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COMMERCIAL DEMAND RESPONSE PROGRAM

Automated Demand Response (ADR) Technical Guide

1.0 INTRODUCTION

1.1 Background

Austin Energy offers medium to large facilities an automated demand response (ADR) signal to enable automatic participation in ERCOT's Emergency Response Service and Austin Energy's Commercial Demand Response programs through the use of OpenADR. ADR can improve delivered demand response by providing a signal to initiate predetermined sequences of operation or temperature resets designed to curtail a facility's electrical load. The ADR system should not require human interaction at the customer facility site to initiate the pre-programmed load reduction sequence. However, events can be overridden by the facility's operations staff when needed. Improving demand response directly translates to larger performance incentives paid by Austin Energy. This automated demand response performance also increases customer convenience.

Starting in late 2016, City of Austin building codes require that OpenADR capabilities be present in the energy management systems for newly constructed buildings or facilities. Some excerpts from the code include:

"C403.2.19 Demand response. When Direct Digital Control is utilized, the controls shall have the capability to remotely setup the operating cooling temperature set point in all non-critical zones in response to signals, based on OpenADR 2.0 or higher protocols, from a centralized contact or software point. Controls may be programmed to provide either an automatic or an operator adjustable degree of change for the temperature setup."

"C405.2.6 Demand response. For all buildings having central control of a) lighting levels and/or b) the ability to turn on and off individual lamps, the controls shall have the capability to reduce lighting level in response to signals, based on OpenADR 2.0 or higher protocols, from a centralized contact or software point. Controls may be programmed to provide either an automatic or an operator adjustable degree of lighting reduction."

This document will assist customers' facility staff in setting up and commissioning ADR systems as part of the new building commissioning process.

1.2 Definitions

Advanced Metering Infrastructure (AMI) – A system providing 15-minute whole-building energy use data for measuring baselines and incentives.

Certificate Authority (CA) – An organization or entity that issues digital certificates. Austin Energy is the CA in this document.

Certificate Signing Request (CSR) – A message containing encoded text that is sent from an applicant to a certificate authority.

Common Name (CN) – A unique identifier assigned to a VEN used to recognize that device by the VTN.

Demand Response Automated Server (DRAS) – Austin Energy’s cloud-based server which provides two-way communication with devices at customer sites; acts as a VTN within a VTN/VEN relationship. See VTN above.

Demand Response Signal – An event called by the local utility communicating a request to reduce electricity consumption for a time period (usually about two hours).

Energy Profiler On-line (EPO) (also known as Load Profiler) – The software system used by Austin Energy to visualize and store IDR meter data as well as provide email and text notifications for curtailment events. The system has a customer portal to monitor facilities’ energy consumption and present the results of curtailment events. Participants in the Commercial Demand Response Program have access to additional features for their curtailment performance for each DR event. All commercial customers can request access to the system.

Interval Data Recording (IDR) Meter – An Austin Energy revenue meter that records energy usage every 15 minutes. The data collected by the IDR meter is used to create energy consumption baselines and calculate customer incentives.

Commercial Demand Response – Austin Energy’s Commercial and Industrial demand response program that incentivizes load reduction based on a demand response signal from the utility.

OpenADR Alliance – A national organization that sets standards for OpenADR communications and certifies products to the OpenADR standards.

OpenADR Event – A demand response occurrence in which a signal is sent to the enrolled customer’s VEN in order for their automation system to begin their pre-programmed, load reduction strategies during the scheduled event.

Virtual End Node (VEN) – This is hardware or software at the customer sites that receives the signal and associated schedule to initiate and terminate the demand response event.

Virtual Top Node (VTN) – The generic term for the software Austin Energy hosts to schedule signals sent to customer sites. See Demand Response Automated Server (DRAS) below.

