YSCP (Yokohama Smart City Project) Battery SCADA System Use Case #2

Peak Shift Contribution by Battery Aggregation (Virtual Energy Storage)

(Version 6.0 Oct. 6.2011)

1 Descriptions of Function

This use case describes interactions between the Grid Operator, Grid EMS, Battery SCADA, Stationary Batteries and Customer side EMS during Peak Shift by Battery Aggregation. Battery SCADA controls many Stationary Batteries as a Virtual Battery.

1.1 Function Name

Battery Aggregation Control function

1.2 Function ID

Identification number of the function

1.3 Brief Description

Many batteries are being deployed in the smart grid. These batteries are small scale and distributed. These batteries can be aggregated and controlled as Virtual Energy Storage which can be used for peak shifting or load leveling. The control technology comprises a Grid EMS, Grid Operator, and communications via Battery SCADA. A scenario that describes control functions for Peak Shift Contribution by Battery Aggregation is introduced in this use case.

Scenario: Peak Shift Contribution by Battery Aggregation (Virtual Energy Storage)

"Peak Shift Contribution by Battery Aggregation" (PSCBA) is the function for peak shifting or load leveling by the aggregated batteries. PSCBA supports a Grid Operator to make the plan for peak shifting. It encapsulates Stationary Batteries to control and customer's batteries to communicate with so that a Grid Operator can conduct the plan.

The interactions are described in this scenario as follows:

PSCBA calculates the total surplus potential of all batteries deployed in the grid and displays the calculated result as virtual energy storage to the Grid Operator. The Grid Operator can use the PSCBA to check whether a peak shifting plan can be realized or not. PSCBA calculates the total surplus potential of Stationary Batteries and customer's batteries and negotiates with a customer side EMS, such as HEMS or BEMS, about utilization of its battery surplus power. Then, PSCBA evaluates the peak shifting plan and displays the result to the Grid Operator.

Where there is no customer side EMS and the customer's battery is controlled directly from PSCBA, the customer's battery assumes the roles of both battery control and EMS in this use case.

1.4 Narrative

1.4.1 Overview of Functions

PSCBA is the function that supports peak shifting or load leveling plans for Grid Operators. PSCBA supports the Grid Operator's implementation of these plans by communicating with and controlling Stationary Batteries and customers' Stationary Batteries.

1.4.2 Peak shift contribution by Battery Aggregation Function

Peak shift contribution by Battery Aggregation. This Function comprises eight sub functions:

1. Default Plans Setting for Peak shift contribution by Battery Aggregation
2. Displaying Potential for Default Plans of Peak shift contribution by Battery Aggregation
3. Making Plan for Peak shift contribution by Battery Aggregation
4. Execution Notification of the Plan for Peak shift contribution by Battery Aggregation
5. Control of the Stationary Battery
6. Operation of the Customer's battery
7. Customer's Battery Operation Plan Collecting
8. Monitoring of Peak shift contribution by Battery Aggregation

These sub functions are described in the sections below.

1.4.2.1 Default Plans Settings for Peak shift contribution by Battery Aggregation

Default plan is the typical pattern such as peak shift or reduction of power demand. A Grid Operator can set default plans based on power system load characteristics. Default plans are represented by a pattern of system load increased/decreased value (%) depending on the time as shown in Fig.1. A Grid Operator can add or delete default plans. For example, upon season change, a new default plan with regards to the specific season can be made and no changes would be required until the next season.

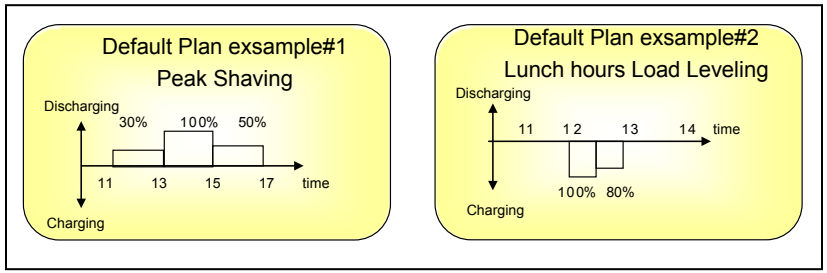


Fig.1 Default Plan

1.4.2.2 Displaying Potential for Default plans of Peak shift contribution by Battery Aggregation

PSCBA calculates the total surplus potential of all batteries corresponding to each default plan by using customer's original operation plan of their batteries. It then represents the result as if there is a virtual energy storage that has a virtual capacity nearly equal to the total surplus potential of all batteries. Upon a Grid Operator request, PSCBA displays the calculated result that is represented by a pattern of system load increased/decreased value (W) depending on the time for each default plan as shown Fig.2.

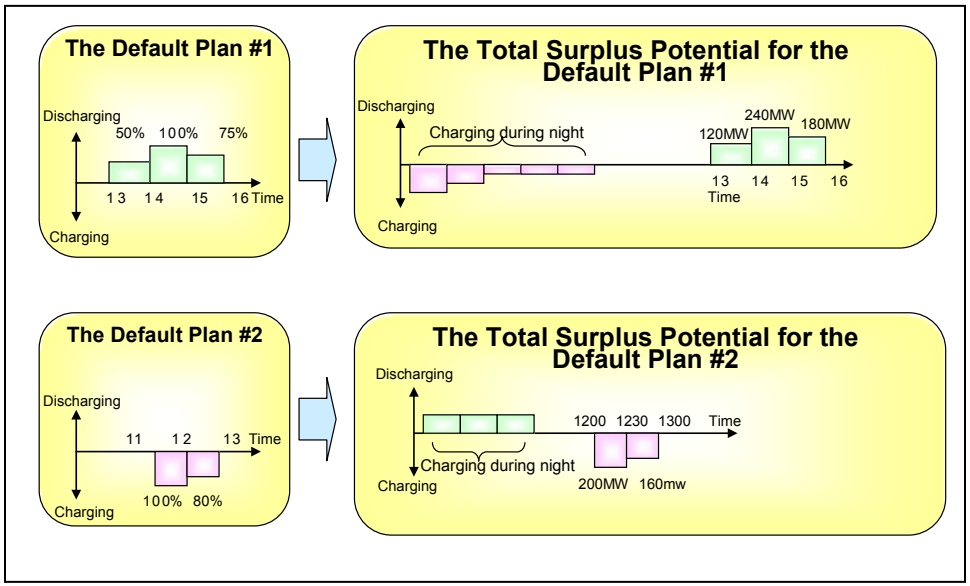


Fig.2 Total Surplus Potential for Default Plan

PSCBA also displays Schedule of Batteries for the Default Plan as shown Fig.3.

