MONETIZING ENERGY ASSETS FOR DATA CENTERS

A complete guide for earning revenue with demand-side energy management

Danielle Bond
CPower Senior Engineer

Nate Soles
CPower National Accounts Executive

Ray Berkebile
CPower Senior Director of Engineering

August 2018

CONTENTS:

I. ENERGY USE IN THE DATA CENTER INDUSTRY

Data centers are in demand. The growth of cloud computing and the subsequent challenge of powering big data has led to a data center construction boom.

Worldwide, data center space is predicted to grow to 1.94 billion square feet in 2018.[1] Much of the new construction aims to continue the industry's trend toward energy efficient buildings, shedding the label of "comatose power drains" issued by the New York Times in a 2012 article that claimed "data centers can waste 90% or more of the electricity they pull off the grid."

Times have changed for the data center industry.

While significantly more efficient than their early 21st century iterations, data centers continue to use a lot of electricity--up to 50 times more than standard office spaces--and subsequently face the high expense of large-scale electricity consumption.[2]

Working toward a more efficient and sustainable future, data center facility managers and executives are increasing their focus on energy management plans rooted in a sustainable building philosophy based on cost-effectiveness and energy-optimization--all while taking top-flight care of their customers and their data.

The data center industry's recent push toward a more efficient and sustainable future comes at a serendipitous time when energy markets around the country are working to reduce demand via energy efficiency investments and to integrate distributed energy resources (DERs) onto their energy grids in an attempt to diversify their fuel mixes.

Right now and for the foreseeable future, grid operators and electric utilities in each of the deregulated energy markets in the US and Canada have created a wealth of incentive programs to encourage commercial and industrial organizations to invest in energy efficiency and to monetize their generation capacity.

Data Centers with distributed resources at their facilities like backup generators are in prime position to reap significant financial benefits by working with a properly licensed company that can help them monetize their existing energy assets.

Organizations that have constructed new facilities (exceeding industry standards for efficiency, like ASHRAE 90.1 and 90.4) or have recently upgraded their existing data center facilities by way of investing in high-efficiency HVAC or IT technologies, specifically free cooling via an air-side or water-side economizer, variable speed drives, high-efficiency servers or UPS devices, and more may also be eligible to earn money for their energy-reducing efforts.

[1] *Managed Application & Network Services; Dun & Bradstreet Industry profile; May 2018* [2] *Energy Star®*

WHAT'S IN THE PAPER:

This paper offers a detailed explanation of how a data center can monetize its existing energy assets with demand-side energy management.

In the sections that follow we're going to examine the challenges data centers face concerning energy management and identify and analyze potential assets many organizations in the industry already possess that can be monetized.

We're also going define what demand-side energy management is and the many types of programs and practices that comprise it. In this explanation, we'll take a close look at the evolving energy industry in the US with an emphasis on the growth of DERs and the role they play and will continue to play in North America's fuel mix of today and tomorrow.

We're then going to outline a complete demand-side energy management plan for a fictitious data center facility in the US. Included in this plan will be a sample curtailment plan the organization uses at one of their facilities to participate in a grid-sponsored demand response program, which pays organizations for using less energy when the grid is stressed or electricity prices are high.

Lastly, we're going to recommend how your data center can get started with demand-side energy management, including how to go about selecting the right company to facilitate your participation and monetize your organization's existing energy assets.

[3] *"Metrics for Responsible Property Investing: Developing and Maintaining a High-Performance Portfolio*

II. ANALYSIS OF A DATA CENTER AND ITS POTENTIAL ENERGY ASSETS

The Importance of Customer Experience

No two commercial buildings are alike and every data center facility is unique. One trait all data centers share, however, is the unwavering desire to provide customers with impeccable service- robust, reliable, and resilient.

That's why every measure a data center operating organization explores concerning energy management should be examined through the customer service lens.

Customers' need for data hosting has been skyrocketing over the last two decades and shows little sign of slowing. The growth of cloud computing and the subsequent challenge for companies to quickly establish tens of thousands of new servers to power their technologies has led to a data center construction boom.[3]

Green Data Centers

Green data centers--those which are environmentally responsible and resource-efficient--aim to lower costs and create a more sustainable operation through improved design and by using more efficient equipment. According to the London-based research organization Technavio, the green data center market is expected to grow at a compound annual rate of about 15% by 2021.

Data hosting organizations that have upgraded their existing facilities to be more energy efficient may be eligible to earn money for the permanent reduction of their electric demand by working with a demand-side energy management company that can offer their reduced demand into forward capacity markets.