1.3 Security

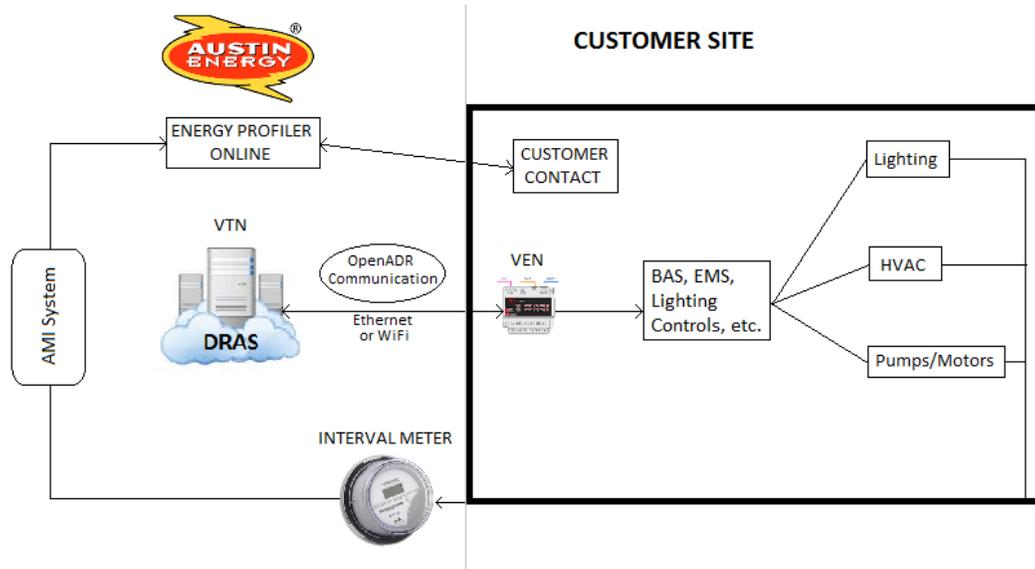
Austin Energy makes every effort to keep signaling and communications between Austin Energy’s systems and its customers’ systems secure. However, the customer is responsible for the cyber security of their systems. The OpenADR standard supports security certificates and utilizes a polling method of communicating event schedules.

1.4 Signaling

In a manual event notification, Austin Energy sends email and text notifications or signals to a customer prior to a scheduled event via the Energy Profiler On-line (EPO). These alerts allow a short window for the participating customer to make adjustments within their system prior to the start of the event. At the end of the demand event, the participating customer can access the EPO to verify their demand response performance and incentive amounts.

In an ADR event, Austin Energy’s VTN sends a signal to the customer’s VEN, activating the customer’s pre-programmed settings (see Figure 1). Austin Energy hosts software (DRAS) that schedules and sends demand response notifications to customer sites through the public internet using a variety of communication systems. Customers can receive signals through Local Area Networks (LAN), Wide Area Network (WAN), cellular, or Wi-Fi communications. The signals are communicated in the OpenADR 2.0b standard supported by the OpenADR alliance.

For more information about the OpenADR alliance and OpenADR standard, visit <http://www.openadr.org/>.



2.0 OVERVIEW

2.1 Strategic Goals

Austin Energy has a goal of achieving 1000 MW of peak demand savings through energy efficiency and demand side management by 2027. Of the total 1000 MW goal, 200 MW are required from demand response programs.

ADR should increase event performance and improve incentive payouts to customers while making it easier for customers to participate.

Improved curtailment event performance not only benefits Austin Energy in achieving its goals, but increases payments to demand response program participants and value to all customers.

2.2 Requirements

The ADR program is open to all Austin Energy Commercial Demand Response customers who have an Austin Energy interval meter installed at their site. If no interval meter is installed at their site, Austin

Energy will install one at no cost to the customer. A building automation system that can receive the ADR signal and control energy-using equipment must already be in place at the customer site with the intent of reducing load during a curtailment event.

2.2.1 ADR Requirements

ADR project eligibility applies to equipment controlled through a central Energy Management System (EMS), Building Automation System (BAS), or other local control system (e.g. thermostats) that can receive an event signal from the Austin Energy VTN/DRAS. The implemented system should not require human intervention at the customer site in order to initiate the pre-programmed load reduction sequence during a demand response event. In addition, the customer maintains control to override the load reduction sequence as needed.

2.2.2 ADR DRAS Signaling Requirements

The customer installed and maintained VEN pulls the ADR event signal directly from the Austin Energy VTN/DRAS over the public internet (See Figure 2). The customer:

- Must have an OpenADR 2.0 b-certified VEN and connect directly with the Austin Energy VTN/DRAS.
- May arrange for a third party to connect to the Austin Energy VTN with a compatible VEN and distribute events to one or more customer sites.
- Is responsible for reliable public internet service for connection to the Austin Energy VTN/DRAS end-point.
- Is responsible for providing their VEN's public Internet Provider (IP) address to Austin Energy.
- Is responsible to ensure VEN includes the proper security certificate for connection to the Austin Energy VTN/DRAS end-point.

