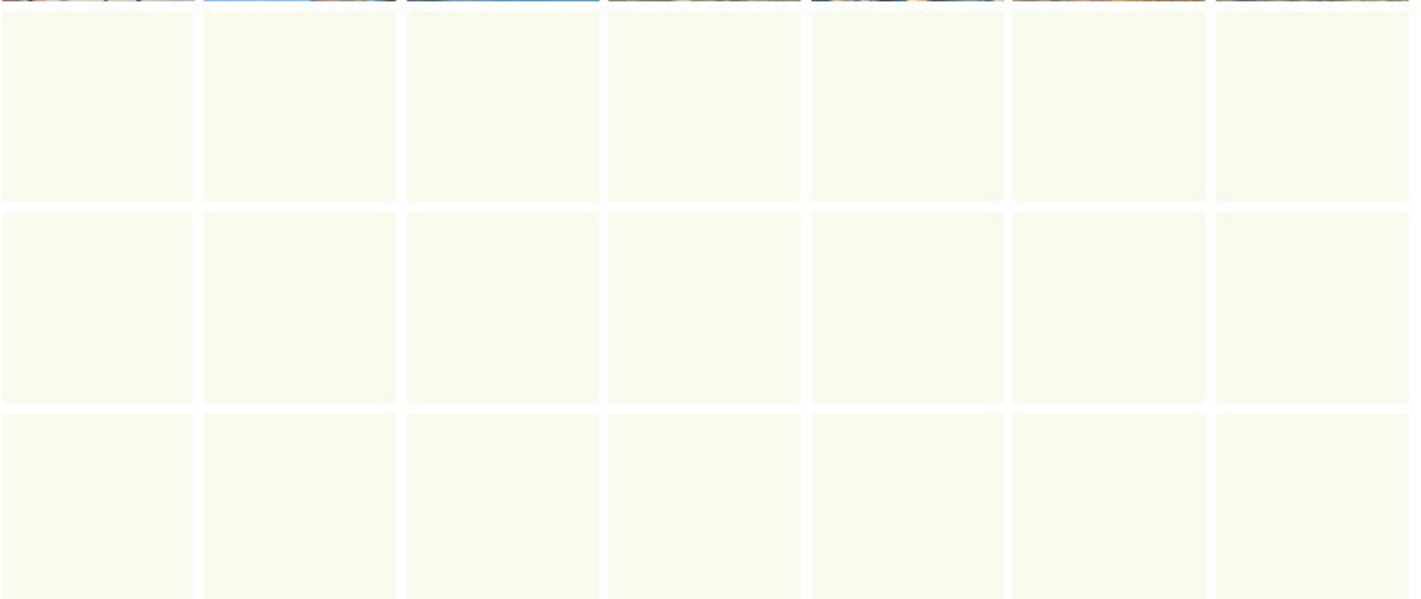


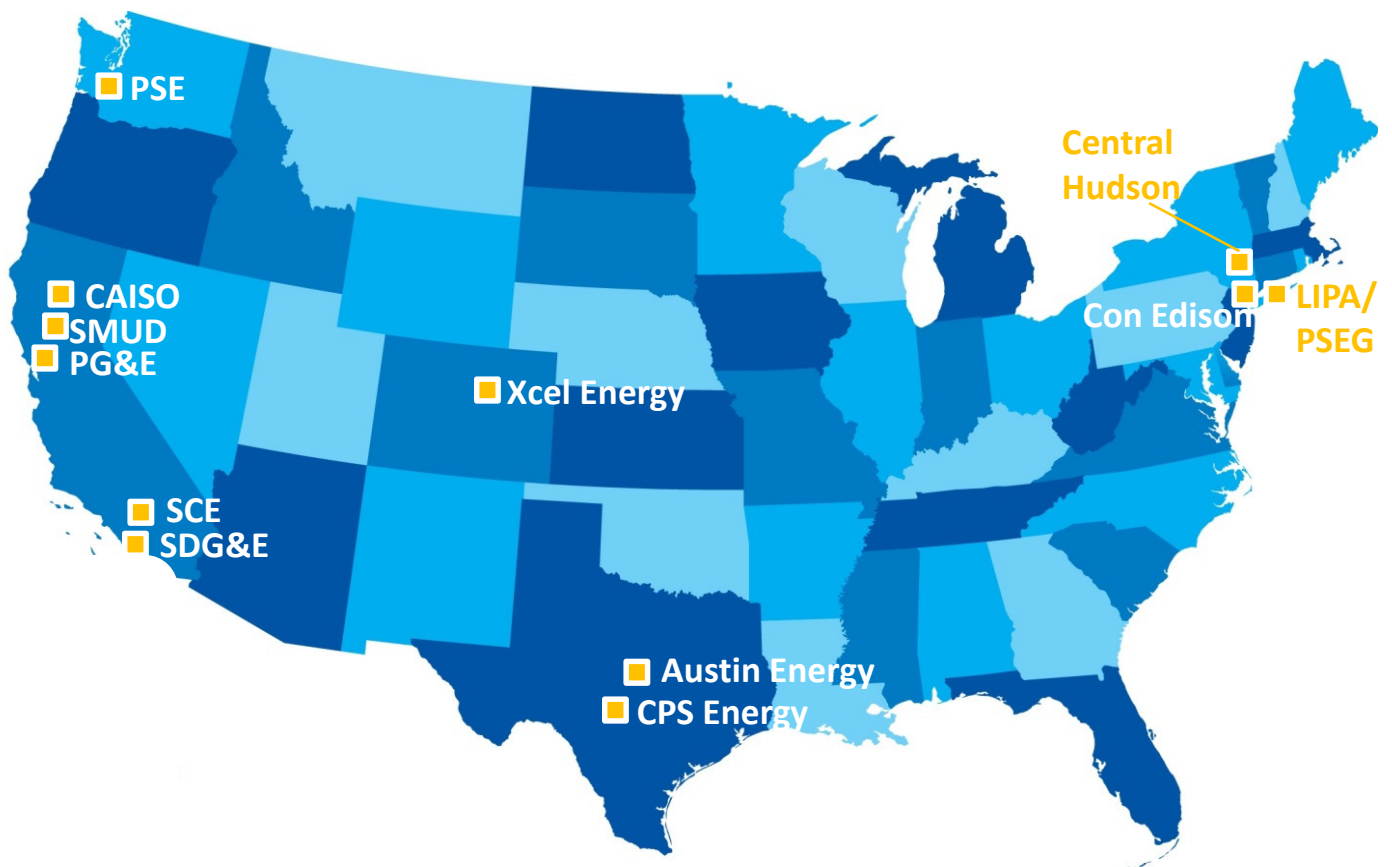
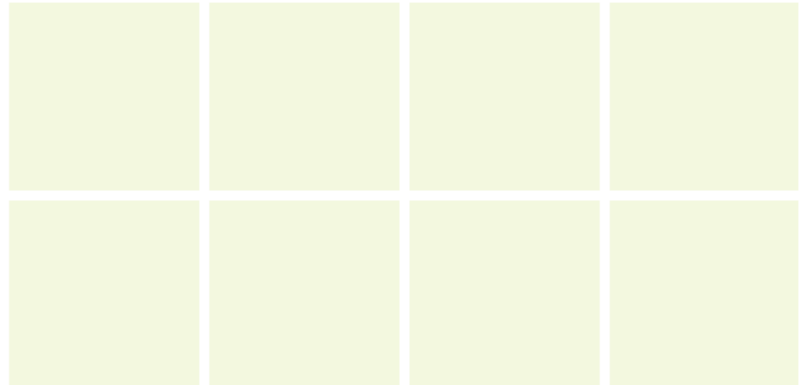
BPA Distributed Energy Resource Benchmarking Report



To learn more visit:
[www.bpa.gov/goto/
distributedenergyresources](http://www.bpa.gov/goto/distributedenergyresources)

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DER BENCHMARKING PARTICIPANTS



LETTER FROM BPA

THE BONNEVILLE POWER ADMINISTRATION has served the Pacific Northwest through the Federal Columbia River Power System for over 75 years. We have been able to meet regional needs with the robust, flexible and low-cost capacity provided by the FCRPS and the typically available Northwest market for wholesale electricity. Currently, regional capacity needs that exceed supply appear on the horizon, both in terms of aggregate system balance, as identified in the Seventh Power Plan, and on a localized level with prospective use of demand response for non-wires initiatives.

These potential constraints have led BPA to look for ways to provide additional capacity beyond that of the FCRPS. Demand Response has been used as a long-term source of capacity elsewhere in the U.S. where utilities do not have access to the robust and ready supply of flexible capacity we have in the Pacific Northwest. Over the past several years, BPA has supported demand response pilots and demonstrations in public utility service territories throughout the region. More recently, we have researched opportunities to utilize additional distributed energy resources in both our Power and Transmission businesses to continue providing the necessary flexibility and reliability for BPA.

To support this research objective, BPA staff met with 12 entities throughout 2017 to better understand how they are using and enabling DERs within their organizations and service territories. We learned about the types of DERs utilities are working with, how they are integrating them, programs available to customers, enabling technologies and future plans for each of the entities. This report provides summaries of what we learned during these discussions.

As manager of the distributed energy resources program at BPA, I'd like to sincerely thank our many utility and ISO partners who generously contributed their valuable time and knowledge to participate in this benchmarking effort. We look forward to continuing these discussions in this important area of our business as new developments unfold.

Sincerely,

Lee Hall
Manager of Power Services' Distributed Energy Resources



BPA Distributed Energy Resources Benchmarking Report



AUSTIN ENERGY

Austin Energy is a publicly owned utility with operations funded entirely through energy sales and services. They are recognized for achieving some of the highest performance standards in the industry, including aggressive renewable and reliability goals and demonstrated efforts to promote new clean energy technologies and a sustainable environment.

The City of Austin's goals for use of renewable energy are some of the most aggressive in the United States and they rank first among Texas utilities for green power sales. Austin Energy is also known in the industry for offering very comprehensive energy efficiency programs and innovative DER programs.

DER at Austin Energy

Austin Energy primarily uses DER for peak load management in the summer months, June through September. The table on the following page provides a detailed look at the distributed energy resources at Austin Energy and how they are being used by the utility.

ERCOT and 4CP

Similar to other utilities in Texas, a primary driver for peak reductions at Austin Energy is the 4CP, four coincident peaks determined by the Electric Reliability Council of Texas, Inc. (ERCOT). The 4CP is defined as the average of ERCOT's four highest peak days within June, July, August and September. Utility transmission costs are based on this peak for the following year.

Predicting when ERCOT will take their 'snap shot' of peak days and times and then reducing their loads at that time, can save Austin Energy a considerable amount of money the following year.



HEADQUARTERS

Austin, Texas

FAST FACTS

- Nation's 8th largest publicly owned electric utility
- Serves more than 450,000 customer accounts/1 million residents in Greater Austin

PEAK DEMAND

2,714 MW

DER PORTFOLIO

- Demand Response
- Energy Storage
- Distributed Generation
- Solar/PV

Distributed Energy Resources at Austin Energy

DER	Description	Size	Primary Purpose/Use
Energy Storage	Lithium Ion Battery	1 MW	Austin Energy received a grant from DOE to build a business case around energy storage and this battery is being used to gather data for this research project.
	Commercial District Cooling – Thermal storage	~20 MW	Austin Energy’s district cooling provides customers their HVAC requirements through a network of underground pipes. It can serve multiple buildings within a particular service area. This system produces ice or chilled water that is stored in a tank and used to cool a building during peak hours allowing a shift in electric cooling operations to off-peak hours.
Distributed Generation	Emergency Reliability Program / Back up diesel generators	~15 MW	These generators are used for emergency response service within ERCOT. Austin Energy bids these MWs into the market when needed. They can automatically start these generators on 10 minutes notice to offset load in an emergency.
Distributed Solar	Utility Scale Solar	150 MW in West Texas by 2020 and up to an additional 600 MW (other PPAs) by 2025	Austin Energy has a solar plan to procure ~750 MW of utility scale solar via Power Purchase agreement. Due to solar power’s current price, it is now considered competitive in the ERCOT market, allowing Austin Energy to further diversify their energy portfolio with renewable resources.
	Residential Solar Incentive program	~26 MW / 5,500 customers	Austin Energy provides considerable incentives for residents to install solar to order to help reduce their summer peak.
	Commercial/Municipal Solar Program	~3.5 MW	This program is used for summer peak reduction and is based on a performance incentive. If under 20kW, customer has a net meter and they are billed on net, over 20kW is billed on delivered amount and anything over 1MW needs to be registered with ERCOT.
Demand Response	Free Thermostat Program	~45 MW / 90,000 thermostats	This program includes one way thermostats operated as a summer peak reduction program in order to reduce cost in ERCOT market. Austin Energy is looking at options for potentially using this resource for year round DR.
	Power Partner Thermostat Cycling Program	~7 MW / ~13,000 thermostats	Wi-Fi connected Bring Your Own Thermostat (BYOT) program that allows customers to choose from any of the approved thermostat providers. The customer pays for the thermostat and installation and Austin Energy provides an incentive for enrolling in the cycling program.
	Water Heater Timers	~11 MW / 17,000 timers	This program includes one way timers to turn off power to water heaters during peak demand to reduce cost in the ERCOT market (used in summer months, June –Sept).
	Load Cooperative Program	~23 MW / 305 accounts for 46 customers	Voluntary program for C&I customers who can reduce load at peak demand times with 1 hour notice. Customers receive an incentive per kWh curtailed. This program is called ~12-15 times per year for 2 hours at a time in order to reduce cost in the ERCOT market.

BYOT Program

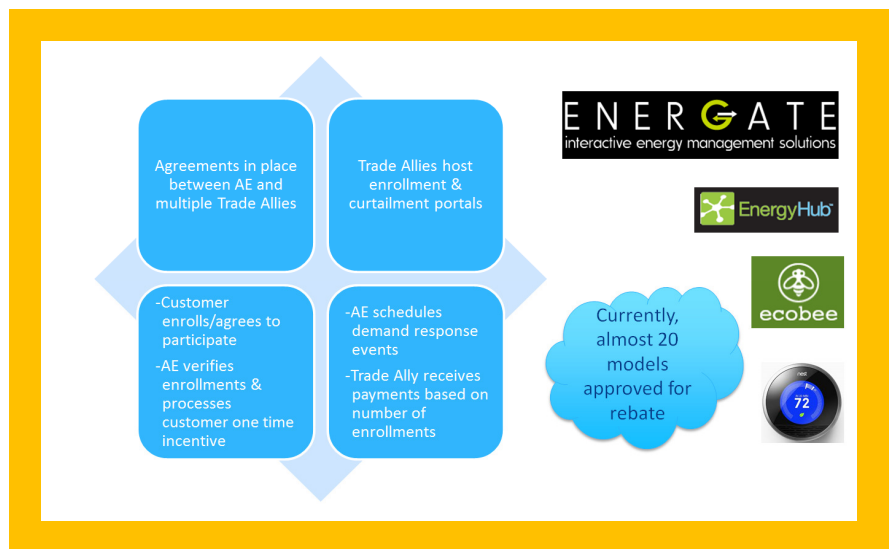
Although Austin Energy has many projects involving DERs, they are well known in the industry for their BYOT program. Austin Energy was one of the first utilities to implement a BYOT program, allowing customer to choose their own Wi-Fi enabled thermostat while saving money and energy.

Customers who have an approved thermostat and enroll in the program with Austin Energy will receive an \$85 incentive to participate in energy cycling events on the hottest days of the year. On these days, Austin Energy will briefly adjust thermostat settings by a few degrees (only as needed) during peak energy demand. This will increase each customer's energy savings while helping to fulfill community-wide demand for electric service.

