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Distributed Energy

A Disruptive Force

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AT A GLANCE

Distributed energy (DE) is becoming a disruptive force in the U.S. power business. No longer dependent on subsidies, growth in DE is now being driven by improving economics and innovation. For traditional utilities, this means that a potential competitive threat lurks in every neighborhood, in every home, and on every rooftop across the country.

From Technology Play to Financing Play

So far, DE's growth has relied on lower costs and improvements in technology. As the industry matures, much of its future growth will be driven by business model innovations, such as leasing models, financing tools that lower the cost of capital, and improved targeting and segmentation of customers.

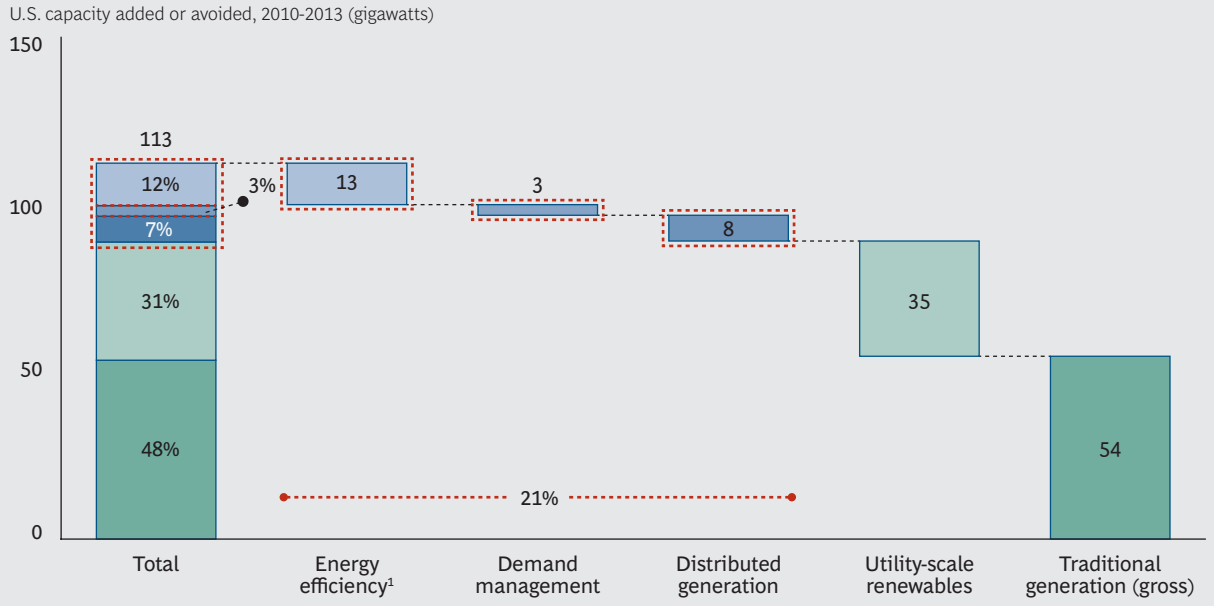
A Threat to Utilities

Utilities' primacy in the generation and delivery of electricity is under attack. What was once a regulated market is becoming increasingly competitive, and the value chain, once served exclusively by utilities, is becoming disaggregated. To stay competitive, utilities must proactively respond to a future with more DE. Utilities have multiple advantages that they can mobilize, but they must do so quickly.

DISTRIBUTED ENERGY (DE) TECHNOLOGIES have grown significantly in the U.S. Last year, DE represented one of the largest investments in the utilities space, and that investment, along with consequent growth, is likely to accelerate. From 2010 to 2013, DE accounted for about 21 percent of all new capacity in the nation. (See Exhibit 1.) The number of commercial and residential rooftop solar installations, for example, increased by 22 percent in 2013. The increase comprised about 1.9 gigawatts and represented roughly $8 billion in investments.

Sunny states, such as California (with about 700 megawatts) and Hawaii and Arizona (with about 130 each), led the growth. New Jersey and Massachusetts, with about 225 and 200 megawatts respectively, also are growth markets because of state-funded support.[1] Government incentives, offered at both the state and the federal levels, have helped drive this growth so far, as have improving economics in the form of decreasing costs and rising retail electricity prices. As the trend toward DE gains strength, however, growth will no longer rely on such subsidies.

