AMI Use Case:

E1 - Real time operations curtails or limits load for economic dispatch (ES&M)

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Document History

Revision History

Revision Number	Revision Date	Revision / Reviewed By	Summary of Changes	Changes marked
(#)	(yymmdd)	(Name)	(Describe change)	(N)
1.0	060206	Prafs Diwate	Initial document	N
1.1	060303	Prafs Diwate	Updated the document according to E1W2 session notes	
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1.3	060501	G. Gilchrist	Clean copy after multiple architectural reviews	
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Approvals

This document requires following approvals.

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Contents

1. Use Case Description

1.1 Use Case Title

Real time operations curtails or limits load for economic dispatch.(ES&M)

1.2 Use Case Summary

Market Operations prepares and submits bids and offers into the market. Bids and offers are evaluated against needs, offsetting bids and offers, and then accepted, matched, or rejected. The evaluated bids will lead to load curtailment when it is economically feasible, the matched bid and offer curtail load, instead of accepting the offers from supply side resources within the ancillary services market.

This use case proposes a computer system known as the Distributed Resources Availability and Control System (DRAACS), which would serve as a clearinghouse for demand response requests submitted to the AMI system. Some of these requests may originate from Market Operations for economic dispatch purposes, and some may originate from the Grid Control Center for reliability purposes. This use case deals specifically with economic dispatch requests.

1.3 Use Case Detailed Narrative

Market Operations performs continuous routines simultaneously to establish and maintain a balance between electric supply and electric demand. These routines include transacting for electric supply in forward markets beyond-day-ahead, day-ahead, hour-ahead, and real-time. The transacting for electric supply involves two elements: market transactions and resource dispatch.

Each market relies on resource data that is updated and provided in advance of the decision making process. The resource data includes load forecast data, supply resource status and availability data. The data is presented for each and every hour for the day(s) in focus. The load forecast data, while complicated to determine, is represented fairly simply. In other words, there is an expected load for each and every hour presented to the day-ahead trader. The supply resource data is more complex. For each and every resource, which includes demand response programs, the marginal or incremental economics are presented. These economics depend upon whether the resource, or unit, is available and/or running. Then market price is layered into the decision-making process. The market price is the price at which electric supply can be bought (the ask) or sold (the bid). The market price can be a simple, single number, or it can be a complex, range of numbers.

This use case limits its universe to the day-ahead through real-time markets. The markets beyond day-ahead does utilize the same data, but as the time until delivery grows from minutes to hours to days, the requirements for the timeliness of updates to the data is significantly reduced. Real-time is a simple reference to the market arena containing the ancillary service products, namely AGC (automatic generation control), spinning reserves, non-spinning reserves and replacement reserves.

The day-ahead market relies on resource data that is updated daily before trading begins. The data is presented in hourly detail. The data is gathered over several hours the day before and updates continue until approximately one-half hour before trading begins. After trading ends, the load and resource data are transferred over to generate schedules for reporting and clearing through the ISO (Independent System Operator).

The hour-head market relies on resource data that is updated throughout the day. The data is also presented in hourly detail. The data gathering continues throughout the day providing periodic reports that are integrated and used by the real-time trader. Generally, the hour-ahead market closes approximately three and a quarter hours before the electricity flows, and schedules are generated and cleared through the ISO.

The real-time markets containing the ancillary services rely on data that is gathered from as short as every 4 seconds to, 5 minutes, 10 minutes, and as long as hourly. The data intervals are, or should be, configurable independently of the gathering rate, or reporting rate, since the two are not strictly correlated. Generally, AGC is presented and gathered every 4 seconds. Spinning and non-spinning reserves are presented in 5 and 10 minute intervals and gathered in a potentially variable range between 5 and 60 minutes. Replacement reserves are generally presented and gathered in hourly intervals.

Market Operations prepares its resource stack by analyzing all resources available and presenting them in order from least cost, cheapest, to high cost, most expensive. Each time information changes (eg market price, resource status, etc.), market operations adjusts the resource stack for the next decision. The energy trader then compares the resource stack to the market price and the load forecast to determine whether the load will be met by market purchases or dispatching resources. If available resources are cheaper than the market, then resources will be dispatched until the load and or the market price are matched.

Demand response programs, load curtailment, may therefore become an option when it is economically feasible to curtail load instead of dispatching a more expensive resource or trading electricity at a higher market price.

Economic Dispatch is this overall process of dispatching required resources, or load curtailment, and trading market electricity such that the total cost of operation is minimized. In relation to the AMI system the resource data for analysis is gathered by SCADA and / or the AMI system.

This use case proposes a computer system known as the Demand Response Availability And Control System. DRAACS provides a tool for Market Operations to manage demand response as another resource for economic dispatch. DRAACS analyzes the response from previous demand response requests and provides energy traders with an estimate of how much load could be reduced through demand response over a selected time period. The energy traders submit their economic dispatch requests to DRAACS, which coordinates them with any other pending requests, including requests from the Grid Control Center for reliability purposes. DRAACS selects a set of customers whose response should satisfy the economic dispatch request. It sends load reduction requests to these customers, who usually have the option to participate or not, depending on their contract. Some customers may have subscribed for load limiting, in which case their AMI meter is permitted to disconnect their service if they do not meet the previously agreed threshold of load reduction.

