
# *Draft for comment* - OpenADR 2.0 Demand Response Program Guide

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CONTENTS

## 1 Introduction

The target audience for this guide is utilities planning to deploy Demand Response (DR) programs that utilize OpenADR 2.0 for communicating DR event related messages between the utility and downstream entities, and the manufacturers of equipment that facilitate that communication exchange. It is assumed that the reader has a basic conceptual understanding of both demand response and OpenADR 2.0 (referred to simply as OpenADR from this point forward).

The OpenADR profile specifications clearly define the expected behaviour when exchanging DR event related information, however there is enough optionality in OpenADR that the deployment of servers (VTNs) at the utility and clients (VENs) at downstream sites is not a plug-n-play experience. OpenADR characteristics such as event signals, report formats, and targeting must be specified on a DR program-by-program basis.

There is no such thing as a standardized DR program. Each DR program design tends to be unique, fitting the structural and regulatory requirements of the geographic region it is deployed in. For each DR program there are numerous possible deployment scenarios involving a variety of actors.

The variability in DR program designs, deployment scenarios, and OpenADR characteristics are an inhibitor to expanded deployment of DR and the use of OpenADR. This variability is for the most part a reflection of the fragmented and complex nature of the smart grid.

Utilities need examples of typical DR programs so that they can be used as models for their own DR program implementations. Equipment manufacturers need to understand typical DR Program usage models so they can validate interoperability as part of the development process rather than on a DR program deployment specific basis. The intent of this guide is to accomplish both these goals as follows:

- Define a small set of standard DR Program templates modelled after the common characteristics of the most popular DR programs implemented to date
- Define a small set of deployment scenarios modelled after real world deployments, with actors and roles clearly identified
- Define best practices recommendations for OpenADR characteristics specific for each of the DR Program templates
- Provide a decision tree that utilities can use to identify the useful DR program templates and deployment scenarios based upon their business needs



The emphasis in this guide will be on keeping things simple by providing a small set of clear recommendations that will address the majority of the details required to deploy a typical DR program, and to enable interoperability testing of equipment deployed in programs using the recommendations in this guide.

## 2 References

- OpenADR Profile Specification and schema - www.openadr.org

## 3 Terms and Definitions

The following terms and definitions are used in this document.

- **Demand Response**: A mechanism to manage customer load demand in response to supply conditions, such as prices or availability signals
- **Aggregator Party** – This is a party that aggregates multiple Resources together and presents them to the DR Program Party as a single Resource in their DR Programs.

- **Aggregator Intermediary Infrastructure** - This is the infrastructure, separate from the Demand Side Infrastructure, which is used by the Aggregator Intermediary Party to interact with both the Resources and the grid side entities
- **Agreement**: A contractual agreement between parties playing a role in a DR program outlining responsibilities and compensation
- **Asset** – A type of Resource that represents a specific collection of physical loads. Resources can be composed of Assets, and an Asset may be Resource, but Assets cannot be further decomposed into multiple Assets or Resources.
- **Associated**: Provide a programmatic association between two entities, through configuration of a device of database. For instance, associated resources with a VEN
- **Baselines**: The calculated or measured energy usage (demand) by a piece of equipment or a site prior to the event as determined by through surveys, inspections, and/or metering at the site.
- **BMS** – This is the Building Management System that may be used to control resources. This is sometimes referred to as an Energy Management System.
- **Compound Resource** – This is a special type of Resource that is an aggregation of multiple physical assets that each have their own means of load control.
- **Customer Incentive**: An inducement provided to the owner/aggregator of demand side resources for participation in a DR program.
- **Demand Side Infrastructure** – This is the infrastructure that houses the Resources that are enrolled in the DR Programs
- **DR Logic**: Algorithms or logic that convert DR signals into actionable load control. Note that DR Logic may be implemented in many different locations and in some case be distributed among multiple sub-systems.
- **DR Program Party** – this is the entity that is responsible for the Grid Infrastructure and furthermore for managing the DR Programs used to mitigate grid issues. This is typically a Utility or ISO.
- **Enrolled**: The owner/aggregator of demand side resources elects to participate in a DR program and may provide information about the specific resources that may be targeted for DR events
- **Event Active Period**: The is the period in the of time during which a change in the load profile is being requested as part of a DR Event
- **Event Constraints**: The time frames during which the customer can expect to receive events and related constraints such as no events on weekends or consecutive days
- **Event Days**: A day when an DR event occurs. Most programs have limitations as to the number of event days that are allowed in a given calendar period
- **Event Descriptor**: Part of the OpenADR event object that describes metadata about the event, such as program name and event priority
- **Event Duration**: The length of the event. Most programs define constraints as to the length of an event, as well as the hours of the day during which the event can occur
- **Event Signals**: The actionable information contained in an event such as electricity pricing or specific levels of load shed requested that typically trigger some pre-programmed load shed behavior by the recipient of the event. A DR program definition should specify the types of event signals used

- **Event Targeting**: The load shedding resources that are the intended recipient for the DR event. The may be a geographic area, a particular class of devices, a group identifier, resource ID, or other identifier. A DR program definition should specify how specific resources are going to be targeted.

- **Events**: An event is a notification from the utility to demand side resources requesting load shed starting at a specific time, over a specified duration, and may include targeting information designating specific resources that should participate in the event

- **Facilitator Intermediary Infrastructure** – This is the infrastructure, separate from the Demand Side Infrastructure, which is used by the Facilitator Intermediary Party to interact with both the Resources and the grid side entities.

- **Facilitator**: A third party that manages some or all of the execution of the DR program on behalf of the utility

- **Grid Infrastructure** – This is the infrastructure that is owned or managed by the DR Program Parties. This infrastructure includes the implementation of the OpenADR VTN that is used to send DR signals to Resources enrolled in the DR Programs

- **Intermediary Party** – This is a party that typically works on behalf of the Resource Party to facilitate their participation in DR Programs.

- **Load Control** – this is the infrastructure related to a Resource that is responsible for actually controlling the Resource and producing a specific load profile.

- **Load Profile Objective**: This motivation behind developing a DR program and issuing events. Such as the desire to shave peak loads.

- **Notification**: A period of time prior to the start time of an event where the demand side resource owner is notified of a pending event

- **Opt Behaviour**: The expected response from the demand side resource owner upon receipt of an event. This response may take the form of and OptIn or OptOut indication whether or not resource will participate in the event

- **Opt Responses**: Whether a specific program should require a response from demand side resources in response to an event, and what those responses typically are.

- **Opt Services**: Schedules communicated over OpenADR to indicate temporary changes in resource availability to participate in events.

- **Prerequisite**: Criteria that must be met in order for a demand side resource owner to enroll in a DR program. This may include the availability of interval meeting or some minimum load shed capacity

- **Primary Drivers**: The primary motivation on the part of the utility for creating the DR program and issuing events. Such as " Peak demand reduction and resource adequacy"

- **Programs** – These are the DR Programs that the Resources are enrolled in.

- **Program Description**: A narrative description of how a program works. Part of the DR Program templates defined in this document

- **Program Time Frame**: The time of the year or seasons during with a DR program is typically active

- **Rate Design**: The specific modifications to the rate structure or incentives paid to motivate demand side resource owners to participate in the program

- **Registration Services**: Service used by the OpenADR protocol to establish basic interoperability between a VTN and VEN, and to validate that the VEN is associated with the utility customers account.
- **Reporting Services**: Service used by the OpenADR to enable VENs to provide reporting to VENs. DR Program should specify the reporting requirements for the program.
- **Resource Party** – This is the party that owns the demand side Resources that may be enrolled in DR Programs
- **Resource** – This is the entity that is enrolled in the DR Programs and is capable of delivering some sort of change to their load profile in response to receiving a DR signal from a VTN.
- **Target Customer**: The profile of demand side resources that may enroll in a specific DR programs such as residential, industrial, or perhaps based on level of electricity consumption.
- **Target Loads**: The demand side resources whose load should be modified upon receipt of a
- **VEN** – This is the OpenADR Virtual End Node that is used to interact with the VTN.
- **VTN** – This is the OpenADR Virtual Top Node that is used to interact with the Resources enrolled in the DR Programs.