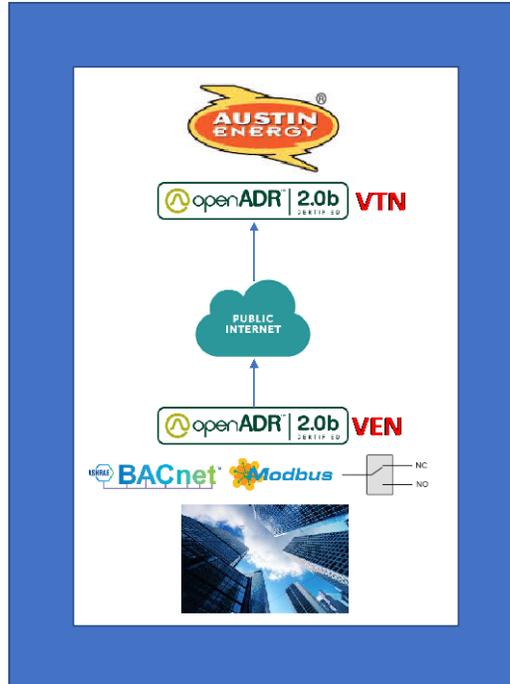


Figure 2 - Auto-DR Diagram

3.0 IMPLEMENTATION PROCESS

3.1 Enrollment

Austin Energy customers interested in participating in ADR must fill out the [Commercial Demand Response Program Enrollment Form](#) (if not already enrolled) and send to loadcoop@austinenergy.com. An Austin Energy Load Cooperative representative will contact the customer to schedule a site visit and discuss network setup, testing, and strategies. Contact your assigned Austin Energy Key Account Manager for more information about ADR.

3.2 Device Installation/Network Setup

The customer is required to install a VEN with the ability to integrate with an OpenADR 2.0 VTN/DRAS. The VEN can either be a separate device (gateway, demand management system, etc.) with internet capabilities that communicates directly with the building control system or the building control system itself may have OpenADR 2.0 protocol. Available products can be found on OpenADR.org's website at <http://products.openadr.org/>.

An Austin Energy Commercial Demand Response participant considering the installation of ADR should also consider the following:

- Contact Austin Energy before purchasing a new VEN to ensure existing compatibility tests¹ have been performed. See Appendix B for ADR products that have been tested by Austin Energy.
- VEN must set the OpenADR event market context field to Load Cooperative.
- VEN must be programmed to poll the Austin Energy VTN/DRAS on at least a one-minute interval.

3.3 Testing/Commissioning

Austin Energy will work collaboratively with the customer, commissioning agent, and/or contractor to develop a testing and commissioning plan. During the development, Austin Energy can assist in recommending curtailment strategies and configuration of VEN communications. This plan will consist of testing and commissioning of the ADR connection between the VTN and VEN, communication paths (e.g. cellular, Wi-Fi, LAN or WAN), and curtailment strategies (including event opt-out procedures).

Testing of the text and e-mail notifications to the building operators as well as the ADR components can be included.

The Austin Energy Test System process includes:

1. New ADR customers will first be provisioned and tested via the Austin Energy Test VTN.
2. Customer will provide Austin Energy with an X.509 certificate signing request (CSR). See Appendix A for details on the CSR process.
3. Austin Energy will then respond with a signed client certificate and self-signed certificate authority (CA).

3.4 Timeframe

The timeframe for implementation of ADR (from first contact with Austin Energy to completion of testing/commissioning) is typically 90-100 days. Equipment lead times and programming of response strategies within the customer's BAS/EMS may increase the implementation timeframe. The bulk of the implementation time is related to device shipping and installation and BMS/EMS programming with Austin Energy's testing and commissioning process generally taking less than a week's time.

3.5 Performance

Ongoing performance can be monitored through Austin Energy's EPO. All Austin Energy customers enrolled in the Commercial Demand Response program have access to this cloud-based energy management and demand response tool. Through load profiling and energy tracking, customers are able to monitor their performance within the ADR program and understand where they may need to make adjustments with pre-programmed DR event strategies. Along with the ADR event signal, the customer will also receive an email notification.

¹ Compatibility tests would include VEN processing of ADR event signal data received from the VTN for suitability with customer existing or new downstream automation equipment

Austin Energy Demand Response representatives will also be available to assist with strategies to improve ADR performance. If assistance is needed, contact Austin Energy through its website or through your designated Key Account Manager. Please note that the customer assumes the lost revenue risk for incorrect load shed due to missed ADR event notifications.

Once online, Austin Energy will monitor the ADR connection to ensure it is active and the VEN is polling the VTN properly. If there appears to be interruptions or inconsistent polling of the VTN, Austin Energy will notify the customer or their designated representative

Once online, the customer is responsible for keeping control strategies enabled as well as Hand-Off-Auto switches in the Auto position, except in the case of safety or maintenance activity. Austin Energy will notify the customer or their designated representative will monitor event performance but may not recognize a problem with the overall event performance once the event is over.

