New Jersey School Boards Association Workshop 2016
Demand Response & OpenADR 2.0

October 25, 2016
• Introductions

• DR & OpenADR performance with the continued operation and comfort of your facilities.

• ISO update

• Revenue Capture is in your energy margins

• DR & the evolution of easy OpenADR

• Q&A with next steps
Independent System Operators, ISO’s

[Map showing various independent system operators across the United States.]
Role of The ISO

1. Keeping the Lights On
   - Grid Operations
   - Supply/Demand Balance
   - Transmission Monitoring

2. Buying & Selling Energy (Market Operations)
   - Energy
   - Capacity
   - Ancillary Services

3. Planning for the future
   - 15-Year Outlook

Source: PJM 2016
Demand Response is a voluntary set of ISO programs that compensates end-use customers for reducing their electricity load, when requested by The ISO, during periods of high power prices or when the reliability of the grid is threatened. Registered customers receive payments from IPKeys a member of The ISO.

BUT – while the payments increase the ISO participation rules also tighten.

Enter, Automated Demand Response or ADR, that helps system operators reduce the operating costs of DR programs while resources increasing DR resource reliability. For customers, ADR reduces the effort required to achieve successful results from multi market DR programs. ADR also makes it possible to translate changes in wholesale markets to corresponding changes in retail rates, enabling customers to respond to DR signals in real-time to reduce demand.
## PJM Capacity Products – New

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Limited DR</th>
<th>Extended Summer DR</th>
<th>Annual DR</th>
<th>Base Capacity Demand Resource (18/19 &amp; 19/20 DY only)</th>
<th>Capacity Performance Demand Resource (Effective 18/19 DY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability</td>
<td>Any weekday other than NERC holidays, during June – Sept. period of DY</td>
<td>Any day during June- October period and following May of DY</td>
<td>Any day during DY (unless on an approved maintenance outage during Oct. - April)</td>
<td>Any day during June-September of DY</td>
<td>Any day during DY (unless on an approved maintenance outage during Oct.-April)</td>
</tr>
<tr>
<td>Maximum Number of Interruptions</td>
<td>10 interruptions</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Hours of Day Required to Respond (Hours in EPT)</td>
<td>12:00 PM – 8:00 PM</td>
<td>10:00 AM – 10:30 PM</td>
<td>Jun – Oct. and following May: 10 AM – 10 PM Nov. – April: 6 AM- 9 PM</td>
<td>10:00 AM – 10:00 PM</td>
<td>Jun – Oct. and following May: 10 AM – 10 PM Nov. – April: 6 AM- 9 PM</td>
</tr>
<tr>
<td>Maximum Duration of Interruption</td>
<td>6 Hours</td>
<td>10 Hours</td>
<td>10 Hours</td>
<td>10 Hours</td>
<td>No limit</td>
</tr>
</tbody>
</table>

Current Limited, Extended Summer, & Annual DR product definitions eliminated effective 2018/2019 DY
The Generation Gap

Generation Increase/Decrease by Year
DY 2007-2018

Source: PJM Base Residual Auctions
PJM & NYISO use LMP and LBMP to set prices for energy purchases and sales in the respective ISO markets and to price transmission congestion costs. Congestion is when the lowest-priced energy is prevented from flowing freely to a specific area on the grid because heavy electricity use is causing parts of the grid to operate near their limits. True to name, LMP & LBMP is based on the location in which the power is received or delivered.
Locational marginal pricing is analogous to a taxi ride for megawatts of electricity. When traffic is light, you can expect a consistent and predictable taxi fare, which would represent a period with little to no congestion on the grid. Similarly, heavy traffic results in a higher fare, which is similar to a time of congestion on the transmission system.
Mission:

The OpenADR Alliance is to foster the development, adoption, and compliance of the Open Automated Demand Response (OpenADR) standards through collaboration, education, training, testing and certification.
What is OpenADR 2.0b?