EXHIBIT 1 | Distributed Energy Accounts for 21 Percent of New U.S. Capacity



Sources: BCG analysis; Energy Velocity; Federal Energy Regulatory Commission; North American Electric Reliability Corporation; U.S. Energy Information Administration.
[1]These technologies are energy extractors, which avoid the need for new capacities; new capacities added in 2013 were estimated.

Utilities must proactively develop a response for a future with more DE.

Already, costs have declined significantly. In the past decade, prices for residential rooftop photovoltaic (PV) solar systems, for example, have dropped by more than 50 percent, declining from about $9.15 per watt in 2004 to $4.50 per watt in 2013. At the same time, improvements in technology have created new applications and market segments that previously were not viable. These technology improvements and ongoing cost reductions, combined with heightened consumer awareness and federal and state incentives, continue to bolster DE's growth.

This growth will be disruptive to incumbent industries, especially utilities. Most U.S. electricity rates are variable, based on the number of kilowatt-hours used. DE reduces the number of kilowatt-hours sold by the utility to the customer. This creates a fundamental shift in cost because the fixed costs of the grid must be paid for by smaller amounts of energy sold. Future changes in rates, such as introducing fixed or demand charges, may help alleviate some of these cost shifts in the near term, but they do not alter the underlying fact that utilities' primacy in the generation and delivery of electricity is being supplanted. What was once a regulated market is becoming increasingly competitive. This will cause disaggregation of the integrated value chain that has been served exclusively by utilities.

This is already happening with PV, but storage is not far behind, and others will likely follow. Utilities must learn to compete in this new environment by proactively developing a response for a future with more DE.

The Three Types of Distributed Energy

Distributed energy, which we define as energy technology that is collocated with the energy load, can be split into three main types:

- *Energy extractors* are technologies that reduce or shift energy loads, and there are two forms: The first, energy efficiency, reduces total energy use. It includes improving control of usage and installing more efficient devices, such as light bulbs, water heaters, and heating and air conditioning systems. The second, demand management, shifts the time of energy use to reduce stress on the grid and to avoid employing expensive and often "dirty" generation, especially during peak demand. Demand response is one type of demand management.

- *Energy sources* are technologies that produce energy on-site, where it is needed, such as through distributed generation. Rooftop PV solar installations are the most prominent example, although others include small-scale wind and combined heat and power, as well as individual diesel and natural-gas generators.

- *Distributed storage* can be connected to energy sources or used as an energy extractor. When connected with an energy source such as a rooftop PV solar installation, it stores energy during the day when the sun shines and discharges it at night. When used as an energy extractor, distributed storage shifts loads during the day to take advantage of time-of-day pricing or to reduce capacity charges. Distributed storage is expected to grow by 34 percent annually through 2020 and to deploy more than 700 megawatts.[2]

The Cost of DE Has Dropped

Technology improvements, benefits of scale, and increased efficiency from manufacturing to installation have reduced the cost of DE. In the past five years, PV module prices have declined by about 80 percent, and the costs of lithium-ion batteries for storage have fallen by about half.[3] The prices of energy efficiency applications—from controls for heating, ventilation, and air-conditioning systems to lighting, such as LED bulbs—have fallen dramatically as well. Further reductions are likely to come from costs related to installation, such as labor, racking materials, and permitting expenses.

As the technology for energy improves, so will the performance of the equipment, which indirectly reduces costs even further because fewer materials are needed to deliver the same value or levels of production. Advances in other forms of technology are creating new opportunities and applications for DE as well. For example, improvements in communications networks and in the miniaturization of computing are enabling greater control of consumer devices, such as lighting, in ways that improve their energy efficiency or allow them to respond to pricing signals during times of peak electricity usage.

Several national policies have also encouraged the growth of DE in the U.S. The investment tax credit (ITC) provides a 30 percent credit for up-front capital costs related to a wide range of DE technologies, including solar cells and fuel cells.

Growth in DE will be driven mostly by financial improvements.