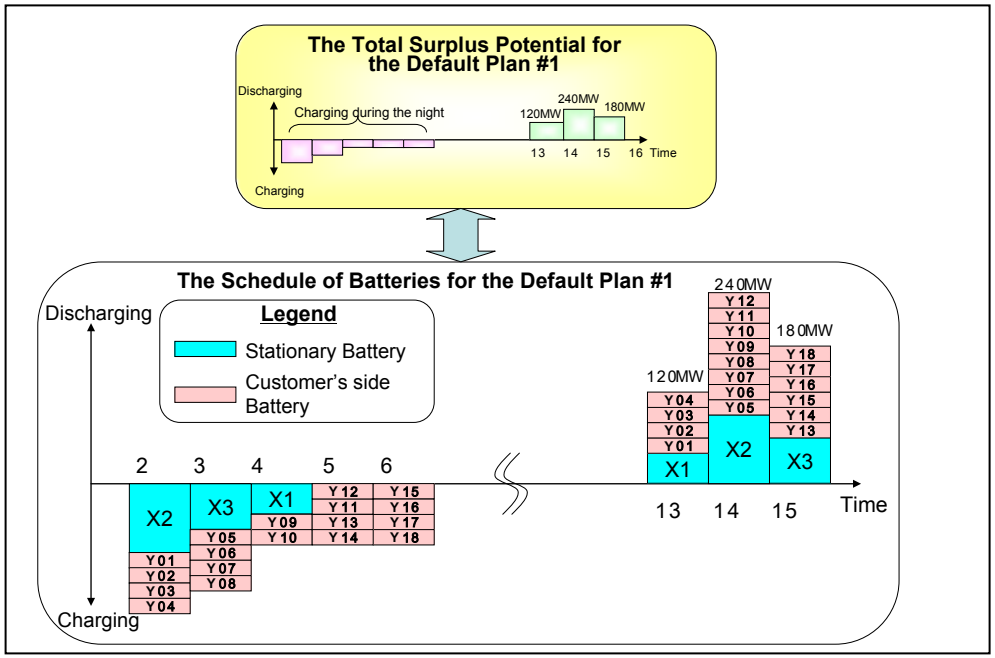


Fig.3 Schedule of Batteries for the Default Plan

1.4.2.3 Plan for Peak shift contribution by Battery Aggregation

A Grid Operator can specify the plan for peak shift contribution by Battery Aggregation, if necessary. The plan is represented by a pattern of system load increased/decreased value (W) depending on the time as shown in Fig.4. PSCBA calculates the total surplus potential of all batteries, and evaluates the plan whether the total surplus is greater than the plan. Continuously, PSCBA selects customer's batteries to make the schedule of batteries for the plan. At that time, the customer's batteries with the lower price are chosen. Then PSCBA displays the evaluation result as if there is one Virtual Battery that has a virtual capacity nearly equal to the total surplus potential of all batteries. The evaluation result includes schedules of Stationary Batteries and customer's batteries for the plan as shown in Fig 5.

The total surplus is the sum of all surpluses of Stationary Batteries and all customers' batteries. Before summing surplus of the customer's battery, Battery SCADA inquires acceptance or rejection of participation to peak shift to each customer side EMS. It sums surplus of the customer's battery, only when PSCBA get acceptance from the customer side EMS. (This procedure is named as the Unrestrictive Demand Response.)

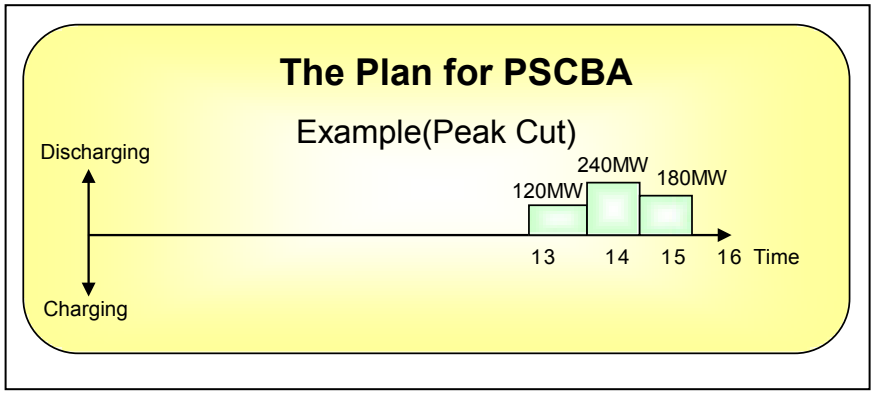


Fig.4 Example of the Plan for PSCBA requested by a Grid Operator

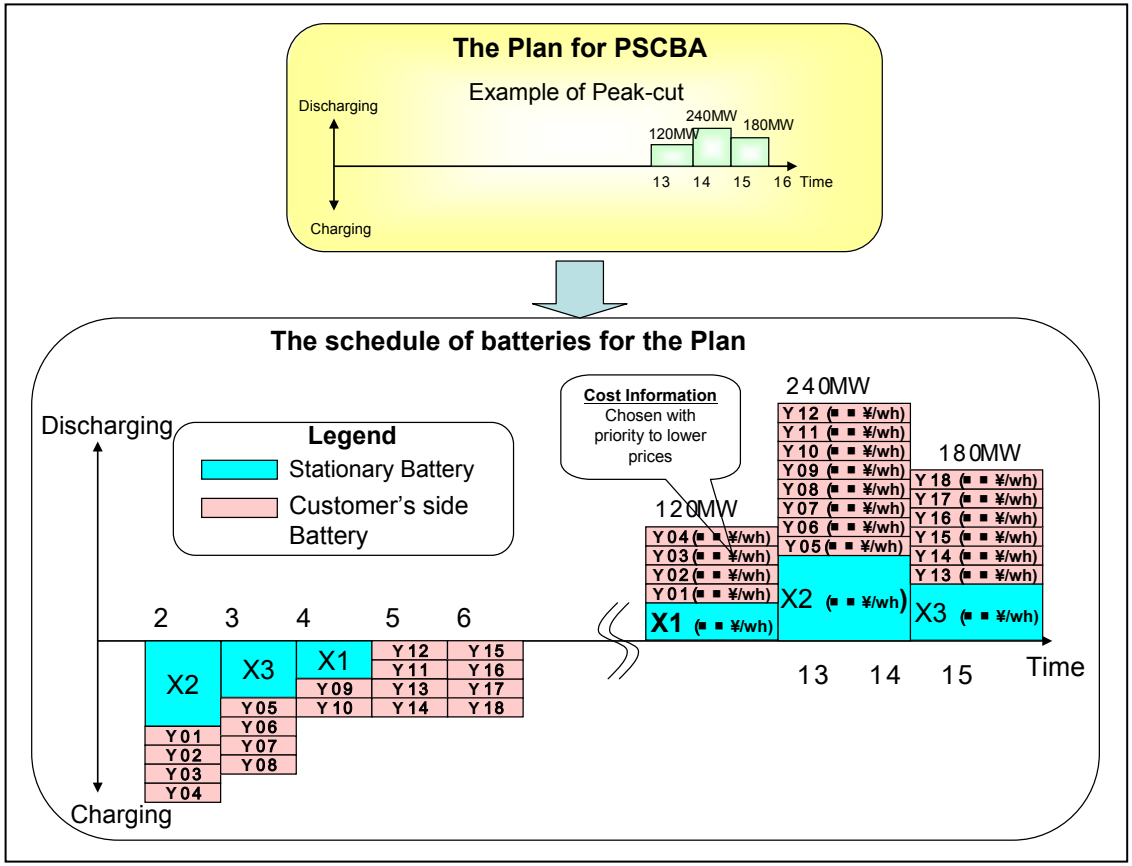


Fig.5 Schedule of Batteries for the Plan

1.4.2.4 Execution Notification of Plan for Peak shift contribution by Battery Aggregation

When the Grid Operator determines that the plan for PSCBA is possible, he notifies the execution of the plan via the terminal of PSCBA. Execution notification of the plan will be sent to respective customer side EMS (e.g. HEMS, BEMS, etc).

