

The future of demand response in electricity distribution

The growing importance and role of demand-side management, user participation and demand flexibility in the era of the digitally enabled grid

A photograph of a solar farm with rows of solar panels stretching into the distance under a clear blue sky. Overlaid on the image are several digital elements: a glowing cyan arc, a glowing cyan sine wave, a semi-transparent circular graphic containing a power line tower, and a large yellow arrow pointing to the right. The text "High performance. Delivered." is positioned at the end of the yellow arrow.

High performance. Delivered.

The historical context of demand response...

The use of demand response in the world's electricity systems is not a new concept. Its earliest manifestations date back several decades, to the radio and ripple control systems that could be used to manage high-consumption components such as air conditioning and water heating systems in the 1970s.

At that time, demand response was primarily used to maintain the integrity and function of the transmission grid by providing load reductions during periods of extreme load, and by curtailing demand on overstretched power generation capacity.

However, in the era of the smart, digitally enabled grid, connected to a growing amount of solar photovoltaics (PV) and other distributed energy resources

(DER). Other devices including storage batteries, modern demand response could be a very different concept. Today's sophisticated programs are potentially capable of providing a wide array of closely targeted services providing direct benefits to the distribution network, reflecting the transformation of demand response from a way to shave peak demand to an increasingly valuable tool to manage the modern grid.



What is demand response?

According to the United States of America's Federal Energy Regulatory Commission, demand response (DR) is defined as: "Changes in electric usage by demand-side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized."

Source: <http://www.ferc.gov/>



...is giving way to a growing future role for distribution utilities

In playing this new role, demand response is essentially about leveraging customer flexibility to help optimize distribution networks by matching supply and demand faster, more responsively, more effectively and above all, more locally.

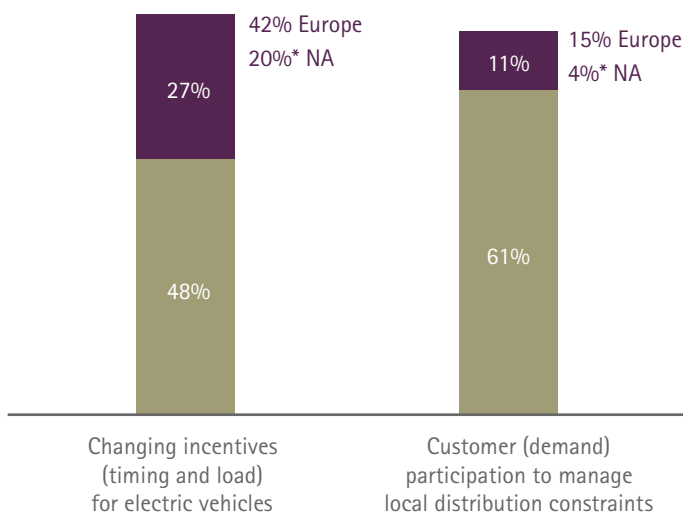
While demand response is already an established tool for supporting optimization of grid-based generation or transmission, it has not been used to any significant extent in distribution networks.

This is set to change. The usage of demand response by distributors is expected to grow significantly, as the combination of increased energy efficiency, distributed generation deployment and economic drivers takes hold. As Figure 1 illustrates, utility executives surveyed in Accenture's 2016 *Digitally Enabled Grid* research program expect the next 10 years to bring growing use of customer demand flexibility to optimize

the distribution network load shape and manage local distribution constraints.

As this trend continues, demand response tools and demand usage incentives such as electric vehicle (EV) charging schemes will become a key tool for electricity distributors to manage peak load and maintain reliability of supply. Accenture modeling indicates that demand-response solutions could provide meaningful changes to peak demand through programs that incentivize action on very few hours per month (see Figure 2). Targeted reductions in peak load could potentially save a utility millions of dollars in deferred reinforcement costs.

Figure 1. How do you expect the distribution network to evolve in the next 10 years (i.e., between now and 2025) with regard to these factors?

