AMI Use Case:

E2 - Utility procures energy and settles wholesale transactions using data from AMI system

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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	060310	Prafs Diwate	Updated the document according to E2W2 session notes	
1.2	060320	Prafs Diwate	Updated the document according to E2W2 AT approved session notes	
1.3	060411	G. Gilchrist	Architectural review	
1.4	060425	G. Gilchrist	Further edits based on discussion with Kevin Wood 060421	
1.5	060425	G. Gilchrist	Removed many of the comments	
1.6	060426	M Davis	Accepted changes and modified hyper by allowing for 2 minute data and removed super hyper data term and requirement.	
1.7	060502	M.C. Janssen	Removed comments and accepted tracked changes. Integrated all comments received during personal discussion with Muir Davis on April 27 and 28	
1.8	060505	G. Gilchrist	Minor touch-ups of text	

Approvals

This document requires following approvals.

Name	Title
Muir Davis	*Mega-Team Lead*
Muir Davis	*Use Case Team Lead*
Kevin Wood	*System Architecture Team Chair*

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1. Use Case Description

1.1 Use Case Title

Utility procures energy and settles wholesale transactions using data from AMI system

1.2 Use Case Summary

Market Operations receives and prepares bids and offers into the wholesale energy market and evaluates the incoming bids from the wholesale market against the needs and the cost of operation. To facilitate this process, Market Operations needs to know what resources, such as distributed generation or demand response, are available and for how long.

In a system without AMI, resource information must be estimated from the historical load profiles averaged from a small set of selected meters. The meters used to build the load profiles may or may not be the same meters involved in the wholesale market transaction.

Using AMI, Market Operations acquires from the AMI system the *actual* aggregate load measured by a particular subset of the utility's meters that are of interest to Market Operations. This subset of meters may, for instance, represent a single customer offering to supply distributed generation over a particular time period for a contracted price; or it may represent a number of customers who are offering through a third-party aggregator to reduce their load.

Using the AMI System, Market Operations can make better decisions about which wholesale transactions to make because:

- The AMI measurements are made from a sample better resembling the portion of the load that is the subject of the wholesale transaction, and,
- The AMI measurements are taken very close in time to when the transaction will take place,

Some time after a wholesale transaction has been completed, Market Operations settles the transaction using actual usage data gathered by the AMI system during the period specified in the transaction. Data from the AMI System is used to prepare bills and invoices to multiple parties involved in the transaction based on existing contracts and tariffs.

1.3 Use Case Detailed Narrative

This use case may apply to a variety of different energy markets, including the ancillary services market, the hour-ahead market, and day-ahead market. The ancillary services market provides offers for energy supplies that can be used in a utility's economic dispatch scheme, which is discussed in use case E1. The ancillary services market is considered the most challenging market but this use case can also apply to the hour-ahead and day-ahead energy markets.

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· Utility procures energy and settles wholesale transactions using data from AMI system

This use case discusses three scenarios: One to describe the events around the time Market Operations evaluates the bids and completes a transaction, and two others describing how AMI data is used to settle transactions either five days (T+5) or up to 45 days (T+45) after the transactions period.

A specialized computer system known as the Distributed Resources Availability And Control System (DRAACS) serves as the interface between Market Operations and the AMI System. The Load Forecasting group within Market Operations uses DRAACS to request that certain sets of meters record usage data at a higher rate than normal. Load Forecasting uses this specially sampled data to drive forecasting models and pricing curves, which it will use to evaluate incoming bids from the wholesale market.

DRAACS responds to the requests from Load Forecasting by remotely re-programming individual meters to record at higher "special" rates. Approximately 1% of the utility's meters are polled at intervals smaller than one hour, in order to generate predictive load profiles based on common customer characteristics such as geography or climate. This "special rate" data is retrieved in time to be used in market forecasts for the next day.

In addition to generating these general next-day profiles, Load Forecasting also uses as input AMI data gathered from the same day the wholesale transaction is to be completed. Load Forecasting asks DRAACS to sample this data at "hyper" intervals as small as every four seconds, from a much smaller subset of meters. DRAACS returns the aggregated load information within a few minutes. The Energy Trader, who is a member of Market Operations, uses forecasts generated from both the "hyper" and "special" samples to evaluate bids in "real-time" and complete transactions.