We'll discuss how data centers can monetize their energy efficiency projects in section III.

The Emergency Generator: A Data Center's Most Valuable Energy Asset

Data centers are powered by electricity from the grid, which is susceptible to outages. Data centers, of course, can't afford to be down due to a brownout or blackout for a single second, lest they risk losing their customers forever.

While primarily seen as a reliability resource of paramount importance, a data center's backup generator can also be a revenue-generating asset for organizations that participate in demand-side energy management, particularly demand response, which we'll discuss in Section III.

Given the supreme need to be up and running at all times, most data centers' generator sets don't just provide full backup for every kilowatt the data center's systems demand. In many cases, they utilize N+1 redundancy, meaning they are equipped with excess generator capacity which exceeds the center's total peak demand.

Such high-capacity emergency generation systems put data centers in prime position to earn significant revenue with demand response, money that can be used, among other things, to offset a participating organization's hefty electricity bill, to fund upgrades to equipment or infrastructure, or to pass along to customers in the form of level rates.

In the next section, we'll explain how.

[3] *Managed Application & Network Services; Dun & Bradstreet Industry profile; May, 2018*

III. MONETIZING ENERGY ASSETS WITH DEMAND-SIDE ENERGY MANAGEMENT

Data centers have ample opportunity to monetize existing energy assets through demand-side energy management. The revenue earned through these efforts can be used as the organization sees fit, including upgrading properties to further enhance customer experience.

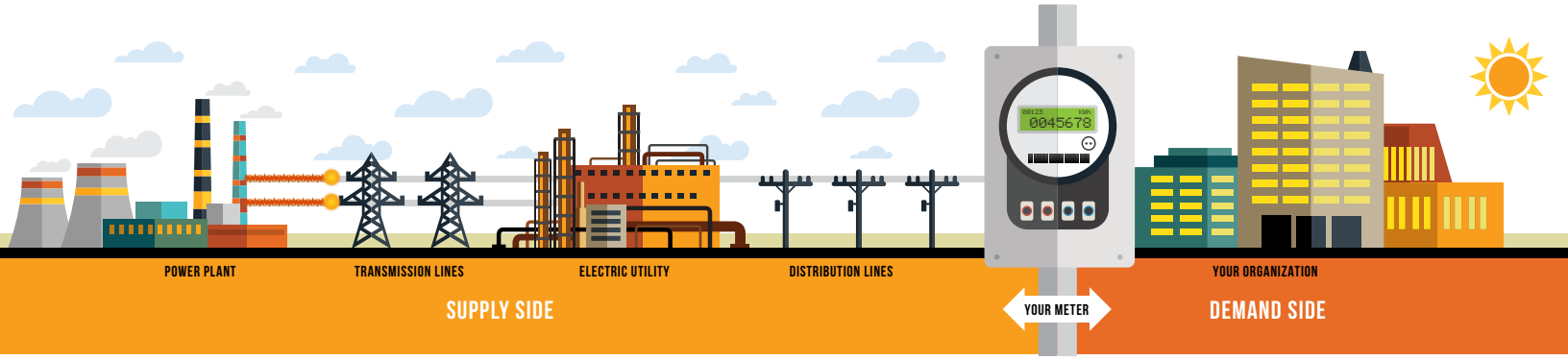
What is Demand-Side Energy Management?

Demand-side energy management is the modification of consumer demand for energy in order to control demand charges and monetize energy assets while ensuring that occupants remain comfortable and business processes are satisfied.

Most of the time, demand-side energy management involves strategies designed to cut back, or curtail, the amount of energy a given facility uses for any number of reasons like saving money, reducing air pollution, cutting carbon footprints, and earning revenue.

How Does Demand-Side Energy Management Work?

To better understand how demand-side energy management works, let us trace the journey of power from its point of generation to consumption.



The energy an organization uses is generated at a power plant and travels along transmission lines until it reaches the electric utility, then it travels along distribution lines to the facility where it's ultimately consumed.

A given building has a meter that monitors how much energy the building consumes. The meter is the imaginary dividing line between the demand side and the supply-side of energy. The supply side of energy refers to everything involved with how an organization goes about receiving its energy, including how it purchases energy from its supplier. The demand-side of energy is often referred to as behind-the-meter. Behind-the-meter energy management includes all the ways an organization controls and uses energy.

