ADR Capabilities of VRF Technologies: Manufacturer Outreach

DR18.11

Prepared by:

Emerging Products
Customer Service
Southern California Edison

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Energy Solutions

ADR Enablement of VRF Controls Workshop: Final Report

To: Kevin Chan
Southern California Edison

From: Kitty Wang
David Zhang
Emily Kehmeier
Jeffrey Johnston
Energy Solutions

Date: April 15, 2020

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1. Overview

Project Background

Variable refrigerant flow (VRF) systems are well suited for automated demand response (ADR) because of their variable speed inverters, inherently zone-based design, and integrated controls available from the factory.

In March 2017, Energy Solutions and ASWB Engineering completed a market characterization study of automated demand response (ADR) capabilities of variable refrigerant flow (VRF) technologies. The objectives of the study were to: research the status of ADR-capable VRF controls among different VRF manufacturers; and verify if and how VRF controls satisfy demand response requirements set by the 2013 Title 24 energy code.

The study found that VRF systems have controls functions now to manually carry out demand reduction strategies. However, the control functions are not sufficiently integrated to perform ADR. Furthermore, VRF manufacturers had a wait and see attitude on making their VRF solutions fully ADR-capable for SCE program participation. Many wanted first to see clear market signals requesting ADR features from their customers, SCE, or both. Manufacturers were generally interested in utility incentive programs to reduce purchase costs for customers, and agreed on the need to comply with state code requirements. However, the interviews by Energy Solutions' team revealed a lack of familiarity with the specific requirements in both the current Title 24 requirements and ADR Program requirements.

The goal of this current Phase 2, 2019 scope of work was to arrive at a common understanding with major VRF equipment manufacturers on SCE's OpenADR product requirements and demand response participation needs, as well as on Title 24 requirements for demand responsive controls. Another project goal was to convince the manufacturers to go one step beyond utility program and Title 24 requirements and create an ADR solution for their products that is plug-and-play – easy to install and commission – for Small and Medium Business (SMB) customers who don't have the resources to spend on custom programming.

VRF Workshop Objectives

The objectives of the workshop were to:

- Review regulatory, policy, and program context for demand response in California and how VRF systems fit in.
- Review Title 24 and SCE ADR Program baseline requirements.
- Agree on a common set of solutions for making VRF systems ADR-capable out-of-the-box for SMB customers
- Leave with the information needed to move forward on agreed solutions.

Manufacturer Engagement Prior to Workshop

Webinar

Energy Solutions held a webinar in early May for VRF manufacturers, "ADR in California: VRF Compliance with Title 24 and Utility Programs". The objective was to equip all VRF manufacturers with basic information about demand response (DR) and ADR in California at the same time. Energy Solutions developed the agenda with input from SCE and manufacturers, which consisted of:

- An overview of the demand response landscape in California,
- An overview 2019 Title 24 DR requirements for heating ventilation and air conditioning (HVAC) equipment,
- ADR Programs in California,
- DR programs at SCE, and
- An overview of this project

One-on-One Manufacturer Calls

Energy Solutions held at least two calls with contacts at each manufacturer between June and September. One manufacturer who was not responsive to efforts to schedule the second call. Since not all manufacturers attended the May webinar, Energy solutions recapped the content from the webinar. Energy Solutions then opened the table for more question and answer with the individual manufacturers.

The calls were also used to gather information and updates on the ADR-readiness status of each manufacturer's technology, and to gather feedback on the draft baseline ADR requirements which Energy Solutions had developed by interviewing SCE staff and key industry experts. The discussions indicate that ADR-readiness statuses remained about the same for VRFs since the 2017 study. Manufacturers generally had many questions and comments on these baseline ADR requirements. Their input was provided to SCE in the form of a manufacturer Q&A which Energy Solutions drafted and refined with additional input from SCE staff and industry experts, and incorporated back into a finalized Baseline ADR Requirements Memo, delivered to SCE in November.

Lastly, during the one-on-one manufacturer calls, Energy Solutions shared plans for the upcoming working group call and in-person workshop, and encouraged manufacturers to participate in both. This included convincing of the value and assuring that manufacturers would not be asked to shared confidential information in the group setting.

Working Group Call

Energy Solutions organized one manufacturer working group call in September. One purpose of the working group call was to review Title 24 requirements, utility program requirements, and project goals for plug-and-play ADR solutions in a group setting. The goals of doing so were two-fold: to answer as many remaining questions as possible, in order to save time at the in-person workshop for deeper-dive topics; and to spark questions and comments in a group setting to create some precedence for manufacturers interacting with each other prior to the workshop. This pre-workshop collaboration was expected to build manufacturer buy-in and encourage active participation at the workshop.

The other main purpose of the working group calls was to engage manufacturers in collaboratively developing an agenda for the workshop. To do this, Energy Solutions drafted an agenda, shared main topics during the working group, and collected input. Manufacturers brought up a handful of good questions in earlier parts of the working group call as well, which informed the creation of manufacturer Q&A which was distributed ahead of the workshop and reviewed briefly during the workshop.

VRF Workshop Attendees

A total of 23 people attended the ADR Enablement of VRF Controls Workshop on November 14, 2019 at the SCE Energy Education Center. Attendees consisted of six manufacturers: Daikin, LG, Mitsubishi, Samsung, Johnson Controls-Hitachi, and Carrier-Toshiba. Although Fujitsu was not able to attend, Energy Solutions followed up with Fujitsu separately after the workshop to answer any questions from their review of the meeting minutes and presentation slides.

SCE had several attendees present to help answer questions about SCE's ADR program and to participate in discussions on ADR-enablement for VRF systems. Kevin Chan, the SCE project manager, coordinated the schedules of SCE staff to make sure that a diverse set of DR functions within SCE would be represented, including ADR technology development, DRAS management, and DR program design. Kitty Wang from Energy Solutions facilitated the workshop presentations and breakout sessions along with Kevin Chan.

Two subject matter experts were brought in to bring knowledge on OpenADR and Title 24 topics. Jim Zuber, the CTO and co-founder of Quality Logic, contributed to the development of OpenADR 2.0a and 2.0b and answered questions about the objective of the OpenADR protocol and described different VEN options for VRF systems. Gabe Taylor, a Building Standards and Sustainability Engineer at the California Energy Commission, developed the 2019 Title 24 Demand Response code language (as well as previous versions of the DR code language) and educated VRF manufacturers on the purpose of DR programs in California and how Title 24 is aiming to reach those goals.