Energy cycling will occur no more than 17 summer days between June and September, during the hours of 4pm – 6pm, to ensure everyone is able to stay cool. There is a manual opt out at any time that can occur easily through an adjustment on the thermostat's smart device app.

Austin Energy works directly with thermostat providers to determine appropriate partners for this utility program. The picture on this page highlights the process for how Austin Energy works with various thermostat providers, who in turn partner with Austin Energy to enroll interested customers in the BYOT program at the utility.

BYOT Process Austin Energy and their Trade Allies



Austin SHINES

Another key initiative at Austin Energy utilizing DERs is their Austin SHINES project. This began in June 2015 when Austin Energy was awarded \$1 million from the State of Texas through an Environmental Quality grant from the Texas Commission. Through this grant, Austin Energy is developing a pilot energy storage system paired with a community solar array.

In addition, Austin Energy was awarded \$4.3 million from the U.S Department of Energy SunShot Initiative in February of 2016. This grant provided Austin Energy the funds to pilot a technology platform to enable and promote integrated distributed energy resources. Collectively, these resources make up the Austin SHINES project (Sustainable and Holistic Integration of Energy Storage and Solar Photovoltaics).

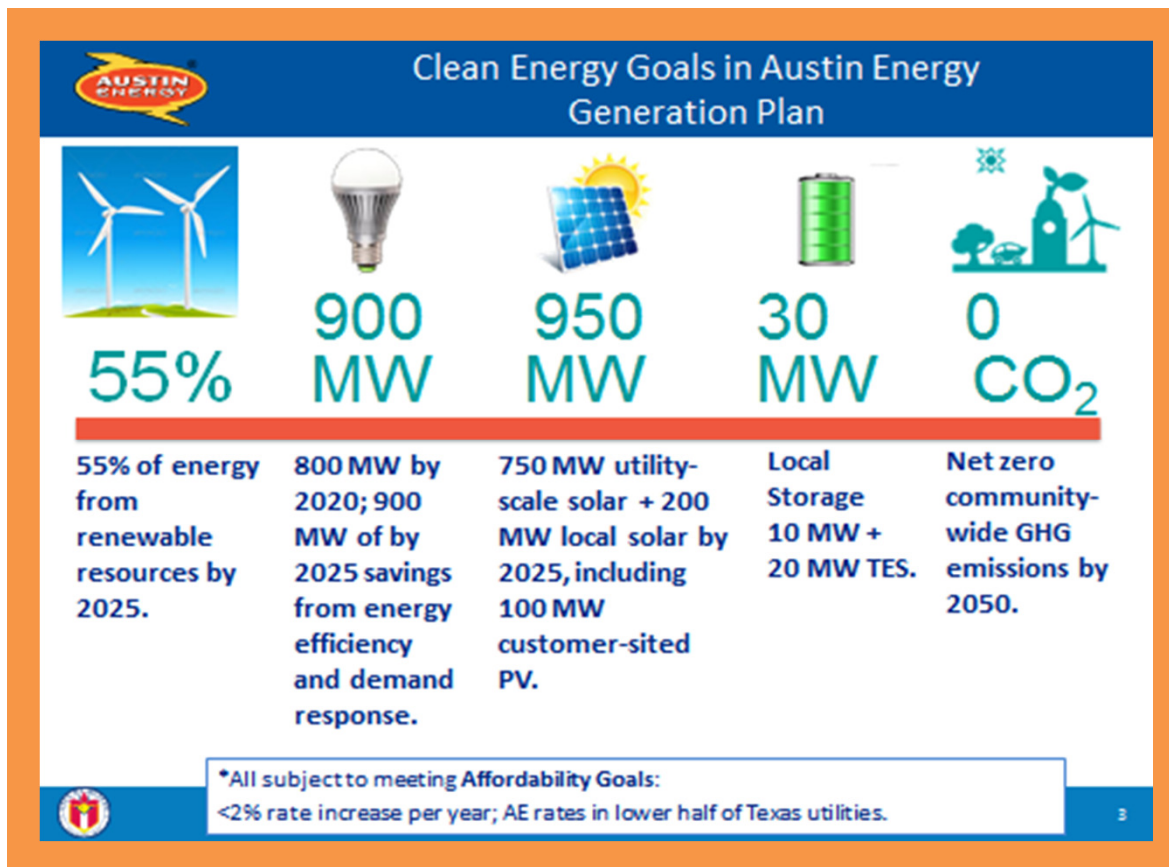
This project will integrate solar power, energy storage, smart inverters, forecasting tools, market signals, advanced communications and a software optimization platform. This will be accomplished by two utility scale energy storage systems tied directly to Austin Energy's distribution system. One grid-battery will be paired with a new community solar array of 2 MW in East Austin and the other grid-battery will support commercial and residential rooftop solar systems in a mixed-use development complex. The main objective of the Austin SHINES project is to analyze and determine best practices for integrating renewable energy and energy storage on the grid at utility, commercial, and residential scales. This is scheduled to be a 39-month project with an estimated completion of April 30, 2019.

WHAT'S NEXT

for Austin Energy

Austin Energy has a goal within their generation plan to provide 55% of their energy from renewable resources by 2025. In order to accomplish this goal,

Austin Energy will continue to focus on the key initiatives discussed in this report as well as leverage DER learnings to develop new initiatives and grow existing programs.





BPA Distributed Energy Resources Benchmarking Report



CALIFORNIA INDEPENDENT SYSTEM OPERATOR

As the only independent grid operator in the western U.S., the California Independent System Operator, grants equal access to 26,000 circuit miles of power lines and reduces barriers to diverse resources competing to bring power to customers. It also facilitates a competitive wholesale power market designed to diversify resources, lower prices, match buyers and sellers of electricity and facilitate over 28,000 market transactions every day to ensure enough power is on hand to meet demand.

DER at CAISO

Demand Response has had the opportunity to participate in the CAISO market for the past few years via two wholesale products, Proxy Demand Resource (PDR) and Reliability Demand Response Resource (RDRR). These were developed by the ISO in response to FERC orders and CPUC rulings to integrate utility programs and provide open access to 3rd party participation. These two products, however, did not accommodate all of the smaller scale resources such as rooftop solar, energy storage and plug-in electric vehicles that are growing rapidly in California.

In order to address this opportunity, the CAISO decided to take on a new challenge and request FERC's approval to revise market rules and better integrate smaller-scale resources into its markets. FERC approved this proposal from the CAISO in 2016 making them first in the nation to open their markets to rooftop solar, energy storage and electric vehicles in aggregation. A new classification and wholesale market product called Distributed Energy Resource Providers (DERPs) was created to allow this participation for distributed energy companies, which could be a utility or any other aggregator entity, to have access to the ISO electricity market.



California ISO

HEADQUARTERS

Folsom, California

FAST FACTS

- Manages 80 percent of California's power grid and a part of Nevada's.
- Facilitates over 28,000 market transactions every day.

PEAK DEMAND

46,232 MW

DER PRODUCTS

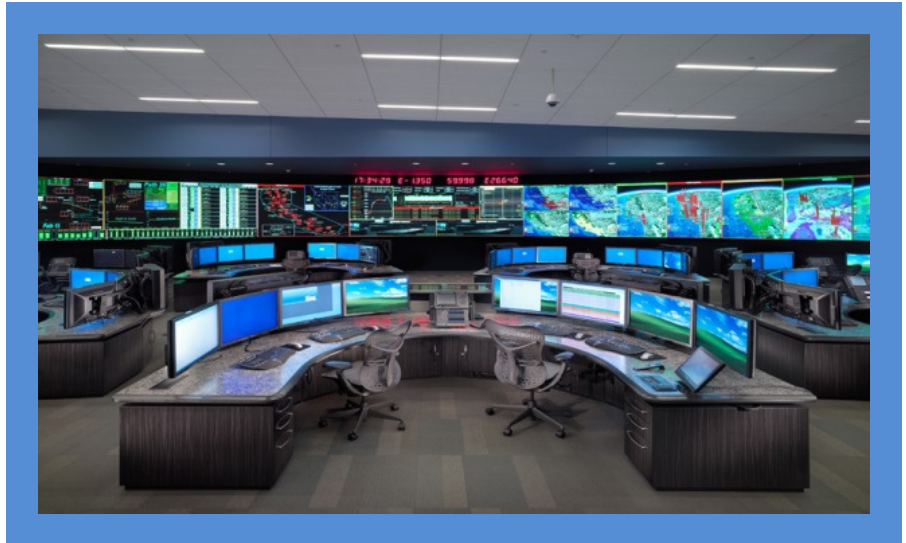
- Proxy Demand Resource
- Reliability Demand Response Resource
- Distributed Energy Resource Provider

DER Participation in the Wholesale Market

With the approval of DERPs, there are now two CAISO wholesale market products that could fit the bill for aggregated DERs to participate in both the energy and ancillary services markets. Although, the PDR product was designed specifically for demand response, it is being used for other aggregated DERs like energy storage today. These resources aren't always recognized as DERs since they are being used similarly to demand response (reducing load) and not injecting power into the grid.

DERPs, on the other hand, introduces the more complicated issue of power delivered back into the grid (such as rooftop solar and other distributed generation). For power to come back from behind the meter into the distribution grid and serve the wholesale market, communications and operational issues still need to be worked through between the distributed energy resource providers and the CAISO. The DERPs product and the concept overall is new so it may take time before all of the details are ironed out and considerable participation begins to occur.

Once more participation begins to occur, CAISO is expecting distributed generation, energy storage and electric vehicle charging stations mainly, but the product leaves open the possibility for market entry by other types of resources located on either side of the customer meter.



CAISO's headquarters building houses one of the most modern control centers in the world

There is a broad definition of eligibility intended to avoid excluding emerging technologies from participating in aggregation. The framework will accommodate various resource types as well as different business models, provided the aggregation is operating as an integrated resource and meets specific technical requirements. Other business models could include microgrids interconnected to distribution systems as well as third-party aggregators and utilities operating DERs.

The CAISO has indicated that demand response participating the PDR product, which already allows aggregation, would continue that participation and would not be part of DERP aggregations (for the same resources).

Distributed Energy Resource Provider

Since the DERP product is fairly new within the wholesale market, this section provides the high level process for participation as well as specific rules associated with the product.

In order to start participating in the wholesale market through the DERPs product, an agreement between a DERP and the CAISO, termed a DERP Agreement, would establish the terms and conditions under which an individual DERP would operate. Multiple aggregations could fall under the umbrella of a single DERP Agreement (.05 MW minimum aggregation is required to enter the market) and the proposal would also allow the managing DERP to communicate with CAISO via a single point of contact.

In order for the DERP agreement to be official, the metering/settlement process also needs to be determined. In today's California market, all of CAISO's centralized generators have a resource ID and are required to have revenue quality metering to participate in the market. That can be via a direct interaction between the ISO and the resource ID, or it can be through a scheduling coordinator that mediates between the ISO and the resource ID. However, for distributed resources, assigning a resource ID to each generator is not feasible (for example, an ISO meter on every rooftop solar installation).

To solve that issue for DERP, a scheduling coordinator takes administrative control of aggregated distributed energy accounts and meters them with any technology, including any online technology that suits their purposes. The aggregator can be its own scheduling coordinator or can hire a third-party. A directly connected interface between the ISO and the aggregator is no longer required, and any communication network or protocol that provides the necessary data in a timely manner is acceptable. The scheduling coordinator is required to provide CAISO the settlement quality data and audit it and ensure accuracy.

Once the set up between the DERP and the CAISO is complete, there are specific rules that would bar some resources from participating in aggregations:

- Generation rated at 1 MW or greater.
- Demand-side resources bid into the market by curtailment service providers.
- Demand response intended to react to grid emergencies.
- Generating units between 0.5 MW and 1 MW would need to terminate their participating generator agreements in order to join an aggregation.
- Resources already participating in a retail net energy metering program.

More details regarding DERP can be found on CAISO's website

<http://www.aiso.com/participate/Pages/DistributedEnergyResourceProvider/Default.aspx>

WHAT'S NEXT for CAISO?

The integration of DERs into the market and the mechanics of how that will occur is an important initiative for the ISO and one that aligns well with their overarching strategies:

1. Lead the transition to a low carbon grid.
2. Reliably manage the grid during energy industry transformation.
3. Expand collaboration to unlock regional benefits.



BPA Distributed Energy Resources Benchmarking Report

CENTRAL HUDSON



Central Hudson Gas & Electric Corporation is a regulated transmission and distribution utility in New York State’s Mid-Hudson River Valley. Central Hudson delivers natural gas and electricity to their service territory that extends from the suburbs of metropolitan New York City north to the Capital District at Albany.

Reforming the Energy Vision

Central Hudson’s primary driver for their use of Distributed Energy Resources is to meet obligations within New York’s Reforming the Energy Vision (REV) Strategy. REV is an energy modernization initiative that will fundamentally transform the way electricity is distributed and used in New York State. REV will build a bridge to a cleaner, more efficient and affordable energy system by concentrating efforts in the following:

- Creating the power grid of the future and enabling customers to better manage and reduce their energy costs.

- Focusing on system efficiency, total bills, carbon emissions, technology innovations, resiliency and competitive markets around customers.
- Addressing issues like rising electric bills, reliability, resiliency, emission reductions, jobs, and the low income “electric divide”.

REV will ultimately help protect the environment, lower energy costs and create opportunities for economic growth.

More information can be found on the New York State’s Department of Public Service website: www.dps.ny.gov



HEADQUARTERS
Poughkeepsie, New York

FAST FACTS

- Serves approximately 302,000 electric and 80,000 natural gas customers
- Employs approximately 1,000 people

PEAK DEMAND
1,088 MW

DER PORTFOLIO

- Residential and Commercial Demand Response via non-wires initiatives

DER at Central Hudson

Currently, Central Hudson uses DERs to reliably reduce transmission congestion or distribution constraints at times of maximum demand in specific geographic areas within their service territory. These investments in distributed energy resources and some changes to the utilities operating procedures can defer or replace the need for specific transmission and/or distribution

projects, at lower total resource cost.

Although Central Hudson has been agnostic of the technology or method they use for these non-wires efforts to date, demand response has been the primary way they have been able to reduce load at critical days/times during their summer peak. It is currently the most cost effective option in their current non-wires scenarios.

Details of Central Hudson’s DERs are provided in the table below. Each of the DERs and/or programs at Central Hudson have been designed to be consistent with the objectives of REV by encouraging market based solutions and direct customer involvement in efforts to limit future electricity costs by delaying the need or large utility investments in future T&D upgrades.

DER	Description	Size	Primary Purpose/Use
Demand Response	Residential Bring Your Own Thermostat (BYOT) Program*	Very small kW, limited number installed	This program was designed for summer peak load relief. Central Hudson is not in need of load relief, proving this program to not be cost effective for their utility at this time.
	Commercial load reduction program*	~4 MW	This program is for commercial customers who are able to reduce their load during Central Hudson’s summer peak. Customers are paid on performance (full amount delivered if an event is called and 50% of what their overall payment is even if no events were called).
	Peak Perks - residential and commercial/industrial	16 MW across 3 distinct non-wires projects* <ol style="list-style-type: none"> 1. 1 MW need – mainly residential central a/c 2. 5 MW need – mainly residential central a/c, 35% participation rate 3. 10 MW mainly load shifting for industrial customers 	This program is managed by Comverge, who recruits customers, manages customer relationship, their amount of load relief and payment of incentives (high incentive due to high need for load relief in this area). Central Hudson is in a supportive role and pays Comverge for performance of these services. Central Hudson determines the need for events, informs Comverge who then executes the event (up to 4 hours, 8 if an emergency in June – September)

*At the time of this report, Central Hudson was approximately half way to their MW goal for these three projects. The utility is considering energy storage options if the customer recruitment for their existing programs is not meeting the necessary MWs.