## 4 Abbreviations

- **BMS**: Building Management System
- **C&I**: Commercial and Industrial
- **Comm**: Communications between two entities
- **DR**: Demand Response
- **EMS**: Energy Management System
- **OpenADR**: Open Automated Demand Response
- **Programs**: Reference to a Demand Response Program(s)
- **VEN**: Virtual End Node
- **VTN**: Virtual Top Node



## 5 Demand Response Program Types

This document contains templates for the DR programs shown below.

1. **Critical Peak Pricing**: Rate and/or price structure designed to encourage reduced consumption during periods of high wholesale market prices or system contingencies by imposing a pre-specified high rate or price for a limited number of days or hours.

2. **Capacity Bidding Program**: A program which allows a demand resource in retail and wholesale markets to offer load reductions at a price, or to identify how much load it is willing to curtail at a specific price.

3. **Residential Thermostat Program/Direct Load Control**: A demand response activity by which the program sponsor remotely controls a customer's electrical equipment (e.g. air conditioner) on short notice. These programs are primarily offered to residential or small commercial customers.

4. **Fast DR Dispatch/Ancillary Services Program**: A demand response program that provides incentive payments to customers for load response during an Emergency Demand Response Event. An abnormal system condition (for example, system constraints and local capacity constraints) that requires automatic or immediate manual action to prevent or limit the failure of transmission facilities or generation supply that could adversely affect the reliability of the Bulk Electric System. These type of programs may sometimes be referred to as "Ancillary Services".

5. **Electric Vehicle (EV) DR Program**: A demand response activity by which the cost of charging electric vehicles is modified to cause consumers to shift consumption patterns.

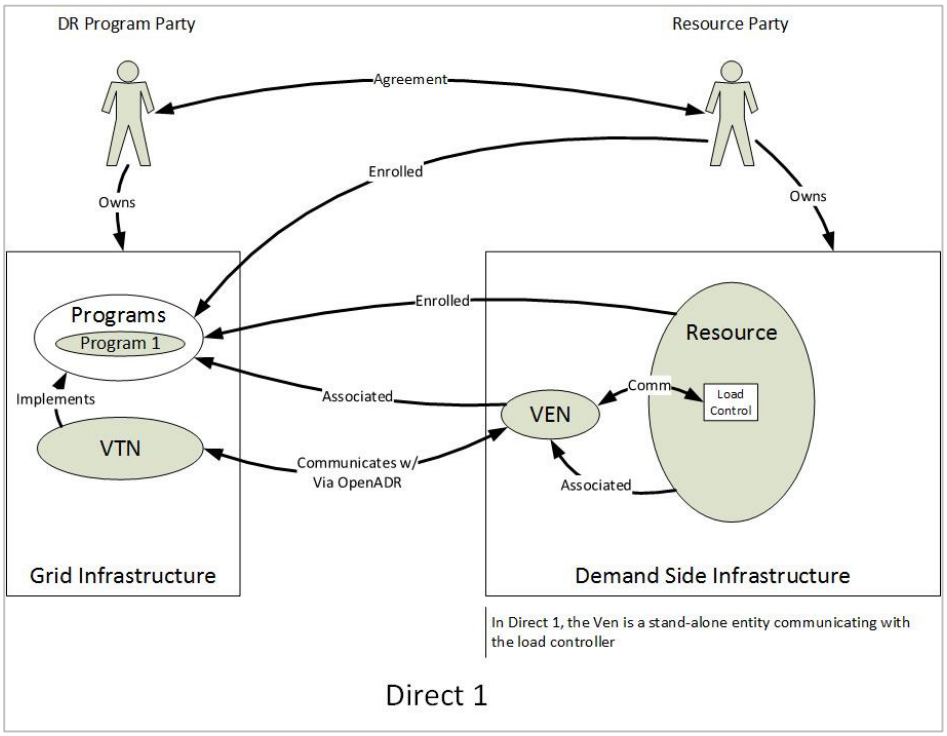
6. **Distributed Energy Resources (DER) DR Program**: A demand response activity utilized to smooth the integration of distribute energy resources into the smart grid.

## 6 Deployment Scenarios

The way in which a DR program is deployed is somewhat independent of the characteristics of the DR program itself. The following diagrams show a variety of ways in which a DR program might be deployed. The following section provides a cross reference between the deployment scenarios and the DR Programs they are most likely to be utilized with.

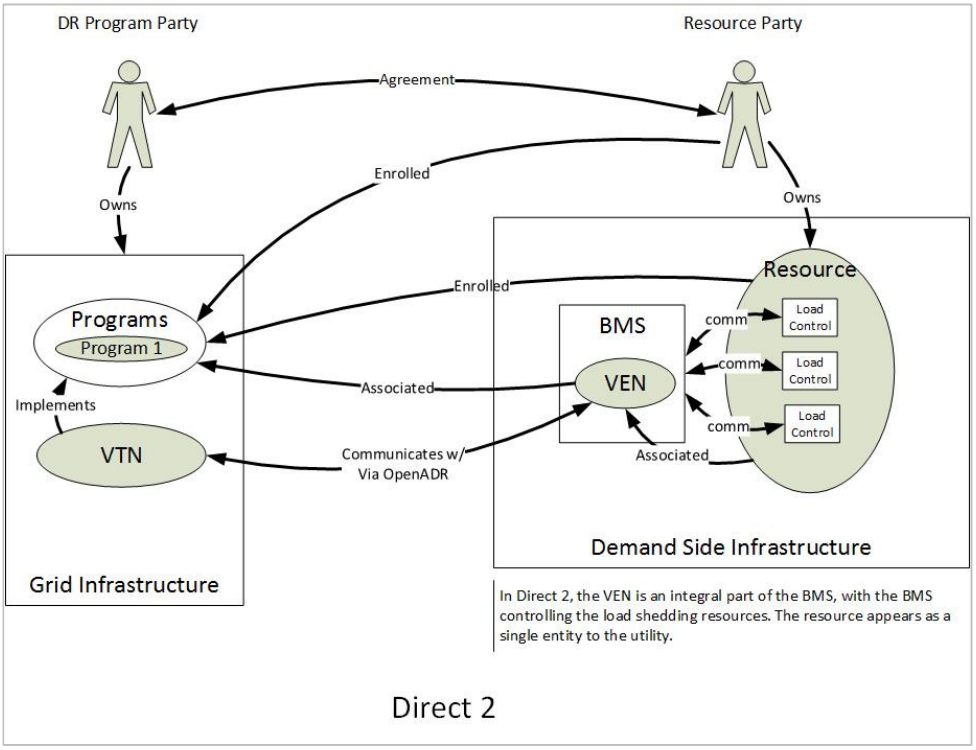
The diagrams in this section show the relationships between the entities in the various scenarios.

