FILE

PUCO EXHIBIT FILING

Date of Hearing: 1/15/2019

Case No. 18-501-EL-FOR, 18-1392-EL-RDR, 18-1393-EL-ATA

PUCO Case Caption: 2018 Long-Term Forecast Report of Ohio Power Company and Related Matters, Application of Ohio Power Company for Approval to Enter Into Renewable Energy Purchase Agreements for Inclusion in the Renewable Generation Rider and Application of Ohio Power Company for Approval to Amend its Tariffs.

List of exhibits being filed: Volume II

AEP 4

IGS/IGS Solar, LLC 1&2

OCC 1&2

IEU- 2,3,4,5,6,7

OMAEG- 1,2,3&4

PUCO

Reporter's Signature: Karen Sue Gibson

Date Submitted:

This is to certify that the images appearing are an accurate and complete reproduction of a case document delivered in the regular course of business.

Technician _____ Date Processed 1/31/19

RECEIVED-DOCKETING DIV
2019 JAN 31 PM 2:36

BEFORE THE PUBLIC UTILITIES COMMISSION OF OHIO

- - -

In the Matter of the 2018 Long-Term Forecast Report of Ohio Power Company and Related Matters.	:	Case No. 18-501-EL-FOR
In the Matter of the Application of Ohio Power Company for Approval to Enter Into Renewable Energy Purchase Agreements for Inclusion in the Renewable Generation Rider.	:	Case No. 18-1392-EL-RDR
In the Matter of the Application of Ohio Power Company for Approval to Amend its Tariffs.	:	Case No. 18-1393-EL-ATA

- - -

PROCEEDINGS

before Ms. Sarah Parrot and Ms. Greta See, Attorney Examiners, at the Public Utilities Commission of Ohio, 180 East Broad Street, Room 11-A, Columbus, Ohio, called at 9:00 a.m. on Wednesday, January 16, 2019.

- - -

VOLUME II

- - -

ARMSTRONG & OKEY, INC.
222 East Town Street, Second Floor
Columbus, Ohio 43215-5201
(614) 224-9481 - (800) 223-9481

- - -

OHIO POWER COMPANY'S SUPPLEMENTAL RESPONSE TO THE OFFICE OF THE OHIO CONSUMERS' COUNSEL'S DISCOVERY REQUEST
PUCO CASE NOS. 18-501-EL-FOR, 18-1392-EL-RDR AND 18-1393-EL-ATA FIRST SET

INTERROGATORY

OCC-INT-01-004 Referring to Mr. Allen's testimony at page 7, please identify the commercial and industrial customers who expressed a need for clean energy. Also identify any documents AEP Ohio has that relate to those customers' expressed need.

RESPONSE

Company witness Allen's testimony at page 7, line 17, lists major U.S. corporations with locations in Ohio that have made public announcements supporting the use of renewable energy. See OCC-INT-01-004 Attachment 1.

Prepared by: William A. Allen

SUPPLEMENTAL RESPONSE

Company witness Allen's testimony at page 7, line 17, lists major U.S. corporations with locations in Ohio that have made public announcements supporting the use of renewable energy. See OCC-INT-01-004 Supplemental Attachment 1.

Prepared by: William A. Allen

Q. ARE THERE NON-PRICE BENEFITS OF THE PROPOSED REPAs?

A. Yes. The Stipulation in the 14-1693 Case established certain preferences regarding the renewable energy projects. One preference was that the proposed solar projects that are substantially located in AEP Ohio's service territory in Appalachian Ohio. Both the Willowbrook and Highland solar facilities, as discussed by Company witness Karrasch, will be located in Highland county, which is part of that region.[4] While the Highland REPA reflects a higher, yet still competitive, price than the Willowbrook REPA, the incremental price difference is exceeded by the incremental economic benefit associated with the Highland solar project. The Highland REPA also includes an annual jobs commitment with pricing reductions to enforce the commitment throughout the term of the REPA. Company witness Williams further describes the jobs benefits to the state of Ohio.

Q. YOU STATE THERE IS AN EXPRESSED NEED BY CUSTOMERS FOR CLEAN, RENEWABLE ENERGY. PLEASE EXPLAIN THIS STATEMENT.

A. It is common to see announcements that major U.S. corporations are planning on powering their businesses, manufacturing plants, data centers, or other corporate locations with renewable energy. In Ohio alone, IKEA, Gap Inc., Nestlé, Schneider Electric, Campbell Soup Company, Whirlpool Corporation, United Technologies

[4] Appalachian Ohio means those Ohio counties identified by the Appalachian Regional Commission as being within the Appalachian Region of Ohio (https://www.arc.gov/counties): Adams, Ashtabula, Athens, Belmont, Brown, Carroll, Clermont, Columbiana, Coshocton, Gallia, Guernsey, Harrison, Highland, Hocking, Holmes, Jackson, Jefferson, Lawrence, Mahoning, Meigs, Monroe, Morgan, Muskingum, Noble, Perry, Pike, Ross, Scioto, Trumbull, Tuscarawas, Vinton, and Washington. AEP Ohio's service territory includes all Appalachian Ohio counties except Ashtabula, Trumbull, Mahoning and Clermont counties.

Corporation, Owens Corning, and others have made public announcements fully supporting renewable energy.

Q. HAVE AEP OHIO CUSTOMERS EXPRESSED THIS SAME DESIRE FOR RENEWABLE ENERGY?

A. Yes, as discussed in my direct testimony in the Amended LTFR case, the Company has validated, through research conducted by Navigant Consulting, that AEP Ohio customers consider it important to make greater use of renewable generation. The survey results and research clearly demonstrate that AEP Ohio customers have a need for renewable energy resources, even if there are additional costs in securing the clean energy. Notably, as supported in the testimony of Company witness Torpey, the proposed REPAs are expected to provide a cost savings to our customers. These factors taken together fully support a finding of need for these specific resources.

Q. HAS THE COMMISSION INDICATED THAT AN INCREASE IN RENEWABLE GENERATION IS BENEFICIAL TO THE STATE OF OHIO?

A. Yes. The Commission indicated in the 14-1693 Case that "renewable energy plays an integral role in promoting a reliable and cost-effective grid" and "enhance[s] the diversity of available generation options" to "offset the price volatility impact that any single fuel source may have on electric rates."[5] And although there is currently no federal regulation of carbon dioxide emissions from coal-fired power-plants, the Commission did recognize in the *ESP IV Order* that investment in renewable generation will afford the state flexibility in complying with any future environmental requirements, by providing

[5] 14-1693 Case, Opinion and Order at 82-83.

AWS & Sustainability

AWS is committed to running our business in the most environmentally friendly way possible

Home **Renewable Energy** **Timeline** **Videos & Photos**

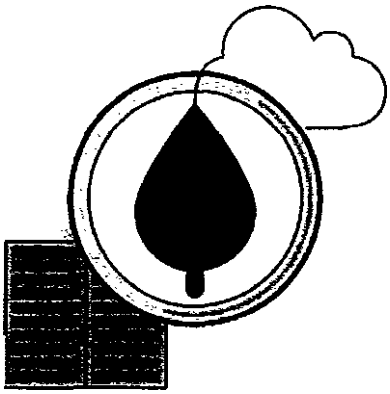
In addition to the environmental benefits inherently associated with running applications in the cloud, AWS has a long-term commitment to achieve 100% renewable energy usage for our global infrastructure footprint.

AEP 4

AWS exceeded our goal of 40% renewable energy by the end of 2016, and we have set a new goal to be powered by 50% renewable energy by the end of 2017.

ON-PREMISES VS. IN THE CLOUD

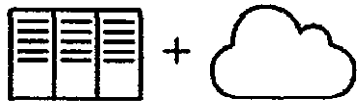
It's greener in the cloud



Any analysis on the climate impact of a data center should consider resource utilization and energy efficiency, in addition to power mix. Carbon emissions are a factor of three things: the number of servers running, the total energy required to power each server, and the carbon intensity of energy sources used to power these servers. A recent blog post by Jeff Barr outlines why using fewer servers and powering them more efficiently is at least as important to reducing the carbon impact of a company's data center as its power mix.

A typical large-scale cloud provider achieves approximately 65% server

This massive improvement in energy efficiency drives a huge reduction in climate impact because less energy consumed means fewer carbon emissions. The climate impact improvements get even better when you factor in that the average corporate data center has a dirtier power mix than the typical large-scale cloud provider. Large-scale cloud providers (AWS included) use a power mix that is 28% less carbon intense than the global average.[3]



	utilization rates versus 15% on-premises, which means when companies move to the cloud, they typically provision fewer than ¼ of the servers than they would on-premises.[1] In addition, a typical on-premises data center is 29% less efficient in their use of power compared to a typical large-scale cloud provider that uses world-class facility designs, cooling systems, and workload-optimized equipment.[2] Adding these together (fewer servers used plus more power efficient servers), customers only need 16% of the power as compared to on-premises infrastructure. This represents an 84% reduction in the amount of power required.	Combining the fraction of energy required with a less carbon-intense power mix, customers can end up with a reduction in carbon emissions of 88% by moving to the cloud and AWS. Read more here.

PROGRESS

Keeping up with our commitment to 100% renewable energy

We've made a lot of progress on this commitment. At the end of 2016, more than 40% of the power consumed by our global infrastructure came from renewable energy sources, and we set a goal to be powered by 50% renewable energy by the end of 2017.

Click on each logo to learn more about our renewable energy projects.

Amazon Solar Farm US East is an 80 megawatt solar farm in Accomack County, Virginia.

Amazon Solar Farm US East 2 is a 20 megawatt solar farm in Buckingham County, Virginia.

Amazon Solar Farm US East 3 is a 20 megawatt solar farm in New Kent County, Virginia.

Amazon Solar Farm US East 4 is a 20 megawatt solar farm in Sussex County, Virginia.

Amazon Solar Farm US East 5 is a 20 megawatt solar farm in Powhatan County, Virginia.

Amazon Solar Farm US East 6 is a 100 megawatt facility in Southampton County, Virginia.

Amazon Wind Farm Fowler Ridge is a 150 megawatt wind farm in Benton County, Indiana.

Amazon Wind Farm US East is a 208 megawatt wind farm in Perquimans and Pasquotank counties, North Carolina.

	Amazon Wind Farm US Central is a 100 megawatt wind farm in Paulding County, Ohio.	Amazon Wind Farm US Central 2 is a 189 megawatt wind farm in Hardin County, Ohio.	☐	☐

These ten renewable energy projects will deliver a total of 2.6 million MWh of energy annually onto the electric grid powering AWS data centers located in the AWS US East (Ohio) and AWS US East (N. Virginia) Regions. The electricity produced from these projects is enough to power the equivalent of over 240,000 U.S. homes annually, which is approximately the size of the city of Portland, Oregon.[5]

In addition to AWS' renewable energy progress, Amazon.com has also announced several renewable projects – please visit the Amazon Sustainability site for more details.

TIMELINE

AWS is always striving toward cleaner, renewable energy sources

NOVEMBER 2016

AWS announced five new solar farms across the Commonwealth of Virginia - these solar farms join the company's existing project, Amazon Solar Farm US East, which went into production in October 2016. Amazon worked with developers Virginia Solar LLC and Community Energy

OCTOBER 2016

AWS announced that it has engaged with EverPower to construct, own, and operate Amazon Wind Farm US Central 2. Read the press release here.

JUNE 2016

AWS and Dominion Virginia Power join forces on a landmark renewable energy delivery deal. With this, Dominion Virginia Power will manage and integrate the energy produced from various Amazon wind and solar farm projects onto the grid that serves AWS datacenters. Read

Solar on the projects, and will further collaborate with an affiliate of Dominion Resources, Inc. to own and operate the solar farms. Read the press release here.

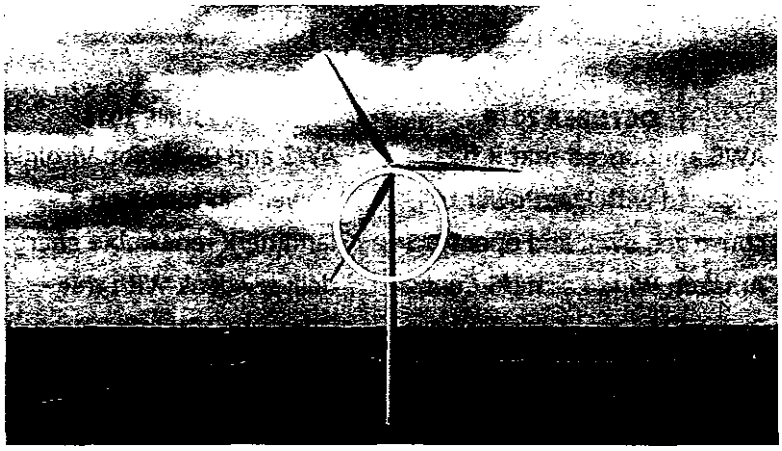
the Rocky Mountain Institute blog here for more details.

VIEW TIMELINE

VIDEOS & PHOTOS

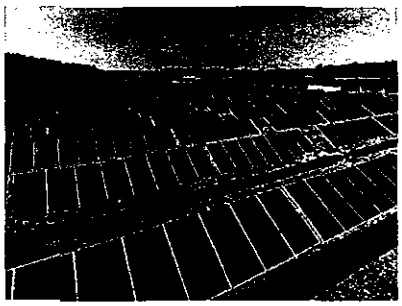
Learn more about how AWS is working to achieve its goal of 100% renewable energy usage for our global infrastructure footprint

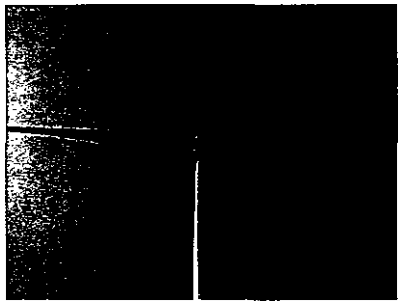
Amazon Wind Farm US Central



Amazon Wind Farm Fowler Ridge

Amazon Solar Farms US East





Visit the gallery to view more photos from our projects

View Gallery

REGIONS

Carbon-neutral options

AWS opened its first carbon-neutral region in 2011 and now offers five separate carbon-neutral regions for customers to utilize.

US WEST
(Oregon)

EUROPEAN UNION
(Frankfurt)

EUROPEAN UNION
(Ireland)

AWS GOVCLOUD
(United States)

MONTREAL
(Canada)

SUSTAINABILITY AT AMAZON

In addition to the sustainability initiatives focused on powering the AWS global infrastructure, Amazon is pursuing sustainability across the company.

For more information, please visit Sustainability at Amazon.

[1] *Source: NRDC 2014 "Data Center Efficiency Assessment" report*

[2] *Source: Power Usage Effectiveness (PUE) of on-premises data centers from 2014 Uptime Institute study and PUE of cloud data centers from Google and Facebook public disclosures plus AWS internal data, all of which show PUEs under 1.2*

[3] *Source: AWS average power mix carbon intensity of 393 grams/kWh for June 2015 and 2014 Global Energy Mix data from the International Energy Agency for on-premises assumptions*

[4] *In 2015, the average annual electricity consumption for a U.S. residential utility customer was 10,812 kilowatt hours (kWh), an average of 901 kWh per month*

[5] *Source: Dividing the population of Portland, Oregon (632,309 in 2015) by the average number of persons per household between 2010-2014 (2.63 according to the US Census), you get 240,421 homes.*

DevOps

Serverless Computing ☐ ☐

Big Data

High Performance Computing

Mobile Services

Digital Marketing

Game Development

Digital Media

Government & Education

Health

Financial Services

Windows on AWS

Retail

Power & Utilities

Automotive

Blockchain

Resources & Training

Developers

Java on AWS

JavaScript on AWS

Mobile on AWS

PHP on AWS

Python on AWS

Ruby on AWS

.NET on AWS

SDKs & Tools

AWS Marketplace

User Groups

Support Plans

Service Health Dashboard

Discussion Forums

FAQs

Documentation

Articles & Tutorials

Test Drives

AWS Business Builder

Manage Your Account

Management Console

Billing & Cost Management

Subscribe to Updates

Personal Information
Payment Method

AWS Identity & Access Management
Security Credentials
Request Service Limit Increases
Contact Us

Amazon Web Services is Hiring.

Amazon Web Services (AWS) is a dynamic, growing business unit within Amazon.com. We are currently hiring Software Development Engineers, Product Managers, Account Managers, Solutions Architects, Support Engineers, System Engineers, Designers and more. Visit our careers page to learn more.

Amazon.com is an Equal Opportunity-Affirmative Action Employer – Minority / Female / Disability / Veteran / Gender Identity / Sexual Orientation.

MAY 17, 2017 | **PRESS RELEASE**

CAMPBELL ANNOUNCES NEW 4.4-MEGAWATT SOLAR ARRAY AT ITS WORLD HEADQUARTERS

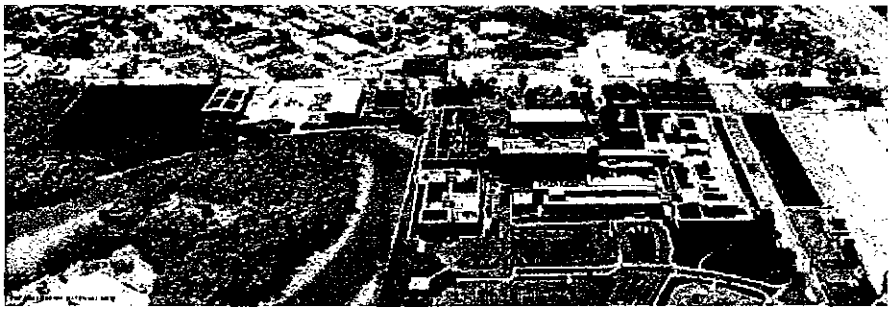
Carport, Roof and Ground-Mount Arrays Expected to Generate the Equivalent of 20 Percent of Campus's Electricity Demand

Upon Completion, System Will Become Largest Solar Array in City of Camden, N.J.

CAMDEN, N.J.–(BUSINESS WIRE)–May 17, 2017–
Campbell Soup Company (NYSE:CPB), in partnership with BNB Renewable Energy Holdings (BNB), SunPower Corp. (NASDAQ:SPWR), and ORIX USA Corp. (TSE: 8591; NYSE: IX), broke ground today on a 4.4-megawatt (MW) solar power project at the company's World Headquarters in Camden, N.J. Scheduled to come online in fall 2017, the system will provide energy to Campbell through a 20-year power purchase agreement (PPA) and generate more than 5 million kilowatt hours of electricity per year. Upon completion, the solar array will become the largest in the city of Camden.

This Smart News Release features multimedia. View the full release here:
(http://www.businesswire.com/news/home/20170517005861/en/)
http://www.businesswire.com/news/home/20170517005861/en/
(http://www.businesswire.com/news/home/20170517005861/en/)

The project, developed by BNB, will feature SunPower's innovative rooftop, carport and



Campbell Soup Company announces new 4.4-megawatt solar array at its World Headquarters in Camden, N.J. (Photo: Business Wire)

ground-mount solar solutions, which are designed to optimize power production for commercial customers like Campbell.

At Campbell's 38-acre World Headquarters campus, 2.7MW will be installed on the rooftops of existing structures and on new solar canopies that will be erected in the parking lots. An additional 1.7MW will be installed on an adjacent 4.5-acre remediated brownfield that BNB purchased specifically for the project, making use of otherwise unusable land and increasing the capacity of the system.

Under the 20-year PPA, Campbell will buy electricity generated by the solar project at a predetermined rate. The fixed PPA rate, which is currently lower than the cost of traditional electricity for Campbell, provides the company with long-term visibility for this portion of its electricity costs.

The system in Camden will be the third solar project that BNB has developed for Campbell, following the 9.8MW system at Campbell's facility in Napoleon, Ohio, and the 1MW system at Campbell's Pepperidge Farm bakery in Bloomfield, Conn. Both of those projects also use SunPower's high-efficiency solar panels.

"We're excited to partner once again with BNB and SunPower to add a third solar array to Campbell's U.S. footprint," said Jim Prunesti, Vice President, Global Engineering, Campbell. "This project contributes clean energy to the local grid and demonstrates to our community the viability of renewable energy sources, all while supporting Campbell's sustainability strategy to deliver long-term value to our business and neighborhoods."

BNB and ORIX USA, a diversified financial company with a strong commitment to renewables, will jointly own the project. The term debt is being financed through PSE&G's Solar Loan Program.

"Bringing a cost-saving solar system to Campbell's World Headquarters marks a great moment, and we see a bright future for other Fortune 500 companies who follow Campbell's lead and turn to renewable energy to stabilize energy costs and reap rewards from the sun," said Matthew Baird, managing partner of BNB. "We are most proud of our collaborative

work with Campbell, SunPower, ORIX, and PSE&G to make this project a reality."

The project will also feature five electric vehicle-charging stations, provided by PSE&G via its EV Workplace Charging Program, for use by Campbell employees.

"It's an honor that Campbell and BNB have chosen SunPower once again as a solar partner for this project," said Nam Nguyen, SunPower executive vice president. "We look forward to delivering the highest quality experience through our innovative solutions."

About Campbell Soup Company

Campbell (NYSE:CPB) is driven and inspired by its Purpose, "Real food that matters for life's moments." The company makes a range of high-quality soups and simple meals, beverages, snacks and packaged fresh foods. For generations, people have trusted Campbell to provide authentic, flavorful and readily available foods and beverages that connect them to each other, to warm memories and to what's important today. Led by the iconic Campbell's brand, its portfolio includes *Pepperidge Farm, Bolthouse Farms, Arnott's, V8, Swanson, Pace, Prego, Plum, Royal* and *Dansk, Kjeldsens Garden Fresh Gourmet*. Founded in 1869, Campbell has a heritage of giving back and acting as a good steward of the planet's natural resources. The company is a member of the Standard & Poor's 500 and the Dow Jones Sustainability Indexes. For more information, visit www.campbellsoupcompany.com (http://cts.businesswire.com/ct/CT?id=smartlink&url=http%3A%2F%2Fwww.campbellsoupcompany.com&esheet=51561019&newsitemid=20170517005861&lan=en-US&anchor=www.campbellsoupcompany.com&index=1&md5=e954de55e4bce0e511678c89be355ed8) or follow company news on Twitter via @CampbellSoupCo (http://cts.businesswire.com/ct/CT?id=smartlink&url=https%3A%2F%2Ftwitter.com%2FCampbellSoupCo&esheet=51561019&newsitemid=20170517005861&lan=en-US&anchor=%40CampbellSoupCo&index=2&md5=d3b2dcc6515bd551434517a871f175bf) . To learn more about how we make our food and the choices behind the ingredients we use, visit www.whatsinmyfood.com (http://cts.businesswire.com/ct/CT?id=smartlink&url=http%3A%2F%2Fwww.whatsinmyfood.com&esheet=51561019&newsitemid=20170517005861&lan=en-US&anchor=www.whatsinmyfood.com&index=3&md5=8044bf0c0a57871779d1ab55b7f74177) .

About BNB

Founded in 2004, BNB Renewable Energy Holdings has developed and constructed more than 600MW of wind and solar projects in North America in the last 10 years, having arranged equity and debt financings in excess of a billion dollars. With offices in New York, Pennsylvania, and Texas, BNB has a three-year project pipeline in excess of 1,500MW in North and South America, comprising both distributed-generation and utility-scale renewable projects. For more information, visit www.bnbrenewables.com (http://cts.businesswire.com/ct/CT?id=smartlink&url=http%3A%2F%2Fwww.bnbrenewables.com&esheet=51561019&newsitemid=20170517005861&lan=en-US&anchor=www.bnbrenewables.com&index=4&md5=8260b58c87f637de6cee99715c3e6457) .

About SunPower

With more than 30 years of proven experience, SunPower is a global leader in solar innovation and sustainability. Our unique approach emphasizes the seamless integration of advanced SunPower technologies, delivering *The Power of One*® complete solar solutions and lasting customer value. SunPower provides outstanding service and impressive electricity cost savings for residential, commercial and power plant customers. At SunPower, we are passionately committed to changing the way our world is powered. And as we continue shaping the future of Smart Energy, we are guided by our legacy of innovation, optimism, perseverance and integrity. Headquartered in Silicon Valley, SunPower has dedicated, customer-focused employees in Africa, Asia, Australia, Europe, North America and South America. Since 2011, we've been majority-owned by Total, the fourth largest publicly-listed energy company in the world. For more information, visit www.sunpower.com (http://cts.businesswire.com/ct/CT?id=smartlink&url=http%3A%2F%2Fwww.sunpower.com%2F&esheet=51561019&newsitemid=20170517005861&lan=en-US&anchor=www.sunpower.com&index=5&md5=be7dea98e5e4a59b781d10437ddb0363)
.

About ORIX USA Corporation

Since 1981, ORIX USA has provided innovative capital solutions that clients need to propel their business to the next level. Based in Dallas, ORIX USA has a team of more than 700 employees spanning nearly 20 offices across the U.S. and Brazil. ORIX USA and its family of companies offer investment capital and asset management services to clients in the corporate, real estate, municipal and energy sectors, while holding $6 billion of assets and managing an additional $29 billion, approximately. Its parent company, ORIX Corporation, is a Tokyo-based, publicly owned international financial services company with operations in 37 countries and regions worldwide. ORIX Corporation is listed on the Tokyo (8591) and New York Stock Exchanges (IX). For more information on ORIX USA, visit www.orix.com (http://cts.businesswire.com/ct/CT?

id=smartlink&url=http%3A%2F%
2Fwww.orix.com&esheet=51561019&newsitemid=20170517005861&lan=en-
US&anchor=www.orix.com&index=6&md5=f0aeb4b1145e21780d34b7c2d1d74c31) .

About PSE&G

Public Service Electric and Gas Company (PSE&G) is New Jersey's oldest and largest regulated gas and electric delivery utility, serving nearly three-quarters of the state's population. PSE&G is the winner of the ReliabilityOne Award for superior electric system reliability. PSE&G is a subsidiary of Public Service Enterprise Group Incorporated (PSEG) (NYSE:PEG), a diversified energy company. For more information, visit www.pseg.com (http://cts.businesswire.com/ct/CT?id=smartlink&url=http%3A%2F%
2Fwww.pseg.com&esheet=51561019&newsitemid=20170517005861&lan=en-
US&anchor=www.pseg.com&index=7&md5=c923d4b316431a8ca7a5e0fa67d95371)
or visit PSEG
on Facebook (http://cts.businesswire.com/ct/CT?id=smartlink&url=https%3A%2F%
2Fwww.facebook.com%
2FPSEG&esheet=51561019&newsitemid=20170517005861&lan=en-
US&anchor=PSEG+on+Facebook&index=8&md5=c0f554661acb713bc8a1acff7d1d762c) ;
PSEG
on Twitter (http://cts.businesswire.com/ct/CT?id=smartlink&url=https%3A%2F%
2Ftwitter.com%2FPSEGNews&esheet=51561019&newsitemid=20170517005861&lan=en-
US&anchor=PSEG+on+Twitter&index=9&md5=8556c49f3270c99f69a882c8cb370850) ;
PSEG
on LinkedIn (http://cts.businesswire.com/ct/CT?id=smartlink&url=https%3A%2F%
2Fwww.linkedin.com%2Fcompany%
2Fpseg&esheet=51561019&newsitemid=20170517005861&lan=en-
US&anchor=PSEG+on+LinkedIn&index=10&md5=eba4d5d75719259b2911a543afb57cea)
; or PSEG's
blog, Energize! (http://cts.businesswire.com/ct/CT?id=smartlink&url=http%3A%2F%
2Fenergizepseg.com%2F&esheet=51561019&newsitemid=20170517005861&lan=en-
US&anchor=PSEG%27s+blog%2C+Energize%
21&index=11&md5=0ab4a266c1e73767e4b55b0c160d0194)

SunPower Forward-Looking Statements

This press release contains "forward-looking statements" within the meaning of the Private Securities Litigation Reform Act of 1995, including, but not limited to, statements regarding project timelines, future projects, projected energy output, and cost savings. These forward-looking statements are based on our current assumptions, expectations, and beliefs and involve substantial risks and uncertainties that may cause results, performance, or achievement to materially differ from those expressed or implied by these forward-looking statements. Factors that could cause or contribute to such differences include, but are not limited to: regulatory changes and

the availability of economic incentives promoting use of solar energy, challenges inherent in constructing and maintaining certain of our large projects, and fluctuations or declines in the performance of our solar panels and other products and solutions. A detailed discussion of these factors and other risks that affect our business is included in filings we make with the Securities and Exchange Commission (SEC) from time to time, including our most recent reports on Form 10-K and Form 10-Q, particularly under the heading "Risk Factors." Copies of these filings are available online from the SEC or on the SEC Filings section of our Investor Relations website at investors.sunpowercorp.com. All forward-looking statements in this press release are based on information currently available to us, and we assume no obligation to update these forward-looking statements in light of new information or future events.