Incentives and policies at the state level are equally important, and though they vary widely from state to state, they can be vital for improving the economics of DE. These policies include renewable portfolio standards supported by a market for renewable energy certificates, energy-efficiency resource targets, state-specific tax credits and rebates, and net energy metering (NEM). While some states have begun to scale back incentives such as technology-specific rebates, these cutbacks are typically offset by cost reductions. More generally, most legislative initiatives to reduce programs such as renewable portfolio standards and NEM have been unsuccessful so far.

Rising retail electricity prices across the country in recent years have improved the economics and payback periods for DE. On average, the residential price of electricity rose 16.5 percent from 2006 to 2013, slightly outpacing inflation. In addition, some states, including California, have instituted tiered pricing based on consumption. Others are introducing time-of-use rates. Both of these pricing structures can further enhance the economics of rooftop PV solar installations and other forms of DE for the consumers who are most likely to adopt these technologies.

A New Wave of Innovation in DE

In addition to the core economic benefits of DE that we have described, a new wave of innovation is helping to establish DE as a mainstream energy source and to encourage sustainable growth. While much of the growth to date has been driven by technological innovation, future growth will be driven mostly by financial improvements, such as leasing models, financing tools that lower the cost of capital, and improved targeting and segmentation of customers. These innovations are fun-

damentally changing the competitive landscape by opening new segments of customers and transforming DE from a technology play to a financing play.

Most DE technologies require significant up-front costs, and lack of access to capital to cover these costs is a major barrier to adopting DE. To overcome this impediment, DE companies—from rooftop solar installers to providers of energy efficiency equipment and services—are introducing leasing, individual customer power-purchase agreements, expanding on energy performance contracts, and a variety of other financing options. Many solar installers, for example, offer a rooftop lease that can replace about $15,000 to $20,000 worth of up-front investment for the customer with monthly payments at a rate below the customer's current utility rate.

For DE lessors, these new leasing models provide an incremental value of as much as 70 cents per watt for each installation. This is in addition to the $1.20 per watt that they already earn as developers. In other words, financing increases the total profit by about 58 percent. This new leasing model does carry additional customer-default risk, but more sophisticated players are mitigating that risk through securitization of their DE leases, which also provides an injection of cash to the company.

Tapping Cheap Sources of Capital. To fund these financing options, DE companies are tapping innovative and relatively cheap sources of capital. These financing tools range from the more conventional, such as traditional bonds or securitization of DE assets, to the more innovative, such as creating a separate publicly listed company for DE assets or crowdsourcing capital from private investors. Using the flexibility and leverage of these methods, DE companies are finding that they can lower their cost of capital to less than that of utilities, nullifying utilities' traditional advantage.

Companies that understand these models and have the best access to capital will be the ones to capture the biggest share of this emerging market. We expect these models to continue to evolve as companies become more comfortable with the risk associated with leasing and other financing agreements. In the next few years, DE may compete directly—without the aid of subsidies—in many states. At the federal level, the ITC is scheduled to be reduced in 2017 and could eventually be eliminated. This new competition may increase the scope of financing options because customers and installers will not have to rely on finding a tax equity partner to monetize the ITC.

The expansion of DE is causing disaggregation of the traditional power model.

It is important to note, however, that today's low interest rates favor the DE business model. A different financial environment in the future could significantly change the economics for the industry.

Giving Consumers New Tools. The expansion of DE is causing disaggregation of the traditional power model, in which an integrated utility controls the market in each state. DE players are now forcing themselves into those markets, capturing part of the value chain by offering consumers an alternative and giving them greater influence over how they meet their power needs. Through leasing and other financing options, these companies are giving consumers the tools to price their power differently. For example, updates and services offered by DE compa-

nies can help commercial customers save money on energy while improving performance through efficiencies such as LED lighting and better heating and cooling controls.

Unlike many utilities, which are required to serve every customer in their territories, DE companies may choose their customers and thus can focus on the ones they believe will be most profitable. They can also tailor their products to specific market segments and use home or commercial energy audits to determine which upgrades make the most economic sense for a particular customer. A quick check of a customer's credit score allows a DE company to select the proper financing option. While many DE companies are struggling to make their marketing and customer acquisitions cost effective, expenses are likely to decline significantly as the companies gain experience, scale, and higher penetration rates.

DE's emergence as a major market player is inevitable.