Attendees:

Organization	Attendee	Job Description/Title
Carrier-Toshiba	Jeremy Lambert*	Controls Specialist, Ductless & VRF
Daikin	Norman Pennant	Sr. Commercial Controls Manager, VRF & light commercial
Daikin	Tao Jia	(Goodman Manufacturing)
Daikin	Hiroshi Yoh*	
LG	Glenn Savage	Controls Engineering Manager, VRF and Ductless Controls
LG	Sidd Goyal*	Controls Engineer
Mitsubishi	Sam Beeson	Utility & Strategic Accounts Manager
Mitsubishi	Anthony Lambert	Sr. Solutions Engineer

Samsung	Sungmin Jang	Application Engineer
Johnson Controls-Hitachi	Badri Patel*	Product Specialist for VRF
CEC	Gabe Taylor	Engineer, author of Title 24 DR Section 110.12
Quality Logic	Jim Zuber	CTO
Southern California Edison	Kevin Chan	Project Manager
Southern California Edison	Sean Gouw	Engineer
Southern California Edison	Rafik Sarhadian	Engineer
Southern California Edison	Brian Van Horn	DR Tech Operations
Southern California Edison	Mark Martinez	Sr. Portfolio Manager for DR and ET
Southern California Edison	Dave Rivers	Emerging Products and Technologies, EE and DR
Southern California Edison	Jerine Ahmed	ET Team Technology Area Lead, HVAC and Controls
Southern California Edison	Peter McFerrin	Sr. Analyst - ADR and DR Programs
Energy Solutions	Jeff Johnston	Sr. Manager - Market Relationships
Energy Solutions	Kitty Wang	Technical Director, DERs
Energy Solutions	David Zhang	Project Manager, DERs
Energy Solutions	Emily Kehmeier	Project Manager, DERs

*On the phone

VRF Workshop Agenda Overview

The VRF workshop involved presentations in the morning with working sessions in the afternoon. The morning presentations were meant to set the stage for why manufacturers should care about developing controls for the load management use case out-of-the-box. The afternoon was a working session, meant to provide deep dive into specific topics on ADR applications for VRF controls. The full workshop agenda is provided in Appendix A.

Morning Session

WELCOME REMARKS

Mark Martinez with Southern California Edison welcomed manufacturers to the workshop and provided some context on the history and the importance of DR to meet California's energy needs. He emphasized that the growth of an ecosystem of grid-connected appliances that can provide DR services is something that SCE is committed to and that they are intended to advance through this workshop.

WORKSHOP OBJECTIVES AND GOALS

Kitty Wang with Energy Solutions reviewed the workshop goals which were to:

- Develop VRF controls capabilities to be applied to the load management use case.
- Review T24 compliance questions.
- Review participation in statewide incentive programs.
- Discuss how to develop VRF DR solutions so that they're more accessible to customer, more plug and play.
- Leave with ideas and action items.

WHY PRIORITIZE DR ENABLEMENT

Jeff Johnston with Energy Solutions offered some arguments regarding why manufacturers should be invested in making their technologies easy-to-use for the ADR use case, from the perspective of contractors. A key takeaway is that contractors will select the products that are quickest and easiest to install and commission (including connection to the DRAS and selection of default DR strategies), since time spent in the field is money.

SCE PRESENTATIONS

Peter McFerrin with Southern California Edison presented an overview of the SCE Auto-DR program, and the eligible DR programs and rates, with a focus on the Critical Peak Pricing rate. Peter covered the details of the rate, the background on SCE defaulting customers to it, and the importance of DR as a means for customers to manage peak prices.

Rafik Sarhadian presented an overview of a lab test conducted at SCE's Technology Test Center in Irwindale. In this experiment, A variable frequency drive was added to a 5-ton rooftop heat pump HVAC unit to control the compressor and indoor fan. The unit was programed with 2 strategies for moderate and high DR events. The objectives were to determine whether the controls worked properly, and to determine the impact on comfort. The VFD controllers successfully executed the DR strategies in response to OpenADR signal. The units reduced total average power by 19-33 percent (medium event) up to 60 percent (high event), but with significant increases in indoor temperatures of 6-9^{o}F (medium event) up to 17^{o}F (high event).

REVIEW TITLE 24 AND MANUFACTURER Q&A

Kitty Wang with Energy Solutions reviewed the demand response requirements in Title 24. There were many questions about the code requirements throughout the whole manufacturer engagement effort. Manufacturer Q&A were also reviewed in an abbreviated structure. The full Q&A document was provided to manufacturers prior to the workshop. See Appendix E for the full Title 24 Q&A document.

ATTENDEE DISCUSSIONS

There was active discussion from attendees during the morning presentations. Manufacturers asked additional questions about DR programs in California and Title 24 requirements related to OpenADR capabilities. Gabe Taylor with the CEC offered historical context and framework for thinking about demand response and load management in California. He pointed out that DR programs in California are likely to change substantially over the next decade. Historically, DR programs conceived in the 1970s after California's first energy crisis focused on emergency events and reducing load. With the state moving to 100 percent zero carbon by 2045, DR programs need to shift to providing changing rates hour to hour and for utilities to incentivize load shifting and shaping, both reducing and increasing load. The hardware that was employed for DR in the 1970s was also quite expensive, and there was a deep concern to protect customers from stranded assets. The CEC is looking at new legislation to encourage appliances to have load management capabilities as well.

Afternoon Session

WORKING SESSION: MAKING ADR ACCESSIBLE OUT-OF-BOX

Manufacturers broke into two working session groups to brainstorm and prioritize solutions for one topic each: 1) Default DR Strategies and 2) VEN Solution. Facilitators introduced the subject matter and goals for the groups and move discussions forward. Notetakers captured all issues and recommendations proposed by the breakout group. For details on objective and content of the working sessions see below in Section 2, Breakout Sessions.

BREAKOUT GROUP PRESENTATIONS

Each group had about thirty minutes to present the results of their discussions to the larger group, and to answer questions. Report-outs were guided by a report-out template. The content of the report-outs is discussed later, in Section 2, Breakout Sessions.

TOUR OF IRWINDALE TEST CENTER

Sean Gouw provided a tour of the Irwindale test center, highlighting some of SCE's current research and test projects on an assortment of appliances. This included a tour of the VRF test lab equipment that Rafik Sarhadian had presented on as part of the SCE presentations.

2. Breakout Sessions

Overview of Topics

The afternoon of the VRF workshop consisted of two parallel, interactive breakout sessions. VRF manufacturers, SCE representatives, and subject matter experts formed two groups to discuss ideas, challenges, and opportunities for topics related to VRF ADR-enablement. One breakout group worked on identifying and comparing VEN solutions for VRF systems, while the other breakout group focused on default DR control strategies that could be executed by VRF systems for a DR event. Each breakout group had 2 hours to discuss their topic, followed by a thirty-minute report-out presentation from each group.

The objective of the VEN solutions breakout session was to evaluate different types of VEN implementation configurations for VRF systems. In order for VRF systems to receive and respond to OpenADR events sent from SCE's DRAS, VRF systems need to either have an integrated VEN or be paired with a 3rd party certified VEN developed by a VEN manufacturer. Once the VEN is registered with the DRAS, it can receive events sent by the DRAS, opt into/out of events, and participate in targeted events. Event signals are then relayed to VRF systems for implementation of specific control strategies.

The objective of the Default DR control strategies breakout session was to develop ideas for built-in demand response strategies that satisfied the load shed goals of SCE ADR programs. Default DR strategies make it easier for customers to install and set up their technologies for ADR program participation. Building in default strategies reduces installation time and costs by contractors and removes the need for technical specialists to be present during ADR setup (i.e. "plug and play"). With additional DR strategies built-in, customers can easily set their DR preference based on their desired level / aggressiveness.

Breakout Group Discussion Points

VEN Solutions Discussion

The VEN Solution breakout group discussions covered several topics including existing payload of OpenADR signals used by SCE, event signaling, the load shed verification procedure, options for different VEN solutions, VEN-VTN connection security requirements, and VEN solutions for small, medium, and large customers. At the beginning of the breakout discussion, VRF manufacturers stated that they were interested in what types of signals the utility is sending out, what DR programs customers are participating in, and how to avoid deploying a solution that would need to be modified down the line.