DRAACS measures the aggregate load reduction and has the possibility to issue additional load reduction requests to selected customers. For this purpose the AMI system shall have multiple curtailment stages that can be activated and deactivated automatically based on curtailment requests from DRAACS.

The Energy Trader receives feedback on the success of the resource dispatch request through two channels:

- The Energy Management System at the Grid Control Center provides DRAACS with aggregate data gathered through the SCADA system in real-time, i.e. at 4 second intervals. DRAACS uses this information immediately to determine whether another curtailment stage will be necessary. When it has attempted all appropriate curtailment stages and has decided that no more demand response is likely, then

DRAACS uses the aggregated SCADA information to supply the Energy Trader with indication of whether the dispatch request was successful. The trader can use this information to make decisions about upcoming market windows.

- DRAACS receives more accurate feedback data from the AMI. This information includes which customers responded and by how much they reduced their load. DRAACS uses this information to improve its estimates for subsequent demand response requests. For most products, DRAACS receives this information the following day. However, for Spinning Reserves and AGC products, the AMI system must provide this more accurate data to DRAACS in real-time, with response times comparable to SCADA. This real-time feedback through AMI is also necessary for supporting the real-time validation required by the ISO.

Curtailment of load for economic dispatch through the AMI system provides the following benefits to the utility:

- By using interval metering, it is possible to more accurately verify actual customer response to specific events and avoid the need for load profiling. This permits the utility to properly report energy usage on the events that are bid into the ISO and avoid both the cost of the uninstructed energy and the cost of uninstructed deviation penalties
- The utility can achieve considerable cost savings by reducing overshooting or undershooting in ISO bidding due to better load forecasting, based on more accurate data from the AMI system

1.4 Business Rules and Assumptions

- The use case applies to customers with a load smaller than 200 kW
- The load curtailment process for this use case can only be applied to customers that have enrolled in a demand-side management program.
- Aggregation of ancillary services bids and offers is out of scope of this use case.
- Load curtailment or limitation for Economic Dispatch is not presently implemented by SCE, so this must be implemented from scratch.
- Customers have electric appliances that can be remotely controlled and shut off. For example, space cooling and/or heating and/or electric water heaters and/or pool pumps.
- This use case is relevant for both accounts under 200kW and accounts over 200kW.
- Real-time feedback on the response from a curtailment/limit request shall for the different market products be acquired from either the SCADA system or by using the AMI system according to the table below

Product	Interval	Gathering Frequency	Real time Feedback
Energy	Hourly	15 minutes	SCADA
Replacement reserves	Hourly	Hourly	SCADA
Non-spinning reserves	30 minutes	Hourly	SCADA
Spinning reserves	10 minutes	15 minutes	AMI system
AGC	4 seconds	4 seconds	AMI system

2. Actors

Describe the primary and secondary actors involved in the use case. This might include all the people (their job), systems, databases, organizations, and devices involved in or affected by the Function (e.g. operators, system administrators, customer, end users, service personnel, executives, meter, real-time database, ISO, power system). Actors listed for this use case should be copied from the global actors list to ensure consistency across all use cases.

Actor Name	Actor Type (person, device, system etc.)	Actor Description
Real Time Traders (RTT)	Person	The Real Time Trader(s) purchases and sells electricity in the hour ahead market. The hour ahead market has no official opening time, but begins trading by approximately 8PM the night before the delivery of energy begins to flow. The hour ahead market closes 3 hours and 15 minutes before the beginning of the flow hour. As an example, for hour ending 1 (midnight to 1AM) the market would close at 8:45PM.
Distributed Resource Availability And Control system (DRAACS)	System	System responsible for maintaining an estimate with a known precision of how much resource is available for dispatch. DRAACS is also responsible for accepting requests for blocks of energy and implementing that request through by issuing load control signals. DRAACS is expected to track the "as implemented" response to load control signals to refine its internal model.
AMI Meter	Device	Advanced electric revenue meter capable of two-way communications with the utility. The meter can receive, record, display and transmit data (e.g. energy data for billing and operations, power quality data, customer data, tariff data, etc.) to and from authorized systems and provides other advanced utility functions.
Resource Stack	System	The stack of resources, generally considered supply resources, listed from cheapest to most expensive allowing the traders to balance supply with forecasted load. In this use case, the amount of demand response available for any given market window is considered a resource in the stack.
Grid Control Center (GCC)	System	The GCC makes requests to DRAACS. The GCC measures the load at the customer site
Energy Trader	Person	The Energy Trader(s) purchases and sells electricity in the day-ahead market and forward. The day-ahead market typically closes sufficiently before the scheduling deadline, allowing the ISO the time to review matched schedules (trades between market participants).

Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
Automatic Generation Control (AGC)	System	AGC is the instantaneous regulation of electricity. AGC is used to maintain frequency on the system within time and frequency parameters. AGC is monitored every 4 seconds, and the frequency is limited to +- 0.08 hertz of 60 hertz.
Energy Management System (EMS)	System	System used by operators of electric utility grids to monitor, control, and optimize the performance of the generation and/or transmission system.

3. Step by Step analysis of each Scenario

Describe steps that implement the scenario. The first scenario should be classified as either a "Primary" Scenario or an "Alternate" Scenario by starting the title of the scenario with either the work "Primary" or "Alternate". A scenario that successfully completes without exception or relying heavily on steps from another scenario should be classified as Primary; all other scenarios should be classified as "Alternate". If there is more than one scenario (set of steps) that is relevant, make a copy of the following section (all of 3.1, including 3.1.1 and tables) and fill out the additional scenarios.

3.1 Primary Scenario: Achieve least cost dispatch

Market Operations prepares its resource stack by analyzing all resources available and presenting them in order from least cost, cheapest, to high cost, most expensive. As information changes (eg market price, resource status, etc.), market operations adjusts the resource stack. The energy trader compares the resource stack to the market price and the load forecast to determine the how load will be met. If available resources are cheaper than the market, then resources will be dispatched until the load and or the market price are matched. Economic Dispatch is this overall process of dispatching required resources, or load curtailment, and trading market electricity such that the total cost of operation is minimized.

This scenario describes the most common sequence to achieve this economic dispatch. The scenario addresses the five products (Energy, Replacement reserves, Non-spinning reserves, Spinning reserves and AGC) as listed above.

The steps to achieve a least cost dispatch in some case occur in parallel. Due to the tabular listing it is not possible to show this accurately. For details please refer to the sequence diagrams for this Use Case.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
A market window is approaching and the utility has the option of either buying more energy at significant cost or reducing demand to avoid the buy.	*Energy Trader*	*A significant number of customers have subscribed to a demand response program and are recorded in DRAACS's database.*	*The Energy Trader's request has caused a reduction in demand sufficient to avoid buying energy.*

3.1.1 Scenario for AGC and Spinning Reserve

Step #	Actor	Description of the Step	Additional Notes
#	What actor, either primary or secondary is responsible for the activity in this step?	Describe the actions that take place in this step. The step should be described in active, present tense.	Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column..
1	DRAACS	DRAACS presents to the Energy Trader the available curtailment and/or distributed generation resources.	
2	Energy Trader	Energy Trader determines if it is feasible to decrease load to achieve least cost dispatch in real time	
3	Energy Trader	Energy Trader submits dispatch request to DRAACS	
4	DRAACS	DRAACS issues individual requests to AMI meters to change the recording interval	
5	AMI Meter	AMI Meter changes the recording interval and confirms the request	The AMI meter shall record the usage data rapidly until a request to resume the normal recording interval is received
6	DRAACS	DRAACS issues individual requests to AMI meters to change the reporting interval	
7	AMI Meter	AMI Meter changes the reporting interval and confirms the request	The AMI meter shall report the usage data rapidly until a request to resume the normal reporting interval is received
8	DRAACS	DRAACS issues individual requests to AMI meters to curtail	
9	AMI Meter	AMI Meter receives signal.	
10	Customer	Customer gets notification of the curtailment signal.	
11	Meter	Meter informs customer whether the load is already sufficiently reduced to meet program requirements.	

Step #	Actor	Description of the Step	Additional Notes
12	Customer	Customer reduces demand through load reduction and/or through on-site generation within the grace period.	
13	AMI Meter	After the grace period, the AMI meter checks the load at the customer site against the curtailment threshold as per the subscription.	
14		Curtailment period ends	
15	Customer	Customer restores load with minimal impact to the network	The phrase “minimal impact to the network” refers to the requirement for a way to avoid a large inrush of load after a curtailment period ends.
16	Customer system / AMI meter	Customer system / AMI meter returns information related to response of individual components to DRAACS (to support DRAACS)	The meter shall return the information in a manner similar as defined in Use Case C1
17	DRAACS	DRAACS provides aggregate load information that allows the Energy Trader to determine whether the load curtailment is/will be achieved	
18	AMI Meter	AMI Meter returns consumption information to billing system	
19	AMI Meter	AMI Meter returns consumption information to DRAACS	
20	DRAACS	DRAACS returns response information to CCC and Billing	
21	Energy Trader	Energy Trader determines if load control is achieved. If not go to step 1 using a different set of customers. If yes END	

3.1.2 Scenario for Energy, Replacement reserves and Non-spinning reserves

Step #	Actor	Description of the Step	Additional Notes
#	What actor, either primary or secondary is responsible for the activity in this step?	Describe the actions that take place in this step. The step should be described in active, present tense.	Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column..
1	DRAACS	DRAACS presents to the Energy Trader the available curtailment and/or distributed generation resources.	
2	Energy Trader	Energy Trader determines if it is feasible to decrease load to achieve least cost dispatch in real time	
3	Energy Trader	Energy Trader submits dispatch request to DRAACS	
4	DRAACS	DRAACS issues individual requests to AMI meters to change the recording interval	
5	AMI Meter	AMI Meter changes the recording interval and confirms the request	The AMI meter shall report the usage data rapidly until a request to resume the normal recording interval is received
6	DRAACS	DRAACS issues individual requests to AMI meters to curtail	
7	AMI Meter	AMI Meter receives signal.	
8	Customer	Customer gets notification of the curtailment signal.	
9	AMI Meter	AMI Meter informs customer whether the load is already sufficiently reduced to meet program requirements.	
10	Customer	Customer reduces demand through load reduction and/or through on-site generation within the grace period.	