In addition, most successful DE players have demonstrated a better understanding of customer behavior than traditional energy-related services have. They have treated the energy space more like a consumer services market, with a stronger focus on customer satisfaction. Devices such as smart thermostats are targeted toward customer preference, with appealing designs and easy-to-use interfaces that reflect an understanding of what customers want. A focus on online platforms, ease of implementation, and customer service is becoming the norm. This focus is yet another factor pushing DE into the mainstream.

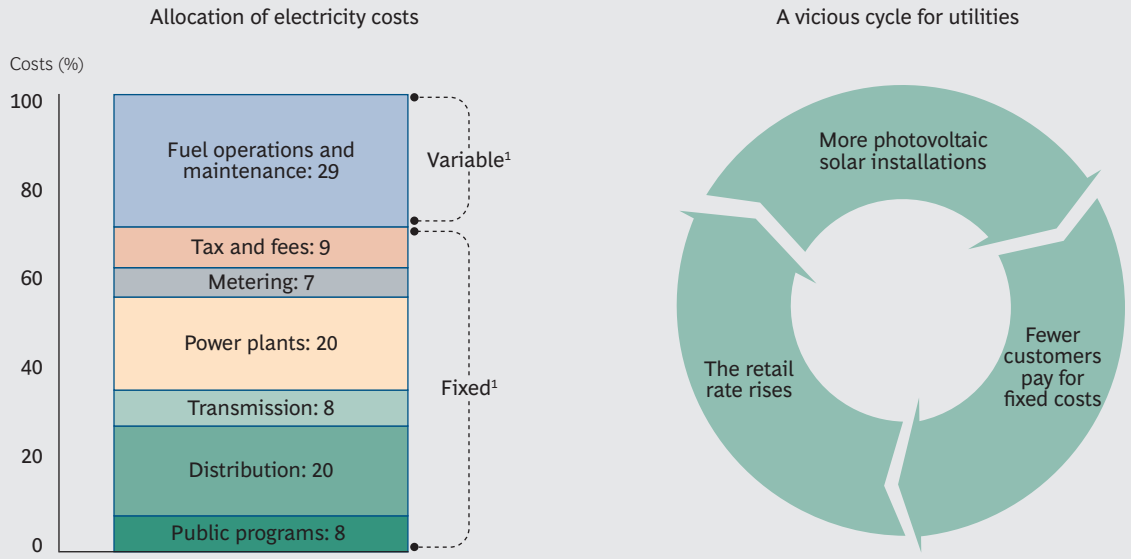
DE's Threat to Utilities

Given the underlying economics, innovation by DE companies, and other market fundamentals, DE's emergence as a major market player is inevitable. Its growth, while still dependent on specific states and markets, could nevertheless result in significant penetration within a decade. This would disrupt many aspects of the current energy landscape, especially with regard to electric utilities, which face multiple threats from the proliferation of DE in their territories. Perhaps the most important is the vicious cycle of rising rates, increasing costs, and the risk of further disintermediation.

Every kilowatt-hour that DE either generates or saves is directly removed from the demand on the grid for energy supplied by traditional generation, known as the total net load. When rates are variable, as they are for most of the U.S., a lower total net load means that fewer dollars are collected to support the traditional electrical system. A utility's costs for maintaining that system, however, do not fall proportionately because of financing expenses and other fixed costs related to infrastructure. (See Exhibit 2.) What's more, those costs are not covered fully by DE customers unless utilities charge them a fixed fee or implement power standby rates.

As DE reduces revenue, utilities seek to recoup their costs by raising the rates for traditional customers, creating an implicit cross-subsidy of DE users. And because higher rates, in turn, create incentives for more customers to install their own generation systems, a vicious cycle is formed. In the short term, regulated utilities' profitability may be protected by decoupling. As rates escalate, however, regulators and

EXHIBIT 2 | As Distributed-Energy Penetration Increases, Energy Costs Could Rise



Sources: BCG analysis; rate case documents from public utilities commissions.
Note: Data shown is for illustrative purposes only; exact allocation of costs will vary by utility.
[1]These cost allocations are typical; some categories may include a mix of variable and fixed costs.

lawmakers will likely take into account the greater burden on consumers and be less inclined to protect utilities at consumers' expense.