3.6 Strategies

In order to best develop demand response strategies, all major electrical loads within the facility must be identified as to which load shedding opportunities exist. With this information, a thorough demand response plan can be developed. The best strategies for the facility and HVAC type will vary and will require striking a balance between maximizing the curtailments and minimizing the impact to occupants or processes. Strategies will need to consider not just load shedding for curtailment, but also recovery strategies for bringing equipment back on-line to avoid load spikes. See Appendix C for a listing of potential demand response strategies and reference sources.

APPENDIX A: ADR VEN Certificate Signing Request Process

Background

Austin Energy offers Commercial Demand Response and potentially other demand response customers the opportunity to become ADR-enabled using OpenADR-based technology. Commercial Demand Response customers with OpenADR equipment can, via the public Internet, securely communicate directly with Austin Energy's OpenADR VTN/DRAS and receive real-time demand response event notifications.

An important first step in the provisioning process is for the customer to request and received a digitally signed certificate file for installation on their OpenADR compatible VEN device.

This process is described in detail in the following sections.

Certificate Signing Process

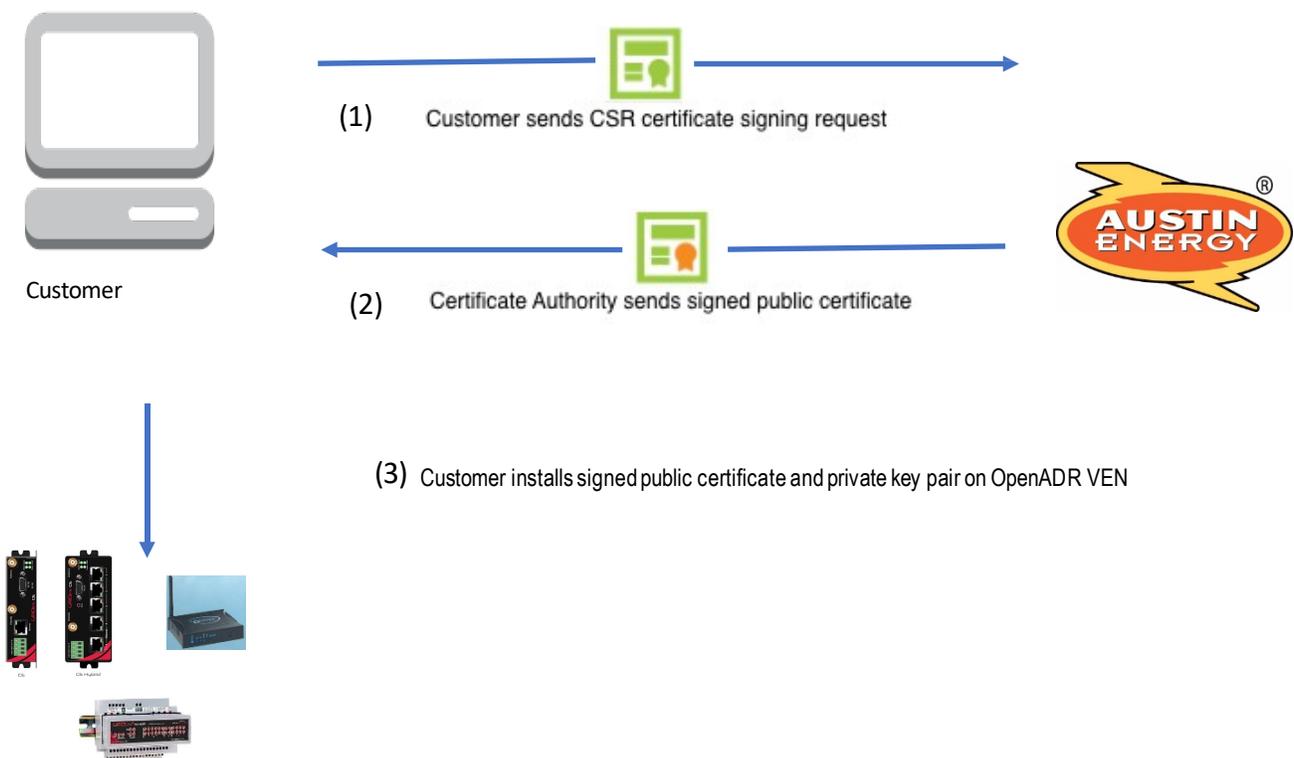


Figure 1 - OpenADR X.509 Certificate Process

Figure 1 depicts a high-level process

- Customer purchases OpenADR 2.0b VEN equipment compatible with Austin Energy's VTN/DRAS.
 - Customer is advised to contact Austin Energy at loadcoop@austinenergy.com before purchasing new VEN equipment to assess compatibility with Austin's VTN/DRAS.
 - Austin Energy will work closely with each customer to ensure the highest quality of installation and testing.