On the topic of improved event signaling, the group discussed ways to leverage the VRF system's ability to limit inverters to respond to DR events. Gabe Taylor explained that the 4-degree setpoint requirement was set up for fixed speed equipment and agreed that it would be a good approach to explore other load shed strategies for VRF systems. VRF manufacturers stated that hourly price signals (either an exact price or a price multiplier) would be a useful input for designing load shed strategies. For example, pricing signals could be used to implement precooling strategies prior to a DR event. Manufactures also agreed that utilities should utilize OpenADR 2.0b, which has the capability to send out multiple pricing signals within a single event payload.

When analyzing the VRF system's ability to receive and respond to a DR signal, VRF manufacturers stated that VEN solutions could easily be implemented for both small and large systems. Small systems could utilize a cloud VEN due to its ease of scalability, while large systems, which typically have a building or energy management system (EMS), could utilize an EMS integrated on-site VEN. However, medium sized VRF systems lacked a cost effective, scalable solution. Medium sized systems are not big enough for a dedicated EMS but are too large to have a single hardware VEN for each device. Medium sized systems also lack a cloud infrastructure, which currently only exist for small business and residential customers.

Default DR Strategies Discussion

The default DR strategies breakout session addressed several questions including the challenges of incorporating DR strategies, ways to accommodate load-up scenarios, choosing between software vs. dry contact programming, the approach for programming a default temperature setpoint function, and the pathway to reach built-in default DR strategies. One feedback from VRF manufacturers was that customers usually choose the control settings that offer the most optimized energy efficiency during commissioning but don't typically interact with the control strategy afterwards. This observation led to the idea that two control modes are needed, one with a fixed optimization scenario for conventional projects, and another with a DR optimized scenario for DR customers. For the DR optimized scenario, customers should have the flexibility to change the temperature setpoint, to define non-critical zones, and to set their own comfort limits.

Similar to the VEN solutions breakout group, VRF manufacturers in the default DR strategies breakout group agreed that compressor speeds could be adjusted as a DR strategy response. This would be especially applicable for scenarios where the temperature setpoint is already at its lowest allowable state, and a DR signal to further reduce the temperature setpoint would have no effect. Another proposed DR strategy would be for the utility to set an absolute temperature setpoint (e.g. set to X°F). This option would be straightforward for the customer to understand and wouldn't be dependent on pre-existing temperature settings prior to the event.

To develop default DR strategies, VRF manufacturers believed that more open protocol commonalities would be needed. As a starting point, utilities could develop a standardized list of loads / signals for VRF manufacturers to design off of. For example, although OpenADR 2.0a currently has three levels of DR signals (low, medium, and high), it wasn't clear how much load VRF systems should shed for each signal level. There also isn't a standardized market definition for what would be considered high load shed vs. low load shed. The group agreed that further investigation would be needed to understand how compressor speeds affect load, and what the lowest allowable compressor speed could be set to, while still maintaining VRF operation.

Report-out

VEN Solutions Report-Out

The report-out for the VEN solution topic was sub-divided into two topics: signaling requirements and VEN solution options. For the signaling requirements subtopic, the group developed the idea to standardize two types of event signals, a simple signal and a pricing signal. These two event signals would act as inputs to help VRF manufacturers create DR-specific control strategies. The simple signal would indicate the load shed level being requested and the pricing signal would contain a list of 24-hourly day-ahead prices. A 24-hourly, day-ahead price signal was identified as the most useful and easiest data source for manufacturers to work with when developing DR control strategies. This type of pricing signal would also allow customers to make decisions based on real time events and prices. The next step identified by the group was for utilities to clearly communicate to VRF manufacturers what event signals would be sent to the VRF systems during an ADR event. Eventually, the development of these new signal type combinations could lead to a new utility ADR program for VRF systems and other technologies.

For the VEN solution subtopic, the breakout team agreed that an on-site hardware VEN would be suitable for large systems serving large C&I customers, while a cloud VEN would be suitable for small systems serving small businesses. A potential solution for medium-sized systems would be an integrated software VEN offered by a 3rd party developer. This option was identified as the most cost-effective VEN solution for these types of customers due its ability to scale at a low price point. The 3rd-party plug-in would be integrated with the standalone VRF control system, which is a selling point and differentiator for VRF systems. However, until utilities agree on what ADR signals will be sent to VRF systems, VRF manufacturers are not able to decide on what the best VEN solution for medium-sized customers will be.

Default DR Strategies Report-Out

The report-out for the default DR strategies breakout session was centered around the development of a new control strategy, outside of the existing Title 24 4°F setpoint adjustment requirement. The idea that the group developed was to create a second optimization scenario to be activated during DR events that goes beyond the regular optimized commissioning scenario. Methods of accomplishing increased load reduction during DR events included:

- Setting compressor load limits based on % thresholds that would be determined by a utility/manufacturer consortium.
- Adding more zones to the non-critical zone category with respect to DR load shed.
- Setting absolute temperature setpoint adjustments.

Having a secondary (DR) optimization scenario (e.g. a combination of the strategies above) increases the potential to shed load during DR events, which is important since VRF systems are already commissioned to optimize efficiency. This also streamlines the experience for the customer, who can initially work with the contractor to define setup criteria such as defining zones and comfort thresholds. After that, customer participation can be minimized. The group believed that an absolute temperature setpoint adjustment would be less confusing to the customer than a relative setpoint adjustment.

Manufacturers can move forward with implementing a secondary DR scenario for buildings that have an EMS, since facility managers can easily tweak DR strategies. To implement solutions for customers without an EMS, the next steps would be to define universal guidelines for the % of load reduction that should be expected from each signal level (low, medium high). This could be accomplished through a consortium of utility and manufacturer members and through research on what AHRI has offered to the lighting industry. Another step that the group identified was to solidify how to get a packet of signals (e.g. pricing) to the VRF manufacturers.

3. VRF Workshop Key Takeaways

Manufacturer Guidance from Utility on ADR signals

A consistent theme throughout the VRF workshop was that manufacturers needed more guidance from utilities on OpenADR signals. This includes guidance on when OpenADR signals would be set, how

often they would be set, which customers would receive these signals, and the event details contained in the OpenADR signal. In order to accomplish this, VRF manufacturers recommended that utilities form a group to develop a common way to signal for DR events. This standardized approach would be used by all manufacturers to develop common (default) control strategies that met the load shed objectives of utility DR programs.

In the afternoon breakout sessions, the SCE DR team proposed that a 24-hourly day ahead pricing signal, which is currently used for the SCE real time pricing (RTP) DR program, could be useful for VRF manufacturers. Manufacturers agreed that this type of pricing signal, coupled with a load dispatch indicator (e.g. % load reduction), would be sufficient data to develop optimized DR control strategies. These types of signals would require utilities to leverage OpenADR 2.0b and for manufacturers to integrate or work with OpenADR 2.0b VEN devices.

Manufacturer Input on Future SCE ADR Programs

During the closing statements of the VRF workshop, Mark Martinez expressed that SCE was interested in incorporating manufacturer feedback in the design of future DR programs. From the workshop, it was clear that manufacturer input would help utilities in developing DR programs that could fully leverage DR-enabled technologies. For example, with simple, pricing, and load dispatch signals, VRF manufacturers would be able to develop DR solutions that optimized both load shed and customer quality of service.