Non-Wires Planning Process

Throughout the planning for their non-wires efforts, Central Hudson has developed an efficient process to help the company determine which projects could replace or defer the need for system upgrades.

The Energy Transformation and Solutions team and the Engineering/Transmission Planning team meet on a regular basis to discuss goals, policies, other external factors and potential non-wires projects so both groups are on the same page

and operating on the same information.

Engineering/Transmission Planning then does a pre-screen (looking at project criteria; project type, cost and timeline) to determine whether these projects could be met with a DER solution or if the upgrade is inexpensive or simple enough that it wouldn't be worth the effort of researching other solutions. If there is a potential for a DER solution, the project is provided back to the Energy Transformation and Solutions team to see if a solution can be provided in the necessary timeframe.

A societal cost test is then run on the non-wires alternative and an RFP is sent out to see what is available in their service territory and who can provide it. Once offers are received, the details can be compared to the original cost test to determine cost effectiveness of this alternative.

This process has proven successful for Central Hudson and they plan to continue utilizing it for future efforts.

WHAT'S NEXT for Central Hudson?

Central Hudson's main use for distributed energy resources will continue to be around non-wires alternatives in the near future. They have recently distributed a new RFP for another non-wires project that requires ~1 MW of load relief. However, the four non-wires projects that are in progress are such a large percentage of Central Hudson's territory, there will not be many more projects that require load relief. The utility predicts that this type of process may be used down road for reliability projects, but those will also be limited for the utility in the near term.



BPA Distributed Energy Resources Benchmarking Report



CON EDISON

Con Edison’s electric, gas and steam service provides energy for the 10 million people who live in New York City and Westchester County. Not only does Con Edison operate one of the most complex and reliable electric power systems in the world, it also distributes natural gas to 1.1 million customer in Manhattan, the Bronx, Queens and Westchester County and steam service to approximately 1,650 customers in Manhattan, making it one of the largest gas and steam distribution companies in the United States.

Consolidated Edison, Incorporated is comprised of several different business entities. However, the information provided in this report is focused on Con Edison Company of New York.

The chart below provides a high level overview of their company structure including regulated utilities, transmission and their other energy businesses .



HEADQUARTERS
New York, New York

FAST FACTS

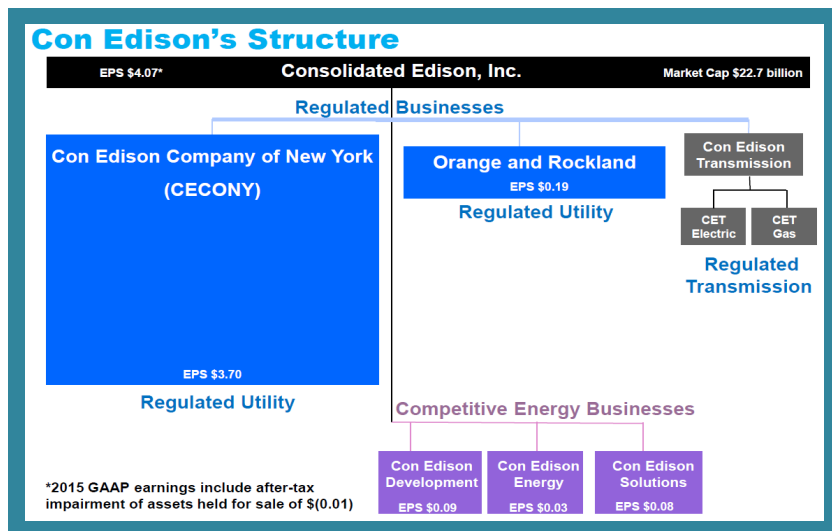
- Founded in 1823, Con Edison operates one of the world’s largest energy delivery systems
- Serves 3.4 million electric customers throughout a 604 square mile territory

PEAK DEMAND

13,322 MW

DER PORTFOLIO

- Residential and Commercial/Industrial Demand Response
- Energy Storage



DER at Con Edison

Con Edison’s primary driver for their use of DERs is to meet customer expectations who seek to manage energy use using increasingly newer technologies while also pursuing initiatives aligned with policies outlined within New York’s Reforming the Energy Vision (REV) Strategy.

Brooklyn-Queens

Con Edison’s largest project, aligned with the REV initiative, is the Brooklyn-Queens Demand Management Program. This program is a non-wires effort designed to defer ~\$1 billion in network upgrades with distributed solutions. The targeted area for this effort includes very heavily populated residential networks that mainly peak in the late summer afternoons (that were forecasted to overload from 12pm to 12am with peaks as late as 9-10 pm).

Building the very costly new infrastructure, including a new substation, in this area would have provided Con Edison with ~250 MW of capability. However, the need for load relief was ~100 MW during the peak timeframe, making this an ideal situation for an alternative solution.

Targeted area for the Brooklyn-Queens Demand Management Program



Con Edison has been authorized funding of up to \$200 million in expenditures to facilitate development of customer side and non-traditional utility side solutions. They started the process by sending out an RFI to understand what type of solutions they would have for additional load reduction. They also provided the opportunity for vendors to bid into a Demand Response auction to determine who could provide the most load reduction at the best cost.

Con Edison received more than 80 responses to the RFI and over 10 bidders in the Demand Response auction. Contracts were then set up with the vendors that were able to meet the criteria cost effectively. The following high level portfolio mix of DERs is currently being used to provide load relief to the utility in this constrained area.

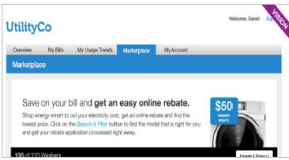

Current DER Portfolio*		
Customer Side (DR, EE, DG, Battery Storage)	41 MW	Spread across targeted area of Brooklyn and Queens
Utility Side (Conservation Voltage Optimization and Utility Battery connected to existing substation)	11 MW	6000 square foot lot owned by Con Edison near the substation

*Con Edison has met reliability goals in the area and plans to go out for additional MWs with remaining budget to ensure they meet all future reliability needs, to achieve additional deferral of traditional infrastructure, and to continue to develop the marketplace for such resources.

WHAT'S NEXT for Con Edison?

Due to the REV initiative, New York State is leading the nation in developing new policies to encourage and reward customers to use new technologies to control energy use. Con Edison has many projects underway in support of the overall REV strategy. There are several demonstrations specifically designed to test utility business models around customer engagement such as Connected Homes, Building Efficiency Marketplace and Storage on Demand (details in the figure below).

Demonstration projects underway

Connected Homes	Building Efficiency Marketplace	Storage on Demand
		
<ul style="list-style-type: none">• Targeted residential offerings• Contracts executed with third parties	<ul style="list-style-type: none">• Commercial DER marketplace• Accelerate DER adoption - mid-sized commercial consumers	<ul style="list-style-type: none">• Maximizing use of mobile battery by using across multiple peak demand needs

Pilots

Con Edison also has pending demonstration projects in the pipeline for Electric Vehicles, Low and Moderate Income initiatives, Smart Home/Rate Design, Renewable Heating and front of the meter Commercial Battery Storage.

AMI

Con Edison is investing heavily in AMI throughout their service territory allowing them even more opportunities to provide new programs and customer choices, such as behavioral programs and time of use rates.

Non-Wires

Con Edison is in process of developing several additional non-wires solicitations. Details on each solicitation can be found on the utility's website at the following link:
www.coned.com/nonwires



BPA Distributed Energy Resources Benchmarking Report

CPS ENERGY



CPS Energy is a municipally-owned utility providing electric and natural gas service to Greater San Antonio. Acquired by the City of San Antonio in 1942, the utility ranks among the nation's lowest-cost energy providers, owns the highest financial ratings of any electric system in the United States and is the largest solar energy provider in Texas.



HEADQUARTERS
San Antonio, Texas

DER at CPS Energy

CPS Energy primarily uses DERs for peak load management in the afternoon and early evenings, June through September.

The driver for these peak reductions is the 4CP, four coincident peaks, determined by the Electric Reliability Council of Texas, Inc. (ERCOT). ERCOT bases transmission costs for the following year on the four highest peaks days within June, July, August and September. If CPS Energy is able to predict when ERCOT will take their 'snap shot' of those peak days and times and reduce their loads, the utility can save themselves up to a half a million dollars in transmission costs for the following year.

Enabling Technology

As CPS Energy continues to build capability within the DER space, they have recognized the need for a system to that can assist with the management of all these resources. The utility has purchased AutoGrid for their Distributed Energy Resources Management System (DERMS) and they are in the process of integrating their dispatch and overall management of current programs in to the system.

The table on the following page provides the detail of CPS Energy's DER programs currently available to their customers.

FAST FACTS

- Serves over 804,000 electricity and more than 343,000 natural gas customers
- 1,566 square mile service area

PEAK DEMAND
4,800 MW

DER PORTFOLIO

- Residential and Commercial Demand Response
- Distributed Solar

Distributed Energy Resources at CPS Energy

DER	Description	Size	Primary Purpose/Use
Distributed Solar PV	Utility Scale Solar	~500 MW	These solar programs primary use is for summer peak reduction (June – September).
	Bring Solar Home / Residential Rooftop Solar (net metering)	~84 MW	
	Roofless Solar / Community Solar (pilot program)	~1 MW, 250 customers (25 year purchase of panels from the array)	
	Solar Host Program	5 MW, 450 customers	This program is via a power purchase agreement for vendor to install solar panels/smart inverters on roofs and CPS Energy takes 100% of the power. Customers receive 3 cents per kW for using their homes as a bill credit.
Demand Response	Smart Thermostat	~86 MW ~140,000 customers	Summer peak reduction for apartments, single family and small commercial buildings.
	Home Manager		Curtail larger new homes for A/C, Water Heater and Pool Pump (3 degree temp set back) during the summer months. A customer portal is available for management of these devices.
	BYOT Qualified Thermostats: Nest, Honeywell, Ecobee (certain models) and many more		Summer peak reduction for customers who currently own a qualified thermostat (approximately 7000 participants).
	C&I Demand Response (300 customers)	~104 MW ~400 customers	Summer curtailment with 2 hour call ahead notification for Retail Stores, Multi-Tenant Office buildings, Data Centers, School and Universities and Hospitals.
	Automated Demand Response		Curtailment enabled with auto DR (less than 1 minute response available year round).

Behavioral Demand Response

Another key DER initiative for CPS Energy is their behavioral demand response pilot.

The utility is in the process of installing AMI meters across their territory and are leveraging these meters right away by implementing a behavioral demand response program for ~100,000 customers that could provide up to 10 MW in summer peak reduction.

Customers for the program are all pre-selected to participate to ensure they have AMI and are not already on a thermostat program, making this all new load for reduction. Customers will receive a phone call or email the day before the event asking them to reduce their energy consumption the following day within a specific timeframe.

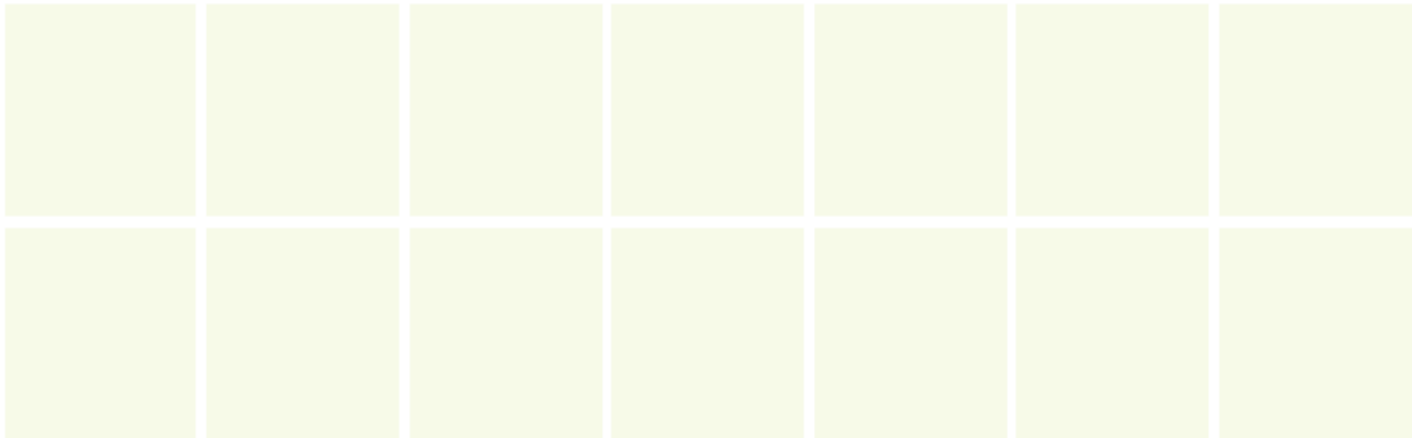
CPS Energy will then notify the customer the day following the event regarding their performance during the event.

This is intended to promote friendly competition, whether for themselves or friends, neighbors or others enrolled in the program.

CPS Energy plans to start this program as a one year pilot with the option to extend for additional time if determined by the utility.

WHAT'S NEXT for CPS Energy?

CPS Energy continues to explore areas to increase customer participation in demand response. As their AMI rollout continues to expand, the roadmap includes: increasing the programs offered to small and mid-size commercial customers (one focus being grocery store and restaurant chains); growing their BYOT program to offer more thermostats; and exploring additional opportunities with their AMI network specifically related to behavioral demand response.





BPA Distributed Energy Resources Benchmarking Report



LONG ISLAND POWER AUTHORITY

The Long Island Power Authority, a non-profit municipal electric provider, owns the retail electric transmission and distribution system on Long Island and provides electric service to customers in Nassau and Suffolk counties and the Rockaway Peninsula in Queens. LIPA does not own or operate any generation plants or retail natural gas assets on Long Island, although many generation plants are under contract to LIPA to meet its power supply needs.

PSEG Long Island

PSEG Long Island is a subsidiary of Public Service Enterprise Group Incorporated (PSEG), a publicly traded diversified energy company. PSEG Long Island has a contract to

operate LIPA's transmission and distribution system on their behalf. Details of the partnership between LIPA and PSEG Long Island, including responsibilities required of each entity, is provided in the figure below.



HEADQUARTERS

Uniondale, New York

FAST FACTS

- 3rd largest municipal electric distribution system in the U.S by customers
- Provides electric service to more than 1.1 million customers
- Governed by a Board of Trustees

DER PORTFOLIO

- Energy Storage
- Residential Demand Response
- Offshore Wind Generation
- Distributed Solar PV

DER at LIPA

LIPA/PSEG Long Island’s primary driver for their use of DERs is to align their initiatives with policies outlined within New York’s Reforming the Energy Vision (REV) Strategy.

REV helps consumers make more informed energy choices, develop new energy products and services, and protect the environment while creating new jobs and economic opportunity throughout the State.

LIPA/PSEG Long Island is doing their part to meet REV goals and build a clean energy future through the several initiatives:

- Expanded AMI deployment
- Dynamic load management
- Super Saver program of advanced rate design pilots
- Solar on-bill financing
- Energy management software
- 800 MW new renewable generation by 2030
- Continued focus on EE
- EV charging stations
- Customer choice/Engagement

Each of the DERs and programs in progress at LIPA/PSEG Long Island are designed to be consistent with the objectives of REV by encouraging market based solutions and direct customer involvement in efforts to limit future electricity costs by delaying the need of large utility investments in future T&D upgrades.

Details of LIPA/PSEG Long Island’s DERs are provided in the table below.