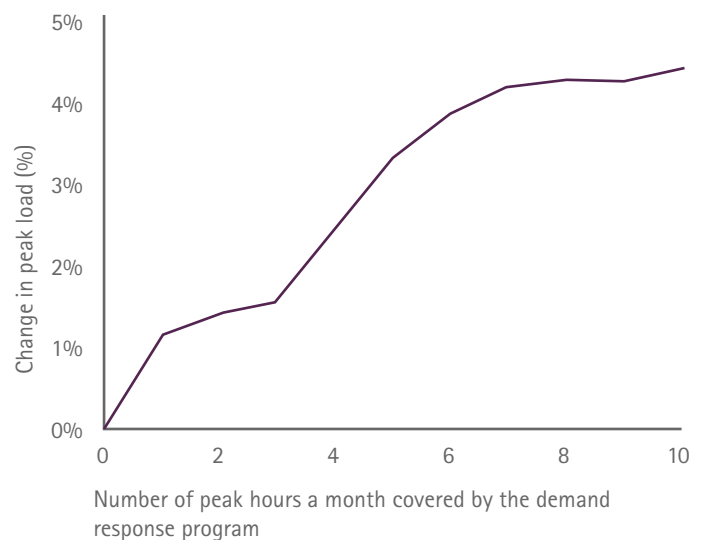


■ Significant growth ■ Moderate growth

Base: All respondents; *please note: due to limited North America sample, results for this region are to be interpreted with caution and within context.

Source: Accenture's *Digitally Enabled Grid* research program, Accenture analysis.

Figure 2. Number of peak hours a month covered by the demand response program, and corresponding change in peak load.



Source: Accenture's *Digitally Enabled Grid* research program, Accenture analysis.

From smoothing out the "duck curve"...

However, as the sophistication and role of demand response evolves, the GTE traditional function of energy balancing remains extremely relevant.

The rising prevalence of distributed energy resources—especially solar generation—has reshaped the daily profile of electricity demand by creating the "duck curve." This curve reflects reduced net demand mid-day, followed by a period in the late afternoon during which demand picks up sharply as solar generation tails off, and household demand increases, requiring other generation to ramp up quickly to cover the increase.

The duck curve can put traditional generation sources under significant stress, especially if their output has been curtailed significantly in the middle of the day when solar generation is at its peak. Consequently, there is a valuable potential role for demand response to play in flattening out the duck curve by moderating the increase in demand at those times.

