fuels are phased out.

2.2.3 Internet of Things and Smart Buildings

The residential Internet of Things (IoT) market continues to gather significant momentum as connected devices bring new comfort and control functionality to consumers. This momentum is part of a megatrend in which an emerging array of technologies empower consumers with choices for increased home automation and energy efficiency. As such, the number of connected devices shipped annually is projected to grow more than fivefold over the next decade. As consumers adopt more connected devices, they face challenges in how to integrate these devices and derive benefits from a more automated and efficient home. When optimized through digital communication driving real-time operations, smart homes and other smart buildings incorporating IoT represent another form of iDER, this one connecting clean mobility and buildings as DER assets available for grid applications.

Smart thermostats, solar PV installations, connected lighting, and EV charging systems are among numerous products consumers are purchasing and connecting to home area networks and, in turn, to electricity grids. The result is an emerging paradigm where traditional utility customers have more affordable tools for automating their homes with greater energy efficiency. Guidehouse Insights expects this trend of automation of connected potential DER in homes to continue as industry stakeholders meet the demand to integrate disparate devices that create a smarter and efficient home, thus contributing to a more diverse, resilient, and bidirectional power market. The ability of iDER strategies to manage this array of potential yet tiny DER assets is key to the concept of prosumers. It also expands the potential resource base for an emerging Energy Cloud paradigm that only will work with expanded iDER use cases.

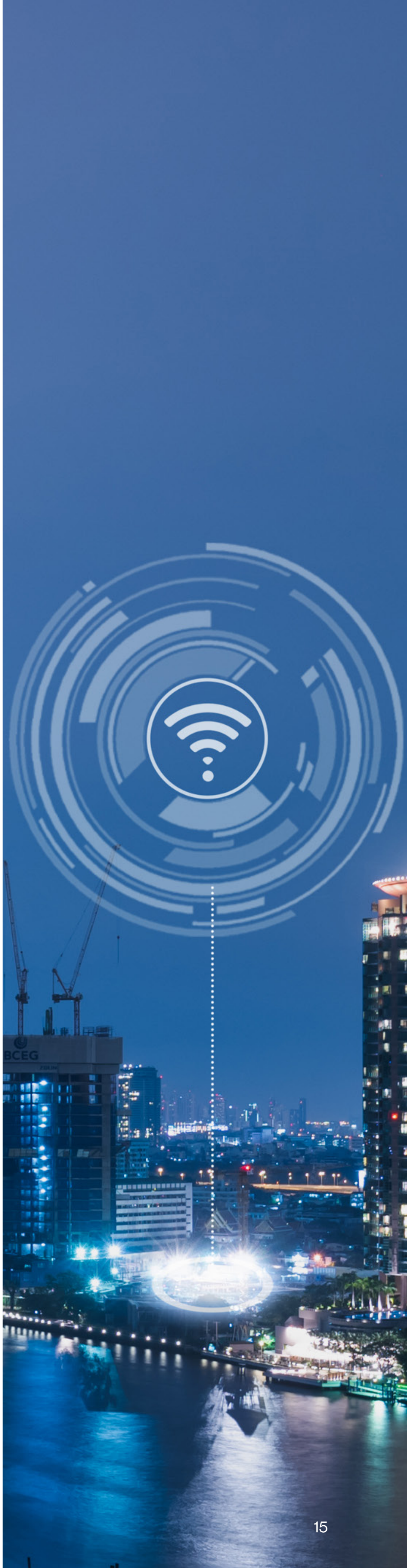
Chart 2-2. Annual Residential IoT Hardware Shipments by Device Type, World Markets: 2020-2029



Source: Guidehouse Insights

Moving iDER beyond the residential sector to commercial and industrial buildings opens up another set of possible solutions to future infrastructure needs. The effects of iDER deployments on these buildings are more advanced and much more significant. The relationship between building energy supply and demand is still evolving, but in a direction consistent with iDER.

For example, intelligent buildings use data analytics to direct automation and controls to optimize energy consumption, comfort, and experience. These digital, future-ready buildings use information technology (IT) to coordinate building operations with other onsite DER assets like solar, storage, or EV charging infrastructure. Synergies will emerge between utilities, technology and service providers, and building owners as traditional market roles give way to a more fluid, competitive ecosystem. As an increasingly dynamic, flexible, and intelligent building stock achieves seamless interaction with an evolving grid infrastructure that prioritizes clean, distributed, mobile, and intelligent market systems, significant value creation opportunities will emerge. Among the key questions that still need to be answered is how can the traditional regulatory construct for energy generators change to support new Building-to-Grid[4] interactions and enable revenue creation without penalizing nonparticipants?



4. Guidehouse, Building-to-Grid: Industry Transformation for Flexible, Integrated, Value-Generating Resources, 4Q 2019, https://guidehouse.com/insights/energy/2019/building-to-grid.