- Customer should plan to perform VEN installation and commissioning test at least 30-60 days in advance.
- Customers must prepare an X.509 CSR and email to Austin Energy at loadcoop@austinenergy.com.
 - This is a one-time procedure by the customer that can be accomplished with any Windows, MAC, or Linux-based computer.
- Upon receipt of the CSR, Austin Energy staff will reply with a digitally-signed public certificate for the customer to install on their VEN.
 - The signed public certificate returned to the customer, along with the private key generated by the customer during the CSR step, shall be installed by the customer in accordance with instructions and/or user interfaces provided by the VEN manufacturer.

Customer: Creating a CSR

For highest compatibility, Austin Energy recommends that customers utilize the OpenSSL command line utility available on Windows, Mac, and Linux computers.

For Windows, the customer will first need to download and install GitHub Desktop at <https://desktop.github.com/> which is a free software download commonly used to manage source code. GitHub Desktop includes something called *GitHub Shell* which is a Linux-like command shell and contains the OpenSSL command line utility.

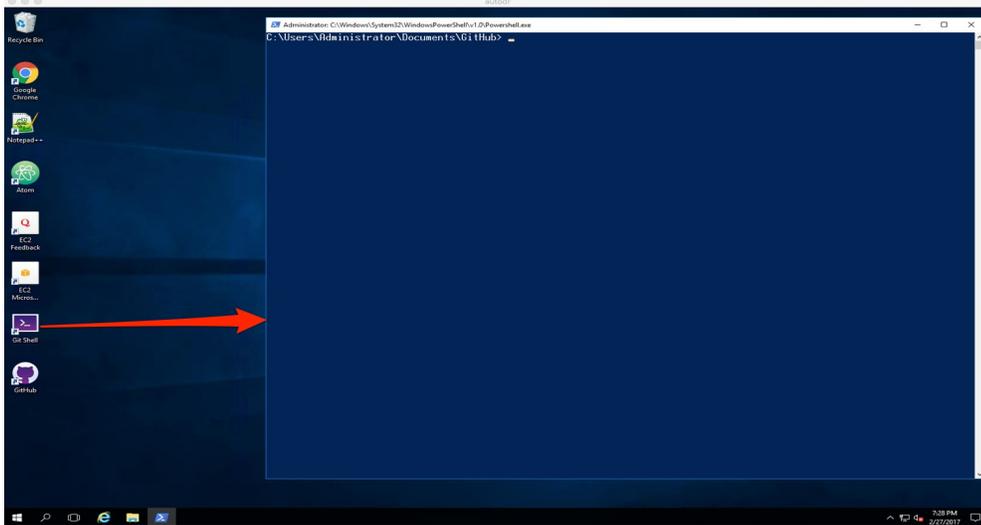


Figure 2 - Preparing to create a CSR using Windows w/GitHub Shell

1. Request Austin Energy for a unique CN, or common name, for the VEN certificate signing request.
 - a. The CN is used during the CSR process to uniquely identify the customer's VEN within Austin Energy's VTN/DRAS.
 - b. The CN must be unique as determined by Austin Energy.
2. Mac and Linux users will need to open a new terminal or window shell to gain access and use the OpenSSL command line utility.
3. Generate a CSR by entering the following command in the window shell:

```
openssl req -new -newkey rsa:2048 -nodes -keyout my_private_key.pem -out my_csr.pem
```

4. Replace **my_private_key.pem** with a filename of your choosing.
 - a. This is a private key file that will be automatically created.
 - b. The text contained in the private key file is a very complex password - protect this file like you would a password.
 - c. Do not email the private key file - keep in a safe location.
5. Replace **my_csr.pem** with a filename of your choosing.
 - a. This file is the file you will email to Austin Energy
6. Run command
 - a. You will be prompted to enter the following:
 - i. Country Name (two letter code): **US**
 - ii. State or Province Name: **TX**
 - iii. Locality: **Austin**
 - iv. Organizational Name: **Your Company**
 - v. Organizational Unit: ok to leave blank
 - vi. Common Name: **CN from step 1 above**
 - vii. Email Address: ok to leave blank
 - viii. A Challenge Password: **Be sure to leave this blank**
 - ix. An optional company name: ok to leave blank
7. Email the generated CSR file to loadcoop@austinenergy.com.
 - a. Do not email the generated private key file - keep in a safe location.