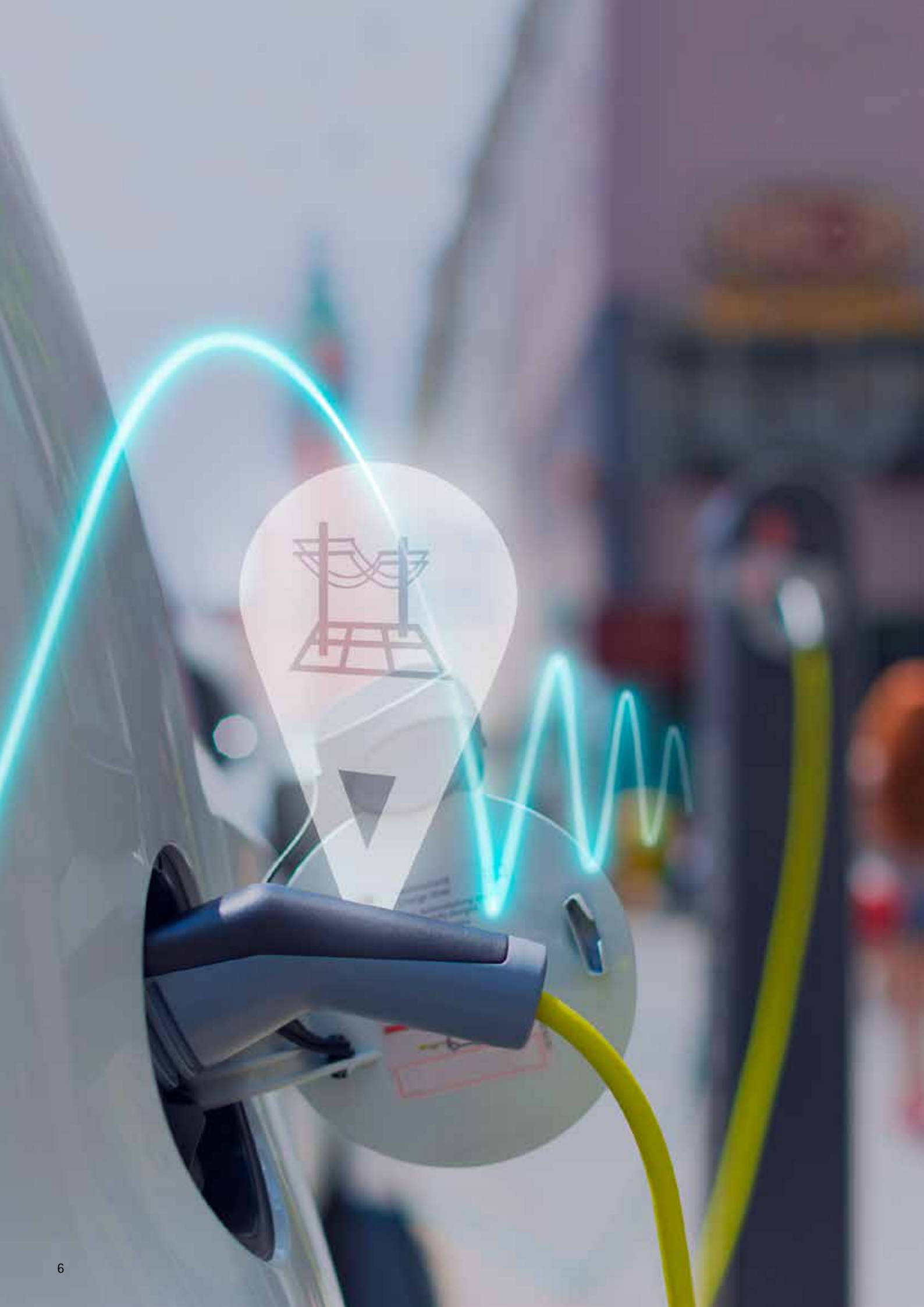
...to enabling localized responses—down to the individual meter level

Alongside its role in balancing supply and demand and managing load at the wholesale level, the need to optimize the modern distribution grid also calls for demand response to be applied in a more localized manner to influence the utilization of grid resources.

In contrast to the relatively blunt, old-fashioned tool of controlling demand from air conditioning systems through radio signals, localized demand management on the modern grid requires an understanding of the network topology and connections between devices and specific meters, so the control signals can be pinpointed to the precise location on the grid.

A classic illustration of this challenge is a grid environment with a high penetration of EV charging stations. In many cases, customers charge their EVs at times of peak load. The draw on the grid for each EV is roughly equivalent to an entire household. So if a feeder has 1,000 homes on it, and 200 of those households decide to charge their EVs at the same time at peak load, then peak load rises by 20 percent.

To address this issue, two things might be needed: smart charging capabilities where EV charge cycles are driven by the grid's needs and shifted to times of lower load, or control of individual loads at the customer level. An active EV charging approach would allow the charging cycle to be flexed slightly if the distribution network is under significant stress. Air conditioning is another demand factor where tighter control through demand response could make a big contribution.



The big opportunity for distribution utilities: The localized view

The big opportunity in demand response for distribution utilities going forward is having a localized, highly granular view of the utilities' assets and contracts in place, and of which areas of demand are flexible.

These insights open the way to a range of demand-response programs to achieve specific goals.

These programs could range from traditional rebate-type programs in which customers receive a rebate on their bill for enabling the utility to control their air conditioning or water heating systems for a few hours each month, to more sophisticated schemes involving multiple devices, sensors and metrics. The key factor in shaping future programs will be the granularity of the view available to the utility—and this is continuously increasing as smart technologies roll out.

Moving to a cost-to-serve charging model...