2.2.4 Comprehensive Smart City Initiatives Emerging

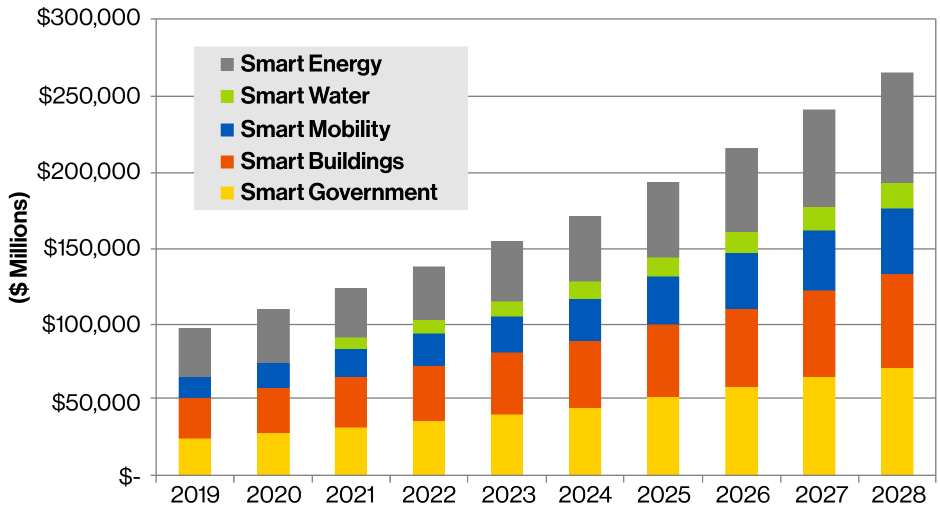
The role of cities in developing a sustainable global economy that can address the need to increase prosperity, respond to climate change, and ensure the well-being of all populations is widely recognized. Local government leaders around the world are committing to low carbon strategies and major energy efficiency initiatives often revolving around the use of new sensors and operational technology advances. As a result, they are examining cutting-edge iDER strategies as they shape the development of their communities to meet these economic, environmental, and social challenges. This shift is occurring not only to meet climate goals but also to improve air quality, reduce traffic congestion, and ensure the future economic competitiveness of a city and its inhabitants.

Critical elements of the emerging city energy landscape include the spread of onsite distributed renewable energy systems as well as building energy programs that can offer load as DER options, and a radical rethinking of city transportation options. The effect of these innovations is amplified by the advance of digital technologies that spawn business models. While no single blueprint exists for any city to follow, utilities should follow these basic concepts when looking to iDER to guide the journey local governments are taking to become a smart city:

- **Engage with city stakeholder groups and leadership teams to help shape low carbon city strategies.** Energy companies can help chart viable programs to turn ambitious city energy and emissions targets into reality, with iDER strategies vital to the success of such initiatives.
- **Deliver benefits to all communities.** Utilities have a unique connection to all city residents, which provides a strong basis for furthering community goals and helping improve and redefine customer relationships. These programs can be designed to benefit all customer segments.
- **Create platforms for delivering new electricity and other energy services that can also be a launchpad for innovative urban service offerings.** Thinking holistically enables existing DER assets and related services to become a base for expansion into other infrastructure areas including water, housing, and security.
- **Develop deep partnerships with iDER technology providers.** Utilities are important conduits to the market for many private sector players. The combination of sector and service knowledge embedded within utilities and then shared with technology leaders is a strong value proposition that will resonate with city leaders.
- **Establish themselves as key orchestrators of urban energy platforms and the ecosystems they support.** Playing a central role in these new networks is key to the development of services and business lines in the city of the future.

Chart 2-3 shows that smart energy, a term that overlaps with iDER, is just one part of the smart city movement. However, one could argue that each of the other smart city revenue streams also will be touched by iDER strategies, especially smart buildings and smart mobility referenced earlier in this white paper.

Chart 2-3. Annual Smart City Revenue by Industry, World Markets: 2019-2028



Source: Guidehouse Insights

3.0 Future iDER Scenarios

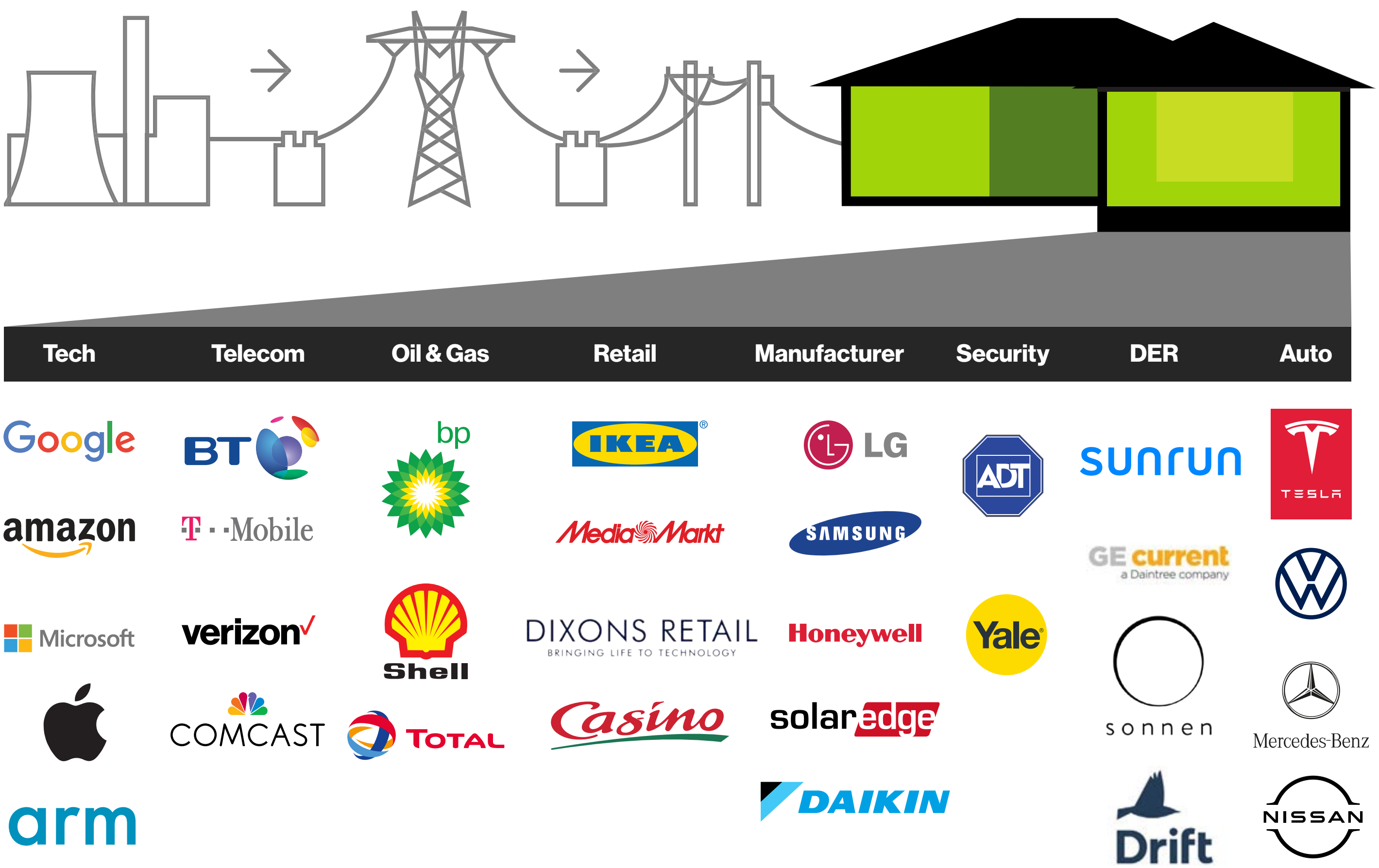
Growth in a wide array of DER technologies is a given. What remains uncertain is how well these DER assets are monetized to deliver value across the Energy Cloud landscape. In this section, Guidehouse contemplates two future scenarios: business-as-usual (BAU) and Energy Cloud accelerator.