View source version on businesswire.com:
http://www.businesswire.com/news/home/20170517005861/en/
(http://www.businesswire.com/news/home/20170517005861/en/)

Source: Campbell Soup Company

Campbell Soup Company
Thomas Hushen, 856-342-5227
Thomas_hushen@campbellsoup.com (mailto:Thomas_hushen@campbellsoup.com)
or
BNB
Renewable Energy
Brandon Wall, 212-366-4330
bwall@bnbrenewables.com (mailto:bwall@bnbrenewables.com)
or
SunPower
Amy
Smith, 408-457-2718
amy.smith@sunpower.com (mailto:amy.smith@sunpower.com)
or
ORIX
USA Corporation
Jeff Smith, 214-237-2301
Jeff.smith@orix.com (mailto:Jeff.smith@orix.com)

PRESS RELEASE ARCHIVE

2018 (23) (#)

2017 (42) (#)

2016 (35) (#)

2015 (36) (#)

2014 (41) (#)

2013 (57) (#)

2012 (68) (#)

2011 (78) (#)

2010 (92) (#)

2009 (94) (#)

2008 (88) (#)

2007 (34) (#)

2006 (26) (#)

2005 (28) (#)

2004 (27) (#)

2003 (41) (#)

2002 (41) (#)

2001 (39) (#)

2000 (13) (#)

QUICK LINKS

Corporate Fact Sheet

Download PDF (/wp-content/uploads/sites/31/2016/11/CSC_Corporate_Fact_Sheets_October_2016_FINAL.pdf)

Media Contact (http://www.campbellsoupcompany.com/newsroom/media-contact/)

Media Library (http://www.campbellsoupcompany.com/newsroom/media-library/)

RSS FEED

Subscribe to RSS (/pressrelease/feed/)

@CAMPBELLSOUPCO
(https://twitter.com/campbellsoupco)

EXPLORE CAMPBELLSOUPCOMPANY.COM

ABOUT US (HTTPS://WWW.CAMPBELLSOUPCOMPANY.COM/ABOUT-CAMPBELL/)

Campbell Soup Company (https://www.campbellsoupcompany.com/about-campbell/)

Leadership Team (https://www.campbellsoupcompany.com/about-campbell/executive-team/)

Our Businesses (https://www.campbellsoupcompany.com/about-campbell/our-businesses/)

Corporate Governance (http://investor.campbellsoupcompany.com/phoenix.zhtml?c=88650&p=irol-govhighlights)

Corporate Responsibility (https://www.campbellsoupcompany.com/about-campbell/corporate-responsibility/)

Campbell Soup Foundation (https://www.campbellsoupcompany.com/about-campbell/corporate-responsibility/campbell-soup-foundation/)

OUR BRANDS (HTTPS://WWW.CAMPBELLSOUPCOMPANY.COM/CAMPBELL-BRANDS/)

INVESTOR CENTER (HTTPS://WWW.CAMPBELLSOUPCOMPANY.COM/INVESTOR-CENTER/)

Investor Overview (https://www.campbellsoupcompany.com/investor-center/)

At a Glance (http://investor.campbellsoupcompany.com/phoenix.zhtml?c=88650&p=irol-irhome)

Stock Information (http://investor.campbellsoupcompany.com/phoenix.zhtml?c=88650&p=irol-stockquotechart)

News & Events (http://investor.campbellsoupcompany.com/phoenix.zhtml?c=88650&p=irol-news&nyo=0)

Financial Information (http://investor.campbellsoupcompany.com/phoenix.zhtml?c=88650&p=irol-sec)

Shareholder Services (http://investor.campbellsoupcompany.com/phoenix.zhtml?c=88650&p=irol-stockpurchase)

Investor Contacts (http://investor.campbellsoupcompany.com/phoenix.zhtml?c=88650&p=irol-contact)

Analyst Coverage (http://investor.campbellsoupcompany.com/phoenix.zhtml?c=88650&p=irol-analysts)

Corporate Governance (http://investor.campbellsoupcompany.com/phoenix.zhtml?c=88650&p=irol-govhighlights)

NEWSROOM (HTTPS://WWW.CAMPBELLSOUPCOMPANY.COM/NEWSROOM/)

Campbell News (https://www.campbellsoupcompany.com/newsroom/)

Press Releases (/newsroom/press-releases)

Media Contact (https://www.campbellsoupcompany.com/newsroom/media-contact/)

Media Library (https://www.campbellsoupcompany.com/newsroom/media-library/)

CONNECT WITH CAMPBELL (HTTPS://WWW.CAMPBELLSOUPCOMPANY.COM/CONNECT-WITH-CAMPBELL/)

Connect With Campbell (https://www.campbellsoupcompany.com/connect-with-campbell/)

FAQ (https://www.campbellsoupcompany.com/connect-with-campbell/faq/)

Product Locator (https://www.campbells.com/where-to-buy/)

International Inquiries (https://www.campbellsoupcompany.com/connect-with-campbell/international-inquiries/)

Directions to World Headquarters (https://www.campbellsoupcompany.com/connect-with-campbell/directions-to-world-headquarters/)

CONNECT

(https://www.campbellsoupcompany.com/connect-with-campbell/email/) (https://twitter.com/CampbellSoupCo) (https://plus.google.com/108251731233633210531/posts) (https://www.linkedin.com/company/campbell-soup-company)

OUR OTHER SITES

Nutrition & Wellness (http://www.campbellnutrition.com/)

Recipes (http://www.campbellskitchen.com/)

Campbell Shop (http://www.campbellshop.com/)

Careers (http://careers.campbellsoupcompany.com/)

Innovation (http://www.campbellideas.com/)

CSR (http://www.campbellcsr.com/)

https://www.gm.com/mol/GM-renewable-energy-by-2018.html

20% of GM's global electricity use will be powered by renewable energy

As part of an ongoing commitment to operate with clean energy, General Motors is buying a total of 200 megawatts of wind energy from Ohio and Illinois wind farms. Once the turbines come online by the end of 2018, renewable energy will power 20 percent of GM's global electricity use.

As part of an ongoing commitment to operate with clean energy, General Motors is buying a total of 200 megawatts of wind energy from Ohio and Illinois wind farms.

All of GM's Ohio and Indiana manufacturing facilities will meet their electricity needs with 100 percent renewable energy by the end of 2018.

General Motors plans to generate or source all electrical power for its 350 operations in 59 countries with 100 percent renewable energy by 2050.

- 1
- 2
- 3

As part of an ongoing commitment to operate with clean energy, General Motors is buying a total of 200 megawatts of wind energy from Ohio and Illinois wind farms. Once the turbines come online by the end of 2018, renewable energy will power 20 percent of GM's global electricity use.

This operation will allow GM to build more vehicles with wind energy. Additionally, all of GM's Ohio and Indiana manufacturing facilities will meet their electricity needs through 100 percent renewable energy. These include those that build the Chevrolet Cruze and Silverado and GMC Sierra light-duty pickup trucks.

"Congratulations to GM on this huge progress leap – a fantastic show of commitment at Climate Week NYC, and all achieved in just a year since the company joined RE100," said Helen Clarkson, CEO, The Climate Group. "GM vocally champions the compelling business case for

renewables and shares learnings with other companies. It shows other companies what's possible."

The new wind deals are enough to meet the electricity needs of Fort Wayne Assembly, Marion Metal Center and Bedford Casting plants in Indiana and Lordstown Assembly, Defiance Casting Operations, Parma Metal Center and Toledo Transmission plants in Ohio.

"Technology is driving solutions for mobility and safety in our vehicles, as well as the new energy solutions that build them," said Gerald Johnson, GMNA vice president of Manufacturing and Labor. "This is the way we do business: offering vehicles that serve our customers' lifestyle needs, while providing sustainable solutions that improve our communities."

GM is leveraging energy efficiency and a mix of onsite and offsite renewable energy solutions to reach its 100 percent renewable energy goal by 2050. The company's four-part strategy acknowledges how its energy and product strategies intersect. As GM works toward advancing zero emissions vehicles, it makes business sense to create a cleaner grid on which to drive them. The company uses EV batteries in tandem with a solar array to power an office building at its Milford Proving Ground in Michigan and is researching the use of fuel cells as energy storage in the future.

"We're helping provide solutions to green the grid through these new renewable energy deals and sharing best practices with other companies so they too can reduce risk and energy costs," said Rob Threlkeld, GM global manager of renewable energy. "With a pragmatic strategy, companies can turn ambitious renewable energy goals into action and scale quickly."

Altenex, an Edison Energy Company and independent renewable energy advisor, supported GM in the negotiation of the power purchase contracts. GM will be the sole user of the Northwest Ohio Wind farm, a 100 MW project owned by Starwood Energy Group. Swift Current Energy will provide 100 MW from its HillTopper Wind Project in Logan County, Illinois.

GM has used renewable energy for decades, saving about $5 million annually as a result. Renewable energy use supports a resilient grid, while offering more stable energy pricing. GM made its first wind purchase in 2014 for several of its Mexico operations, followed by deals supporting Texas wind farms for 30 and 50 megawatts of energy. The company uses solar power at 26 facilities and generates electricity from landfill gas at two assembly plants.

For more information, visit GM's sustainability report or environmental blog.

Back to Sustainability

PRESS RELEASE

Brands: Gap Inc. **Categories:** Social Responsibility

01/21/2016

GAP INC. SETS AMBITIOUS NEW CLIMATE GOAL TO FOSTER CLEANER GLOBAL BUSINESS AND DEEPENS EFFORTS TO HELP PROTECT HUMAN RIGHTS ACROSS GLOBAL SUPPLY CHAIN

With release of the company's most recent global sustainability report, Gap Inc. commits to reducing absolute greenhouse gas (GHG) emissions across all global owned and operated facilities by 50 percent from 2015 levels by the end of 2020

SAN FRANCISCO – January 21, 2016 – As a strategic investment to foster cleaner global business, Gap Inc. (NYSE: GPS) today announced an ambitious new goal to reduce absolute greenhouse gas (GHG) emissions across all owned and operated facilities globally by 50 percent from 2015 levels by the end of 2020. With this new emissions target, Gap Inc. joins the international effort to tackle climate change, building upon the momentum of the landmark Paris Agreement reached last month by the 2015 United Nations climate change summit, COP 21.

Gap Inc.'s new climate goal was announced as part of the company's most recent Global Sustainability report, "Our Futures are Woven Together," which outlines the company's steadfast commitment to protect human rights and improve working conditions in garment factories across the company's supply chain; to advocate for greater equality and opportunity across its global enterprise; and to change the lives of one million women through P.A.C.E., its award-winning women's life skills education program by 2020.

Recognizing Gap Inc.'s commitment to equality, inclusion and diversity, the leading nonprofit Catalyst announced today that Gap Inc. would be presented with the prestigious 2016 Catalyst Award at their annual awards dinner on March 16.

CEO Art Peck opens the new report, reflecting on the social and environmental challenges collectively faced by Gap Inc. and the people touched by its business, as well as on the opportunities and promise that lie ahead. "Change is not just possible, but imperative – our futures are tied together and we can't afford not to act," Peck writes.

"At Gap Inc., we believe that environmental issues are fundamentally human rights issues. We also believe that creating a more sustainable environment is critical to our company's business success," said Melissa Fifield, Senior Director of Sustainable Innovation at Gap Inc. "As we look to integrate our sustainability efforts more deeply into our business strategies and policies, we recognize the potential to create tremendous positive change for the people touched by our business while unlocking new possibilities to grow our global enterprise. We recognize that much work lies ahead of us, but we remain steadfast in our commitment to help ensure the safety and well-being of the people who make our clothes, to advocate for greater equality, and to foster more sustainable communities in the places we live and work."

Gap Inc. has set its new emissions goal after having achieved its previous goal, which called for reducing absolute greenhouse gas emissions across U.S. operations from a 2008 baseline by 20 percent by the end of 2015; the company is reporting today a total of approximately 37 percent emissions reduction during the 2008-2015 timeframe. Gap Inc. today also announced a companion waste goal for its U.S. facilities to divert 80 percent of waste from landfill by the end of 2020.

"With our new environmental goals, we are stepping up to join the unprecedented global effort to tackle climate change and create a healthier, low-carbon future. As a global fashion company, we rely on the same vital resources that are critical to the health of the communities that support our business. We recognize that embedding our new emissions and waste goals into our company's priorities and practices is not only the right thing to do, it will allow us to further drive innovation and cost savings across our business," said Shawn Curran, Executive Vice President of Global Logistics at Gap Inc. and Executive Sponsor of Gap Inc.'s Environmental Council.

The new report details the company's most recent sustainability initiatives, and covers data from fiscal years 2013-2014. Gap Inc. was one of the first apparel companies to issue a comprehensive social responsibility report in 2003, and the company continues to re-examine the progression of this work as it learns more about the root causes of the challenges across the global value chain and strives to identify, test and implement solutions that can help achieve even greater positive impacts.

Report highlights include:

Environment

- Setting a goal to reduce absolute greenhouse gas emissions in our owned and operated facilities globally by 50 percent by the end of 2020
- Committing to a goal of 80 percent waste diversion from landfill across our U.S. owned and operated facilities by the end of 2020
- Working towards phasing out the use of hazardous chemicals in the making of our products by 2020, as a founding member of the Zero Discharge of Hazardous Chemicals group
- Partnering with fabric mills to fight pollution and conserve water through our partnership with the Natural Resources Defense Council and the Sustainable Apparel Coalition
- Providing access to clean water for 17,000 people in India through our new Women + Water program

Working Conditions

- Consistently visiting the factories that make our clothes, about 1,000 factories each year, to assess and improve working conditions for garment workers
- Expanding Gap Inc.'s P.A.C.E. (Personal Advancement & Career Enhancement) program, our signature, award-winning life skills education program, to more factories and communities to give one million women worldwide by 2020 the opportunity to gain the skills and confidence to change their lives
- Improving the lives of the people who make our clothes and forging industry-wide change through innovative partnerships with leading organizations focused on improving workplace conditions and labor standards, such as Better Work and Verité

Equality and Opportunity

- Establishing Gap Inc. as the first Fortune 500 Company to disclose that we pay our female and male employees equally for equal work across our global organization
- Announcing plans in 2014 to raise the hourly minimum wage to $10 for more than 60,000 U.S. employees in 2015, making Gap Inc. one of the first U.S. retailers to make this investment in our frontline talent
- Gap Inc. employees volunteered more than one million hours over 2013 and 2014; this new record was set with the support of more than 2,000 Community Leaders across the world, who lead a wide range of volunteering projects for their teams
- Creating opportunities for more than 2,000 youth and young adults since 2006, by providing job training and store internships through our This Way Ahead program; our investments in nonprofit organizations have reached 270,000+ teens and young adults in the past three years
- Standing up as a voice for marriage, racial and gender equality; in 2015, women made up more than 70 percent of our senior leadership, and we sponsored six employee resource groups to promote diversity and inclusion
- Signing the Women's Empowerment Principles, developed by UN Women and United Nations Global Compact to advance gender equality; one of the first acts by Art Peck as chief executive officer in February 2015
- Receiving the 2016 Catalyst Award, a leading nonprofit organization with a mission to expand opportunities for women and business; Gap Inc. is being recognized for its commitment to equality, inclusion and diversity

To learn more, please visit gapinc.com/sustainability, where you can also download a copy of the report.

About Gap Inc.

Gap Inc. is a leading global retailer offering clothing, accessories, and personal care products for men, women, and children under the Gap, Banana Republic, Old Navy, Athleta, and Intermix brands. Fiscal year 2014 net sales were $16.4 billion. Gap Inc. products are available for purchase in more than 90 countries worldwide through about 3,300 company-operated stores, over 400 franchise stores, and e-commerce sites. For more information, please visit www.gapinc.com.

Back

Resources
Customer Bill of Rights
Franchise Information
Gap Inc. Policies
Factory List

Careers
Behind the Scenes
Apply for a Job

Keep In Touch
Contact Us
Email Alerts
aDressed Blog

Contact Us Terms of Use Privacy Policy

Ikea powering Columbus store with 3,546 solar panels on its roof

Mar 29, 2017, 12:11pm EDT

Ikea doesn't have an open date for its upcoming Columbus store but it does have solar power.

The Swedish home furnishings retailer has completed a 213,000-square-foot solar array on the roof of its Columbus store off Polaris Parkway.

The 3,546-panel system will produce an estimated 1.4 million kilowatt-hours of electricity a year, equivalent to reducing 1,017 tons of carbon dioxide. According to the U.S. EPA's greenhouse gas equivalencies calculator, that is equal to emissions from 215 cars or electricity for 150 homes a year.

IKEA

Ikea installed a 213,000-square-foot solar array on the roof of its Columbus store off Polaris Parkway.

California-based REC Solar designed and installed the system. Chicago-based Pepper Construction Co., which has offices in Dublin, is building the store.

Ikea still says the 354,000-square-foot store will open this summer, but has not yet set an opening date.

It's the company's 46th solar project in the U.S. It has arrays on the roofs of nearly 90 percent of its U.S. stores.

Ikea has allocated $2.5 billion for renewable energy worldwide through 2020 with the goal of energy independence. It has installed more than 700,000 solar panels and owns 300 wind turbines including 104 in the U.S.

Dan Eaton
Staff reporter
Columbus Business First

IKEA IKEA USA
News from IKEA

IKEA COMPLETES ONE OF OHIO'S LARGEST ROOFTOP SOLAR ARRAYS ON FUTURE IKEA COLUMBUS, OPENING SUMMER 2017 AS 2ND IN THE STATE

03/28/2017 6:00 AM | Sustainability News

[National]

COLUMBUS, OH - IKEA, the world's leading home furnishings retailer, today announced that the solar panel installation is complete atop its future Columbus store opening Summer 2017. The array is one of the largest solar rooftops in Ohio, just as is the Cincinnati-area one.

The Columbus store's 213,000-square-foot solar array will consist of a 1.21 MW system, built with 3,546 panels, and will produce approximately 1,447,700 kWh of electricity annually for the store, the equivalent of reducing 1,017 tons of carbon dioxide (CO_2) - equal to the emissions of 215 cars or providing electricity for 150 homes yearly (calculating clean energy equivalents at www.epa.gov/energy/greenhouse-gas-equivalencies-calculator).

For the development, design and installation of the new store's solar power system, IKEA selected REC Solar, a national leader in solar electric design and installation with more than 550 systems built across the U.S. Pepper Construction is building the store that will reflect the same unique architectural design for which IKEA stores are known worldwide.

"Completing the solar installation is another exciting and sustainable step in the progress towards opening the future IKEA Columbus," said David Garcia, store manager. "IKEA strives to create a sustainable life for communities where we operate, and IKEA Columbus is adding to this goal with one of Ohio's largest rooftop solar arrays."

This array represents the 46th solar project for IKEA in the U.S., contributing to the IKEA solar presence atop nearly 90% of its U.S. locations, with a total generation goal of more than 40 MW. IKEA owns and operates each of its solar PV energy systems atop its buildings - as opposed to a solar lease or PPA (power purchase agreement) - and globally allocated $2.5 billion to invest in renewable energy through 2020, reinforcing its confidence and investment in solar photovoltaic technology. Consistent with the goal of being energy independent by 2020, IKEA has installed more than 700,000 solar panels on buildings across the world and owns approximately 300 wind turbines, including 104 in the U.S.

IKEA, drawing from its Swedish heritage and respect of nature, believes it can do good business while minimizing impacts on the environment. Globally, IKEA evaluates locations regularly for conservation opportunities, integrates innovative materials into product design, works to maintain sustainable resources, and flat-packs goods for efficient distribution. Specific U.S. sustainable efforts include: recycling waste material; incorporating environmental measures into the actual buildings with energy-efficient HVAC and lighting systems, recycled construction materials, skylights in warehouse areas, and water-conserving restroomms; and operationally, eliminating plastic bags from the check-out process, and selling only LED bulbs. IKEA has installed electric vehicle charging stations at 16 stores, with more locations planned, including 3 units at the future Columbus store.

The 354,000-square-foot future IKEA Columbus and its 1,200 parking spaces is being built on 33 acres at the northeastern corner of Interstate-71 and Gemini Place in the Polaris Centers of Commerce. Until the store opens, local customers can shop at the closest IKEA stores in: West Chester, OH; Pittsburgh, PA; and Canton, MI; or online at IKEA-USA.com.

Since its 1943 founding in Sweden, IKEA has offered home furnishings of good design and function at low prices so the majority of people can afford them. There are currently more than 380 IKEA stores in 48 countries, including 43 in the U.S. IKEA has been ranked among "Best Companies to Work For" and, as further investment in its coworkers, has raised its own minimum wage twice in two years. IKEA incorporates sustainability into day-to-day business and supports initiatives that benefit children and the environment. For more information see IKEA-USA.com, @IKEAUSANews, @IKEAUSA or IKEAUSA on Facebook, YouTube, Instagram and Pinterest.

Joseph Roth, Property Public Affairs
(610) 834-0180, ext. 6500

www.ikea.com/us/en/about_ikea/newsitem/032917_rooftop_solar_array_completed_on_IKEA_Columbus

https://www.energymanagertoday.com/clean-energy-boom-ohio-0176899/

A renewable energy boom in Ohio is all but inevitable, according to a new report that has support from major companies like Walmart, Procter & Gamble, and Owens Corning.

Authored by Synapse Energy Economics and the Great Lakes Energy Institute at Case Western Reserve University, the Powering Ohio report says the state can attract billions in investment by embracing clean energy by building on strengths such as industrial research and automotive manufacturing.

"This report provides concrete examples of how many leading companies, operating in Ohio, are making investments in clean energy and developing new strategies to support the transition to a lower-carbon economy," Matthew Arnold, global head of sustainable finance for JPMorgan Chase & Co. wrote in the foreword.

In addition to JPMorgan Chase, the report's advisory council included Owens Corning, Walmart, Eaton, Procter & Gamble, the Ohio Manufacturers' Association, GEM Energy, EDP Renewables, Whirlpool, and Ceres.

Ohio has the necessary components for major growth and can build on a strong foundation, the report says. The authors outline these key reasons:

- **Manufacturing powerhouse:** Ohio's 15,500 manufacturers produce $106 billion of annual industrial output and employ more than 685,000 Ohioans, placing the state third nationally in manufacturing employment.
- **Innovation:** Ohio is home to dozens of corporate and federal research-and-development centers, and it has ranked tenth in the country in patents since 2010.
- **Skilled workforce:** The state graduates more than 20,000 science, technology, engineering, and math students each year and is home to 34 accredited engineering programs. More than 150 apprenticeship programs train Ohioans to be machinists, and the state supports over 11,000 registered apprentices in construction.
- **Business opportunity support:** Ohio offers a low cost of doing business, programs that support entrepreneurship, and a history of effective partnership between business and political leaders.

Nearly half of the Fortune 500 companies — and 71 of the Fortune 100 companies — have set targets to increase their clean energy use or reduce greenhouse gas emissions from their operations, the report points out. "The renewably powered data center investment opportunity alone is worth at least $6.2 billion over the next 10 years."

Last summer, Facebook said that its 10th US-based data center would be located in New Albany, Ohio, and powered entirely by renewable energy. Sources like wind, solar, and hydro were critical to choosing the location, Facebook's director of data center strategy and development said at the time.

Companies already leading the renewables push in the state include Whirlpool, which announced plans last fall for three wind turbines to power its manufacturing facility in Greenville. GM inked a deal to purchase wind energy from turbines in Ohio that are expected to come online later this year.

Corporate demand for clean energy is a growing market, and states like Ohio that allow customers to choose their own energy supplier are easiest for meeting company energy goals, the Powering Ohio report says. "Ohio can go further. It can help companies reduce energy market risk by reducing siting barriers so that companies can more easily pair stably priced in-state renewable energy investments with their local facilities."

Ohio Environmental Protection Agency | ENCOURAGING Environmental EXCELLENCE

Encouraging Environmental Excellence Achievement Level Recognition

March 17, 2017

The Ohio EPA Encouraging Environmental Excellence Program targets those who reduce waste, improve efficiency and work to continuously improve as an environmental steward. The program has a four-level approach to provide recognition to Ohio businesses and other organizations completing environmentally beneficial activities. Higher levels of recognition are for those who exceed regulatory requirements or commit to future environmental stewardship efforts. The Achievement Level recognizes any applicants completing environmentally beneficial activities. Any business, trade association, professional organization or local government in Ohio may apply. Achievement Level participants must demonstrate significant progress in one of eight environmental stewardship criteria: Impact to the environment; pollution prevention; energy efficiency; renewable energy; renewable, recovered or recycled materials; green building; recycling programs or organics diversion. Achievement Level participants must also demonstrate some level of progress in at least six additional environmental stewardship criteria and indicate they are in compliance with environmental laws and regulations.

Ohio EPA is recognizing the following organization that successfully met the criteria for the Achievement Level of the Encouraging Environmental Excellence Program. Below is a summary of their efforts.

Nestle Quality Assurance Center (Dublin) – The Nestlé Quality Assurance Center (NQAC) is located in Dublin. It is the lead quality assurance center for all Nestlé businesses in the Americas. It has the ability and capacity to test virtually every Nestlé product, ingredient and manufacturing environment to verify that they conform to all applicable regulatory requirements, and meet Nestlé's high quality and safety standards. Test results from the Dublin lab are critical to the Americas and often to the entire global supply chain.

NQAC began improving its impact on the environment in 2012. The lab director committed to achieving ISO 14001 certification, which was achieved in 2014. A robust internal and external audit program led to a recertification in 2016 with zero audit gaps. Since 2014, the facility has continued to improve its commitment to the environment by investing in numerous new equipment technologies, continually increasing its waste reduction efforts, and in 2016, starting an organics diversion effort. Strategic goals are set for the facility as part of the operational master plan, which helps ensure commitment from the entire facility to continually improve their environmental management system.

The NQAC Green Team was started in September 2016 to work on environmental projects and information sharing. The Team is made up of 9 volunteers that each spend approximately 6 hours a month working on environmental projects to drive innovation and find solutions for waste reduction and energy efficiency. NQAC management is committed to supporting recycling and composting efforts although they have an initial cost increase compared to waste disposal. This approach provides time for employees to be educated on the environmental benefits of these approaches and provides resources

for continuous improvements. Time was provided for associates to attend and participate in Earth Day activities where they learned about new recycling and composting initiatives at NQAC.

Nestlé corporate initiatives set targets for individual facilities to improve their sustainability. These initiatives then drive NQAC to set annual objectives for the facility and forecast for 3 years. The last three years have included environmental goals such as reduction targets for waste to landfill and preparing to reduce energy usage by 35% by 2020. A 33% reduction in waste to landfills was achieved in 2015. This reduction percentage was increased to 53% in 2016. Monthly waste measures are tracked in the Safety Health and Environmental (SHE) monthly operation review. Overall, the amount of waste generated by the facility decreased 41% from a 2014 baseline. One project to help with this reduction was the investment of more than $166,000 to implement the Laserfische scanning system to reduce the amount of paper documents used and stored off site.

NQAC previously solidified their biohazardous waste that was picked up, treated and disposed by a third party company. NQAC invested more than $1,000,000 in 2014 to install two autoclaves. This system decreased the amount of infectious waste sent to disposal from over 405 tons in 2014 to 178 tons in 2015. This amount was reduced to zero in 2016 providing NQAC a return on their capital investment within two years.

An ammonia system was brought on line in 2014 for cooling a new area built as part of a facility expansion. The benefits of this system are reduced energy for cooling and the use of refrigerant that has no long term impact to the environment. The facility is implementing energy efficient LEDs and motion sensing lighting when areas are renovated. In 2015, a 22000 sq. ft. renovation occurred replacing 278 T8 bulbs with 234 LED Columbia LJB MW bulbs and fixtures.

While NQAC does not have a goal regarding water conservation, they have implemented projects to reduce water consumption. For example, a glycol loop will be added to the ammonia system in 2017 to reduce water consumption.

NQAC supports Lean projects that focus on improving processes to reduce environmental impacts. For example, a current project is analyzing the use of re-usable coolers and packaging for samples to reduce packaging waste. And NQAC created a new equipment checklist in 2016 to ensure that all new equipment and projects are reviewed for safety and environmental impacts.

Food waste from three labs, Chemistry Compositing, Microbiology Central Weigh and Chemistry Vitamins Labs and the break area began in September 2016. Any food sample waste that is not used in samples is placed in composting bins in the labs then taken to Price Farms in Delaware, Ohio. 2.7 tons of material from the labs were diverted from disposal to composting during the first two months of the program (September and October 2016).

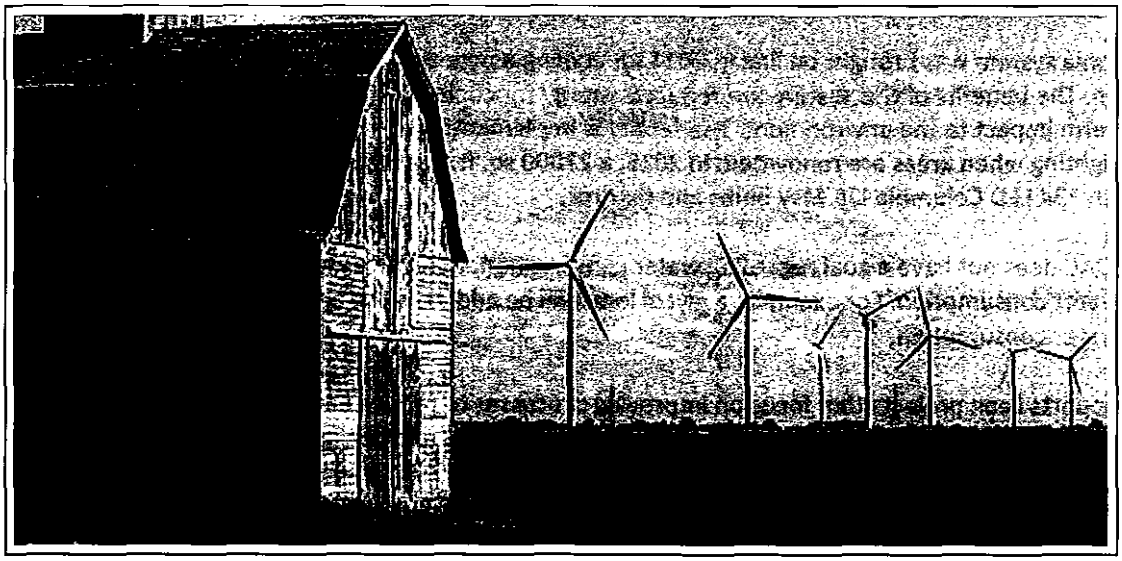
For more information about the Encouraging Environmental Excellence Program and the four levels of recognition, visit www.epa.ohio.gov/ohioE3.aspx or call (800) 329-7518.

Nestlé Good Food, Good Life

Nestlé Leverages Wind Power in Partnership with EDP Renewables in Step Toward 100% Renewable Electricity Goal

Power purchase agreement will provide approximately 80 percent of the electricity load for five Nestlé facilities in southeastern Pennsylvania

Arlington, VA,Feb 12, 2018

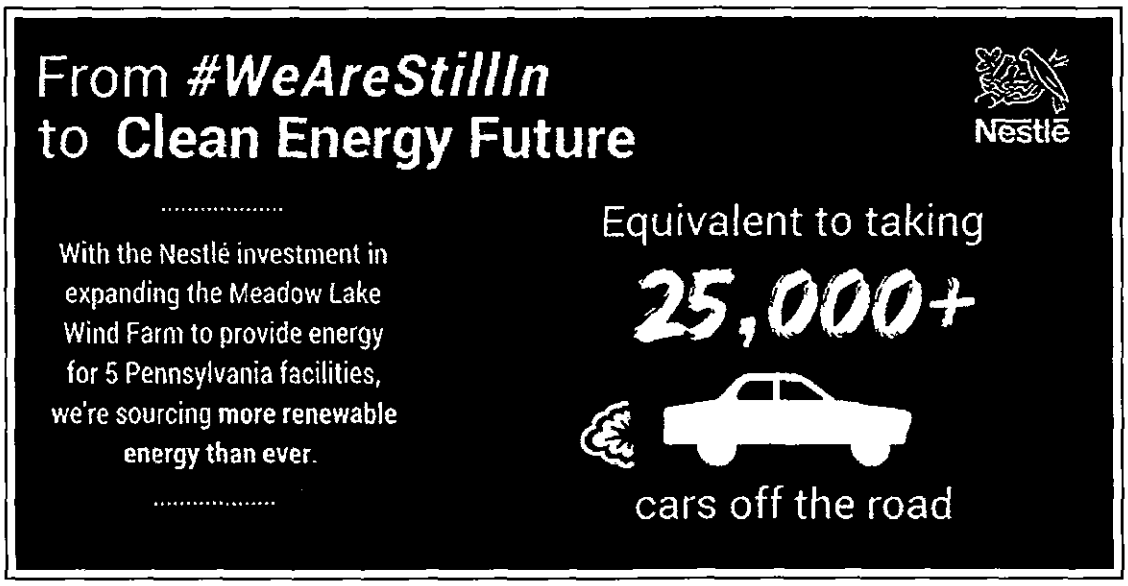


Nestlé in the U.S., in partnership with EDP Renewables (Euronext: EDPR), a global leader in the renewable energy sector and one of the world's largest wind energy producers, today announced a 15-year power purchase agreement that will provide approximately 80 percent of the electricity load for five Nestlé facilities in southeastern Pennsylvania. The agreement is a major step forward for Nestlé's ambition to procure 100 percent of its electricity from renewable sources.

EDP Renewables' Meadow Lake VI wind farm will generate and deliver 50 megawatts of electricity through the PJM Interconnection grid to manufacturing facilities and distribution centers operated by Nestlé Purina PetCare, Nestlé USA and Nestlé Waters North America in Allentown and Mechanicsburg, Pennsylvania. Because the wind farm and the recipient facilities are located on the same regional grid, the power purchase agreement provides traceability from the Pennsylvania facilities back to the wind farm. With the addition of the energy from the wind farm, 20 percent of the electricity Nestlé uses in the U.S. will come from renewable sources in 2019.

This power purchase agreement is in line with Nestlé's support and advocacy for state policies to ensure companies have access to renewable energy. This renewable energy project will help Nestlé cut energy costs, avoid the volatility of fossil fuel prices, and stay competitive.

"Our partnership with EDP Renewables propels us forward in our ambition to create zero environmental impact by 2030, and is another example of our business transformation journey," said Kevin Petrie, Chief Supply Chain Officer at Nestlé USA. "This power purchase agreement perfectly illustrates our creating shared value strategy—that we create value for our business through contributing to a healthier future for the planet."