Distributed Energy Resources

Distributed energy resources (DERs) consist of smaller power sources—like on-site generation, battery or thermal storage, or solar photovoltaic, —that can be aggregated to provide the power necessary to help meet an organization's regular demand for electricity otherwise required from the grid.

Distributed energy resources have developed at their own individual pace and with little interaction with each other since the 1970s energy crisis when the US and the world faced elevated gas prices due to real and perceived petroleum shortages.[4]

[4] *Optimizing Corporate Energy Management: Choosing an Integrated DER Vendor for C&I Customers---Brett Feldman, Roberto Labastida, Alex Eller; Navigant Research, Q2 2018 (DERs are defined as a critical part of the US Smart Grid Initiative and the US Department of Energy's Master Roadmap plan.)*

In recent years, technological, economic, and regulatory changes in the energy industry have made it feasible for grid operators to integrate DERs onto their electric grids in an effort to support a robust and secure electric grid and move away from large scale, centralized fossil fuel generation.

This trend presents an opportunity for data centers to monetize DER assets--including on-site generator sets--they may already have at their properties.

Integrated DERs, DER Aggregators, and the Link to Monetization

Integrated DERs include distributed generation resources such as diesel gensets, solar photovoltaic, demand response, energy storage, and energy efficiency. The link between these assets, which are used within the data hosting industry, and the grid is formed by DER aggregators, which are licensed companies with the proper expertise and technology platforms to connect the energy resources with the grid.

By partnering with an experienced demand-side energy management company that specializes in DER aggregation, data centers can leverage their existing energy assets, turning these resources into sources of revenue.

Types of Revenue-Earning Demand-Side Energy Management

Demand Response (DR)

Demand response programs pay organizations to reduce electricity usage during times of grid stress or high energy prices.

Occasionally, the grid operator assesses there is not enough electricity generation to cover the projected demand based on the current rate of demand growth on the grid.

In these cases, the grid operator can offset the imbalance by calling on commercial and industrial organizations to reduce the amount of electricity being consumed from the grid when demand exceeds supply. Sometimes the demand for energy outpaces the grid's ability to supply it, which can lead to brownouts or blackouts. Demand response provides critical back-up to ensure grid reliability.

Since the early 2000s, demand response has grown in wholesale energy markets across the US. As DR's popularity has flourished, regulators have called for tighter requirements to ensure demand response remains a reliable resource when called upon to help balance the grid. These increasingly stringent regulations have caused many smaller curtailment service providers (licensed companies that ensure DR participants execute safe and compliant curtailment) to leave the market due to their inability to compete amidst less forgiving regulations and larger more established competitors.

While demand response programs vary in detail from utility to utility and from market to market, they essentially fall into three basic types: capacity, ancillary services, or economic.

For a detailed explanation of Demand Response, click here.

Because data centers use generators capable of handling large loads (greater than 50 megawatts in some cases) and their use of uninterrupted power supply (UPS), which allows for short-term frequency shifts or power reductions while the generator is activated, they are ideal for demand response participation.

Energy Efficiency

Energy Efficiency (EE) is the permanent reduction of electrical demand through the installation of high efficiency equipment and systems, including new investments and upgrades to existing devices or processes.

In some energy markets in the US (PJM and New England, for example) organizations can earn money for these permanent reductions in demand by partnering with a licensed demand-side management company who can offer these "negawatts" (capacity generated through conservation,) into the Independent System Operator's (ISO) forward capacity market.

The sale of "negawatts" into the ISO's forward capacity market creates another revenue stream, sometime referred to as energy efficiency credits, to either decrease project paybacks or allow for reinvestment for future projects.

For a detailed explanation of Energy Efficiency, click here.

A sample energy efficiency project for a data center that reduced demand by way of upgrading its chilled water plant and retrofitting its supply and return fans with variable speed fan drives (VFDs) might look like this:

APPLICATION	TOTAL SYSTEM SIZE	TOTAL VERIFIED SAVINGS
Chilled water plant upgrades including high efficiency variable speed chillers and free cooling heat exchanger	400 Tons	900 kW
Retrofit supply and return fans with VFDs	400 hp	200 kW

IV. ENERGY MARKETS IN NORTH AMERICA

A brief history of energy markets in the US

When the electric grid in America was initially constructed in the early 20th century, the safe and reliable distribution of electricity to homes and businesses was deemed a responsibility too important to our society to be subjected to the ups and downs of pure free-market capitalism.