Some time after the wholesale transaction is complete, information gathered from the AMI system and elsewhere will be used in the settlement process to prepare bills and invoices to multiple parties based on contracts and tariffs. The data used for this settlement process is the actual data from the subset of meters specified in the transaction.

The value of using AMI data, sampled at a higher than normal rate, to perform real-time load forecasting for the purposes of procuring energy and settling wholesale transactions is:

1. It produces higher accuracy for forecasts which reduces the risk and associated cost of forecasting error. The cost of forecast errors is presently unknown. Presently this cost is part of the overall cost of service and passed along to customers.

2. If the real time position at the time of the transaction can be known more accurately then there is the potential that the amount of energy sold into the ex-post market unknowingly can be reduced such that millions in potential annual savings may be achieved.

3. There are marketability issues associated with load forecasting error and the ex-post market. These ex-post market issues expose the utility to liquidity risks. There is cost risks associated with buying / selling into the real-time market because price is unknown and it is a small market. Due to the volume of energy transacted in the ex-post market, the purchase or sale is more costly than the hour-ahead or day-ahead market where there is more control over what is being bought / sold.

Capturing high-rate interval data will significantly increase the quality of the meter data reported to the ISO today and will provide a more accurate estimate of the actual cost of the energy. Today, misreporting occurs due to the inaccuracy of the load profiles. The economic impact to the utility customers could be positive or negative.

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In addition, it may be possible to reduce the labour costs associated with reporting this type of data.

1.4 Business Rules and Assumptions

- The use case applies to customers with a load smaller than 200 kW
- Aggregation of ancillary services bids and offers is out of scope of this use case.

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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
Market Operations	Organization	This is a generic term for those actors within the normal process flow of data within ES&M. The actors include the load forecast group, the planning group, the day-ahead traders, the schedulers, and real time operations.
Aggregation System / Usage Measurement Aggregation (UMA)	System	The system that aggregates usage data from a subset of customers whose energy has been "bundled" together as part of a bid into a wholesale energy market. May be considered part of the Meter Data Management System (MDMS) in some utilities.
Distributed Resources Availability And Control System (DRAACS)	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 handling the details of implementing that request through the issuance of load control signals. DRAACS is expected to track the "as implemented" response to load control signals to refine its internal model.
Load Forecasting	Organization	Portion of the Market Operations organization responsible for predicting what the load will be in a given market window.
Energy Trader	Person	Member of the Market Operations organization. TheEnergy Trader purchases and sells electricity in the hour ahead market. The hour ahead market has no official open, 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.
VEE System	System	Portion of the MDMS that normally does Validation, Estimation and Editing of data.

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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: Energy Trader procures energy from wholesale market based on information from the AMI system.

This scenario describes how the Real-Time Trader uses customer usage data from the AMI system to determine whether to purchase or sell energy. A day or more prior to the wholesale transaction, Load forecasting asks DRAACS to begin sampling data from large profile groups of customers at a special sub-hourly rate. DRAACS sends commands to the appropriate meters to begin sampling at the special rate and the AMI Meters begin sending usage data to DRAACS at the special rate. DRAACS provides load estimates to Load Forecasting based on the special rate data and historical patterns.

In addition Load forecasting asks DRAACS to begin sampling data from a particular subset of customers at a (hyper) rate sufficient to perform real-time load forecasting. DRAACS sends commands to the appropriate meters to begin sampling at the hyper rate. AMI Meters begin sending KW, KWH, KVAR, KVARH data to DRAACS at the hyper rate.

This process are the pre-conditions for this scenario.

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	*Energy Trader*	*AMI System has been gathering usage data at normal recording intervals (e.g. hourly data)*	*The RTT has made a decision to buy or sell energy.*

3.1.1 Steps for this scenario

Describe the normal sequence of events that is required to complete the scenario.