Distributed Energy Resources at LIPA/PSEG Long Island

DER	Description	Size	Primary Purpose/Use
Energy Storage	Clean fuel cell technology	~40 MW	Operation of these systems (powered by natural gas) enable the evaluation of the integration of fuel cells at the specific point of need, as a backup generation source and integration into the existing utility electric grid and development of remote dispatch capability for distributed power sources.
	2 Lithium Ion Batteries	5 MW each	Used as part of the South Fork non-wires project which will defer and reduce the cost of transmission investments using a combination of distributed and renewable resources
Distributed Generation	Offshore wind	90 MW	
	Temporary generators	18 MW	
Distributed Solar PV	Utility scale solar farms	~140 MW	These programs will be used to reduce peak demand and integrate more renewables into the grid and help to meet New York state renewable goals.
	Feed-in tariff for utility-scale and commercial rooftop solar	~60 MW	
	Behind-the-meter rooftop solar market	> 40,000 participating customers	
Demand Response/ Dynamic Load Mgmt.	Direct load Control Program	3,600 thermostats, ~3.5 MW	BYOT program that encourages customers to install smart t-stats. PSEG Long Island remotely controls enrolled t-stats to reduce the power required by central a/c for up to 4 hrs. per day, May – Sept.
	Commercial System Relief Program*	24 customers, ~7 MW	Customers are paid to reduce their electric load when system-wide load relief is needed. At least 21 hrs. advance notification and includes a reservation and a performance payment.
	Distribution Load Relief Program*	24 customers, ~7 MW	Customers in the area served by a specific T&D system component (e.g. transmission line, substation, distribution feeder) are paid to reduce their electric load when the T&D system component approaches load limit. Minimum of 2 hr. advance notice for events.

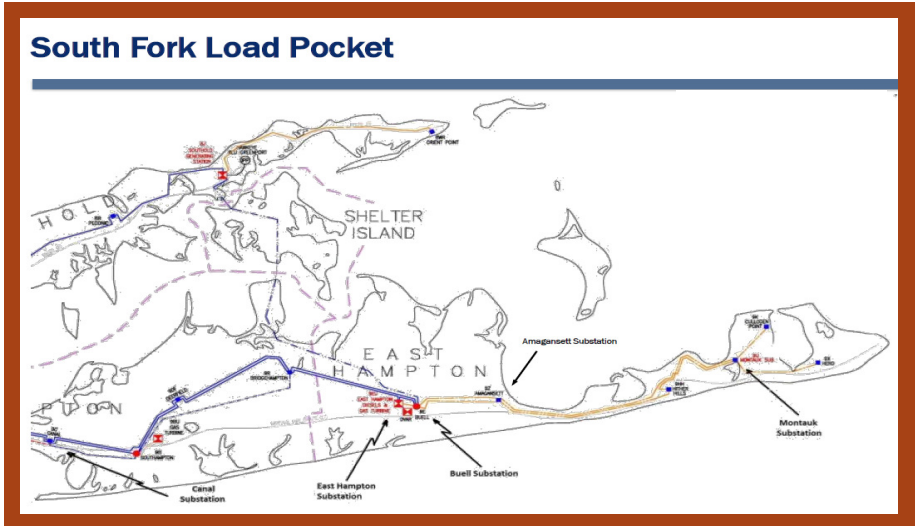
*Aggregators are used for both of these programs. It is expected that customers and/or aggregators will install and employ one or more DER technologies to accomplish the required load curtailments. DER technologies to be employed may be either dispatchable or routinely in operation, and may use either a) controls or increased efficiency, or b) on-site generation to reduce the load imposed on PSEG Long Island’s electric grid.

South Fork Non-Wires Project

At this time, LIPA/PSEG Long Island’s main use of DERs is to reliably reduce transmission congestion or distribution constraints at times of maximum demand in specific geographic areas.

One critical project is the South Fork of Long Island, which includes the Hamptons. It is a high growth area and also a load pocket. Given projected load growth on the South Fork, existing resources and transmission infrastructure will not reliably meet customers’ future needs beginning in 2017. LIPA’s objective for this project was to acquire sufficient local resources to reliably meet projected load growth and defer the need for new transmission until 2022, in support of the REV initiative.

The Request For Proposal went out in June 2015 and allowed load reduction, energy efficiency, renewable generation, energy storage, and conventional



generation connected to substations, distribution feeders, or at customer facilities. Any renewable resources would receive credit towards LIPA’s 400 MW renewable resource goal as well.

Bids were received in December 2015 and the proposals included offshore wind, demand response, battery storage, conventional generation, and solar power with sizes ranging from .07 MW to 60 MW.

All of the proposals received were grouped into nine different ‘Portfolios’ for evaluation purposes. After a rigorous evaluation process, a winning portfolio was determined based on several benefits:

1. Least cost option that met South Fork’s growing energy needs and LIPA’s renewable energy goals.
2. Resource combination that met the reliability needs of the area through 2030.
3. Supports renewable energy on Long Island.
4. Supports REV objectives.

Winning Portfolio

Proposal	MW Size	Location	In Service
Temporary Generators	18 ¹	Montauk & East Hampton	2017 to 2019
Load Reduction	8.3	South Fork Area	2017 to 2019
Energy Storage	5.1	Montauk	2018 (May)
Energy Storage	5.1	East Hampton	2018 (May)
Offshore Wind	90 ²	East Hampton Connection	2022 (December)

¹ Initial proposal was 10 MW. Increased load growth created additional need.

² The proposed wind farm would be rated at 90 MW, but a slightly smaller amount would be delivered to East Hampton due to transmission losses.

WHAT'S NEXT

for Long Island Power Authority?

LIPA has several projects and pilots in support of REV and other state initiatives and goals that are continuing to build experience in the DER space as well as set them up for success in the near term. Key projects include:

1. Island wide AMI

Metering Network -

Communications network is completed and a total of 50,000 AMI meters are now installed.

2. Super Savers Pilot –

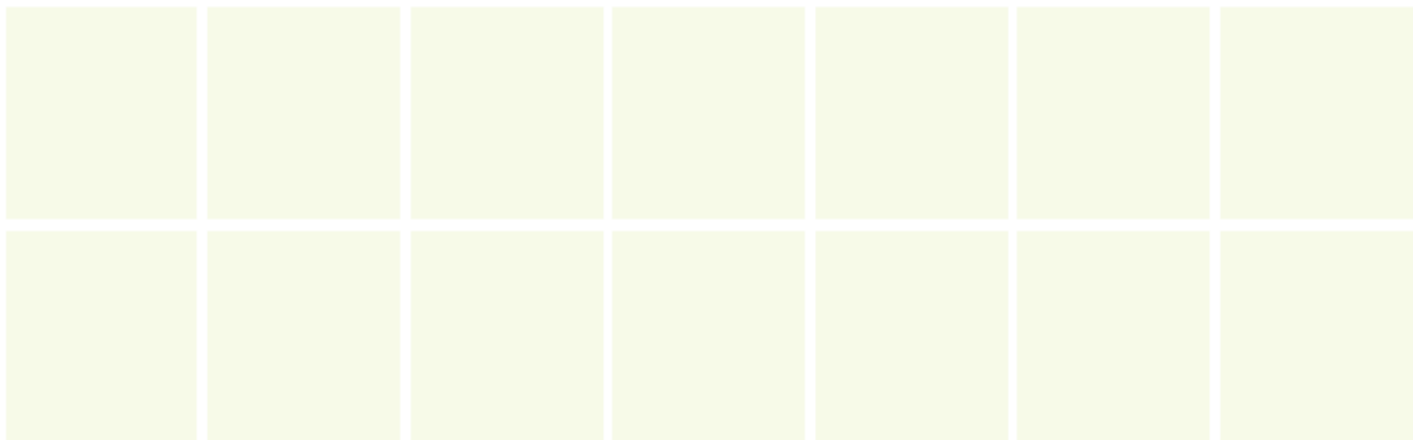
This initiative is intended to pilot a comprehensive REV approach for a substation approaching its design capacity. It will incorporate load management tools and techniques such as:

- Install AMI meters.
- Perform energy audits at no cost to residential customers.
- Offer Smart Thermostat rebate and enroll in direct load control program.
- Offer Time Of Use pricing and monitor progress to maintain reliability and measure benefits.

3. Electric Vehicle

Program –

In discussions to potentially purchase 10 electric plug in vehicles for use by LIPA/PSEG Long Island to show support for cleaner, greener vehicles. They also plan to invest \$500k for Workplace chargers in 2017. This pilot would purchase/install a workplace charger for any business that commits to having at least five of its employees driving plug in electric vehicles. The goal is 100 new charging stations over a two-year period.





BPA Distributed Energy Resources Benchmarking Report

PACIFIC GAS AND ELECTRIC COMPANY



Pacific Gas and Electric Company is one of the largest combination natural gas and electric utilities in the United States. There are approximately 20,000 employees who carry out PG&E’s primary business—the transmission and delivery of energy. The company provides natural gas and electric service to approximately 16 million people throughout a 70,000-square-mile service area in northern and central California.

DER at PG&E

PG&E and other utilities in the state are regulated by the California Public Utilities Commission (CPUC). The regulations and mandates put forward by the CPUC drive many of the new products, technologies, pilot projects and programs for PG&E within the distributed energy resources space.

One of the mandates, approved in 2013, requires California’s big three investor owned utilities to add 1.3 gigawatts of energy storage to their grids by 2020, with all projects operational by 2024. PG&E’s total share of this mandate is 580 MW.

The details of their procured energy storage needed to meet this mandate, as well as other distributed energy resources utilized at the utility, are included in the tables on the following pages.



HEADQUARTERS
San Francisco, California

FAST FACTS

- Incorporated in 1905
- 5.4 million electric and 4.3 million natural gas customer accounts
- Governed by a Board of Directors

PEAK DEMAND
~21,000 MW

DER PORTFOLIO

- Energy Storage
- Demand Response
- Solar PV
- Electric Vehicles

Distributed Energy Resources at PG&E

DER	Description	Size	Primary Purpose/Use
Energy Storage	Vaca-Dixon Sodium sulfur battery / Vaca-Dixon Substation	2 MW	This battery is used for participation in the CAISO wholesale market.
	Yerba Buena Sodium sulfur battery / Customer R&D facility, San Jose, CA	4 MW	This battery is used for participation in the CAISO wholesale market as well as reliability purposes.
	Tesla Powerpack utility scale, lithium ion battery / Browns Valley, CA substation	500 kW	The battery facility will be used for peak shaving in the hot summer months well as improve power quality and reliability for customers. The Powerpack systems will charge when demand is low then send reserved power to the grid when demand grows, providing power (up to four hours) to address potential overloading on the substation transformers.
	Transmission connected stand-alone lithium-ion battery energy storage resource / Livermore, CA at Tesla 115kV substation	30 MW	This energy storage resource is provided by NextEra Energy, Golden Hills Energy Storage LLC and the primary purpose is for participation in the CAISO wholesale market. This battery has discharge duration of 30 minutes.
	Distribution connected stand-alone zinc-air battery energy storage resource / Lemoore, CA at Henrietta Substation	10 MW	This energy storage resource is provided by Convergent and the primary purpose is for participation in the CAISO wholesale market. This battery has discharge duration of four hours.
Distributed Generation	Renewable Generation Net Metering Residential/Commercial	Numbers vary	For home/business renewable generation assets, PG&E meters the energy produced and subtracts the energy used. PG&E deducts the energy exported to the grid at times when generation exceeds on-site demand from monthly bills.
Distributed Solar PV	Solar Choice Rates – residential and commercial utility owned community solar	~280,000 customers	Customers can enroll through PG&E to purchase solar energy from a pool of solar projects in Northern and Central CA. This program will be used to reduce peak demand and integrate more renewables into the grid.
	Regional Renewable Choice – renewable developer owned community solar		Customers can purchase renewable energy from a specific project within PG&E’s service territory. Customers contact participating renewable developers directly to sign up. Renewable developers will invoice customers directly and a bill credit will be provided by PG&E on a monthly basis. This program’s primary purpose is to increase the integration of renewables by providing more options for customers.

Distributed Energy Resources at PG&E

DER	Description	Size	Primary Purpose/Use
Electric Vehicles	Rate plans and incentives	~100,000 electric vehicles	This program provides incentives to reduce the cost of electric vehicles for PG&E customers as well as provide rates that promote charging at specific times of the day when energy is less expensive. These rates assist in reducing peak demand.
Demand Response	Base Interruptible Program for large C&I customers	~300 MW/~330 enrolled accounts	This program is dispatched for reliability purposes. There is a 30 minute notification of events and includes a monthly capacity payment with high penalties for non-performance. This is a supply side resource that is being bid into the CAISO wholesale market.
	SmartAC™ for residential customers	~75 MW / ~150,000 enrolled accounts	This is an air conditioning direct load control program that is dispatched based on system temperatures and reliability. There is a one-time enrollment incentive for sign-up. This is a supply side resource that is required to be bid into the CAISO wholesale market.
	Capacity Bidding Program	~20 MW / ~900 enrolled accounts	This program is used to reduce loads based on economic need. Day-of or day-ahead notification of events is provided, depending on the option customers select. Customers receive monthly capacity payments based on nominated/committed load reduction and energy payments for actual load reduction with penalties for non-performance. This product is also a supply side resource that is required to be bid into the CAISO wholesale market.
	Peak Day Pricing & SmartRate™	~80 MW / ~338,000 enrolled accounts	This product is designed for peak shaving and provides day-ahead notification of events. There are elevated rates during event hours but a discounted rate during all other hours.
	Automated Demand Response (ADR)	~94 MW (62 MW currently active) / 595 enrolled accounts	The ADR program incentivizes customers to adopt enabling technologies that automate end-use loads in conjunction with participation in qualifying DR programs.

Energy Storage

PG&E has released two energy storage solicitations to date, one for 79 MW and the other for 165 MW, in order to meet the mandate set forth by the CPUC. For the first solicitation, several vendors were selected and all 79 MWs were procured. These batteries are included in the list of PG&E's energy storage projects in the previous tables.

Although these energy storage systems are not required to be operational until 2024, PG&E has gotten started down the deployment path with some of their small battery storage systems in order to gain experience, capture learnings and improve their understanding of how to operationalize and effectively use these storage systems. The three fully deployed battery storage systems are Vaca-Dixon (sodium sulfur), Yerba Buena (sodium sulfur) and Browns Valley (lithium ion).

Lithium ion batteries have been the primary technology procured by utilities for their energy storage systems to date. PG&E, however, was interested in diversifying their portfolio to include different types of energy storage technologies and did this as a part of their initial procurement process. Some of these new, less established technologies unfortunately could not meet their contractual requirements and were terminated from PG&E's energy storage portfolio.

The utility still has a large amount of energy storage to procure to meet their 580 MW mandate by 2020.

They believe the effort they are putting in now to determine the right energy storage solutions for their utility and leveraging the learnings from procurements, tests and deployments along the way will help them successfully navigate this challenging endeavor.

Non-wires Solicitations

PG&E is also planning to use energy storage as a way to defer infrastructure builds across their service territory. One of the first rounds of their 79 MW energy storage solicitation called for 8 MWs to help back up remote distribution grid substations across its Northern California territory. PG&E only selected utility-owned and operated battery systems for this portion of the solicitation as the cost of the storage systems were justified by the savings of not building or upgrading substations.

PG&E has also been testing the concept of non-wires alternatives with storage and other DERs.

As a part of its Distribution Resources Plan implementation, PG&E has targeted demonstration projects in areas in which investment in distribution system asset upgrades could be deferred through procurement of DER products and services, such as energy efficiency and/or solar PV.

As part of these demonstrations projects, DERs could be used to maintain system safety and reliability, while also potentially creating additional value for customers, third-party DER asset owners, and the grid.

Pictured are two of early implements of battery energy storage systems for PG&E. There were several accomplishments associated with operation of these systems including peak shaving, integration into the CAISO, renewable integration, power quality and islanding.