1.4.2.5 Control of the Stationary Battery

Upon execution notification of plan for PSCBA, it controls the stationary battery according to the schedule of batteries for the plan.

1.4.2.6 Control of the Customer's Battery

When the customer side EMS receives execution notification of the plan, it controls the customer's storage battery according to the electrical charge and discharge schedule sent from PSCBA.

1.4.2.7 Customer's Battery Operation Plan Collection

The customer side EMS sends the detail schedule, the outline schedule or the surplus schedule of the customer's battery to Battery SCADA to participate the plan conducted by PSCBA. PSCBA records and uses them to calculate the total surplus potential of all batteries.

1.4.2.8 Monitoring of Peak shift contribution by Battery Aggregation

PSCBA displays 'the plan for PSCBA' and 'the schedule of batteries for the plan'. It also calculates the sum total of charging/discharging of batteries which are listed in the plan, and displays them upon the Grid Operator's request. The Grid Operator can monitor the operation situation of PSCBA.

1.5 Actor (Stakeholder) Roles

Grouping (Community)'		*Group Description*
Actors inside of Smart Grid		*Actors that perform their specific function inside of Smart Grid*
Actor Name	*Actor Type (person, organization, device, system, or subsystem)*	*Actor Description*
Grid EMS	System	This actor possesses many functions with regards the monitoring and controlling of the grid. That includes frequency and voltage quality maintenance of the grid, economical operation and reliability of the grid. Grid EMS provides man-machine interface for a Grid Operator.
Grid Operator	Person	Responsible for the maintenance of the grid's frequency and voltage quality, economic operation and grid reliability. The total demand will be forecasted 24 hours ahead, and the generation schedule designed to cover the total demand is made. Due to the considerable change in the forecast in the demand after making the plan for generation schedule, or due to outage of the power generator appointed for use, the Grid Operator has to make the plan of peak shift and conduct it. At this time, PSCBA (Peak shift contribution by Battery Aggregation) is required.
Battery SCADA	System	Battery SCADA enables the Grid Operators to utilize Stationary Batteries and the surplus capability of the customers' batteries as one large Virtual Battery on its own. The Battery SCADA conducts the calculation of the total potential of the stationary battery's and the customer's battery's surplus power. And It edits calculated results for the Grid Operators as if they have a large

Grouping (Community)		*Group Description*
Actors inside of Smart Grid		*Actors that perform their specific function inside of Smart Grid*
Actor Name	*Actor Type (person, organization, device, system, or subsystem)*	*Actor Description*
		Virtual Battery. Battery SCADA controls Stationary Batteries to carry out peak shift contribution by Battery Aggregation. It also sends demand request to use surplus of customer side EMS. Battery SCADA collects detail schedule or surplus schedule of customer's batteries based on which it calculates the total surplus of customer's batteries. Battery SCADA receives the real charging/discharging power corresponding to peak shift contribution by Battery Aggregation from customer side EMS.
Stationary Battery	Device	Stationary Battery charges and discharges according to the charging/discharging commands from Battery SCADA.
Customer's battery	Device	Customer's batteries are controlled by Customer side EMS.
Customer side EMS	System	Customer side EMS determines participation in the unrestrictive Demand Response according to the conditions such as the collateral condition and the maximum and minimum value of the battery output power that are specified by the customer. Upon participation, Customer side EMS controls the Customer's Battery according to the request from Battery SCADA.

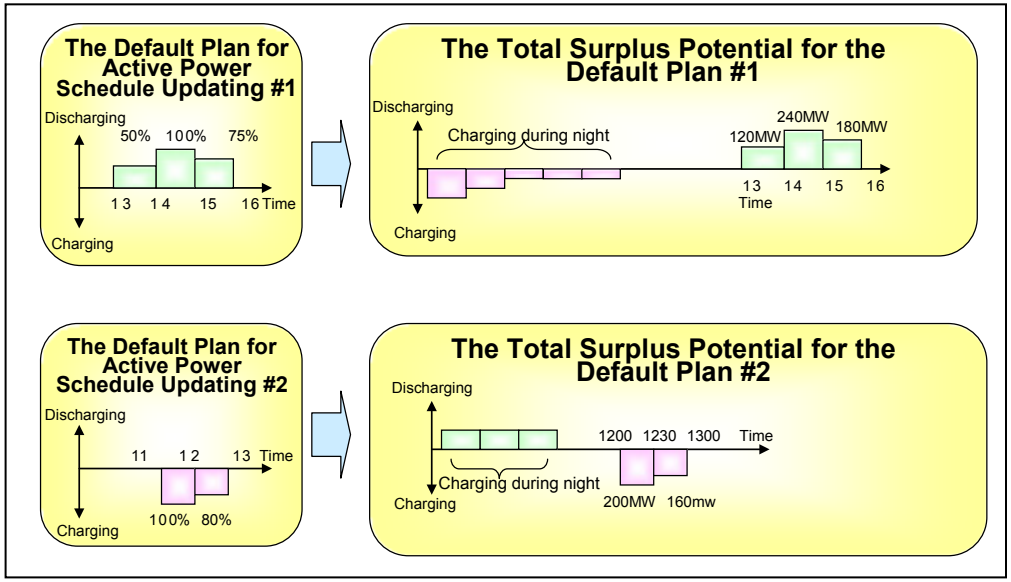
1.6 Information exchanged

Information Object Name	*Information Object Description*
Request for Current Status of Customer's Battery	This is a request command for Current Status of Customer's Battery. Every 30mins, this command will be sent from the Battery SCADA to each customer side EMS.
Current Status of each Customer's Battery	This information includes active power, SOC and operation condition.
Current Status of each Stationary Battery	This information includes active power, SOC and operation condition, and Remote/local condition.
Default Plan for PSCBA (Peak Shift Contribution by Battery Aggregation)	Commonly used pattern for PSCBA. Time period is displayed by power in percentage. See Fig. 1 for Default Plan for PSCBA.
Display Request of Default plans	This is a display request of Default plan.
Calculation Request of the total surplus potential for default plan	This is a calculation Request of the total surplus potential for default plan
Calculation Request of the total surplus potential for the plan	This is a calculation Request of the total surplus potential for the plan
Display Request of the total surplus potential for default plan	This is a display request of the total surplus potential for default plan
The total surplus potential for each default plan	Absolute value (in MW) pattern that showed how much contribution can be actually done to each default plan for PSCBA by summing up the surplus power of Stationary Batteries and customer's batteries. Unit is in MW per hour. See Fig.2 for the total surplus potential for each