### 6.1 Direct 1



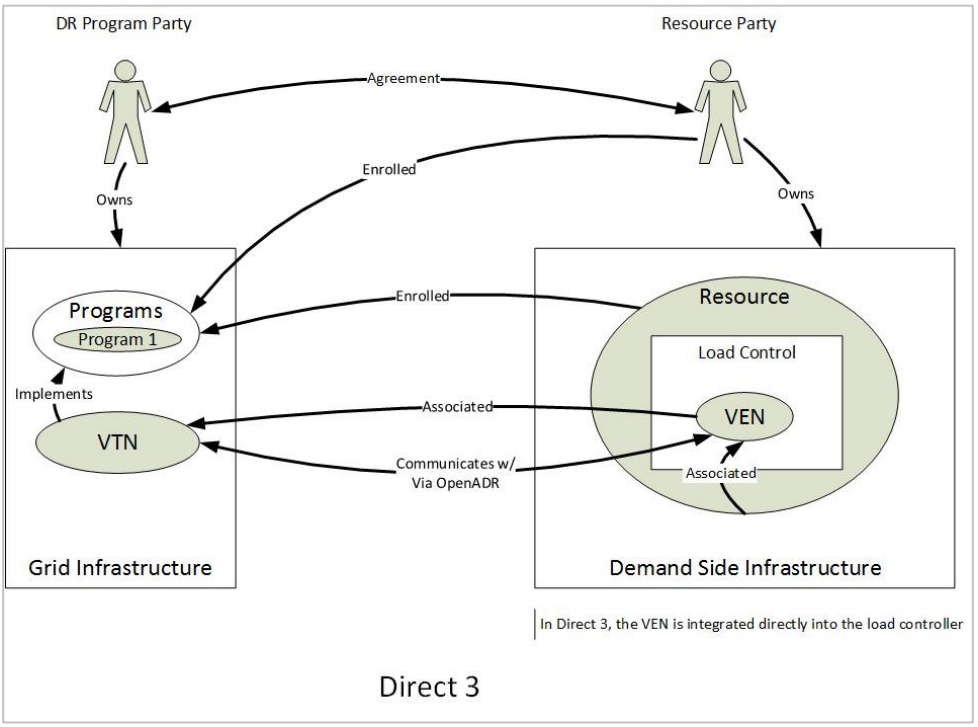

This is a simple scenario in which there is a direct relationship between the DR Program Party and the Resource Party. The Resource Party is responsible for enrolling their own Resources into the DR Programs and the Grid Infrastructure interacts directly with the Resources via a VEN that resides within the Demand Side Infrastructure. Furthermore the VEN is owned by the Resource Party and is separate from the Resources and their controllers. When a DR signal is received by the VEN it typically does not implement any load control logic, but simply forwards the signals to the load controllers who take the appropriate action. Examples of this scenario would include C&I buildings that may install a gateway that contains an OpenADR VEN and when a signal is received by that gateway it simply translates it into some other protocol and forwards to the load controllers themselves.

### 6.2 Direct 2



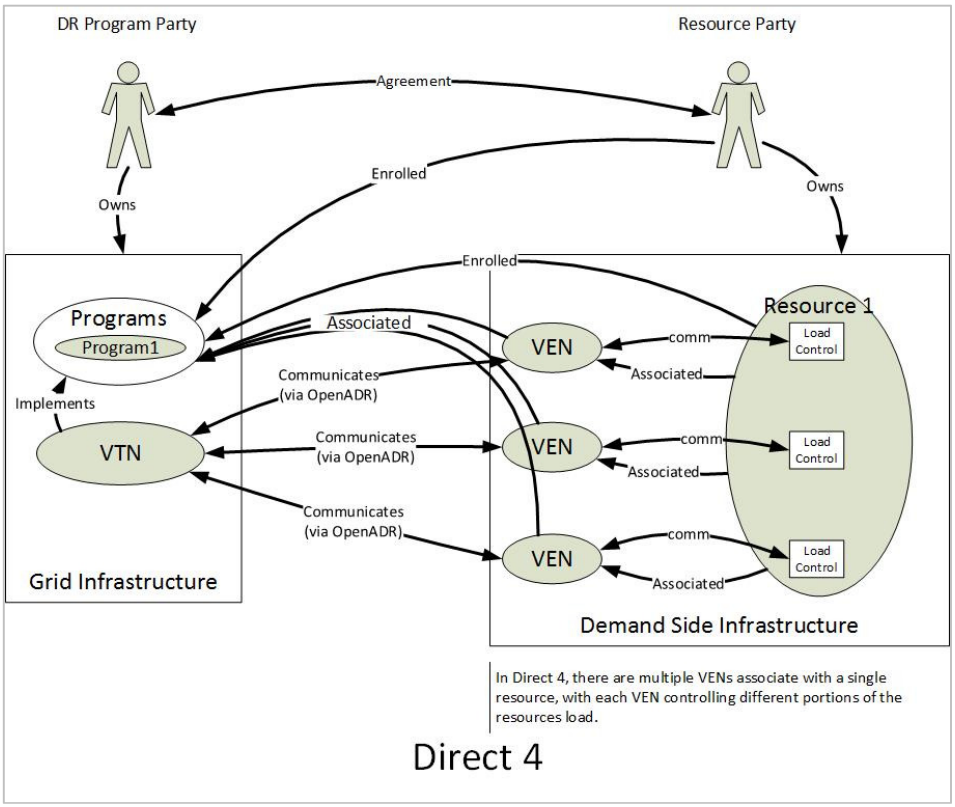

This is very similar to the Direct 1 scenario. The main difference being in how the VEN is instantiated and the interactions with the VTN facilitated. The VEN is instantiated in an entity like a centralized BMS that can implement DR logic and interact with Compound Resource and their many different load controllers from a more centralized location. Examples include large buildings with a BMS that control many different loads in a building (e.g. lighting, HVAC, industrial processes, etc.) to campuses that may have multiple facilities with a centralized control system.

### 6.3 Direct 3



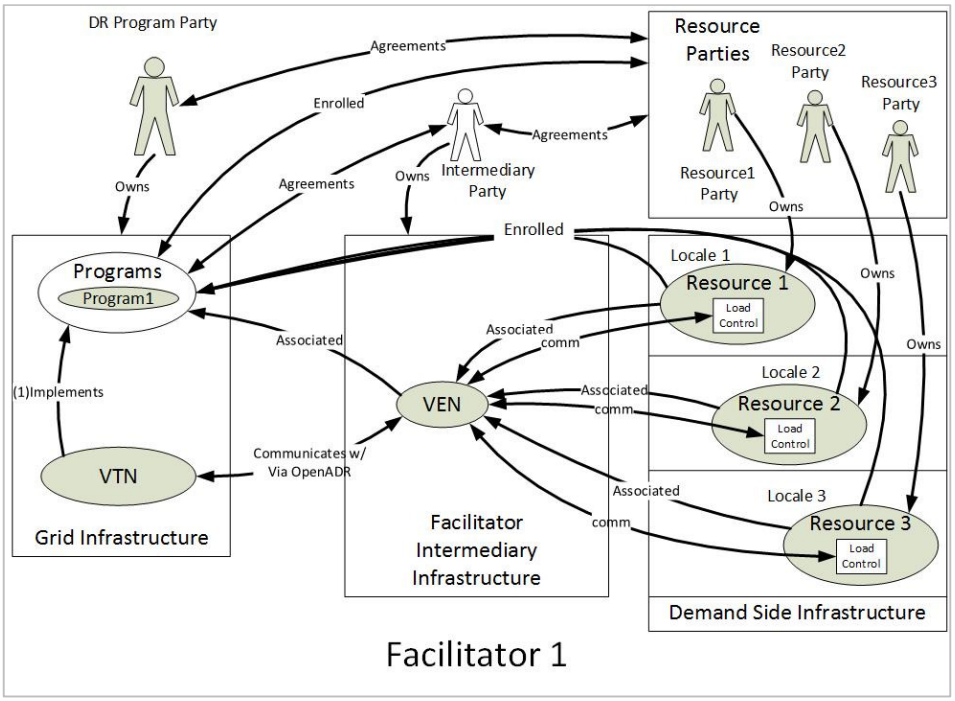

This scenario is very similar to the Direct 1 scenario. The main difference being that the VEN is instantiated directly in the resource and its load controller. In this case the DR signals are sent directly to the resource and its load controller. The so called “prices to devices” scenario falls into this category. Examples would include any sort of load controller such as HVAC (i.e. thermostat) that has an embedded VEN that is capable of interacting directly with the grid side entities VTN.