Vaca-Dixon BESS
2 MW / 14 MWh NAS Battery
Vaca-Dixon Substation



Yerba Buena BESS
4 MW / 28 MWh NAS Battery
Customer R&D Facility, San Jose

DR Programs

The use of demand response in conjunction with DERs is an area where PG&E has a lot of experience. They have a long standing, successful portfolio of programs that include residential, commercial/industrial and agriculture customers. PG&E's demand response portfolio continues to evolve over time to meet grid needs and CPUC requirements, such as integration of its programs into the CAISO wholesale market. While the size of PG&E's demand response portfolio has contracted in recent years, there has also been growth of the third-party Demand Response market and it is still viewed as a very important resource. PG&E is committed to developing innovative new programs and improving existing programs through better alignment with evolving grid needs, greater flexibility for customers' participation and a broader array of choices for residential customers, including enabling a robust market of third party demand response providers. .

Enabling Technology

Given the differences in system capabilities across customers, aggregators and various other vendors, PG&E uses several different systems to support multiple DER functions today. The organization is working on implementing a more holistic Distributed Energy Management System (DERMS) to help with the management of all of these resources. However, PG&E has found that the DERMS offerings are not "off the shelf" systems. At this time, PG&E continues to conduct pilots and create a holistic integrated grid platform, which will incorporate a number of DER-related capabilities, as well as other advanced distribution management functions.

As more of their programs and resources are bid into the markets, PG&E is also continuing to increase their capabilities around system integration with the CAISO. They are building these capabilities in-house so they can streamline processes and leverage existing systems as much as possible.


WHAT'S NEXT

for Pacific Gas and Electric?

As DER continues to evolve at PG&E, their efforts will be primarily focused on leveraging these resources to meet the following targets:


1. 50% renewables by 2030.
2. Double the amount of energy efficiency in existing buildings by 2030.
3. Increase the number of electric vehicles to 1.5 million by 2025.

In order to provide their contribution to these targets and continue to increase the integration of DERs, PG&E will also be providing significant investment into the grid to address complexities.

 **The Grid is a Vital Component to a Reliable Energy Future & for Further PV Enablement**

The increase in distributed energy resources (DERs) leads to increased grid complexity

Significant investment in the grid is needed to address this complexity



- Expand System Monitoring
 - Test and deploy new sensing and communication technologies
 - Develop and utilize sophisticated system modeling and forecasting
- Dynamic and Localized Control
 - Build communication and control systems to mitigate any grid instability
 - Test and deploy controls to capture potential grid value from DERs and other customer solutions
- Simple & Standard Integration
 - Strengthen the core system in preparation for expanded DER penetration
 - Develop and deploy standardized interconnection and ensure easy customer participation

Multiple levels of integration - interoperability
Distributed Generation Renewable Generation Storage Demand Response



BPA Distributed Energy Resources Benchmarking Report



PUGET SOUND ENERGY

Puget Sound Energy is Washington State's oldest local energy company, providing electric and natural gas service to homes and businesses primarily in the Puget Sound region of Western Washington. In addition to being a provider of safe, dependable and efficient energy service for more than 135 years, PSE is also a national leader in wind power. They are recognized by the American Wind Energy Association as the second largest utility owner of wind energy facilities in the United States.

DER at PSE

Since 1979, no other utility in the Pacific Northwest has helped its customers save more energy than PSE. Their energy efficiency programs have helped customers conserve nearly 5 billion kilowatt-hours of electricity and almost 50 million therms of natural gas. In order to continue to save money and be as cost effective as possible, PSE has recently gotten involved with demand response. Although there were a few DR programs from 2001 – 2011, none of them gained much momentum for the utility. It wasn't until PSE's 2015 Integrated Resource Plan (IRP) selected DR as a cost-effective resource (mainly driven by regional resource

adequacy by 2020-2021) and planned plant closures or retirements, that more emphasis was placed on developing longer standing, substantial DR programs.

PSE's IRP identified two types of DR to be cost effective for their utility; direct load control with a 70 MW goal (space and water heat) and Commercial and Industrial curtailment with 51 MW goal. RFPs were sent out with the following objectives:

1. To provide 121 MW of winter peak capacity with 1 hour (at a minimum) of notice by 2021.
2. Have access to an available resource to call on year round when there is a need for capacity.



HEADQUARTERS

Bellevue, Washington

FAST FACTS

- 6,000 square miles of service territory
- Serves approximately 1.1 million electric and 790,000 natural gas customers
- Over \$3 billion in revenues with 2,700 employees

DER PORTFOLIO

- Energy Storage
- Demand Response
- Electric Vehicles

DER at PSE, cont'd

3. Provide faster response times (<10 minutes).
4. Energy imbalance market (EIM) participation (PSE joined the EIM in October 2016).
5. Increase customer engagement with integrated DR and EE.

PSE received 18 responses between their C&I and direct load control RFPs. Respondents partnered with technology providers and aggregators when necessary to provide a full end to end solution as requested in the RFP. PSE will more than likely utilize the Distributed Energy Resources Management System (DERMS) proposed by the vendors in their proposals which would be different systems for the direct load control and C&I programs.

In addition to the demand response work in progress, PSE is also researching the use of other distributed energy resources via pilot projects. The table below summarizes PSE's current mix of distributed energy resources.

Energy Storage

PSE has two energy storage pilots that are in progress; the Glacier Batter Storage Pilot and the Distributed Storage Pilot.

For the Glacier Battery Storage Pilot, PSE and Washington State Department of Commerce developed a utility-scale battery energy storage pilot project in Glacier to test the benefits of distributed generation. The state of the art system is tied to PSE's electric distribution power grid and located near the existing Glacier substation.

This project was funded in part by a generous \$3.8 million Smart Grid Grant from the state Department of Commerce in addition to \$5.8 million invested by PSE.

The Distributed Storage Pilot started by analyzing several storage use cases to determine how each scenario would work for their customer base. PSE is currently in the early stages of this pilot and looking to implement small scale batteries (~25 kW) across their service territory. The next step is to work with PSE planners to determine where the batteries should be located. Once that is determined, they will begin the next phase that will start sometime in the 2018-2019 year.

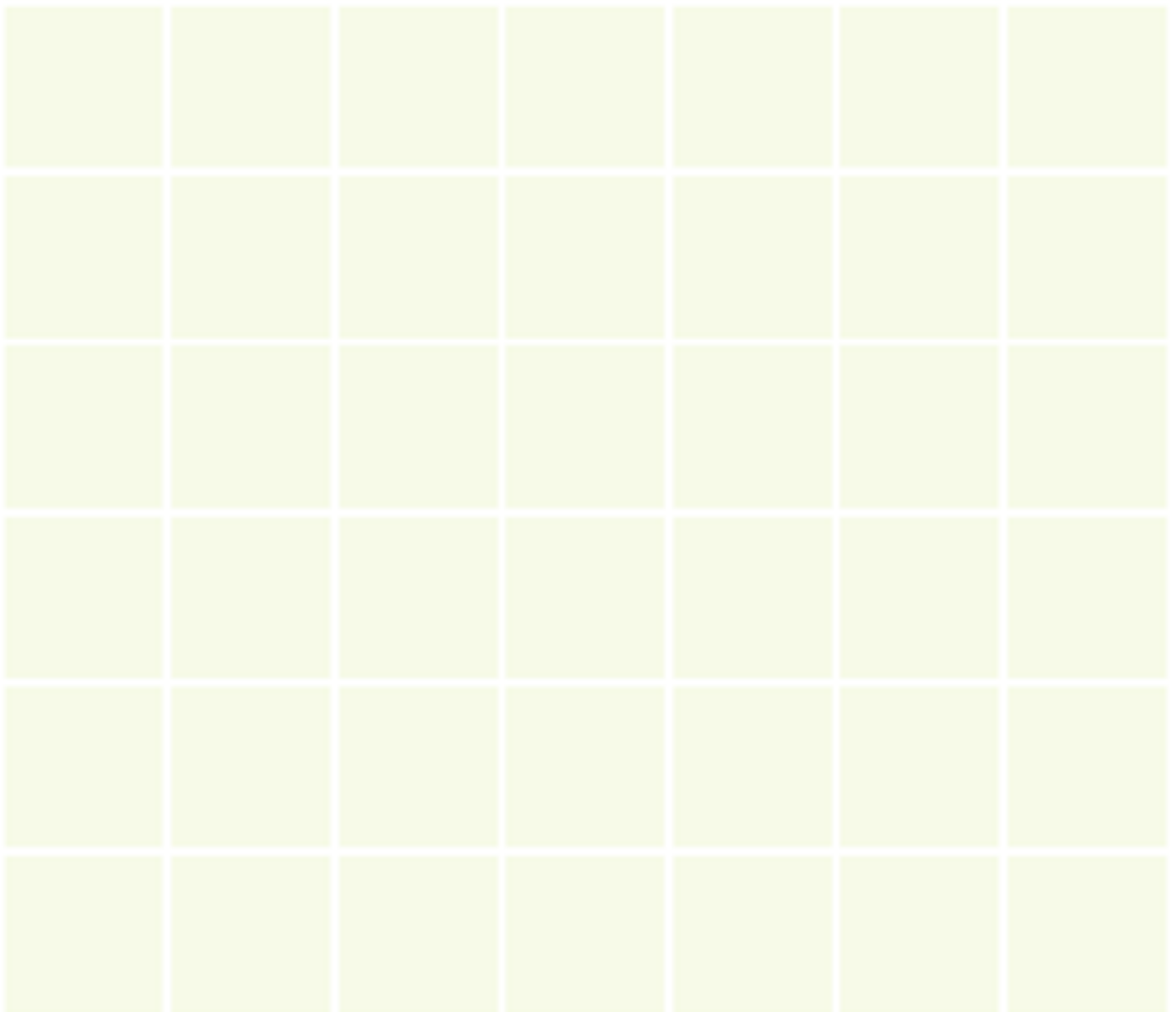
Distributed Energy Resources at PSE

DER	Description	Size	Primary Purpose/Use
Energy Storage	Glacier Lithium Ion Battery Pilot	2 MW/4.4 MWh	<ol style="list-style-type: none"> 1. Serve as a short-term backup power source to a portion of the local Glacier circuit during outages. 2. Reduce system load during periods of high demand. 3. Balancing energy supply and demand, helping to support greater integration of intermittent renewable generation on PSE's grid.
	Distributed Storage Pilot	Multiple ~25kW batteries across PSE's service territory	<p>These batteries will be used to gather research on the following scenarios:</p> <ol style="list-style-type: none"> 1. T&D deferral 2. Voltage/power quality 3. Customer demand on residential side (solar and home battery) 4. Demand change management
Electric Vehicles	Electric Vehicle Charging Pilot	~1500 participants	Baseline data collection program around load shape, charge time and customer behavior. The purpose of this pilot is to understand what PSE can do to shift the load. Participants receive an upfront \$500 rebate towards a level two charger.
Demand Response	Residential Direct Load Control	~70 MW	The purposed of these demand response programs is primarily to reduce winter peak and provide PSE with year round capacity as needed.
	C&I Curtailment	~51 MW	

WHAT'S NEXT

for Puget Sound Energy?

PSE is in the process of building their Residential Direct Load Control and Commercial and Industrial Curtailment programs so they can begin leveraging this capacity when needed. They are also continuing to further refine their pilot projects by reviewing data, understanding the benefits to their utility and determining how to proceed in the near future.





BPA Distributed Energy Resources Benchmarking Report

SOUTHERN CALIFORNIA EDISON



Southern California Edison Company, a public utility engaging in the generation, transmission, and distribution of electricity to more than 14 million people in Southern California. The company generates electricity through hydroelectric, diesel, natural gas, nuclear, and photovoltaic resources. Its distribution system includes approximately 53,000 line miles of overhead lines; 38,000 line miles of underground lines; and approximately 800 distribution substations. They serve approximately 5 million customer accounts within the commercial, residential, industrial, agricultural and public sectors.

DER at SCE

Within less than 10 years, approximately 1.5 million SCE customers are predicted to be connected to clean energy technologies such as electric vehicles, rooftop solar, energy storage and energy management systems. All of these customer preferences and technologies require SCE to make considerable changes to successfully prepare for these DERs entering their system.

Internal technology systems are also a key piece of the puzzle for SCE as they continue to broaden their capabilities within the DER space. They believe continual

improvement in their processes to increase efficiency and automation are absolutely necessary to their success as a utility. One of recent enhancements SCE made was to implement an online system for their Solar Interconnection – called the Grid Interconnection Processing Tool. According to the team at SCE, this was one of the biggest improvements they have made in their interconnection process, reducing the time required from 73 days down to approximately 2 days (depending on the size of the DER). Since the interconnection process itself crosses so many areas of the business (billing, call center, Transmission, metering, etc.),



HEADQUARTERS

Rosemead, California

FAST FACTS

- Electric service provider for more than 125 years
- 89 billion kWh of electricity delivered to:
 - More than 14 million people
 - 180 incorporated cities
 - 50,000 sq. miles of service area

PEAK DEMAND

~23,000 MW

DER PORTFOLIO

- Energy Storage
- Demand Response
- Solar PV
- Electric Vehicles

Enabling Technology cont'd

implementing an online tool that all of those areas can use and see where projects are at any given point in time significantly increased efficiency, consistency and accuracy. SCE contracted with a 3rd party to create this customized solution.

SCE is also looking more broadly for a system that can provide an integrated solution for all the DERs they are working with and have planned in the near future. This solution would integrate behind the meter technologies, in front of the meter technologies as well as their typical demand side management programs and incentives.

To date, SCE has found that there is not a single vendor that can provide

this comprehensive solution without a considerable amount of customization. Vendors are in the process of trying to broaden their abilities, but right now they appear to be more specialized, without considerable experience providing a solution across all of these areas.

The tables on the following pages provide information on the many programs, projects and pilots currently in progress at SCE in the DER space.

Energy Storage

As evidenced by the list of energy storage projects currently in flight at SCE, they are one of the most experienced utilities in the procurement and installation of batteries in the country.

However, the utility says that they still have a lot to learn when it comes to the actual operation of their batteries. There has been such a big push to get energy storage systems purchased and set up with the necessary systems and connections in the appropriate locations (with detailed permitting requirements) that SCE is just getting to point where they will start operationalizing the majority of these large systems.

Although this will be a significant effort for SCE, they believe they are well prepared and set up for success through their partnerships and contractual mechanisms.

Distributed Energy Resources at SCE

DER	Description	Size	Primary Purpose/Use
Energy Storage	Lithium Ion Battery with a more efficient gas generator / Alamitos Energy Center in Long Beach	300 MW	SCE has contracted with AES through a Power Purchase Agreement to replace an older gas plant that has been in operation since the 1950s with a battery storage system and new, more efficient gas plant that will be able to start generating energy within minutes allowing AES to help smooth the integration of more renewables onto California's grid.
	Low Emission Hybrid Lithium Ion Battery Storage System / Peaker Plants Norwalk and Rancho Cucamonga	10 MW battery storage combined with a gas turbine	SCE is partnering with GE and Wellhead Power Solutions for this advanced lithium ion battery that provides energy to the grid immediately, allowing time for the gas turbine to ramp up and take over (if needed). The battery will recharge at a later time. This is designed to improve the ability to integrate renewable power to the grid because it can instantly step in when the wind or sun can no longer meet system needs. These can now participate in the spinning reserve market.
	Lithium Ion Battery / located in Irvine, CA	2 MW	SCE is partnering with Powin Energy to provide this energy storage system primarily to increase reliability of the grid due to Aliso Canyon shut down.
	Lithium Ion Battery / located in San Gabriel Energy Facility	20 MW /80 MWh	SCE is partnering with AltaGas Pomona Energy to provide this energy storage system primarily to increase reliability of the grid due to Aliso Canyon shutdown.