- Open Automated Demand Response (OpenADR2), provides a **non-proprietary open standard** interface that provides a secure, 2-way communication about electricity prices and system grid reliability directly to customers over networks such as the Internet.

- OpenADR 2.0b provides the highest level of cybersecurity; it supports interoperability among control equipment and RTO/ISO markets.

- The OpenADR2 standard is supported by:
  - U.S. Department of Energy,
  - National Institute of Standards
  - The Technology Smart Grid Interoperability Standards
  - OpenADR Alliance [www.openadr.org/](http://www.openadr.org/)
Benefits of OpenADR 2.0

- Use Automated Load Management to Participate in DR
  - Enables faster response (meet 10 or 30 minute notice)
  - Provides for response even if personnel are not available at time event is dispatched
  - Allows remote monitoring and override options
  - Reduces the stresses of program compliance
  - Secure Connections
  - Signaling Direct to SCADA/EMS/BAS

- Send and Acknowledge DR Events

- Define Availability

- Set & Forget levels
Automated Load Reduction can be achieved by:

- Reducing VFD’s
- Automated Gen Set
- Automated Energy Storage
- Automated chiller control
- Addressable Lighting Systems
- Automatically raising air conditioner temp set point
- Automated cycling of HVAC motors
- Turning off certain production lines with safety or maintenance work conducted
IPKeys openADR2.0b Certified EISS® 2.0 VTN EISSBox 2.0 VEN Telemetry & Revenue Map

ISO DR Signals

Event Dispatch: Program, Time, Resource

Event Status: Change / Termination

VTN - Virtual Top Node
VEN - Virtual End Node

Heartbeat: Constant Virtual Connection

IPK EISS® VTN

Signal Analysis: Program, Time, Resource, Telemetry Data Capture for M&V

Event Creation
Event Status Change
Event Completion

Traditional Demand Response and Easy oADR2.0b Performance via enabled Building Automation Systems

Secure OpenADR 2.0b Connection

Increased oADR Revenue Capture

Online Above Property Platform
Two-way Secure Communications, Telemetry & Control

EISS™
ENERGY INTEROP SERVER & SYSTEM

ASSET CONTROL
MARKET SIGNALING
LOAD MONITORING
EVENT VALIDATION
TELEMETRY
AUTOMATION

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### Three Year DR Revenue Estimated Example

**500KW JCP&L**

<table>
<thead>
<tr>
<th>Year</th>
<th>Capacity</th>
<th>Event Energy</th>
<th>Real Time Energy</th>
<th>Reserves</th>
<th>3 Year TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>$21,731</td>
<td>$2,773</td>
<td>$14,400</td>
<td>$27,187</td>
<td>$124,880</td>
</tr>
<tr>
<td>2017</td>
<td>$19,358</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>$38,439</td>
<td>$38,439</td>
<td>$14,400</td>
<td>$27,187</td>
<td>$124,880</td>
</tr>
</tbody>
</table>

**Assumptions:**
- 500KW of DR
- Event Energy for one (1) 2 hr event/year
- Real Time Energy standing bid at $500 for ≈20 hours of annual participation
- Reserves availability 8am-5pmx365
- Back Up Generators may be eligible pending air permit review
- PJM Shut Down Costs Reimbursement not included
Current customers actively participating in the program!

Lopatcong
Hackettstown
Great Meadows
Joseph Kushner Hebrew Academy
Berlin
Hunterdon Regional
Readington
Somerset
Warren County Technical School
Patterson
Roxbury Schools
Voorhees Public Schools
Mountainside
Hardyston
Ridgewood
IPKeys Technologies

- Established in March, 2005
- 227 employees
- WBE
- DoD, cyber-security, energy, public safety divisions
- Headquarters in Eatontown, NJ. Offices in CA, MD, VA,

Mission: Deliver secure, high quality, scalable technology platforms with integration and consulting services for the DoD, Public Safety and Energy & Utility markets.
IPKeys Service & Platforms

Department of Defense
- Information Assurance & Cyber Security
- Network Communications Engineering
- System Engineering
- Program Acquisition & Management
- DoD Gaming Solutions & Simulations

Public Safety
- Network Design & Systems Integration
- Wired & Wireless

IPKeys Power Partners
- DR & ADR Aggregator & Curtailment Service Provider
- EISS® & EISSBox secure scalable energy management platform
- BAS | EMS | PLC | SCADA | Gen Set | Renewable Integration
Thank you!