DE penetration has been associated with increased load volatility, which can raise grid-maintenance costs for utilities. At a high enough level of penetration, DE will begin to alter the way energy flows through the networks, creating new patterns for which those networks may not be well designed.

PV solar installations, in particular, are associated with load volatility. The power that these systems deliver can fluctuate rapidly and unexpectedly as bright sunshine gives way to cloud cover. Also, solar resources are mostly available during daylight hours, not during the late-evening peak-demand period. As a result, traditional load profiles can dramatically change, increasing the gap between peak and off-peak hours.

How extensively these challenges will translate into additional material costs is unclear, but operational challenges posed by DE are becoming more frequent. Energy storage and related technologies, such as demand management and demand response, may reduce the effects of load volatility—but not without additional cost.

DE Penetration Lowers the Value of Traditional Generation

As DE proliferates, traditional generation assets are likely to decline in value. Parallels with the German market—in which the total share of generation represented by nuclear and fossil-fuel-based sources is expected to fall from a level of 83 percent in 2010 to 30 percent by 2030—illustrate the devastating financial impact that such a drop can have on utilities. (See *Is Germany Pioneering a Global Transformation*

of the Energy Sector?, BCG report, March 2013.) By lowering the total net load, DE reduces the market value for traditional generation. The intermittent nature of distributed generation means that the greater DE's penetration, the greater the requirement for base-load generation to become more flexible. (The problem is compounded by utility-scale renewables, which also provide intermittent power and often receive loading preference.) In most cases, DE, combined with demand response programs and other forms of demand management, will also shave the peak off the load, cutting into the most profitable portion of the traditional generation business. These factors are influencing utilities' decisions about whether to invest in generation or hold off and seek to optimize its residual value instead.

DE may also be a harbinger for a broader type of deconstruction that is affecting the power value chain. Integrated utilities provide bundled services: energy generation, transmission, grid services (such as power reserve and stabilization), demand response management, distribution, metering, and customer service. When a non-utility third-party cherry picks the value chain and provides specific services at a lower price, the traditional rate design no longer matches costs and revenues. New entrants have a growing stake in generation through distributed products, but they also derive benefits from services such as demand response management and energy storage. Over time, the power value chain could change dramatically.

The utilities' business model is about investing capital and capturing returns. As DE penetration increases, capital shifts from areas that utilities have traditionally controlled to areas in which they are not involved. (See Exhibit 3.)

EXHIBIT 3 | Distributed Energy Shifts Revenues away from Traditional Utilities

	Traditional utility services					New services	
	Generation and wholesale	Transmission	Distribution	Metering	Retail	Services "behind the meter"	Distributed generation
Revenues for a traditional utility (%)	30-40	15-20	40-50	0-10	0-5	0-2	0-2
Drivers of value shift	Lower plant utilization	Investment in grid, lower regulated remuneration		Smart-meter, AMI services[1]	IT systems, self-service applications	Smart equipment, IT	Distributed-generation equipment installation and leasing
Direction of shift	↓	↓	↓	↑	↑	↑	↑
Future revenues with DE (%)	20-30	10-15	20-30	5-15	5-10	0-10	15-20

Sources: BCG analysis; rate case documents from public-utilities commissions.
Note: Data shown is for illustrative purposes only; exact allocation of costs will vary by utility.
[1]AMI = advanced metering infrastructure.

What's more, as large investors turn their attention to the emerging DE industry, traditional utilities are beginning to lose their advantage in terms of low cost of capital. For example, we estimate that when a major solar installer and developer securitized its solar leases last year, the company's cost of capital dropped to a level that was 200 to 300 basis points lower than most regulated utilities' cost of capital.

With microgrid technology, DE has the potential to enable areas such as subdivisions, cities, and counties to form "islands" that either exist off the grid entirely or depend on it only for backup generation. DE could, therefore, turn the existing infrastructure of transmission lines and power plants designed to serve those areas into stranded assets.

Finally, utilities' regulatory edge is eroding as DE companies gain leverage through regulatory management teams that represent a growing number of individual consumers. Taken as a whole, these changes are turning the odds against the traditional utility model.