4. Next Steps

Follow up Meetings with SCE and Manufacturers

As a next step for this project, the SCE project manager, Kevin Chan, will review the discussion and findings from the VRF workshop, along with the Baseline ADR Requirements and Refined Baseline ADR Requirements that were developed prior to the workshop documented by Energy Solutions. SCE subject matter experts will then meet internally to discuss a pathway for further engagement with VRF manufacturers.

Basic next steps would include follow up phone conversations with VRF manufacturers and the coordination of future working group sessions to discuss ADR program development and signal payloads. However, Energy Solutions team is skeptical that conversations alone will induce manufacturers to make tangible progress on making their equipment ADR-capable out-of-the box. Taking action to address VRF manufacturer's request for clearer and more specific guidance from utilities is recommended. Manufacturers expressed support for this team to organize a consortium of utilities, manufacturers and customers to develop specific guidelines on how equipment should respond, for example to low-medium-high DR signals. Gabe Taylor with the CEC emphasized that manufacturers shift their focus to supporting customer needs in a future where rates change hour to hour and utilities incentivize load shaping and demand shifting. Manufacturers are traditionally accustomed to responding to their customer needs (as opposed to state or utility mandates). If the project team can effectively frame the discussion around how customer needs will change, it will be easier for the manufacturers to push the changes within their own companies.

Broaden Outreach to other Technologies

SCE showed interest in broadening the ADR-enablement engagement with manufacturers to other technologies, such as HVAC controls more broadly, energy storage, electric vehicle charging, or smart inverters. This effort would involve incorporating feedback from additional technology manufacturers (or other teams within VRF manufacturer organizations) on the design of future ADR programs and learning about what DR signal information they would need from utilities. SCE will meet internally to discuss if they would like to move forward with this approach, and what technologies it would make sense to broaden the ADR-enablement initiative to.

5. Appendices

Appendix A: Workshop Agenda

General Meeting Information:

Meeting Date:	November 14, 2019
Meeting Time:	10am – 5pm
Meeting Facilitator:	Southern California Edison
Meeting Location:	Energy Education Center 6090 N. Irwindale Avenue Irwindale, CA 91702

Invitees (Preliminary):

Organization
Southern California Edison
Energy Solutions
Carrier-Toshiba
Daikin
LG
Mitsubishi
Samsung
Fujitsu (Remote)
Johnson Controls (Remote)

Agenda:

9:30am **Check-in to SCE Energy Education Center**

10:00am **Welcome by SCE**

1. Why Demand Response
2. Workshop Objectives and Goals

10:30 am **Presentations by SCE**

1. SCE ADR Program
2. Lab Assessment of a DR Controller for Rooftop Units

11:30 am **Review Title 24 Requirements and Q&A**

1. OpenADR 2.0 VEN
2. Demand Shed Control Strategy
3. Additional Thermostat Requirements

12:00pm Lunch

1:00pm Break out Session: Making DR Accessible Out-of-Box for SMB

1. Breakout groups:
    a. VEN Solution
    b. Default DR strategy

2:30 pm Report Out on Break Outs: Making DR Accessible Out-of-Box for SMB

1. Break Out Session Presentations
    a. VEN Solution
    b. Default DR strategy
2. Conclusion and Next Steps

4:00 pm Tour of Irwindale Test Center

Appendix B: ADR Enablement of VRF Controls Workshop Minutes

General Meeting Information:

Meeting Date:	November 14, 2019
Meeting Time:	10:00am – 5:00pm
Meeting Facilitators:	Southern California Edison, Energy Solutions
Meeting Location:	Irwindale Energy Education Center

Welcome Remarks

Mark Martinez, SCE

- Demand Response (DR) is a *temporary* change in energy consumption.
- DR is among the faster grid solutions - ranges from day-ahead to real time.
- Oversupply of energy compared to demand until the sun sets, and then there is a shortage of supply.
    - SCE has changed its rates to cover this.
- Evolution of DR from 1.0 to 2.0 to 3.0 (happening all across the country)
    - DR 1.0 (pre-2005): Largely manual response called primarily for emergency grid needs, some economic events, 1-way communication.
    - DR 2.0 (2005 – present): Introduction of automated and smarter building controls, begin integration of DR resource with wholesale power market for emergency events.
    - DR 3.0 (present and beyond): Begin use of storage and other distributed energy resources, 2-way communication, economic or price-based DR events, dynamic time of use tariffs, use of DR for additional grid ancillary services.
    - With DR 3.0, all technologies are assets that can be used for DR.
- OpenADR: cybersecure, approved and used internationally. Communication to appliances and the cloud.
- SCE is trying to bring a lot more value to the DR ecosystem through this workshop.

Workshop Objectives and Goals

Kitty Wang, Energy Solutions

- Develop ideas for latent VRF features to be more easily applied to the load management use case.
- Review T24 compliance questions.
- Review participation in statewide incentive programs.
- How to develop VRF DR solutions so that they're more accessible to customer, more plug and play?
- Leave with ideas and action items.

Market Case for DR Enablement

Jeff Johnston, Energy Solutions

- Customers will increasingly need technology solutions to manage the high electricity prices associated with utility Time of Use (TOU) rates.
- To be successful in the DR-enabled technologies market, manufacturers should consider going beyond code compliance and create products that the customers (contractors) will want.
- We have seen contractors spend over 2 days in the field configuring load shed strategies and connecting to the DRAS.
- The design and specifying companies and big customers are not going to want to pay for that much install time.
- Importance of preprogrammed strategies are that customers don't have to pay for the custom configuration of strategies that they want for their VRF systems.

Presentations by SCE

SCE ADR Program –

Peter McFerrin, SCE

- DR Automation eliminates uncertainty in curtailment.
- SCE is not party to the load shed agreement between the implementer and the customer.
- SCE treats DR as a wholesale resource in CA - when it's dispatched it is expected to happen.
- For express incentives (For SMB - Restaurants, offices, and food stores up to 500kWh), the whole incentive is payed upfront.
- SCE DR programs/rates:
  - Capacity Bidding Program
  - Critical Peak Pricing (rate)
  - Demand Response Auction Mechanism
  - Real-Time Pricing (rate)
- Growing trend around the whole country to use Time Of Use rates.
- SCE recently defaulted a lot of customers to Critical Peak Pricing (CPP). Details:
  - Significantly incentivizes energy usage during midday.
  - 80 cents/kWh during 4-9pm next year (40 cents this year) during CPP events.
  - Customers are notified on the previous business day.
  - Most events occur between June-September.
  - Large customers (>200kW) were defaulted several years ago, but about 30,000 customers in the medium (20-200kW) range and 300,000 customers in the small range (<20kW) were defaulted last spring.
  - SCE customers had bill protection this year. Their bill shows what they would have paid without protection. Bill protection goes away next year and critical peak period prices go up from 40 cents/kWh to 80 cents/kWh.

Q&A:

- Verification of performance is from the utility meter?
  - Yes. A kWh is a kWh - doesn't matter how it happens.
- Customers are not escaping the 80 cents/kWh by doing demand response, they're still paying that rate during the critical peak events just less if they use less, correct?
  - Yes. They also avoid penalties for not exceeding their peak demand for the month. And they get a credit on demand charges Jun-Sep for being on CPP.
  - The demand credits are based on the peak demand (kW) throughout the month. The 80 cents/kWh is a usage price applied to the energy consumed (kWh).