Q&A

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Energy Management Incorporating Demand Response

*Not intended for reuse, please do not copy*
Why Energy Management

• Reduce & Manage Rising Utility Costs
• Reduce over all cost of operation
• Reduce Carbon Footprint
• Improve Energy Efficiency
Building Check List: Let’s give our self's a check up for energy management

- **OBTAINING ENERGY DATA:**
  - Collect and gather utility data/ Kilowatt usage
  - Create spread sheet / for utility data
  - Heating & Cooling Degree Days
  - look at building envelope
  - Create schedule for automation to reduce PLC
  - Create energy team, who will collect and manage data.
### Building Automation & Scheduling can Change depending on the season

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Location</th>
<th>on</th>
<th>off</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTU-5</td>
<td>Library</td>
<td>5:20</td>
<td>2:45</td>
</tr>
<tr>
<td>HRU-1</td>
<td>E-Hall</td>
<td>5:40</td>
<td>2:45</td>
</tr>
<tr>
<td>HRU-2</td>
<td>C-Hall</td>
<td>6:00</td>
<td>2:45</td>
</tr>
<tr>
<td>Air-Handler</td>
<td>Pre-K &amp; 1st</td>
<td>6:40</td>
<td>2:45</td>
</tr>
<tr>
<td>Unit Ventilator</td>
<td>2th Grade</td>
<td>7:00</td>
<td>2:45</td>
</tr>
<tr>
<td>Unit Ventilator</td>
<td>3th Grade</td>
<td>7:20</td>
<td>2:45</td>
</tr>
<tr>
<td>Unit Ventilator</td>
<td>4th Grade</td>
<td>7:40</td>
<td>2:45</td>
</tr>
<tr>
<td>RTU-3</td>
<td>Main Office</td>
<td>8:00</td>
<td>2:45</td>
</tr>
<tr>
<td>RTU-1</td>
<td>New Gym/ cafe</td>
<td>8:20</td>
<td>2:45</td>
</tr>
<tr>
<td>RTU-2</td>
<td>New Gym/ cafe</td>
<td>8:40</td>
<td>2:45</td>
</tr>
<tr>
<td>RTU-4</td>
<td>Band Room</td>
<td>9:00</td>
<td>3:30</td>
</tr>
<tr>
<td>AHU-C 2</td>
<td>E-Hall</td>
<td>9:20</td>
<td>2:45</td>
</tr>
<tr>
<td>AHU-C 3</td>
<td>B-Hall</td>
<td>9:40</td>
<td>2:45</td>
</tr>
<tr>
<td>AHU-C 4</td>
<td>Café</td>
<td>10:20</td>
<td>3:00</td>
</tr>
</tbody>
</table>
Areas of Reduction

- Energy cost per student 2105 ~ $20.06
- Energy Cost per student 2016 ~ $18.08
- March to June 2016 / reduced 554 hours of operation
- Carbon Footprint 181,219 lbs/C02 = 9.06 cars off the road
- Reduced our PLC from 135 to 98.5
Elementary School Gym
Elementary School Boiler Room

High Bridge Elementary School
Hot Water System

Lochinvar Boilers
Enable: Enabled

Mixing Valve
Command: 0.0 % to Boiler

Auxiliary Boiler
Enable: Disabled

Pump 3
Start: On
Status: On
Speed: 79.7 %
Fault: Normal

Pump 4
Start: Off
Status: Off
Speed: 0.0 %
Fault: Normal

Hot Water System
Outside Enable: Enabled
Outside Enable: 60.0 °F
Deadband: 5.0 °F
Allow Lag Boiler: Yes
Deadband: 10.0 °F