The founding planners of the US grid saw the inherent problems that would arise should a financially struggling electric company providing power to consumers go out of business and leave portions of the public in the dark.

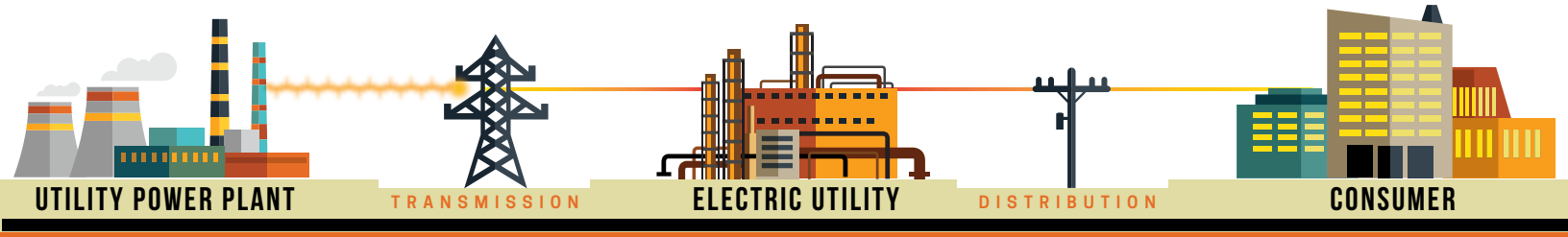
To ensure safe and reliable electric service and to also make sure that didn't include unsightly and dangerous messes of competing proprietary equipment littering the streets of an expanding America, the same type of vertically integrated electric generation and delivery system as we have in many states today was established.

Electric utilities have been granted rights by the states in which they operate to be the sole provider of electricity in a geographic area. This serves to ensure consistent and reliable service to customers. It also guarantees a level of financial success for the utility, which is subject to a wealth of laws--which cap the utilities' profits and losses--that aim to secure their continued success in delivering safe and reliable electric service while limiting their otherwise apparent ability to act like unfettered monopolies.

Today, there are two types of energy markets in the US: regulated and deregulated.

Regulated Energy Markets

Many states in the US operate a regulated energy market in which the power consumed by citizens is controlled from the power plant to the end-user's building by a vertically-integrated utility, who sends the consumer an electric bill each month that reflects levels of consumption

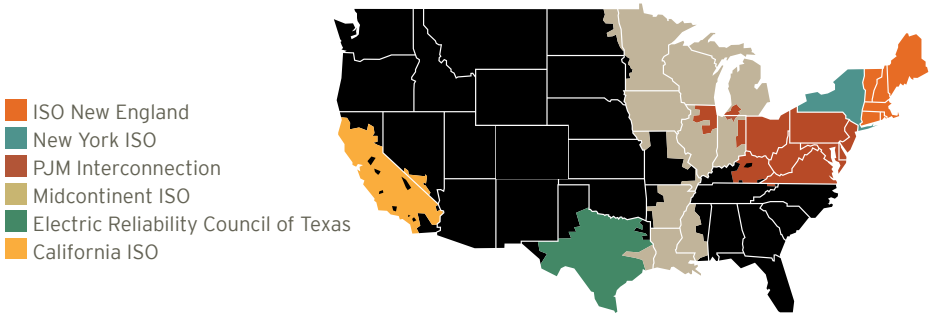


In a regulated market, vertically-integrated utilities control power from its generation source to consumption by the end user. Utilities are highly regulated to keep them from acting as monopolies.

Deregulated Energy Markets

In the 1990's, six deregulated energy markets emerged in the US with an aim to provide a more competitive arena for electricity. Those markets remain today.

Deregulated Energy Markets in the U.S.



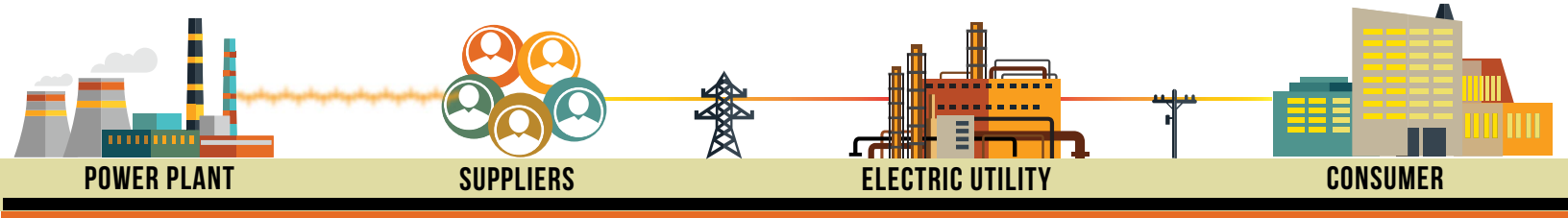
How a deregulated energy market works

Deregulated markets feature grid operators that administer wholesale electricity markets to ensure reliability on the grid and prevent blackouts.