The rise of digitally enabled power grids also opens the way to another advance linked to demand-response mechanisms: pricing based on cost-to-serve.

In traditional electricity billing, most of the network costs borne by customers are for grid capacity rather than the total amount of energy flow. But tariffs, particularly for residential consumers, are dominantly based on kWh demand.

However, in a number of markets there has been a move toward more capacity-based pricing, which can even be built into the meter. For example, when customers in Spain sign up for a supply contract, they specify how much capacity they want, which is programmed into the meter. If that capacity limit is exceeded, the meter will trip, providing a strong incentive to the customer to manage their energy usage.

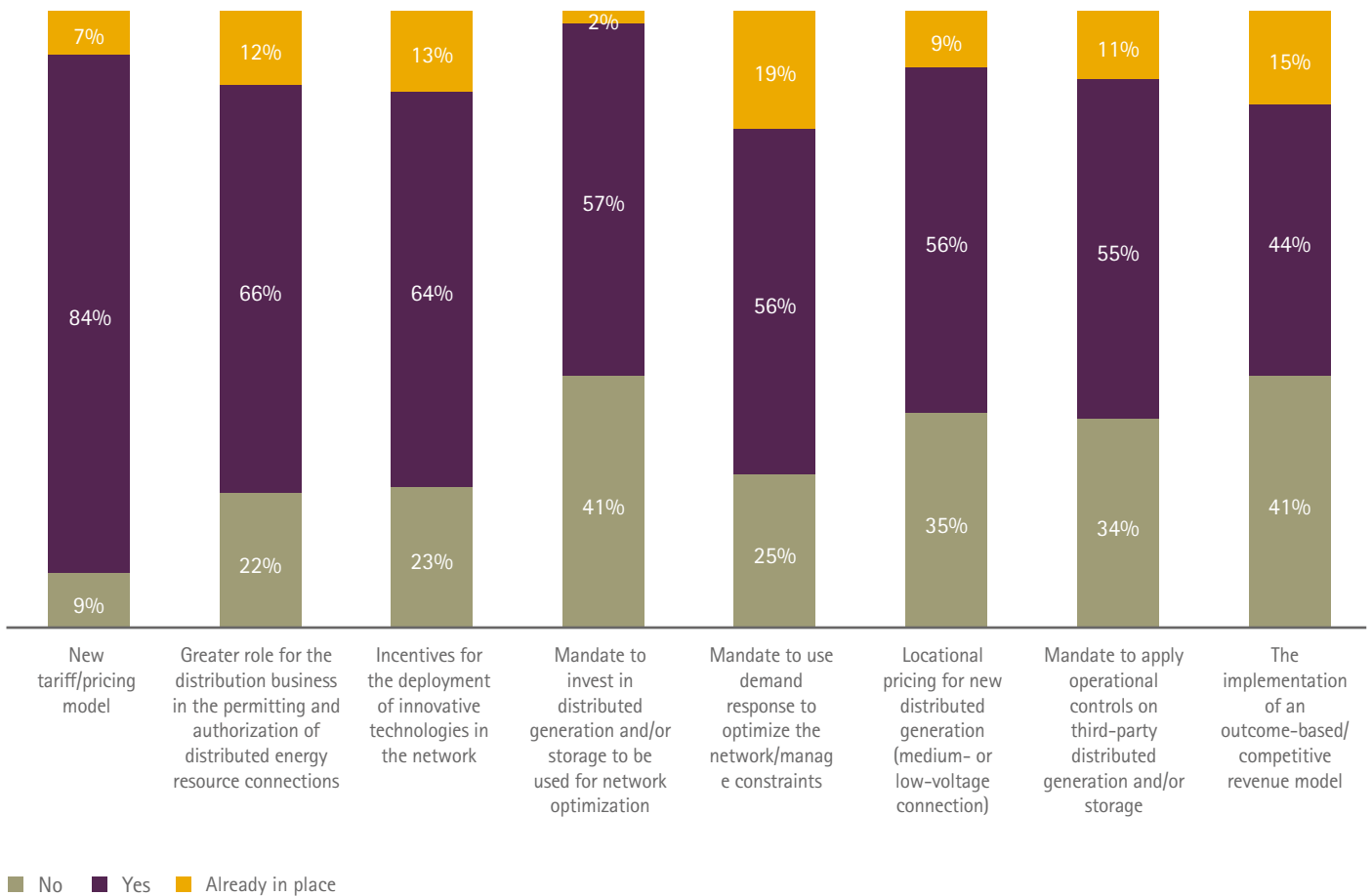
This model has had an interesting effect on the energy demand curve. In most developed markets, demand peaks have stayed fairly flat while total demand has decreased. Conversely, in Spain the peaks have fallen significantly, while overall consumption has held steady. This indicates that consumers in Spain are responding to demand-based pricing by shifting their consumption to off-peak time periods.