3.1 Business-as-Usual

The BAU scenario assumes the misalignment of new technology and regulatory models makes only incremental steps toward harmonization over the next 5 years. A fragmented and uncoordinated response to emerging challenges attached to an increased reliance on DER assets frustrates efforts to maximize value creation, though this growth in full spectrum DER assets sets the stage for longer-term enhanced value plays. The market forecasts included in Chart 1-1 are based on this scenario assuming the pace of regulatory reforms continues at its current clip. Under this scenario, significant value from DER assets is still inevitable, but a lack of coordination and thoughtful and comprehensive integration leads to missed opportunities. Consider the following if BAU is the future:

- **Incumbent players lose market share and consumer costs increase.** Under the BAU scenario, incumbents, including utilities, continue to lose market share to new players, both small and large. Powerful nontraditional players in the energy space such as Google, Microsoft, and other IT firms begin to leverage customer relationships and offer new products and services that directly compete with utilities. Rather than forging partnerships and identifying clear roles within the entire Energy Cloud ecosystem, turf wars between incumbents and new actors sow confusion. In some cases, consumers may pay more for electricity and energy services due to a marketplace littered with bankruptcies and stranded investments that mar delivery of a service that is the lifeblood of the economy.

Figure 3-1. Retail Disruption Led by iDER in the Energy Cloud



Source: Guidehouse Insights

- **Cost shifts not adequately addressed by regulators.** One of the key challenges facing new iDER business models is they shift emphasis from the previous one-size-fits-all service to a system where differentiated service customized to the needs of any consumer is possible. Differentiation and customization are why the role of an orchestrator, a key function embedded within iDER concept, is necessary. If not done carefully, iDER strategies could result in cost shifting, an issue amplified by the common policy of net metering for DER assets such as solar PV. Does a homeowner with a rooftop solar PV system to lower its own energy costs while using the larger grid as a battery shift costs to consumers who do not self-generate? In the past, discounted interruptible rates for DR programs for large industrial customers that might rarely be interrupted during a time of shortage (or that might self-generate with onsite fossil fuel generators) were often viewed as beneficiaries of cost shifts from a residential class of customers, the latter of which had few options for energy optimization compared to large and sophisticated energy consumers.

  Perhaps the historical ideas surrounding utility obligation to provide uniform service and subsidized rates for either the disadvantaged or large industry need to be revisited and expanded upon to also include sustainability, autonomy, individualized, and more flexible service offerings designed to meet common Energy Cloud goals. Under the BAU scenario, these issues continue to seek resolution with no comprehensive solution in sight.

- **Stranded regulations and operational siloes thwart DER value creation.** Stranded regulations translate into stranded assets on both sides of the meter. Without new rules to address issues such as power crossing public rights-of-way or allowing over-the-fence transactions with neighbors, the ability to create a community microgrid will be thwarted. Trying to squeeze iDER innovation within a system still dictated by residual rules that once governed a pure monopoly system of electricity delivery will be difficult. The value embedded in DER assets will not be maximized unless regulations are reformed to help break down siloed thinking fostering trade-offs instead of win-wins. Outside the box innovators are helping to break down these siloes but an important role for regulators remains.

3.2 Energy Cloud Accelerator Scenario

A combination of market reforms linked to technology advances and reimagined relationships among utilities, suppliers, and consumers creates an environment where win-win scenarios can play out across the DER ecosystem as standard practice, not as exceptions. This scenario is what true iDER looks like. While precise regulatory reforms will vary according to historical utility structures, available resources, and wider market development efforts across regions, the following three principles can guide rethinking the relationship between a utility and its customers. These overriding themes also can shape the best role private and public sector players can play in this evolving Energy Cloud landscape.