Through this power purchase agreement, EDPR will expand the capacity of its Meadow Lake VI wind farm in Benton County, Indiana. The expansion will add 50 MW, enough to power approximately 17,700 homes for one year, to the existing 150 MW EDPR has already secured for the project. Additionally, the wind farm will bring a number of economic benefits to the state of Indiana in the form of jobs, landowner and tax payments, and money spent in local communities. Construction on the expansion project will begin in the next two months, and the facility will be fully operational at the end of 2018. With the completion of the wind farm, the six-phase Meadow Lake project will total 800 MW.

"This power purchase agreement enables EDP Renewables to further expand our presence in Indiana, the state in which we are the leading producer of wind energy," said João Manso Neto, CEO of EDP Renewables. "EDP Renewables is proud to partner with Nestlé to help in achieving its forward-looking goal of obtaining all of its energy from renewable sources."

Nestlé Commitment to Environmental Sustainability

Providing climate change leadership is just one of many societal commitments against which Nestlé transparently reports its progress every year. Reducing greenhouse gas emissions by becoming more efficient and switching to cleaner fuels, including renewable energy, is a core focus area for the company. By 2020, Nestlé aims to reduce its global GHG emissions (Scope 1 and 2) per tonne of product in every product category to achieve an overall global reduction of 35% in its manufacturing operations versus a 2010 baseline.

Nestlé has made significant progress towards its environmental sustainability goals in the U.S., as reported in its 2016 Nestlé in the U.S. Creating Shared Value Report:

- 47 Nestlé factories—60% of its total in the U.S.—achieved zero waste to landfill status
- Reduced waste for disposal by 74% per metric ton of product since 2010
- Decreased total water withdrawal by across operations by 11% per metric ton of product since 2010

For more information on this project, hear from our Chief Supply Chain Officer on Nestlé's U.S. renewable energy investments.

About Nestlé in the U.S.

Nestlé in the United States is committed to enhancing quality of life and contributing to a healthier future—for individuals and families, for our thriving and resilient communities, and for the planet. Our diverse portfolio of foods and beverages provides nutritious options for every member of the family, and supports both the first 1000 days of life and healthy aging for people and pets.

Nestlé in the U.S. consists of eight main businesses: Nestlé USA, Nestlé Waters North America, Nestlé Nutrition, Nestlé Professional, Nespresso, Nestlé Health Science, Nestlé Skin Health and Nestlé Purina PetCare Company. Together, these companies operate in more than 120 locations in 47 states and employ 50,000 people. In the U.S., Nestlé product sales topped $27 billion in 2016, making it the largest Nestlé market in the world.

Nestlé has been recognized as a member of the MIT Technology Review's "Smartest Companies," the top food company on Fortune's "Change the World" List, and the top food company on the Dow Jones Sustainability Index.

About EDP Renewables North America

EDP Renewables North America LLC ("EDPR NA") and its subsidiaries develop, construct, own, and operate wind farms and solar parks throughout North America. Headquartered in Houston, Texas, with 45 wind farms, five solar parks, and 13 regional and development offices across North America, EDPR NA has developed more than 6,200 megawatts (MW) and operates more than 5,600 MW of renewable energy projects. EDPR NA is owned by EDP Renováveis, S.A. (EDPR).

For more information, visit www.edpr.com/en or www.edprnorthamerica.com/.

About EDP Renewables (EDPR)

EDP Renewables (Euronext: EDPR) is a global leader in the renewable energy sector and the world's fourth-largest wind energy producer. With a sound development pipeline, first class assets and market-leading operating capacity, EDPR has undergone exceptional development in recent years and is currently present in 12 markets (Belgium, Brazil, Canada, France, Italy, Mexico, Poland, Portugal, Romania, Spain, the UK and the US). Energias de Portugal, S.A. ("EDP"), the principal shareholder of EDPR, is a global energy company and a leader in value creation, innovation and sustainability. EDP has featured on the Dow Jones Sustainability Index for ten consecutive years.

For further information, please visit www.edpr.com.

Media Contacts:

Nestlé
Josh Morton
Corporate Communications Team Lead
joshua.morton@us.nestle.com

EDP Renewables
Rafael Solís
Head of Corporate Communication & Stakeholders Management
rafael.solis@edpr.com

EDP Renewables North America
Blair Matocha
Communications Manager
blair.matocha@edpr.com

Nestlé

Enhancing quality of life and contributing to a healthier future

Ceres

October 25, 2016 BOSTON Clean Energy Clean Trillion Climate Change

Nine businesses that collectively employ more than 25,000 people in Ohio are urging state lawmakers to reinstate and strengthen Ohio's standards on energy efficiency and renewables.

Campbell Soup Company, Clif Bar & Company, Gap Inc., JLL, Nestlé, Owens Corning, Schneider Electric, United Technologies and Whirlpool Corporation are calling on lawmakers to reinstate Ohio's clean energy standards. The request comes as lawmakers are currently debating the future of Ohio's energy standards, which shape everything from where Ohio's electricity comes from to how much that energy will cost and what services utility companies will offer to customers. Lawmakers are expected to vote on proposals in the days following the election.

"Now is the time for lawmakers to strengthen Ohio's energy efficiency and renewable energy standards," said Alli Gold Roberts, policy manager at Ceres and one of the organizers of the business group. "These standards are good for business, and failing to reinstate them will send the wrong signal to companies and investors throughout the state."

Two years ago, Ohio launched an experiment on energy policy, becoming the first state to freeze its energy efficiency and renewable energy standards. The freeze has been in place ever since. State lawmakers, with Senate Bill 320 and other proposals, are debating what to do once the freeze expires at the end of the year.

Supporters of the freeze, which began in 2014, said Ohio needed a chance to reevaluate whether the standards were working. Since then, a wealth of new data has become available—almost all of it showing the standards' effectiveness.

While the energy standards were in place:

- Electricity customers were saving hundreds of millions of dollars each year on their bills and were on track to save over $5 billion by 2020.
- Investments in Ohio's clean energy sector created thousands of new jobs and stimulated over $160 million in annual GDP growth.
- Every dollar spent on energy efficiency saved all Ohio electricity customers more than two dollars in power costs.

During the freeze on the energy standards:

- Utility companies reduced services to customers, in some cases, suspending energy efficiency programs.
- Clean energy jobs moved out of state.
- Ohio's wind industry **lost more than 1,400 jobs last year**, according to the report by the Clean Energy Trust and Environmental Entrepreneurs.

All of the businesses in the coalition released their own statements about the standards. Those statements can be read below.

"We urge Ohio's leaders to lift the state's freeze on the renewable energy and energy efficiency standards. Continuing to undo smart clean energy policies won't help us build a stronger Ohio for tomorrow. Campbell remains supportive of removing barriers and promoting incentives for low carbon energy options. We believe renewable energy and energy efficiency are good for the environment and good for business. The solar project on Campbell's Napoleon, OH site is expected to save $4 million and eliminate 250,000 metric tons of greenhouse gas over the purchase agreement's 20-year period."

—Dave Stangis, Vice President Corporate Social Responsibility, **Campbell Soup Company**

Ohio Locations: Cincinnati - Office, Columbus - Retail Store, Jeffersonville - Retail Store, Napoleon - Food Processing Plant, Westlake - Retail Store, Willard - Manufacturing Plant

"Clif Bar opposes Ohio's current freeze on renewable energy and energy efficiency standards. As a company that loves the outdoors, we understand that clean, renewable energy is good for people and the planet. We also know that it's good business to run a green business. We use 100% green power in our Clif Bar bakeries and headquarters, and are committed to 50% or more green power within our supply chain by 2020. With facilities in Ohio, we hope to see legislators reinstate the state's renewable energy and energy efficiency standards."

—Elysa Hammond, Director of Environmental Stewardship, **Clif Bar & Company**

Ohio Locations: Cincinnati – Office

"The time to act is now. We urge leaders in Ohio to lift the freeze on the state's renewable energy and energy efficiency standards. Clean energy policies are smart and will build a stronger and more resilient Ohio. As a company with a large presence in the state, energy efficiency and renewable energy is important to our business and our future. We've set an ambitious goal to reduce our GHG emissions by 50% by 2020, and we encourage Ohio's leaders to help us all move toward a clean energy future."

—Christina Nicholson, Director Environmental Impact, **Gap Inc.**

Ohio Locations: Grove City – Office, Groveport – Distribution Center and Gap, Banana Republic, Old Navy and Athleta Retail Stores across the state

"At JLL we are committed to reducing greenhouse gas emissions because it helps our bottom line and our planet. That's why we call on Ohio lawmakers to pass common sense legislation that will reinstate Ohio's renewable energy and energy efficiency standards. We want to see a future where the built environment has a positive impact on the places and cities in which we live and work. To help get us there, we continuously embed sustainability and energy efficiency into our business, and support clean energy policies that send a strong market signal to the private sector." Bob Best, Head of JLL Energy and Sustainability Services."

—Bob Best, Head of JLL Energy and Sustainability Services, **JLL**

Ohio Locations: Offices in Cincinnati, Cleveland and Columbus (x2)

"As a major manufacturing company in Ohio, we rely on clean energy to reduce costs and lower our carbon emissions. We've set ourselves clear targets to further reduce greenhouse gas emissions in all of our manufacturing operations. We're making good progress and our support of policies that encourage the transition toward a low carbon economy helps us, and other companies, to continually improve our environmental performance. We know this is also important to many of our consumers and we strongly believe that lifting the freeze on Ohio's renewable energy and energy efficiency standards is good for the environment and good for business, as well as the state's economy and the people who call it home."

— Paul Bakus, President, Corporate Affairs, **Nestlé**

Ohio Locations: Solon– Prepared Foods HQ, Manufacturing & Product Technology Center; Cleveland– Manufacturing; Marysville – Product Technology Center; Zanesville – Nestlé Purina Manufacturing; Hilliard - Nestlé Waters Bottling Plant; Dublin – Food Quality Scientific Center

"As a large local and global electricity consumer, continuously seeking more sustainable energy supplies, ***we support immediately lifting the freeze on Ohio's energy efficiency and renewable energy standards****. Additionally, Owens Corning is a market leader in manufacturing energy saving products and materials that enhance wind energy performance. This uniquely positions us to speak to the energy savings, environmental impact and job-creating value of expanding the penetration of energy efficiency and renewable energy solutions. Our recognition of renewable energy's diverse value is also reflected in our actions. In 2015, Owens Corning announced that it had executed power supply agreements of newly installed capacity that represented, at the time, the largest wind power agreements reported by an industrial company in the world. That same day, Owens Corning dedicated a 2.4-megawatt solar parking lot canopy at the company's headquarters in Toledo, the largest system of its kind in the Midwest. We support lifting the freeze."*

— Frank O'Brien-Bernini, VP and Chief Sustainability Officer, **Owens Corning**

Ohio Locations: *Owens Corning operates eight facilities in the state of Ohio, including our global business headquarters in Toledo, our global R&D headquarters in Granville, and six manufacturing operations around the state (Newark, Mt. Vernon, Medina, Tallmadge, Tiffin, Columbus).*

"Energy efficiency proved to be an effective cost saving program for both residential and commercial customers in Ohio. Great progress has been made in growing Ohio's economy and creating local jobs, and yet the program had not come close to realizing its full

potential before it was halted. Lifting Ohio's freeze on the Energy Efficiency Resource Standard will bring future benefits and cost reductions to Ohio consumers."

—Trisha Knych, Vice President Government Relations & North America Communications, **Schneider Electric**

Ohio Locations: Oxford - Manufacturing; West Chester - Field Service; West Chester - Field Office; Kettering - Manufacturing; Broadview Heights - Field Service; Westerville - Field Office

"When we use energy more efficiently, we reduce costs, increase productivity and become more competitive. Annual electricity bills can be a significant cost to many businesses. Energy efficiency helps reduce those costs, and the benefits of efficiency compound across the supply chain. Ending the freeze on energy efficiency will allow Ohio to be more competitive in the global economy."

— John Mandyck, Chief Sustainability Officer, **United Technologies**

Ohio Locations: Akron, Columbus, Dayton, Heath, Independence, Sharonville, Troy, Uniontown

"Whirlpool Corporation urges Ohio's leaders to restore the state's Energy Efficiency Resource Standard and be proactive in supporting energy policies that promote affordability, reliability and protection of the environment. These priorities are a foundation for Ohio's continued economic growth. As the number one major appliance manufacturer in the world, Whirlpool Corporation will continue to do its part by developing innovative resource-efficient appliances and by improving the environmental performance of our facilities."

— Jeff Noel, Corporate Vice President, Communications and Public Affairs, **Whirlpool Corporation**

Ohio Locations: Clyde (clothes washer manufacturing), Marion (clothes dryer manufacturing), Findlay (dishwasher manufacturing), Ottawa (freezer and ice maker manufacturing), Greenville (KitchenAid small appliance manufacturing), and Columbus (regional distribution center)

Media Contacts

Sara Sciammacco
Senior Director, Communications and Marketing, Ceres

Ceres
Sustainability is the bottom line.

Headquarters
99 Chauncy Street, 6th Floor
Boston, MA 02111

California Office
212 Sutter Street, 2nd Floor
San Francisco, CA 94108

(617)247-0700 | info@ceres.org

CONTACT US

Ohio Renewable Sources

http://www.crainscleveland.com/article/20180218/blogs05/152231/personal-view-protecting-ohios-clean-energy-key-investment

In October, Trillium [*Trillium Asset Management*] stood alongside Gap, IKEA, Nestle, Schneider Electric and others to urge lawmakers to vote against HB 114. These businesses have continued to show support for clean energy policies and voice concerns about policy uncertainty for the last three years.

https://www.bizjournals.com/columbus/news/2017/03/29/ikea-powering-columbus-store-with-3-546-solar.html

Ikea has allocated $2.5 billion for renewable energy worldwide through 2020 with the goal of energy independence. It has installed more than 700,000 solar panels and owns 300 wind turbines including 104 in the U.S.

http://www.gapinc.com/content/gapinc/html/media/pressrelease/2016/med_pr_gps_gsreport16.html

Setting a goal to reduce absolute greenhouse gas emissions in our owned and operated facilities globally by 50 percent by the end of 2020

http://toledoblade.typepad.com/ripple-effect/2016/10/renewable-energy-gets-backing-again-from-some-major-ohio-manufacturers.html

But on Tuesday, nine business that collectively employ more than 25,000 people in Ohio flexed their muscle in support of renewables, urging state lawmakers to reinstate and strengthen the state mandates.

They include Campbell Soup Company, Cliff Bar & Co., Gap Inc., JLL, Nestle, Owens Corning, Schneider Electric, United Technologies, and Whirlpool Corp.

http://www.whirlpoolcorp.com/whirlpool-corporation-announces-plans-for-wind-turbines-at-greenville-manufacturing-facility/

"We are proud that this will be our fourth of five plants in Ohio to utilize sustainable energy, and we are committed to continuing to grow initiatives and projects like these that help reduce our overall energy footprint."

https://www.ceres.org/news-center/press-releases/ohio-businesses-lawmakers-strengthen-standards-renewable-energy-and

We've set an ambitious goal to reduce our GHG emissions by 50% by 2020, and we encourage Ohio's leaders to help us all move toward a clean energy future."

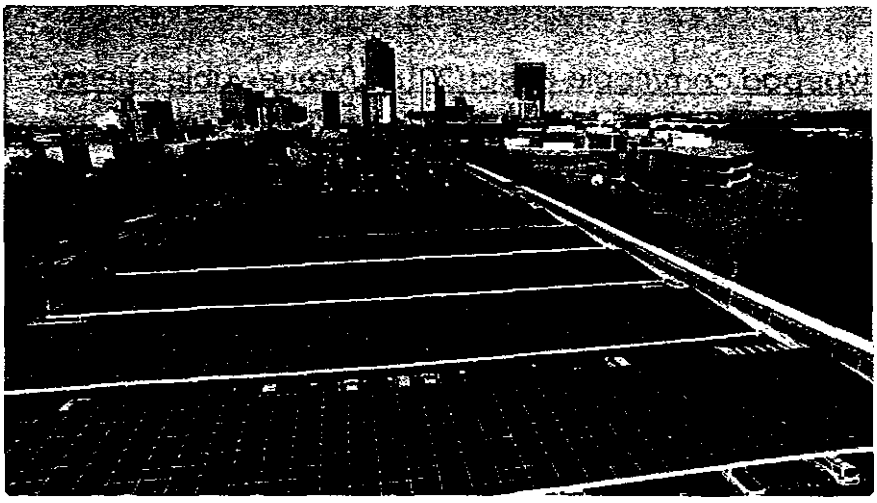
— Christina Nicholson, Director Environmental Impact, Gap Inc.

https://twitter.com/nestleusa/status/794199990864375809

Nestlé US ✓
@NestleUSA

Follow

We all need to step up & fight climate change. That's why we're asking Ohio lawmakers to commit to renewable energy. bddy.me/2fyUiX8



8:30 AM - 3 Nov 2016

http://media.owenscorning.com/press-release/corporate/owens-corning-announces-significant-sustainability-goals-and-renewable-energ

https://www.owenscorning.com/corporate/sustainability/environmental-sustainability/footprint

•Reported a 48% reduction against our 2020 Greenhouse Gas goal with a base year of 2010.

•Achieved 23% absolute reduction in Scope 1 emissions and 34% of market-based Scope 2 emissions from 2010 to 2017.

•Owens Corning enabled, through our power purchase agreements, new wind power capacity of 250MW which came online in 2016 and had a substantial impact on our scope 2 GHG emissions.

https://aws.amazon.com/about-aws/sustainability/

Amazon Wind Farm US Central 2 is a 189 megawatt wind farm in Hardin County, Ohio.

Amazon Wind Farm US Central is a 100 megawatt wind farm in Paulding County, Ohio.

NEWS RELEASE

MEDIA CONTACT

Chuck Hartlage
Corporate Media Relations
419-248-5395
chuck.hartlage@owenscorning.com (mailto:chuck.hartlage@owenscorning.com)

Owens Corning Announces Significant Sustainability Goals and Renewable Energy Actions

Positions Company as World's Largest Industrial Purchaser of Renewable Energy

Friday, October 30, 2015 7:29 am EDT

TOLEDO, Ohio--(BUSINESS WIRE (http://www.businesswire.com))--Owens Corning (NYSE:OC) today announced more ambitious sustainability goals to reduce greenhouse gas and toxic air emissions, along with new renewable power initiatives that will continue to expand the company's impact through sustainability.

"We have taken an important step in aligning our goals consistent with the scientific consensus on what's needed."

"Owens Corning has a history of promoting energy efficiency through our products, our suppliers and our operations," said Chairman and CEO Mike Thaman. "Today's announcements reflect a continuation of our company's history of being a good steward of the environment."

The key elements of the company's announcement include:

- Executing power supply agreements of new installed capacity that represent the largest wind power agreements reported by an industrial company in the world[1];
- Dedicating a 2.4 megawatt solar canopy at the company's headquarters in Toledo that is expected to supply approximately 30 percent of the facility's annual electricity needs, and offset the equivalent greenhouse gases emitted from the commute of its local workforce;
- Establishing new 2020 sustainability goals to reduce greenhouse gas intensity by 50 percent and toxic air emissions intensity by 75 percent from its 2010 baseline.

"Our new sustainability goals are ambitious and impactful. Importantly, they are made more achievable by these large scale renewable energy actions and by partnering with leading providers of solar photovoltaic systems to continue our leadership in this area," said Vice President and Chief Sustainability Officer Frank O'Brien-Bernini.

O'Brien-Bernini noted that the wind energy deal will:

- Generate the equivalent electricity to that needed to power more than 65,000 U.S. homes; and
- Support the wind power industry by enabling the construction of new wind power assets, a market to which the company supplies high performance glass fiber reinforcements for wind turbine blades.

"Our new greenhouse gas reduction goal is informed by science-based methodologies that are designed to reduce carbon emissions enough to limit global warming to less than 2 degrees Celsius compared to pre-industrial temperatures," said O'Brien-Bernini. "We have taken an important step in aligning our goals consistent with the scientific consensus on what's needed."

Owens Corning's 2014 Sustainability Report and a downloadable summary progress report are available online at: http://sustainability.owenscorning.com (http://cts.businesswire.com/ct/CT?id=smartlink&url=http%3A%2F%2Fsustainability.owenscorning.com&esheet=51213325&newsitemid=20151030005198&lan=en-US&anchor=http%3A%2F%2Fsustainability.owenscorning.com&index=1&md5=fe1d068d774577a4335d7d132f2d5818).

Specific information about the company's greenhouse gas intensity reduction can be found at: http://sustainability.owenscorning.com/environmental/footprint/greenhouse-gas/ (http://cts.businesswire.com/ct/CT?id=smartlink&url=http%3A%2F%2Fsustainability.owenscorning.com%2Fenvironmental%2Ffootprint%2Fgreenhouse-gas%2F&esheet=51213325&newsitemid=20151030005198&lan=en-US&anchor=http%3A%2F%2Fsustainability.owenscorning.com%2Fenvironmental%2Ffootprint%2Fgreenhouse-gas%2F&index=2&md5=b0e89c1c080b4ecf1c5ca4388cfd7db1)

Specific information about the company's toxic air emissions intensity reduction can be found at: http://sustainability.owenscorning.com/environmental/footprint/toxic-air-emissions/ (http://cts.businesswire.com/ct/CT?id=smartlink&url=http%3A%2F%2Fsustainability.owenscorning.com%2Fenvironmental%2Ffootprint%2Ftoxic-air-emissions%2F&esheet=51213325&newsitemid=20151030005198&lan=en-US&anchor=http%3A%2F%2Fsustainability.owenscorning.com%2Fenvironmental%2Ffootprint%2Ftoxic-air-emissions%2F&index=3&md5=1796b85e67e8a097fe79824374de9cc6)

About Owens Corning

Owens Corning (NYSE:OC) develops, manufactures and markets insulation, roofing and fiberglass composites. Global in scope and human in scale, the company's market-leading businesses use their deep expertise in materials, manufacturing and building science to develop products and systems that save energy and improve comfort in commercial and residential buildings. Through its glass reinforcements business, the company makes thousands of products lighter, stronger and more durable. Ultimately, Owens Corning people and products make the world a better place. Based in Toledo, Ohio, Owens Corning posted 2014 sales of $5.3 billion and employs about 15,000 people in 26 countries. It has been a Fortune 500® company for 61 consecutive years. For more information, please visit www.owenscorning.com (http://cts.businesswire.com/ct/CT?id=smartlink&url=http%3A%2F%2Fwww.owenscorning.com&esheet=51213325&newsitemid=20151030005198&lan=en-US&anchor=www.owenscorning.com&index=4&md5=7185fea15d83bad281eac2d7bd8c82c0).

[1] Based on global publically-available data collected and analyzed by the Rocky Mountain Institute's Business Renewables Center

CONTACT:
Owens Corning
Media
Chuck Hartlage, 419-248-5395
or
Investors
Thierry Denis, 419-248-5748

FOOTPRINT

Owens Corning is seven years into our second set of 10 year environmental footprint goals. We have made significant progress yet we continue to look for opportunities to shrink our environmental footprint through a continuous reduction of resource use and environmental emissions from our operations. Our goals are for the period of 2010 to 2020 and based on what matters most given our specific operations.

In October of 2015, we announced we had met our greenhouse gas and toxic air emissions goals ahead of schedule. At that time we made a decision to increase our 2020 commitments of 50 percent and 75 percent reductions for these environmental impacts respectively, and incorporated science-based greenhouse gas target-setting methodology into our strategy. Off our 2010 baseline year, we have now exceeded our goals for primary energy, water and fine particulate. We are on-track to meet our goals for greenhouse gas and toxic air emissions. However, we continue to be challenged by our waste-to-landfill goal.

We focus on six key aspects:

Primary Energy

- Achieved a 20% consumed energy intensity reduction and an 26% primary power intensity reduction since 2010.
- Approximately 39% of our electricity was sourced through renewable sources, such as wind, hydro, solar and geothermal across our portfolio globally; this metric is defined as the renewable energy sourced from the grid as well as that sourced from agreements.
- Within the United States, approximately 56% of our electricity was sourced through renewable sources of wind (54%), hydro (1%), and solar (1%). This percentage includes renewable energy sourced from the grid as well as that sourced from power purchase agreements (PPAs) that provide us renewable energy credits. Of the 56%, Owens Corning is proud to state that 52% is directly attributable to our renewable energy programs with a breakdown of 51% from wind and 1% from solar.
- Owens Corning's Fairburn, Georgia, plant became home to a 1-megawatt solar project. Through a partnership with Constellation and Georgia Power, a solar power system comprising nearly 3,000 photovoltaic panels was built on the plant site. The project is expected to result in an estimated 1,054 metric tons of CO2 reduction during its first year of operation.
- Since 2006, Owens Corning has implemented more than 1,125 energy-use reduction projects in its facilities across the globe, which together have reduced our MwH usage by more than 1,250,000 MwH.

Greenhouse Gases (GHG) Emissions

- Reported a 48% reduction against our 2020 Greenhouse Gas goal with a base year of 2010.
- Achieved 23% absolute reduction in Scope 1 emissions and 34% of market-based Scope 2 emissions from 2010 to 2017.
- Owens Corning enabled, through our power purchase agreements, new wind power capacity of 250MW which came online in 2016 and had a substantial impact on our scope 2 GHG emissions.
- For the second year in a row Owens Corning received a level recognition for 2017 CDP Climate Leader's for our disclosure and reporting on our GHG emissions.

- Owens Corning received A level recognition for our 2018 Supply Chain disclosure and reporting on our GHG emissions.

Fine Particulate Matter (PM2.5) Emissions +

Toxic Air Emissions (TAE) +

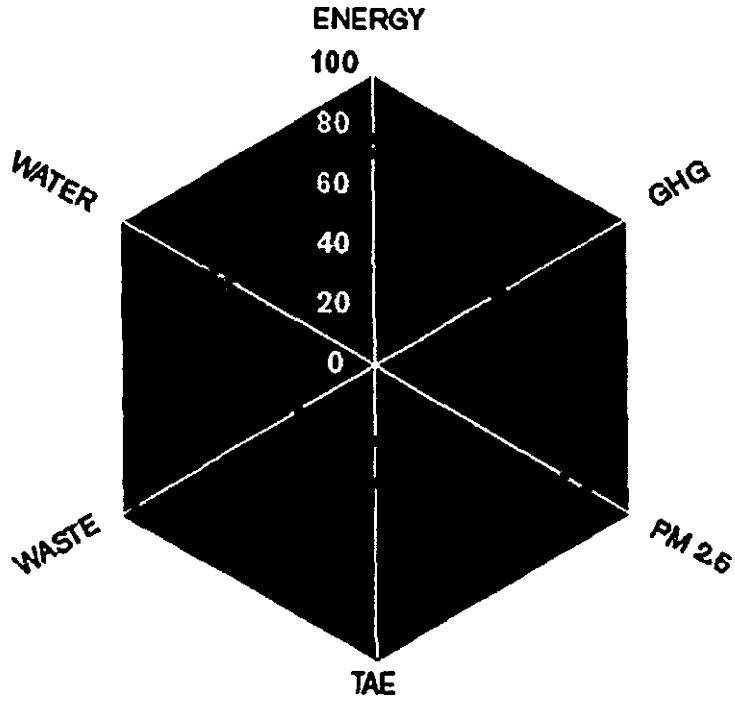
Waste-to-Landfill +

Water +

To assist in our reduction efforts, Owens Corning implemented an enterprise wide software solution to better manage our environmental sustainability data and ensure our facilities have data to make decisions and are informed of their impact on our goals. The system combines quality assurance and data capture capabilities while allowing a streamlined external audit process. To ensure consistency and standardization, Owens Corning follows World Resource Institute (WRI) Corporate Accounting & Reporting Standard for all our environmental reporting. We report under operational control.

The company's six aspects are shown in the footprint graphic below. The 2010 baseline year is shown as the dark blue outside border of the spider chart, representing 100 percent of each aspect. The pink center footprint indicates the company's 10-year intensity goals. The light blue footprint represents our status at the end of 2017.

Environmental Footprint Progress and Goals



2010 BASE

2010-17 PROGRESS

2020 GOALS

ACTUAL ENVIRONMENTAL IMPACTS, 2010 AND 2017

This table shows the actual values of the monitored parameters in 2010 and 2017.

Emission or Resource						
Year	Consumed Energy (millions of MwH)	GHG (millions of TPY)	PM 2.5 (thousands of TPY)	TAE (TPY)	Waste to Landfill (thousands of TPY)	Water (millions of m3)
2010	8.9	4.8	2.2	1.0	284.9	12.2
2017	9.3	3.5	2.2	0.5	333.3	11.0

Primary Energy — Total energy required to generate, transmit, and distribute electricity from the power generation source as well as energy sources used onsite such as fossil fuels
Consumed Energy — Energy used onsite such as the electricity consumed on site and fossil fuel usage
GHG — Greenhouse gases, defined as gases which contribute toward the Greenhouse effect, including carbon dioxide, methane, nitrous oxide, HFCs, and HCFCs
$PM_{2.5}$ — Particulate matte with a mean diameter of 2.5 microns or less, defined and reported according to regional government requirements.
TAE— Toxic air emissions include hexavalent chromium, formaldehyde, manganese, polycylic aromatic compounds and ammonia emissions.
Waste-to-Landfill — all types of solid wastes going to landfill for disposal
Water — Water that enters the plant; sources include local utilities and wells
TPY — Metric tons per year
m^3 — Cubic Meters
MwH — Megawatt hours

Intensity is normalized based on product produced.

For more information on our programs and efforts related to our goals view our annual sustainability report.

SCS Global Services performed the assurance of the Owens Corning 2017 Sustainability Report against the AA1000 Assurance Standard (2008). In addition, SCS Global Services evaluated the Report against the Global Reporting Initiative's (GRI) Standards for reporting. Specific performance data were assessed utilizing internationally recognized standards including:

- *ISAE 3000 (Revised), Assurance Engagements Other than Audits or Reviews of Historical Financial Information*
- World Resources Institute's Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (Revised Edition), March 2004 along with Scope 2 and Scope 3 Guidance
- *ISO 14064-3:2006 Specification with guidance for the validation and verification of GHG assertions*

To view the assurance statement, please see pages 230-232 within Our 2017 Sustainability Report (https://www.owenscorning.com/corporate/sustainability/docs/2018/OwensCorning_2017SustainabilityReport.pdf).

Click here (https://www.owenscorning.com/corporate/sustainability/docs/2018/OwensCorning_2017AdditionalSocialMetrics.pdf) for additional information on the economic and social metrics verified through SCS.

The boundary of all these aspects covers our entire global operations including Asia Pacific, Europe, Latin America, Canada and the United States. The internal boundary includes all Owens Corning plants and offices that are owned and leased.

Ripple Effect

10/25/2016

Renewable energy gets backing (again) from some major Ohio manufacturers

One of the bigger political stories getting lost in the shuffle during this presidential election is the fate of Ohio's mandates on energy efficiency and renewables.

It's huge because it could not only impact energy markets for solar power and wind power, but also the nation's climate and landscape.

The Ohio General Assembly is trying to decide what to do after the state's two-year freeze on such mandates expires at the end of this year.

Ohio - the nation's fourth-largest energy user - is a pivotal state on this issue.

It remains the only state that went forward with a freeze, a grand experiment that yielded mixed results.

Gov. John Kasich went through with it, despite opposition from many businesses that saw value in promoting renewable energy as a way of generating jobs.

Although the Kasich administration now says the freeze served its purpose and should expire, that has done little to dissuade conservatives who want to do anything from modifying rules to making the freeze permanent.

But on Tuesday, nine business that collectively employ more than 25,000 people in Ohio flexed their muscle in support of renewables, urging state lawmakers to reinstate and strengthen the state mandates.