...will further boost the importance of demand response

In light of such experiences, utilities in other markets are looking at basing pricing more closely on cost-to-serve.

As this move gains momentum, the focus on demand response as an economic driver for both utilities and their customers will continue to increase. It is no coincidence that utilities regard tighter collaboration with regulators as particularly necessary in areas such as new tariffication models and mandates to use demand response, as our 2016 *Digitally Enabled Grid* research shows (see Figure 3).

Figure 3. Which of the following regulatory changes do you believe will be necessary in the next 10 years (i.e., between now and 2025)?



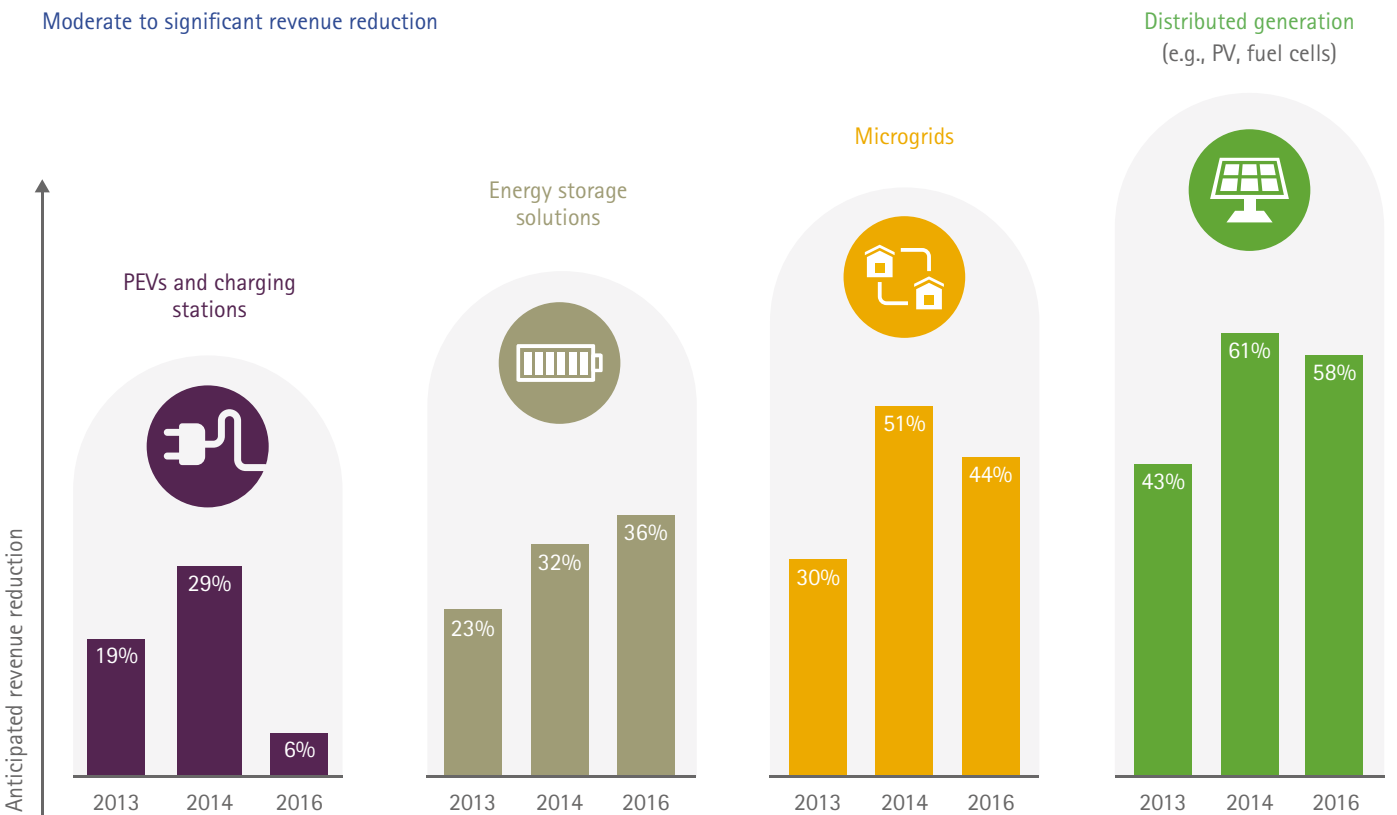
Base: All respondents.