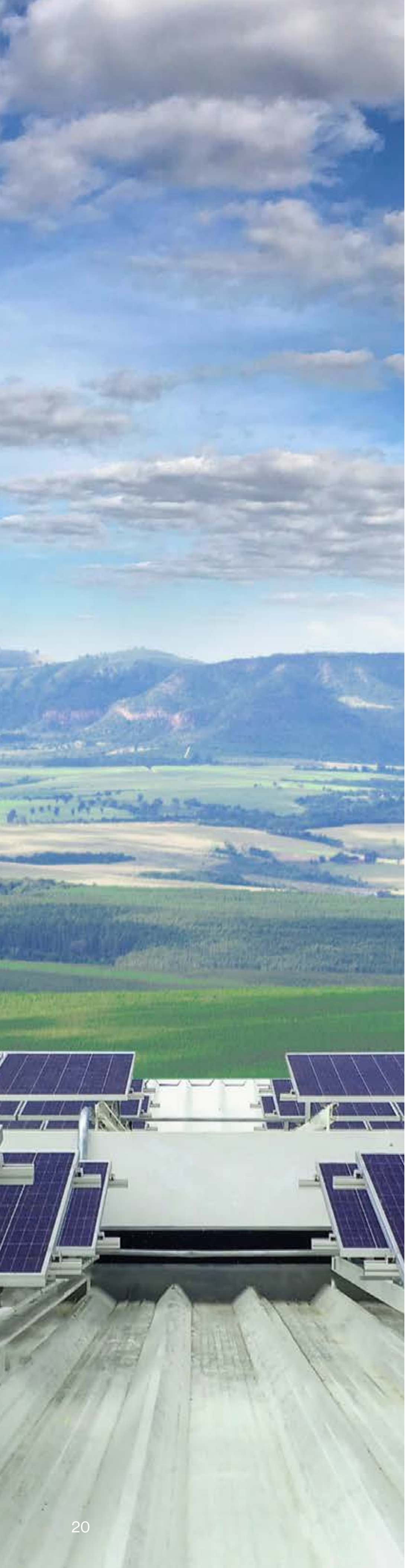
- **Cutting the need for centralized generation by more than half.** According to recent Guidehouse Insights analysis, iDER could conservatively shrink demand for centralized generation by 50%. The proliferation of DER will be among the most disruptive trends to the traditional power and utility industry for the foreseeable future. As deployments of solar PV, distributed energy storage, PEVs, and microgrids gain further traction, the effect on incumbent utility revenue will become more pronounced.

  Applying a modest capacity (production) factor of 20% for installed DER capacity cited in Chart 1-1, Guidehouse Insights estimates installed DER capacity would produce nearly 43,000 TWh of power, more than enough to cover the US Energy Information Administration's (EIA's) nearly 39,000 TWh of expected electricity consumption. In other words, DER could obviate the need for centralized generation entirely by 2030.

  DER could obviate the need for centralized generation entirely by 2030.

  DER also includes so-called negative generation — e.g., DR and energy efficiency — which lowers overall electricity consumption by an estimated 18,000 TWh globally. Assuming a modest 20% capacity factor for these assets, they account for 24,500 TWh of DER capacity. This finding leaves roughly 6,000 TWh directly attributable to DG, or what might be characterized as positive generation, which represents 15% of power consumption relative to EIA estimates.

  Combining the positive generation and demand reductions associated with DER, a 50% reduction in the volume of electricity passing through bulk transmission is entirely plausible — and likely a conservative projection. The ripple effects caused by a 50% reduction in demand for centralized generation would be broadly felt, suggesting grid infrastructure investment should be steered away from the bulk transmission system and instead toward distribution networks, the part of the grid where utilities still hold sway. In an Energy Cloud accelerator scenario, centralized generation could be reduced by 75%, opening up even more room in the system for iDER strategies.
- **Asset ownership matters less than orchestration to maximize value.** Direct ownership of assets has long been the preferred business model of utilities and most business ventures. Direct ownership and control equaled greater profit or, in the case of a utility, ability to maximize return on capital deployed — or so was status quo thinking. As the digital economy shows, value creation is often anchored in orchestration of assets to meet market needs. The ability to connect the dots via real-time digital technologies and direct assets owned by multiple parties provides multiple value streams. The greatest value can be created in the current markets where real time matters more than ever. This priority and attached value proposition applies to energy markets and to other services such as lodging (Airbnb) and transportation (Uber/Lyft).



- **Increased value is shared across the stakeholder landscape.** The energy industry is shifting toward a more dynamic and volatile distribution network. Self-consumption and micro-trading will be the norm, whether between prosumers and the power grid or between prosumers under a transactive energy paradigm. The disruption created by this shift will be deep and pervade the entire energy value chain. Utilities can no longer ignore the threats and opportunities that lie within the Energy Cloud. Prosumers are vital parts of the equation, as are a long parade of solutions providers offering hardware, software, and integration/control offerings. Along with utilities, this latter group will lead on iDER. Despite the entry of new players to help orchestrate the flows of energy and data required to realize the Energy Cloud vision, utilities can still play vital roles if they move now to embrace iDER and forge partnerships with private sector innovators and their customers.

What would an Energy Cloud accelerator scenario mean for the future? By 2030, data will inform automated infrastructure algorithms within prosumer smart contracts of the optimum time to store excess generation, sell the excess generation to the grid, and participate in DR programs (among others). Data from a customer's premise will feed iDER trends, inform market operators of consumption and production, and alert potential customers of when and how much power the prosumer can export.