They include Campbell Soup Company, Cliff Bar & Co., Gap Inc., JLL, Nestle, Owens Corning, Schneider Electric, United Technologies, and Whirlpool Corp.

Lawmakers are expected to vote on proposals days after the election.

"Continuing to undo smart clean energy policies won't help us build a stronger Ohio for tomorrow," Dave Stangis, Campbell Soup's vice president corporate social responsibility, said, citing

the company's solar project in Napoleon that is expected to save Campbell $4 million and keep 250,000 metric tons of greenhouse gases out of the atmosphere in the next 20 years.

"We believe renewable energy and energy efficiency are good for the environment and good for business," he said.

Frank O'Brien-Bernini, Owens Corning vice president and sustainability officer, said that company supports lifting the freeze because it is "a market leader in manufacturing energy saving products and materials that enhance wind energy performance."

Owens Corning is proud of its 2.4-megawatt solar parking lot canopy at its Toledo headquarters, the largest canopy of its kind in the Midwest, he said.

Whirlpool has manufacturing plants at four northwest Ohio plants - Clyde, Marion, Findlay, and Ottawa.

Renewable energy mandates "are a foundation for Ohio's continued economic growth," Jeff Noel, Whirlpool vice president of communications and public affairs, said.

A report by Clean Energy Trust and Environmental Entrepreneurs, promoted by advocates, contends Ohio lost more than 1,400 jobs in the wind industry alone in 2015.

Opponents question such claims, asserting Ohio is better off without the mandates.

Posted at 07:12 PM | Permalink

Reblog (0)

Comments

You can follow this conversation by subscribing to the comment feed for this post.

Verify your Comment

Previewing your Comment

Posted by: |

This is only a preview. Your comment has not yet been posted.

Post Edit

Your comment could not be posted. Error type:
Your comment has been posted. Post another comment

The letters and numbers you entered did not match the image. Please try again.

As a final step before posting your comment, enter the letters and numbers you see in the image below. This prevents automated programs from posting comments.

Having trouble reading this image? View an alternate.

Continue

Post a comment

Comment below or sign in with Typepad Facebook TwitterGoogle+and more...

(URLs automatically linked.)

Your Information

(Name and email address are required. Email address will not be displayed with the comment.)

Name Name is required to post a comment

Email Address Please enter a valid email address

Web Site URL Invalid URL

Post Preview

"Heaven is under our feet as well as over our heads."
- Henry David Thoreau

About Ripple Effect

Every pollution battle ultimately comes down to mankind's desire to better itself while protecting its sense of home. In this blog, Blade Staff Writer Tom Henry looks at how Great Lakes energy-

environmental issues have a ripple effect on our public health, our natural resources, our economy, our psychological well-being, and our homespun pride.

About Tom Henry

Tom Henry is an award-winning journalist who has covered primarily energy and environmental issues the past two decades. He is a member of the national Society of Environmental Journalists, one of North America's largest journalism groups.

Contact:
Email (preferred):
thenry@theblade.com
Phone: 419-724-6079
FAX: 419-724-6439
Address: c/o The (Toledo) Blade,
541 North Superior Street, Toledo, OH 43660

Read Online

THE BLADE

Subscribe to this blog's feed

Search

Search

The (Toledo) Blade
Follow
2 Following
12 Followers

Archives

- July 2017
- May 2017
- April 2017
- January 2017
- October 2016
- September 2016
- July 2016
- June 2016
- May 2016
- April 2016

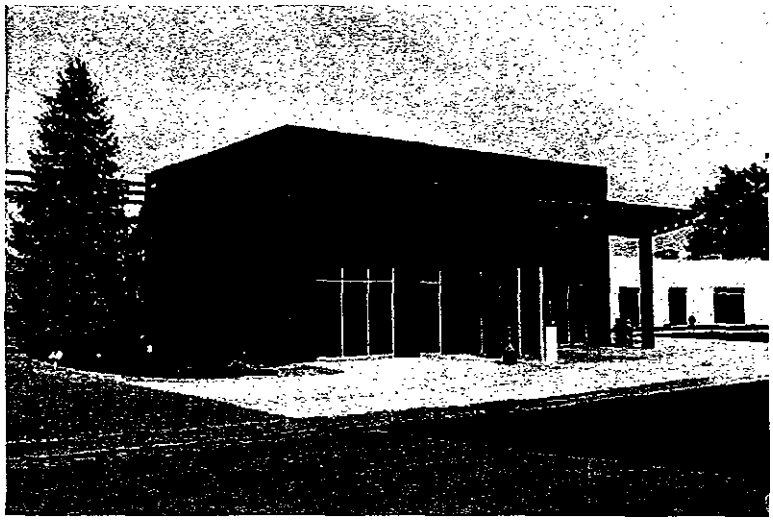
Categories

- Science

- Ripple Effect
- Powered by Typepad

Whirlpool Corporation Announces Plans for Wind Turbines at Greenville Manufacturing Facility

Nov 15, 2017 | Our Company, What Matters To Us



Whirlpool Corporation today announced plans for three wind turbines to power its manufacturing facility in Greenville, Ohio and further build on the company's 46-year commitment to sustainable manufacturing. Beginning construction in early 2018, the turbines will be the same as those developed for Whirlpool Corporation's manufacturing facilities in Findlay, Marion, and Ottawa, Ohio, and will be developed in coordination with One Energy Enterprises.

The three Greenville turbines will generate more than 12 million kWh annually and offset approximately 70 percent of the plant's electricity consumption – eliminating the equivalent of more than

nine thousand annual tons of CO2. This is equivalent to generating enough clean energy to power more than 900 average American homes.

"By investing in on-site wind energy, we're ensuring that Whirlpool Corporation is set up for success now and in the future, while also expanding the commitment to sustainability that is vital to our company," said Ron Voglewede, Whirlpool Corporation Global Sustainability Director. "We are proud that this will be our fourth of five plants in Ohio to utilize sustainable energy, and we are committed to continuing to grow initiatives and projects like these that help reduce our overall energy footprint."

Similar to previous wind turbine projects, all three turbines will be built and financed by One Energy Enterprises as part of its Wind for Industry® projects. The Greenville plant is the latest Ohio facility where Whirlpool Corporation is implementing wind energy to partially power its manufacturing operations, following installation of wind turbines at facilities in Findlay, Marion, and Ottawa, Ohio. The completion of these additional wind farms will potentially make Whirlpool Corporation one of the largest users of on-site wind energy of any Fortune 500 company in the United States. Greenville Operations manufactures stand mixers, stand mixer attachments and accessories, hand mixers, blenders, aerated beverage machines and cutlery blocks under the KitchenAid brand.

In addition to the wind turbines and as part of its continued commitment to the community surrounding the Greenville plant, Whirlpool Corporation will also create three $5,000 Megawatt Scholarships (one per turbine, for a total of $15,000 annually).

These will be awarded annually for every year the turbines are in operation. The Megawatt Scholarships will be awarded annually to local high school graduates pursuing a two-year or four-year STEM degree.

In Case You Missed It...

- Whirlpool's new frost-free fridge freezers for longer lasting freshness
- Taking Pride in One's Food
- Whirlpool EMEA wins a 2018 Business International Finance Award
- *Discovery-Based Experience Center from* Whirlpool Corporation Opens at World of Whirlpool
- Camille Cunningham Pierce Named to Black Enterprise's Top Executives in Corporate Diversity
- Whirlpool Foundation, IU alumni Jeff and Marcia Fettig give $2 million to Kelley School of Business
- Whirlpool Corporation and Habitat for Humanity Renew Commitment Through 2018
- New Ways to Use Gladiator
- Whirlpool EMEA pledges to adopt components of appliances made of 100% of recycled plastics by 2025
- Indesit takes its #doittogether campaign to the next level in 2018

OHIO POWER COMPANY'S RESPONSE TO
INTERSTATE GAS SUPPLY'S
DISCOVERY REQUEST
PUCO CASE NO. 18-501-EL-FOR, 18-1392-EL-RDR, AND 18-1393-EL-ATA
SECOND SET

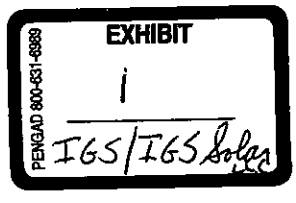
INTERROGATORY

IGS-INT-2-004 The Amendment to the Long Term Forecast Report states (at p. 7), "it is far from evident that the competitive market will meet the renewable needs of AEP Ohio customers." Identify all facts and evidence that supports this statement.

RESPONSE

The Company's filing includes testimony and analysis demonstrating the interest of AEP Ohio's customers in renewable energy (see the testimony of Company witnesses Horner and Fry). The Company's testimony also shows that the operator of the wholesale market that AEP operates in (PJM) doesn't take into account customer demand for renewable energy when procuring capacity or energy (see the testimony of Company witness Allen).

Prepared by: William A. Allen



GE
Energy Consulting

PJM Renewable Integration Study

Executive Summary Report

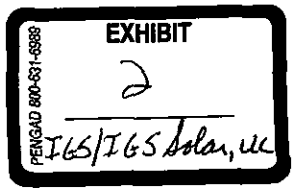
Revision 05

Prepared for: PJM Interconnection, LLC.

Prepared by: General Electric International, Inc.

March 31, 2014

imagination at work



Legal Notices

This report was prepared by General Electric International, Inc. (GE) as an account of work sponsored by PJM Interconnection, LLC. (PJM). Neither PJM nor GE, nor any person acting on behalf of either:

1. Makes any warranty or representation, expressed or implied, with respect to the use of any information contained in this report, or that the use of any information, apparatus, method, or process disclosed in the report may not infringe privately owned rights.

2. Assumes any liabilities with respect to the use of or for damage resulting from the use of any information, apparatus, method, or process disclosed in this report.

Contact Information

This report was prepared by General Electric International, Inc. (GEII); acting through its Energy Consulting group (GE) based in Schenectady, NY, and submitted to PJM Interconnection, LLC. (PJM). Technical and commercial questions and any correspondence concerning this document should be referred to:

Gene Hinkle
Manager, Investment Analysis
GE Energy Management
Energy Consulting
1 River Road
Building 53
Schenectady, NY 12345 USA
Phone: (518) 385 5447
Fax: (518) 385 5703
gene.hinkle@ge.com

Table of Contents

List of Figures

List of Tables

1 Project Overview

At the request of its stakeholders, PJM Interconnection, LLC. (PJM) initiated this study to perform a comprehensive impact assessment of increased penetrations of wind and solar generation resources on the operation of the PJM grid. The principal objectives include:

- Determine, for the PJM balancing area, the operational, planning, and energy market effects of large-scale integration of wind and solar power as well as mitigation/facilitation measures available to PJM
- *Make recommendations for the implementation of such mitigation/facilitation* measures

This study is motivated by the need for PJM to be prepared for a considerably higher penetration of renewable energy in the next 10 to 15 years. Every jurisdiction within the PJM footprint, except for Kentucky and Tennessee, has a renewable portfolio standard (RPS), or Alternative Energy Portfolio Standard (AEPS), or non-binding Renewable Portfolio Goal (RPG)[1].

This study investigates operational, planning, and energy market effects of large-scale wind/solar integration, and makes recommendations for possible facilitation/mitigation measures. It is not a detailed near-term planning study for any specific issue or mitigation. The target year is 2026, which was used to estimate the PJM annual load profile used in the study scenarios.

The growth of renewable energy is largely driven by Renewable Portfolio Standards and other legislative policies. The cost-benefit economics of renewable resources, and quantifying the capital investment required to install additional wind and solar infrastructure, were beyond the scope of this study and were not investigated. The study assumed that the penetration of renewable resources would increase and investigated how the PJM system would be affected.

The impact of renewables on production cost savings was investigated, but the analysis did not include possible secondary impacts to the capacity market such as increased retirements due to non-economic performance or a possible need for generators to recover more in the capacity market because of reduced revenue in the energy market.

Project Team

Six companies joined forces to execute the broad range of technical analysis required for this study.

[1] www.dsireusa.org

- GE Energy Consulting – overall project leadership, production cost and capacity value analysis
- AWS Truepower – development of wind and solar power profile data
- EnerNex – statistical analysis of wind and solar power, reserve requirement analysis
- Exeter Associates – review of industry practice/experience with integration of wind/solar resources
- Intertek Asset Integrity Management (Intertek AIM), formerly APTECH – impacts of increased cycling on thermal plant O&M costs and emissions
- PowerGEM – transmission expansion analysis, simulation of sub-hourly operations and real-time market performance

Data Sources

This study used a combination of publicly available and confidential data to model the Eastern Interconnection, the PJM grid, and its power plants. The hourly production simulation analysis was performed using GE's Concorda Suite Multi-Area Production Simulation (GE MAPS) model. In order to protect the proprietary interests of PJM stakeholders, the production simulation analysis was primarily based on publically available data, reviewed and vetted by PJM to assure consistency with the operating characteristics of the PJM grid and the power plants under its control. The sub-hourly analysis used PowerGEM's Portfolio Ownership and Bid Evaluation (PROBE) program, which is regularly used by PJM to monitor the performance of the real-time market[2]. PROBE uses proprietary power plant data, but that data was not shared with any other study team members per PJMs existing non-disclosure agreement with PowerGEM.

AWST provided wind and solar power generation profiles and power forecasts within the PJM interconnection region, as well as the rest of the Eastern Interconnection, as inputs to hourly and sub-hourly grid simulations. These data sets were based on high-resolution simulations of the historical climate performed by a mesoscale numerical weather prediction (NWP) model covering the period 2004 to 2006.

Meteorological data from NREL's EWITS project[3] was used to produce power output profiles for both wind and solar renewable energy generation facilities. A site selection process was completed for onshore and offshore wind as well as for the centralized and distributed solar sites within the PJM region. The selection includes sites that could be developed to meet and

[2] PowerGEM website, http://www.power-gem.com/PROBE.htm

[3] http://www.nrel.gov/docs/fy11osti/47078.pdf

exceed renewable portfolio standards for the PJM Interconnection. Power output profiles were produced for each of the sites using performance characteristics from the most current power conversion technologies as of July 2011. The resulting wind and solar power profiles were validated against measurements.

2 Study Scenarios

Table 1 summarizes the PJM wind and solar installed capacity for the ten study scenarios. Note that the scenarios are defined in terms of percentage of renewable energy generation (MWh), whereas Table 1 summarizes the wind and solar capacity (MW) in each scenario. Also, all scenarios include 1.5% of non-wind, non-solar renewable generation.

2% BAU:	This is a Business As Usual (BAU) reference case with the existing level of wind/solar in year 2011. This case is a benchmark for how PJM operations will change as wind and solar penetration increases.
14% RPS:	Wind and solar generation meets existing RPS mandates by 2026, with 14% renewable energy penetration in PJM.
20% LOBO:	20% wind and solar energy penetration in PJM, Low Offshore and Best Onshore; 10% of wind resources are offshore, 90% of wind resources are onshore in locations with best wind quality.
20% LODO:	20% wind and solar energy penetration in PJM, Low Offshore and Dispersed Onshore; 10% of wind resources are offshore, 90% of wind resources are onshore. Incremental onshore wind added in proportion to load energy of individual states.
20% HOBO:	20% wind and solar energy penetration in PJM, High Offshore and Best Onshore; 50% of wind resources are offshore, 50% of wind resources are onshore in locations with best wind quality.
20% HSBO:	20% wind and solar energy penetration in PJM, High Solar and Best Onshore; similar to 20% LOBO, but with twice the solar energy and proportionately less wind energy.

The 30% scenarios are similar to the 20% scenarios, but with more wind and solar resources to achieve 30% wind and solar energy penetration in PJM.

Table 1: Total PJM Wind and Solar Capacity for Study Scenarios

Scenario	Renewable Penetration in PJM	Onshore Wind (MW)	Offshore Wind (MW)	Centralized Solar (MW)	Distributed Solar (MW)	Total (MW)
2% BAU	2%	5,122	0	72	0	5,194
14% RPS	14%	28,834	4,000	3,254	4,102	40,190
20% LOBO	20%	39,452	4,851	8,078	10,111	62,492
20% LODO	20%	40,942	4,851	8,078	10,111	63,982
20% HOBO	20%	21,632	22,581	8,078	10,111	62,402
20% HSBO	20%	32,228	4,026	16,198	20,294	72,746
30% LOBO	30%	59,866	6,846	18,190	16,907	101,809
30% LODO	30%	63,321	6,846	18,190	16,907	105,264
30% HOBO	30%	33,805	34,489	18,190	16,907	103,391
30% HSBO	30%	47,127	5,430	27,270	33,823	113,650

Figure 1 shows the locations of wind plants for the 14% RPS scenario. Note the high concentration of wind plants in Illinois, Indiana and Ohio, which have high quality wind resources. Other study scenarios where onshore wind resources were selected based on a "best sites" criteria also have high concentrations of wind plants in these western PJM states. Scenarios with the "dispersed sites" criteria moved some of the Illinois and Indiana wind resources eastward, to Ohio, Pennsylvania, and West Virginia.

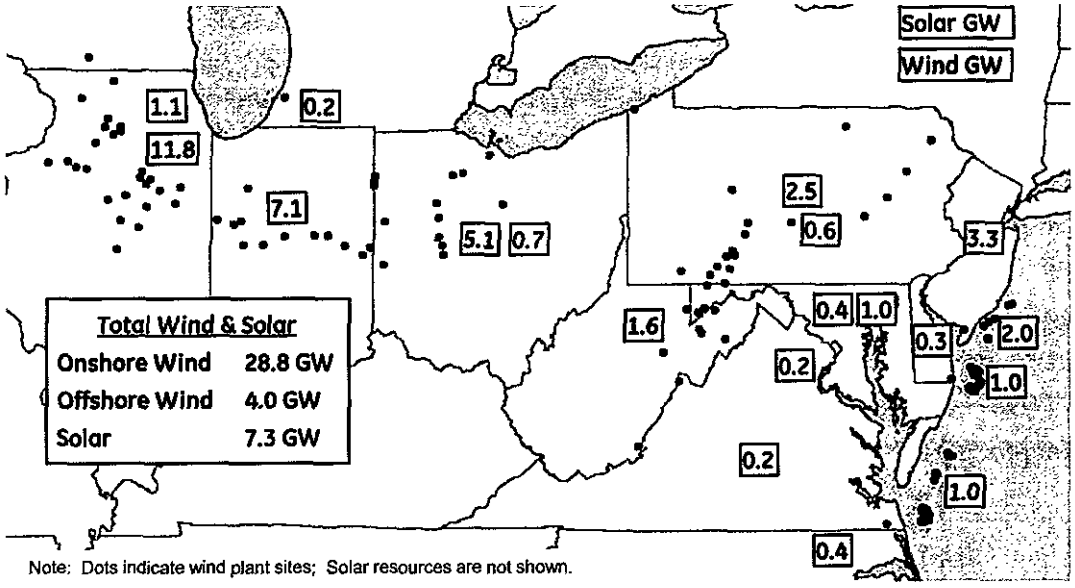


Figure 1: PJM Wind and Solar Capacity by State for 14% RPS Scenario

Most of the scenario technical analysis was performed using wind, solar and load profiles from year 2006. Four scenarios (2% BAU, 14% RPS, 20% LOBO, and 30% LOBO) were analyzed with 2004, 2005, and 2006 renewable and load profiles, in order to quantify differences in performance using different profile years. Although there were some observable differences in operational and economic performance due to differences in wind and solar production across the three profile years, the overall impacts were relatively small and did not affect the study conclusions.

3 Study Assumptions

PJM annual load energy was extrapolated to the study year 2026 using a method to retain critical daily and seasonal load shape characteristics. The average annual load growth for PJM was assumed to be 1.1%[4]. Load for the rest of the Eastern Interconnection was based on Ventyx "Historical and Forecast Demand by Zone".

New thermal generators (about 35 GW of SCGT and 6 GW of CCGT) were added to the PJM system in the 2% BAU scenario to meet the reserve margin requirements in 2026 consistent

[4] The base case assumed a PJM net energy forecast of 969,596 GWh in 2026 (excluding EKPC) based on the 2011 PJM Load Forecast Report (January 2011). The 2014 Preliminary PJM Load Forecast report shows a net energy forecast of 889,841 GWh in 2026 excluding EKPC, i.e., a reduction of 8.2%.

with the assumed load growth (for a total of about 65 GW of SCGT and 38 GW of CCGT). For consistency across scenarios, the new thermal generators added to meet reserve requirements in the 2% BAU scenario remained available in all higher renewable penetration scenarios. The additions included ISA/FSA qualified plants from the PJM queue, but rest of the additions were not reflective of other future projects in the PJM queue.

Some existing PJM power plants were assumed to retire by 2026, per retirement forecast data from PJM and Ventyx.

All operating power plants were assumed to have the necessary control technologies to be compliant with emissions requirements. No emission or carbon costs were assumed in the base scenarios although Carbon costs were considered in one of the sensitivity cases.

Fuel prices used for production cost simulations are shown in Table 2.

Table 2: Forecasted Fuel Prices for Study Year 2026

Fuel Type	Nominal Price	Source	Comments
Natural Gas	$8.02/MMBtu	EIA 2012 Energy Outlook	At Henry Hub; Regional basis differentials provided by PJM
Coal	$3.51/MMBtu	EIA 2012 Energy Outlook	Adjusted to reflect regional price differences ($1.15 to $6.08) per Ventyx historical usage data
Nuclear	$0.75/MMBtu	Ventyx Energy Velocity Forecast	
Residual No.2 Oil	$15.04/MMBtu	Energy Velocity NYMEX Forecast	Adjusted to include monthly variation patterns ($14.92 to $15.20)
LS No.2 Diesel	$22.56/MMBtu	Energy Velocity NYMEX Forecast	Adjusted to include monthly variation patterns ($22.37 to $22.79)

The wind profiles produced for this study used performance characteristics from the most current power conversion technologies as of July 2011. Therefore, the power output profiles are slightly higher than what has been historically observed in PJM.

4 Major Conclusions and Recommendations

A brief summary of the major conclusions and recommendations are listed here. Further details are presented in subsequent sections of this report.

Conclusions

The study findings indicate that the PJM system, with adequate transmission expansion and additional regulating reserves, will not have any significant issues operating with up to 30%

of its energy provided by wind and solar generation. The amount of additional transmission[5] and reserves required are briefly defined later in this summary and in much greater detail in the main body of the report.

- Although the values varied based on total penetration and the type of renewable generation added, on average, 36% of the delivered renewable energy displaced PJM coal fired generation, 39% displaced PJM gas fired generation, and the rest displaced PJM imports (or increased exports).
- No insurmountable operating issues were uncovered over the many simulated scenarios of system-wide hourly operation and this was supported by hundreds of hours of sub-hourly operation using actual PJM ramping capability.
- There was minimal curtailment of the renewable generation and this tended to result from localized congestion rather than broader system constraints.
- Every scenario examined resulted in lower PJM fuel and variable Operations and Maintenance (O&M) costs as well as lower average Locational Marginal Prices (LMPs). The lower LMPs, when combined with the reduced capacity factors, resulted in lower gross and net revenues for the conventional generation resources. No examination was made to see if this might result in some of the less viable generation advancing their retirement dates.
- Additional regulation was required to compensate for the increased variability introduced by the renewable generation. The 30% scenarios, which added over 100,000 MW of renewable capacity, required an annual average of only 1,000 to 1,500 MW of additional regulation compared to the roughly 1,200 MW of regulation modeled for load alone. No additional operating (spinning) reserves were required.
- In addition to the reduced capacity factors on the thermal generation, some of the higher penetration scenarios showed new patterns of usage. High penetrations of solar generation significantly reduced the net loads during the day and resulted in economic operation which required the peaking turbines to run for a few hours prior to sun up and after sun set rather than committing larger intermediate and base load generation to run throughout the day.
- The renewable generation increased the amount of cycling (start up, shut down and ramping) on the existing fleet of generators, which imply increased variable O&M costs on these units. These increased costs were small relative to the value of the fuel displacement and did not significantly affect the overall economic impact of the renewable generation.

[5] This study did not examine the cost allocation for the transmission expansion required to deliver the renewable energy in the study scenarios.

- While cycling operations will increase a unit's emissions relative to steady state operations, these increases were small relative to the reductions due to the displacement of the fossil fueled generation.

Recommendations

Adjustments to Regulation Requirements

The amount of regulation required by the PJM system is highly dependent upon the amount of wind and solar production at that time. It is recommended that PJM develop a method to determine regulation requirements based on forecasted levels of wind and solar production. Day-ahead and shorter term forecasts could be used for this purpose.

Renewable Energy Capacity Valuation

Capacity value of renewable energy has a slightly diminishing return at progressively higher penetration, and the LOLE/ELCC approach provides a rigorous methodology for accurate capacity valuation of renewable energy.

PJM may want to consider an annual or bi-annual application of methodology in order to calibrate its renewable capacity valuation methodology in order to occasionally adjust the applicable capacity valuation of different classes of renewable energy resources in PJM.

Mid-Term Commitment & Better Wind and Solar Forecast

Inherent errors in the day-ahead forecasts for wind and solar production lead to suboptimal commitment of generation resources in real-time operations, especially if simple cycle combustion turbines are the primary resources used to compensate for any generation shortages. Wind and solar forecasts are much more accurate in the four- to five-hour-ahead timeframe than in the current day-ahead commitment process. It is recommended that PJM consider using such a mid-range forecast in real-time operations to update the commitment of intermediate units (such as combined cycle units that could start in a few hours). The wind and solar forecast feature can be added to the current PJM application called Intermediate Term Security Constrained Economic Dispatch (IT SCED)[6] which is used to commit CT's and guides the Real Time SCED (RT SCED) by looking ahead up to two hours. This would result in less reliance on higher cost peaking generation.

Exploring Improvements to Ramp Rate Performance

Ramp-rate limits on the existing baseload generation fleet may constrain PJM's ability to respond to rapid changes in net system load in some operating conditions. It is

[6] "Real-time Security-Constrained Economic Dispatch and Commitment in the PJM: Experiences and Challenges", Simon Tam, Manager, Markets Coordination, PJM Interconnection, June 29, 2011.

recommended that PJM explore the reasons for ramping constraints on specific units, determine whether the limitation are technical, contractual, or otherwise, and investigate possible methods for improving ramp rate performance.

5 Statistical Characteristics of Load, Wind and Solar Profiles

A wide variety of statistical evaluations were performed on the load, wind and solar profiles to build understanding on how they would impact the annual, seasonal, daily, and short-term operation of the PJM grid. A few examples are presented here.

Figure 2 exhibits duration curves of load-net-renewables (wind + solar), which show the portion of the PJM load that must be served by non-renewable generation resources. The right-hand portions of the curves show that in the higher penetration scenarios, renewables serve about half of total system load during low-load periods.

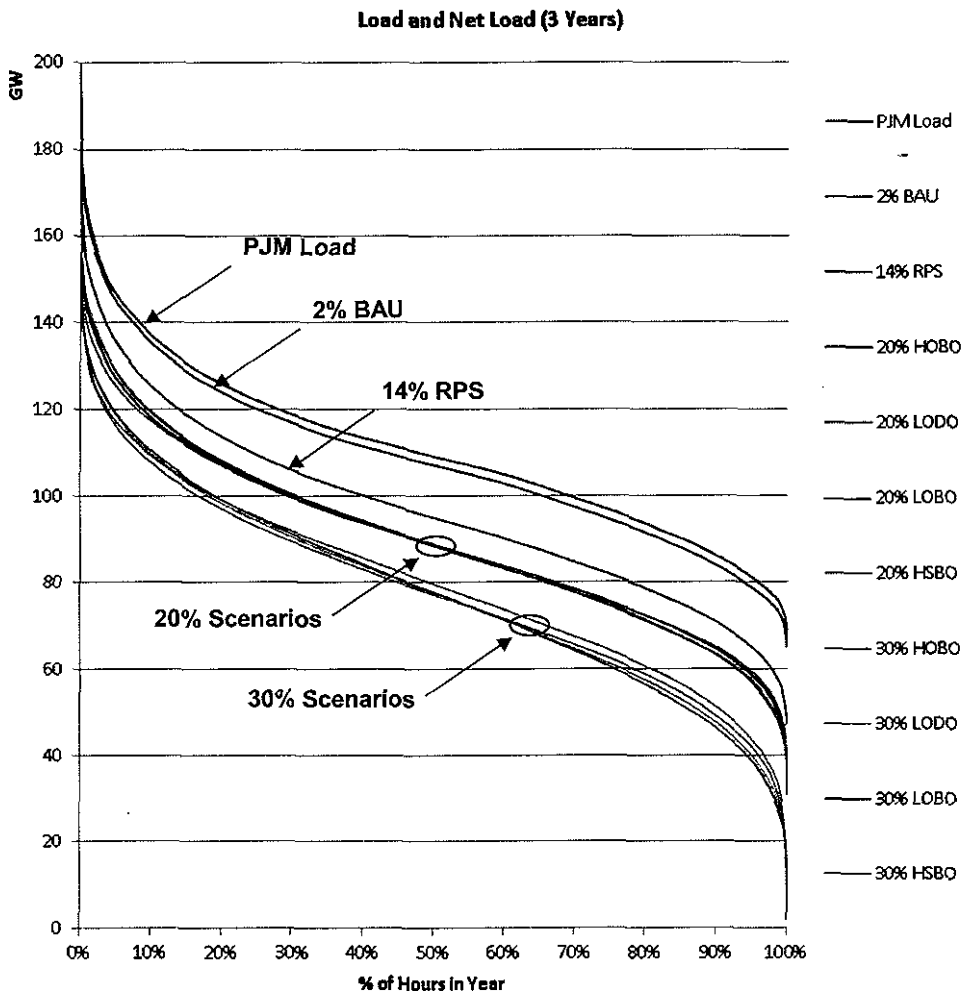


Figure 2: Duration Curves of PJM Load and Load-Net-Renewables for Study Scenarios

Figure 3 shows 10-minute variability (i.e., the change in 10-minute renewable production from one 10-minute period to the next) as a function of total renewable production for three scenarios with increasing renewable penetration (2%, 14%, and 30%). One significant trend is that the maximum 10-minute variations occur when renewable production is about half of total renewable capacity. Variability is lower near maximum production levels, partly because many wind plants are operating above the knee in the wind-power curve where changes in wind speed do not affect electrical power output. This characteristic of variability is relevant to the regulation requirements, which is discussed later.