### 6.4 Direct 4




This is a combination of sorts of the Direct 1 and Direct 2 scenarios. The main difference being that multiple VEN's are associated with a single Compound Resource that is comprised of multiple assets with their own load controllers. Each of the load controllers that comprise the Compound Resource may be associated with a different VEN. Note that all the VEN's would be under control of the same Resource Party that owns the Compound Resource. This scenario exists in order to facilitate Demand Side Infrastructures that have Compound Resources, but do not have a centralized BMS like the Direct 2 scenario. Examples might include buildings with different load controllers on each floor, but no centralized BMS, or campuses with different controllers in each building, but no campus wide controller. Since from the DR Program Party's perspective there is only a single resource enrolled in the program when it wants to send a DR signal to the resource it may simply send the same signals to each of the designated VENs that have been associated with the Resource.

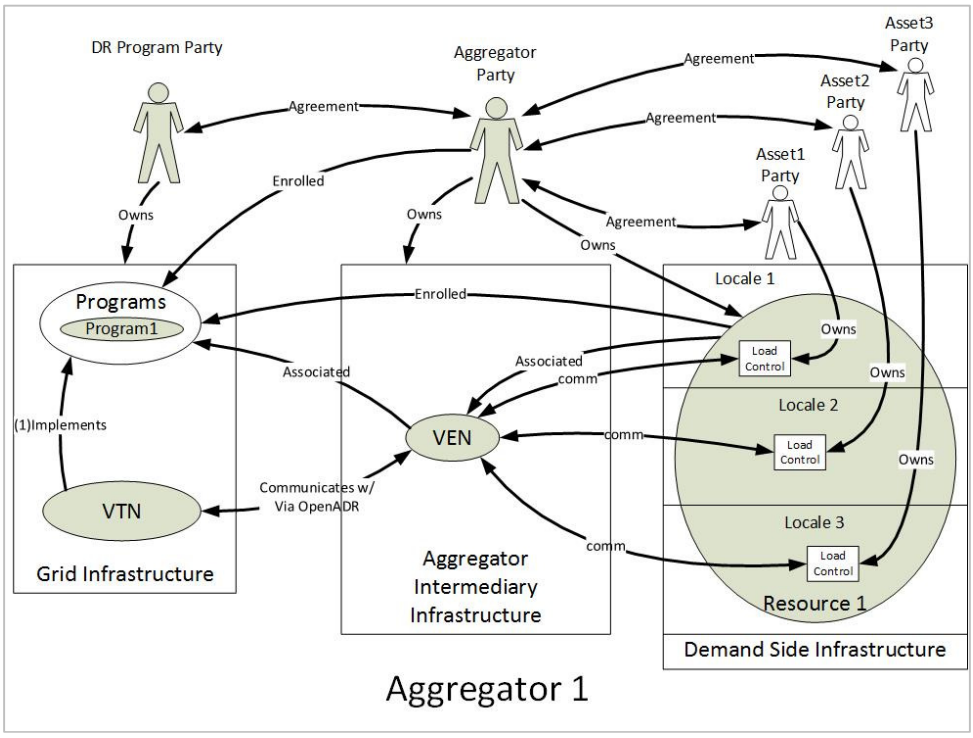
### 6.5 Facilitator 1




In this scenario there is an intermediary that facilitates interactions between the DR Program Party and the Resources. Typically the Intermediary Party works on behalf of the Resource Party to help them manage their Resources. The Resource Parties have direct relationships with the DR Program Party and they enroll their own Resources into the DR Programs. Thus the DR Program Party views each Resource Party as a separate Resource and may interact with them individually. The role of the Intermediary Party is to act as a go between for all the OpenADR related interactions, thus the VEN is instantiated within the Facilitator Intermediary Infrastructure. Such infrastructure is often cloud bases and offered to the Resource Parties as Software as a Service (SaaS). When the DR signal is received by the Facilitator's VEN a number of different actions may take place including forwarding the DR signal to the appropriate Resource and possibly implementing some sort of DR Logic and sending load control commands to each Resource's load controller. Examples of this scenario include:

- Vendors that manage the facilities for large commercial chains such as big box retailers.
- Industrial control intermediaries.
- Energy Services Companies (ESCO's)
- Cloud based appliance and device management systems such as the emerging smart communicating thermostat vendors.

### 6.6 Aggregator 1




This scenario is similar to the Facilitator scenario. The main difference being that the Aggregator Party has the relationship with the DR Program Party as opposed to the Resource Parties. The Aggregator Party aggregates multiple customer Assets into a single Resource that it enrolls into the DR Programs. The DR Program Party does not have visibility into the individual Assets the Aggregator is managing. As with the Facilitator the Aggregator has their own infrastructure where the VEN is instantiated. The difference being that when a DR signal is received it references a single resource and the Aggregator implements some sort of DR logic over all the Assets in their portfolio to achieve the objectives specified in the DR signal.

## 7 Deployment Scenario and DR Program Mapping



The table below provides recommendations as to which deployment scenarios map to a given DR Program. The number values in each cell provide an indication as to which deployment scenarios is most common for a specific DR Program.

| | Deployment Scenario | | | | | |
|---|---|---|---|---|---|---|
| **DR Template** | **Direct 1** | **Direct 2** | **Direct 3** | **Direct 4** | **Facilitator 1** | **Aggregator 1** |
| **CPP Program** | **1** | **?** | **?** | **?** | | |
| **Capacity Bidding Program** | | | | | | **1** |
| **Residential Thermostat Program** | | | | | **1** | |
| **Dynamic Pricing Program** | | | | | | |
| **Fast DR Dispatch** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Electric Vehicle (EV) DR Program** | | | | | | |
| **Distributed Energy Resources (DER) DR Program** | | | | | | |

The table below provides a mapping between the demand response programs defined in this document and a representative sample of DR programs that were active in the industry at the time this document was written.

| DR Template | Utility | DR Program Name |
|---|---|---|
| **CPP Program** | | |
| **Capacity Bidding Program** | | |
| **Residential Thermostat Program** | | |
| **Dynamic Pricing Program** | | |
| **Fast DR Dispatch** | | |
| **Elective Vehicle (EV) DR Program** | | |
| **Distributed Energy Resources (DER) DR Program** | | |

## 8 Selecting a DR Program Template

The following are a set of questions that are relevant to any utility about to implement a new DR program. This is not meant to be comprehensive, but represents some of the more pertinent issues. The intent of these questions is to help guide utilities towards an appropriate set of DR Program templates.

**Q: Why do you want to do DR? What grid condition or operational issue are you trying to mitigate with DR?**

This is by far the most important question and forms the basis for the overall requirements and objectives for what the DR program is supposed to achieve. The answer to this question defines how the demand side load profile is supposed to be shaped by the DR program. All other requirements flow from the answer to this question.

- Are you trying to shave peaks?
- Do you want to fill the belly of the duck?
- Are you trying to hedge the spot price of electricity?
- Are you concerned with grid reliability?
- Are you trying to preserve grid assets?
- Etc. etc. etc.

The table below provides some additional context to the motivations behind wanting to develop a DR Program

| | |
|---|---|
| Grid Reliability & Safety | Frequency and Voltage Stability |
| | Resource Adequacy |
| | Peak Capacity |
| | Ramping |
| | Contingency |
| Procurement of Energy | Spot Market Prices |
| | Price Arbitrage |
| Asset Management | Damage Prevention |
| | Maintenance Reduction |
| | Lifetime Extension |
| Capacity Management | Economic Benefits |
| | Emergency Management |
| Environmental | Negawatt |
| | Clean Energy |



**Q: Is there an existing DR program or tariff already in place for this program?**

- Often times the program rules are spelled out explicitly in a tariff.

**Q: What demand side market segment are you targeting with this program?**

This may help determine the targeting of the resources in the event and the type of signal.

- Residential
- Large C&I
- Small C&I

- Agriculture
- Water management
- Electric Vehicles
- Etc, etc, etc

**Q: Are you trying to target specific types of loads?**

- Thermostats
- Electric vehicles
- Ag pumps
- etc.