    - The customers are enrolled on CPP whether they have ADR or not. ADR programs can incentivize a significant percentage of the cost of mitigating the charges.
- Gabe Taylor: DR Programs are likely to change substantially over the next decade. Don't need to get lost in the details of the programs.
- Biggest issue with all the programs is; we want to automate everything but there's no common way. We can leverage all the signals offered in 2.0. What I would look for at the utility level is coordinating a standard way of delivering those requests. Should we load up? What is my real-time and peak pricing? Manufacturers just need a common signal. Utilities should form a group to form a common way to signal this.
    - Gabe Taylor: Keep in mind that your customers are not only utilities. The customer your serving is whoever is managing the VRF system.
    - Dave River: SCE has 2.0B. To accomplish load reduction, you'll have to respond to that 2.0B signal. We don't like opt-outs. How do you, from a system approach, manage the comfort? Kitty: more time this afternoon to address the communication and the DR strategy pieces.

Lab Assessment of a DR Controller for Rooftop Units

Rafik Sarhadian, SCE

- Add-on VFD that controls the compressor and controller at the same time.
- 2 preprogrammed DR strategies, one for moderate and one for high.
- Goal was to see whether the controls did what they were supposed to do and what the comfort impact was.

Q&A:

- During a typical DR event, the outside ambient temperatures are typically higher.
    - Requires another set of testing. This was on a commercial package unit.
- Have there been any studies on what temperatures customers are comfortable with sacrificing?
    - Peter can ask the CPP program team, but probably not.
    - Effect on comfort depends on the building envelope.
    - SCE is looking into penalizing customers with a certain opt-out rate, through the Smart Energy Thermostat Program.
    - Gabe Taylor: From a state policy perspective, the goal is to have zero discomfort. The building code is moving to a more passive house design, much tighter envelope and thermal mass, ability to use the building as a battery so that there is no discomfort.
    - Norm: When commercial spaces have indoor t-stats, they typically limit what occupants can control, and occupants wouldn't be able to opt-out of DR. The DR signal is coming to the central controller.
    - With apps and accessibility these days, people are making economically-based "comfort" choices.

Review California Title 24 ADR Requirements and Q&A

Presentation by Kitty Wang, Energy Solutions

Q&A

- Code language for DR is in section 110.12.

- Specifically, for HVAC systems with direct digital controls (DDC) to the zone-level must comply with automated demand shed control (ADSC) requirements.
- Thermostat requirements in JA 5 would apply to single-zoned systems.
- Gabe Taylor: if you think a communications protocol should be added to the list, please talk to me.

Working Session: Making ADR Accessible Out-of-Box

VEN Solution Breakout Group Discussion

- What Participants are Looking for From the Working Session
  - Understand how a utility will be utilizing OpenADR features and what requirements manufacturers need to conform to.
- Brainstorming Questions
  - How much detail is expected from the utility? Are they expecting levels of operation or something more high level?
    - OpenADR is about the VEN receiving a signal (usually generalized request) from the DRAS.
    - Utilities are not going to be managing devices at a granular level, they will express a need over a period of time.
    - VRF is responsible for translating the signal to a specific control strategy.
  - Where does it make sense to receive an OpenADR signal? Is the signal enough to allow for prepackaging of DR strategies?
  - What types of signals are utilities sending out? What programs are customers participating in?
  - How can we avoid deploying something that needs to be tweaked in 6 months or needs a controller change over time?
  - How can we optimize demand that does not reduce customer quality of service?
- Things for VRF Manufacturers to Consider
  - VEN Solution - HW vs. SW, 3rd Party vs. Integrated
  - Have a clear picture of 1 - 4 signals that you'll receive from the utility and prebake a suggested strategy for the owner to deploy.
  - Coordinating with other loads on site - e.g. need for EV charging.
- Existing OpenADR Payload Signals used by SCE
  - Event start time and duration
    - DRAS is sending a day ahead signal for CPP.
  - Level signal (null, load, medium, high)
    - Emergency shed signal (Level 3 of level signal).
  - Price signal
    - Currently only used by the SCE RTP (Real Time Pricing) ADR program to broadcast 24-hour day ahead prices.
  - Load dispatch signal
    - Load up / load down.
    - AHRI1380 defined low, medium, and high load up signals for residential and small commercial systems.
- Improved Event Signaling
  - Want to see not just a 4-degree setpoint requirement but also the ability to limit inverters

        - Results in the ability to limit demand through a relative load reduction (X % reduction in load).
        - Gabe Taylor: 4 degrees was set up for fixed speed equipment, it's legacy requirement.
    - Preference that the utility sends hourly price signal
        - 24-hour pricing signals would be helpful for manufacturers and customers - either price or price multiplier.
        - Would help manufacturers develop DR strategies such as precooling or heating a hot water tank earlier, etc.
        - Allows customers to make a decision based on real time events, customers may not want to shed load for every event.
    - Leaving a lot on the table from not using 2.0b.
        - Utilities could leverage 2.0b to target specific buildings.
        - Additional capabilities include multiple signals in one event, rolling events, etc.
        - Some programs may want telemetry data from the site (e.g. tell the utility the % the compressor speed is at a certain time).
- Load Shed Verification Procedure
    - ADR engineer predetermines how much load can be shed based on building characteristics.
    - Verification Engineer performs a load shed test where the DR strategy.
    - Verification engineer tells the utility, and then the utility tells CAISO the load shed potential.
        - If we followed a capacity limiting strategy, then the load shed potential would be "X" % less than the baseline.
    - Total timeline for ADR program implementation is 3-10 months. May be ok for large C&I customers but would need to reduce for 95% of smaller customers that are getting defaulted to CPP.
- VEN Solution Options
    - Build it into the existing control software, add in OpenADR stack with a GUI interface, low cost solution.
    - Buy an OpenADR gateway device on Amazon with interfaces that can tie into your equipment, also low cost.
    - Cloud based VEN that can tie into backend infrastructure through an API to pass along requests from the utility.
- VEN - VTN Connection Security Requirements
    - Most of the deployment issues are due to IP addresses, ports, X.509 certificate authentication, etc.
    - One of the value propositions of the cloud is that you avoid having to understand ports / IP address / test certificates.
        - Manufacturer doesn't need to build a cloud ecosystem, there are 3rd parties that can provide a cloud based.
    - When you're inside your own network and you don't have to worry about security, its easy - just HTTP socket.
    - OpenADR certification requires a high threshold of security, utilities can elect to scale that up or scale it down.
- VEN Solutions for Small / Medium / Large Customers

  - Small (cloud VEN) and large systems (on-site VEN tied into EMS) have an existing communication pathway.
  - Medium sized systems aren't big enough for an EMS but are too big for a single VEN for each device.
  - Medium systems need something new and it needs to be at the right price point.
  - VRF systems are well suited for medium size customers because they have their native control systems and don't require an EMS.