Utilities Must Respond Proactively

We believe that utilities must respond proactively to the rising threat of DE. The fallout from changes in other industries underscores the danger of resisting disruptive technology or hesitating to act in the face of such a threat.

So far, most utilities have taken a defensive approach, primarily by fighting regulations and rate designs that encourage DE adoption. For example, many utilities have opposed net metering. Others have tried to introduce broader fixed charges to lower variable rates or have attempted to impose specific charges on customers that have adopted DE. But our analysis shows that unless implemented aggressively, these responses will not combat the economic appeal of DE or halt the shift away from centralized generation. Instead, utilities must consider business models that will capture more of the shift in the value chain that is resulting from greater DE adoption.

Utilities can capitalize on the key areas in which DE companies are struggling.

Utilities are well positioned to capitalize on the key areas in which DE companies are struggling. Consider customer acquisition, for example. Utilities already have access to customers and have earned their trust. In terms of targeting and understanding customers, utilities can capitalize on the benefits of smart meters and the smart grid by either exploiting these advantages directly or partnering with third parties to become common carriers of energy-related services. DE companies, by contrast, are starting from scratch.

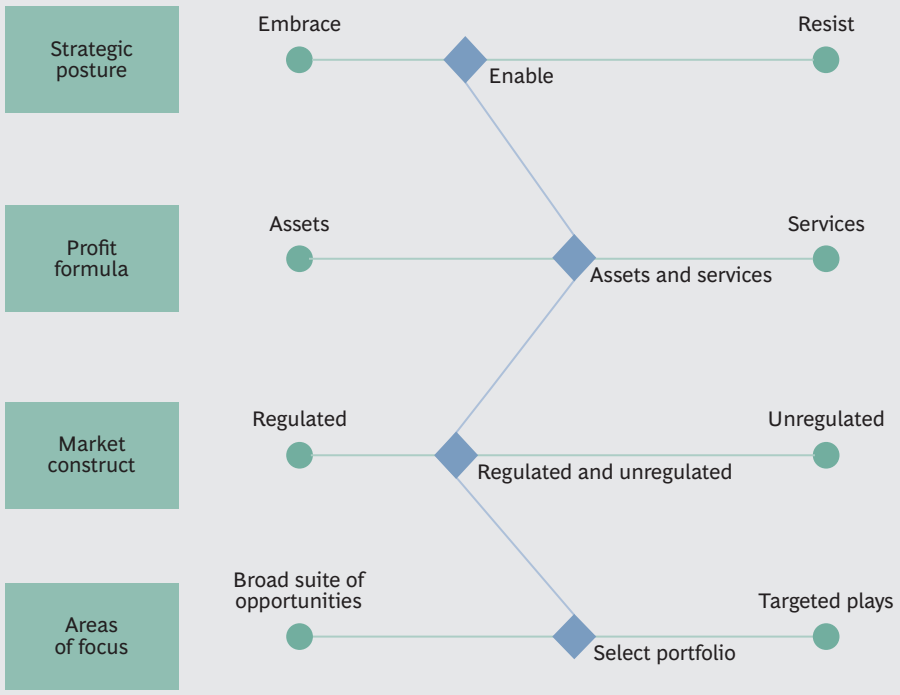
Utilities crafting their response to DE should ask themselves the following questions:

- How do we choose the right business model and strategy given the potential disruption of DE?
- How can we adjust our regulatory and policy positions?
- How can we adapt our product and services offerings?

- How will we need to modify our grid and generation assets?
- What skills, resources, and competencies are required to execute our plan?

The Need for Innovative Business Models. To develop a strategy, utilities must consider how to approach the DE market. Do they want to own assets such as rooftop PV solar installations and storage? Do they want to offer services "behind the meter"? Do they want to simply enable third-party services, or do they want to compete as fully integrated providers? (See Exhibit 4.)

EXHIBIT 4 | Utilities Must Make Strategic Decisions



Source: BCG case experience and analysis.

But before they develop such a strategy, utilities must first consider how aggressively they will respond to DE trends. One approach would be to focus more on core investments in the grid, such as adding a rate base for more grid-scale storage to enable DE, and on using regulatory or policy channels to seek increases in fixed charges that would reduce the cross-subsidies from net energy metering. As we discussed earlier, however, utilities might risk stranding their assets with this approach, which also fails to capture the shift of value and capital to DE assets and their related products and services.