**Q: What is your deployment model?**

The answer to this question can influence how resources are defined within the program and determine how those resources are targeted within events.

- Direct to customers
- Through intermediaries like aggregators or facilitators
- Customer responsible for procuring and deploying their own VEN equipment?
- etc.

**Q: At what level of specificity do you want to interact with the demand side loads?**

This question is somewhat related to the deployment model and determines how the resources in the program are defined and targeted. It is one of the most important and possibly complex questions.

- Interact with each individual resource
- Interact through a facilitator or aggregator with no specification of the resources behind them
- Interact through a facilitator or aggregator AND specify which resources behind them should be dispatched
- Use location as an attribute to specify resources
- Use some sort of utility defined grouping mechanism to specify resources
- Target individual assets such as thermostats
- Interact with no resources at all and just broadcast DR events
- etc.

**Q: What interaction pattern do you want to employ to influence your customers load profiles?**

This question determines the type of DR signals that will be sent to participants in a program.

- Incentives (e.g. dynamic pricing)
- Load dispatches (e.g. ancillary services)
- Direct load control
- Generic event signal
- etc.

**Q: What is the general resource scheduling attributes of the program?**

- Dates and times that events may be called
- Frequency of events
- Duration of events
- Allowable latencies for the propagation of events
- etc.

**Q: How is the availability of resources in the program determined?**

- By strict program rules
- As part of some nomination or bidding process done by the resource
- Opt In/Out allowed?
- etc.

**Q: What type of visibility do you need into the resource's performance?**

This is a very broad question and determines what type of information is fed back from the resources in the DR program. In general this determines the type of reports that are required.

- Online/Offline
- Usage (current and/or historical)
- Load response potential
- Load availability
- Load/asset state (current and/or historical)
- Etc., etc. etc.

# 9 Demand Response Program Templates

## 9.1 Critical Peak Pricing Program (CPP)

### 9.1.1 CPP DR Program Characteristics

| | |
|---|---|
| Load Profile Objective | -Peak demand reduction |
| Primary Drivers | -Reduced capital expenditures and reduced energy costs |
| Program Description | When utilities observe or anticipate high wholesale market prices or power system emergency conditions, they may call critical events during a specified time period (e.g., 3 p.m.—6 p.m. on a hot summer weekday), the price for electricity during these time periods is substantially raised. |
| Customer Incentive | Customers may be offered discounted energy prices during non-peak times as an incentive to participate in the program. |
| Rate Design | CPP is a price program with rates increasing during critical peaks in energy consumption. Typically CPP rates are an adder or multiplier to flat, tiered, or TOU base rates. |
| Target Customer | -Residential or C&I |
| Target Load | -Any |
| Prerequisite | -Customer must have interval metering<br>-C&I customers may have to meet a demand criterion |
| Program Time Frame | -Typically spans months of the year where peak energy consumption occurs, although may be year round in some cases. |
| Event Constraints | -Typically Monday through Friday, excluding holidays, with consecutive day events typically allowed |
| Event Days | -Typically 9 to 15 per year |
| Event Duration | -Typically during a fixed time frame for all events ranging from 4 to 6 hours during the highest energy consumption times of the day. |
| Notification | -Typically day ahead |
| Opt Behaviour | -Typically customers are not required to participate in events |
| Certification Events | -Typically none |

### 9.1.2 OpenADR Characteristics for CPP Programs

| | |
|---|---|
| Event Signals | -**A SIMPLE signal with levels 1 to 3 mapped to the pricing impact of the CPP event**. If a CPP program has a single pricing component it should be mapped to level 1. For CPP programs with multiple pricing components, the smallest price component should be mapped to level 1, with the other price components mapped to levels 2 and 3 in increasing degree of pricing impact.<br><br>-If the deployment supports B profile VENs, **in addition to the SIMPLE signal, an ELECTRICITY_PRICE signal may be included** in the payload with a type of priceRelative, priceAbsolute, or priceMultiplier depending on the nature of the program. |
| Opt Responses | -VTNs sending events **should set the oadrResponseRequired element to "always"**, requiring the VEN to respond with an optIn or optOut<br><br>-As participation in a CPP program is a "best effort" exercise, there is no formal meaning to optIn or optOut beyond a courtesy availability indication of intent to participate. We recommend that **VENs respond with optIn unless there has been some specific override action taken by the customer**.<br><br>-The oadrCreateOpt payload would typically not be used to qualify resources participating in events. |
| Event Descriptor | -The event **priority should be set to 1** unless the program rules or VTN configuration specify otherwise<br><br>-**Test events are typically not used** with CPP programs. However if they are allowed the testEvent element should be set to "true" to indicate the test event. If additional parameterized information is required in this element it can follow "true" separated by a space with this additional information. |
| Event Active Period | - **eiRampUp, eiRecovery, tolerance elements are typically not used** |
| Baselines | -**Baselines are typically not included in the event payload** |
| Event Targeting | -CPP programs typically don't differentiate between resources for a given customer. **Targeting typically specifies the venID**, indicating that all the resources associated with the VEN should participate, **or a list of all the resourceIDs** associated with VEN. |
| Reporting Services | -**Telemetry reporting is typically not used** as it is not absolutely necessary for CPP programs |

| | |
|---|---|
| Opt Services | -**Use of the Opt service** to communicate temporary availability schedules **typically would not be used** as part of a CPP program. However, some deployments could use this service to preserve available event days for customers who indicate lack of availability. |
| Registration Services | **Polling intervals** requested by the VTN for typical day-ahead CPP programs **are not required to be more frequent that once an hour**. However, the use of polling for heartbeat detection may require more frequent polling. |

## 9.2 Capacity Bidding Program

### 9.2.1 Capacity Bidding DR Program Characteristics

| | |
|---|---|
| Load Profile Objective | -Peak demand reduction and resource adequacy |
| Primary Drivers | -Reduced capital expenditures and reduced energy costs |
| Program Description | The capacity bidding program is used by ISO/utilities to obtain pre-committed load shed capacity from aggregators or self aggregated customers. This pre-committed load shed capacity is utilized by ISO/utilities when they observe or anticipate high wholesale market prices, power system emergency conditions, or as part of normal energy resource utilization by calling DR events during a specified time period.<br><br>Note that each aggregator is typically responsible for designing their own demand response program as well as customer acquisition, and event notification in order to meet the capacity commitments made as part of this program. |
| Customer Incentive | Aggregators/customers receive two types of incentives. First, they receive a capacity payment for holding a specific amount of load shed capacity available for DR events during a future time window. Second, if an event is called during the future time window an energy payment may be made for load shed over the duration of the event. |
| Rate Design | Participants in the program make a "capacity nomination" bid indicating the load shed capacity they are willing to hold as available during a future time window. The bid may also include the incentive the aggregator/customer is willing to accept for load shed below a baseline value.<br><br>In utility markets the capacity commitment is typically for the next calendar month, although much longer time frames are used in ISO markets. As part of the capacity nomination, the customer may be able to chose between a number of characteristics including day-ahead or day-of notification and the event duration window (such as 1-4 hours, 2-6 hours, ...).<br><br>A capacity payment is made to the customer for this pre-commitment even if there are no events called during the time window. If an event is called during the time window the customer may receive an energy payment for the load shed in relation to a baseline, however penalties may apply if less than the pre-committed load shed capacity is delivered at the time the event is called. |
| Target Customer | -Aggregators and self aggregated C&I customers |
| Target Loads | - Any |

| | |
|---|---|
| Prerequisite | -Customer must have interval metering<br>-C&I customers may have to meet a demand or bid criterion |
| Program Time Frame | -Anytime |
| Event Constraints | -Typically Monday through Friday, excluding holidays, with consecutive day events typically allowed |
| Event Days | -Typically a maximum of 30 hours per month |
| Event Duration | -Typically during a fixed time window for all events during the highest energy consumption times of the day (qualify). Event duration varies by customer capacity commitment preferences ranging from 1 to 8 hours or the design of the program |
| Notification | -Day-ahead or day-of depending on customer capacity commitment preferences or the design of the program |
| Opt Behaviour | -Typically customers would opt-in to events given that as they have pre-committed load shed capactity. |
| Certification Events | -Typically two per year (Test) |