Information Object Name	*Information Object Description*
	default plan.
The total surplus potential for the plan	Absolute value (in MW) pattern that showed how much contribution can be actually done to the plan for PSCBA by summing up the surplus power of Stationary Batteries and customer's batteries.
The schedule of batteries for each default plan	This schedule is provided for each default plan by Battery SCADA. This schedule includes schedules of all Stationary Batteries and all Customer side Batteries for the default plan. See Fig3 for the schedule of batteries for each default plan.
Request for Schedule	Request command for schedule from the Battery SCADA to the customer side EMS. It will be stated as the next day schedule or the same day schedule. Upon receiving this request, the customer's battery sends the detail schedule, outline schedule or surplus schedule of it to Battery SCADA.
Detail Schedule of Customer's Battery	This schedule is On-the-day-Schedule or the next-day-Schedule of each customer's battery, and includes the initial SOC, charging/discharging power of each period according to the customer's original schedule and the customer collateral condition.
Outline schedule of Customer's Battery	This schedule is On-the-day-Schedule or the next-day-Schedule of each customer's battery, and includes the initial SOC, maximum charging/discharging power of each period according to the customer's original schedule charging/discharging power of each period according to the customer's original schedule, restriction of SOC of each period and the customer collateral condition.
Surplus schedule of Customer's Battery	This schedule is On-the-day-Schedule or the next-day-Schedule of each customer's battery, and includes the initial SOC, surplus of charging/surplus of discharging power of each period, restriction of SOC of each period and the customer collateral condition.
Plan for PSCBA (Peak Shift Contribution by Battery	This is a pattern of the power values which a Grid Operator is going to cut or shift and is represented in MW per time period. See Fig 4 for example of the plan for PSCBA.

Information Object Name	*Information Object Description*
Aggregation)	
Current Status of Virtual Battery for PSCAB	This is the sum total of the performance results of all batteries that are included in the Schedule of Batteries for the Plan. A Grid Operator can suppose this to be the performance result of the virtual energy storage.
The Schedule of Batteries for the Plan	This schedule includes schedules of all Stationary Batteries and all Customer side Batteries for the plan and is provided by Battery SCADA. See Fig.5 for the Schedule of Batteries for the Plan.
Message of lack of surplus for the plan	When Battery SCADA detects lack of surplus of the sum total of all batteries during calculation of The Schedule of Batteries for the Plan, it displays this message for the Grid Operator.
Inquiry	Request for response on acceptance or rejection for surplus power usage of customer's battery. The surplus (kW for each period) of the customer's battery to be used by the plan for PSCBA is included in the inquiry. It is sent from the Battery SCADA to the customer side EMS.
Inquiry Acceptance	Acceptance in response to the inquiry made. It is sent from the customer side EMS to the Battery SCADA.
Inquiry Rejection	Rejection in response to the inquiry made. It is sent from the customer side EMS to the Battery SCADA.
Execution Notification	This is the notification of Executing the plan. Grid Operator determines the notification.
Charging/Discharging command	Command sent from the Battery SCADA to the Stationary Battery.

1.7 Activities/Services

Activity/Service Name	*Activities/Services Provided*
Calculation of the total surplus potential for the default plan	The total surplus power of Stationary Batteries and customer side batteries are calculated based on each detail/outline/surplus schedule of battery and the default plan that is represented as % pattern as shown in Fig.6. The calculation result is displayed for a Grid Operator as shown below.  Fig.6 Calculation of the total surplus potential for the default plan

Activity/Service Name	*Activities/Services Provided*
Calculation of the schedule of batteries for the default plan	From the result of calculated total surplus potential for the default plan, Battery SCADA makes the schedule of batteries for the default plan that is shown in Fig.7.

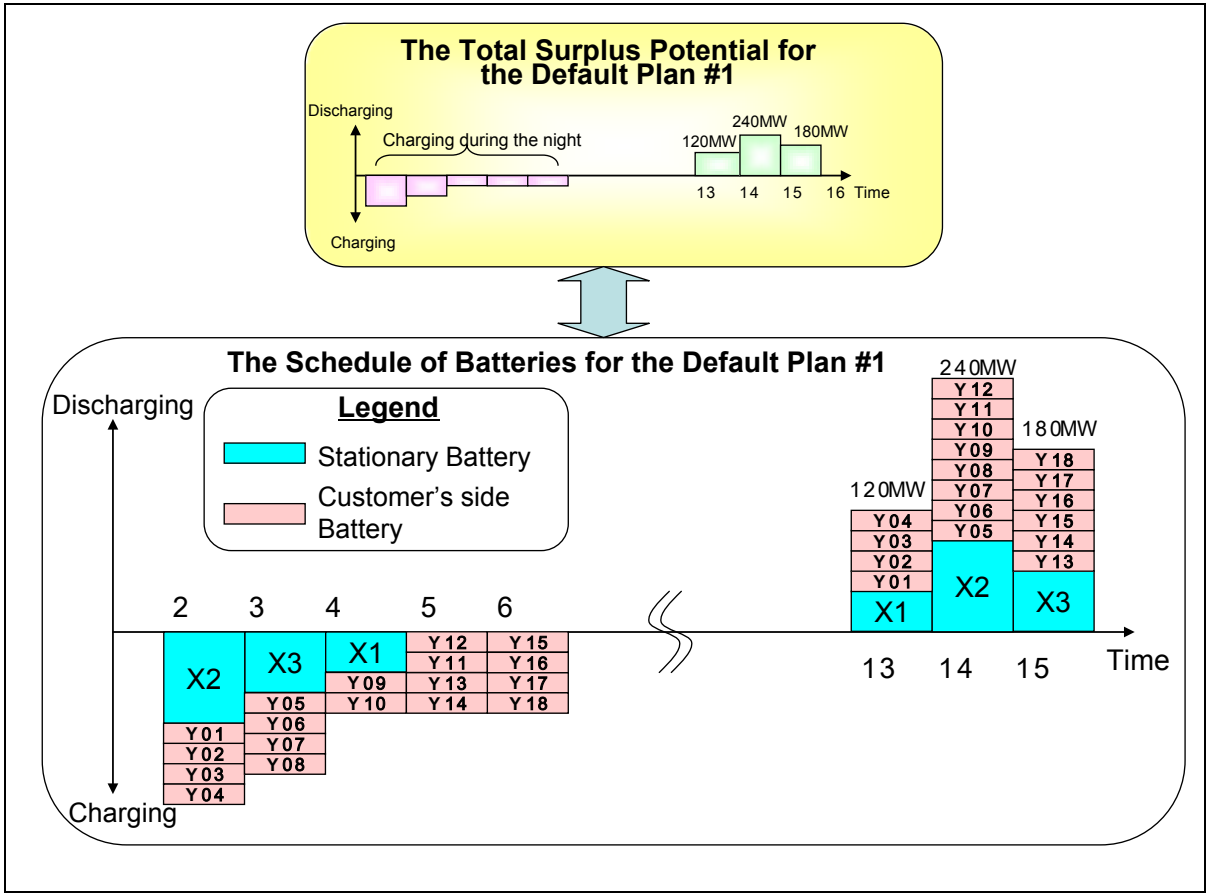


Fig. 7 Calculation of the schedule of batteries for the default plan

Activity/Service Name	*Activities/Services Provided*
	The schedule of batteries for the default plan includes the cost information that is derived from expenses, condition of electrical companies, the policy condition of electric power company and the customer collateral condition specified by each customer.