Figure Three shows an example of a completed CSR:

Figure 3 - Completed CSR



```
1. Dark Pastel (sh)
sh-3.2$ openssl req -new -newkey rsa:2048 -nodes -keyout my_private_key.pem -out my_csr.pem
Generating a 2048 bit RSA private key
.....+++
.....+++
writing new private key to 'my_private_key.pem'
-----
You are about to be asked to enter information that will be incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank.
-----
Country Name (2 letter code) [AU]:US
State or Province Name (full name) [Some-State]:TX
Locality Name (eg, city) []:Austin
Organization Name (eg, company) [Internet Widgits Pty Ltd]:your-business-name-here
Organizational Unit Name (eg, section) []:
Common Name (e.g. server FQDN or YOUR name) []:unique-common-name-provided-by-austin-energy
Email Address []:

Please enter the following 'extra' attributes
to be sent with your certificate request
A challenge password []:
An optional company name []:
sh-3.2$ dir
sh: dir: command not found
sh-3.2$ ls *.pem
my_csr.pem          my_private_key.pem
sh-3.2$
```

Customer: Installing Public Certificate and Private Key

At this point, the following should be complete:

- The customer has created a CSR and associated private key 'my_private_key.pem'.
- The customer has emailed the CSR to the CA (Austin Energy).
- The CA has created a signed public certificate 'my_cert.pem' and emailed to the customer.
- The CA has also emailed the ca-chain.cert.pem CA public certificate chain to the customer.

What happens next is entirely dependent upon the VEN being provisioned. In many cases, the vendor will have specific procedures regarding deployment of signed X509 certificates and associated private key.

If a VEN vendor requires the newly acquired X509 certificate to be in the industry standard PKCS 12 format, follow the steps below. Note: This format simply takes the signed public certificate, private key, and CA certificate chain and combines them into one file.

To create a new PKCS 12 file 'my_cert.pfx' containing:

- private key
- public certificate
- CA public certificate

enter the following command:

```
openssl pkcs12 -export -out my_cert.pfx -inkey my_private_key.pem -in my_cert.pem -certfile ca-chain.cert.pem
```

The result of this command is a new file 'my_cert.pfx' that is suitable for deployment to VEN devices requiring the PKCS 12 format.

APPENDIX B: AUSTIN ENERGY OpenADR Tested Products

Austin Energy supports open standards and does not recommend specific products. The guide below is to assist in finding Open ADR products that have been tested by Austin Energy using Austin Energy's Demand Response software platform. Prior to the purchase of any ADR equipment, please consult with Austin Energy staff in the Customer Energy Solutions group at (512) 482-5346 or at conservation@austinenergy.com. These listings should not be construed as all-inclusive of compatible devices or products, and Austin Energy is willing to test and add products to this list. Consider this a guide only and your specific use and application of OpenADR products should be considered for product selection.

Austin Energy Tested OpenADR Products

Below is a sample of products compatible with Austin Energy's program. This list in no way limits the products a customer can use to connect to Austin Energy's Open ADR system.

IPKeys/EISS Box – Open ADR Certified VEN

<https://ipkeyspowerpartners.com/products/eiss-energy-interop-server-system/eiss-box/>

IC Systems/Gridlink – Open ADR Certified VEN

<http://gridlinktechnologies.com/>

Pelican Wireless – Open ADR Certified VEN

<http://www.pelicanwireless.com/>

Universal Devices – Open ADR Certified VEN

<http://www.universal-devices.com/>

OpenADR Certified Products

A listing of all OpenADR products currently certified by the OpenADR Alliance can be located at <http://products.openadr.org/>.

APPENDIX C: Demand Response Strategies

The following are some potential demand response and recovery strategies that have been presented by industry resources. Not all strategies are viable for every facility and must be evaluated on a case-by-case basis to determine suitability for implementation. For more detail information on each strategy, please refer to the provided reference sources.