In a deregulated market, the electric utility is also granted franchise rights to provide electricity to customers and bill them monthly. However, in a deregulated market the utility has no control over the supply of electricity. Instead, utilities divest all ownership in generation and transmission of electricity and are only responsible for the distribution of electricity to consumers and for billing those same consumers.

Deregulated energy markets are often called open or competitive because they promote choice and free market enterprise to provide consumers with electricity prices that are fair and just.

In a deregulated market, the consumers are allowed to choose their commodity supplier. The structure of the market motivates retailers to differentiate their products from the utility's and those of competitors by developing innovative features, pricing plans, and options that are not available in regulated markets.



Consumers can choose their supplier in a deregulated market. Choice and competition strive to keep electricity prices fair and just, but there is no guarantee that customers in deregulated markets will pay less than those in regulated markets.

Monetizing Energy Assets in a Deregulated Energy Market

Each deregulated market differs in its rules and regulations involving demand-side energy management. Each offers its own set of demand response programs and policies for monetizing energy assets including reduced demand from energy efficiency projects. Each has its own way of calculating electricity rates, including demand charges, which are inextricably tied to being connected to the grid. Each has its own unique plan for integrating distributed energy resources with its grids. Each has its own very unique rules and parameters for how aggregators can help integrate DERs onto the grid and how organizations are compensated for providing those assets.

The opportunity to monetize energy assets for commercial consumers lies, first and foremost, in deregulated energy markets. Data hosting organizations aiming to monetize energy assets should consider consulting a demand-side energy management company that operates in the deregulated markets where their facilities reside.

V. DEMAND-SIDE ENERGY MANAGEMENT IN ACTION

Now let's take a look at how a fictitious data hosting organization might go about monetizing its energy assets working with CPower, a real-life demand-side energy management company.

In this exercise, we'll assume the perspective of two principal organizations. The first is the customer, a data center organization with 16 facilities in five different deregulated energy markets in North America: Texas, New York, New England, PJM, and Ontario.

The second organization is CPower, a licensed curtailment service provider (CSP) that helps more than 1,700 commercial and industrial organizations across the US and Canada monetize their existing energy assets.

National Experience. Local Expertise.

That the customer has properties in four different US energy markets and one in Canada presents a series of challenges when it comes to enacting a cohesive demand-side energy management strategy.

Each market has its own set of complex regulations governing energy use and monetization of energy assets for commercial and industrial customers. Each building in the organization's portfolio is unique in the way it consumes energy and the types of assets it possesses on its grounds.

With teams of energy experts working in each of the nation's deregulated energy markets, CPower is in a unique position to help this data center customer devise a demand-side energy management strategy that includes contributions from as many properties the customer chooses to include.

Facility Assessment

Working with one of CPower's national coordinators, the customer's Director of Facilities will arrange to provide CPower with the ability to assess the participating facilities to determine an optimized strategy for asset monetization.

Part of this access includes the customer sharing their facilities' energy usage data. With authorization, CPower can access this data from the customer's electric utilities, often dating back the previous two years, allowing for CPower's team of engineers to analyze each facility's historical consumption patterns prior to visiting individual sites.

In assessing the customer's facilities, CPower engineers work with facility staff to identify opportunities to curtail electric load at each of the customer's facilities. Keeping the data center's customer service in mind, CPower looks for potential loads that can be curtailed and offered into demand response programs.

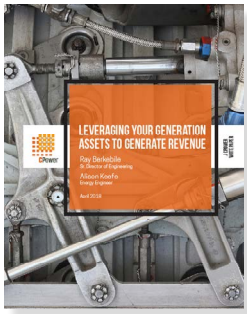
Generators

Often, the first item to examine is the data center's generator set. As we've discussed, data centers rely on generators to backup large loads.

What type of generator set does the data center have? Is it part of a scale model, whereby the generator backs up a certain portion of the data center's load? Or is the generator part of a hyperscale model in which multiple generators are connected by a bus that enables high-capacity loads to be delivered where and when needed.