4.0 Preparing for Accelerated iDER

4.1 Blueprint for an iDER Strategy

Navigating the transition to an Energy Cloud ecosystem of infrastructure solutions will require new partnerships. iDER is no different. Tools such as Guidehouse's iDER Maturity Assessment can help your organization benchmark progress and identify areas of strength and weakness.[5]

Utilities and energy providers that operate in jurisdictions with policies and regulations enabling a more distributed, decarbonized, and digitized energy system (i.e., aggressive renewable and distributed resource integration policies) are likely to be further along the iDER maturation curve. Proactive initiatives typically focus on developing new services — integrating EV charging with demand response, offering bring your own device programs to customers — to support an integrated, plug-and-play electricity system that can enhance the value of individual assets across the network. With the goal of shifting away from the traditional ratepayer model, more mature iDER utility and energy providers are typically focused on maximizing customer flexibility and offering choice in how they use energy to maximize value across the network. To accomplish this, mature iDER utilities proactively build collaborative partnerships with technology providers.

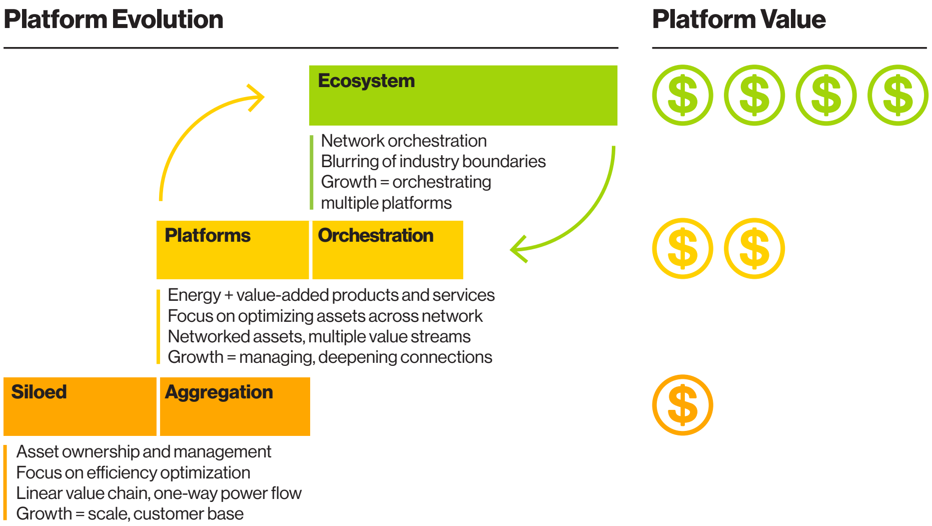
Though the journey of each stakeholder may be different depending on stakeholder category, region, and regulatory factors, they all lead to a more dynamic, networked, and connected iDER landscape. Whether the initial focus is VPPs, DERMS, microgrids, or other iDER strategies, the need to orchestrate DER assets to maximize value for asset owner, the larger grid, society, and the environment is shared.

5. Guidehouse, "iDER Maturity Assessment, 2016, https://guidehouse.com/-/media/www/site/downloads/energy/2016/idermaturityassessmentenergycloudplaybook.pdf.

4.2 Assessing Your Organization's Readiness

The interplay between iDER and Energy Cloud platform orchestration can lead to the growth of solution ecosystems that can respond to the challenges of sustainability and resilience, economic growth, and climate change mitigation. The broader the network of stakeholders, technologies, and interactions across the iDER ecosystem, the more value can be created. Increasing your organization's individual points of connection (number of connected customers, stakeholder partners, individual DER assets, and enabling technologies like smart meters) is critical to achieving iDER at scale even if it requires managing more complexity.

Figure 4-1. Platform Evolution Increases iDER Value Over Time



Source: Guidehouse

All organizations should adopt a dual innovation mindset to balance the needs of their current objectives with the pursuit of iDER ecosystem orchestration. This mindset requires focusing on optimizing the core business for resilience, and anticipating disruptive tipping points and deploying business models that better leverage customer-centric solutions and emerging technologies across emerging iDER platforms. Organizations will need to assess their relative level of risk — regulation and policy, financial, and customer — and the maturity of Energy Cloud platforms like iDER within their territories to assess how aggressively to pursue new business opportunities. Doing so will yield key findings around the organization's Energy Cloud readiness.

Energy Cloud disruptors (wat we may generally regard as leaders in pursuing Energy Cloud platforms) typically enjoy lower regulatory, policy, and financial risk while benefitting from high customer demand for innovative services and greater satisfaction and greater penetration of AMI and grid modernization infrastructure. In turn, they typically demonstrate a strong commitment to innovation, a higher frequency of M&A activity, greater integration of digitization and new products, and a stronger vision and strategy focused on Energy Cloud platforms. However, utilities and energy providers operating in territories evolving more slowly should still prepare for an eventual transition to Energy Cloud platforms but should still take proactive steps like engaging regulators around business model resiliency and making strategic investments in emerging technologies.

4.3 Five Dimensions for Accelerated iDER Implementation

The key to capturing value from iDER under an Energy Cloud accelerator scenario rests on five key dimensions:

- Technology
- Customers
- Public policy and regulations
- Business models
- Operational excellence

Identifying the specific intersections between these dimensions and broad trends such as shifts to clean energy, increased integration of distributed resources, e-mobility, and greater intelligence across the network can help organizations identify their relative strengths and anticipate potential vulnerabilities across an iDER platform.