Distributed Energy Resources at SCE

DER	Description	Size	Primary Purpose/Use
Energy Storage	Lithium Ion Battery/Mira Loma Battery Storage Project	20 MW/80 MWh / 15,000 homes for 4 hours	This battery storage facility is a partnership between SCE and Tesla. Its primary use will be to charge when there is more renewable energy than demand, and supply that energy to customers during peak hours, enabling greater use of lean energy technologies, such as residential solar, and will help California meet its energy and climate change goals.
	Lithium Ion Battery / Tehachapi Energy Storage Pilot Project	8 MW / 32 MWh for 4 hours	This battery system will be used to store and release electricity mainly from wind generated in the Tehachapi wind resource area.
	Lithium Ion Battery / Distributed Energy Storage Integration (DESI) located in Orange	2.5 MW for ~1.5 hours, supporting 500-750 homes during this time	This project was one of SCE's first battery storage system specifically designed to help bolster reliability on the local distribution grid.
	Sodium-Sulfur Battery / Catalina Battery Storage System	~2 MW/7.2 MWh	This battery storage system reduces emissions on the island by charging overnight and supplying electricity back to the Catalina power grid during the day.
Distributed Generation	Self Generation Incentive Program (SGIP) / Energy generation related to wind, fuel cell, waste heat capture, energy storage (stand alone or paired with solar)	Numbers vary	This program offers rebates to residential, commercial and industrial, government and non-profit customers who install qualifying types of distributed generation to meet all or a portion of their own energy needs. This can help reduce greenhouse gas emissions while also helping reduce electrical system demand.
Distributed Solar	Net Metering Residential/Commercial Solar	~225,000 Customers	For homes/businesses with solar panels, SCE meters the energy produced and subtracts the energy you use for your home. They deduct the energy you export to the grid at times when generation exceeds on-site demand from your bill. This program now requires a smart inverter and customers must take service with a Time Of Use rate.

Non-wires solicitations

SCE is also getting out in front of another CPUC mandate, California's Distribution Resources Plan proceeding. This mandate requires investor owned utilities to open up a portion of their grid investment planning process to include distributed energy resource alternatives. In response, SCE put out the 2017

Integrated Distributed Energy Resources Request for Offers (IDER RFO) that aims to procure DERs to defer the need for capital expenditures for traditional distribution infrastructure upgrades at two distribution projects without a loss of system reliability. These DERs include energy efficiency, demand response, renewables, and energy storage, deployed during times in which high energy consumption

strains the infrastructure. Reducing the strain on the infrastructure will allow upgrades to occur at a later time, which may lower overall financial impacts to SCE's customers. The solicitation is expected to launch in October 2017 (pending final CPUC decision).

Preferred Resources Pilot

Another major non-wires initiative for SCE is their Preferred Resources Pilot. In 2013, SCE launched this pilot to test the ability of DERs to safely, reliably and affordably serve the electrical needs of customers in a real-world environment.

The Preferred Resources Pilot is designed to determine if and how the use of a diverse mix of “preferred” clean energy resources – including energy efficiency, demand response, renewable energy and energy storage – can offset up to 300 MW of increasing customer demand for electricity in a specific geographic area, to defer or eliminate the need to procure new gas-fueled power in the region.

The project is located in Orange County and includes 13 cities and

approximately 250,000 residential and commercial customers.

Being the first of its kind project to use clean energy resources to meet localized power needs in a major U.S metropolitan area, the Preferred Resources Pilot has provided scalable lessons for SCE (and others) to apply to other grid-constrained areas within its service area.

1. New approaches to portfolio design and acquisition.
2. New opportunities for customers to participate in different Demand Side Management programs to better meet their needs.
3. New methods to measure DER performance that also impact distribution forecasting and planning.

This pilot project is planned to complete in 2018 and will undoubtedly have many more lessons learned that will continue to advance California’s environmental goals as well as the efforts of other utilities following SCE’s progress in these areas.

Distributed Energy Resources at SCE

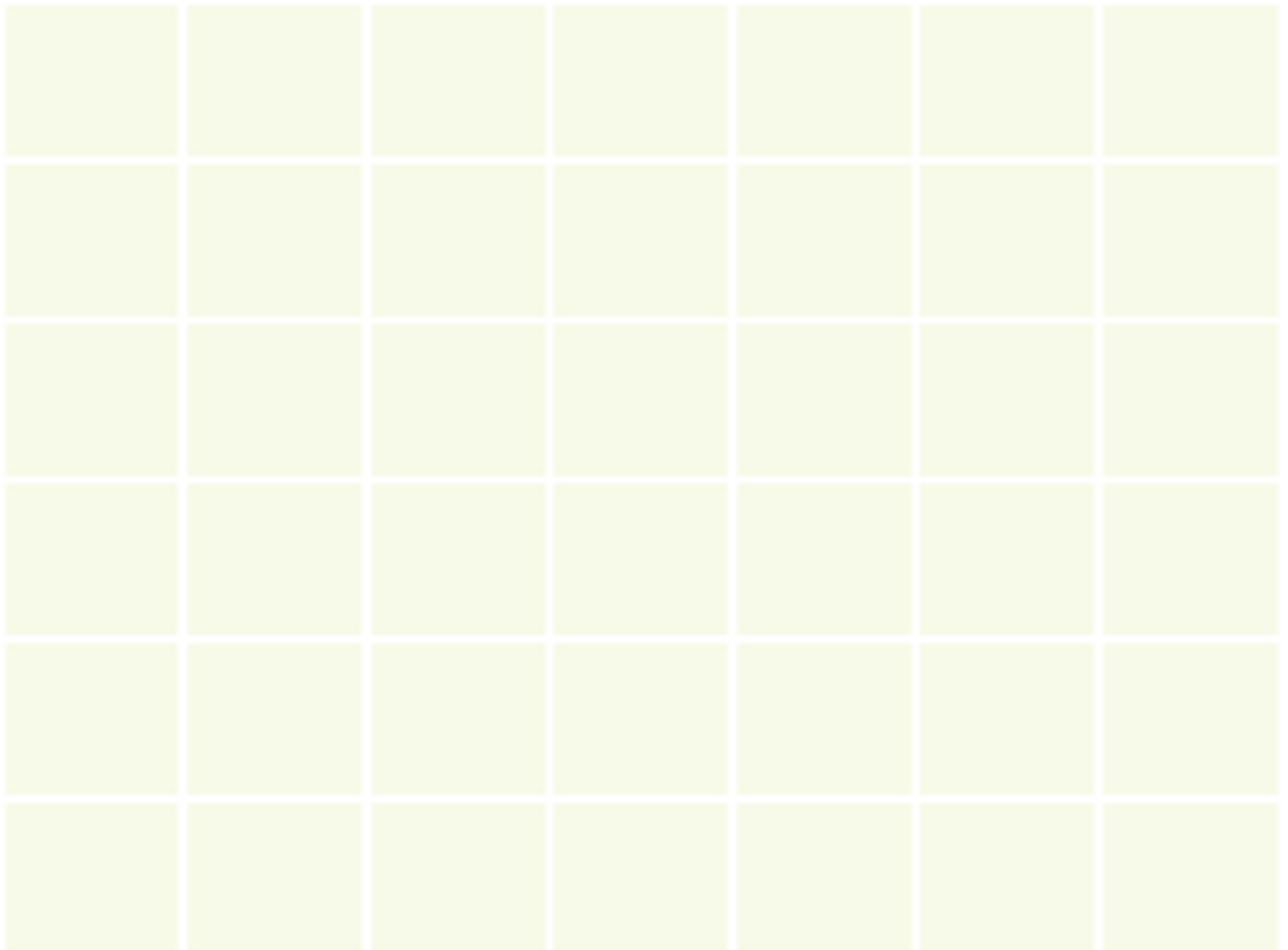
DER	Description	Size	Primary Purpose/Use
Demand Response	Time of Use Base Interruptible Program (TOU-BIP)	660 MW	This program is used to reduce energy usage to a pre-determined level during emergency situations / for reliability of the grid.
	Agricultural Pumping & Interruptible (AP-I)	60 MW	This program Interrupts electric service temporarily to customers during emergency situations / for reliability of the grid.
	Demand Bidding Program (DBP)	110 MW	This program is used to reduce power during a DBP event – for economic purposes, day-ahead energy
	Critical Peak Pricing (CPP) program	25 MW	Reduce energy costs by reducing usage at specific times during the summer months / economic (June – September)
	Aggregator Managed/ Capacity Bidding Program (CBP)	145 MW	Flexible bidding program that pays for reducing energy when energy prices are high, demand reaches critical levels or supply is limited (third party economic energy and capacity)
	C&I Summer Discount Plan (SDP)	65 MW	A/C cycling direct load control (both economic and emergency / reliability use)
	Residential - Summer Discount Plan (SDP)	295 MW	A/C cycling direct load control (both economic and emergency / reliability use)
	Save Power Day/Peak Time Rebate	30 MW	Reduce energy costs by reducing residential usage at specific times during the summer months (June – September)

WHAT'S NEXT

for Southern California Edison?

As DER continues to evolve at SCE, the utility is looking at industry trends and focusing their strategy accordingly to prepare for the future. Some key areas for near term advancement are as follows:

- Grid Modernization to support more customer choice in energy technology and how customers interact with the grid.
- Transportation Electrification through SCE's Charge Ready program, a five-year, \$355 million effort to install the infrastructure for up to 30,000 electric vehicle charging stations at locations across SCE's service area.
- Energy Storage through both utility-owned and market driven applications.





BPA Distributed Energy Resources Benchmarking Report



SAN DIEGO GAS AND ELECTRIC

SDG&E is a regulated public utility that provides energy service to 3.6 million people through electric and natural gas meters in San Diego and southern Orange counties, spanning approximately 4,100 square miles. SDG&E's parent company, Sempra Energy is a San Diego-based Fortune 500 energy services holding company whose subsidiaries provide electricity, natural gas and value-added products and services.

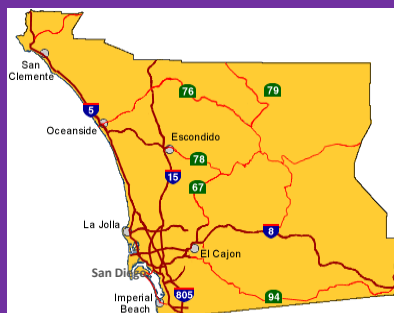
DER at SDG&E

SDG&E, along with other investor owned utilities in the state, are regulated by the California Public Utilities Commission (CPUC) and the Federal Energy Regulatory Commission (FERC). The CPUC regulations and mandates drive many of the new products/ technology, pilot projects and programs for SDG&E within the distributed energy resources space.

One of the mandates, approved in 2013 requires California's big three investor owned utilities to add 1.3 gigawatts of energy storage to their grids by 2020, with all projects operational by 2024. SDG&E's share of this mandate is 165 MW.

The details of their procured energy storage needed to meet this mandate as well as other distributed energy resources utilized at the utility are provided in the tables on the following pages.

SDG&E's Service Territory



A Sempra Energy utility®

HEADQUARTERS

San Diego, California

FAST FACTS

- Originally founded in 1881 as the San Diego Gas Company
- Serves 1.4 million electric customers
- Employs more than 4,000 people

PEAK DEMAND

4890 MW

DER PORTFOLIO

- Energy Storage
- Demand Response
- Solar PV
- Electric Vehicles

Integration of Renewable Energy & Energy Storage

As evidenced by the list of DERs being utilized at SDG&E, specifically battery storage systems and solar programs, it is not surprising that the utility is the forefront of renewable energy deployment. SDG&E was already getting 43% of its electricity from renewable energy in 2016 and with the resources it has under contract, they will reach more than 45% in 2020 which is well ahead of the state’s mandate.

They have also procured more than 75% of their energy storage requirements, which is also well ahead of the 2020 mandate.

Now that a large number of their storage systems have been procured, SDG&E’s is working with their energy storage partners and vendors to operationalize them in the most effective way possible. The team at SDG&E believes that energy storage is the right solution to deal with renewable energy and increase reliability; they just need to ensure that each system is meeting a specific set of criteria.

In order for each storage system to be effective, SDG&E has identified four criteria; 1) right place, 2) right time, 3) right size, and 3) with the right certainty, which must be guaranteed in performance guarantees with vendors. These criteria are becoming even more apparent to the utility with all work in progress to set up, install and begin operations. If all of these criteria are met, SDG&E believes that these storage systems will be successful for their intended use within the utility.

Distributed Energy Resources at SDG&E			
DER	Description	Size	Primary Purpose/Use
Energy Storage	Lithium Ion Battery (Escondido, CA)	30 MW/ 120 MWh	SDG&E in partnership with AES Energy Storage installed what is said to be the largest lithium-ion battery storage facility in the world. It is capable of serving 20,000 customers for up to four hour and will primarily be used to help incorporate more solar and wind into the grid.
	Lithium Ion Battery (El Cajon, CA)	7.5 MW/ 30 MWh	This battery storage facility was also put into service in partnership with AES. This will be used to store power at times of high renewable energy output.
	Lithium Ion Battery (Fallbrook, CA) (pending)	40 MW/ 160MWh	This battery storage system will have 4 hour rating and will be installed by AES, but owned and operated by SDG&E. It will be used to help incorporate more solar and wind into the grid by storing power at times of high renewable energy output and releasing it when output is low.
	Lithium Ion Battery (Miramar, CA) (pending)	30 MW/ 120 MWh	Renewable Energy Systems (RES) Americas will build this 4 hour rated storage system for SDG&E. It will be owned and operated by SDG&E. The primary use will be to integrate higher levels of renewable energy.
	Lithium Ion Battery (Escondido, CA)	6.5 MW/ 26 MWh	These storage projects will be owned by third parties including Powin Energy, Enel and Advanced Microgrid Solutions. The primary purpose of these storage systems will be to help enhance grid security integrate higher levels of renewable energy. These systems will also have a four-hour duration.
	Lithium Ion Battery (Poway, CA)	3 MW	
	Lithium Ion Battery (San Juan Capistrano, CA)	4 MW	
	Vanadium redox flow battery	2 MW/ 8MWh	This battery is part of a pilot project between SDG&E and Sumitomo Electric (SEI). It will be a 4 year demonstration project for SDG&E to research of flow battery technology can economically enhance the delivery of reliable energy to customers, integrate growing amounts of renewable energy and increase the flexibility in the way the company manages the grid.

Demand Response at SDG&E

Demand Response is another area where SDG&E has a great deal of experience. However, the way SDG&E programs are developed and managed have changed considerably in the past couple years. DR is aimed to avoid or defer new conventional-generation resources and transmission and distribution infrastructure, and by so doing, reduce greenhouse gas emissions by reducing or shifting the amount of load that must be served.

The CPUC has mandated all demand response programs fall into the two categories; Supply Side and Load Modifying. All investor owned utility supply side resources must be bid into the CAISO and the mandate prohibits the utilities from proposing any new supply side demand response. Any new supply side resources must come from third parties, through procurement auctions or requests for offers, which compete with SDG&E’s utility programs for DR enrollments. Load modifying resources do not qualify for wholesale markets and

can continue to be used solely for utility purposes. Examples of load modifying resources are Time of Use rates, Dynamic Pricing Rates and DR programs that provide technology incentives.

SDG&E is in the process of fully complying with this mandate by 2018 and integrating all supply side DR programs into the CAISO. They are also working to develop new price-signal driven rates and programs as they see an opportunity for managing and growing load modifying resources for their local needs.