### 9.2.2 OpenADR Characteristics for Capacity Bidding Programs

| | |
|---|---|
| Event Signals | -**A SIMPLE signal with levels 1 to 3 mapped to the amount of load shed.** If the program only supports a single level of load shed, that should be mapped to level 1. For programs with mutiple levels of load shed, the smallest change from normal operation should be mapped to the level 1, with the load shed values mapped to levels 2 and 3 in increasing degree of load shed.<br><br>-If the deployment supports B profile VENs, **in addition to the SIMPLE signal, a BID_LOAD and/or BID_PRICE signal may be included** in the payload with signal types of setpoint and price, and units of powerReal and currencyPerKW respectively. The BID_LOAD would reflect the requested load shed up to capacity amount bid by the aggregator/customer, and the BID_PRICE would reflect the incentive bid by the aggregator/customer. Need to confirm that the BID_PRICE unit is actually KW and not KWh |
| Opt Responses | -VTNs sending events **should set the oadrResponseRequired element to "always"**, requiring the VEN to respond with an optIn or optOut<br><br>-As aggregators/customers have pre-committed capacity **VENs should respond with optIn.** An opt out may be sent in response to the event, but this is an informal availability indication, not a formal opt out of the event.<br><br>-The **oadrCreateOpt payload would typically not be used** to qualify resources participating in events as typically the load is a single aggregated entity. |

| | |
|---|---|
| Event Descriptor | -The event **priority should be set to 1** unless the program rules or VTN configuration specify otherwise<br><br>-**Test events may be used** with Capacity Bidding programs. If they are allowed, the testEvent element should be set to "true" to indicate the test event. If additional parameterized information is required in this element it can follow "true" separated by a space with this additional information. |
| Event Active Period | - **eiRampUp, eiRecovery, tolerance elements are typically not used** |
| Baselines | -**Baselines are typically not included in the event payload** as this data typically is not be available at the time the event is initiated. However, both utilities and aggregators/customers would view the inclusion of baseline information in events as useful. |
| Event Targeting | -Capacity Bidding programs typically don't differentiate between resources for a given customer. **Targeting typically specifies the venID**, indicating that all the resources associated with the VEN should participate, **or includes a resourceID representative of the aggregated load** associated with VEN. |
| Reporting Services | **ISO Capacity Bidding programs typically require TELEMETRY_USAGE reports** with powerReal data points. **Telemetry reporting for utility Capacity Bidding typically is not required**.<br><br>**Note that telemetry reporting requires B profile VENs.** |
| Opt Services | -**Use of the Opt service** to communicate temporary availability schedules **typically would not be used** as part of a Capacity Bidding program as customers have pre-committed their availability. However, this service may be useful as an informal way for participants to indicate a lack of availability for extenuating reasons such as equipment failure. |
| Registration Services | **Polling intervals** requested by the VTN for typical day-ahead programs **are not required to be more frequent that once an hour**. However, the use of polling for heartbeat detection or day-of programs may require more frequent polling. |

### 9.3 Residential Thermostat Program

This program is representative of Direct Load Control (DLC) where the Demand Response signal directly modifies the behavior of load shedding resources, without a layer of abstraction between receipt of the signal and the specific load shedding action taken.

#### 9.3.1 Residential Thermostat DR Program Characteristics

| | |
|---|---|
| Load Profile Objective | -Peak demand reduction |
| Primary Drivers | -Reduced capital expenditures and reduced energy costs |
| Program Description | -When utilities observe or anticipate high wholesale market prices or power system emergency conditions, they may initiate an event that modifies the behavior of the customer's programmable communicating thermostat (PCT) over a specified time period (e.g., 3 p.m.—6 p.m. on a hot summer weekday) in order to reduce energy consumption.<br><br>-The change to the PCT behavior in response to the event may be a simple change in temperature setpoint for the duration for the event or a more complex set of changes, including pre-cooling, that minimize the impact of the event on the customer's comfort level. |
| Customer Incentive | -Incentives take two general forms. First, customers may be provided with a free PCT or offered discounts/rebates on customer purchased PCTs as an incentive to enroll in the DR program. Second, customers may receive an ongoing annual stipend for continued enrollment in the program. Less common would be ongoing incentives paid to customers based upon actual energy reduction during events. |
| Rate Design | -Primarily an incentive program, where customers receive discounted or free PCT's for enrolling in the DR program. Some programs may pay a periodic stipend or incentive payments based upon energy reduction during events. |
| Target Customer | -Residential |
| Target Load | -HVAC |
| Prerequisite | -Typically none, as customers receive a PCT as part of the program enrollment |
| Program Time Frame | -Typically spans months of the year where peak energy consumption occurs, although may be year round in some cases. |
| Event Constraints | -Typically Monday through Friday, excluding holidays, with consecutive day events typically allowed. |
| Event Days | -Typically 9 to 15 per year |
| Event Duration | -Events could occur at any time, with durations ranging from 2 to 4 hours, although typically events occur during the highest energy |

| | |
|---|---|
| | consumption times of the day. |
| Notification | -Typically day ahead, although some programs may have notification times as short as 10 minutes. |
| Opt Behavior | -Customers are not required to participate in events, however they will automatically be opted in to events unless they take action to override the event or make manual adjustments to temperature during the event. |
| Certification Events | -Typically none |

### 9.3.2 OpenADR Characteristics for Residential Thermostat Programs

| | |
|---|---|
| Event Signals | -**A SIMPLE signal with levels 1 to 3 mapped to the change in PCT temperature setpoint offsets or thermostatic cycling percentage .** If a residential thermostat program has a single offset/cycling component it should be mapped to level 1. For programs with multiple offset/cycling components, the smallest change from normal operation should be mapped to the level 1, with the other offset/cycling values mapped to levels 2 and 3 in increasing degree of load shed impact.<br><br>-If the deployment supports B profile VENs, **in addition to the SIMPLE signal, a LOAD_CONTROL signal may be included** in the payload **with a type of x-LoadControlLevelOffset or x-LoadControlCapacity** to specify the desired temperature setpoint offset or thermostatic cycling percentage respectively. It is recommenced that a **unit type of "temperature" by used in payloads utilizing the x-LoadControlLevelOffset signalType** to indicate Celsius or Fahrenheit for the offset. Note that the use of a temperature unit currently would currently violate conformance rule 104, however the team has agreed to update table 1 in the profile specification to allow this usage. Refer to Mantis issue post. |
| Opt Responses | -VTNs sending events **should set the oadrResponseRequired element to "always"**, requiring the VEN to respond with an optIn or optOut<br><br>- **VENs Should respond with optIn unless there has been some specific override action taken by the customer**.<br><br>-The **oadrCreateOpt payload may be used by VENs** to qualify the participation of resources in an event. For instance, an event may target the resourceID's of two thermostats that control separate HVAC systems. If the customer decides that only one of the HVAC systems can participate in the event, this would get communicated to the VTN using the oadrCreateOpt payload. **Note that the oadrCreateOpt payload is only supported by B profile VENs** |
| Event Descriptor | -The event **priority should be set to 1** unless the program rules or VTN configuration specify otherwise<br><br>-**Test events are typically not used** with Residential Thermostat |

| | |
|---|---|
| | programs. However if they are allowed the testEvent element should be set to "true" to indicate the test event. If additional parameterized information is required in this element it can follow "true" separated by a space with this additional information. |
| Event Active Period | -**Randomization is typically used for residential thermostat events using the tolerance element**<br><br>- **eiRampUp and eiRecovery elements are typically not used** |
| Baselines | -**Baselines are typically not included in the event payload** |
| Event Targeting | -Residential Thermostat programs target HVAC resources controlled by PCTs. **Targeting typically specifies the resourceIDs** of the HVAC systems (i.e. the thermostat) associated with VEN **or the venID with the event signal device class target set to Thermostat** |
| Reporting Services | -**Telemetry reporting is typically not used** as it is not absolutely necessary for residential thermostat programs |
| Opt Services | -**Use of the Opt service** to communicate temporary availability schedules **typically would not be used** as part of a CPP program. |
| Registration Services | **Polling intervals** requested by the VTN for typical day-ahead Residential Thermostat programs **are not required to be more frequent that once an hour**. However, the use of polling for heartbeat detection may require more frequent polling as would residential thermostat programs with substantially shorter notification times. |