Temperature Control
Outside Air Setpoint
60.0 °F → 110.0 °F
Result: 118.9 °F

Pump Control
Pump 3 Runtime: 2189.5 hr
Pump 4 Runtime: 2083.2 hr
Runtime Switchover: 168.0 hr
Lead Pump: HW Pump-3

Pressure Control
Setpoint: 20.00 psi
Setpt Minimum: 5.00 psi
Setpt Maximum: 20.00 psi
VFD Speed: 79.7 %
Max Heating Demand: 95.0 %
Demand Setpoint: 95.0 %
Cost of operation

Energy Cost of operation from April 2014 to May 2015

$49,601.00

Energy Cost of operation May 2015 to May 2016

$38,872.00

Reduced cost of operation by $10,729.80 / 10 months

Kwh went down from 404,480 to 340,800

Reduction of 63,680 Kwh

Natural Gas 2014 to 2015 $16,069.88

2015 to 2016 $7,244.59

Reduction $8,825.29

Total Energy Saved $19,555.09
DDC control of Pneumatic zones
## Energy Savings for April 2011

<table>
<thead>
<tr>
<th>Chiller Kw</th>
<th>Utility Rate</th>
<th>Cost Per Hr</th>
<th>Hr Saved</th>
<th>power factor</th>
<th>savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>$0.11</td>
<td>$34.00</td>
<td>160</td>
<td>70.00%</td>
<td>$3,808.00</td>
</tr>
<tr>
<td>399</td>
<td>$0.11</td>
<td>$43.89</td>
<td>167</td>
<td>70.00%</td>
<td>$5,130.74</td>
</tr>
</tbody>
</table>

**Total** $8,938.74

## Energy Savings For May 2011

<table>
<thead>
<tr>
<th>Chiller Kw</th>
<th>Utility Rate</th>
<th>Cost Per Hr</th>
<th>Hr Saved</th>
<th>power factor</th>
<th>savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>$0.11</td>
<td>$34.00</td>
<td>141.5</td>
<td>70.00%</td>
<td>$3,367.70</td>
</tr>
<tr>
<td>399</td>
<td>$0.11</td>
<td>$43.89</td>
<td>55</td>
<td>70.00%</td>
<td>$1,689.76</td>
</tr>
</tbody>
</table>

**Total** $5,057.46
VFD, Information provided by Broudy Precision,

<table>
<thead>
<tr>
<th>Percent Speed</th>
<th>Frequency (Hertz)</th>
<th>Percent Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>60</td>
<td>0%</td>
</tr>
<tr>
<td>90%</td>
<td>54</td>
<td>27%</td>
</tr>
<tr>
<td>80%</td>
<td>48</td>
<td>49%</td>
</tr>
<tr>
<td>70%</td>
<td>42</td>
<td>66%</td>
</tr>
<tr>
<td>60%</td>
<td>36</td>
<td>78%</td>
</tr>
<tr>
<td>50%</td>
<td>30</td>
<td>88%</td>
</tr>
<tr>
<td>40%</td>
<td>24</td>
<td>94%</td>
</tr>
<tr>
<td>30%</td>
<td>18</td>
<td>97%</td>
</tr>
<tr>
<td>20%</td>
<td>12</td>
<td>99%</td>
</tr>
<tr>
<td>10%</td>
<td>6</td>
<td>100%</td>
</tr>
<tr>
<td>0%</td>
<td>0</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Fan, 60% of Max Flow**