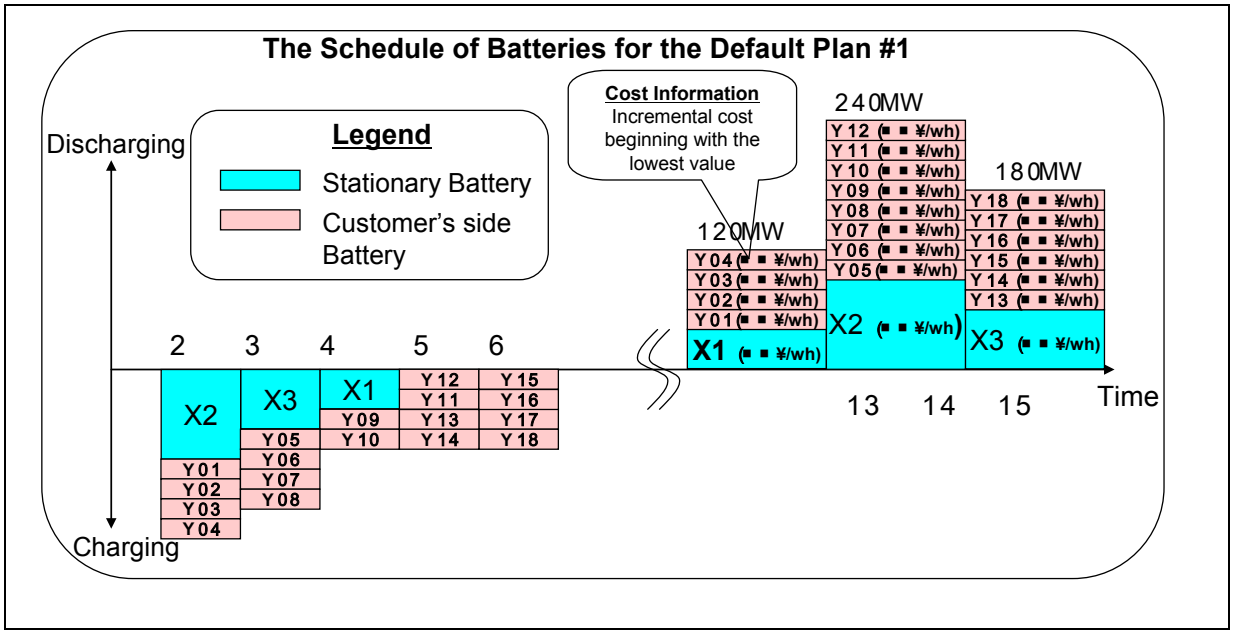


Fig.8 Calculation of the schedule of batteries for the default plan

Activity/Service Name	*Activities/Services Provided*
Calculation of the schedule of batteries for the plan	The schedule of batteries is calculated based on each detail/outline/surplus schedule of battery and the plan that is represented as kW pattern as shown in Fig.9. The calculation result is displayed for a Grid Operator as shown below.

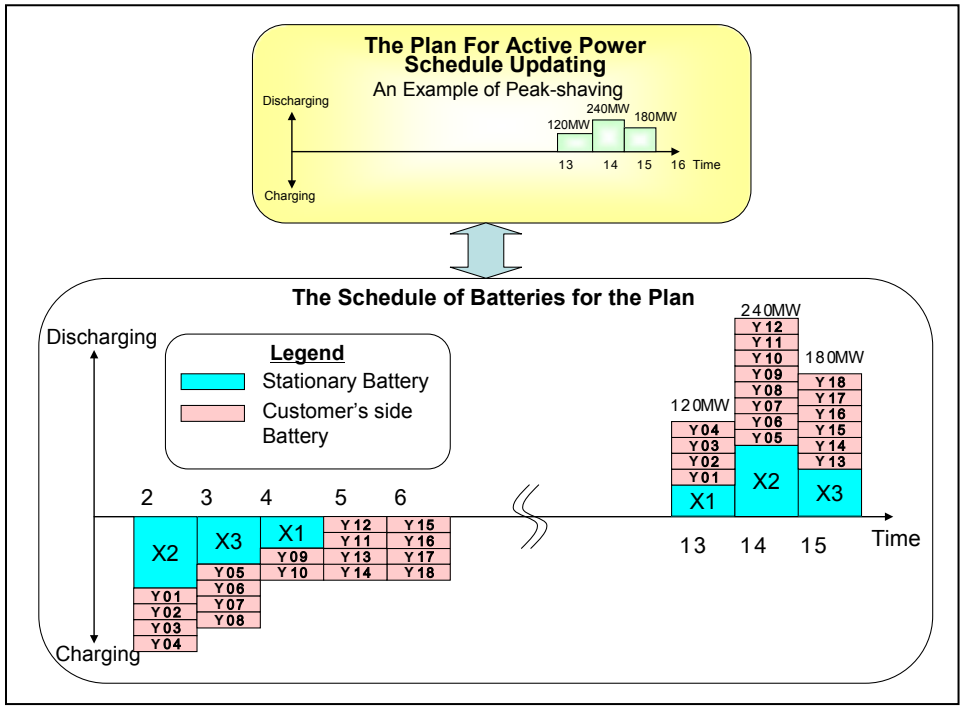


Fig.9 Calculation of the schedule of batteries for the plan

1.8 Contracts/Regulations

Contract/Regulation	*Impact of Contract/Regulation on Function*
Contract between Electric Power Company and the Customer	Contract is made between the electric company and the customer. It includes following: -Battery SCADA and the customer side EMS communicate each other. -The electric company uses the surplus of customer's battery when the customer accepts. -In return, the customer gets a reward for operating its battery according to requests from Battery SCADA.

2 Step by Step Analysis of Function

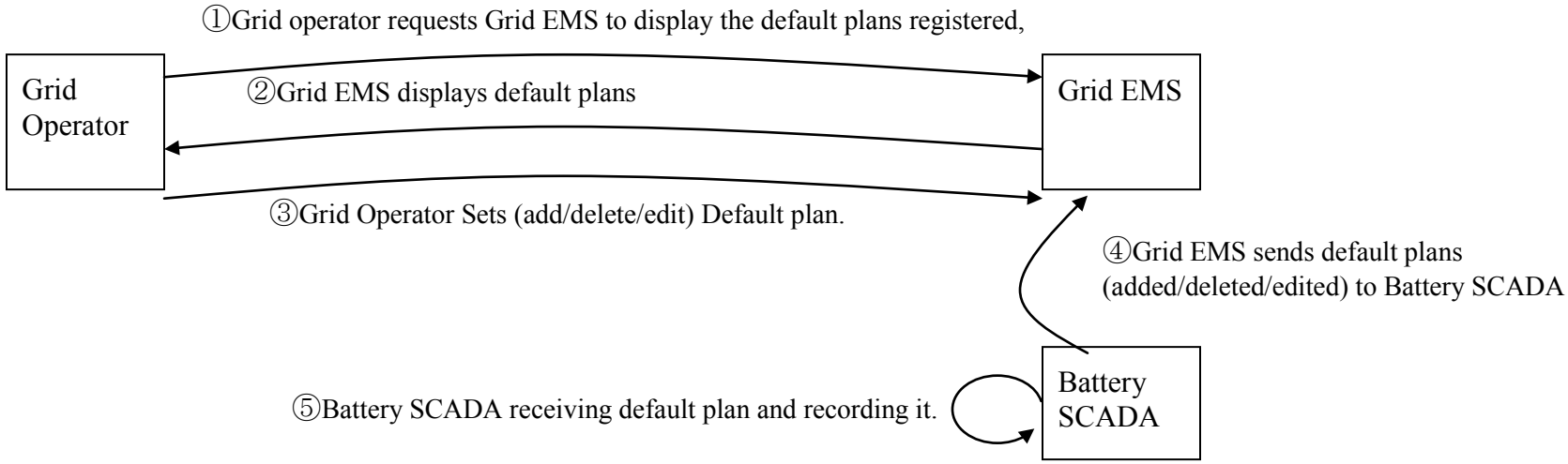
2.1 Steps to implement function – Peak shift contribution by Battery Aggregation