## 9.4 Fast DR Dispatch

### 9.4.1 Fast DR Dispatch Program Characteristics



| | |
|---|---|
| Load Profile Objective | -Dispatch resources to achieve load response in “real-time” |
| Primary Drivers | -Grid reliability and ancillary services |
| Program Description | Fast DR is used by ISO/utilities to obtain pre-committed load response in “real-time”. This pre-committed load response is utilized by ISO/utilities when they observe conditions that require immediate action to maintain the stability and integrity of the grid. Real-time means that resources are typically dispatched with a latency ranging from 10 minutes for resources that are used as reserves to 2 seconds for resources that are used for regulation purposes.<br><br>The size of the load response must be large enough to make a difference in mitigating the grid condition and thus resources are typically very large and often managed by aggregators as part of an aggregated resource. Minimum sizes for the load response for a resource to qualify to participate in ancillary services are typically around 500 kW, but can be as low as 100 kW for some programs. |

| | |
|---|---|
| | Note that if the resource is used as a reserve it will typically be called upon to decrease (i.e. shed) load, but if it is being used for regulation purposes it may be dispatched to either increase or decrease load. |
| Customer Incentive | Aggregators/customers typically receive two types of incentives. First, they receive a payment for committing and making available a specific amount of load response available for DR events during a future time window. The amount of load response, the time window of availability and the amount to be paid is typically set by the aggregator/customer. Second, if an event is called during the future time window a payment based upon the amount of load response over the duration of the event. |
| Rate Design | Participants in the program submit a bid indicating the load response they are willing to make available during a future time window. The bid typically also includes the payment the aggregator/customer is willing to accept for the load response.<br><br>In utility/ISO markets the bid is typically submitted either the day ahead or the day of the time period for which the commitment is being made. As part of their qualification and registration in the markets various performance envelops parameters are associated with the resource such as ramp rate and min and max operating limits. Such parameters govern how it will be dispatched.<br><br>If a participant's bid is accepted a payment may be made to the customer for their pre-commitment even if there are no events called during the time window. If an event is called during the time window the customer may receive additional payments for their performance during the event. Such performance based payments may be based on a number of factors including amount energy, power, how closely the resource follows the dispatch instructions, and a "mileage" payment which reflects how much their load profile was required to change during the event. Some of these parameters such as energy and power may be with respect to a baseline. |
| Target Customer | -Aggregators and self-aggregated C&I customers |
| Target Loads | - Those which can respond to real-time dispatches. |

| | |
|---|---|
| Prerequisite | -Customer must have interval metering<br>-Must meet minim size requirements for the load response<br>-Must be able to respond to real-time dispatches<br>-Typically have to supply real-time telemetry that shows the current load response |
| Program Time Frame | -Anytime |
| Event Constraints | -none |
| Event Days | -none |
| Event Duration | -Typically short (less than 30 minutes), but in any case will never exceed the time window that the participant made the resource available when they submitted their bid. |
| Notification | -none |
| Opt Behavior | -Customers are opted in to events by default given that they have pre-committed load response |
| Certification Events | -Typically one per year (Test) |

### 9.4.2 OpenADR Characteristics for Capacity Bidding Programs

| | |
|---|---|
| Event Signals | -**A SIMPLE signal with levels 1 to 3 mapped to the amount of load response.** If the program only supports a single level of load response, that should be mapped to level 1. For programs with mutiple levels of load response, the smallest change from normal operation should be mapped to the level 1, with the load shed values mapped to levels 2 and 3 in increasing degree of load response.<br><br>-If the deployment supports B profile VENs, **in addition to the SIMPLE signal, a dispatch in the form of a LOAD_DISPATCH signal may be included** in the payload with signal types of setpoint or delta, and units of powerReal. This signal represents the desired "operating point" of the load and can be expressed either as an absolute amount of mW (i.e. setpoint) or some relative number of mW (i.e. delta) from the resources current operating point. |
| Opt Responses | -VTNs sending events **should set the oadrResponseRequired element to "always"**, requiring the VEN to respond with an optIn or optOut<br><br>-As aggregators/customers have pre-committed capacity **VENs should respond with optIn.** An opt out may be sent in response to the event, but this is an informal availability indication, not a formal opt out of the event.<br><br>-The **oadrCreateOpt payload would typically not be used** to qualify resources participating in events as typically the load is a single aggregated entity. |
| Event Descriptor | -The event **priority should be set to 1** unless the program rules or VTN configuration specify otherwise |

| | |
|---|---|
| | -**Test events may be used**, especially during the registration and qualification of a resource. If they are allowed, the testEvent element should be set to "true" to indicate the test event. If additional parameterized information is required in this element it can follow "true" separated by a space with this additional information. |
| Event Active Period | - **Tolerance elements are not used**. The eiRampUp and eiRecovery periods are typically part of a resource's parameters when they register and may be used. Because of the nature of the dispatches they may be open ended and thus there may be no end time for the event. |
| Baselines | -**Baselines are typically not included in the event payload** as this data typcially is not be available at the time the event is initiated. However, both utilities and aggregators/customers would view the inclusion of baseline information in events as useful. |
| Event Targeting | -Capacity Bidding programs typically don't differentiate between resources for a given customer. **Targeting typically specifies the venID**, indicating that all the resources associated with the VEN should participate, **or includes a resourceID representative of the aggregated load** associated with VEN. |
| Reporting Services | **Fast DR programs typically require TELEMETRY_USAGE reports** with powerReal data points. The usage report depicts the resources current operating point and is used by the Utility/ISO to determine how closely the resource is following the dispatch instruction that was sent.<br><br>In some cases the telemetry may include other data points such as voltage readings and charge state (i.e. energy) in the case where the resources is some form of storage. In some cases the reporting frequency may be as high as every 2 seconds.<br><br>**Note that telemetry reporting requires B profile VENs.** |
| Opt Services | -**Use of the Opt service to communicate temporary availability** schedules **typically would not be used** as customers have pre-committed their availability. However, this service may be useful as an informal way for participants to indicate a lack of availability for extenuating reasons such as equipment failure. |
| Registration Services | Because of the low latency requirements of the real-time dispatches **only push interaction patterns are used**. |

### 9.5 Electric Vehicle (EV) DR Program

#### 9.5.1 Electric Vehicle (EV) Program Characteristics

| | |
|---|---|
| Load Profile Objective | A demand response activity by which the cost of charging electric vehicles is modified to cause consumers to shift consumption patterns. |
| Primary Drivers | |
| Program Description | |
| Customer Incentive | |
| Rate Design | |
| Target Customer | |
| Target Loads | |
| Prerequisite | |
| Program Time Frame | |
| Event Constraints | |
| Event Days | |
| Event Duration | |
| Notification | |
| Opt Behavior | |
| Certification Events | |

#### 9.5.2 OpenADR Characteristics for Electric Vehicle (EV) Programs

| | |
|---|---|
| Event Signals | |
| Opt Responses | |
| Event Descriptor | |
| Event Active Period | |
| Baselines | |
| Event Targeting | |
| Reporting Services | |
| Opt Services | |
| Registration Services | |