Step #	Actor	Description of the Step	Additional Notes
11	AMI Meter	After the grace period, the AMI meter checks the load at the customer site against the curtailment threshold as per the subscription.	
12		Curtailment period ends	
13	Customer	Customer restores load with minimal impact to the network	The phrase “minimal impact to the network” refers to the requirement for a way to avoid a large inrush of load after a curtailment period ends.
14	Customer system / AMI meter	Customer system / AMI meter returns information related to response of individual components to DRAACS (to support DRAACS)	The meter shall return the information in a manner similar as defined in Use Case C1
15	Energy Management System	Energy Management system provides aggregate load information that allows the Energy Trader to determine whether the load curtailment is/will be achieved	
16	AMI Meter	AMI Meter returns consumption information to billing system	
17	AMI Meter	AMI Meter returns consumption information to DRAACS	
18	Energy Management System	Energy Management System returns response information to CCC and Billing	
19	Energy Trader	Energy Trader determines if load control is achieved. If not go to step 1 using a different set of customers. If yes END	

3.1.3 Alternate scenario for opting out of a curtail request

Opting out is NOT possible for AGC and Spinning Reserve scenarios because of the real time nature of these scenarios

Step #	Actor	Description of the Step	Additional Notes
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column..*
1	DRAACS	DRAACS presents to the Energy Trader the available curtailment and/or distributed generation resources.	
2	Energy Trader	Energy Trader determines if it is feasible to decrease load to achieve least cost dispatch in real time	
3	Energy Trader	Energy Trader submits dispatch request to DRAACS	
4	DRAACS	DRAACS issues individual requests to AMI meters to change the recording interval	
5	AMI Meter	AMI Meter changes the recording interval and confirms the request	The AMI meter shall report the usage data rapidly until a request to resume the normal recording interval is received
6	DRAACS	DRAACS issues individual requests to AMI meters to curtail	
7	AMI Meter	AMI Meter receives signal.	
8	Customer	Customer gets notification of the curtailment signal.	
9	Customer	Customer opts out of curtailment.	
10		No curtailment takes place at customer site.	
11	AMI Meter	AMI Meter notifies DRAACS of the opting out	
12	AMI Meter	AMI Meter goes back to normal recording interval	
13		Curtailment period ends	

Step #	Actor	Description of the Step	Additional Notes
14	AMI Meter	AMI Meter returns consumption information to billing system	
15	AMI Meter	AMI Meter returns consumption information to DRAACS	
16	DRAACS	DRAACS returns response information to CCC and Billing	

3.1.4 Scenario for when Energy Trader decides the curtailment is no longer necessary

This scenario is written assuming theEnergy Trader is bidding either AGC or Spinning Reserve products.

Step #	Actor	Description of the Step	Additional Notes
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column..*
1	DRAACS	DRAACS presents to the Energy Trader the available curtailment and/or distributed generation resources.	
2	Energy Trader	Energy Trader determines if it is feasible to decrease load to achieve least cost dispatch in real time	
3	Energy Trader	Energy Trader submits dispatch request to DRAACS	
4	DRAACS	DRAACS issues individual requests to AMI meters to change the recording interval	
5	AMI Meter	AMI Meter changes the recording interval and confirms the request	The AMI meter shall record the usage data rapidly until a request to resume the normal recording interval is received
6	DRAACS	DRAACS issues individual requests to AMI meters to change the reporting interval	This step only takes place for AGC and Spinning Reserve products.

Step #	Actor	Description of the Step	Additional Notes
7	AMI Meter	AMI Meter changes the reporting interval and confirms the request	This step only takes place for AGC and Spinning Reserve products. The AMI meter shall report the usage data rapidly until a request to resume the normal reporting interval is received
8	DRAACS	DRAACS issues individual requests to AMI meters to curtail	
9	AMI Meter	AMI Meter receives signal.	
10	Customer	Customer gets notification of the curtailment signal.	
11	Energy Trader	Energy Trader determines the curtailment is no longer necessary and issues a curtailment end request	May occur at any time during the curtailment period.
12	DRAACS	DRAACS issues a “curtailment end” signal	
13	AMI Meter	AMI Meter receives curtailment end signal.	
14	Customer	Customer gets notification of the curtailment end signal.	
15	AMI Meter	If meter has disconnected, meter reconnects	
16	AMI Meter	AMI Meter removes threshold and notifies customer	
17	AMI Meter	AMI Meter goes back to normal recording interval	
18	AMI Meter	AMI Meter goes back to normal reporting interval	This step only takes place for AGC and Spinning Reserve markets.
19	AMI Meter	AMI Meter returns consumption information to billing system	
21	AMI Meter	AMI Meter returns consumption information to DRAACS	
22	DRAACS	DRAACS returns response information to CCC and Billing	