Demand Response

- HVAC Systems
 - Global Temperature Adjustment²
 - Absolute Setpoint Adjustment⁴
 - Relative Setpoint Adjustment⁴
 - Building Pre-Cooling (Passive Thermal Mass Storage)²
 - Duct Static Pressure Decrease²
 - Fan Variable Frequency Drive Limit²
 - Supply Air Temperature Increase²
 - Cycle Constant Air Volume HVAC Units³
 - Load Cycle Package AC Units³
 - Fan Quantity Reduction²
 - Cooling Valve Limit²
 - Chilled Water Temperature Increase²
 - Chiller Demand Limit²
 - Chiller Quantity Reduction²
 - Reduce Outside Air Ventilation³
 - Thermal Energy Storage⁴
- Lighting Systems
 - Zone Switching²
 - Luminaire/Lamp Switching²
 - Stepped Dimming²
 - Continuous Dimming²
 - Turning Off Lights⁴
- Miscellaneous Equipment
 - Shutdown Fountain Pumps²
 - Turnoff Anti-Sweat Heaters on Cold Display Cases²
 - Do Not Charge Electric Vehicles²
 - Shutdown Unnecessary Industrial Process Equipment²
 - Air Compressor Shedding²
 - Cold Storage Load Shedding²
 - Shutdown or Cycle Elevators and Escalators²
 - Shutdown Irrigation Water Pumps²
 - Shutdown Pool Heating and Pumps³
 - Do Not Charge Batteries or Battery-Operated Equipment³
 - Use Pre-Charge Battery-Operated Equipment³
 - Turnoff Nonessential Equipment (e.g. printers, copiers, shredders, coffee makers, fans)³
 - Turnoff Beverage Vending Machines and Ice Machines³

- Turnoff Decorative Features (e.g. ambient audio and video, signage, window displays)³
- Shutdown Water Heaters
- Shed Non-Critical Plug Load

- Use on-site generation that complies with state, city, and county regulations¹
 - Electrical Storage Systems⁴
 - Solar
 - Wind
 - Geothermal
 - Generators (if allowed by utility)

- Energy Management Control System Programming
 - Demand Limiting Strategy²
 - Price-level Response Strategy²

- Behavior
 - Conduct meetings during events timeframes to minimize use of equipment.³
 - Adjust employee schedules and shifts so that times of increased production or energy use occur before or after events timeframes.³
 - Complete dishwashing and housekeeping activities before or after an event.³

Recovery

- Slow Recovery²
- Sequential Equipment Recovery²
- Extended DR Control Period²

References

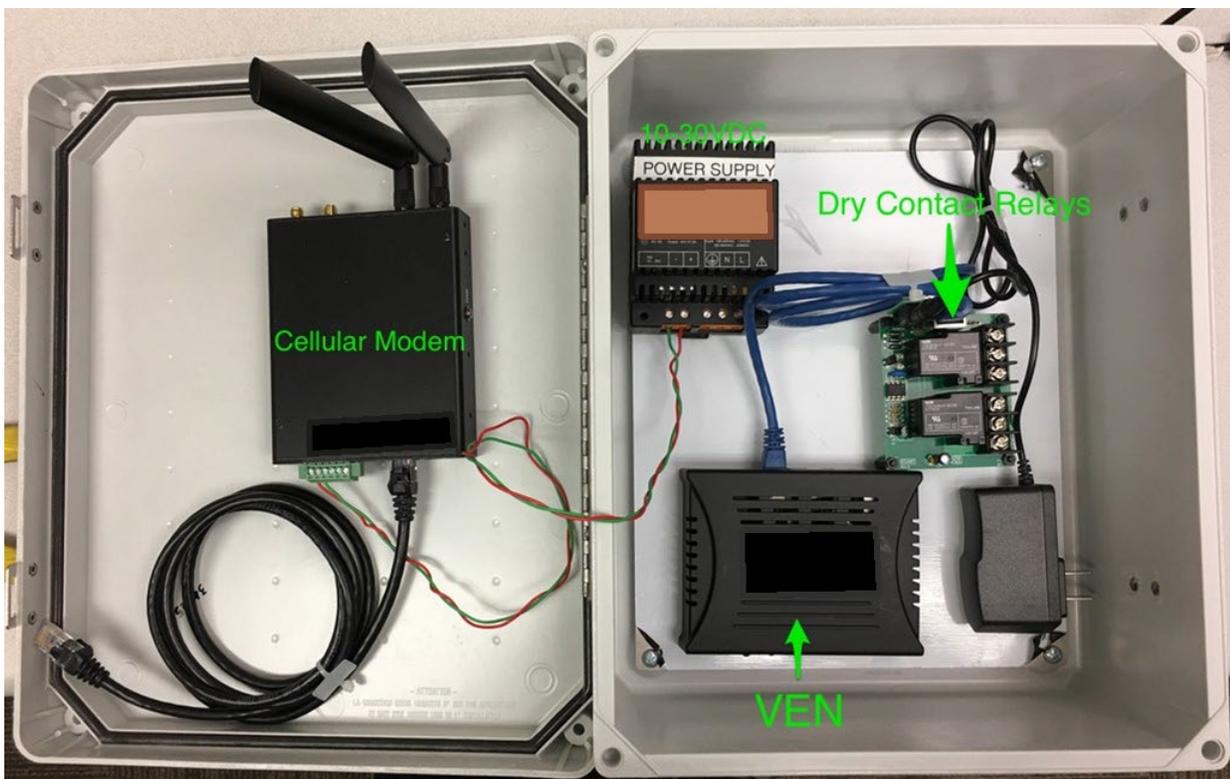
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2. Montegi, N. P. (2007). Introduction to Commercial Building Control Strategies and Techniques for Demand Response. Lawrence Berkeley National Laboratory, Demand Response Research Center, Berkeley, CA. Retrieved May 31, 2017, from <http://gaia.lbl.gov/btech/papers/59975.pdf>
3. Pacific Gas and Electric Company. (2017). Energy Reduction Strategies. Retrieved May 31, 2017, from https://www.pge.com/en_US/business/save-energy-money/energy-management-programs/demand-response-programs/energy-reduction-strategies/energy-reduction-strategies.page
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APPENDIX D: Building an ADR Endpoint