Distributed Energy Resources at SDG&E

DER	Description	Size	Primary Purpose/Use
Demand Response	Base Interruptible Program (BIP)	~2 MW	This Day Of & Day Ahead emergency program offers a monthly capacity payment to commercial customers that can commit to curtailing at least 15% of monthly average peak demand. Supply side & bid into the ISO.
	Capacity Bidding Program (CBP)	~6 MW	Day Of & Day Ahead program that provides incentives to commercial customers in exchange for a commitment to shed load when requested by SDG&E. This program is bid into the ISO.
	A/C Cycling	14 MW	Residential and Commercial program using direct load control switches. SDG&E bids this supply side program into the ISO when needed.
	Critical Peak Pricing (CPP-D)	8 MW	For those business customers in this program, there is an opportunity to manage their electric costs by reducing load during high cost pricing periods or shifting load to a lower cost pricing period.
	Reduce Your Use (RYU) – Day Ahead - , Residential	3 MW	SDG&E emails or texts customers before a Reduce Your Use Day (participation is optional). If you reduce your use during 11am – 6pm, customers receive a monthly bill credit. Typically called to reduce peak during extremely hot weather or if another unusual situation occurs.
	RYU with Programmable Thermostats	5 MW	Provides a one-time incentive for installation of technology to enable automated demand response. Used primarily for residential programmable thermostats or pool pumps.
	Technology Incentives	MWs reflected above	SDG&E provides incentives for large technology projects for commercial customers. Requires enrollment for 3 years in a commercial DR program such as BIP, CBP, or a third party DR program.
	Third Party DR Programs – Residential and Commercial	Not available at this time	SDG&E has procured third party DR through the CPUC’s mandated DR Auction Mechanism pilots. SDG&E has held one auction each year for 2016, 2017 & 2018-19 delivery. SDG&E ordered to procure up to the budget caps each year (\$1.5M for 2016 and 2017, \$3M for 2018-19). Pilot to be evaluated in 2018 by the CPUC for cost effectiveness, efficiency, and participation. Bid into the ISO.

Distributed Energy Resources at SDG&E

DER	Description	Size	Primary Purpose/Use
Distributed Energy Generated Behind the Meter	Net Energy Metering	Solar – 790 MW Solar/Wind – 1.3 MW Wind – 1.1 MW Total – ~119K NEM customers @ ~793 MW	For homes/businesses with distributed energy generated onsite. SDG&E meters the energy produced and subtracts the energy used for the premise. SDG&E deducts the energy customers export to the grid at times when generation exceeds on-site demand from your bill. This is used for peak reduction and to increase utility integration of renewables.
	EcoChoice – Procured Community Solar – Residential and Commercial	Capped at a shared 59 MWs with EcoShare.	Customers can subscribe up to 100% of their power to be renewable when purchased from a large solar array. It is difficult for SDG&E to get large solar farms permitted in the city and county and land is expensive so this program is available only as available. Uses will be for peak reduction as well as increasing SDG&E's use of renewables.
	EcoShare – Developer Community Solar – Residential and Commercial	Capped at a shared 59 MWs with EcoChoice.	Through this program, customers work directly through 3 rd party renewable energy developers to purchase the rights to a portion of the energy generated from a new renewable energy facility. Customers enter into an agreement directly with the energy developer and participating energy developers have a Power Purchase Agreement with SDG&E and are only paid the extra energy generated outside of what the customer has purchased. This is used for peak reduction and to increase utility integration of renewables.

WHAT'S NEXT

for San Diego Gas and Electric?

Although SDG&E's main focus in the near term is operationalizing their energy storage systems, the utility is committed to continuing the development of new and innovative pilot projects in the DER space to build broad experience and knowledge. Their customer base has continually shown support for renewable generation projects and expects them to increasingly adopt automated energy management systems, install distributed energy resources, utilize energy storage capabilities, and charge electrical vehicles. SDG&E plans to continue to stay out in front of these technologies and

be able provide all these services options to their customers. Over Generation and Electric Vehicle Grid-Integration are two key pilots currently in progress and designed to help provide data to continue to build the capabilities SDG&E's customers want.

Over Generation Pilot

This 2017 pilot is designed to determine whether distributed energy storage facilities can effectively and economically address excessive solar export during non peak hours and lack of flexible generation during demand response events. SDG&E has requested to extend the pilot in 2018 and plans to analyze the results to determine pilot to program conversion based on those results.

Electric Vehicle Grid-Integration Pilot

In late 2017, there are more than 20,000 electric vehicles in SDG&E's service territory, and the number grows daily. In its EV pilot, SDG&E will own and install electric vehicle charging stations at up to 350 businesses and multi-family communities through the region, with 10 chargers at each location for a total of 3,500 separate chargers. They will install at least 10% of the chargers in disadvantaged communities. The project will overcome many current obstacles to electric vehicle growth and reassure local electric vehicle drivers that they will have a place to charge, while maximizing the use of renewable energy and minimizing the need for new fossil-fuel power plants.

In addition to expanding access to electric vehicles, the pilot features special rates that encourage drivers to charge their cars when electricity supply, including renewable energy, is plentiful and energy prices are low. With rates encouraging off-peak charging, vehicles will be efficiently integrated into the grid, helping to avoid on-peak charging that drives the need to build more power plants and other electric infrastructure.



SACRAMENTO MUNICIPAL UTILITY DISTRICT

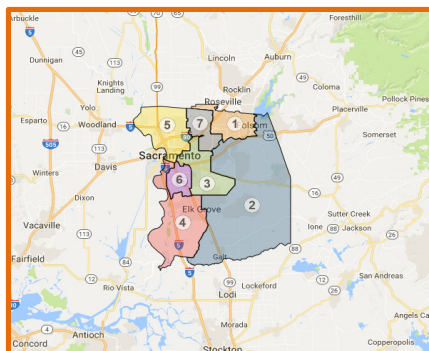


As the nation’s sixth largest community-owned electric service provider, SMUD has been providing low-cost, reliable electricity for more than 65 years to Sacramento County and small adjoining portions of Placer and Yolo Counties. SMUD is a recognized industry leader and award winner for its innovative energy efficiency programs, renewable power technologies, and for its sustainable solutions for a healthier environment.

DER at SMUD

SMUD defines DER at their utility to include customer or utility sited storage, demand response, electric vehicles, solar PV and energy efficiency. SMUD, as a municipal district, is not regulated by the California Public Utilities Commission. Due to this, their DER products and services are not driven by mandates and regulations passed down from the CPUC, but are created along with an elected board of directors.

SMUD’s Board of Directors is made up of seven elected board members, one from each of the seven wards in SMUD’s service territory.



Although SMUD and their board have not identified specific goals in the DER space for the next few years, the utility has made many developments and plans for DERs and they are highlighted on the following pages.



HEADQUARTERS
Sacramento, California

FAST FACTS

- 1st large California utility to receive > 20% of its energy from renewable resources
- Serves 624,700 accounts across 900 square miles of service territory
- Employs ~2,000 people

PEAK DEMAND
~2700 MW

DER PORTFOLIO

- Solar PV
- Electric Vehicles
- Demand Response

Community Solar

Solar is a distributed energy resource where SMUD has a great deal of experience, specifically community solar. Their community solar program currently allows customers to buy energy in fixed energy priced contracts of five, ten or twenty years with a delivery service charge that covers some additional grid costs for the utility. This provides a consistent savings to customers over the course of their contract. The utility is expecting to add approximately 100 MW of community solar over the next three to four years through large customers like the State of California and data centers as well as new residential customers.

SMUD is currently working on some new products associated with community solar as well. One is for residential new construction. There will be dedicated systems for large new communities where customers can buy a home and automatically be on the solar shares rate.



SMUD's solar plant near Rancho Seco

Another new product is for commercial customers who want to have solar visible at their company. SMUD will assist with the development of parking lot solar arrays and include them on the utility side of the meter. They will also build a set of electric vehicle charging stations with it and sell it to them as part of a Solar Shares Package.

These are new, innovative ways for SMUD to work with customers to meet specific objectives and needs.

ENABLING TECHNOLOGY

As SMUD continues their strategic planning around DERs, they see a need for a system to manage all the different technologies and programs that will become necessary at their utility. They are currently in the middle of procuring an Advanced Distribution Management System (ADMS) and as part of that agreement with the ADMS vendor, SMUD has requested they also include the development of a Distributed Energy Management System (DERMS) for SMUD to manage their distributed energy resources as they come online. They know that this will be a large effort and are planning ahead to be well prepared for what is to come in the near future.

Electric Vehicles

SMUD has also been developing more capabilities and growing the market for EVs. They are doing this through research and development projects around charging infrastructure as well as looking at ways to incentivize dealers and train them on how to provide a better experience for customers who are interested in purchasing an EV.

the cost of expanding existing, or creating new demand response programs for SMUD given current and projected market prices and power availability.

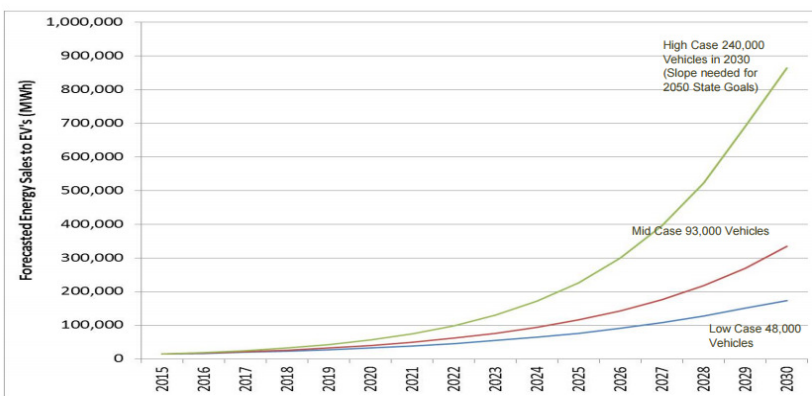
Since SMUD does not have mandates around demand response from a PUC, they need to determine the costs, benefits and risks internally and determine how to proceed if/as it makes sense for the utility.

into more sparsely populated areas). Because of this, SMUD has found that any distribution system capacity projects fall in a narrow band from a budget standpoint. For example, they don't have a 100 mile feeder so all or most of their distribution projects are bounded at \$1-3 million per project, such as building a new substation or upgrading or replacing a transformer at a substation. This means there is a very limited budget in terms of what they can do with DERs, specifically demand response programs or energy storage as compared to a \$15-20 million project with a five year deferral.

Due to this understanding within the utility, SMUD looks to leverage existing DERs, such as any existing solar PV or implement some new energy efficiency measures in the targeted area to defer an infrastructure upgrade as opposed to investing heavily in new resources.

The SMUD team has also started looking at non-wires alternatives as a way to get additional time to refine their forecasts in order to avoid overbuilding for every project that appears to require an infrastructure upgrade/build. A small investment in energy efficiency or solar installations, for example, could provide enough load relief for a year to allow SMUD time to hone in on the area and refine their load forecast and better determine how to handle the area long term. SMUD plans to continue assessing this process and making adjustments as necessary based on the types of projects, budget and lead time.

SMUD Market Adoption / Load Planning



3



Demand Response

Demand response is not currently viewed as a needed resource at SMUD due to the fact that peak capacity has not been growing much over the last ten years.

However, they do see some changes on the horizon, specifically around the growth of indoor agriculture and reverse transmission flows, due to high solar PV penetration, that could both potentially create a need for capacity. Even with these changes, it is still hard to justify

Non-wires Efforts

SMUD is also evaluating the use of DERs for non-wires efforts across their service territory. To date, their non-wires efforts have been focused on the distribution system as they do not have any transmission capacity constraints that require an alternate solution. They define their distribution system as relatively homogeneous, mainly serving one county and the feeder lines are not very long (compared to the large CA IOUs that may have more rural areas to serve that ripple out

Energy Storage

SMUD has recently spent considerable time and effort around the analytics for energy storage to determine what it could or could not do for the utility. They have determined at this time it is still not cost effective in their service territory.

However, their analytics also show that battery storage may be on the horizon within the next five to seven years or possibly sooner based on how fast business models and technology are moving. Knowing that this is coming in the near future, SMUD is ramping up some of their business model demonstration projects, especially behind the meter models, so they can

participate more with their customers and help them understand how to realize some of the investment value from storage as well.

SMUD is currently at the point in their energy storage research to recommend a target to their board of directors. Their recommendation is 75 MW of energy storage, mostly behind the meter initially (which is ~2% relative to their peak demand). The 75 MW will be made up of 2/3 battery storage and 1/3 residential and commercial thermal storage.

The team at SMUD has initiated work with their rates team to develop a roadmap to assist in the

development of rate structures they can rollout along with a storage pilot that would be conducive to sharing value with their customers.

SMUD is doing their due diligence now to prepare themselves and their customers to be successful in piloting these technologies.

WHAT'S NEXT

for Sacramento Municipal Utility District?

Over the next several years, SMUD has projects planned that involve several different DERs; energy storage (both battery and thermal), electric vehicles, additional solar PV as well as the implementation of a DERMS. In addition to near term DER efforts, SMUD is also engaged in new load building programs. Due to flattening of loads in their service territory over the past several years, they have decided to focus on three key areas where they see the biggest growth potential; the electrification of homes, cannabis cultivation and electric transportation.



BPA Distributed Energy Resources Benchmarking Report

XCEL ENERGY INCORPORATED



Xcel Energy Incorporated, a holding company consisting of four wholly owned utility subsidiaries, provides electric and natural gas service across eight states. These utility subsidiaries, referred to as operating companies, are Northern States Power Company-Minnesota, Northern States Power Company-Wisconsin, Public Service Company of Colorado and Southwestern Public Service Company.

DER at Xcel Energy

Xcel Energy’s primary drivers for the use of DERs are maintaining grid reliability, reducing marginal costs through interruption or buy-through and deferring Transmission and Distribution costs and generation expenditures in the long-term. The majority of Xcel Energy’s experience within the DER space is in Demand Response.

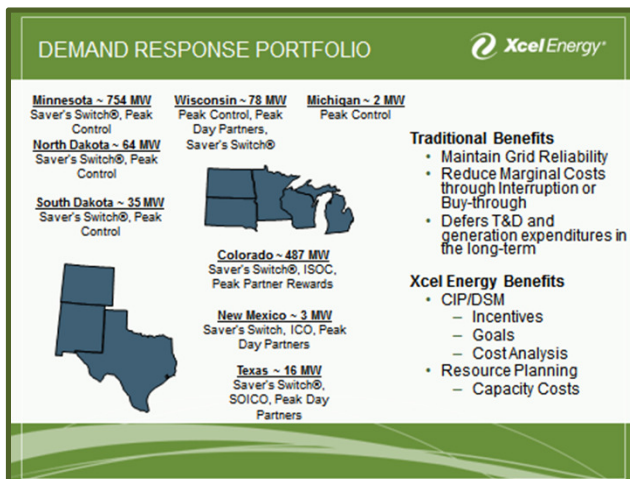
They have long standing, successful programs across their eight states. Below is a high level snapshot of their Demand Response programs, megawatts of DR that they provide to their portfolio and the key benefits of Demand Response for Xcel Energy. The following page provides a table with more detailed program descriptions.