### 9.6 Distributed Energy Resources (DER) DR Program

#### 9.6.1 Distributed Energy Resources (DER) Program Characteristics

| | |
|---|---|
| Load Profile Objective | A demand response activity utilized to smooth the integration of distribute energy resources into the smart grid. |
| Primary Drivers | |

| | |
|---|---|
| Program Description | |
| Customer Incentive | |
| Rate Design | |
| Target Customer | |
| Target Loads | |
| Prerequisite | |
| Program Time Frame | |
| Event Constraints | |
| Event Days | |
| Event Duration | |
| Notification | |
| Opt Behavior | |
| Certification Events | |

### 9.6.2 OpenADR Characteristics for Distributed Energy Resources (DER)

| | |
|---|---|
| Event Signals | |
| Opt Responses | |
| Event Descriptor | |
| Event Active Period | |
| Baselines | |
| Event Targeting | |
| Reporting Services | |
| Opt Services | |
| Registration Services | |

# 10 Sample Data and Payload Templates

The following tables and XML payload samples will provide implementers with tangible examples of how the DR templates in this document should be implemented,

## 10.1 Critical Peak Pricing Program (CPP)

**CPP Scenario 1 - Simple Use case, A or B Profile**

- Event
  - Notification: Day before event
  - Start Time: 1pm
  - Duration:4 hours
  - Randomization: None
  - Number of signals: 1
  - Signal Name: SIMPLE
    - Signal Type: level
    - Units: N/A
    - Number of intervals 1
    - Interval Duration(s):4 hours
    - Typcial Interval Value(s): 1 or 2
    - Signal Target: N/A
  - Event Target(s): venID_1234
  - VEN Expected Response:optIn
- Reports
  - N/A

**CPP Scenario 2 - Typcial Use Case, B profile**

- Event
  - Notification: Day before event
  - Start Time:1pm
  - Duration: 4 hours
  - Randomization: None
  - Number of signals: 2
  - Signal Name: Simple
    - Signal Type: level
    - Units: Level 0,1, 2, 3)
    - Number of intervals 1
    - Interval Duration(s):4 hours
    - Typcial Interval Value(s): 1 or 2
    - Signal Target: None
  - Signal Name: ELECTRICITY_PRICE
    - Signal Type: price
    - Units: USD per Kwh
    - Number of intervals 1
    - Interval Duration(s):4 hours
    - Typcial Interval Value(s): $0.10 to $1.00
    - Signal Target: None
  - Event Targets: venID_1234
  - VEN Expected Response: optIn
- Reports
  - None

**CPP Scenario 3 - Complex Use Case**

- Event
  - Notification: Day before event
  - Start Time: 2pm

  Duration: 6 hours
  - Randomization:None
  - Number of signals:2

    - Signal Name: Simple
        - Signal Type: level
        - Units: Level 0,1, 2, 3)
        - Number of intervals 3
        - Interval Duration(s):1 hour, 4 hours, 1 hour
        - Typcial Interval Value(s): 1, 2, 1 (for each interval respectively)
        - Signal Target: None
    - Signal Name: ELECTRICITY_PRICE
        - Signal Type: price
        - Units: USD per Kwh
        - Number of intervals 3
        - Interval Duration(s):4 hours
        - Typical Interval Value(s): $0.50, $0.75, $0.50 (for each interval respectively)
        - Signal Target: None
    - Event Targets: Resource_1, Resource_2, Resource_3
    - VEN Expected Response:
- Reports
    - None

**Sample Payload - Typical B Profile Use Case**

```
<ns7:oadrPayload>
  <ns7:oadrSignedObject>
    <ns7:oadrDistributeEvent ns2:schemaVersion="2.0b">
      <ns3:requestID>OadrDisReq091214_043740_513</ns3:requestID>
      <ns2:vtnID>TH_VTN</ns2:vtnID>
      <ns7:oadrEvent>
        <ns2:eiEvent>
          <ns2:eventDescriptor>
            <ns2:eventID>Event091214_043741_028_0</ns2:eventID>
            <ns2:modificationNumber>0</ns2:modificationNumber>
            <ns2:modificationDateTime>2001-12-17T09:30:47Z</ns2:modificationDateTime>
            <ns2:modificationReason>Update</ns2:modificationReason>
            <ns2:eiMarketContext>
              <ns4:marketContext>http://MarketContext1</ns4:marketContext>
            </ns2:eiMarketContext>
            <ns2:createdDateTime>2014-12-09T12:37:40Z</ns2:createdDateTime>
            <ns2:eventStatus>far</ns2:eventStatus>
          </ns2:eventDescriptor>
          <ns2:eiActivePeriod>
            <ns5:properties>
              <ns5:dtstart>
                <ns5:date-time>2014-12-09T12:38:41Z</ns5:date-time>
              </ns5:dtstart>
              <ns5:duration>
                <ns5:duration>PT4H</ns5:duration>
              </ns5:duration>
              <ns2:x-eiNotification>
                <ns5:duration>PT24H</ns5:duration>
              </ns2:x-eiNotification>
            </ns5:properties>
            <ns5:components/>
          </ns2:eiActivePeriod>
          <ns2:eiEventSignals>
            <ns2:eiEventSignal>
              <ns6:intervals>
                <ns2:interval>
                  <ns5:duration>
                    <ns5:duration>PT4H</ns5:duration>
                  </ns5:duration>
                  <ns5:uid>
                    <ns5:text>0</ns5:text>
                  </ns5:uid>
                  <ns2:signalPayload>
                    <ns2:payloadFloat>
                      <ns2:value>2.0</ns2:value>
                    </ns2:payloadFloat>
                  </ns2:signalPayload>
```

```
              </ns2:interval>
            </ns6:intervals>
            <ns2:signalName>SIMPLE</ns2:signalName>
            <ns2:signalType>level</ns2:signalType>
            <ns2:signalID>String</ns2:signalID>
            <ns2:currentValue>
              <ns2:payloadFloat>
                <ns2:value>0.0</ns2:value>
              </ns2:payloadFloat>
            </ns2:currentValue>
          </ns2:eiEventSignal>
          <ns2:eiEventSignal>
            <ns6:intervals>
              <ns2:interval>
                <ns5:duration>
                  <ns5:duration>PT4H</ns5:duration>
                </ns5:duration>
                <ns5:uid>
                  <ns5:text>0</ns5:text>
                </ns5:uid>
                <ns2:signalPayload>
                  <ns2:payloadFloat>
                    <ns2:value>0.75</ns2:value>
                  </ns2:payloadFloat>
                </ns2:signalPayload>
              </ns2:interval>
            </ns6:intervals>
            <ns2:signalName>ELECTRICITY_PRICE</ns2:signalName>
            <ns2:signalType>price</ns2:signalType>
            <ns2:signalID>SIG_02</ns2:signalID>
            <ns7:currencyPerKWh>
              <ns7:itemDescription>currencyPerKWh</ns7:itemDescription>
              <ns7:itemUnits>USD</ns7:itemUnits>
              <ns11:siScaleCode>none</ns11:siScaleCode>
            </ns7:currencyPerKWh>
            <ns2:currentValue>
              <ns2:payloadFloat>
                <ns2:value>0.0</ns2:value>
              </ns2:payloadFloat>
            </ns2:currentValue>
          </ns2:eiEventSignal>
        </ns2:eiEventSignals>
        <ns2:eiTarget>
          <ns2:venID>venID_1234</ns2:venID>
        </ns2:eiTarget>
      </ns2:eiEvent>
      <ns7:oadrResponseRequired>always</ns7:oadrResponseRequired>
    </ns7:oadrEvent>
  </ns7:oadrDistributeEvent>
</ns7:oadrSignedObject>
</ns7:oadrPayload>
```



### 10.2 Capacity Bidding Program

Place Holder

### 10.3 Residential Thermostat Program

Place Holder

### 10.4 Fast DR Dispatch

Place Holder

### 10.5 Electric Vehicle (EV) DR PRogram

Place Holder

### 10.6 Distributed Energy Resources (DER) DR Program

Place Holder