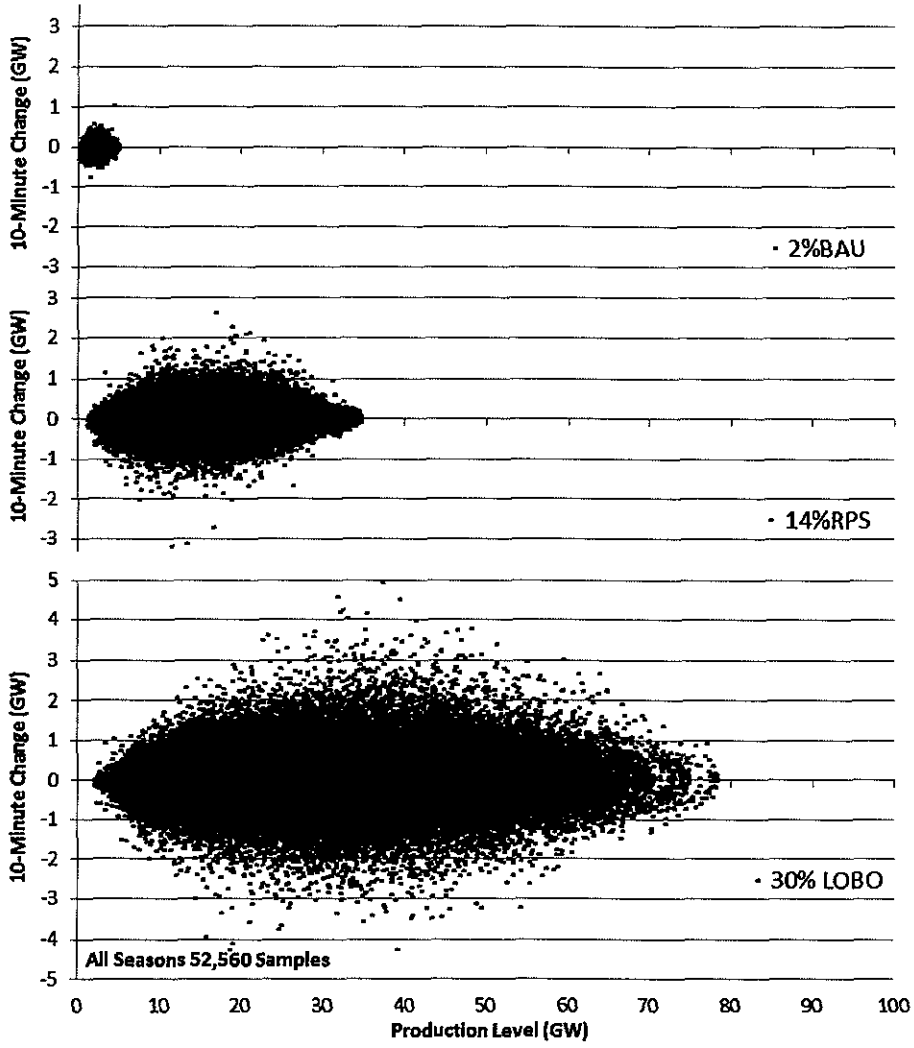


Figure 3: Ten-Minute Wind and Solar Variability as Function of Production Level for Increasing Renewable Penetration

Figure 4 shows average daily wind profiles by season for two scenarios. The trends show lower power output during the midday hours, especially during the summer season. This trend is complementary to solar profiles which naturally peak during midday and have higher production during the summer season.

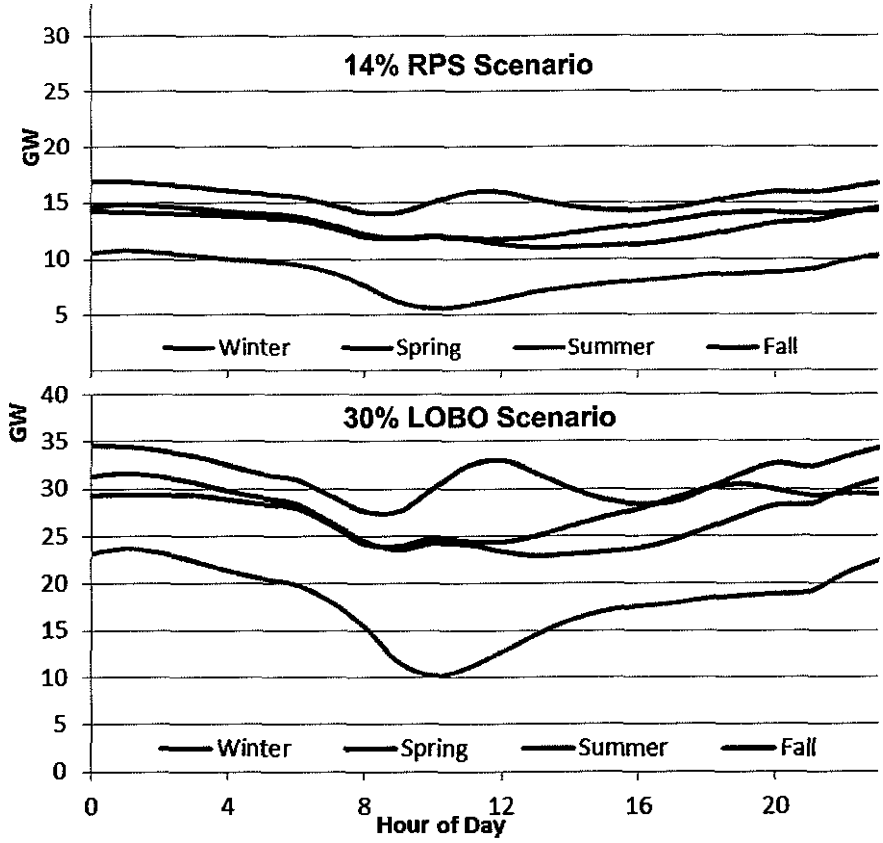


Figure 4: Average Daily Wind Profile by Season for 14% RPS and 30% LOBO Scenarios

Figure 5 illustrates how the variability of individual wind and solar PV plants is reduced when all wind and solar PV plants are aggregated over PJM's footprint. The upper traces show the high variability associated with individual plants. The two wind plants and the Illinois solar plant show high short term variability. The New Jersey solar plant has a smooth profile, indicating a relatively clear or hazy day. The next traces below show the aggregate profiles for all wind and solar plants within the states of New Jersey, Pennsylvania, and Illinois. The lower traces show profiles for all wind plants in PJM, all PV plants in PJM, and the combination of all wind and PV plants in PJM. Short-term variability is dramatically reduced when aggregated across PJM's footprint. Values shown are in terms of per units of capacity ratings. PJM's large geographic footprint is of significant benefit for integrating wind and solar generation, and greatly reduces the magnitude of variability-related challenges as compared to smaller balancing areas.

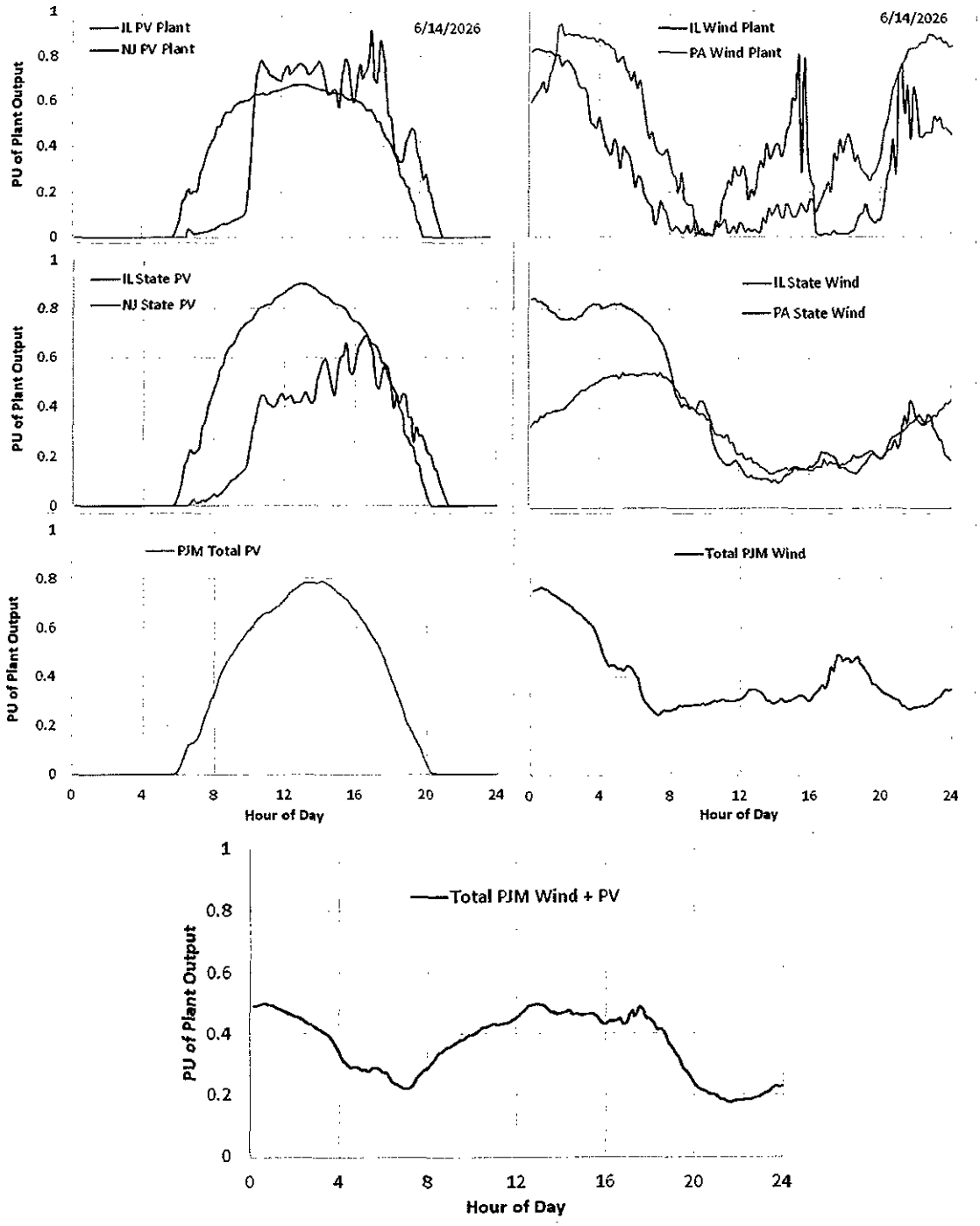


Figure 5: Smoothing of Plant-Level 10-Minute Variability over PJM's Footprint, June 14, 30% LOBO

6 Regulation and Reserves

With increasing levels of wind and solar generation, it will be necessary for PJM to carry higher levels of reserves to respond to the inherent variability and uncertainty in the output of those resources. Currently PJM has four categories of ancillary services:

- Regulation, which include generating units or demand response resources that are under automatic control and respond to frequency deviations,
- Reserves, which include Contingency (Primary) Reserve (combination of Synchronized and Non-Synchronized Reserves), and Secondary Reserve,
- Black Start Service, which include generating units that can start and synchronize to the system without having an outside (system) source of AC power, and
- Reactive Services, which help maintain transmission voltages within acceptable limits.

Statistical analysis of wind, PV and load data was employed to determine how much additional regulation capacity would be required to manage renewable variability in each of the study scenarios. The regulation requirement for wind and solar was combined with the regulation requirement for load (a percentage of peak or valley load MW, per PJM rules) to calculate a total regulation requirement.

The analysis illustrated that the variability of wind and solar power output is a function of the total production level (see Figure 6). More regulation is needed when production is at mid-level, and less regulating reserves are needed when production is very low or very high. Previous studies have established that a statistically high level of confidence for reserve is achieved at about 3 standard deviations (or 3σ in industry parlance) of 10-minute renewable variability. The 3σ criterion was also adopted for this study, which means that the regulation requirements are designed to cover 99.7% of all 10-minute variations. Table 3 summarizes the range of regulation required for each scenario. In the production cost and sub-hourly simulations, the amount of regulation was adjusted hourly as a function of the total renewable energy production in each hour.

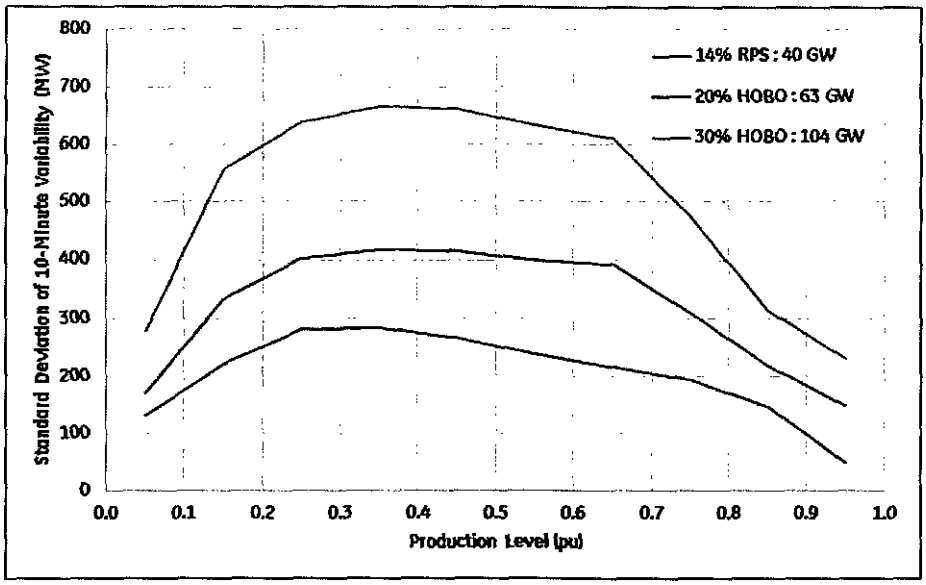


Figure 6: Ten-Minute Variability in Wind and Solar Output as a Function of Production Level

Table 3: Estimated Regulation Requirements for Study Scenarios

Regulation	Load Only	2% BAU	14% RPS	20% HOBO	20% LOBO	20% LODO	20% HSBO	30% HOBO	30% LOBO	30% LODO	30% HSBO
Maximum (MW)	2,003	2,018	2,351	2,507	2,721	2,591	2,984	3,044	3,552	3,191	4,111
Minimum (MW)	745	766	919	966	1,031	1,052	976	1,188	1,103	1,299	1,069
Average (MW)	1,204	1,222	1,566	1,715	1,894	1,784	1,958	2,169	2,504	2,286	2,737
% Increase Compared to Load		1.5%	30.1%	42.4%	57.3%	48.2%	62.6%	80.2%	108.0%	89.8%	127.4%

From a contingency perspective, none of the wind or solar plants added to the PJM system was large enough such that their loss would increase PJM's present level of contingency reserves. And given the large PJM footprint for a single balancing area, the impacts of short-term variability in wind and solar production is greatly reduced by aggregation and geographic diversity.

The following approach was adopted to assess the need for additional ancillary services due to wind and solar variability:

- Simulate hourly operation using GE MAPS, with regulation allocated per the criteria described above and contingency reserves per PJM's present practices.

- Using the hourly results of the GE MAPS simulations, compare the ramping capability of the committed units each hour with the sub-hourly variability of wind and solar production in that hour.
- Quantify the number of periods where ramping capability is insufficient.

Figure 7 is an excerpt from the ramp analysis, showing a day with three 10-minute periods when the change in net load (red dots) exceed the ramp-up capability of the committed generators (green line). Table 4 summarizes the analytical results for several scenarios, and shows that there are relatively few periods in a year when renewable ramps exceed fleet ramping capability, and those few events would not likely cause an unacceptable decrease in PJM's Control Performance Standard (CPS) measures.

The adequacy of the regulation was further confirmed by the challenging days simulated in the PROBE sub-hourly analysis. The selection criteria specifically included days with low ramp-rate and ramp-range capability relative to wind and solar ramps.

The results of the combined analytical methods indicate that no additional operating reserves would be required for the study scenarios.

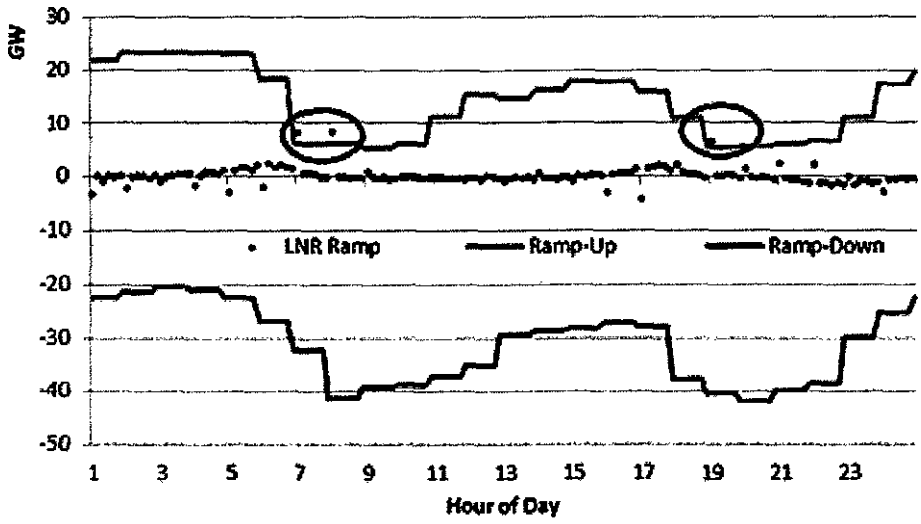


Figure 7: Sample Day Showing 10-Minute Periods that Exceeded Ramp Capability

Table 4: Ten-minute Periods Exceeding Ramp Capability for Selected Scenarios

52,560 Samples	2% BAU		14% RPS		30% HOBO		
Number of 10-Min samples exceeding dispatched ramp capability	Count	%	Count	%	Count	%	
Ramp-up	25	0.048%	32	0.061%	322	0.613%	
Ramp-down	0	0.000%	0	0.000%	5	0.010%	

7 Transmission System Upgrades

The transmission model was built upon the 2016 and 2017 Regional Transmission Expansion Plan (RTEP) models provided by PJM. New lines and other transmission upgrades were added to the transmission models for each study scenario to serve the increased load and generation resources. Given that the output of wind and solar resources inherently varies by time of day and season of year, the traditional transmission expansion planning methods were augmented by production cost analysis to ensure adequate transmission capacity without overbuilding. Some wind plants and thermal plants share common transmission corridors, and since wind plants are not dispatchable, it is not appropriate to size those corridors to accommodate simultaneous maximum output from both wind and thermal plants.

The transmission expansion process involved the following steps:

- Security-constrained optimal power flow analysis to identify transmission paths that are overloaded under contingency conditions and cannot be relieved by adjusting the dispatch.
- Generator deliverability analysis with wind and solar plant loaded to 100% of capacity value, to identify reliability problems that required transmission upgrades.
- Generator deliverability analysis with wind and solar plant loaded to 100% of energy value, to identify flowgates that could be overloaded and therefore should be monitored in production cost analysis.
- Production cost analysis to quantify annual transmission path utilization and congestion, and to identify paths with excessive congestion.

These steps were performed iteratively on each scenario to design a set of transmission upgrades that would achieve deliverability and reliability objectives while limiting congestion to a reasonable level. This was achieved by increasing transmission capacity until the largest contribution to congestion costs by a constrained element between two nodes with highest and lowest average annual LMP in the system was $5/MWh, averaged across the year.

Table 5 summarizes the transmission additions and upgrades for each scenario. New lines indicate new line construction on new or existing right-of-ways. Upgrades involve improvements to existing lines (i.e., reconductoring to increase current rating).

Table 5: New Lines and Transmission Upgrades for Study Scenarios

Scenario	765 kV New Lines (Miles)	765 kV Upgrades (Miles)	500 kV New Lines (Miles)	500 kV Upgrades (Miles)	345 kV New Lines (Miles)	345 kV Upgrades (Miles)	230 kV New Lines (Miles)	230 kV Upgrades (Miles)	Total (Miles)	Total Cost (Billion)	Total Congestion Cost (Billion)
2% BAU	0	0	0	0	0	0	0	0	0	$0	$1.9
14% RPS	260	0	42	61	352	35	0	4	754	$3.7	$4.0
20% Low Offshore Best Onshore	260	0	42	61	416	122	0	4	905	$4.1	$4.0
20% Low Offshore Dispersed Onshore	260	0	42	61	373	35	0	49	820	$3.8	$4.9
20% High Offshore Best Onshore	260	0	112	61	363	122	17	4	939	$4.4	$4.3
20% High Solar Best Onshore	260	0	42	61	365	122	0	4	854	$3.9	$3.3
30% Low Offshore Best Onshore	1800	0	42	61	796	129	44	74	2946	$13.7	$5.2
30% Low Offshore Dispersed Onshore	430	0	42	61	384	166	44	55	1182	$5.0	$6.3
30% High Offshore Best Onshore	1220	0	223	105	424	35	14	29	2050	$10.9	$5.3
30% High Solar Best Onshore	1090	0	42	61	386	122	4	4	1709	$8	$5.6

8 Impact of Renewables on Annual PJM Operations

Hourly annual operation for all study scenarios was simulated using the GE Multi-Area Production Simulation (GE MAPS) model. GE MAPS model employs Security-Constrained Unit Commitment (SCUC) and Security-Constrained Economic Dispatch (SCED) to emulate the hourly operation of a competitive market and models the full transmission system to account for congestion. The results show the following impacts of higher wind and solar energy penetration on the PJM grid:

- Lower Coal and CCGT generation under all scenarios. Wind and solar resources are effectively price-takers and therefore displace more expensive generation resources.
- Lower emissions of criteria pollutants and greenhouse gases, due to reduced operation of thermal generation resources.

- No unserved load and minimal renewable energy curtailment. New thermal resources were added to meet reserve requirements for the 2% BAU case in 2026, and those resources were kept available for all higher renewable penetration scenarios. This is a contributing factor in the result that in all scenarios there were adequate reserves and no instances of unserved load[7]. There were no operating conditions where wind/solar variability or uncertainty caused an insufficiency of generation. Nearly all of the wind and solar energy was used to serve load.
- Lower system-wide production costs (i.e., fuel and O&M costs for thermal generators)
- Lower gross revenues for conventional generation resources
- Lower average LMP and zonal prices across the PJM grid

Figure 8 illustrates how the energy dispatch shifts from gas and coal generation to renewable resources as the renewable penetration increases. The upper plot shows the progression to 20% penetration and the lower plot extends to 30% penetration of wind and solar energy. On average for all scenarios, about 36% of the renewable energy displaces coal-based generation about 39% displaces gas-fired generation, as compared to the 2% BAU Scenario.

[7] If the study plan had assumed constant installed reserve margins across all study scenarios, there would likely have been more instances of unserved load or demand response calls in the higher penetration scenarios.

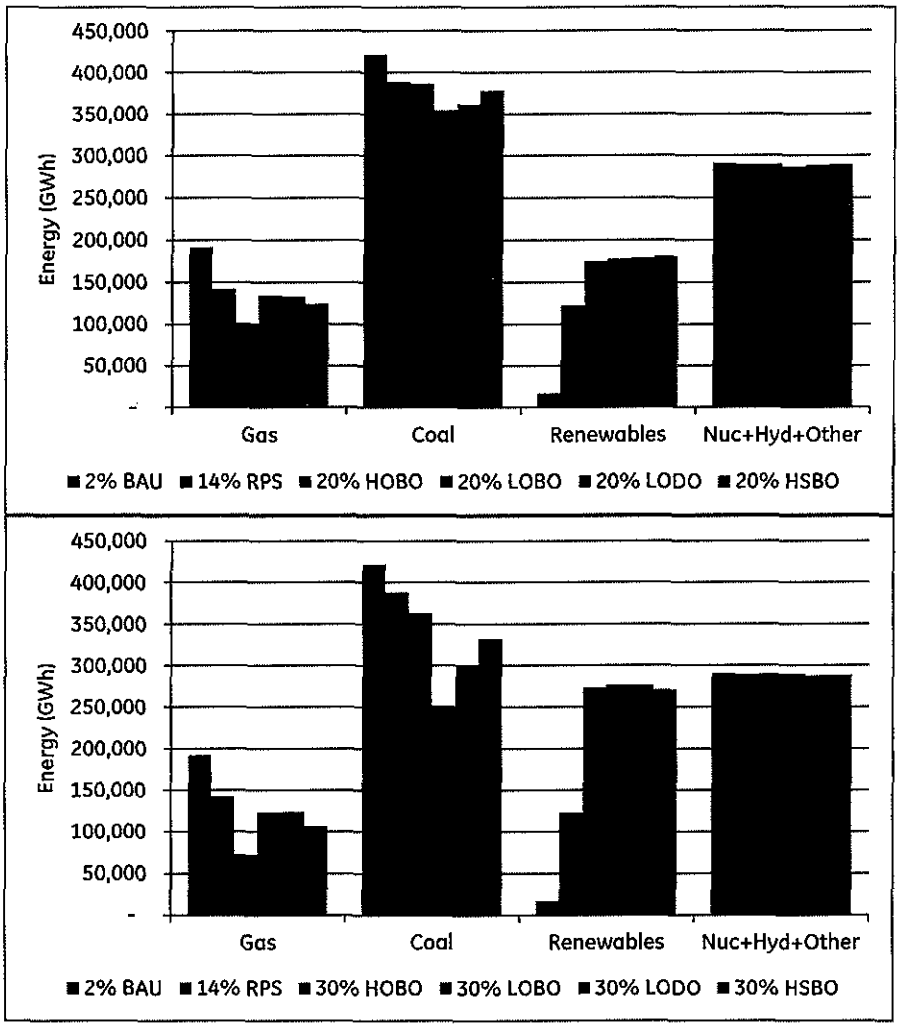


Figure 8: Annual Energy Production by Unit Type for Study Scenarios

Table 6 shows how several economic and energy parameters are affected by increased renewables in the study scenarios. Changes are measured relative to the 2% BAU scenario. In the 14% RPS scenario, 47% of the additional renewable energy displaces gas-fired resources and 31% displaces coal. In several of the 20% and 30% scenarios, proportionately more coal energy is displaced.

Table 6: Annual Production Cost and Energy Displacement by Unit Type for Study Scenarios

Scenario	Renewable Energy Delivered (GWh)	Production Cost ($B)	Wholesale Load Payments Delta ($B)	Gas Delta (GWh)	Coal Delta (GWh)	Imports Delta (GWh)	Gas Displacement (%)	Coal Displacement (%)	Reduced Imports (%)
2% BAU	17,217	40.5	7.18	192,025	421,618	67,390	0%	0%	0%
			Delta Relative to 2% BAU Scenario						
14% RPS	105,642	-6.8	-4.2	-49,590	-32,866	-21,397	-47%	-31%	-20%
20% HOBO	157,552	-10.6	-21.5	-90,194	-34,604	-31,302	-57%	-22%	-20%
20% LOBO	160,490	-9.9	-10.1	-56,854	-66,940	-32,267	-35%	-42%	-20%
20% LODO	161,542	-10.1	-8.6	-58,322	-59,647	-41,085	-36%	-37%	-25%
20% HSBO	164,253	-12.1	-12.7	-66,682	-42,505	-53,696	-41%	-26%	-33%
30% HOBO	256,400	-16.1	-21.5	-118,876	-58,453	-77,631	-46%	-23%	-30%
30% LOBO	259,428	-14.8	-10.1	-68,192	-170,920	-19,134	-26%	-66%	-7%
30% LODO	259,345	-15.1	-8.6	-68,013	-119,526	-68,653	-26%	-46%	-26%
30% HSBO	253,918	-15.6	-15.5	-84,511	-88,847	-78,382	-33%	-35%	-31%
Average							39%	-36%	-24%

Production Cost is sum of Fuel Costs, Variable O&M Costs, any Emission Tax/Allowance Costs, and Start-Up Costs – adjusted by adding Imports Costs and subtracting Export Sales.

Coal, Gas, and Import Displacement values are the ratio of GWh reductions in each energy resource (Coal, Gas, Imports) relative to the GWh increase in Total Renewable Energy Delivered.

This study did not evaluate potential impacts on the PJM Capacity Market due to reduced generator revenues from the wholesale energy market, nor did it evaluate the impact of renewables on rate payers. It is conceivable that lower energy prices would be at least partially offset by higher capacity prices.

Figure 9 shows several annual operational trends for the study scenarios. Compared to the 2% BAU scenario,

- Coal and CCGT capacity factors decline with increasing renewables
- CCGT annual starts remain the same for the 14% RPS scenario and double for many of the 20% and 30% scenarios, indicating an increase in cycling duty. Annual starts for coal plants increase slightly, indicating that there are periods of the year when some coal plants are not committed.
- Net energy revenues for CCGT and coal plants decline significantly with increasing renewables, potentially leading to additional generator retirements. This study did

not look at revenue adequacy, potential retirements, or the cost to maintain resource adequacy.

- Most of the new renewable energy is used to serve load and only a small portion must be curtailed in the 20% and 30% scenarios, mostly due to local congestion.

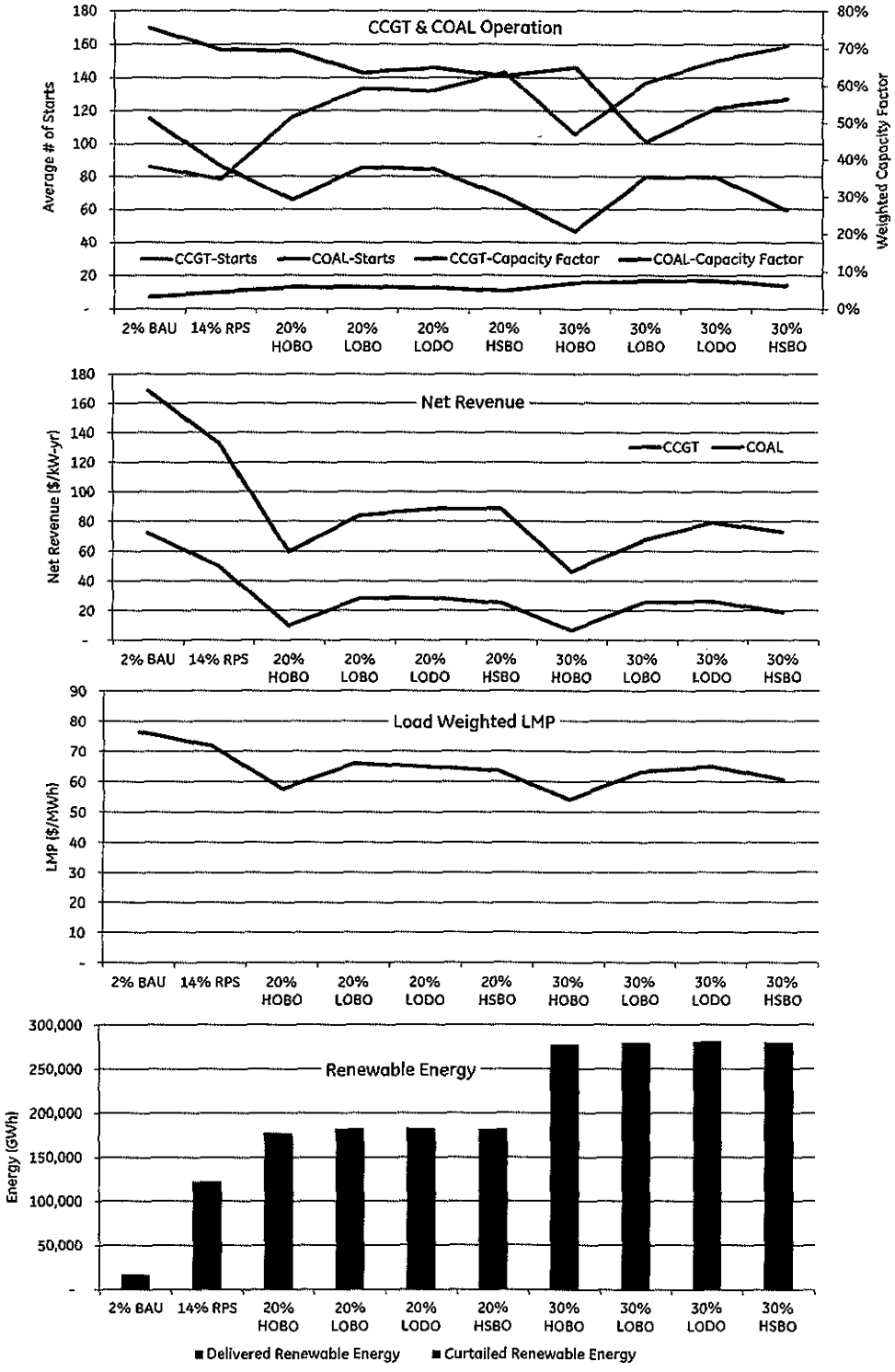


Figure 9: PJM Annual Operation Trends for Study Scenarios

Figure 10 shows trends in total PJM production costs and transmission expansion/upgrade costs as a function of renewable penetration level. Production costs are fairly similar for all scenarios with the same renewable energy penetration. Estimated transmission costs are similar for all 20% penetration scenarios but dramatically different for the 30% scenarios. The 30% LOBO scenario includes a high concentration of wind power in the western PJM region, and significant transmission upgrades are needed to transport that wind energy to load centers. In the LODO scenario, wind resources are more dispersed across the PJM footprint, so the wind plants are closer to load centers.