One of the most important questions to answer concerning a data center's generator, is whether the generator is eligible for demand response. Depending on where a given data center resides, there are numerous regulations that determine if a generator can participate in a given DR program.

CPower is familiar with energy laws in all deregulated markets as well as those enforced at the national level by the Environmental Protection Agency and can determine if a generator is qualified to participate in DR or needs a few upgrades in order to participate.



Read to learn more: "Leveraging Your Generation Assets to Generate Revenue"

Energy Efficiency Projects

In this case, the discussion also includes identifying potential reductions in demand from energy efficiency projects that, depending on the energy market where the facility resides, may be verified and monetized.

Improving air flow has been a major initiative in the data center industry as organizations push to become more energy efficient. Has the data center implemented a hot aisle/cold aisle layout whereby the fronts of the server racks face each other, improving efficiency by reducing the mixing of hot and cold air? What about enclosing server racks to further reduce mixing cold air supply with hot exhaust air?

Beyond air flow management, let's examine other improvements the data center may have made to their HVAC systems. Interior humidity and high temperatures are a data center's natural enemy. For a long time, data center facility managers did everything but post an armed guard by their thermostats.

Recently, however, set-point recommendations have been updated, and data centers have made upgrades to their HVAC systems that may be eligible for monetization. Has the center retrofitted any equipment with a variable speed drive? What about an economizer?

Has the data center upgraded and/or consolidated the technology at any of its facilities?
For example, many data centers in recent years have virtualized their servers, reducing energy costs by 10-40% as a result of consolidating multiple, independent servers to a single more efficient server.

No one knows more about their data centers than the facility staff. That's why a good demand-side energy management team will spend a great deal of time listening to the facility team explain the intricacies of their buildings, collaboratively developing an optimized energy strategy..

When it comes to measuring and verifying reduced demand for monetization, it pays to be thorough and leave no stone unturned.

Toward Demand Response and Monetization

When it comes to devising curtailment scenarios, the facility staff knows better than anyone which loads and how much of each are absolutely necessary.

Curtailing load for demand response participation needn't be an all-or-nothing endeavor. The goal should be the create a curtailment plan that allows a facility to reduce load when called upon by the grid operator and still meet the needs of day-to-day business.

CPower's engineers have extensive experience working other data centers and meet with the facility's staff to determine if any of them are appropriate to explore.

Choosing the right set of demand response programs begins with assessing the customer's properties (described above), then selecting the optimal set of DR programs in which the customer will participate.

In this case, the customer's demand response participation breakdown for each of its properties might look like this:

TOTAL # PROPERTIES ENROLLED	MARKETS	TOTAL # DEMAND RESPONSE PROGRAMS ENROLLED IN
16 (several may participate in multiple programs)	5	10

REGION: NewYork

PROGRAM	# PROPERTIES ENROLLED	TYPE	DESCRIPTION	SEASON
Special Case Resources (SCR)	2	Capacity	NYISO DR Program	Summer Winter
Commercial System Relief (CSRP)	1	Capacity	Utility (ConEd) DR Program	Summer
Demand Side Ancillary Service Program (DSASP)	1	Ancillary Service	NYISO Offered Ancillary Service DR Program	Summer

REGION: New England

PROGRAM	# PROPERTIES ENROLLED	TYPE	DESCRIPTION	SEASON
Connected Solutions	1	Capacity	Utility (National Grid) DR Program	Summer
Price Responsive Demand	1	Capacity/ Economic	ISO-NE DR Program	Summer Winter