Default DR Strategies Breakout Group Discussion

- What are the challenges involved in incorporating DR strategies for the manufacturers and how can they be addressed?
  - Being able to take the signal in directly. To create a VEN, you have to get certified, not just create the VEN.
  - T24 just about setpoint, nothing about compressors.
  - How to show customer that DR can offer additional savings.
    - David Rivers: For Title 24 compliance you just have to be able to do the ADR handshake.
    - Can broaden definition of non-critical zones.
  - Finding those non-critical areas that are able to do DR is not possible for every customer.
  - Control strategies are set up during the commissioning of the equipment. Most of the time, customer chooses commissioning settings that already optimize energy efficiency. Once you set a system up it just runs, and the compressors do what they need to do to optimize. How to achieve DR savings beyond that?
    - Dave Rivers: Sounds like the general input is that we have a fixed optimization commission scenario, and then there could be a secondary option that's not a standard offering but that could be created for DR done.
      - If the customers are uncomfortable, they can change the setpoint.
      - Could maybe raise the setpoint and use outside air to cool or heat.
      - The customer can set the limit beyond which their comfort cannot be reduced.
      - Is there a secondary strategy that you can offer the customer based on occupancy?
      - As part of the optimization plan to do the 2nd operating scenario (DR scenario), could include more zones in non-critical classification.
- Are other strategies easier to implement than setpoint? Why or why not?
  - For VRF manufactures, compressors make more sense. There might be times where the temperature is already at its lowest. If the DR event is called then, a temperature strategy won't make a difference.
- How will you accommodate load-up scenarios? Snap-back for load up?
  - When our compressors come on, they're not going 0-100, it's a step-wise ramp up.
  - Dave Rivers: Can you reverse the strategy so that it steps into 76 to 84? From a comfort standpoint.
    - Yes, you can include the logic to do that. The compressor does that in a staged motion anyway. Anything is possible, we could develop that into our DR strategy (to step up into the desired temperature setback).

- What are the pros and cons of programming DR strategies through software vs. through dry contact?
    - Dry contact - it's an immediate reaction. The con is that it can't do a step wise strategy without software. Another con from the behavior standpoint is that it is all or nothing and there could be comfort implications.
    - Software - more data and potential for 2- and 3-way communication. And ability to get the customer involved in the strategy.
- How would a default temperature setpoint function (relative/absolute)?
    - Talking about a relative setback, the strategy depends on where we are at when the event is called.
    - Option to offer both options and let the customer choose? Too confusing.
    - Coming up with a few presets will satisfy 90% of customers. The contractor can ask them if they want to use high, medium, or low.
    - An absolute setpoint temperature is the best from the point of being less confusing to the customer.
- What efforts are needed to develop default DR strategies and what is the pathway to get there?
    - Need open protocol commonalities; create a whole list of loads/signals you can send out. If everyone has a different marker and you don't know what that full list of markers are, that's a problem.
    - Mark Martinez: Maybe need to go back to OADR alliance to create more discrete levels that we include in the message package, a common language of what they are looking for.
        - Need a consortium like BACnet to better understand when it means when a utility sends out a specific signal. Ex: what does moderate, medium, and low mean. For lighting, its defined in terms of percentages. Could ramp compressor speed to 40% at high, and 80% at low.
            - Mark Martinez: We really don't understand how compressor speeds affect load.
            - Instead of looking at temperature setpoints, look at how compressor could fit into that role.
        - Mark Martinez: Take the example of how low can you go and still maintain lighting? Same thing with AC, what's the lowest level you can go to, to at least keep things running?
- If you're looking at a single 10-ton VRF compressor vs ten of them, would the strategies be the same?
    - Yes.
- If you're talking about compressor strategy, can't always differentiate between critical and non-critical zones.
    - Would have to have one compressor for critical areas and one for non-critical areas (which is a common design choice).
    - As opposed to a setpoint strategy which can differentiate between zones connected to the same compressor.

Appendix C: Workshop Slides

ADR Enablement of
VRF Controls In-Pers

Appendix D: Summary of Breakout Group Reports

VEN Solution Breakout Session Report-Out

Title: Signaling Requirements and VEN Solutions

Description of Idea(s):

- What idea or ideas are being presented?
- What benefits does the ideas bring?
- Are there prerequisites for the idea?
- What are some potential challenges and ways to overcome them?

Signaling Requirements

Standardize to two types of event signals, a simple signal and a pricing signal, would help VRF manufacturers to develop DR control strategies for ADR programs for utilities. The simple signal would indicate the load level needed and the pricing signal would include a list of 24 hourly day-ahead prices.

VEN Solution Option

An on-site hardware VEN is suitable for large systems, while a cloud VEN is suitable for small systems. A potential solution for medium systems would be an integrated software VEN offered by a 3rd party developer.

Value Stream:

- What value does the idea provide to the end-use customer?
- Which problem is the idea solving?
- How does the idea this align with utility goals?

Signaling Requirements

A 24-hourly, day-ahead price signal is the most useful and easiest data source to work with when developing DR control strategies. It also allows customers to make decisions based on real time events and prices.

VEN Solution Option

An integrated 3rd party software VEN is the most cost-effective VEN solution for customers of medium sized systems. This would tie-in with the fully integrated VRF controls, which are a selling point / differentiator for VRF systems. This is more cost effective than building a complete cloud solution for medium sized systems.

Actions and Next Steps:

- What are the immediate next steps after the workshop?
- How do we reach a minimum viable product?
- What key activities required to bring the idea to market?

Signaling Requirements

The next step is for utilities to clearly communicate to VRF manufacturers what event signals will be sent the VRF systems in the case of an ADR event, such as 24 hour pricing signals. The minimum viable product would be a new utility ADR program with 24 hour pricing signals.

VEN Solution Option

The next step is for utilities to tell VRF manufacturers what signals the utility will be sending. Then, VRF manufacturers will be able to decide on a VEN Solution. A new rulemaking that gives CEC authority to direct utilities in the creation of new programs for energy storage, load management, and new rate structures, will contribute to this effort.

Default DR Strategies Breakout Session Report-Out

Title: DR Optimization Scenario

Description of Idea(s):

- What idea or ideas are being presented?
- What benefits does the ideas bring?
- Are there prerequisites for the idea?
- What are some potential challenges and solutions?

Create a second optimization scenario, to be activated during DR events, that goes beyond the regular optimized comissioning. Methods of accomplishing increased load reduction during DR events could include:

- Compressor load limits based on % thresholds that will be determined by a utility/manufacturer consortium.
    - Ability to use compressor strategy depends on critical and non-critical loads being tied to separate compressors.
- More zones included in non-critical category, just for DR events.
- Absolute temperature setpoint adjustments.

Value Stream:

- What value does the idea provide to the end-use customer?
- Which problem is the idea solving?
- How does the idea this align with utility goals?

Having one secondary (DR) optimization scenario which is a combination of strategies increases the potential to shed load during DR events, which is important since VRF systems are already comissioned to optimize efficiency.

This also streamlines the experience for the customer, who can initially work with the contractor to define setup criteria such as defining zones and comfort thresholds. After that, customer participation can be minimal.

The absolute temperature setpoint adjustment is thought to be less confusing to the customer than a relative setpoint adjustment.

Actions and Next Steps:

- What are the immediate next steps after the workshop?
- How do we reach a minimum viable product?
- What key activities required to bring to market?