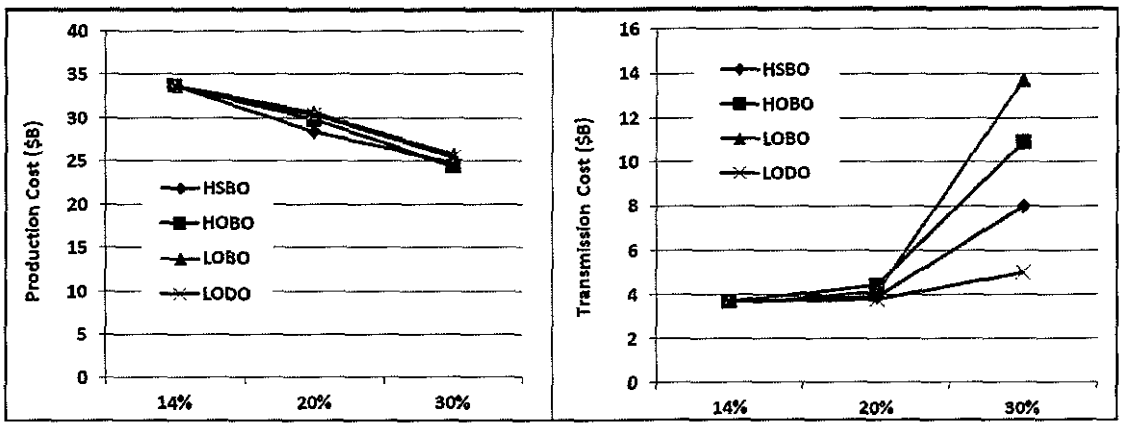


Figure 10: Trends in Production Costs and Transmission Costs versus Renewable Penetration

Table 7 shows the impact of renewable energy in production cost savings in each of the study scenarios. The value is calculated as the reduction in PJM annual production cost divided by the increase in delivered renewable energy, relative to the 2% BAU scenario. The right-hand column shows the production cost savings of the renewables adjusted for the estimated annualized cost of transmission upgrades. The range of production cost savings due to renewable energy ranges from $56 to $74 per MWh of Renewable Energy based on production costs alone, and $49 to $71 per MWh of Renewable Energy if estimated costs for transmission upgrades are included. As noted before, Production Cost is sum of Fuel Costs, Variable O&M Costs, any Emission Tax/Allowance Costs, and Start-Up Costs - adjusted by adding Imports Costs and subtracting Export Sales. A carrying charge of 15% was used to calculate the annualized transmission cost from total estimated capital costs.

Table 7: Renewable Contribution to Lowering Production Cost

Scenario	Renewable Energy Delivered (GWh) over the 2% BAU Scenario (GWh)	Production Cost Savings over the 2% BAU Scenario ($B/Year)	Production Cost Savings per MWh of Delivered Renewables ($/MWh RE)	Annualized Transmission Costs ($M/Year)	Transmission Costs per MWh of Delivered Renewables ($/MWh RE)	Production Cost Savings Adjusted for Transmission Costs ($/MWh RE)
14% RPS	105,642	-6.8	63.9	555	4.5	59.4
20% HOBO	157,552	-10.6	67.4	660	3.8	63.7
20% LOBO	160,490	-9.9	61.4	615	3.5	58.0
20% LODO	161,542	-10.1	62.6	570	3.2	59.4
20% HSBO	164,253	-12.1	73.8	585	3.2	70.6
30% HOBO	256,400	-16.1	62.7	1,635	6.0	56.8
30% LOBO	259,428	-14.8	56.9	2,055	7.4	49.5
30% LODO	259,345	-15.1	58.1	750	2.7	55.4
30% HSBO	253,918	-15.6	61.6	1,200	4.4	57.2

9 Sub-Hourly Operations and Real-Time Market

Sub-hourly analysis was performed to augment the hourly production cost simulations, to check if committed resources and reserves could keep up with short-term changes in load and renewables in real-time operations. The analysis explored:

- Adequacy of reserves
- Commitment/dispatch of quick-start CTs to follow rapid changes in net load
- Ramping capability and performance of dispatchable units
- Impact of day-ahead forecast errors and forward-market commitments
- Potential for unserved load
- Ability of the system to respond to fast-moving events

The analysis was performed using PowerGEM's PROBE simulation software, which is presently used by PJM to monitor daily performance of the real-time market. The approach involves identifying several challenging days for each scenario; that is, days with rapid changes in renewable output or other situations that would present difficulties for real-time operations. If the system performs successfully during the challenging days, then other less-challenging days would have acceptable performance as well. The screening criteria included:

- Largest 10-minute ramp in Load-Net-Renewable (LNR)
- Largest daily range in LNR (maximum LNR – minimum LNR for the day)

- Largest 10-minute ramp up or down deviations relative to the ramp capability of committed units
- High volatility day, with largest number of 10-minute periods where the change in net load (LNR) exceeded the range capability of committed units

In general, all the simulations of challenging days revealed successful operation of the PJM real-time market. Although there were occasionally periods of reserve shortfalls and new patterns of CT usage, there were no instances of unserved load.

The level of difficulty for real-time operations largely depends on the day-ahead unit commitment, which in turn depends on the day-ahead forecast for load, wind and solar. On days when the day-ahead commitment was significantly lower than the actual net load to be served in the real-time market - most commonly due to an over-forecast of wind and solar energy - additional CT generation resources were committed in real-time. The modeled installed CT capacity in PJM in 2026 is about 65 GW and these units were able to compensate for forecast errors and fast-moving events even on the most challenging days investigated in this study.

Higher penetrations of renewable energy (20% and 30%) create operational patterns that are significantly different than what is common today, especially with respect to CT usage. Figure 11 shows the CT usage for a summer-peak day in the 2% BAU scenario. It shows that about 56 GWs of CTs were committed in the day-ahead market (blue region) to meet the anticipated peak load during the mid-day hours. About 3 GWs of additional CTs were committed in the real-time market (red region) to make up for relatively minor forecast errors on that day. At the peak, there were still about 1 GWs of CTs available to respond to other unanticipated events.

Figure 12 shows a plot of CT usage for February 17 in the 30% LOBO scenario. The blue trace is total system demand, the red trace is total renewable generation, and the green symbols show the number of committed CTs. Figure 13 shows the March 4 PJM average LMP for several 20% and 30% scenarios. The price peaks around 8 am and 6 pm indicate increased commitment of CTs to compensate for short-term changes in load and renewables. These plots illustrate trends observed in many of the high renewable scenarios, where CT's are used less during peak load periods and more during periods where there are rapid changes in load, wind, and solar (particularly during the beginning and end of the solar day, when solar power output ramps up or down) or to compensate for errors in the day-ahead renewable energy forecast.

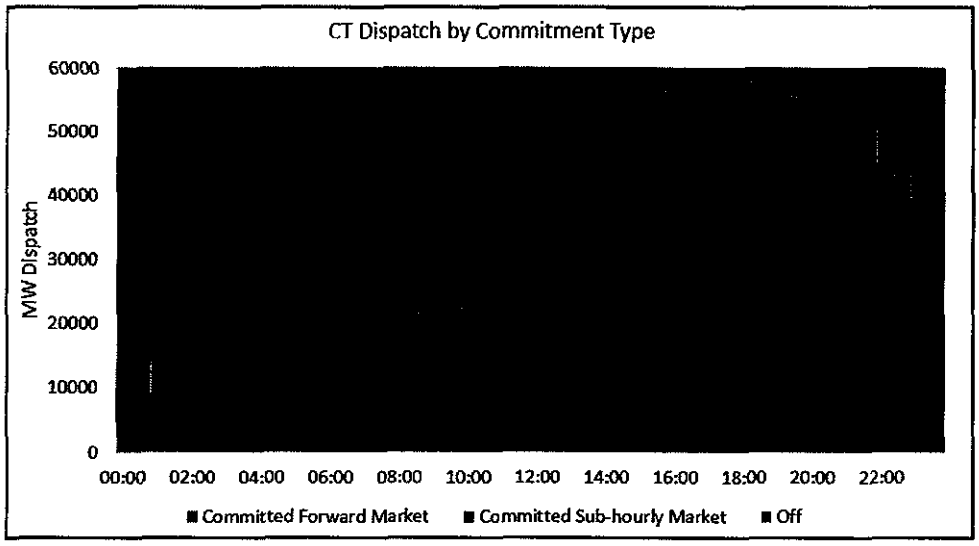


Figure 11: CT Capacity Committed (2% BAU, July 28)

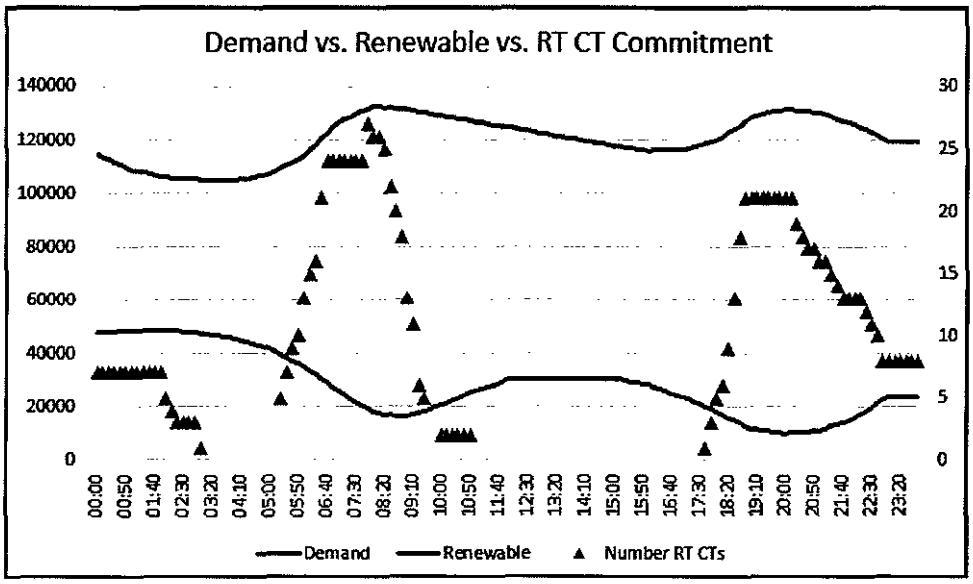


Figure 12: Demand MW, Renewable Dispatch, and # of CTs Committed in RT (30% LOBO, February 17)

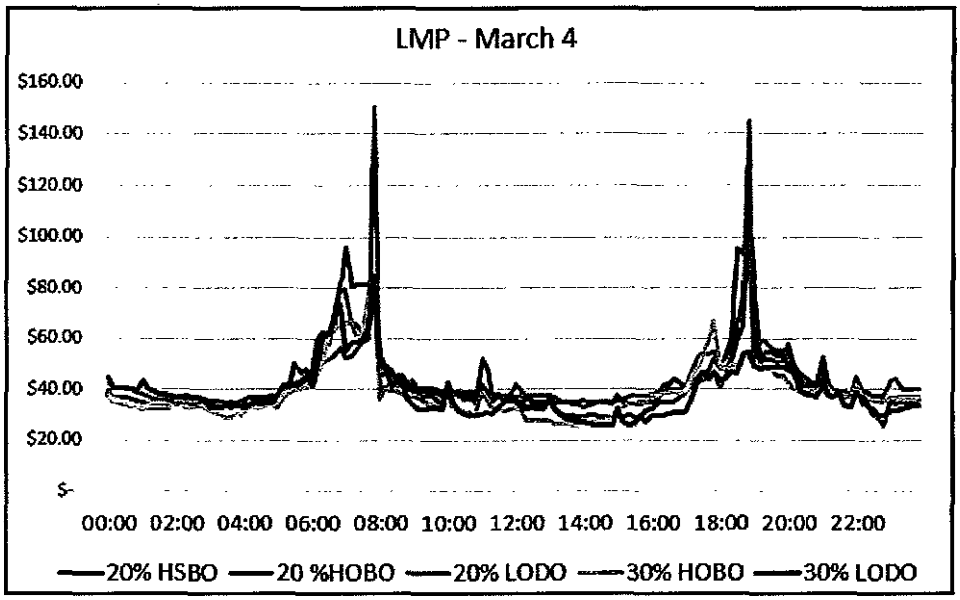


Figure 13: LMP Comparison for Several 20% and 30% Scenarios (March 4)

10 Capacity Value of Wind and Solar Resources

The reliability of a power system is governed by having sufficient generation capacity to meet the load at all times. There are several types of randomly occurring events, such as generator forced outages, unexpected de-ratings, etc., which must be taken into consideration during the planning stage to ensure sufficient generation capacity is available. Since the rated MW of installed generation may not be available at all times, due to the factors described above, the effective capacity value of generation is normally lower than 100% of its rated capacity. This effect becomes more pronounced for variable and intermittent resources, such as wind and solar PV. As an example, a 100 MW gas turbine will typically have a capacity value of approximately 95 MW, while a 100 MW wind plant may only have a capacity value of approximately 15 MW. It is therefore important to characterize the capacity value of such resources so that grid planners can ensure sufficient reserve margin or generation capacity is available at all times under a projected load growth scenario.

This report presents the analysis on the capacity value of wind and solar resources in different scenarios considered in the study. The analysis was conducted using GE Multi-Area Reliability Simulation (GE MARS) Software, and the capacity value was measured in terms of "Effective Load Carrying Capability" (ELCC). The ELCC of a resource is defined as the increase in peak load that will give the same system reliability as the original system without the resource. Figure 14 shows that the addition of a block of renewables allowed the peak load to increase by

30,000 MW in order to bring the system reliability back to the original design criteria of 0.1 days/year.

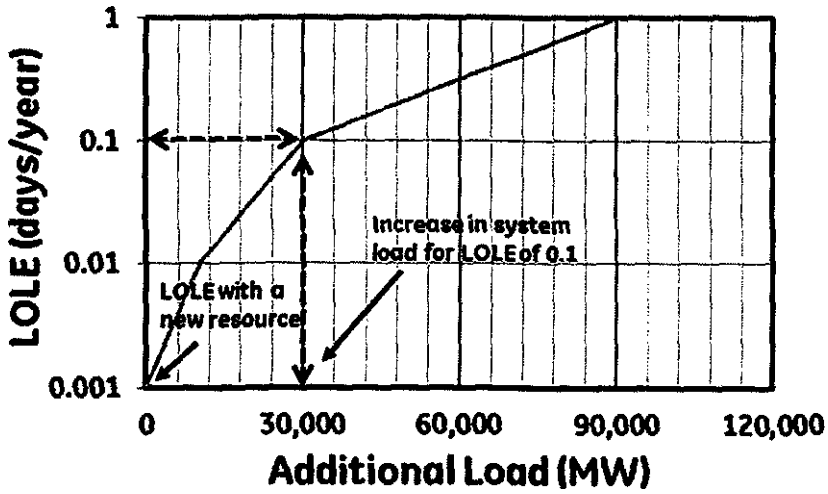


Figure 14: Effective Load Carrying Capability of a Resource

If this was for the addition of 100,000 MW of renewable capacity, the average ELCC would be 30% (i.e., 30,000 / 100,000). These values were determined for each renewable generation type over the range of penetration scenarios considered.

PJM Manual 21 defines the current procedures for estimating the capacity value of intermittent resources, such as wind and solar PV generators. The manual defines the capacity value of the intermittent resource (in percentage terms) as the average capacity factor that the resources have exhibited in the last three years during the Summer Peak Hours[8]. Table 8 compares the range of ELCC values to those determined using the PJM Manual 21 methodology. These values can be compared since they were based on the same hourly generation profiles.

[8] Summer Peak Hours are those hours ending 3, 4, 5, and 6 PM Local Prevailing Time on days from June 1 through August 31, inclusive.

Table 8: Range of Effective Load Carrying Capability (ELCC) for Wind and Solar Resources in 20% and 30% Scenarios

Resource	ELCC (%)	PJM Manual 21 (Summer Peak Hour Average Capacity Factor)
Residential PV	57% - 58%	51%
Commercial PV	55% - 56%	49%
Central PV	62% - 66%	62% - 63%
Off-shore Wind	21% - 29%	31% - 34%
Onshore Wind	14% - 18%	24% - 26%

These values are larger than the current class averages of 13% for wind and 38% for solar which were based on actual historical values. This is because the profiles were developed at optimum sites using the most current power conversion technologies. It was felt that these would provide a better estimate of the likely capacity values of the renewable plants in the future. Individual plants will continue to have their capacity values based on their actual performance and it is expected that the plants with newer technology will have higher values than existing ones.

11 Impact of Cycling Duty on Variable O&M Costs

Start-up/shutdown cycles and load ramping impose thermal stresses and fatigue effects on numerous power plant components. When units operate at constant power output, these effects are minimized. If cycling duty increases, the fatigue effects increase as well, thereby requiring increased maintenance costs to repair or replace damaged components. Figure 15 illustrates several types of cycling events that cause fatigue damage, with cold starts having the greatest impact.

The following technical approach was used to quantify the variable O&M (VOM) costs due to cycling for the various study scenarios:

- Characterize past cycling duty by examining historical operations data for the major types of thermal units in the PJM fleet; supercritical coal, subcritical coal, gas-fired combined cycle, large and small gas-fired combustion turbines[9].

[9] Nuclear and hydro units were not evaluated since nuclear units operate at constant load and hydro units do not experience thermal fatigue damage from cycling.

- Quantify O&M costs for those levels of cycling duty based on Intertek AIM's O&M/cycling database for a large sample of similar types of units.
- Establish baseline of cycling O&M costs by unit type for the 2% BAU scenario.
- Calculate changes to cycling duty and O&M costs for new operational patterns in each of the study scenarios from annual production cost simulation results.

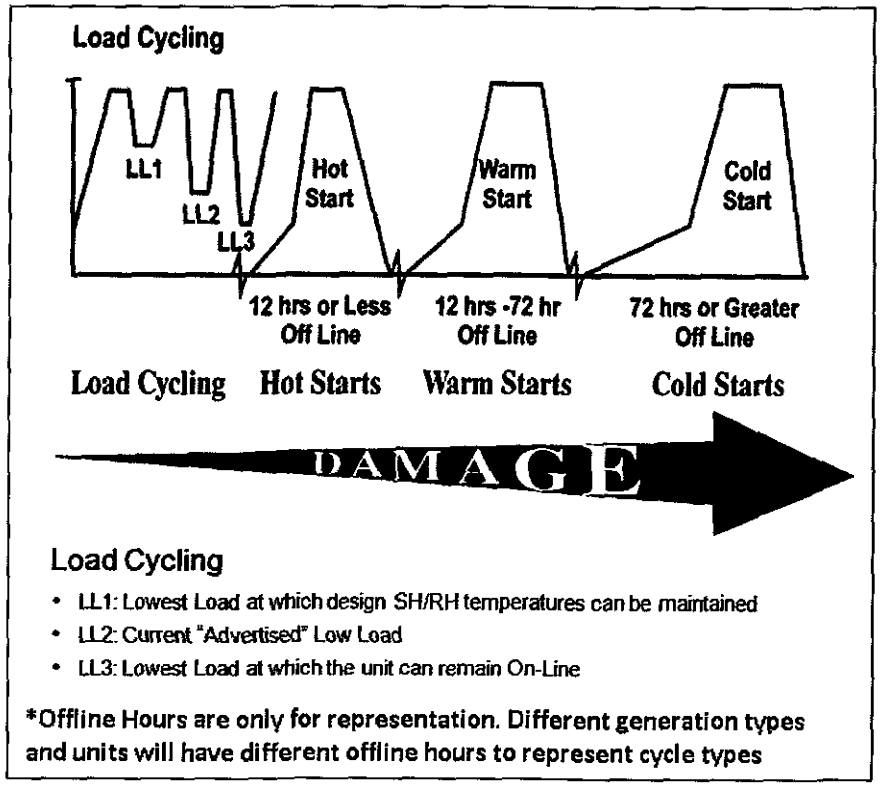


Figure 15: Types of Cycling Duty That Affect Cycling Costs

Figure 16 summarizes changes in cycling duty by study scenario for five types of PJM units. Combined cycle units experience the largest change in cycling duty as renewable penetration increases. Some increase in cycling is also evident for supercritical coal units in the 30% scenarios. Combined cycle units perform majority of the on/off cycling in the scenarios, with the coal units performing much of the load follow cycling.

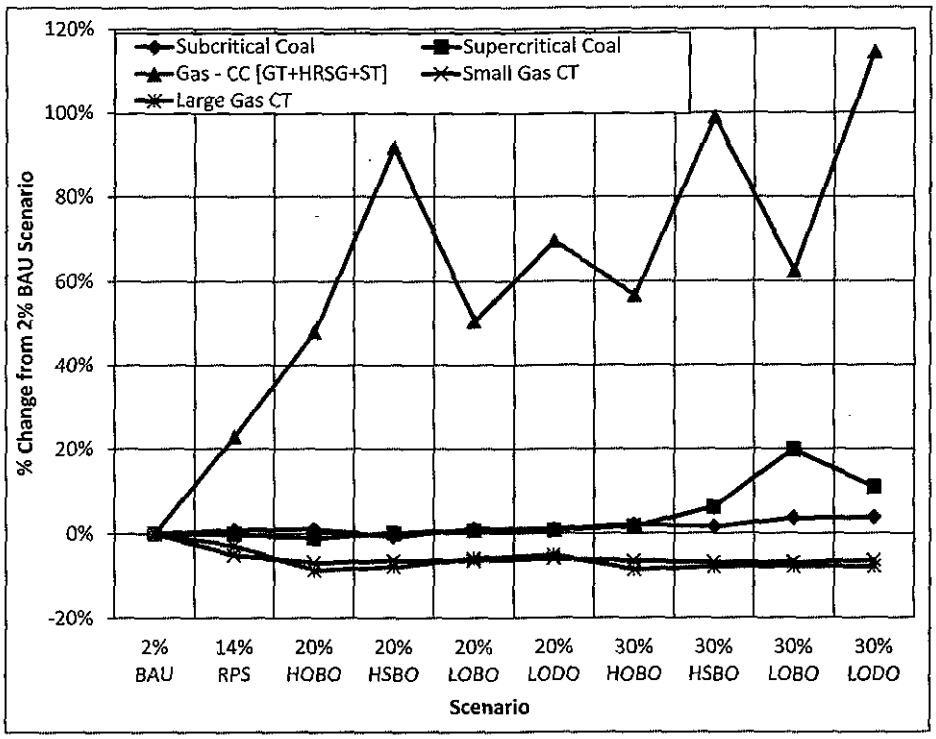


Figure 16: Net Effect on Cycling Damage Compared to 2% BAU Scenario

Table 9 shows cycling VOM costs in $/MWh. In almost all of the scenarios, the coal and combined cycle units perform increasing amounts of cycling; resulting in higher cycling related VOM cost and reduced baseload VOM cost, where:

Total VOM Cost = Baseload VOM + Cycling VOM

Table 9: Variable O&M Costs ($/MWh) Due to Cycling Duty for Study Scenarios

	2% BAU	14% RPS	20% HOBO	20% HSBO	20% LOBO	20% LODO	30% LOBO	30% HSBO	30% HOBO	30% LODO
Subcritical Coal	$1.14	$0.61	$1.78	$0.51	$0.69	$0.59	$1.09	$1.46	$2.52	$1.01
Supercritical Coal	$0.09	$0.11	$0.21	$0.15	$0.15	$0.14	$0.99	$0.31	$0.34	$0.46
Combined Cycle [GT+HRSG+ST]	$1.80	$2.69	$6.29	$5.19	$4.77	$4.68	$5.43	$7.55	$6.76	$5.81
Small Gas CT	$1.65	$1.74	$0.41	$0.52	$0.51	$0.60	$0.92	$0.87	$0.51	$0.82
Large Gas CT	$3.32	$3.41	$1.88	$2.68	$2.19	$2.42	$1.56	$1.52	$1.85	$2.02

Note: Cycling Costs = Start/Stop + Significant Load Follow

Figure 17 shows the net effect when cycling costs are included in the calculation of total system production costs. The two bars on the left show the total production costs for the 2% BAU and 30% LOBO scenarios, without considering the "extra" wear-and-tear duty imposed by increased unit cycling. The two bars on the right show the total production costs for the 2% BAU and 30% LOBO scenarios, with the "extra" wear-and-tear duty imposed by increased unit cycling. The 2% BAU production costs increase by about $0.87B from $40.47B to $41.34B, an increase of about 2.1%. The 30% LOBO production costs increase by about $0.50B from $25.71B to $26.21B, an increase of about 1.9%.

Looking at the two cases (with and without cycling costs) separately, it can be seen that the increased renewables in the 30% scenario reduce annual PJM production costs by $14.76B. If the VOM costs due to cycling are included in the calculation (the right-side bars), the increased renewables in the 30% scenario reduce annual PJM production costs by $15.13B.

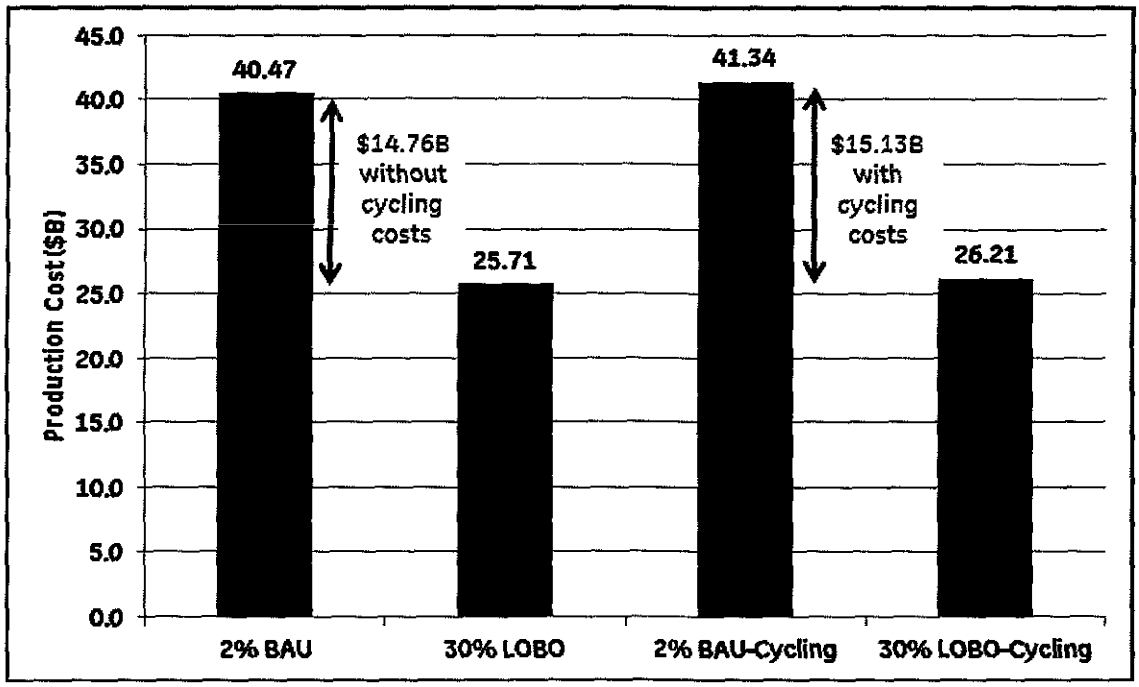


Figure 17: Impact of Cycling Effects on Total Production Costs for 2% BAU and 30% LOBO Scenarios

12 Power Plant Emissions

Variability of renewable energy resources requires the coal and gas fired generation resources to adapt with less efficient ramping and cycling operations, which in turn impacts their environmental emissions. This study examined the changes in emissions amounts and rates for the PJM portfolio for each of the study scenarios which differ in the level of cycling operations of the units.

Actual historical power plant emissions were analyzed to derive the impact of plant cycling on each type of power plant. Regression analysis was used to quantify the changes in plant emissions during ramps in plant output, when plant emission controls are often unable to keep emission rates as low as during steady-state operation.

GE MAPS production cost simulations were used to calculate the steady state "without cycling" emission amounts, which were then updated using Intertek AIM's regression results to generate the total "with cycling" emissions estimates.

Total Emissions = Steady State Emissions (from GE MAPS)
+ Extra Cycling-Related Emissions (from Intertek AIM Regression Model)

Figure 18 and Figure 19 show the overall results of the emissions analysis. In Figure 18, the dark blue bars show steady-state SOx emissions as calculated by the production cost simulations. The dark red bars stacked over the dark blue bars show incremental SOx emissions due to unit cycling. In Figure 19, the green and orange bars show similar results for NOx emissions. The black lines show total generation energy from the thermal power plants. The results indicate that SOx and NOx emissions decline as renewable penetration increases, but increased cycling causes the reduction to be somewhat smaller than would be calculated by simply considering a constant emission rate per MMBtu of energy consumed at gas and coal generation facilities. Table 10 presents similar results for CO2 emissions.

The overall results of the emissions analysis show that:

- Emissions from coal plants comprise 97% of the NOx and 99% of the SOx emissions.
- For scenarios that experience increased emissions due to cycling, the increases are dominated by supercritical coal emissions.
- NOx and SOx rates (lbs./MMBtu) increase at low loads for coal plants and decrease for CTs.
- Load-follow cycling is the primary contributor of cycling related emissions.

- Including the effects of cycling in emissions calculations does not significantly change the level of emissions for scenarios with higher levels of renewable generation. However, on/off cycling and load-following ramps do increase emissions over steady state levels. This analysis has provided quantified data on the magnitudes of those impacts.