2.1.1 Preconditions and Assumptions

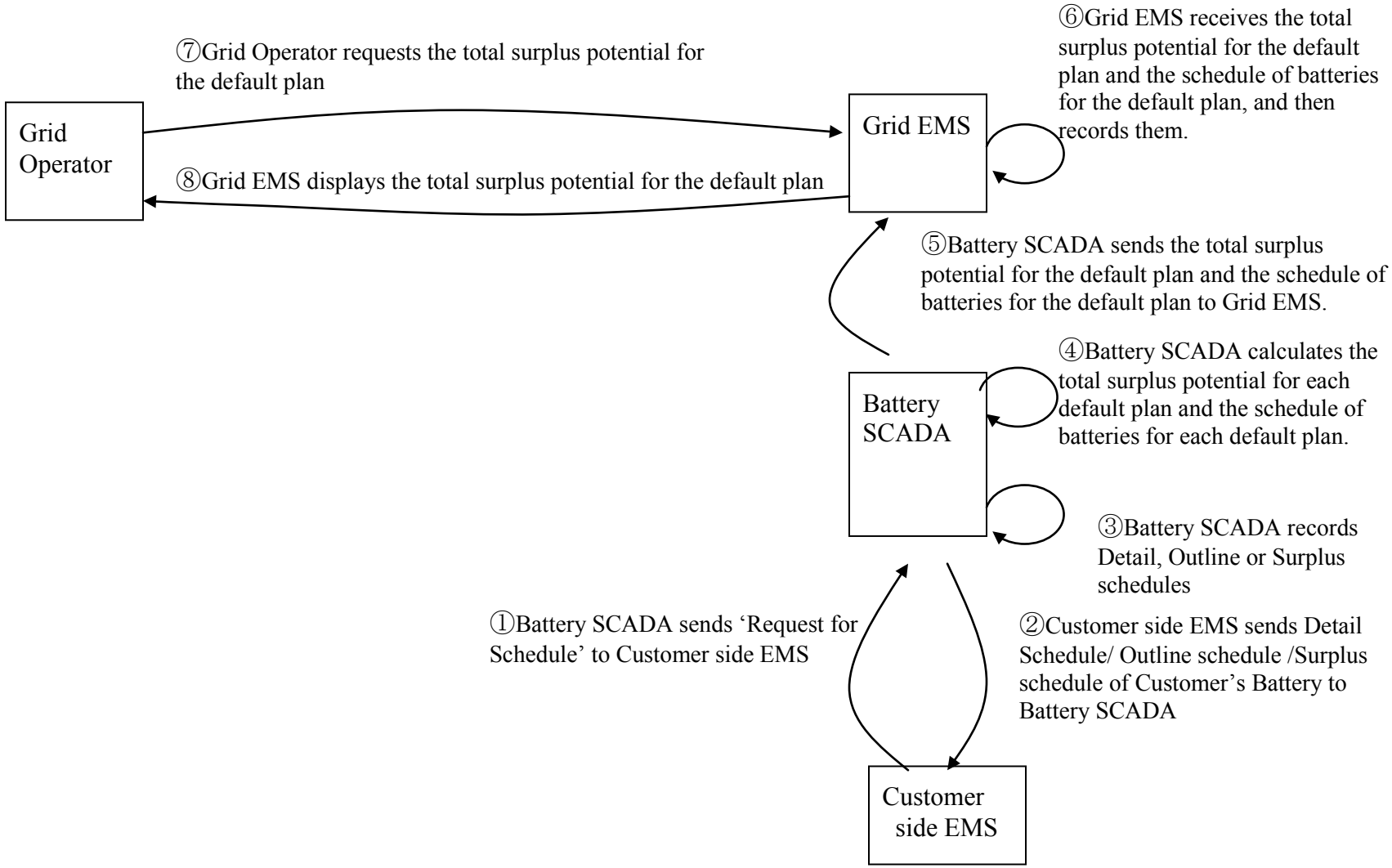
Actor/System/Information/Contract	*Preconditions or Assumptions*
Grid Operator	Grid Operator is going to plan peak shift contribution by Battery Aggregation such as peak shifting, load leveling, or smoothing the fluctuations of the power load during night hours.
Grid EMS	Grid EMS provides man-machine interface for a Grid Operator.
Battery SCADA	Battery SCADA is ready to control Stationary Batteries, communicate with customer side EMS and communicate with Grid EMS.
Stationary Battery	Stationary Batteries can be controlled by Battery SCADA.
Customer side EMS	Customer side EMS is ready to communicate with Battery SCADA and can control Customer's battery.