This document will outline an example configuration of products and physical connections needed to construct a compatible OpenADR field device capable of:

1. **Internet:** Cellular and/or Ethernet-based internet communications to the Austin Energy OpenADR 2.0b Virtual Top Node (VTN) - server
2. **VEN Device:** Real-time DR (demand response) event receipt and processing via a compatible OpenADR 2.0b Virtual End Node (VEN) field device and interfacing with customer equipment via dry contact relays

Figure 1 - AutoDR integrated solution with NEMA-4X Enclosure



Prior to the purchase of any ADR equipment, please consult with Austin Energy staff in the Customer Energy Solutions group at (512) 482-5346 or at conservation@austinenergy.com.

Internet Communications

Austin Energy requests that an ADR customer supply their own Internet access, preferably Ethernet-based.

For customers without Ethernet-based internet access, a cellular modem is required.

Please note:

- a) Customer must support their own cellular data SIM card from either AT&T or Verizon

- b) Anticipated data usage is ≤ 2 Gb/month
- c) Upon request, remotely administer the setup and configuration
- d) If remote setup is desired, Austin Energy will need the serial number from the purchased device.

OpenADR 2.0b Compatible VEN

While there are many OpenADR 2.0b VEN products, Austin Energy is recommending the following solution for customers desiring a simple, dry contact relay interface between the Austin Energy controlled VEN and their own building automation system.



Figure 2 - VEN Basic View

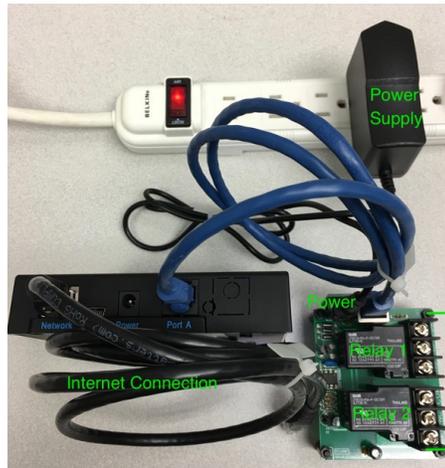


Figure 3 - VEN Alternate View

Relay Output Programming

Austin Energy will send the following OpenADR event signal payloads shown in Table 1.

Table 1 - OpenADR Event Signals and Customer Relay Operations.

OpenADR Event Signal Payload	Relay One	Relay Two	Notes
No Event	Open	Open	Both relays are N.O.
Pre-Event or Ramp Up period	Closed	Open	This is reserved for Commercial Demand Response events and will optionally close 60 minutes before the start of an event enabling the customer to 'pre-cool' or perform other needed pre-event automated activities
Moderate	Open	Closed	Customer-dependent programming for less aggressive load reduction
High	Closed	Closed	Customer-dependent programming for more aggressive load reduction

Note: AUSTIN ENERGY can randomly choose to send a moderate or a high event signal payload as specified in the table above.

Uninterruptible Power Supply (UPS)

For participation in ERS, Austin Energy requires the VEN be connected through a UPS (uninterruptible power supply) to reduce the possibility of erroneous AutoDR event status following an unexpected loss of power to equipment.

Second Internet Connection

For participation in the Commercial Demand Response program, only a single internet connection is required. However, participation in Austin Energy's Emergency Response Service (ERS) programs requires two Internet connections - WAN and Cellular with automated failover. The customer will need to provide both a wired Ethernet connection and Cellular data card for participation in an ERS program. Contact your assigned Austin Energy Key Account Manager for more information about Austin Energy's demand response programs.