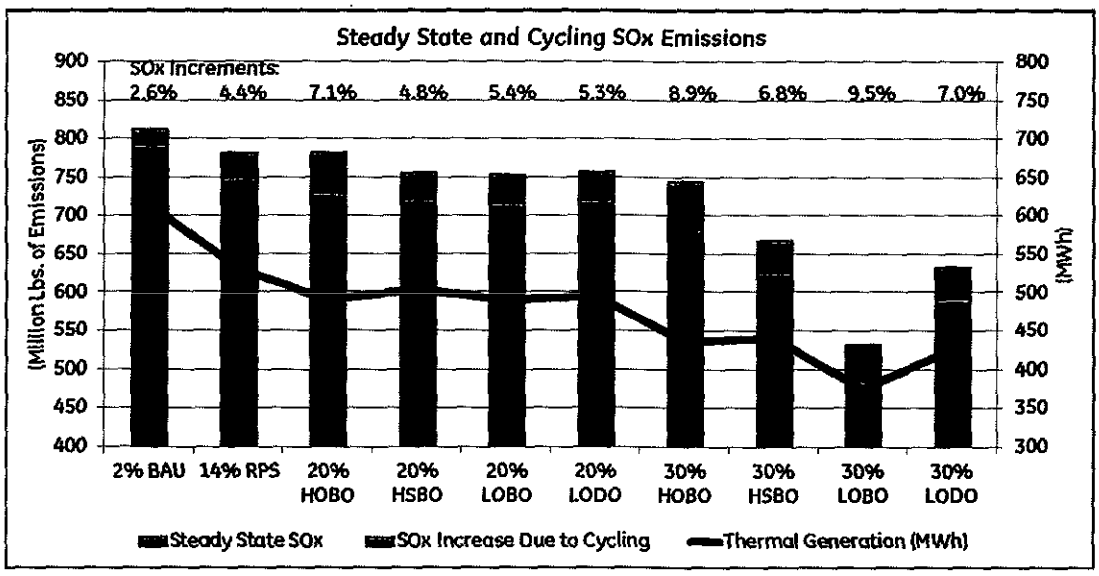


Figure 18: SOx Emissions for Study Scenarios, With and Without Cycling Effects Included

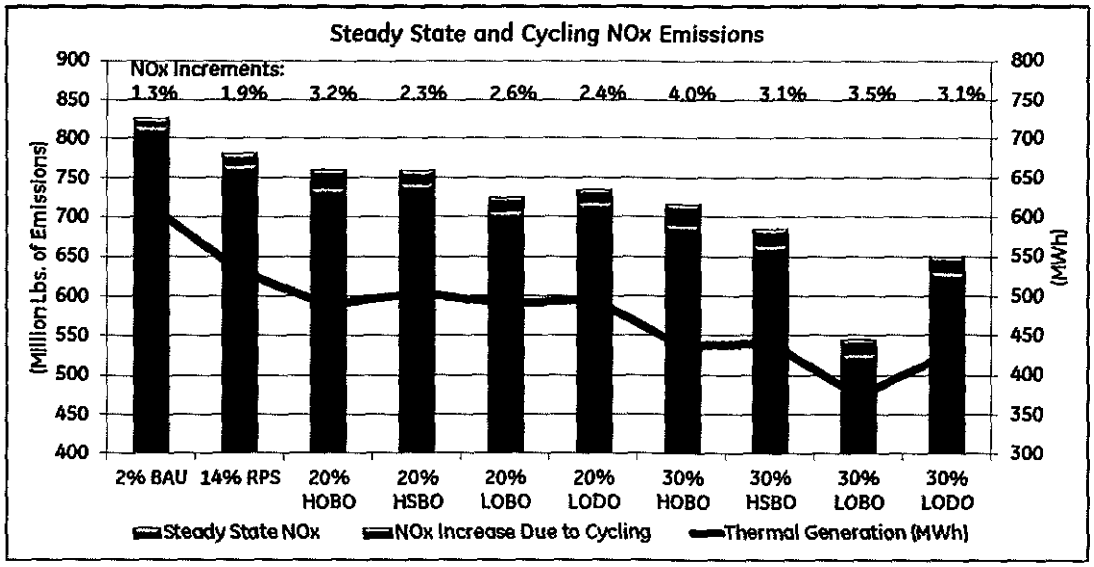


Figure 19: NOx Emissions for Study Scenarios, With and Without Cycling Effects Included

Table 10: CO2 Emissions from PJM Power Plants for Study Scenarios

Scenario	Reduction in MWh Energy Output from Coal and Gas Plants Relative to 2% BAU Scenario	Reduction in Heat Input (Fuel) Relative to 2% BAU Scenario	Reduction in CO2 Emissions Relative to 2% BAU Scenario
14% RPS	15%	14%	12%
20% HOBO	20%	18%	14%
20% HSBO	18%	16%	15%
20% LOBO	19%	19%	18%
20% LODO	18%	18%	17%
30% HOBO	35%	32%	27%
30% HSBO	31%	29%	28%
30% LOBO	40%	40%	41%
30% LODO	30%	29%	29%

13 Sensitivities to Changes in Study Assumptions

The following sensitivities were investigated using production cost simulations:

LL Low Load Growth: 6.1% reduction in demand energy compared to the base case

LG Low Natural Gas Price: AEO forecast of $6.50/MMBtu compared to $8.02/MMBtu in the base case

LL, LG Low Load Growth & Low Natural Gas Price

LG, C Low Natural Gas Price & High Carbon Cost: Carbon Cost $40/Ton compared to $0/Ton in the base case

PF Perfect Wind & Solar forecast: Perfect knowledge of the wind and solar for commitment and dispatch, which provides a benchmark of the maximum possible benefit from forecast improvements.

The analysis was performed on the 2% BAU, 14% RPS, 20% LOBO and 30% LOBO scenarios. Table 11, Table 12, and Table 13 show overall PJM production cost, generation revenue, load cost, and load-weighted LMP for the 14% RPS, 20% LOBO, and 30% LOBO scenarios. Figure 20 shows representative results for the 20% LOBO scenario, focusing on annual energy production by unit type and total system emissions.

Table 11: Sensitivity Analysis Results for 2% BAU Scenario

PJM Sensitivities	2% BAU	2% BAU (LL)	2% BAU (LL, LG)	2% BAU (LG)	2% BAU (LG, C)	2% BAU (PF)
Production Costs ($M)	40,470	36,099	34,370	38,341	59,763	40,462
Change from Base	0	-4,372	-6,100	-2,129	19,292	-8
Relative Change	0.00%	-12.11%	-17.75%	-5.55%	32.28%	-0.02%
Generator Revenue ($M)	70,023	61,057	53,826	62,263	93,352	70,182
Change from Base	0	-8,966	-16,197	-7,760	23,328	158
Relative Change	0.00%	-14.68%	-30.09%	-12.46%	24.99%	0.23%
Costs to Load ($M)	70,947	62,358	57,036	65,814	100,545	71,795
Change from Base	0	-8,589	-13,911	-5,133	29,597	848
Relative Change	0.00%	-13.77%	-24.39%	-7.80%	29.44%	1.18%
Load Wtd LMP ($/MWh)	76.5	71.8	65.7	70.9	108.4	77.4
Change from Base	0.0	-4.7	-10.8	-5.5	31.9	0.9
Relative Change	0.00%	-6.51%	-16.45%	-7.79%	29.44%	1.18%

Table 12: Sensitivity Analysis Results for 14% RPS Scenario

PJM Sensitivities	14% RPS	14% RPS (LL)	14% RPS (LL, LG)	14% RPS (LG)	14% RPS (LG, C)	14% RPS (PF)
Production Costs ($M)	33,719	29,791	28,482	32,102	50,380	33,470
Change from Base	0	-3,928	-5,237	-1,617	16,660	-250
Relative Change	0.00%	-13.19%	-18.39%	-5.04%	33.07%	-0.75%
Generator Revenue ($M)	66,390	59,628	52,242	59,283	91,473	62,829
Change from Base	0	-6,762	-14,148	-7,107	25,083	-3,561
Relative Change	0.00%	-11.34%	-27.08%	-11.99%	27.42%	-5.67%
Costs to Load ($M)	66,625	60,026	54,054	61,618	97,718	64,026
Change from Base	0	-6,599	-12,571	-5,007	31,093	-2,598
Relative Change	0.00%	-10.99%	-23.26%	-8.13%	31.82%	-4.06%
Load Wtd LMP ($/MWh)	71.8	69.1	62.2	66.4	105.3	69.0
Change from Base	0.0	-2.7	-9.6	-5.4	33.5	-2.8
Relative Change	0.00%	-3.91%	-15.39%	-8.12%	31.82%	-4.05%

Table 13: Sensitivity Analysis Results for 20% LOBO Scenario

PJM Sensitivities	20% LOBO	20% LOBO (LL)	20% LOBO (LL, LG)	20% LOBO (LG)	20% LOBO (LG, C)	20% LOBO (PF)
Production Costs ($M)	30,610	26,947	25,454	28,879	44,919	30,537
Change from Base	0	-3,663	-5,156	-1,731	14,309	-73
Relative Change	0.00%	-13.59%	-20.26%	-5.99%	31.86%	-0.24%
Generator Revenue ($M)	59,178	52,141	45,549	51,916	82,857	58,725
Change from Base	0	-7,037	-13,629	-7,262	23,679	-453
Relative Change	0.00%	-13.50%	-29.92%	-13.99%	28.58%	-0.77%
Costs to Load ($M)	61,341	52,551	47,541	54,528	90,294	59,197
Change from Base	0	-8,790	-13,800	-6,814	28,952	-2,144
Relative Change	0.00%	-16.73%	-29.03%	-12.50%	32.06%	-3.62%
Load Wtd LMP ($/MWh)	66.1	60.5	54.7	58.8	97.3	63.8
Change from Base	0.00	-5.62	-11.39	-7.35	31.21	-2.31
Relative Change	0.00%	-9.29%	-20.81%	-12.50%	32.06%	-3.63%

Table 14: Sensitivity Analysis Results for 30% LOBO Scenario

PJM Sensitivities	30% LOBO	30% LOBO (LL)	30% LOBO (LL, LG)	30% LOBO (LG)	30% LOBO (LG, C)	30% LOBO (PF)
Production Costs ($M)	25,708	22,255	20,778	24,092	36,517	25,506
Change from Base	0	-3,452	-4,930	-1,615	10,809	-201
Relative Change	0.00%	-15.51%	-23.72%	-6.71%	29.60%	-0.79%
Generator Revenue ($M)	56,860	49,648	43,001	48,969	79,940	55,769
Change from Base	0	-7,212	-13,859	-7,891	23,079	-1,091
Relative Change	0.00%	-14.53%	-32.23%	-16.11%	28.87%	-1.96%
Costs to Load ($M)	61,635	54,289	48,345	55,156	89,008	59,735
Change from Base	0	-7,346	-13,291	-6,479	27,372	-1,900
Relative Change	0.00%	-13.53%	-27.49%	-11.75%	30.75%	-3.18%
Load Wtd LMP ($/MWh)	63.2	59.3	52.8	56.6	91.3	61.3
Change from Base	0.00	-3.94	-10.43	-6.65	28.07	-1.95
Relative Change	0.00%	-6.65%	-19.76%	-11.75%	30.75%	-3.19%

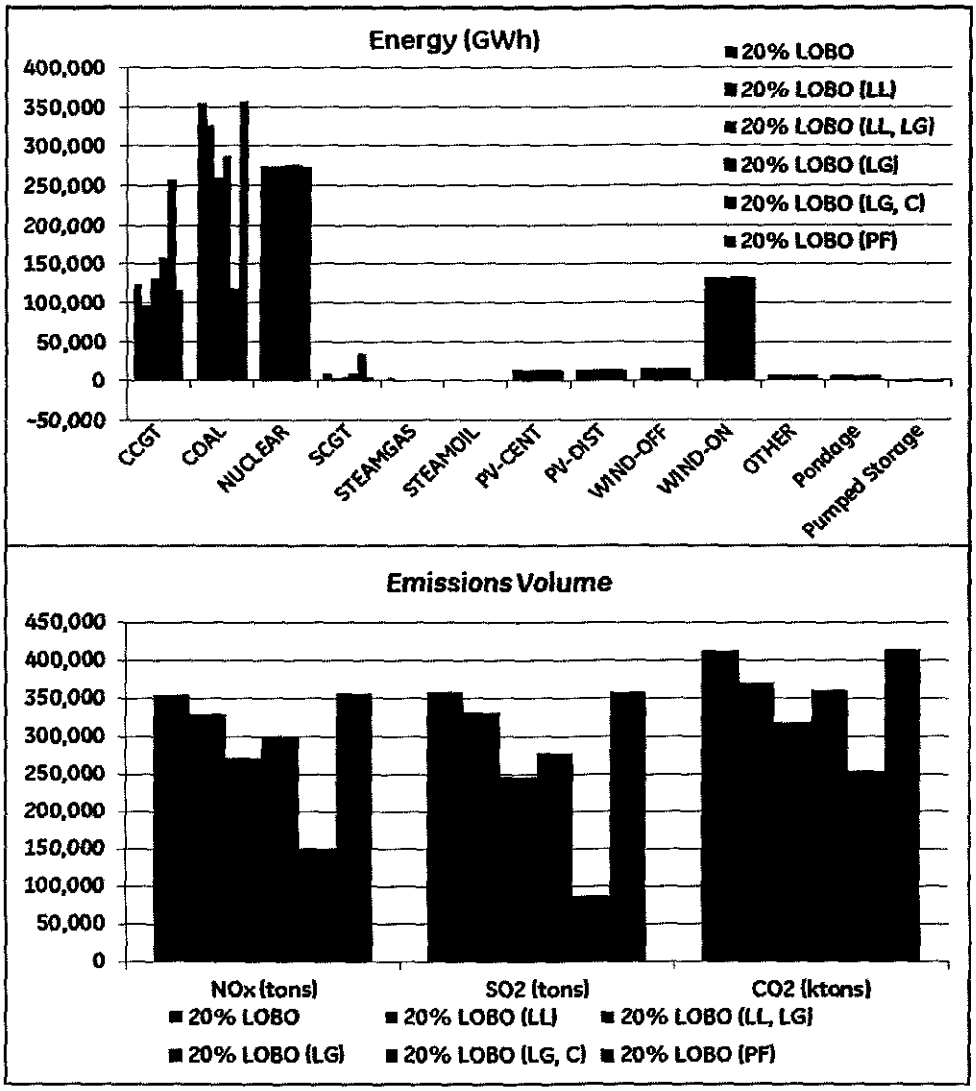


Figure 20: Sensitivity Analysis Results for 20% LOBO Scenario; Total Emissions and Energy by Unit Type

The sensitivity analysis revealed the following trends:

- Lower load growth caused a reduction of both coal and gas generation, resulting in lower production costs and average LMPs.
- Lower natural gas price caused an increase in gas-fired generation and a decrease in coal generation, also resulting in lower production costs and average LMPs.
- Lower natural gas price with increased carbon cost caused a dramatic decrease in coal generation and a significant increase in CCGT and SCGT operation. With the

carbon price included in the variable operating costs, total production costs and LMPs and load costs all increased by about 30% relative to the baseline assumptions.

- Lower load growth with lower natural gas price resulted in a reduction in coal generation, with minimal impact on the energy production of other generation resources.
- Perfect renewable forecast appeared to result in relatively small decrease in economic variables compared to the other sensitivities.
- Production cost savings from renewable energy can vary significantly depending on assumptions about fuel prices, load growth, and emission costs. For example, as shown in Table 15, compared to the base scenario, production cost savings in the 14% RPS scenario were 12.8% lower for the Low Load / Low Gas sensitivity and 39% higher for the Low Gas / High Carbon sensitivity.

Table 15: Impact of Sensitivities on Production Costs

	Base	(LL)	(LL, LG)	(LG)	(LG, C)	(PF)
Production Costs($M)						
2% BAU	40,470	36,099	34,370	38,341	59,763	40,462
14% RPS	33,719	29,791	28,482	32,102	50,380	33,470
20% LOBO	30,610	26,947	25,454	28,879	44,919	30,537
30% LOBO	25,708	22,255	20,778	24,092	36,517	25,506
Delta Relative to 2% BAU						
2% BAU	0	0	0	0	0	0
14% RPS	-6,751	-6,307	-5,888	-6,239	-9,383	-6,993
20% LOBO	-9,860	-9,151	-8,916	-9,462	-14,844	-9,925
30% LOBO	-14,763	-13,843	-13,592	-14,249	-23,246	-14,956
Compared to the Base Case						
2% BAU	-	-	-	-	-	-
14% RPS	-	-6.6%	-12.8%	-7.6%	39.0%	3.6%
20% LOBO	-	-7.2%	-9.6%	-4.0%	50.5%	0.7%
30% LOBO	-	-6.2%	-7.9%	-3.5%	57.5%	1.3%

14 Review of Industry Practices and Experience on Renewables Integration

This task investigated the current state of the art with variable generation integration, mostly focused on the United States but providing a few international examples where particularly relevant. The results are documented in a free-standing task report[10]. Key findings with particular relevance to PJM include:

Energy Market Scheduling

- Sub-hourly scheduling and dispatch, for both internal (within-RTO and within-utility) and for scheduling on external interconnections with other balancing authorities, improves performance relative to sub-hourly variability.

Visibility of Solar Distributed Generation

- Install telecommunications and remote control capability to clusters of solar DG in PJM's service area. Alternatively, have distribution utilities install such capability and communicate data and generation to PJM.
- Include distributed solar in variable generation forecasting.
- Account for the impacts of non-metered solar DG in load forecasting.
- Follow and/or participate in industry efforts to reconcile provisions in IEEE-1547 and Low-Voltage Ride-Through Requirements.

Reserves

- Consider separating regulation requirements into regulation up and regulation down if there is a shortage of regulation for certain hours, if there is a disproportionate need for a certain type of regulation (up or down), or if there is a desire to more finely tune regulation requirements.
- Have operating reserve requirements set by season or by level of expected variable generation, instead of a static requirement that changes infrequently.
- Use demand response to provide some reserves.
- Consider using contingency reserves for very large but infrequent wind and solar ramps.
- Require wind and solar generators to be capable of providing AGC.

[10] *PJM Renewable Integration Study, "Task Report: Review of Industry Practice and Experience in the Integration of Wind and Solar Generation", Prepared by: Exeter Associates, Inc. and GE Energy, November 2012.*

Wind and Solar Forecasting

- Implement a centralized forecasting system for wind and utility-scale solar that offers day-ahead, very short-term (0-6 hours), short-term (6-72 hours), and long-term forecasts (3-10 days).
- Ensure that short-term wind and solar forecasting systems can capture the probability of ramps, or implement a separate ramping forecast.
- Institute a severe weather warning system that can provide information to grid operators during weather events.
- Monitor the use of confidence intervals on forecast data and consider adjusting them periodically based on actual performance.
- Integrate the wind and solar forecasts with load forecasts to provide a "net load" forecast.
- Institute requirements for data collection from wind and solar generators that can be used to track forecast performance.

Intra-Day Unit Commitment: Consider establishing intra-day unit commitment, if one is not already in place, and incorporate short-term wind and solar forecasts.

Look-Ahead Dispatch: Consider Establishing a Look-Ahead Dispatch for very-short time frames.

Capacity Value of Wind and Solar: Conduct an ELCC study of wind and solar capacity value at regular intervals, and use them to calibrate or modify other approximate methods for calculating capacity values of wind and solar plants.

Wind Ramps: Require wind generators to be equipped with control functions that can limit ramp rates.

Frequency Response: Do not impose frequency response requirements on wind or central solar plants unless it is absolutely necessary.

15 Methods to Improve PJM System Performance

Several methods of mitigating operational issues or improving overall system performance were explored. The findings are summarized below.

Dynamic Procurement of Regulation Reserves

Study results show that the short-term variability in PJM load net renewables during a given hour is highly dependent upon the amount of wind and solar generation output during that hour. If the wind and solar generation is at a low level, then their contribution to variability is

small and the need for regulation is dominated by load variability. However, if wind and solar generation is high, then wind and solar variability dominate and more regulation is required. In an effort to minimize system operating costs, it would be prudent to only procure enough regulation to cover actual system needs each hour, as a function of wind and solar output each hour.

During this study period, PJM's practice was to set regulation requirements day-ahead as a percentage of forecast peak and valley load levels, and then to procure regulation during the operating day. When wind and solar penetration increases, PJM should consider a process to:

- Procure a portion of the necessary regulation in the day-ahead market, based on hourly forecast profiles of wind and solar generation.
- Dynamically adjust regulation procurement in the real-time market, based on short-term (1-2 hour ahead) wind and solar forecasts.

Figure 21 illustrates the process.

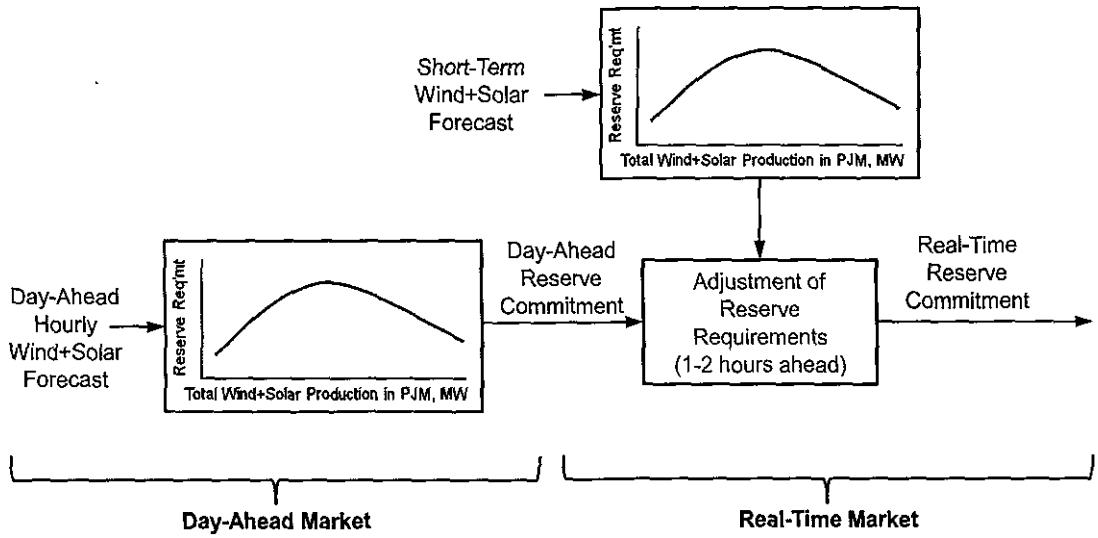


Figure 21: Process for Calculating Real-Time Regulation Requirements

Improving Commitment of Generation Resources

All study scenarios (with the possible exception of 2% BAU) experienced operational challenges on days when wind and solar energy were over-forecast in the day-ahead market. Given PJM's substantial fleet of CTs in 2026, the study results showed no situations of unserved load or other unacceptable conditions, but operation was certainly less optimal than it could have been if other more-efficient generation resources could have been used

to serve the load on those days. Two possible approaches to address this issue were investigated:

- Short-term recommitment using a 4-hour ahead wind and solar forecast
- Improvements in accuracy of the day-ahead wind and solar forecast

Short-Term Recommitment during Real-Time Operations

PJM's present practice is to commit most generation resources in the day-ahead forward market, and only commit combustion-turbine resources in the real-time market to make up for the normally small differences from the day-ahead forecast. When higher levels of renewable generation increase the levels of uncertainty in day-ahead forecasts, the present practice could lead to increased CT usage, in some cases for long periods of time where day-ahead wind and solar forecasts were off for many consecutive hours. In such circumstances, it would be more economical to commit other more efficient units, such as combined cycle plants that could be started in a few hours.

Figure 22 shows PJM production costs for the 14% RPS scenario. The left bar represents the present practice. The middle bar represents the same case, but with unit commitments adjusted during real-time operations using a 4-hour ahead forecast. It shows a $70M reduction in annual production costs, largely due to shifting a portion of generation from CTs to combined cycle units and a reduction in PJM imports. This is further illustrated in Figure 23, which shows the change in CT dispatch for one day of operation in the 14% RPS scenario.

As a point of comparison, the bar on the right in Figure 22 shows that production costs would be reduced by $250M if perfect wind and solar forecasts were possible.

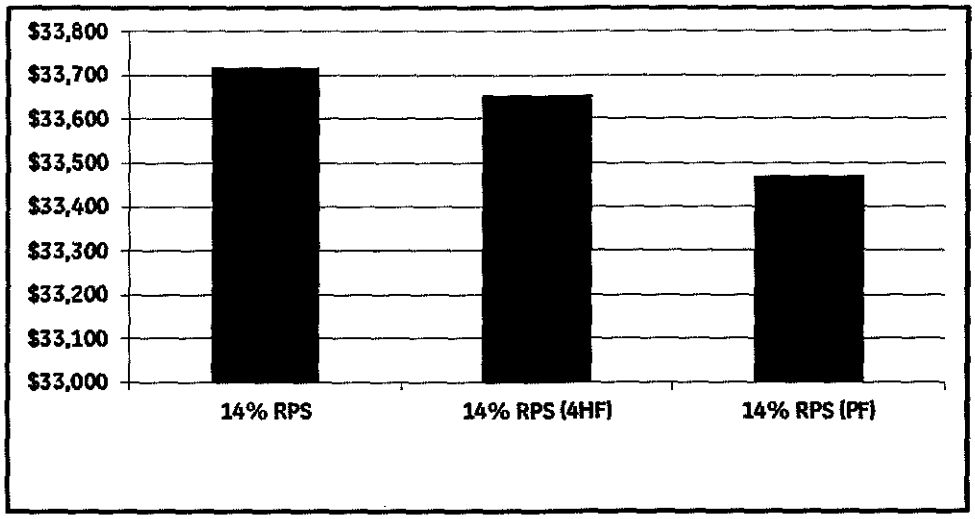


Figure 22: Production Cost Reduction with 4-Hour-Ahead Recommitment, 14% RPS Scenario

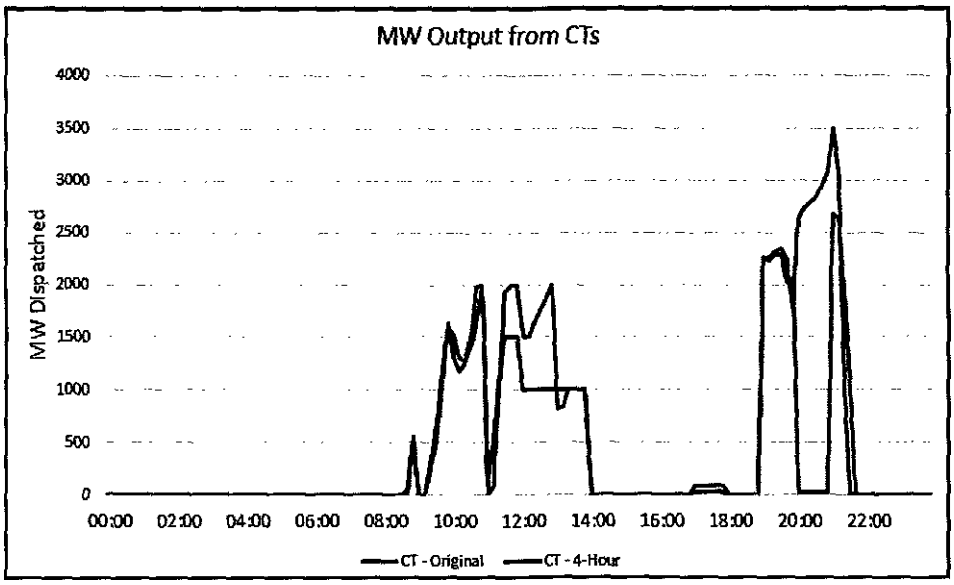


Figure 23: CT Dispatch for Existing Day-Ahead Unit Commitment Practice and 4-Hour-Ahead Recommitment (14% RPS Scenario, May 26)

Improvements in Day-Ahead Forecast Accuracy

Another approach to improve unit commitments and operational efficiency is to have a more accurate day-ahead wind and solar forecast. Study results indicate that a 20% reduction in day-ahead forecast errors could reduce annual production costs by about $15M

per year in the 20% LOBO scenario. Although it is not realistic for PJM to independently procure such improved forecasting technology, PJM could actively encourage and participate in ongoing research efforts by NREL, NOAA, and others to develop improved wind and solar forecasting methods. The success of such efforts would directly benefit PJM and all other operating areas with increasing penetrations of wind and solar energy.

Storage or Demand Response Resources for Spinning Reserve

There is a growing industry trend to use energy storage and demand response resources as an alternative to generation resources for spinning reserves. This study considered a case where 1000 MW of storage or demand response resources were used in place of generator resources for spinning reserves in the 30% LOBO scenario. Total system production costs were reduced by $17.41M/year, which corresponds to $1.99/MWh or $17.41/kW-year.

Energy storage resources are emerging as viable contributors to regulation reserves in some operating areas where the market prices of regulation services are adequate to make the capital investment worthwhile. This especially true in markets where the inherent fast-ramping capability of some storage technologies is financially rewarded (e.g., a mileage charge). In fact, some storage resources are already participating in PJM's regulation market. However, this study did not include economic assessment of the regulation market in PJM, so no specific conclusions can be drawn with respect to the economic competitiveness of energy storage devices as regulation resources in PJM as renewable penetration increases. The market price of regulation and the capital costs of energy storage devices will ultimately dictate viability.

Ramp-Rate Capabilities of Existing Power Plants

The sub-hourly analysis revealed a number of operating conditions where the system was constrained by the ability of the committed power plants to keep up with changes in net load. The power plants were ramp-rate limited. Investigation of these periods revealed that some power plants have very small ramp rates – significantly below 2% per minute, which is considered to be typical for steam power plants.

Figure 24 shows the number of ramp constrained units for a day of operation in the 30% LODO scenario. The blue trace corresponds to the existing ramp-rate limits and the red traces shows a case where all ramp-rate limits smaller than 2%/min were increased to 2%/min. The results of this analysis show a 51% reduction in ramp-constrained generation, fewer CTs get committed, lower LMPs, fewer transmission constraints, and more operating flexibility.

The results suggest that it would be beneficial for PJM to reevaluate the capability and performance of units with ramp rates that are below the fleet average. Experience from other operating areas has shown that power plant operators prefer to operate at constant outputs and have little or no incentive to ramp their units quickly. As a result, ramp-rate limits may be set to a conservative low value. It would be prudent for PJM to learn more about the factors affecting ramping performance of its generation fleet to prepare for a future when faster ramping would be beneficial to renewable energy integration.

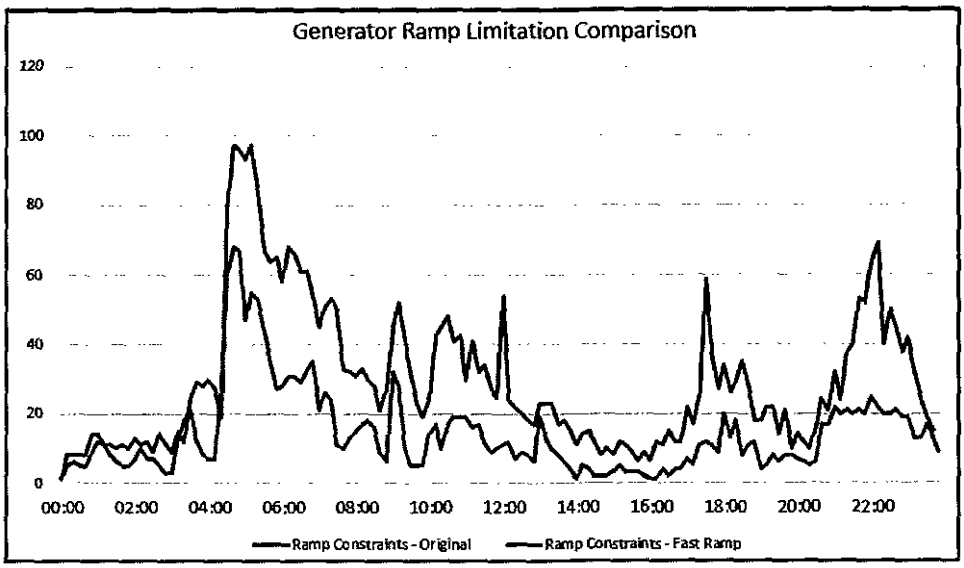


Figure 24: Number of Ramp Constrained Units with Existing Ramp Limits and 2%/min Ramp Limits

16 Topics for Further Study

Impacts of Reduced Energy Revenues for Conventional Power Plants

The study results show that as renewable penetration increases, wind and solar resources will displace energy production from conventional coal and gas generating plants. Energy revenues for conventional generation resources will decline significantly. To remain economically viable, these plants would either need to receive a larger share of their revenues from a capacity market or perhaps increase energy prices to help cover fixed costs. Alternatively, some conventional plants may not be viable and would be retired. It is suggested that PJM investigate the potential consequences of reduced capacity factors and energy revenues on its conventional generation fleet.

Flexibility Improvement for Conventional Power Plants

There is an emerging body of industry knowledge on methods for increasing the flexibility of power plants that have traditionally been operated as baseload units. A recent NREL study[11] summarizes recent progress. It is suggested that PJM investigate possible methods that could be applied to existing units with limited ramping or cycling capabilities.