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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 provides load estimates to Load Forecasting based on the hyper rate data and historical patterns.	
2	Load Forecasting	Forecast is provided by forecasting group to day ahead and real time traders. (RTT)	
3	Energy Traders	Energy Trader measures forecast against available resources and market prices.	
4	Energy Traders	Energy Trader determines appropriate procurement activity.	
5	Energy Traders	Energy is purchased / sold.	

3.2 Primary Scenario: Power Procurement Finance settles wholesale invoices - T+5 (Payment acceleration)

This scenario describes how AMI data is used to make it possible to invoice wholesale energy transactions within five days of the completion of the transaction.

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)*
Wholesale transaction completes	*Finance?* *Aggregation System?*	*Scenario 1 was completed with the required subset of meters still gathering data at the necessary rate.*	*Invoice is issued to the participant in the wholesale transaction within five days.*

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3.2.1 Steps for this scenario

Describe the normal sequence of events that is required to complete the scenario.

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	MDMS	MDMS gathers meter data (KWH + ID) from individual meters.	
2a	MDMS	MDMS provides the gathered data to an Aggregation System prior to T+4.	Some data may be missing due to network or equipment problems
2b	MDMS	MDMS provides information on the missing reads (rate group, voltage level) prior to T+4.	
3	Procurement Data Estimator and Aggregator	Aggregation System aggregates and estimates the supplied meter data across all the customers specified in the wholesale transaction, over the time interval of the transaction.	
4	Procurement Data Estimator and Aggregator	Aggregation System submits aggregated data and wholesale transaction information to Power Procurement Finance for generating invoices to the ISO and Third Parties.	
5	Power Procurement Finance	Generates invoices	

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3.3 Primary Scenario: Power Procurement Finance settles wholesale invoices – T+45 (Revenue quality meter data)

This scenario describes how AMI data is used to make it possible to invoice wholesale energy transactions as part of the normal billing cycle within forty-five days of the completion of the transaction.

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)*
Wholesale transaction completes	*Finance?* *Aggregation System?*	*Scenario 1 was completed with the required subset of meters still gathering data at the necessary rate.*	*Invoice is issued to the participant in the wholesale transaction within five days.*

3.3.1 Steps for this scenario

Describe the normal sequence of events that is required to complete the scenario.

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	MDMS	MDMS gathers meter data (KWH + ID) from individual meters.	Same procedure as described in use case C2
2a	MDMS	Once meter data is passed through the VEE (Validate, Edit, Estimate), it is sent to the Aggregation System..	
2b	MDMS	Accounts not read will be estimated by the MDMS based on the account's historical usage data.	

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Step #	Actor	Description of the Step	Additional Notes
3	Procurement Data Estimator and Aggregator	Aggregation System submits aggregated data and wholesale transaction information to Procurement Finance for generating invoices to the ISO and Third Parties.	
4	Power Procurement Finance	Generates invoices	

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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)
AMI system shall supply aggregate interval meter data for transmission to the ISO. AMI System = MDMS for the purpose of this use case The detail data must be available in the MDMS for analysis in addition to providing the aggregation capability	2	4
Meter shall provide the reading for KW, KWH, KVAR, KVARH. The information shall be provided for each interval. The average values for kW and kVAR shall be monitored during the interval	1 2	1 1
Programmable interval shall be flexible to support market requirements. (4 sec, 5 min, 15 min). The intervals shall be configurable depending on its use	1	1
AMI system shall provide indication of missing data for T+5 data. T is the trade date related to energy delivered for today T+5 – 5 days from the trade date	2	2b
Interval data in 1-15 minutes shall be programmable and delivered once a day	1	1
The meter shall be capable of being configured for sampling consumption data (kW-seconds) at a rate (hyper-interval) sufficient to support Load Forecasting's effort to perform near real time load forecasts. The regular billing cycle shall continue.	1	1
Load Forecasting and/or DRAACS shall be capable of selecting which meters shall sample consumption data at hyper intervals.	1	1

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4.2 Non-functional Requirements