<table>
<thead>
<tr>
<th>Power Ratio</th>
<th>Estimated Savings for Motor Horsepower Per Year</th>
<th>AVG Savings Per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>VFD</td>
<td>0.28</td>
<td>$2,221 $3,332 $4,443 $5,554</td>
</tr>
<tr>
<td>Inlet Guide vane</td>
<td>0.62</td>
<td>$3,920 $5,881 $7,841 $9,802</td>
</tr>
<tr>
<td>Outlet Damper</td>
<td>0.88</td>
<td>$3,920 $5,881 $7,841 $9,802</td>
</tr>
<tr>
<td>&quot;Ride the fan curve&quot;</td>
<td>0.88</td>
<td>$4,705 $7,057 $9,410 $11,762</td>
</tr>
<tr>
<td>Bypass Damper</td>
<td>1</td>
<td>$4,705 $7,057 $9,410 $11,762</td>
</tr>
<tr>
<td>No Control</td>
<td>1</td>
<td>$4,705 $7,057 $9,410 $11,762</td>
</tr>
</tbody>
</table>

**Pump, 70% of Max Flow**

<table>
<thead>
<tr>
<th>Power Ratio</th>
<th>Estimated Savings for Motor Horsepower Per Year</th>
<th>AVG Savings Per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>VFD</td>
<td>0.4</td>
<td>$3,528 $5,293 $7,057 $8,822</td>
</tr>
<tr>
<td>Discharge Valve</td>
<td>0.94</td>
<td>$3,920 $5,881 $7,841 $9,802</td>
</tr>
<tr>
<td>Bypass Valve</td>
<td>1</td>
<td>$3,920 $5,881 $7,841 $9,802</td>
</tr>
<tr>
<td>No Control</td>
<td>1</td>
<td>$3,920 $5,881 $7,841 $9,802</td>
</tr>
</tbody>
</table>

*Based on $.10/kwh & 24 hrs a day operation (or 8760hrs/yr)
**Power ratio is a conservative assumption based on HVAC applications showing that fans and pumps operate on avg at 60 & 70 percent of max flow, respectively.
Installing VFD on Fan Coil unit to help make room more quiet for academic classes

Before VFD was installed:

\[ 460 \text{ v} / 1.732 = 796.72 \text{ Kw} / 1.24 \text{ Amps} = 0.98793 \text{ Watts} \]
\[ 0.98793 \text{ Watts by 1,000} = 0.98793 \text{ Kw} = 60 \text{ Hz} \]
\[ 0.98793 \text{ Kw} / .104 \text{ per Kw} = 10.2 \text{ cents per hr.} \]

After VFD is installed:

\[ 157.0 \text{ V} / 1.732 = 271.924 \text{ Kw} \]
\[ 271.924 / 1.04 \text{ Amps} = 282.8 \text{ Watts} \]
\[ 282.8 \text{ Watts by 1,000} = .2828 \text{ Kw} = 20 \text{ Hz} \]
\[ 2828 \text{ Kw} / .104 \text{ per Kw} = 2.9 \text{ cents per hr.} \]

This installation not only reduced the noise but also increased the efficiency by 72% savings.

Without the installation of VFD at the cost of 10.2 cents per Kw / 9 hrs a day = 91.8 cents per day.

91.8 cents per day / 5 day work week = $4.59 per week

$4.59 per week / 41.167 weeks per yr of operation = $188.95 per yr.

Once the installation of the VFD was done here is the cost 2.9 cents per hr / 9 hr day = .26 cents per day / 5 days a week $1.30 per week

$1.30 per week / 41.167 weeks per yr of operation = $53.72

Saved $135.23

There are 13 more 3 phase units in our class rooms in our school should we move forward and complete the rest cost savings would be $1,757.99 saved per yr.
Collecting Measurable Data with use of Data Loggers

Unoccupied 55 - Occupied 72 - Runtime 48 mins

Unoccupied 62 - Occupied 72 - Runtime 27 mins
Data Logger Calculation

For example: if we measure 55 amps: $75\% \times 55 \text{ amps} = 41 \text{ kw}$. If the machine is operated for 8 hours at $0.15/\text{kwh}$ then: $41 \text{ kw} \times 8 \text{ hours} \times 0.15 = \$49.20$. 
Time For Questions and Answers

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