Expanding System Flexibility through Active Power Controls on Wind and Solar Plants

Another potential source of system flexibility is from wind and solar plants. In the past decade, manufacturers have made significant advancements in control methods that can make plant power output responsive to grid-level controls, including frequency response and down-regulation. A recent NREL report summarizes several possible concepts related to frequency control[12]. Given the growing industry concern over declining frequency response performance of the Eastern Interconnection, it would be prudent for PJM to investigate how wind and solar plants could contribute to frequency response, and work towards interconnection requirements that ensure PJM will continue to meet its grid-level performance targets.

17 PJM PRIS Report Sections

PJM PRIS Report sections include the following:

- PJM PRIS Executive Summary Rev05
- PJM PRIS Meeting 2014-03-03 Rev09
- Final_Report_AWST_Final_23Sep2011
- Task1 Load Profile data
- Task2 Scenario Selection__012612
- best practices report final to GE Nov 2012

[11] "Flexible Coal: Evolution from Baseload to Peaking Plant", National Renewable Energy Laboratory (NREL), December 2013, http://www.nrel.gov/docs/fy14osti/60575.pdf

[12] "Active Power Controls from Wind Power: Bridging the Gaps", National Renewable Energy Laboratory (NREL), January 2014, http://www.nrel.gov/docs/fy14osti/60574.pdf

- PJM PRIS - Task 3A Part A – Modeling and Scenarios
- PJM PRIS - Task 3A Part B – Statistical Analysis and Reserves
- PJM PRIS - Task 3A Part C – Transmission Analysis
- PJM PRIS - Task 3A Part D – Production Cost Analysis
- PJM PRIS - Task 3A Part E – Sub-Hourly Analysis
- PJM PRIS - Task 3A Part F – Capacity Valuation
- PJM PRIS - Task 3A Part G – Plant Cycling and Emissions
- PJM PRIS - Tasks 3B & 4 - Market Analysis and Mitigation


imagination at work

OHIO POWER COMPANY'S RESPONSE TO
THE OFFICE OF THE OHIO CONSUMERS' COUNSEL'S
DISCOVERY REQUEST
PUCO CASE NO. 18-501-EL-FOR 18-1392-EL-RDR AND 18-1393-EL-ATA
TENTH SET

INTERROGATORY

OCC-INT-10-116 Referring to the Company's response to Direct INT 01-008:

a) please indicate the basis for the statement that "it would appear that the Company's supply of renewable energy is undersupplied." Identify all information the Company is relying upon to support the statement.

b) How would the Company calculate the level of undersupply? What information would be needed and is that information readily available to the Company?

c) Does the Company have an estimate of the undersupply? If so, please provide that estimate.

RESPONSE

a) As indicated in the survey presented in our filing, customers desire that the company increase its level of renewable resources and it would appear that the Company's supply of renewable energy is undersupplied to meet its customer's needs.

b-c) The Company would first survey its customers to determine whether customers desire the company increase its level of renewable resources. One piece of information that could be looked at is the total annual energy consumption of the Company's customers. For 2017 this value was approximatley 42,700 GWh. The Company has not calculated the level of undersupply. However, for example, if the Company were to provide 2% of that energy from renewable resources that would be approximatley 850 GWh annually.

Prepared by: William A. Allen

OHIO POWER COMPANY'S RESPONSE TO
DIRECT ENERGY, LP
DISCOVERY REQUEST
PUCO CASE NO. 18-501-EL-FOR, 18-1392-EL-RDR, AND 18-1393-EL-ATA
FIRST SET

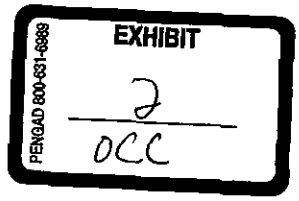
INTERROGATORY

Direct-INT-01-008 To the extent AEP Ohio contends there is an undersupply of renewable energy available to Ohio consumers, quantify the level of undersupply.

RESPONSE

As indicated in the survey presented in our filing, customers desire that the company increase its level of renewable resources and it would appear that the Company's supply of renewable energy is undersupplied to meet its customer's needs. The Company has not calculated the level of undersupply.

Prepared by: William A. Allen



OHIO POWER COMPANY'S RESPONSE TO
THE OFFICE OF THE OHIO CONSUMERS' COUNSEL'S
DISCOVERY REQUEST
PUCO CASE NOS. 18-501-EL-FOR, 18-1392-EL-RDR AND 18-1393-EL-ATA
NINTH SET

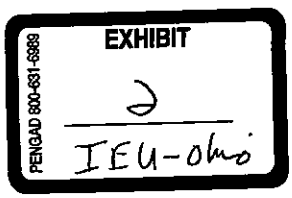
INTERROGATORY

OCC-INT-09-090 Please identify for the calendar year 2017, the retail sales of renewable energy (Million kWh) in competitive markets in Ohio showing residential and non-residential sales

RESPONSE

The Company objects to this request as seeking information that is neither relevant nor reasonably calculated to lead to the discovery of admissible evidence. Without waiving the foregoing objection(s) or any general objection the Company may have, the Company states as follows. The Company is not in possession of the requested information. The request seeks information from providers other than AEP Ohio.

Prepared by: William A. Allen
Counsel



OHIO POWER COMPANY'S RESPONSE TO
DIRECT ENERGY, LP
DISCOVERY REQUEST
PUCO CASE NO. 18-501-EL-FOR, 18-1392-EL-RDR, AND 18-1393-EL-ATA
FIRST SET

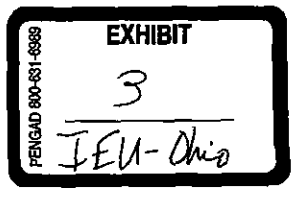
INTERROGATORY

Direct-INT-01-011 Identify the quantity (in MW) of solar resources currently deployed in Ohio.

RESPONSE

The Company objects to this interrogatory as vague and ambiguous. The Company further objects in accordance with Ohio Adm. Code 4901-1-19(D) because this request seeks information that is publicly available and which is equally burdensome for either the proponent of the interrogatory or the Company to obtain and review. Without waiving the foregoing objections or any general objection the Company may have, the Company states that it does not track the requested information. Information regarding utility-scale solar is readily available through EIA's Electricity Data Browser.

Prepared by: William A. Allen
Counsel



Energy Choice Ohio
powered by choice

Ohio.gov Sta

Search Website

Home | Compare Offers | About Choice | Electric | Natural Gas | FAQs | Contact Us

Apples to Apples Comparison Chart

American Electric Power (AEP)

To best utilize this offer comparison tool, it is suggested that you have your most current utility bill available for reference. Compare the supplier offers contained in the chart with the "Price to Compare" shown on your electric bill.

The offer prices below reflect that of the generation portion of your bill. Your distribution and transmission rates are determined through your local utility company.

EDU Chart Archive

Helpful Resources

Steps to Switching

What to Ask Suppliers

What is Aggregation?

Glossary of Terms

Find more answers in our FAQs

American Electric Power : Residential

Search

36 RECORDS FOUND

◉ American Electric Power

My Current Rate (Optional)

Price per kWh:
From $ to $

Term Length (months):
From to

Early Termination Fee:
From $ to $

Monthly Fee
From $ to $

Renewable Content
76 - 100 %

Rate Type
All

Electric Supplier Listing
All

Click to Compare	Supplier	$/KWh	Rate Type	Renew. Content	Intro. Price	Term. Length	Early Term. Fee	Monthly Fee	Promo. Offers
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,TX 77079 (800) 388-3862 Company Url Offer Details Terms of Service Sign Up	0.0925	Fixed	100%	No	12 mo.	$0	$0	Yes details
☐	**IGS Energy** 6100 Emerald Parkway Dublin,OH 43016 (800) 280-4474 Company Url Offer Details Terms of Service Sign Up	0.0779	Fixed	100%	No	12 mo.	$99 details	$0	No
☐	**Viridian Energy PA, LLC** 535 Connecticut Avenue Norwalk,CT 06854 (866) 663-2508 Company Url Offer Details Terms of Service Sign Up	0.0729	Fixed	100%	No	24 mo.	$0	$0	No
☐	**American Power & Gas Of Ohio, LLC** 10601 S Belcher Rd Seminole,OH 33777 (800) 205-7491	0.0870	Fixed	100%	No	12 mo.	$150 details	$0	No

	Company Url Offer Details Terms of Service Sign Up								
☐	**Liberty Power Holdings LLC** 2100 W. Cypress Creek Road Suite 130 Ft. Lauderdale,FL 33309 (866) 769-3799 Company Url Offer Details Terms of Service Sign Up	0.0838	Fixed	100%	No	12 mo.	$10 details	$0	Yes details
☐	**LifeEnergy LLC** 2000 West Loop South Suite 2010 Houston ,TX 77027 (844) 662-1222 Company Url Offer Details Terms of Service Sign Up	0.0679	Fixed	100%	No	12 mo.	$149	$0	No
☐	**Frontier Utilities Northeast, LLC** 5444 Westheimer, Ste 1100 Houston,TX 77056 (866) 777-3158 Company Url Offer Details Terms of Service Sign Up	0.0630	Fixed	100%	No	6 mo.	$10 details	$0	No
☐	**AEP Energy Inc** 303 Marconi Blvd. Suite 400 Columbus,OH 43215 (877) 648-1922 Company Url Offer Details Terms of Service Sign Up	0.0639	Fixed	100%	No	12 mo.	$0	$0	Yes details
☐	**LifeEnergy LLC** 2000 West Loop South Suite 2010 Houston,TX 77027 (844) 662-1222 Company Url Offer Details Terms of Service Sign Up	0.0679	Fixed	100%	No	18 mo.	$149	$0	No
☐	**Liberty Power Holdings LLC** 2100 W. Cypress Creek Road Suite 130 Ft. Lauderdale,FL 33309 (866) 769-3799 Company Url Offer Details Terms of Service Sign Up	0.0803	Fixed	100%	No	36 mo.	$10 details	$0	Yes details
☐	**Verde Energy USA Ohio LLC**	0.0749	Fixed	100%	No	24 mo.	$0	$0	Yes details

	12140 Wickchester Ln Suite #100 Houston,TX 77079 (800) 388-3862 Company Url Offer Details Terms of Service Sign Up								
☐	**Viridian Energy PA, LLC** 535 Connecticut Avenue Norwalk,CT 06854 (866) 663-2508 Company Url Offer Details Terms of Service Sign Up	0.1139	Variable	100%	No	1 mo.	$0	$0	No
☐	**Indra Energy** 1515 Market Street, Suite 1200 Philadelphia,PA 19102 (888) 504-6372 Company Url Offer Details Terms of Service Sign Up	0.0940	Fixed	100%	Yes 1 mo. details	18 mo.	$0 details	$0	Yes details
☐	**FirstEnergy Solutions Corp** 341 White Pond Dr Akron,OH 44320 (888) 254-6359 Company Url Offer Details Terms of Service Sign Up	0.0577	Fixed	100%	No	24 mo.	$50	$0	No
☐	**LifeEnergy LLC** 2000 West Loop South Suite 2010 Houston,TX 77027 (844) 662-1222 Company Url Offer Details Terms of Service Sign Up	0.0629	Fixed	100%	No	6 mo.	$149	$0	No
☐	**Indra Energy** 1515 Market Street, Suite 1200 Philadelphia,PA 19102 (888) 504-6372 Company Url Offer Details Terms of Service Sign Up	0.0820	Variable	100%	Yes 2 mo. details	1 mo.	$0 details	$0	Yes details
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,TX 77079 (800) 388-3862 Company Url Offer Details Terms of Service Sign Up	0.0789	Fixed	100%	No	12 mo.	$0	$0	Yes details
☐	**Clearview Electric Inc**	0.0759		100%	No	6 mo.	$50	$0	No

	901 Main Street STE 4700 Dallas,TX 75202 (800) 746-4702 Company Url Offer Details Terms of Service Sign Up		Fixed						
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,TX 77079 (800) 388-3862 Company Url Offer Details Terms of Service Sign Up	0.0925	Fixed	100%	No	12 mo.	$0	$0	Yes details
☐	**NRG Home** 3711 Market St. 10th Floor Philadelphia,PA 19104 (855) 388-5276 Company Url Offer Details Terms of Service Sign Up	0.0610	Fixed	100%	Yes 6 mo. details	6 mo.	$0 details	$0	No
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,OH 77079 (800) 388-3862 Company Url Offer Details Terms of Service Sign Up	0.0749	Fixed	100%	No	24 mo.	$0	$0	No
☐	**Clearview Electric Inc** 901 Main Street STE 4700 Dallas,TX 75202 (800) 746-4702 Company Url Offer Details Terms of Service Sign Up	0.0769	Fixed	100%	No	12 mo.	$50	$0	No
☐	**Liberty Power Holdings LLC** 2100 W. Cypress Creek Road Suite 130 Ft. Lauderdale,OH 33309 (866) 769-3799 Company Url Offer Details Terms of Service Sign Up	0.0805	Fixed	100%	No	24 mo.	$10 details	$0	Yes details
☐	**Clearview Electric Inc** 901 Main Street STE 4700 Dallas,TX 75202 (800) 746-4702 Company Url Offer Details Terms of Service Sign Up	0.0729	Fixed	100%	No	12 mo.	$50	$0	No
☐	**Indra Energy**	0.0940		100%	Yes	18 mo.	$0	$0	Yes

	1515 Market Street, Suite 1200 Philadelphia,PA 19102 (888) 504-6372 Company Url Offer Details Terms of Service Sign Up		Fixed		1 mo. details		details		details
☐	**Indra Energy** 1515 Market Street, Suite 1200 Philadelphia,PA 19102 (800) 504-6372 Company Url Offer Details Terms of Service Sign Up	0.0520	Variable	100%	Yes 2 mo. details	1 mo.	$0 details	$0	Yes details
☐	**Viridian Energy PA, LLC** 535 Connecticut Avenue Norwalk,CT 06854 (866) 663-2508 Company Url Offer Details Terms of Service Sign Up	0.1139	Variable	100%	No	1 mo.	$0	$0	No
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,TX 77079 (800) 388-3862 Company Url Offer Details Terms of Service Sign Up	0.0859	Fixed	100%	No	6 mo.	$0	$0	No
☐	**IGS Energy** 6100 Emerald Parkway Dublin,OH 43016 (800) 280-4474 Company Url Offer Details Terms of Service Sign Up	0.0719	Fixed	100%	No	36 mo.	$99 details	$0	No
☐	**SmartEnergy Holdings LLC** 575 Lexington Avenue 4th Floor New York,NY 10022 (800) 443-4440 Company Url Offer Details Terms of Service Sign Up	0.0810	Fixed	100%	No	6 mo.	$0	$0	No
☐	**Clearview Electric Inc** 901 Main Street STE 4700 Dallas,TX 75202 (800) 746-4702 Company Url Offer Details Terms of Service Sign Up	0.0829	Fixed	100%	No	6 mo.	$50	$0	No
☐	**Star Energy Partners LLC** 3340 W Market Street, Floor 1 Akron,OH 44333	0.0579	Fixed	100%	No	27 mo.	$0	$15	No

	(855) 427-7827 Company Url Offer Details Terms of Service Sign Up								
☐	**Ambit Northeast, LLC** 1801 N Lamar Street Dallas,TX 75202 (877) 262-6248 Company Url Offer Details Terms of Service Sign Up	0.0738	Variable	100%	No	1 mo.	$0	$0	No
☐	**Frontier Utilities Northeast, LLC** 5444 Westheimer, Ste 1100 Houston,TX 77056 (877) 777-5158 Company Url Offer Details Terms of Service Sign Up	0.0690	Fixed	100%	No	12 mo.	$10 details	$0	No
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,TX 77079 (800) 388-3862 Company Url Offer Details Terms of Service Sign Up	0.0789	Fixed	100%	No	12 mo.	$0	$0	No
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,TX 77079 (800) 388-3862 Company Url Offer Details Terms of Service Sign Up	0.0859	Fixed	100%	No	6 mo.	$0	$0	No

Print Search Results Export offers to XML Export all offers to CSV (Excel)

Printing only applies to offers which have the checkbox selected under the "click to compare" column header. Filtering applies to XML and CSV export files.

Apples to Apples Comparison Chart

American Electric Power (AEP)

To best utilize this offer comparison tool, it is suggested that you have your most current utility bill available for reference. Compare the supplier offers contained in the chart with the "Price to Compare" shown on your electric bill.

The offer prices below reflect that of the generation portion of your bill. Your distribution and transmission rates are determined through your local utility company.

EDU Chart Archive

Helpful Resources

Steps to Switching

What to Ask Suppliers

What is Aggregation?

Glossary of Terms

Find more answers in our FAQs

American Electric Power : Small Commercial : GS-1

Search

13 RECORDS FOUND

◉ American Electric Power

My Current Rate (Optional)

Price per kWh:
From $ ____ to $ ____

Term Length (months):
From ____ to ____

Early Termination Fee:
From $ ____ to $ ____

Monthly Fee
From $ ____ to $ ____

Renewable Content
76 - 100 %

Rate Type
All

Electric Supplier Listing
All

Click to Compare	Supplier	$/KWh	Rate Type	Renew. Content	Intro. Price	Term. Length	Early Term. Fee	Monthly Fee	Promo. Offers
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,TX 77079 (800) 388-3862 Company Url Offer Details Terms of Service Sign Up	0.0859	Fixed	100%	No	6 mo.	$0	$0	No
☐	**Indra Energy** 1515 Market Street, Suite 1200 Philadelphia,PA 19102 (888) 504-6372 Company Url Offer Details Terms of Service Sign Up	0.0710	Fixed	100%	Yes 1 mo. details	18 mo.	$0	$0	Yes details
☐	**Ambit Northeast, LLC** 1801 N. Lamar Street Dallas,TX 75202 (877) 282-6248 Company Url Offer Details Terms of Service Sign Up	0.0499	Variable	100%	No	1 mo.	$0	$0	No
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,TX 77079 (800) 388-3862	0.0749	Fixed	100%	No	24 mo.	$0	$0	Yes details

	Company Url Offer Details Terms of Service Sign Up								
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,TX 77079 (800) 388-3862 Company Url Offer Details Terms of Service Sign Up	0.0789	Fixed	100%	No	12 mo.	$0	$0	Yes details
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,TX 77079 (800) 388-3862 Company Url Offer Details Terms of Service Sign Up	0.0859	Fixed	100%	No	6 mo.	$0	$0	No
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,TX 77079 (800) 388-3862 Company Url Offer Details Terms of Service Sign Up	0.0789	Fixed	100%	No	12 mo.	$0	$0	No
☐	**Indra Energy** 1515 Market Street, Suite 1200 Philadelphia,PA 19102 (888) 504-6372 Company Url Offer Details Terms of Service Sign Up	0.0710	Fixed	100%	Yes 1 mo. details	18 mo.	$0	$0	Yes details
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,TX 77079 (800) 388-3862 Company Url Offer Details Terms of Service Sign Up	0.0925	Fixed	100%	No	12 mo.	$0	$0	Yes details
☐	**IGS Energy** 6100 Emerald Parkway Dublin,OH 43016 (800) 280-4474 Company Url Offer Details Terms of Service Sign Up	0.0719	Fixed	100%	No	12 mo.	$99 details	$0	No
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,OH 77079 (800) 388-3862	0.0749	Fixed	100%	No	24 mo.	$0	$0	No

	Company Url Offer Details Terms of Service Sign Up								
☐	**Verde Energy USA Ohio LLC** 12140 Wickchester Ln Suite #100 Houston,TX 77079 (800) 388-3862 Company Url Offer Details Terms of Service Sign Up	0.0925	Fixed	100%	No	12 mo.	$0	$0	Yes details
☐	**Ambit Northeast, LLC** 1801 N. Lamar Street Dallas,TX 75202 (877) 282-6248 Company Url Offer Details Terms of Service Sign Up	0.0699	Fixed	100%	No	12 mo.	$0	$0	No

Print Search Results Export offers to XML Export all offers to CSV (Excel)

Printing only applies to offers which have the checkbox selected under the "click to compare" column header. Filtering applies to XML and CSV export files.

Energy Choice Ohio
powered by choice.

Ohio.gov

Search Website

Home | Compare Offers | About Choice | Electric | Natural Gas | FAQs | Contact Us

Apples to Apples Comparison Chart

American Electric Power (AEP)

To best utilize this offer comparison tool, it is suggested that you have your most current utility bill available for reference. Compare the supplier offers contained in the chart with the "Price to Compare" shown on your electric bill.

The offer prices below reflect that of the generation portion of your bill. Your distribution and transmission rates are determined through your local utility company.

EDU Chart Archive

Helpful Resources

Steps to Switching

What to Ask Suppliers

What is Aggregation?

Glossary of Terms

Find more answers in our FAQs

American Electric Power : Small Commercial : GS-2

Search

2 RECORDS FOUND

◉ American Electric Power

My Current Rate (Optional)

Price per kWh:
From $ to $

Term Length (months):
From to

Early Termination Fee:
From $ to $

Monthly Fee
From $ to $

Renewable Content
76 - 100 %

Rate Type
All

Electric Supplier Listing
All

Click to Compare	Supplier	$/KWh	Rate Type	Renew. Content	Intro. Price	Term. Length	Early Term. Fee	Monthly Fee	Promo. Offers
☐	**Ambit Northeast, LLC** 1801 N. Lamar Street Dallas,TX 75202 (877) 282-6248 Company Url Offer Details Terms of Service Sign Up	0.0699	Fixed	100%	No	12 mo.	$0	$0	No
☐	**Ambit Northeast, LLC** 1801 N. Lamar Street Dallas,TX 75202 (877) 282-6248 Company Url Offer Details Terms of Service Sign Up	0.0499	Variable	100%	No	1 mo.	$0	$0	No

Print Search Results Export offers to XML Export all offers to CSV (Excel)

Printing only applies to offers which have the checkbox selected under the "click to compare" column header. Filtering applies to XML and CSV export files.

Public Utilities Commission of Ohio 180 East Broad Street, Columbus, Ohio 43215 (800) 686-PUCO (614) 466-3292 (local) 7-1-1 (TTY-TDD)

Climate + Energy

The time to act is now - for all of us

Climate change is a global challenge that transcends boundaries, affecting people and communities everywhere. We view it as an environmental issue, a human rights issue, and a business issue. We also feel an ethical responsibility to address climate change by *aligning our goals and strategies with the best science* and industry practices.

We view climate change as both an environmental issue and a human rights issue.

Our climate goal—to achieve a 50% absolute reduction in the GHG emissions of our owned and operated facilities globally between 2015 and the end of 2020—builds on our previous goal to reduce our absolute U.S. GHG emissions 20% by 2015, based on a

2008 baseline. We exceeded that goal by achieving a 37% reduction by the end of fiscal 2015, and have achieved an additional 14% reduction from our 2015 baseline.

Our Approach

We have three main areas of focus to reduce our climate impacts: improving energy efficiency at our stores, offices, and distribution networks; expanding our investments in renewables; and setting ambitious, science-based goals. We also support broader change through a business-led advocacy initiative.

THE SHORT STORY

OPERATIONAL ECO-EFFICIENCY

- We take steps every day to reduce the climate and waste impacts of our stores, offices and distribution networks.
- We are exploring ways to purchase cleaner energy through various renewable energy initiatives.
- We signed on to the Science-Based Target initiative to align our climate goals with the scientific consensus and core commitment of the Paris Agreement to limit global warming below 2°C.

Improving the Energy Efficiency of Retail Stores and Distribution Networks

Retail stores are the focus of Gap Inc.'s energy program since they generate approximately 85% of our direct (scope 1 and 2) GHG emissions. We are taking steps to adapt to climate change and regulatory changes by piloting and expanding energy-management solutions for our retail operations, updating HVAC systems and exploring renewable energy options.

To work toward our 2020 emissions-reduction goal, we used the EPA EnergyStar platform to analyze differences in store performance and prioritize regions, brands and initiatives with the greatest opportunities for energy improvements. We piloted a new energy-efficiency program at 100 stores across North America to provide real-time monitoring and management of our energy use. We have installed LED lighting—which use 80% less energy than conventional lights—at over 1,000 of our stores. Not only do these lights reduce our energy use, they last five to 10 times longer and they pay for themselves in just two to three years.

In addition to our efforts to reduce the energy impacts of our retail stores, we look for ways to improve the efficiency of our distribution networks. In 2011, we joined

a voluntary government and industry collaboration known as the SmartWay Shipper Program, which brings together carriers, freight shippers and logistics companies to improve fuel efficiency.

We were also selected as a SmartWay High Performer in both 2016 and 2017 and have committed to increasing the amount of freight we ship by SmartWay carriers by 5% each year. To support that, we also have committed to using cleaner modes of transportation and encouraging the use of fuel-saving strategies and technologies. Moving forward, we are working to integrate more of our business operations into the SmartWay program and improve our data collection to better measure results.

Investing in Renewable Energy

As we have continued to improve the energy efficiency of our stores, we have come to understand that we cannot achieve our 2020 goal through these efforts alone. Because our stores are often housed in buildings and malls owned by landlords, we have limited ability to implement efficiency improvements and building upgrades. For this reason, we are exploring ways to purchase cleaner energy through various renewable energy initiatives that will help us meet our goal.

In 2017, we began to explore possible large-scale renewable energy solutions. Ultimately, we believe our investments in renewable energy will not only help us meet our goal and address the energy impacts of our more than 3,000 sites, it will provide business benefits by reducing our operating costs. Moreover, it will help drive demand for renewable energy and spur the growth of the low-carbon economy.

We have identified an opportunity to install an onsite solar array at our Fresno, California, distribution center that will reduce the site's emissions by the equivalent of removing 254 passenger cars from the road annually. This facility will begin generating power in 2019. In addition to adding solar energy to our distribution

CLIMATE • ENERGY

GOALS

- Reduce absolute scope 1 and 2 greenhouse gas emissions in our owned and operated facilities globally by 50% by 2020
- We are also establishing a scope 3 goal to reduce upstream and downstream emissions.

centers, we are exploring multiple offsite renewable energy opportunities to offset the impacts of our retail fleet.

Our company can thrive only in a world with abundant natural resources and a healthy environment that supports the well-being of all of us.

Developing a Science-Based Target

In 2017, Gap Inc. signed on to the Science-Based Target initiative to align our climate goals with the scientific consensus and core commitment of the Paris Agreement to limit global warming below 2°C. The initiative, a partnership between CDP, WRI, WWF, and the UN Global Compact, includes more than 400 companies. By setting and meeting these goals, we are doing our part to help the world avoid the most dangerous impacts of climate change.

Our 2020 Scope 1 and 2 GHG emissions-reduction goal was based on science-based methodology. To meet the standards of the Science-Based Target protocol, we are also establishing a Scope 3 goal to reduce upstream and downstream emissions, including in transportation and our supply chain. We collect environmental data from our finished product (Tier 1) and textile manufacturing (Tier 2) suppliers using the Sustainable Apparel Coalition's Higg index, a self-reporting tool that evaluates environmental performance and helps identify opportunities for improvement.

Through our participation in this initiative, we joined the Apparel and Footwear Sector Guidance Working Group to help define how our industry should determine Scope 3 emissions and set science-based goals. Together with other global apparel companies, we are researching and aligning on best practices and approaches to calculating Scope 3 emissions. Using this methodology, we plan to submit Gap Inc.'s science-based target for Scope 3 emissions in 2019.

Supporting Broader Change

Since 2007, we have been actively engaged with Ceres, a leading nonprofit organization dedicated to mobilizing the business community to build a sustainable economy. As a member of Ceres' Business for Innovative Climate and Energy Policy (BICEP) coalition, we advocate for progressive policy action on climate and energy issues, and publicly affirmed our commitment to the Paris Agreement on climate change.

We were selected as a 2017 SmartWay High Performer for our efforts to use cleaner modes of transportation and encouraging the use of fuel-saving strategies.

Related Stories

Circular Design > (/product/mapping-product-life-cycle)

Chemical Management > (/environment/protecting-our-shared-environment/reducing-chemicals)

Waste > (/environment/protecting-our-shared-environment/diverting-waste)

Working towards 80% waste diversion

Product Sustainability > (/product/product-sustainability)

Environmental Management > (/environment/protecting-our-shared-environment)

A priority for people and our business

Resources (/resources)
CA Supply Chains Act (http://www.gapinc.com/content/gapinc/html/sustainability/ca-transparency-insupplychainsact.html)
Contact Us (/contact-us)

(https://twitter.com/GapInc) (https://www.facebook.com/GapInc/)

(https://www.instagram.com/gapinc/) (https://www.linkedin.com/company/1677?trk=vsrp_companies_res_name&trkInfo=VSRPsearchId%3A565445514525452274 80%2CVSRPtargetId%3A1677%2CVSRPcmpt%3Aprimary)

(https://www.youtube.com/user/GapInc)

Gap Inc. (/)
Global
Sustainability

(http://www.gap.com/) (http://www.bananarepublic.com/) (http://www.oldnavy.com/) (http://www.athleta.com/) (http://www.intermixonline

OHIO POWER COMPANY'S RESPONSE TO
DIRECT ENERGY, LP'S DISCOVERY REQUEST
PUCO CASE NOS. 18-501-EL-FOR, 18-1392-EL-RDR AND 18-1393-EL-ATA
SECOND SET

INTERROGATORY

Direct-INT-02-021 Quantify the impact the Timber Road II facility has had on the PJM LMP, from the time AEP Ohio obtained a contractual entitlement to the output of this facility to the present.

RESPONSE

The Company has not performed the requested analysis.

Prepared by: Kamran Ali

OHIO POWER COMPANY'S RESPONSE TO
DIRECT ENERGY, LP'S DISCOVERY REQUEST
PUCO CASE NOS. 18-501-EL-FOR, 18-1392-EL-RDR AND 18-1393-EL-ATA
SECOND SET

INTERROGATORY

Direct-INT-02-019 Quantify the impact the Wyandot Solar facility has had on the PJM LMP, from the time AEP Ohio obtained a contractual entitlement to the output of this facility to the present.

RESPONSE

The Company has not performed the requested analysis.

Prepared by: Kamran Ali

OHIO POWER COMPANY'S RESPONSE TO
DIRECT ENERGY, LP'S DISCOVERY REQUEST
PUCO CASE NOS. 18-501-EL-FOR, 18-1392-EL-RDR AND 18-1393-EL-ATA
SECOND SET

INTERROGATORY

Direct-INT-02-017 Quantify the impact the Fowler Ridge II facility has had on the PJM LMP, from the time AEP Ohio obtained a contractual entitlement to the output of this facility to the present.

RESPONSE

The Company has not performed the requested analysis.

Prepared by: Kamran Ali

OHIO POWER COMPANY'S RESPONSE TO
INDUSTRIAL ENERGY USERS-OHIO'S DISCOVERY REQUEST
PUCO CASE NO. 18-501-EL-FOR
FIRST SET

INTERROGATORY

IEU-INT-01-001 Does AEP-Ohio anticipate the need for transmission plant additions or upgrades to connect the additional renewable generation for which a need finding is requested?

RESPONSE

Yes. The transmission plant additions/upgrades for these additional renewable generation resources are part of the PJM Generation Interconnection Queue, and have been studied by PJM in accordance with the tariff to determine the need for local interconnection facilities and network upgrades.

The specific information related to these upgrades can be found in the Generation Interconnection System Impact Study Reports, which are publicly available via the following links:

- Willowbrook (Mar 2017): ftp://www.pjm.com/planning/project-queues/feas_docs/ac1089_fea.pdf
- Willowbrook (Mar 2018): ftp://ftp.pjm.com/planning/project-queues/impact_studies/ac1089_imp.pdf
- Highland (Feb 2017): ftp://www.pjm.com/planning/project-queues/feas_docs/ac1085_fea.pdf
- Highland (Oct 2018): ftp://www.pjm.com/pub/planning/project-queues/impact_studies/ac1085_imp.pdf

Prepared by: Kamran Ali