Source: Accenture's *Digitally Enabled Grid* research program, 2016 executive survey.

An additional factor in the future development of demand response will be the rising deployment of end-user storage. The presence of consumer-owned storage significantly increases the potential range of network optimization services that a distribution business could purchase from both residential and commercial customers. As Figure 4 illustrates, utility executives increasingly expect storage to impact demand and revenues.

In Accenture's view, the potential to link energy storage to the financial metrics in demand-response programs could position storage as a significant element in utilities' overall demand-response strategies.

Figure 4. What impact will the following network assets have on your organization by 2030?



Base: All respondents; excludes "Not applicable" answers.
 Source: Accenture's *Digitally Enabled Grid* research program, 2016 executive survey.

Conclusion: Mapping out the complex new landscape of demand response

The evolution of the digitally enabled grid is increasingly transforming the demand-response environment, creating very different dynamics around how to manage demand and encourage customers to change their behavior.

From the distribution utility's point of view, the ability to control air conditioning and water heaters could offer a high degree of certainty about what the response will be, since such control is relatively direct and reliable.

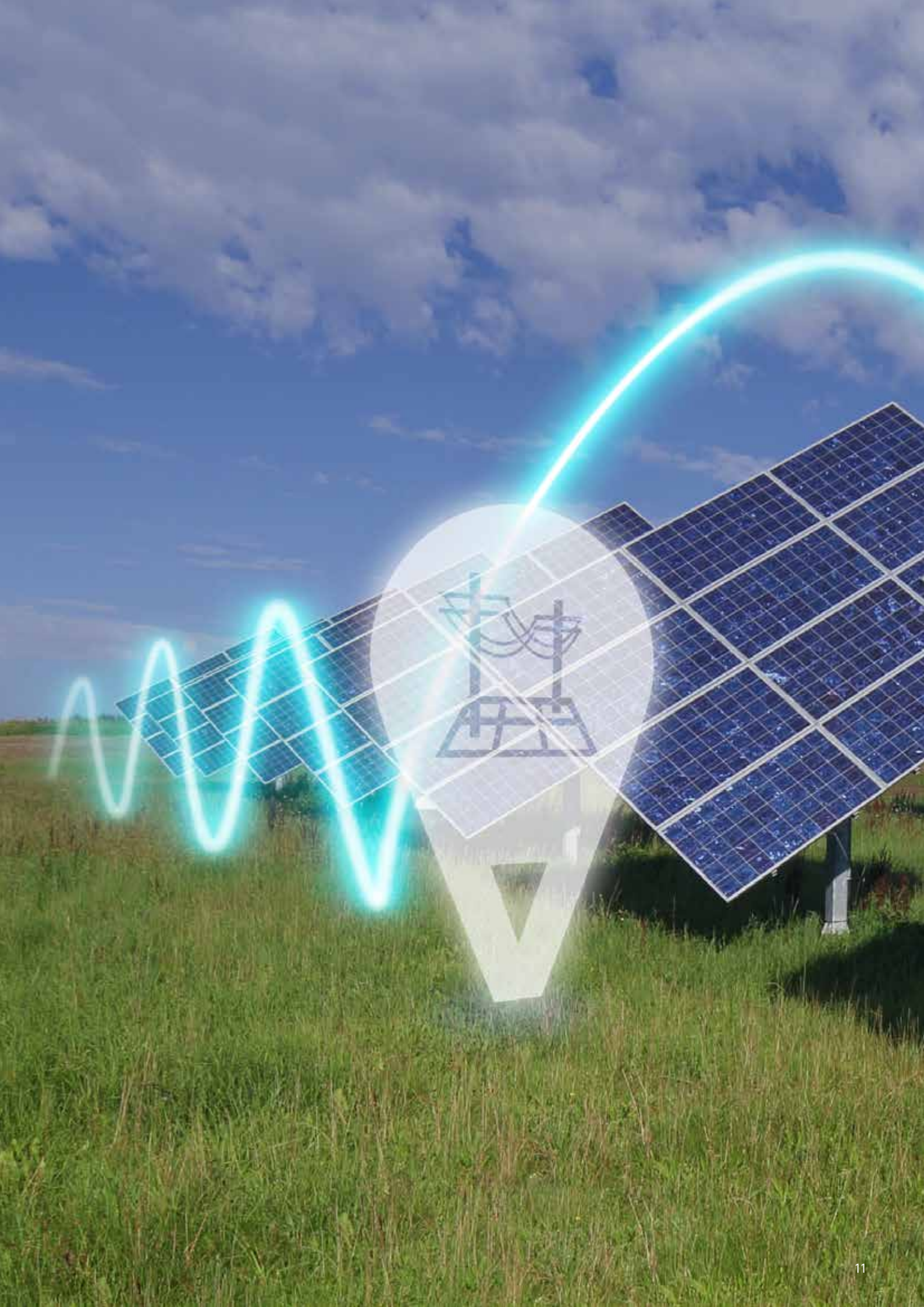
But a digitally enabled grid also brings with it more complexity. The utility potentially has a blend of mechanisms to influence or control demand through a range of pricing signals and responses targeted at specific users in their homes, possibly including cost-to-serve parameters. And when customers have the ability to manage the scale and timing of consumption by devices, their responses need to be verified.

All of this points to a rising degree of granularity and localization in demand-response initiatives, and some important decisions for utilities around how to