Manufacturers can move forward on implementing DR strategies for buildings that have BMS, since facility managers can easily tweak DR strategies. To implement solutions for customers without BMS, next steps include:

- Define universal guidelines for the % of load reduction that should be expected from various types of signals (ex: high, medium, low).
    - Develop consortium of utility and manufacturer members.
    - Investigate what AHRI has offered to the lighting industry (% lighting reductions defined) as a template for VRF.
- Solidify how to get a packet of signals (such as pricing) to the manufacturers.

Appendix E: VRF Manufacturer Q&A on Title 24 and SCE ADR Program Requirements

Prepared by: Energy Solutions | November 2019

Introduction

The questions below were asked during the VRF Working Group meeting on September 13th, 2019 and throughout one-on-one VRF manufacturer calls during August 2019 – September 2019. Questions were asked by VRF Manufacturers, including but not limited to LG, Fujitsu, Carrier-Toshiba, Samsung, Daikin, Mitsubishi, and York. Responses were collected from subject matter experts at the California Energy Commission, Honeywell, and SCE and compiled by Energy Solutions staff.

Title 24 Requirements Questions

1) Does Title 24 requirements allow for a cloud VEN?

   Title 24 language does not make the distinction between cloud or non-cloud VEN. However, out of the two options to comply with the OpenADR certified VEN requirement, only one allows for a cloud VEN. Option A (§110.12(a)1A) requires the VEN to be physically within the building, while Option B (§110.12(a)1B) allows the VEN to be separately located on-site, offsite or in the cloud. These options are documented in Appendix D, Section 1.1 of the Nonresidential Compliance Manual.

   If a project uses a cloud-based VEN through Option B, they would need to comply with the building code using Section 110.12(a)1B. This option says the DR control system must be certified to the Energy Commission as being "capable of responding to a demand response signal from a certified OpenADR 2.0b Virtual End Node by automatically implementing the control functions requested by the Virtual End Node for the equipment it controls". This requirement does not mean that the DR control system must be connected to a 2.0b certified VEN upon installation. When the DR control system is connected to a VEN, it must be connected to an OpenADR certified 2.0 VEN, but it can be either a 2.0a or 2.0b.

   For Option B, the DR control system is required to be added to the Energy Commission's list of certified demand responsive controls. The Energy Commission maintains a list of certified products and instructions on how manufacturers can certify products on their website: http://www.energy.ca.gov/title24/equipment_cert/. When verifying compliance with T24, the inspector will confirm that the controls are on Energy Commission's list of certified DR controls. They will not confirm that the controls talk to the VEN.

Title 24 also includes a requirement for manual control in Section 110.12(b)5B: "Manual control by authorized facility operators to allow adjustment of heating and cooling set points globally from a single point in the EMCS".

2) Is the 4-degree setpoint required for all zones?

   The 4-degree setpoint is not required for all zones. Temperature setbacks are only required in non-critical zones. Title 24 defines a critical zone as "a zone serving a process where reset of the zone temperature setpoint during a demand shed event might disrupt the process, including but not limited to computer rooms, data centers, telecom and private branch exchange (PBX) rooms, and laboratories". Non-critical zones are defined as "a zone that is not a critical zone".

3) Title 24 requires having an adjustable rate of change when the temperature is adjusted at the beginning and at the end of the DR period. Why is an adjustable rate of change needed going into an event? Wouldn't you want it to be as fast as possible?

   When an event begins and the demand response signal is received, the temperature rate of change would typically be set to be as rapid possible. However, with increasing grid complexity through a variety of demand response drivers (e.g. resiliency, renewable integration, frequency / voltage regulation, stability) there could be use cases where a slower rate of change is desired. Note: The temperature rate of change is only required to be adjustable. There is no requirement that it be set at a particular rate.

   When an event ends, the rate of change can be adjusted to mitigate snapback concerns. However, Title 24 code does not speak to snapback for the end of demand shed events.

4) How is Title 24 coordinated with AHRI?

   AHRI 1380 is complementary to Title 24. Both standards reference OpenADR as the communications protocol. Although AHRI is not explicitly stated in Title 24 code, Appendix D, Section 1.3 of the Nonresidential Compliance Manual states that DR control can also comply with protocols required by other code. Note: AHRI participates in the development and refinement of code change proposals for Title 24.

   > 1.3 **Additional Communication** §110.12(a)3 Section 110.12(a)3 explicitly states that DR controls are allowed to use communications protocols in addition to the ones required above. This means that the control can communicate with entities that initiate DR signals using different protocols, including but not limited to proprietary protocols and other non-proprietary protocols like the American National Standards Institute (ANSI) / Consumer Technology Association (CTA) Standard for Modular Communications Interface for Energy Management (ANSI/CTA-2035-A), provided that the control also complies with one of the options for OpenADR compatibility. Similarly, the DR control system is allowed to use other physical means of communication provided at least one of the specified methods is supported. Appendix D – Demand Responsive Controls Page D-5 2019 Nonresidential Compliance Manual January 2019 The DR control may use any of its available communication features to participate in DR programs.

5) Can Lonworks be listed as an approved language?
   There is no problem with using another communication protocol in addition to Wifi, ZigBee, BACnet, Ethernet, or hard-wiring. Section 1.3 of Appendix D in the 2019 Nonresidential Compliance Manual elaborates on this: https://ww2.energy.ca.gov/2018publications/CEC-400-2018-018/CEC-400-2018-018-CMF.pdf#page=741

SCE ADR Program Questions

1) Do Utility ADR Programs allow for a Cloud VEN?
   Large Business customers (commercial and industrial) must have VEN controls onsite that are OpenADR 2.0a or 2.0b certified to receive SCE ADR program incentives. This requirement does not apply to SMB customers, who are allowed to have cloud-based controls. SCE also allows for cloud-only solutions in their residential thermostat program.

   SCE and PG&E ADR programs require cloud-based solutions to pass a “stranded asset test”, whereby the site has a way to receive communications directly from the DR Automation Server (DRAS) if the cloud is inoperable. Utilities need the building controls systems to be able to respond to demand response events if the VEN’s cloud goes down. This requires a local VEN at the site so that the DRAS can both send an OpenADR signal through the cloud and a signal directly to the site via the local VEN.

2) How do we make sure that our systems can connect to the DRAS "out of the box"?
   To ensure that devices can connect to the DRAS, SCE offers DRAS testing opportunities through a DRAS test server. The DRAS test server allows manufacturers to test a variety of features including VEN registration, DRAS polling, and event payload signaling. The DRAS test server is an exact replicate of the DRAS production server.

   Common issues that occur during the initial phase of setup to the DRAS are typically due to OpenADR specifications and requirements not being followed. SCE strongly recommends that manufactures developing integrated VENs thoroughly read the OpenADR 2.0A and/or 2.0B specifications located at: https://www.openadr.org/specification.

   For additional reference, SCE has an ADR Help Desk, and both SCE and PG&E have DRAS Connection Guides with how-to information on VEN / DRAS connectivity. The Utility ADR Program Teams will support customers with the process of connecting DR-enabled systems to the DRAS.

3) If we're looking at 1-3 DR strategies and looking at 2.0b, is there a standard way that utilities will request these types of signals or DR strategies

ADR customers determine what DR strategies they prefer to use in response to an event notification from the utility using OpenADR protocol. The OpenADR Protocol for OpenADR 2.0a devices only specifies the level of demand shed (0 = null, 1 = moderate, 2 = high, 3 = special). For OpenADR2.0b, additional event information can be added such as pricing information or load up/load down. Information on the event payload is also listed in the OpenADR specifications on the OpenADR Alliance website.