HEADQUARTERS
Minneapolis, Minnesota

FAST FACTS

- Operates in 8 states: Colorado, Michigan, Minnesota, New Mexico, North Dakota, South Dakota, Texas and Wisconsin
- Serves 3.3 million electric and 1.8 million natural gas customers
- Runs the 4th biggest transmission system in America



DER PORTFOLIO

- Energy Storage
- Demand Response
- Solar PV

DR Program	Description	State(s) Available
Saver's Switch	<p>Saver's Switch Residential has ~640,000 one-way load control receivers on central air conditioning systems. Communication occurs through both radio and paging infrastructure and to perform standard (15 min on/15 min off) and smart (10-15 min on/10-15 min off) cycling of the AC units. Participant incentives vary by state, but include; 15% off electric energy charges (June –September), \$40/year or \$50/year for an approximate load relief of .06-1.0 kW on each unit. Attrition for this program has remained at <1%.</p> <p>Saver's Switch Business program details mirror the residential program. There are 19,000 participants with 49,000 units enrolled, mainly central AC (with generators allowed in WI). Load relief is ~.2kW per AC ton and the incentive is \$20/year per AC ton for their participation. Incentives may vary by state.</p>	Colorado Minnesota New Mexico North Dakota South Dakota Texas Wisconsin
Critical Peak Pricing	<p>During periods of peak energy demand, such as hot summer days, the Critical Peak Pricing (CPP) program provides participants a price signal to encourage them to reduce their electricity during these periods. Participants can save between 5 and 10% on their annual Excel Energy electric bill (depending on how much load they are able to reduce).</p>	Colorado
Peak Partner Rewards	<p>This program is available to all business customers who can agree to reduce usage during the summer months, June through September, between the hours of 2pm and 6pm by a minimum of 25 kilowatts. Xcel works with participants to develop an energy reduction plan and when Demand Response events are called, these plans are initiated and load is reduced during the timeframe requested (metered at each facility for verification).</p>	Colorado
Interruptible Service Option Credit (ISOC)	<p>Generally, ISOC customers to reduce their electricity demand on hot summer days between June 1st and September 30th. Businesses that can reduce their electricity demand by a minimum of 300 kilowatts when notified qualify for a monthly credit on their Xcel Energy bill. Monthly credit amounts are tied to things like contract interruptible load, the number of hours interrupted each year, and the advance notice option selected.</p>	Colorado
Interruptible Credit Option	<p>Monthly credits when transmission level customers (only) agree their electric load can be subject to interruption upon notice. There are several options available; Notice option/1 Hour, Firm Demand Option, Annual Hours of Interruption (40, 80 or 160/year), and Short duration interruption option (<4 hours). Interruptible load must be at least 500 kW in Texas and 300 kW in New Mexico and can be called on for capacity, contingency or economic.</p>	New Mexico Texas
DR Standard Offer Program	<p>Participating customers must provide at least 100 kW of peak demand reduction, be non-residential, distribution level and/or non-profit customer or government entity, including educational institutions. Performance period for this program is June 1 through September 30, weekdays between 12 and 8pm and can be used for system reliability as well as peak reduction. There are 2 options for interruption; 24 hours for \$35 credit per kW (max of 6 events lasting 4 hours each) or 48 hours for \$50 credit per kW (max of 12 events lasting 4 hours each).</p>	Texas
Electric Rate Savings/Peak Control	<p>Participating customers agree to reduce their demand for electricity to a predetermined demand level when Xcel calls a control period. The minimum controllable load is 50kW and must be provided at least one time during June – September. This program also offers more opportunities to save if a portion of peak load can be shifted to off-peak hours, a minimum of 50 kW between 9pm – 9am.</p>	Michigan Minnesota New Mexico North Dakota South Dakota Wisconsin

SMART THERMOSTATS



One of Xcel Energy's pilot projects is 'Bring Your Own Thermostat' (BYOT) for residential smart thermostat customers in Colorado and Minnesota. Xcel is currently targeting 1,000 participants in each state using Honeywell and Ecobee Smart Thermostats. Xcel reached their goal number of participants and have been running the pilot for just over a year.

The second thermostat pilot is direct install for smart thermostats. They are being implemented with New Mexico residential and Colorado Small Business customers. New Mexico is targeting 1500 participants with Ecobee as their technology partner. The Colorado Small Business portion is targeting 100 participants (~300 thermostats) with Honeywell as their technology partner.

DER Pilot Projects

Xcel Energy has several pilot projects they are working on to continue development of their DER capability across service territories.

They are focused on strengthening their presence within the segments that have significant potential; residential and small to medium sized businesses.

Building Optimization

One key pilot project within the small to medium sized business sector is focused on implementing Demand Response and Energy Efficiency measures that will allow for peak reduction in both the summer and winter seasons.

The implementation of BuildingIQ Software-as-a-Service will be installed for businesses who are a part of this pilot to optimize their HVAC temperature and pressure as well as communicate demand response events.

Xcel energy will be fully funding this pilot in the first year and sharing the cost 50/50 with the commercial customers in year two.

If this pilot is successful, it will be very beneficial in helping the company meet their peak reduction goals for the coming year.

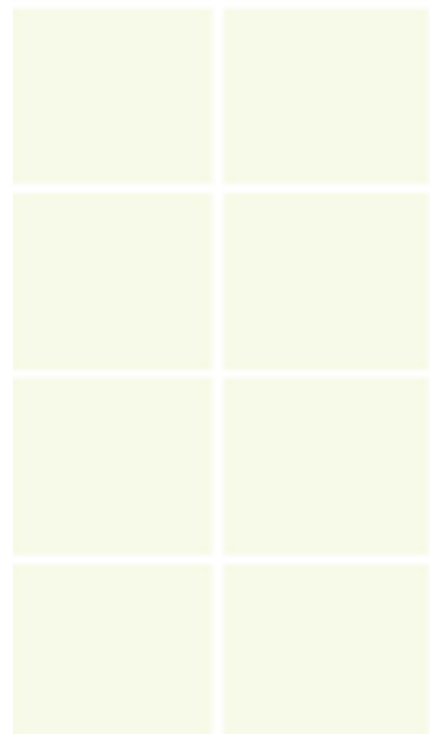
Non-Wires Alternatives

Xcel Energy is also developing pilots to test the effectiveness of non-wires alternatives. They are using energy efficiency, demand response, solar PV, and batteries, to avoid or defer traditional distribution investments in both Colorado and Minnesota.

In Colorado, Xcel is developing a pilot focused on the use of traditional EE and DR to defer a new substation transformer and feeder. They plan to leverage existing AC switches on this feeder and drive increased adoption of residential DR and EE measures with peak load benefits

through targeted messaging and bonus rebates.

In Minnesota, Xcel filed a pilot to use front-of-meter battery and solar to defer a new substation transformer and feeder. Unfortunately the commission did not approve the pilot and Xcel is currently evaluating whether they want to re-file.



Energy Storage Projects

Xcel Energy has two key battery projects in progress that were launched in 2015.

The Panasonic Battery Storage/Microgrid Demonstration is a partnership between Xcel Energy, Panasonic and Denver International Airport. The Panasonic facility will be constructed with a utility owned 259 kW net metered PV system and they will also host the utility owned battery system to be used to help mitigate the concentration of PV in the area.

Xcel Energy is planning on a three year test period to learn how to best optimize the battery system.

After the test period they plan to operate the battery as part of the normal distribution system in the manner identified as most optimal.

The second battery project is called the Stapleton Battery Storage/Solar Integration pilot. They will be deploying six community storage systems and six residential Behind the Meter systems on this residential feeder with high PV penetration.

The goal of this pilot is to demonstrate that Xcel can stop the reverse power flow that has begun at the substation and basically shift some storing of power at the peak of the day and discharging again once the sun goes down in the evening.

From these pilots, Xcel is looking to gather information on battery operations as well as the potential for value stacking for both the utility and their customers. The utility gets value from mitigating the impact of high penetration PV generation to the distribution grid, providing system peak demand reduction (demand response), energy arbitrage as well as regulation services. Customers will get value if the battery can provide them back-up power. There are several use cases and Xcel is in the process of determining how many they can realistically use for each battery.

The information gathered and research results determined will be published at the completion of these pilot projects.



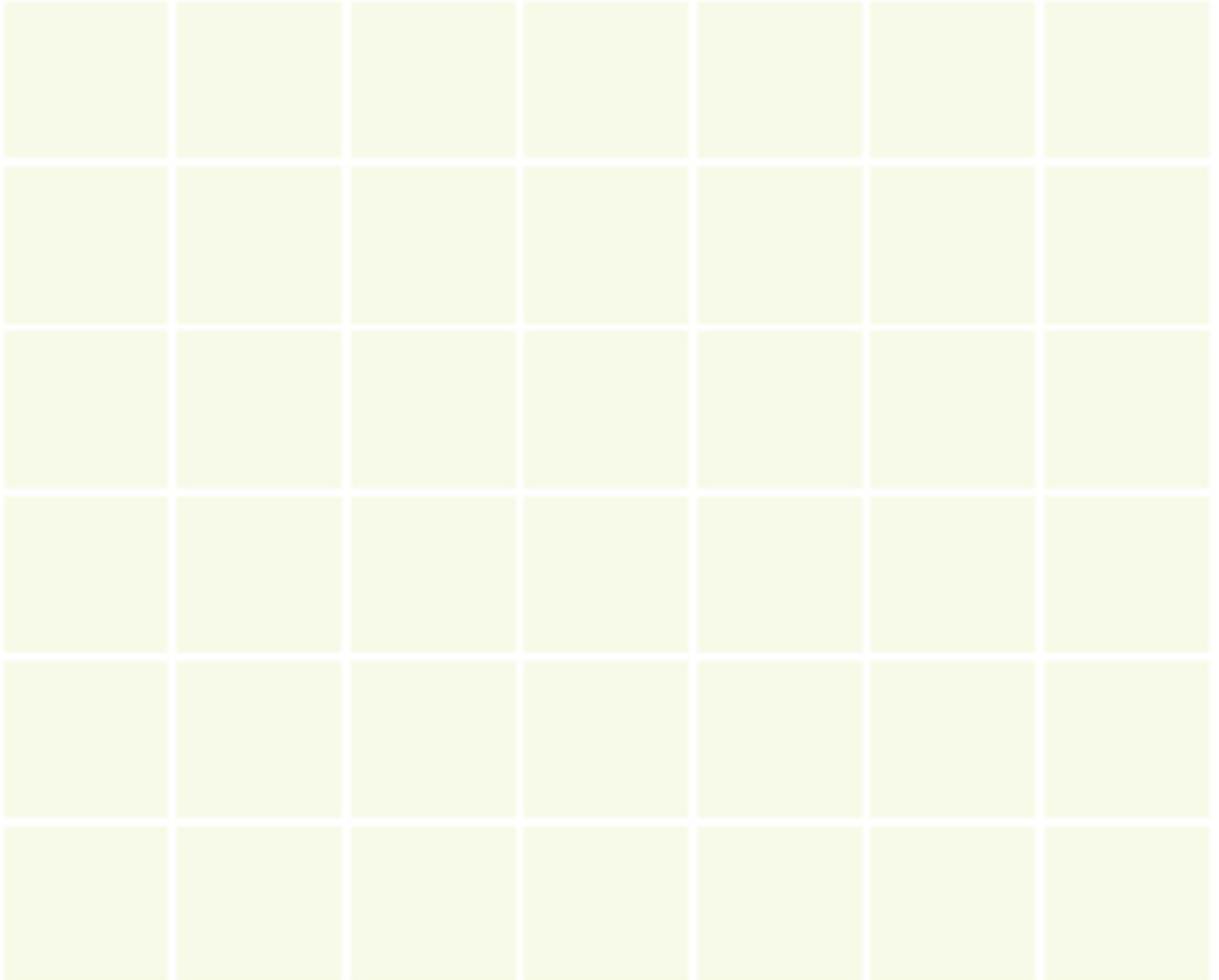
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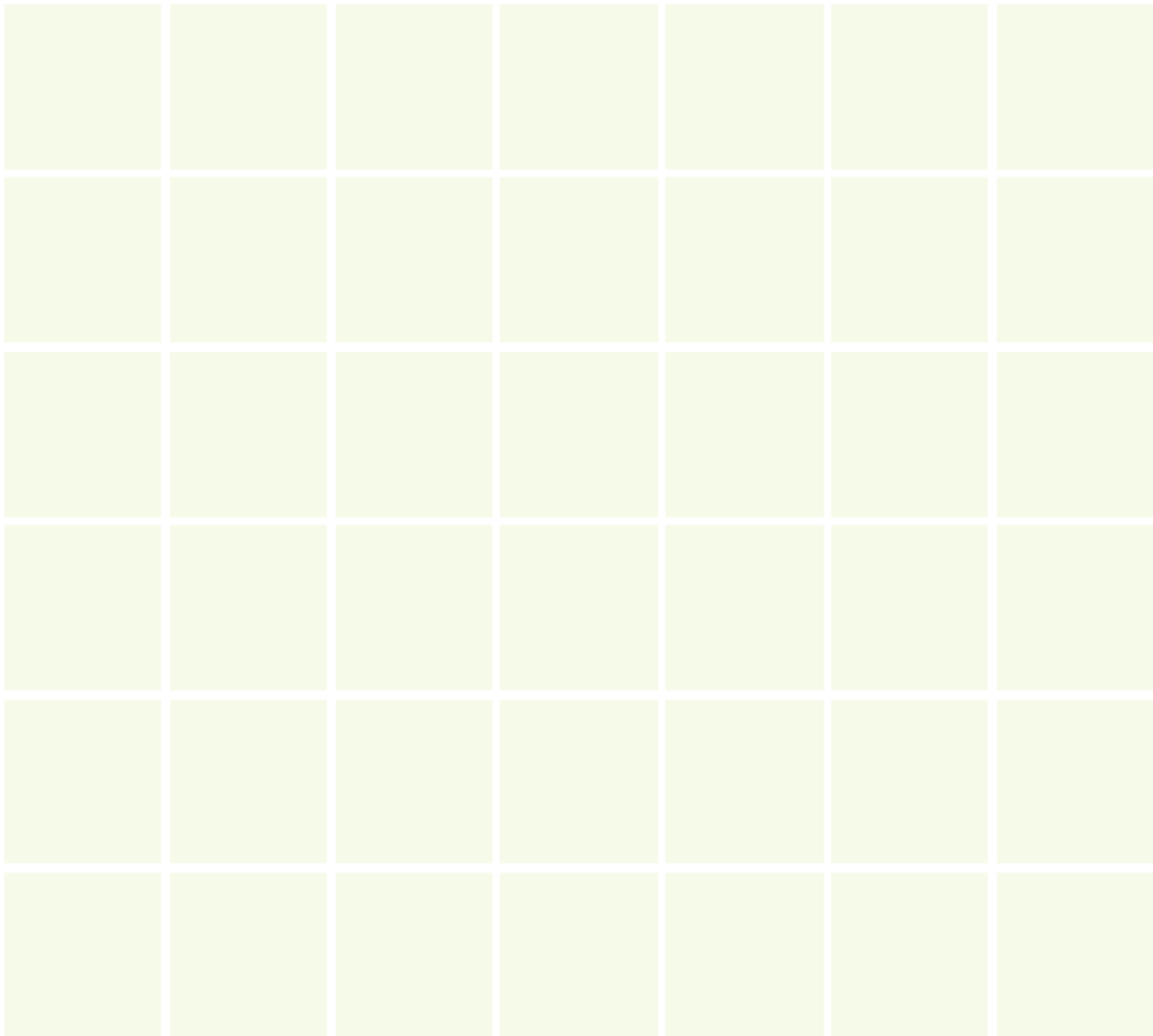
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SA+R
03/06/2015

WHAT'S NEXT

for Xcel Energy?

As Xcel continues to dive deeper into DERs, they have determined that they need to update their outdated information technology solution that is being used mainly for demand response today. They believe the current system is limiting future growth in this area so they have begun working with a vendor to develop Xcel's Distributed Energy Resources Management System (DERMS) in a four phase approach. They will eventually be integrating with several areas of the business with the goal of this being a one stop system for DERs across Xcel.





Acknowledgement and Disclaimer

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