Non-Functional Requirements	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
Aggregation interval shall be <= 1 hour. The MDMS shall aggregate the intervals.	2	3
Data timestamps shall be accurate to 3 minutes or current VEE rules. The current rules state 4 minutes. The target for the new system is 2 minutes. **Assumption: Timestamp is obtained from the internal time of the meter**	3	2a
The special (hyper) sampling rate for real-time load forecasting shall be every 4 seconds – 2 minutes	1	1
The number of meters expected to be configured for the special sampling rate for real-time load forecasting is around 60,000 meters based on random sampling and/or from pre-selected profile groups (e.g. climate zones, customer profiles, etc.) All meters shall have this capability.	1	1
Once configured for the special rate, the selected meters would run in this mode for hours to months to forever	1	1
The elapsed time from the time a meter is selected to be included in the special rate group until it is recording data at this rate can be days or weeks	1	1
Once collected, the hyper rate data needs to be retrieved within 24 hours of capture (nightly)	1	1
The special rate data is not useful if there is more than a 2 days delay (latency) in receiving the data	1	1
A smaller subset of meters (< 10,000) will be capable of spontaneously reporting in real-time (hyper data) the 4 second rate data within 2 minutes of capture	1	1
AMI system shall supply aggregate interval meter data for transmission to the ISO within 3 days of usage date. Aggregated data = 100% of Edison's retail customers.	3	3
The meter shall retain hyper sampling interval data for 4 hrs	1	1

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4.3 Summary of Data Requirements

Name of Data	Customer Group	Recording Interval	Gathered	Preferred Latency	Maximum Latency	Time Retained in Meter	Value
Special Rate Data	1-2% of customers, selected randomly, by geographic area, climate, or other common factors	1-15 minutes	Continuously, with daily reports to be used for the next days' forecasts	4 hours	2 days	(not defined yet)	For day-ahead or longer forecasts
Hyper Rate Data	Up to 0.2% of customers – a more specialized set selected by Load Forecasting	4 seconds – 2 minutes	Continuously for up to 4 updates per hour of the day-ahead forecasts	less than 1 hour	24 hours	4 hours	For hour-ahead and longer forecasts. The 4 second data rolls up to 2 minute data and is then used as the basis for the hour-ahead forecasts that are made daily at predefined times

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4.4 Business Requirements

Business Requirement	*Associated Scenario # (if applicable)*	*Associated Step # (if applicable)*
AMI Data shall have the right quality and detail for settlements, planning and forecasting.	2	
Aggregated revenue quality data shall be provided to ISO. Required interval today is hourly. Future requirements could reduce interval to 5 min. The MDMS is the source of aggregated revenue quality data. The MDMS stores the detail data and is capable of reporting aggregated information.	3	

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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
1	1	DRAACS	Load Forecasting	Aggregated customer usage estimate • kWH • KVARH • Average KW • Average KVAR
1	2	Load Forecasting	Energy Trader	Forecast usage for given market window • kWH • KVARH
2	1	AMI Meter	MDMS	Meter data (kWh and ID)
2	2a	MDMS	Aggregation system	Meter data
2	2b	MDMS	Aggregation system	Missing meter data information

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Scenario #	Step #, Step Name	Information Producer	Information Receiver	Name of information exchanged
2	4	Aggregation system	Power Procurement Finance	
2	5	Power Procurement Finance	Wholesale Transaction Party	Invoice
3	1	AMI Meter	MDMS	Meter data (kWh and ID)
3	2a	MDMS	VEE system	Meter data
3	2a	VEE system	Aggregation system	VEE Meterdata
3	2b	MDMS	Aggregation system	Missing meter data information
3	4	Aggregation system	Power Procurement Finance	
3	5	Power Procurement Finance	Wholesale Transaction Party	Invoice

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.

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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.

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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**
Ex-post market	CAISO after the fact market – A price applied at settlement time
T+5	The practice of invoicing for wholesale energy transactions within five days of the transaction completion. Also known as payment acceleration.
T+45	The practice of invoicing for wholesale energy transactions as a part of the normal monthly billing cycle, i.e. within 45 days of the transaction completion.
Settlement	The process of calculating invoices and bills based on wholesale energy trading.
Wholesale Transaction Completion	The moment at which a wholesale energy bid or offer is accepted.

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8. References

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

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9. Bibliography (optional)

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

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