2.1.2 Sequence Diagram of Peak shift contribution by Battery Aggregation

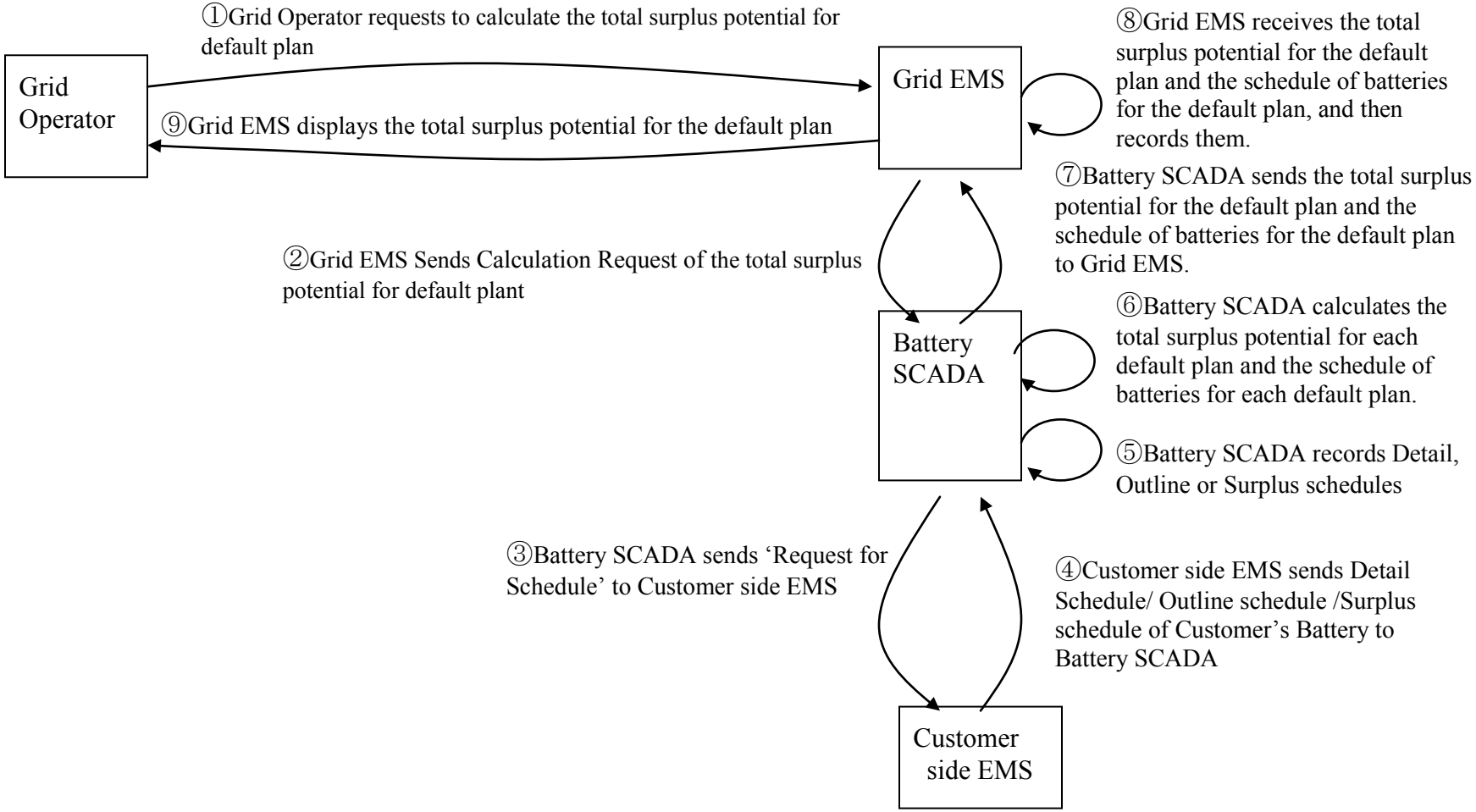
（1） Default Plans Setting for Peak shift contribution by Battery Aggregation



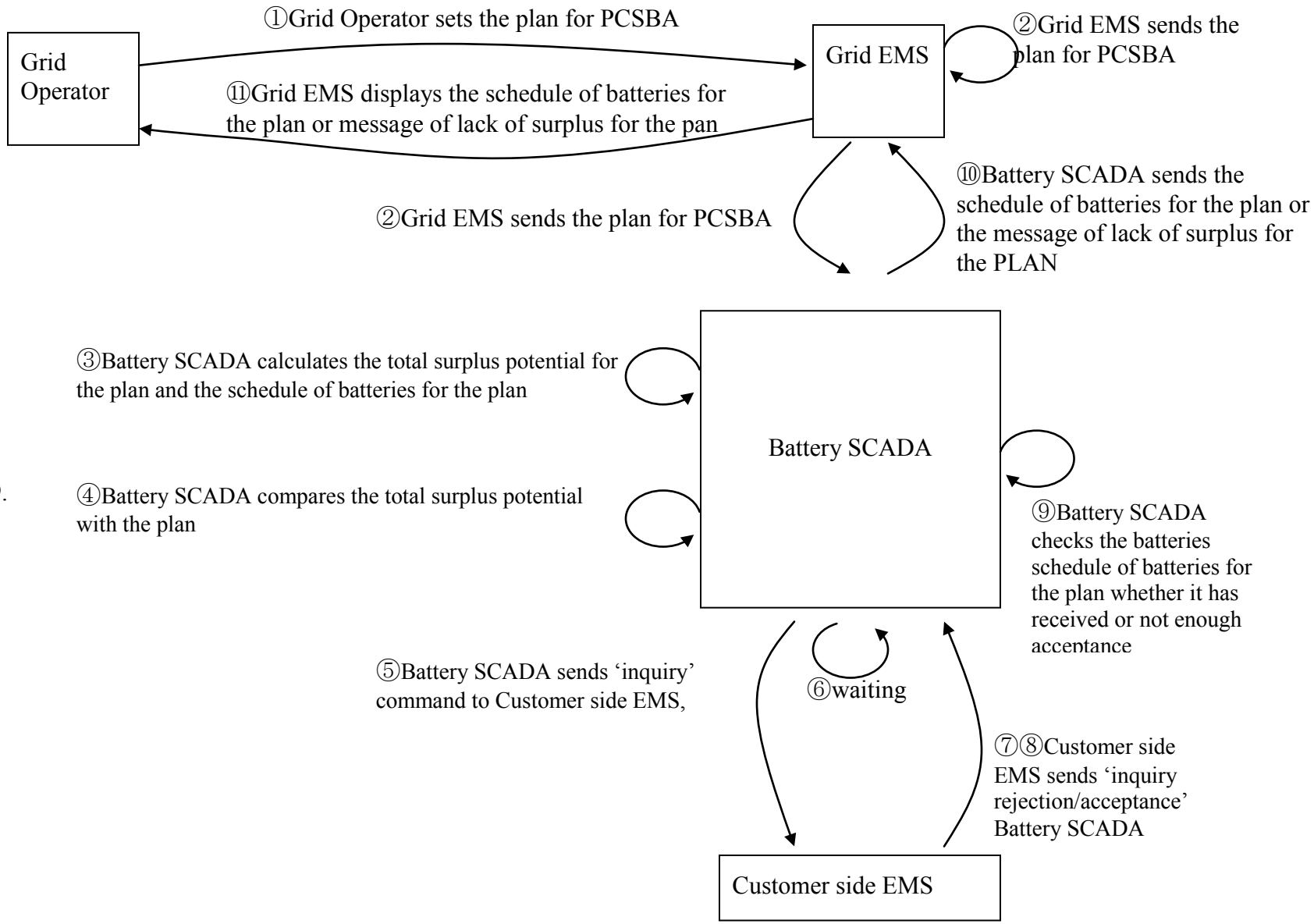
（２）Displaying Potential for Default Plans of Peak shift contribution by Battery Aggregation（case 1）



（３） Displaying Potential for Default Plans of Peak shift contribution by Battery Aggregation（case2）