3.1.5 Scenario for when the load at the customer site is already below threshold

Step #	Actor	Description of the Step	Additional Notes
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column..*
1	DRAACS	DRAACS presents to the Energy Trader the available curtailment and/or distributed generation resources.	
2	Energy Trader	Energy Trader determines if it is feasible to decrease load to achieve least cost dispatch in real time	
3	Energy Trader	Energy Trader submits dispatch request to DRAACS	
4	DRAACS	DRAACS issues individual requests to AMI meters to change the recording interval	
5	AMI Meter	AMI Meter changes the recording interval and confirms the request	The AMI meter shall record the usage data rapidly until a request to resume the normal recording interval is received
6	DRAACS	DRAACS issues individual requests to AMI meters to change the reporting interval	This step only takes place for AGC and Spinning Reserve products.
7	AMI Meter	AMI Meter changes the reporting interval and confirms the request	The AMI meter shall report the usage data rapidly until a request to resume the normal reporting interval is received
8	DRAACS	DRAACS issues individual requests to AMI meters to curtail	
9	AMI Meter	AMI Meter receives signal.	
10	Customer	Customer gets notification of the curtailment signal.	

Step #	Actor	Description of the Step	Additional Notes
11	AMI Meter	AMI Meter informs customer whether the load is already sufficiently reduced to meet program requirements.	
12		Load at the customer site is already below threshold.	
13		No curtailment at customer site.	
14	AMI Meter	After the grace period, the AMI meter checks the load at the customer site against the curtailment threshold as per the subscription.	
15		Curtailment period ends	
16	Customer	Customer restores load with minimal impact to the network	The phrase “minimal impact to the network” refers to the requirement for a way to avoid a large inrush of load after a curtailment period ends.
17	Customer system / AMI meter	Customer system / AMI meter returns information related to response of individual components to DRAACS (to support DRAACS)	The meter shall return the information in a manner similar as defined in Use Case C1
18	DRAACS	DRAACS provides aggregate load information that allows the Energy Trader to determine whether the load curtailment is/will be achieved	
19	AMI Meter	AMI Meter returns consumption information to billing system	
20	AMI Meter	AMI Meter returns consumption information to DRAACS	
21	DRAACS	DRAACS returns response information to CCC and Billing	
22	Energy Trader	Energy Trader determines if load control is achieved. If not go to step 1 using a different set of customers. If yes END	

3.1.6 Scenario for when the actual load remains > subscribed threshold

This scenario is written assuming theEnergy Trader is bidding either AGC or Spinning Reserve products.

Step #	Actor	Description of the Step	Additional Notes
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column..*
1	DRAACS	DRAACS presents to the Energy Trader the available curtailment and/or distributed generation resources.	
2	Energy Trader	Energy Trader determines if it is feasible to decrease load to achieve least cost dispatch in real time	
3	Energy Trader	Energy Trader submits dispatch request to DRAACS	
4	DRAACS	DRAACS issues individual requests to AMI meters to change the recording interval	
5	AMI Meter	AMI Meter changes the recording interval and confirms the request	The AMI meter shall record the usage data rapidly until a request to resume the normal recording interval is received
6	DRAACS	DRAACS issues individual requests to AMI meters to change the reporting interval	This step only takes place for AGC and Spinning Reserve markets.
7	AMI Meter	AMI Meter changes the reporting interval and confirms the request	This step only takes place for AGC and Spinning Reserve markets.The AMI meter shall report the usage data rapidly until a request to resume the normal reporting interval is received

Step #	Actor	Description of the Step	Additional Notes
8	DRAACS	DRAACS issues individual requests to AMI meters to curtail	
9	AMI Meter	AMI Meter receives signal.	
10	Customer	Customer gets notification of the curtailment signal.	
11	AMI Meter	Meter informs customer whether the load is already sufficiently reduced to meet program requirements.	
12	Customer	Customer reduces demand through load reduction and/or through on-site generation within the grace period.	
13	AMI Meter	After the grace period, the AMI meter checks the load at the customer site against the curtailment threshold as per the subscription.	
14	AMI Meter	If actual load > subscribed threshold, load curtailment takes place via the AMI meter disconnect.	
15	Customer	Customer reduces potential load	
16	Customer	Customer requests power back.	
17	AMI Meter	Disconnect closes	
18		Go to step # 11	
19		Curtailment period ends	
20	Customer	Customer restores load with minimal impact to the network	The phrase “minimal impact to the network” refers to the requirement for a way to avoid a large inrush of load after a curtailment period ends.
21	Customer system / AMI meter	Customer system / AMI meter returns information related to response of individual components to DRAACS (to support DRAACS)	The meter shall return the information in a manner similar as defined in Use Case C1
22	DRAACS	DRAACS provides aggregate load information that allows the Energy Trader to determine whether the load curtailment is/will be achieved	

Step #	Actor	Description of the Step	Additional Notes
23	AMI Meter	AMI Meter returns consumption information to billing system	
24	AMI Meter	AMI Meter returns consumption information to DRAACS	
25	DRAACS	DRAACS returns response information to CCC and Billing	
26	Energy Trader	Energy Trader determines if load control is achieved. If not go to step 1 using a different set of customers. If yes END	

3.2 Primary Scenario: Dispatch requirements are not met

This scenario describes what happens if scenario 1 repeats several times but DRAACS is unable to provide sufficient demand response to meet the utility's needs.