Figure 4-2. Illustrative iDER Trend Impact Matrix

Intersections	CLEAN	DISTRIBUTED	MOBILE	INTELLIGENT
CUSTOMERS	Sustainability	Self-generation	Charging network	Transactive energy
TECHNOLOGY	Onsite solar + storage	Microgrids	EVs	Smart home
POLICY & REGS	Clean fuel initiatives	NY REV	Drive America Forward Act	Grid Modernization Act
BIZ MODELS	Green pricing	Automated demand response	Mobility services	Smart grid as a Service
OPERATIONS	Transmission upgrades	Aggregation	Load balancing	Cybersecurity

Source: Guidehouse

Shifting customer demand, technology innovation, and policy and regulatory changes are forces of change outside the organization's control. However, internal innovation focused on business model design and operational excellence are within the organization's span of control and can greatly accelerate the iDER journey.

The following sections outline several examples of rapid transformation across these five dimensions.

4.3.1 Technology: Optimize the Grid for iDER

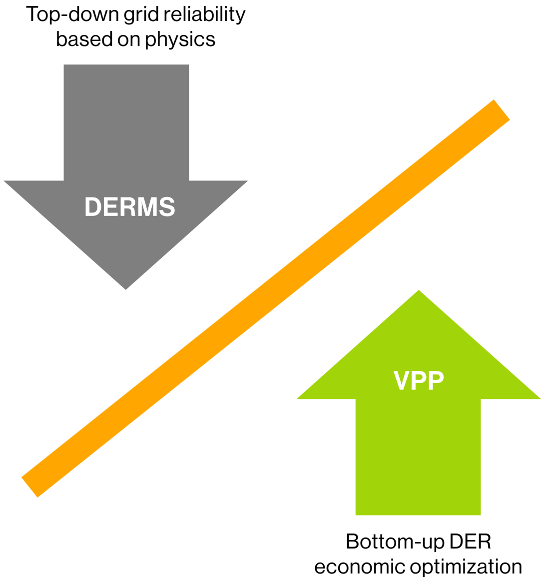
Telemetry that allows for the measurement and verification of energy services traded between regulated and unregulated entities is a necessary cornerstone to iDER. Without smart meters, smart inverters, and other new forms of intelligence embedded into the grid itself (as well as motors, generators, and appliances at customer sites), iDER would not be possible. A smart grid is a basic and fundamental component in the chain of technology advancements that enable VPPs. As DER portfolios continue to diversify and grow, a dynamic network enabling two-way communication is not enough to harvest value from DER assets. What will be needed is a neural grid,[6] the next generation of technologies enabling even more advanced iDER applications.

6. Guidehouse, From Smart Grid to Neural Grid: Industry Transformation and the Top Five Technologies Poised to Bring the Grid Into the Cloud, 1Q 2018, https://guidehouseinsights.com/webinars/building-the-neural-grid.

Utilities historically took a top-down view on the need to see, touch, and control resources interconnected to their power grids. This view led to the creation of advanced distribution management systems, which typically provide a snapshot in time every 15 minutes. In the past, these snapshots were sufficient because supply was dominated by large centralized supply sources that operated round-the-clock, simplifying the job of keeping grids up and running. In today's increasingly distributed and decentralized energy systems, new forms of control are needed. Aggregators partnering with prosumers lean toward a more bottoms-up perspective. One could consider this approach a more distributed controls paradigm. This approach views the world from the customer perspective, seeking to maximize value onsite first while ensuring it is capable of sending value upstream. To do that, a more flexible and fast-acting response time is required — literally split-second optimization.

The best way to accomplish the goal of merging a top-down approach with a bottoms-up iDER perspective is through a state-of-the-art topology synchronization. A top-down view can be a starting point when configuring a DERMS solution, for example. If one then layers the real-time updates possible with a bottoms-up iDER platform such as a VPP, a grid operator can optimize the system based on preferred outcomes and real-time conditions. Having it both ways is key to orchestrating resources in an iDER world — one where the technologies enable a massive shift away from centralized energy to distributed energy today and into the future.

Figure 4-3. Top-Down and Bottom-Up Perspectives of iDER Platforms



Source: Guidehouse Insights

Case in Point:

Government purchases of iDER can set an example and help de-risk investment in an Energy Cloud future, but more needs to be done. Government support can take many forms. Incentives such as tax credits, low interest loans, or other forms of financial assistance for key enabling technologies like solar PV systems can help facilitate microgrid developments. However, these incentives are fairly ubiquitous and are not specifically focused on integrating these assets into iDER strategies. Below is a list of common ways governments de-risk iDER deployments with direct and indirect support:

- **Direct government grants:** Perhaps the most basic form of government support, covering upfront capital cost of projects with typically no obligation to pay back these public investments.
- **Direct government solicitations:** Common tool to support iDER platforms such as microgrids to encompass critical facilities and community assets because these projects do not often move forward absent public policy guidance and specific regulatory support.
- **Government targets and mandates:** Though typically not focused on iDER, governments set targets and mandates in the form of renewable portfolio standards, energy storage mandates, and greenhouse gas reductions. Each of these can provide indirect incentives for states and territories to embrace iDER. Programs targeting specific DER options are particularly helpful but less common today—this will change in the future.
- **Government financing:** Along with grants, governments can create institutions and programs that can help finance iDER projects such as microgrids through tools such as low interest loans and other ways to lower the costs associated with the CAPEX of iDER infrastructure. Green and energy resilience banks are examples of such programs deployed in Connecticut and New Jersey, respectively, for microgrids.

4.3.2 Customers: Use Government Purchasing Power and Infrastructure Funding as a Change Agent

Government at all levels — federal, regional, state, and local — can help set an example with its massive purchasing power. One good way to build momentum in a new market is for governments to lead the way, using contracts for new infrastructure and services to pilot technologies and concepts. This role of government links to smart city initiatives, clean energy bulk purchase programs, and strategic engagements integrating deeper resilience into critical facilities such as fire stations, water districts, jails, hospitals, and schools. While local governments often lead when it comes to application sites, state and federal government most frequently act as funding sources, though their buildings and facilities also often feature DER deployments. iDER use cases such as microgrids or VPPs are less common at these government sites. In the future, this must change. With the help of utilities and technology vendors large and small, all levels of government need to lead by example, helping to de-risk private investment through demonstration projects that highlight the value of iDER.