REGION: PJM (Pennsylvania-Jersey-Maryland Interconnection

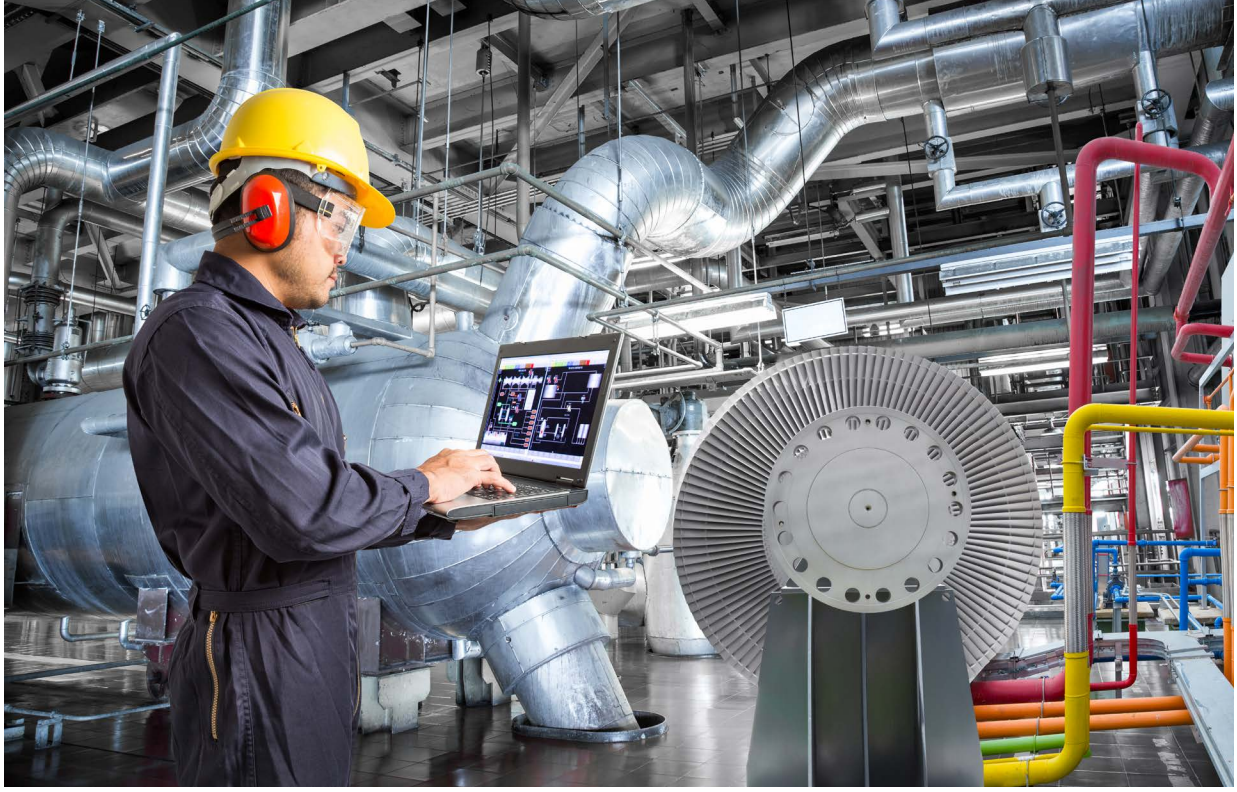
PROGRAM	# PROPERTIES ENROLLED	TYPE	DESCRIPTION	SEASON
Capacity Performance (CP)	4	Capacity	PJM DR Program	Summer Winter
Economic Load Response (ELR)	3	Economic	PJM DR Program	Summer
PA Act 129 Program	3	Capacity	Utility-Offered (First Energy, PECO) DR Program	Summer

REGION: Texas

PROGRAM	# PROPERTIES ENROLLED	TYPE	DESCRIPTION	SEASON
Load Resource (LR)	6	Ancillary Service	ERCOT DR Program	Summer

REGION: Ontario, Canada

PROGRAM	# PROPERTIES ENROLLED	TYPE	DESCRIPTION	SEASON
Demand Response Auction	4	Capacity	IESO DR Program	Summer



CURTAILMENT IN ACTION

Now that the customer's facilities have been assessed and programs have been selected, it's time to issue a curtailment plan.

Curtailment plans are easy-to-follow lists of action items to be executed at a specific facility in preparation for a demand response event. They outline a detailed procedure for reducing load at a given facility.