Other responses to DE would avoid that pitfall. For example, utilities could scale back or divest their generation assets and instead equip the grid for DE by investing in smart meters, advanced metering infrastructure, and grid management capabilities. Or, utilities could facilitate third-party DE services in which utilities capture the

value by leveraging data collected across their networks to provide and enable value-added services. For example, they could use real-time data to track PV production. Utilities could also invest in DE companies directly, develop regulated DE offerings, or begin building unregulated DE capabilities themselves.

While becoming more involved in DE could cannibalize their retail electricity sales, utilities cannot allow themselves to be hamstrung by such concerns. Too many companies in other industries—telecommunications, movie rentals, and film photography to name just a few—have made this mistake in the face of a technological shift. Rather than trying to stem the tide of DE, utilities should consider offering distributed-generation solutions through bill payments and by facilitating the transfer of asset ownership. Utilities could also monetize their assets by offering DE installers access to grid information or to communications infrastructure to help them monitor and track customer usage.

As markets evolve, utilities will need different strategies to adapt, and those strategies must take into account possible scenarios for a future with more DE. They should also identify potential tipping points. Utilities should use a specific set of metrics, monitored regularly, to do so and to refine those strategies. Utilities must also stay flexible so that they can adapt to changes in the market.

The Role of Regulatory Dialogue. Utilities' interaction with regulators has always been important, but the relationship will be particularly instrumental in sorting out the role of utilities and DE companies in the coming years. Rather than fighting DE, utilities would be better off seeking a rate structure that avoids cross-subsidies and more accurately reflects their costs. At the same time, they must find a way to participate in these new markets to reduce the destructive effects of DE on the existing value chain.

Utilities must be careful in their approach to regulators, of course. If they are perceived as impeding the growth of DE, especially in states that favor renewable energy, utilities may find themselves opposed by regulators, lawmakers, and customers. What's more, utilities must consider interdependencies and the unintended consequences of their regulatory and policy positions. For example, pushing for aggressive capacity or fixed charges may discourage DE adoption in the short term, but over the longer term it may encourage increased use of storage, community aggregation—or even complete disconnection from the grid.

Utilities must be prepared to offer new DE-related products and services.

Because regulators play such a dominant role in dictating utilities' business models, any strategy should call for starting a dialogue and testing ideas with them. This must be done early in the process to allow for the lag in regulatory response times.

Heightened Customer Expectations. The increase in DE adoption has raised customers' expectations for utilities as well. As a result, utilities must be prepared to offer customers new DE-related products and services. Rather than view these new offerings as a burden, utilities should see them as a vital way to capture the shifting value caused by DE while also deterring third parties from disintermediating important parts of the energy value chain.

As the incumbents in the market, utilities have greater access to customers than new entrants, and they can use that advantage when selling new products and services. Leasing services for heating and cooling, water heaters, or even distributed generation could represent new revenue opportunities that build on utilities' core business models. Leased products can drive efficiency and service reliability for the utilities while offering customers more choices and convenience.

Traditional utilities will have to develop many new capabilities.

Storage offers another opportunity for revenue generation. Utilities could provide distributed-storage equipment as a service for commercial and industrial customers to improve power quality and reliability. Utilities are uniquely positioned to provide storage services because they can use the entire grid as a virtual storage space.

By leveraging customer access, utilities could partner with energy efficiency manufacturers and service providers and collect referral fees or create redundant billing options and monitoring services, such as smartphone applications, for residential customers.

Pilot programs allow utilities to test these new products and services and gauge the reactions of regulators, customers, and third parties. At the same time, such programs give utilities a better understanding of the capabilities they will need to compete in a market in which DE plays a larger role.

Preparing the Grid for DE. To prepare for increasing DE penetration and the problems of balancing the grid that will come from additional intermittent generation, utilities must consider investments in energy storage, smart-grid solutions, grid management and dispatch, flexible generation, advanced inverters, and other new technologies. This will typically require significant investment in the grid. Utilities with generation assets will need to become more flexible and shift away from traditional base-load plans. Altering those plans will require an open dialogue among the companies, consumers, and regulators to ensure that everyone is aware of the costs involved.