The coronavirus outbreak starkly underscores the role of government funding in responding to crisis. Stimulus funding can play a transformational role in infrastructure. Just as the stimulus funding during the last recession in 2008 planted seeds for grid modernization, smart meters, and pioneer iDER projects, what can government responses to this outbreak do for green infrastructure upgrades? (The European Union has proposed more than $200 billion for low carbon energy infrastructure, for example.) Can government de-risk investments in DER assets to enable low cost private sector financing?

4.3.3 Policy and Regulation: Integrated Resource Planning Links to Strategic iDER

The process of integrated resource planning (IRP) was once a cornerstone for creating a roadmap for utilities planning for future investment priorities. Originally designed to incorporate the effects of energy efficiency on future power plant investments, trends toward deregulation and the privatization of power supply — first at the wholesale level and then at the retail level — rendered the process moot. Nevertheless, the concepts behind IRP are gaining new life when applied to DER growth.

New forms of IRP are being developed by utilities to factor in future scenarios and technology trends. Because much of the new incremental capacity coming online over the next decade will be different forms of DER not owned or directly controlled by utilities, the focus of these plans has changed. Instead, they will guide thinking on the right fit for iDER platforms that bring bidirectional value to retail and wholesale markets. The key to future success will be establishing stretch goals on DER management, looking at both the economic and the physical requirements of the changing Energy Cloud landscape.

Creating new markets via IRP and other planning exercises does not necessarily mean the role of incumbent utilities will be reduced. Quite the opposite could be true as DERMS also will undoubtedly play a larger role in the future. As the focus shifts from wholesale markets to distribution system optimization, utilities will need to help orchestrate DER assets to solve voltage issues and other grid challenges that require active power management with targeted relief. They are already fine-tuning demand forecasts reflecting how DER additions change modeling assumptions about wholesale supplies. Advanced analytics are key to revamping IRPs to shape future utility iDER strategies.

4.3.4 Business Models: Reimagining Utility Rate-Basing

While several utilities in the US have successfully rate-based microgrids[7] — San Diego Gas & Electric's Borrego Springs microgrid being the first successful deployment — many have also struggled, including Baltimore Gas & Electric, PECO Energy, Pepco, and ComEd. In 2018, ComEd ultimately succeeded in gaining approval from the Illinois Commerce Commission to construct the $25 million FTM Bronzeville microgrid supported by a $5 million US Department of Energy grant. ComEd's original proposal that was included in state legislation would have authorized $250 million for a portfolio of FTM utility distribution microgrids. The most noteworthy aspect of the approved ComEd Bronzeville microgrid is that it is being constructed adjacent to an existing third-party campus microgrid at the Illinois Institute of Technology, allowing the two microgrids to share resources and be orchestrated collaboratively. ComEd partnered with Siemens, which is providing controls software that ComEd will then be able use for future microgrid deployments (including those developed by third parties). Another noteworthy stipulation ComEd made was to create a microgrid services tariff that allows third parties to develop microgrids using existing utility infrastructure. The Illinois Commerce Commission regulatory decision keeps ComEd in the development loop, allowing the utility to lead the design, implementation, and controls. This is a great example of how utility rate-basing and collaboration with a private sector technology provider can foster innovation.

4.3.5 Operational Excellence: Resolve Security Concerns on Data Management Vital to iDER Success

Data is critical to the realization of the Energy Cloud and is important to the success of all iDER strategies. Data is created across the value chain from multiple sources. This data feeds the many different requirements of associated applications such as grid services, resiliency, and sustainability because each of these services depends on accurate and timely data as well as analytics and insights from numerous sources.

Data management will need to be secure for the Energy Cloud to become as ubiquitous as envisioned under an accelerated iDER scenario. Data may supersede the value of the electrons as electricity becomes commoditized. The primary value of iDER to the market will be integration, aggregation, and optimization of energy services through data management. The value of data in terms of managing increased transactional complexity for iDER platforms will generate revenue streams for entities that perform this service. Without confidence in the security of data from prosumers and consumers alike, the Energy Cloud's perceived value dissipates and market adoption suffers. New standards may lead to open communication and interoperability, but they can also lead to data breaches and compromised systems. Cybersecurity will become paramount to the success of the Energy Cloud.

Case in Point:

Perhaps the most novel approach to rate-basing iDER comes in an offering that could be considered micro orchestration from Emera Technologies (ETL). ETL's primary business model entails installing all facilities making up a microgrid in front of the meter. Thus, the entire system can be utility owned, operated, and maintained. This means builders and homeowners are not burdened with upfront capital costs, system maintenance requirements like replacing components, or complexities when selling their home. Utilities can retain customers with a unique form of a microgrid and make progress against renewable energy mandates while responding to growing customer interest in DER options.

The offering is a complete power system solution that integrates generation, storage, cabling, and controls to serve new residential subdivisions. With solar and battery capacity at every home, as well as additional resources at a small energy park, all generation and storage in a neighborhood become shared resources available to every customer. The ETL system can island indefinitely thanks to its DC configuration. When grid-connected, it can provide grid services such as excess capacity back to the power grid.