For traditional Demand response, SCE has only utilized the demand shed signals. SCE is currently piloting pricing through the OpenADR protocol. Additionally, the configuration of demand shed versus pricing is dependent on the utility program, which is represented in the MarketContext field of the OpenADR payload. With each utility having different program names, this creates different MarketContexts. SCE has found this to be difficult to manage as customers can switch from one program to another within the same utility and a single customer can participate in multiple programs on different utilities. Therefore, many VENs in SCE and PG&E ADR program implementation have been configured with the wildcard (*) for the Market Context. This will allow the VEN to receive any type of program from the VTN, and the utility configures things on the DRAS side to make sure only the correct program signals are sent.

For reference, the SCE DRAS Connection Guide provides information on confirming VEN connectivity and scheduling a test event with SCE's DRAS.

4) Are utilities involved in taking advantage of 2.0b features (e.g. duration of rebound, capacity limiting)?

   SCE has 2.0b servers currently piloting more advanced signaling approaches and pricing signals available in the 2.0b protocol.

5) Are utilities all sending out DR signals the same way? Are utilities coming together to align on DR strategies or payloads?

   All California utilities send the DR events/signals in a similar way for OpenADR VEN endpoints (2a and 2b). However, event and signal definitions can be different for different DR programs in terms of how events are triggered, how resources should be notified, aggregation of involved resources, signal types, etc. Some DR programs support aggregation with different scopes of location, while other DR programs support different types of OpenADR signals (level, pricing, capacity, etc.).

   Both the PG&E and SCE DRAS use the same program and strategy design tools, but each utility is managed in a standalone DRAS server with its own set of programs and strategies. However, utilities may work together to align the strategies and payloads.

6) Would there be any limitations or restrictions on what utilities can send? What's preventing utilities from sending multiple DR events in a short amount of time?

   The number of events that is sent out and the timing of events depend on the demand response program that the customer is enrolled in. A customer can also choose to opt-out of demand response events ahead of time.

   The current DR program policies in place prohibit customers from dual enrollment in more than one DR program that would result in simultaneous event signals received for different programs at the same time.

7) What happens when the VRF system is already under load shed requirements?

   If the system is already meeting load shed requirements (e.g. the building is running at minimum load when the event is dispatched), then the amount of load shed is expected to be marginal. These types of cases are considered during the customer ADR enrollment process.

8) How are we determining what capacity to go to - is that based on current load levels or baseline load levels?

   During the ADR enrollment process, the utility program team will work with the customer to determine the load control strategy that the customer is comfortable with (e.g. increase setpoint temperature by 4 degrees when an event starts). These load control strategies determine the kW shed potential analyzed relative to a CPUC-approved statewide baseline methodology based on historical load data.

9) What would cause a customer to want to participate in the DR event?

   All commercial customers including SMB customers were defaulted to the CPP (Critical Peak Pricing) tariff on 3/1/19. It's a time-of-use tariff with an off-peak rate, on-peak rate, and a much higher CPP rate. SCE wants to make sure that all customers have access to energy management solutions to deal with this CPP tariff. Customers who enroll in a demand response program not only save money by using less energy when electricity is costly, but they also receive ongoing payments for their participation.

   In addition, customers can participate in an ADR Incentive Program, which offers customers an upfront and performance-based incentive amount for the purchase of OpenADR certified technologies.

10) Why wouldn't we pursue DR enablement by partnering with a company like Cpower who is selling DR? Doesn't there have to be an aggregator between the utility and VRF?

    Enrolling through an aggregator is a fine pathway to DR enablement but they target large commercial and industrial customers. There are a couple aggregators in CA that target medium and small customers, but the current activity level won't scale large enough or be

implemented fast enough to accommodate California's 100% zero carbon electricity goal by 2045.

In addition, an aggregator can facilitate demand response events but a customer can participate in DR programs and apply for ADR program incentives without going through an aggregator.

11) How do controls systems know what strategy to implement when we get a demand response event signal?

The customer chooses what strategy they want for each event notification. Currently these are programmed manually on site on a custom or case by case basis. Ideally the manufacturer can offer pre-set DR strategy options for customers to choose from (what we are working towards in the ADR Enablement of VRF Controls In-Person Workshop) or provide a customized programming solution (current practice). You would assign a demand response strategy to each DR event signal level (0 = null, 1 = moderate, 2 = high, 3 = special for OpenADR 2.0a).

12) How do we convince customers that this technology will be able to achieve the required amounts of load shed?

The actual load shed when a DR event is called depends on the design and operating conditions of the VRF (i.e. percentage of full load capacity to meet temperature control setpoints based on occupant comfort preferences), the design and operating conditions of the building, outside temperature, # of occupants and other equipment (e.g. lights) which affect the internal heat gain. These factors affect the amount of kW load that can be shed at the time the DR event is called.

It may be possible for the manufacturer to provide a range or an average / typical load shed value based on % rather than kW. However, it is not the responsibility of the manufacturer to ensure to customers that the VRF system will shed a specific amount of load for kW since the shed depends on a variety of factors.

Once a customer initiates enrollment in an ADR incentive program, they will first go through a load-screening process, where an engineering team will estimate the potential load shed capability based on historical load data and desired demand response strategies. After ADR-enabled technologies have been installed, an ADR test will be conducted to verify that load shed is close to the initial calculated load shed.

13) What is a VTN?

VTNs (Virtual Top Nodes) are either physical or software-based information exchange servers, typically operated by utilities or third-party providers, that transmit events and/or

price information. VTNs send OpenADR signals to VENs or virtual end nodes, which are also physical or software gateways.

VENs tell building energy controls to initiate customer-designed, pre-programmed controls sequence for demand response. A device can be both a VTN and VEN if it receives data transmitted by a VTN and transmits the event to VENs that it is connected to (e.g. a demand response aggregator)

For more information, see the OpenADR Alliance website (www.openadr.org).

Appendix F: Links to Relevant Documents (OpenADR Spec, Title 24)

Document	Link / Attachment	Notes
OpenADR 2.0a 2.0b Specifications	https://openadr.memberclicks.net/index.php?option=com_mcform&view=ngforms&id=24296	Must go through a free sign-up to download
2019 Title 24 Building Energy Efficiency Standards for Residential and Non-Residential Buildings	https://ww2.energy.ca.gov/2018publications/CEC-400-2018-020/CEC-400-2018-020-CMF.pdf	Sections 100.1, 110.12, 110.2
2019 Title 24 Nonresidential Compliance Manual	https://ww2.energy.ca.gov/2018publications/CEC-400-2018-018/Compliance_Manual-Complete_without_forms.pdf	Appendix D
2019 Title 24 Reference Appendices	https://ww2.energy.ca.gov/2018publications/CEC-400-2018-021/CEC-400-2018-021-CMF.pdf	JA5, NA7.5.10
SCE OpenADR Vendor Connection Guide	 SCE OpenADR Vendor Connection	E-mail autodr@sce.com for further questions
SCE ADR Program Handbook	https://www.sce.com/sites/default/files/inline-files/Auto-DR%20Program%20Handbook%200919_1.pdf	