prioritize outcomes, whether balancing bulk generation or controlling distribution congestion at the local level. Whatever the objectives being pursued, there is a need for measurement and verification to validate that customers have curtailed their load and should be compensated in return.

The message is clear: the move toward localized demand response in the modern distribution grid takes the degree of complexity to a whole new level. If a utility is put off by such complexity, it is important to remember that the potential significant benefits in terms of deferred capital spend and improved quality outweigh the challenges. As the digitally enabled grid continues to evolve, it will become easier to incorporate customer flexibility into a more optimized distribution system.





About Accenture's Digitally Enabled Grid research program

Accenture's *Digitally Enabled Grid* research program provides actionable insights and recommendations around the challenges and opportunities utilities face along the path to a smarter grid. Drawing upon primary research insights from utilities executives around the world as well as Accenture analysis, the Digitally Enabled Grid research program examines how utilities executives expect smart grid technologies and solutions to contribute to their future networks.

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References

Accenture's *Digitally Enabled Grid* research program

Reports on Demand Response & Advanced Metering, <http://www.ferc.gov>


About Accenture Smart Grid Services

Accenture Smart Grid Services focuses on delivering innovative business solutions supporting the modernization of electric, gas and water network infrastructures to improve capital efficiency and effectiveness, increase crew safety and productivity, optimize the operations of the grid and achieve the full value from advanced metering infrastructure data and capabilities. It includes four offering areas: Digital Asset Management, Digital Field Worker, Intelligent Grid Operations and Advanced Metering Operations.

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