To date, Duke Energy has had the most success with regulated investment in microgrids in North America because of its use of the non-wires alternative approach. An obstacle to rate-basing microgrids is justifying customer dollars going to infrastructure when the primary benefits only flow to a small pool of customers located inside the microgrid. In October 2018, the company filed for a solar PV system in the Hot Springs community of Madison County in North Carolina to benefit the small community and also the broader grid. Along with localized resiliency, the microgrid will provide energy and grid support to all Duke Energy customers while deferring ongoing maintenance of an existing distribution power line that serves the remote town.

7. Rate-basing is the typical process utilities use to finance infrastructure, referring to their unique ability to charge for such upgrades through the rates they charge their captive customers.

5.0 Launching iDER

With DER capacity expanding rapidly and enabling technologies unlocking opportunities to optimize revenue creation and capture, utilities, energy companies, and other DER stakeholders should move beyond readiness assessments to capitalize on the inevitable concentration of value around iDER platforms.

5.1 Implement No Regrets Actions

Once an organization has evaluated its readiness, including identifying threats and opportunities across the iDER threat matrix, Guidehouse recommends it immediately initiates several internal no regrets planning steps:

- **Begin breaking down siloes while aligning culture to support cross-functional collaboration.** Sponsor diverse teams focused on innovation across the company to form a coherent vision of the future, followed by a precise yet flexible implementation plan. Establish metrics to measure progress, aligning any new ventures around the need for revenue generation that flows from new iDER shifts to support infrastructure upgrades linked to the Energy Cloud. While setting 5-year goals is still relevant, even more important are flexible and nimble responses to changing market conditions and emerging opportunities.
- **Ready the organization to play both offense and defense.** When it comes to iDER, utilities historically focused on a good defense, including protecting the core business. While focusing on the core business is still extremely important as the company or stakeholder conducts assessments and develops an internal alignment strategy, it is only delaying the inevitable. Positioning for long-term success around iDER requires an offensive strategy designed to maximize revenue and value creation. Utilities should seek creative partnerships and transparent ways of banking value through orchestration, reinvention, and renewal.
- **Develop multiple planning scenarios.** The coronavirus outbreak is a wakeup call. The world is more volatile, connected, and interrelated than ever before. The effects from climate change on the global economy and core business will be disruptive and will force change. While it is important to be prepared for the unknown and unexpected, acknowledge and plan for the impacts that are unpredictable in their timing but likely to occur (i.e., the gray rhinos). Contingency planning and optimizing the grid and business for continuous operations is a premium opportunity to transform what might be viewed as a catastrophe or crisis into a stimulus for rapid change and transformation. iDER remains a significant opportunity to build resiliency and flexibility into an increasingly fragile infrastructure system.
- **Assemble a team dedicated solely to seizing opportunities (and innovating, optimizing, and, when necessary, abandoning opportunities).** The time for patience, wait-and-see, and pause or delay is no longer viable. Opportunities to innovate are popping up all around the world and in virtually every market segment and infrastructure plan. Optimizing what might already be in place is an important first step. However, if programs have failed to deliver after a few years, it may be better to abandon than hold on too long to outmoded business models or technologies that did not deliver value.
- **Commit to transform consumers into prosumers.** iDER rests on the premise that asset ownership is just one path to value creation. While investments flow to infrastructure, the vital link to market success is the consumer. With iDER, each consumer has the potential to become a prosumer. iDER is perhaps the ultimate win-win-win strategy, matching up clean energy with resiliency and affordability, while following the path to sustainability, digitization, and decarbonization.

- **Prepare to pivot away from asset ownership toward orchestrating distributed networks.** The rise of DER capacity is a certainty. While the degree of penetration remains uncertain, overbuild and redundancy will be rife — especially as more DER technologies achieve grid parity. While the individual value of these deployments will decline over time, it will be the innovative business models that unlock stacked value across diverse iDER networks that will thrive in the new Energy Cloud landscape.

While each organization's iDER journey will be unique, it is critical that iDER stakeholders adopt a dual approach to innovation, embracing the difficult balancing act of optimizing the core business and improving upon existing processes while positioning the organization to embrace new growth initiatives. This will present many challenges, but if the no regrets actions above are faithfully executed, dual track innovation will yield greater returns.

5.2 Optimize the Core Business

Higher resilience in the current business model (as indicated by minimal risk to the utility's current business model posed by the five dimensions of change outlined in Section 4.3) will allow organizations more flexibility in pursuing an iDER strategy. At the same time, relative stability in the legacy business could also lull the organization into a false sense of security. Lower core business model resilience will mean the organization may need to play more defense and adopt a more reactive strategy in response to the energy transformation. Many European Utilities, for example, have had to adapt aggressively to a more Energy Cloud platform-centric strategy as the viability of legacy businesses faced significant regulatory and technology-induced market disruption. Guidehouse recommends that utilities and energy companies assess specific risks within their territory, including taking into account how proactive and demanding local policies and regulations are in accelerating marking transformation. This also means considering potential Energy Cloud and iDER tipping points within the organization's market(s).

5.3 Innovate Future Business Models

Innovation's other track, pursuing future business models, will also turn on specific market conditions and the organization's risk tolerance. Business model innovation laggards will likely find themselves increasingly hemmed in defending legacy revenue streams heavily dependent on increasingly vulnerable infrastructure. Increasing the resilience of the current business model will buy time. Guidehouse recommends that utilities and energy companies kick-start future business model innovation if not already in motion. This means rapidly augmenting the organization's capacity to articulate an ambitious vision and tolerance for failure. Measuring success is equally important as traditional revenue models and kilowatt-hours will matter less in an iDER world.

Guidehouse strongly recommends that utilities and energy companies assess, pivot, optimize, and innovate within the next 2-5 years to adequately prepare for the iDER evolution already well underway.

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