Triggering Event	Primary Actor	Pre-Condition	Post-Condition
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
Dispatch requirements are not met	Energy Trader	Scenario 1 has not met its goals	Utility has enough energy supply available to meet its needs.

3.2.1 Scenario 3.2.1: There is no emergency. DRAACS has tried multiple options to achieve the reduction and was unable to do so

Step #	Actor	Description of the Step	Additional Notes
#	What actor, either primary or secondary is responsible for the activity in this step?	Describe the actions that take place in this step. The step should be described in active, present tense.	Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column..
2.1.2	Energy Trader	Energy Trader buys generation instead of using curtailment	

3.2.2 Scenario 3.2.2: A Stage 2 or 3 Emergency is underway – see use case D1

The scenario's and requirements associated with this particular scenario are described in Use Case D1

3.3 Primary Scenario: Day ahead scenario

This scenario is essentially the same as the "hour ahead" scenario

3.4 Primary Scenario: Third party scenario – Aggregator uses AMI data for economic dispatch

This scenario is the same as the first scenario except for the requirement that requests to DRAACS be able to specify that the load reduction comes from a particular subset of AMI meters.

4. Requirements

Detail the Functional, Non-functional and Business Requirements generated from the workshop in the tables below. If applicable list the associated use case scenario and step.

4.1 Functional Requirements

Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
The Energy Supply and Management system creating the resource stack shall need the following resource information from the AMI system: ○ Volume (MW) ○ Duration of availability of resource (hrs/min) ○ Price ($) ○ Response time from when needed to when available. (hrs/min) ○ Location of available load.	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	1 1 1 1 1 1
The data used to update the resource stack shall be gathered in accordance with FERC standards of conduct	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	1 1 1 1 1 1
Once the Energy Trader has dispatched a request, feedback is necessary within certain period of time to confirm that resource has responded.	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	3 3 3 3 3 3
The difference between required and obtained dispatch shall be calculated to determine which resources are in over/under performance.	3.1.1 3.1.2 3.1.5 3.1.6	17 15 18 22

Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
In accordance with FERC rules the Energy Trader shall need direct access to dispatch instead of going through GCC.	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	3 3 3 3 3 3
GCC actions shall not be visible to the Energy Trader in a manner consistent with FERC regulations.	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	3 3 3 3 3 3
A curtailment event message initiated by GCC shall be a higher priority than the curtailment message initiated by the Energy Trader	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	3 3 3 3 3 3
Individual addressing of resources at the customer shall be possible to allow for customer specific programs.	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	8 6 6 8 8 8
AMI System shall allow the customers to opt out of voluntary economic curtailments.	3.1.3	9
AMI System shall be flexible to support different rate structures.	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	4 4 4 4 4 4

Functional Requirements	*Associated Scenario #* *(if applicable)*	*Associated Step #* *(if applicable)*
DRAACS shall provide information about the time the load control event (voluntary economic curtailment) was called, event identification, duration of the event, customer identification.	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	8 6 6 8 8 8
MDMS shall provide the time stamped status of AMI meter activities.	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	5, 7, 16, 18, 19 5, 7, 14, 16, 17 5, 14, 15 5, 7, 17, 18 5, 7, 19, 20 5, 7, 21, 23
AMI System shall provide means to differentiate between equipment failure and customer non-response to event call classified by each controllable device.	3.1.6	14
Some of the load control programs may require recording of individual status of controllable loads.	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	-
Load control system shall have a default set of instructions to respond.	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	-
AMI meter shall be programmable to meet various tariff programs.	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	-

Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
AMI meter shall provide the amount of load and response time to DRAACS.	3.1.1 3.1.2 3.1.5 3.1.6	17 15 18 22
The AMI meter shall log all curtailment requests and "opt out" choices and return the log to the AMI system at the next read	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	3 3 3, 11 3 3 3
The DRAACS or Energy Management System shall provide to Billing sufficient information to credit customers for successfully participating in a curtailment. (Details of "sufficient" to be filled in by the B and C use case teams)	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	20 18 16 19 21 25
The DRAACS shall schedule curtailment requests to avoid repeated requests to the same customers, unless exceptions are made for a particular program	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	4 4 4 4 4 4
The AMI meter shall disconnect a customer if the customer has not opted out of a curtailment and has not reduced load below the specified threshold	3.1.6	14
DRAACS shall react to curtailment "opt out" signals from customers by selecting the next available block of customers for curtailment. This would increase the likelihood of a curtailment being successful. The business case for this requirement needs to be examined	3.1.3	3
The DRAACS and AMI meter shall permit customers to "opt out" of curtailment requests	3.1.3	3

Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
The curtailment request from the DRAACS to the AMI meter shall contain the following information: - Load threshold - Grace period - Time of day the message is being sent - Start time of the event - Length of event - Type of event (e.g. in an emergency event, the AMI meter may not permit "opt out")	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	8 6 6 8 8 8
DRAACS shall determine the type and set of customers necessary to curtail based on the type of request and source of request (e.g. GCC, Real-time Trader, or Day-Ahead Energy Trader)	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	4 4 4 4 4 4
DRAACS shall be able to send "end curtailment" signals to AMI meter based on instructions from Energy Traders	3.1.4	11
The AMI meter shall reconnect disconnected customers and remove thresholds if it receives an "end curtailment" signal during a curtailment event	3.1.4	13
DRAACS shall make curtailment response information for individual consumers available to the customer service center representatives to resolve questions from customers regarding events	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	20 18 16 19 21 25
DRAACS shall permit load reduction requests specifying that the load reduction come from a specific subset of AMI meters. This requirement permits aggregators to reduce load from their clients	3.4	-

Non-functional Requirements

Non-Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
The resource response time shall be 4 seconds for an AGC or spinning reservecase.	3.1.1	1
The resource response time shall range from 5 – 60 min (5, 10, 30, 60) for a non AGC case. 90% shall be within 5 min and remainder shall be within an hour.	3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	1 1 1 1 1
Tariff programs shall be programmable down to 5 min intervals.	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	1 1 1 1 1 1
If the bid is for the ancillary service market, the load curtailment shall take place within 10 minutes from the notification from the ISO that reduction is necessary	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	1 1 1 1 1 1
For bids into the hour-ahead market, the load curtailment shall take place within 3 hours from the notification from the ISO that reduction is necessary	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	1 1 1 1 1 1
For bids into the day-ahead market, the load curtailment shall take place within 24 hours from the notification from the ISO that reduction is necessary	3.3	-

Non-Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
DRAACS shall make curtailment response information available to customer service representatives by the next AMI meter reading cycle (not billing cycle)	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	20 18 16 19 21 25
DRAACS shall notify customer service representatives of the issuing of a curtailment event within one minute of the issuing of the event	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	8 6 6 8 8 8
The resource stack shall be updated within at least one day and preferably within 1.5 hours of a change to permit Energy Traders to make decisions regarding market and load. The shorter the interval, the better. This functionality is most important during summer peak. Further estimates on cost are needed	3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	-

4.2 Business Requirements

Business Requirement	Associated Scenario # (if applicable)	Associated Step # (if applicable)
Evaluation of program success can be done through measurement and reporting of individual controllable loads.		
AGC (responsive) – If model used then it should be accurate enough to fulfill ISO requirements.		
All curtailment requests for dispatch purposes shall come through the Scheduling Coordinator. **Value: This permits a top-down, unified approach to dealing with the meters for purposes of load reduction and simplifies security issues**		

5. Use Case Models (optional)

This section is used by the architecture team to detail information exchange, actor interactions and sequence diagrams

5.1 Information Exchange

For each scenario detail the information exchanged in each step

Scenario #	Step #, Step Name	Information Producer	Information Receiver	Name of information exchanged
#	Name of the step for this scenario.	What actors are primarily responsible for Producing the information?	What actors are primarily responsible for Receiving the information?	Describe the information being exchanged
3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	1 1 1 1 1 1	DRAACS	Energy Trader	List of available distributed resources • How much is available • Probability of success • Possible time frame
3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	3 3 3 3 3 3	Energy Trader	DRAACS	Dispatch request • Name of requestor • Amount of request • Time frame required • Subset of meters from which the response can be gathered (e.g. a third-party request)
3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	4 4 4 4 4 4	DRAACS	AMI Meter	Change recording interval request