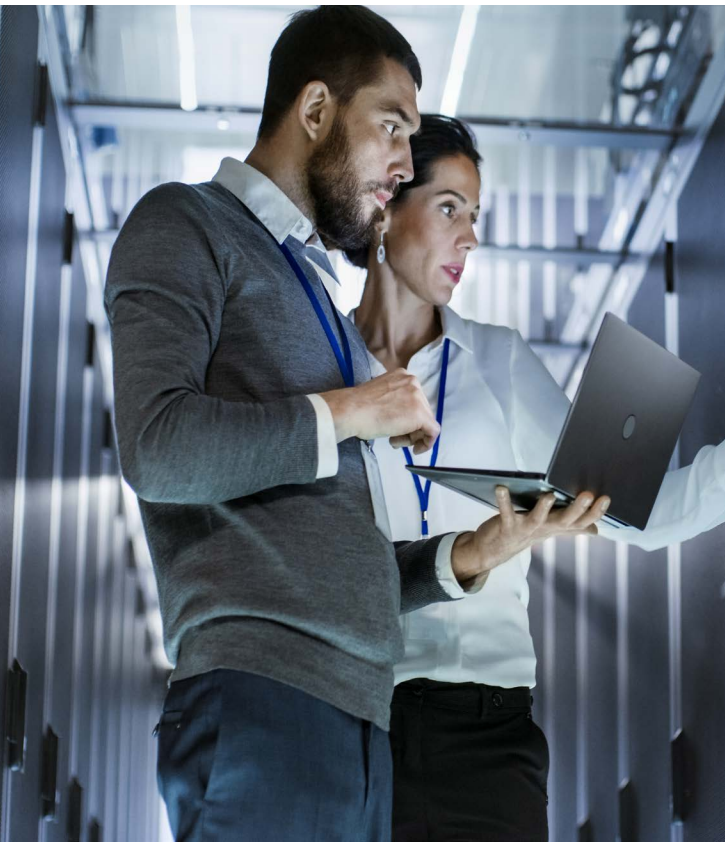
What follows is an abbreviated curtailment plan for one of the customer's fictitious facilities in Manhattan, New York.

PROPERTY: ACME Facilty
LOCATION: NewYork
PROGRAM: Special Case Resources (SCR)

The following actions should be taken at least 30 minutes prior to the start time of an event.

STEP #	EQUIPMENT INVOLVED	CURTAILMENT ACTION
1	Generator(s)	Activate the emergency generator(s) and transfer entire load (450-600kW)

VI. GETTING STARTED WITH DEMAND-SIDE MANAGEMENT



Organizations in the data center industry have a host of opportunities to monetize their existing energy assets through demand-side energy management.

Getting started involves selecting the right demand-side energy management company to guide you through and facilitate your participation.

When selecting a company to guide your demand-side energy management, it's important to consider the company's scope of demand-side expertise. Do they serve the markets where your properties reside? Does the company specialize in one type of demand-side energy management, or is it equally skilled in a wide range of energy asset monetization practices?

Most importantly, a demand-side energy management partner should earn your trust in every aspect of the relationship your organizations share.

Demand-side energy management is not a one-size-fits-all exercise. No two buildings are alike and every data center is unique in its complexities.

Like your business, your demand-side energy management strategy should evolve and refine over time, forever in pursuit of perfection as energy markets continue to change and your needs as an organization evolve.

ABOUT THE AUTHORS

DANIELLE BOND,
Senior Engineer

A Ph.D. in mechanical engineering, Danielle has more than 10 years of engineering experience in the energy industry, most recently with the acquisition and expansion one of the leading energy efficiency measurement and verification firms in the PJM market.

NATE SOLES,
CPower National Account Executive

In his near decade in the energy industry, Nate has helped guide the demand-side energy management of the most recognizable brands in the United States. He holds a bachelor's degree in mechanical engineering from Tufts University.

RAY BERKEBILE,
Sr. Director of Engineering

Ray has worked in the energy industry for more than 30 years. He pioneered CPower's approach to adapt to new generator regulations, personally reviewing over 3000 generators from 2015-2017 to ensure they complied and could be monetized with demand response. He holds a BSME from Widener University and is a member of the National Engineering Honor Society

CPower

***CPOWER** is a demand-side energy management company. We create optimized energy solutions that help organizations reduce energy costs, generate revenue, increase grid reliability, and help achieve sustainability goals.*

Learn more about CPower and its extensive experience tailoring its demand-side energy management solutions to the data center industry.

REFERENCES

Understanding and Designing Energy-Efficiency Programs for Data Centers; Energy Star.

Managed Application & Network Services: an industry profile; Dun & Bradstreet--February 5, 2018

Data Center IT Efficiency Measures; National Renewable Energy Laboratory. January, 2015

"Power, Pollution, and the Internet" James Glanz; The New York Times--Sept. 22, 2012

"Here's How Much Energy all US Data Centers Consume" Yevgeniy Sverdlik; Data Center Knowledge--June 27, 2016

Optimizing Corporate Energy Management: CHoosing an Integrated DER Vendor for C&I Customers---Brett Feldman, Roberto Labastida, Alex Eller; Navigant Research, Q2 2018

Effective Integration of Demand Response and Energy Efficiency in Commercial Buildings--Jon Starr, Jesus Preciado, and Wes Morgan; EnerNOC, INC. ACEEE Summer Study on Energy Efficiency in Buildings