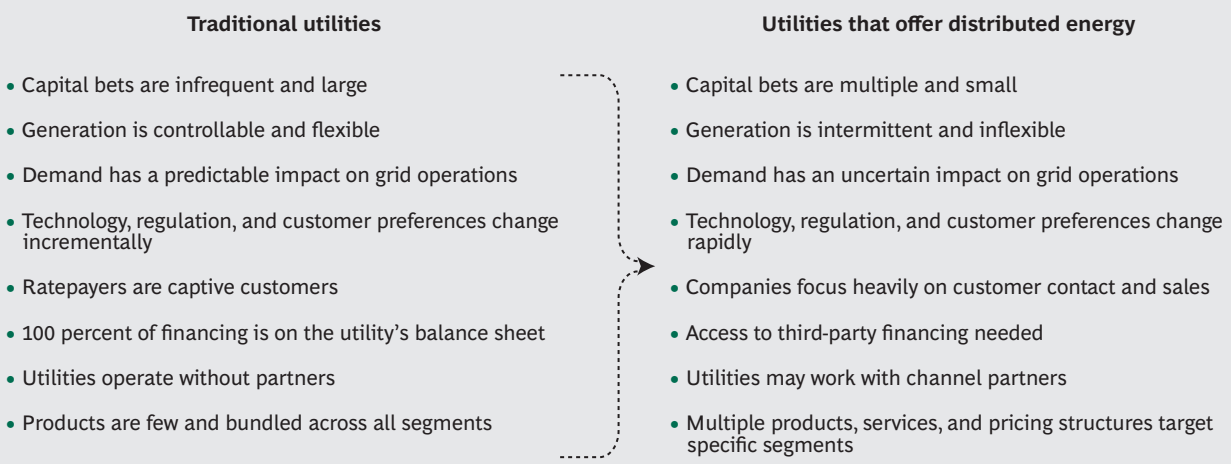
The rise in DE adoption and the evolution of technology will transform the energy landscape. We predict an increasingly rapid pace of change, a greater focus on customers, and a more complex environment with multiple products, services, and pricing structures. This will require traditional utilities to develop many new capabilities. (See Exhibit 5.) For example, just as DE companies have developed financial and technical solutions, utilities will have to identify and build similar capabilities if they hope to keep up with the level of innovation.

Distributed Energy as a Disruptive Force

The growth of DE shows few signs of abating. It is being driven by improving economics derived from decreasing costs, customer choice, and innovations in technologies and business models. DE companies are spurring that innovation, and they will continue to embrace new products and services that will keep the competitive pressure on incumbent utilities.

DE will thus continue to present challenges to utilities as it forces the fixed cost of the grid to be borne by shrinking revenues from traditional electricity generation

Exhibit 5 | Distributed Energy Will Require Utilities to Develop New Capabilities



Source: BCG case experience and analysis.

and as it starts to disintermediate part of the utility value chain. Simply put, a potential competitive threat for traditional utilities now lurks in every neighborhood, in every home, and on every rooftop across the country.

We believe utilities must be proactive in developing a response for a future defined by more DE. Being defensive or worrying about cannibalizing existing retail sales will not deter the underlying advantages of the DE companies' business models, which will only strengthen in the future. Utilities can't afford to ignore the long list of companies in other industries that discovered how a wait-and-see strategy could be fatal. Fortunately, utilities have many advantages that they can leverage in this emerging, more competitive environment, including low-cost customer access, control of the grid's unique capabilities, and an established brand with customers.

Distributive energy is a disruptive force. It will require an equally big disruption among utilities if they are going to survive and grow in the changing U.S. power environment.

Notes

1. *Tracking the Sun VI: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2012,* Lawrence Berkeley National Laboratory, 2013.
2. *Distributed Energy Storage 2014: Applications and Opportunities for Commercial Energy,* GTM Research, February 6, 2014, www.greentechmedia.com/research/report/distributed-energy-storage-2014.
3. *Photovoltaic (PV) Pricing Trends: Historical, Recent, and Near-Term Projections,* National Renewable Energy Laboratory and Lawrence Berkeley National Laboratory, November 2012.

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