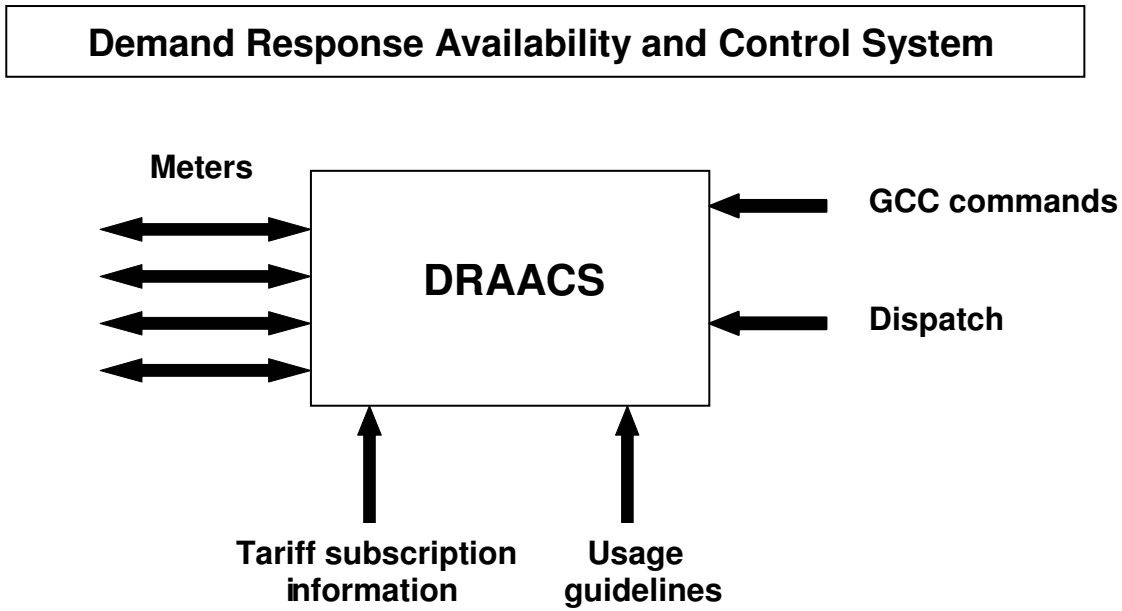
Scenario #	Step #, Step Name	Information Producer	Information Receiver	Name of information exchanged
3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	5 5 5 5 5 5	AMI Meter	DRAACS	Confirm recording interval change
3.1.1 3.1.4 3.1.5 3.1.6	6 6 6 6	DRAACS	AMI Meter	Change reporting interval request
3.1.1 3.1.4 3.1.5 3.1.6	7 7 7 7	AMI Meter	DRAACS	Confirm reporting interval change
3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	8 6 6 8 8 8	DRAACS	AMI Meter(s)	Curtailment request message • Type of event = economic curtailment • Meter/Customer ID • Geographical or logical subset identifier • Event ID • Start time • End time • Requested load level
3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6	10 8 8 10 10 10	AMI Meter	Customer	Notification of curtailment event
3.1.3	9	Customer	AMI Meter	Choice to opt out of curtailment event
3.1.3	11	AMI Meter	DRAACS	Choice to opt out of curtailment event • Event ID
4.1.4	11	Energy Trader	DRAACS	Cancellation of economic curtailment event
4.1.4	12	DRAACS	AMI Meter(s)	Cancellation of economic curtailment event
4.1.4	14	AMI Meter	Customer	Notification of curtailment event cancellation

Scenario #	*Step #, Step Name*	*Information Producer*	*Information Receiver*	*Name of information exchanged*
3.1.1 3.1.2 3.1.3 3.1.5 3.1.6	11 9 11 11 11	AMI Meter	Customer	Compliance status
4.1.6	14	AMI Meter	Disconnect Switch	Request to disconnect service
4.1.6	16	Customer	Customer Service Representative	Request to reconnect service • Reason = load has been reduced per contract
4.1.6	16	Customer Service Representative	Customer Service System	Request to reconnect service
4.1.6	16	Customer Service System	System Console	Request to reconnect service
4.1.6	16	System Console	AMI Meter	Request to reconnect service
4.1.6	16	AMI Meter	Disconnect Switch	Command to reconnect service
		DRAACS	AMI Meters	End of economic curtailment event
		AMI Meter	DRAACS	Confirmation of individual customer participation in economic curtailment event
3.1.1 3.1.5 3.1.6		DRAACS	Energy Trader	Aggregate load information that allows the Energy Trader to determine whether the load curtailment is/will be achieved
3.1.2		EMS/SCADA	Energy Trader	Aggregate load information that allows the Energy Trader to determine whether the load curtailment is/will be achieved
3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6		AMI Meter	Billing System	Energy usage during economic curtailment event

Scenario #	*Step #, Step Name*	*Information Producer*	*Information Receiver*	*Name of information exchanged*
3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6		AMI Meter	DRAACS	Energy usage during economic curtailment event
3.1.1 3.1.2 3.1.3 3.1.4 3.1.5 3.1.6		DRAACS	Customer Service Billing System	Confirmation of individual customer participation in economic curtailment event

5.2 Diagrams

The architecture team shall use this section to develop an interaction diagram that graphically describes the step-by-step actor-system interactions for all scenarios. The diagrams shall use standard UML notation. Additionally, sequence diagrams may be developed to help describe complex event flows.



6. Use Case Issues

Capture any issues with the use case. Specifically, these are issues that are not resolved and help the use case reader understand the constraints or unresolved factors that have an impact of the use case scenarios and their realization.

Issue
Describe the issue as well as any potential impacts to the use case.
• Will the feedback of customer response through the AMI system ever be fast enough for Energy Traders to use that feedback, rather than the SCADA feedback, to make trading decisions? If so, would the additional detail be useful or not? • The algorithms and decision-making process of DRAACS are crucial to the success of this use case and need to be developed.

7. Glossary

Insert the terms and definitions relevant to this use case. Please ensure that any glossary item added to this list should be included in the global glossary to ensure consistency between use cases.

Glossary	
Term	**Definition**

References

Reference any prior work (intellectual property of companies or individuals) used in the preparation of this use case.

8. Bibliography (optional)

Provide a list of related reading, standards, etc. that the use case reader may find helpful.