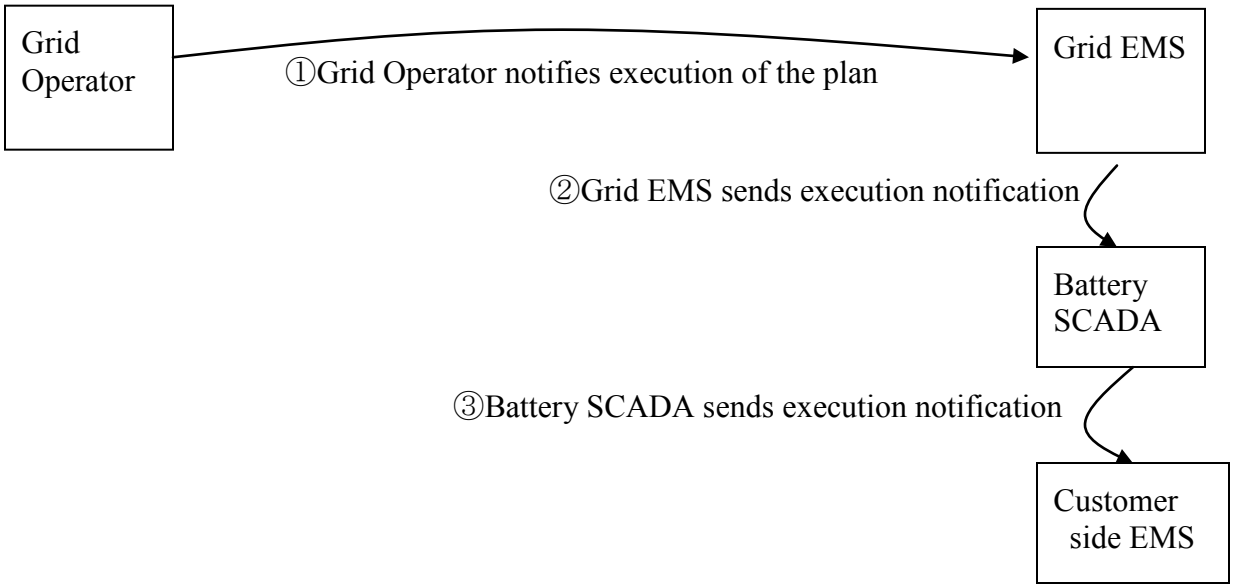


（４）Making Plan for Peak shift contribution by Battery Aggregation

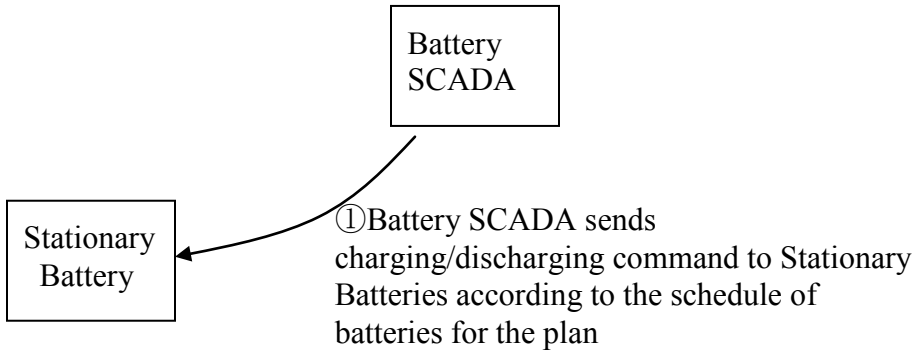


9.

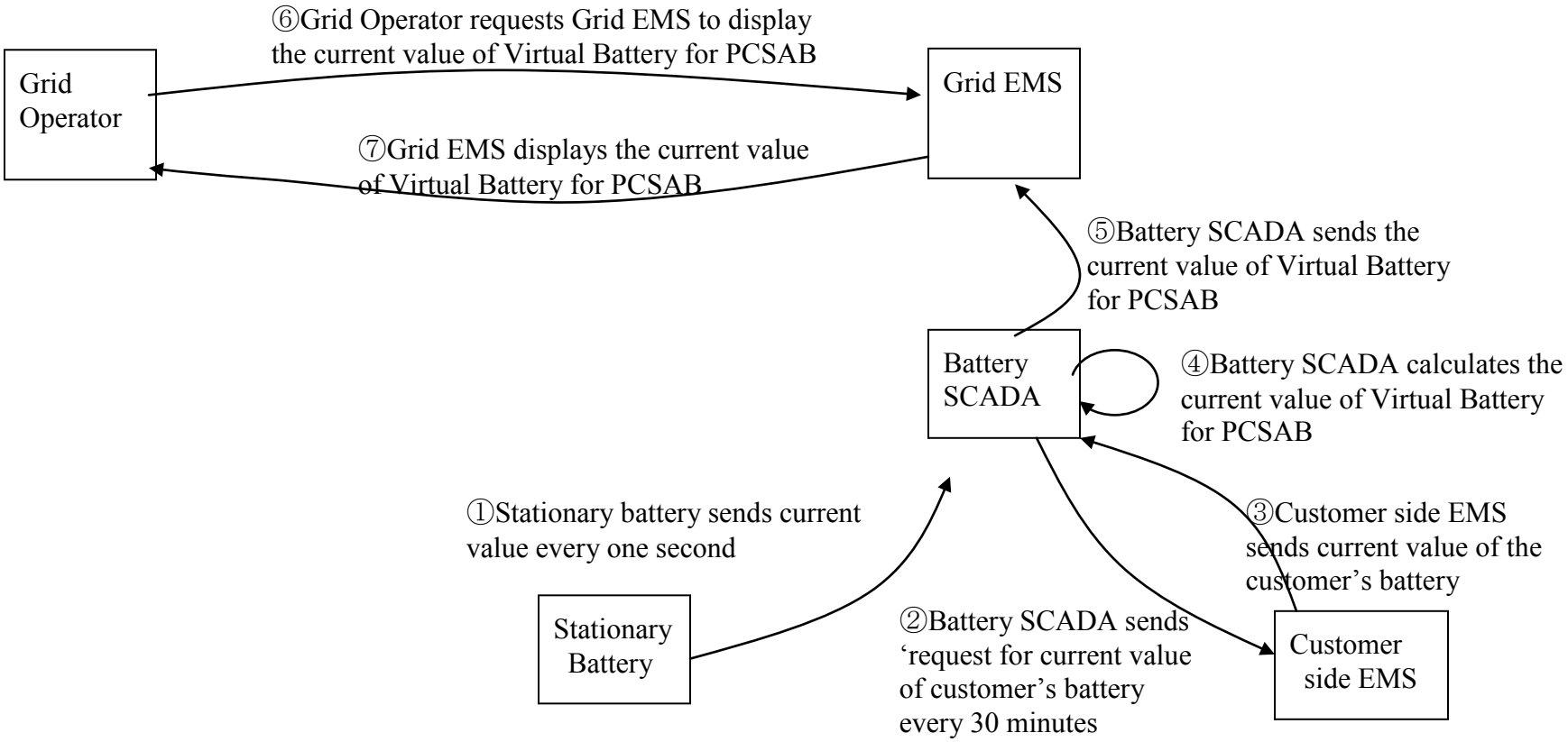
（５） Execution Notification of the Plan for Peak shift contribution by Battery Aggregation



（６） Control of the Stationary Battery



（７）Monitoring the Virtual Battery of PSCAB (Monitoring of Peak shift contribution by Battery Aggregation)



2.1.3 Steps – Peak shift contribution by Battery Aggregation

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
#	*Triggering event? Identify the name of the event.*[1]	*What other actors are primarily responsible for the Process/Activity? Actors are defined in section1.5.*	*Label that would appear in a process diagram. Use action verbs when naming activity.*	*Describe the actions that take place in active and present tense. The step should be a descriptive noun/verb phrase that portrays an outline summary of the step. "If …Then…Else" scenarios can be captured as multiple Actions or as separate steps.*	*What other actors are primarily responsible for Producing the information? Actors are defined in section1.5.*	*What other actors are primarily responsible for Receiving the information? Actors are defined in section1.5.* *(Note – May leave blank if same as Primary Actor)*	*Name of the information object. Information objects are defined in section 1.6*	*Elaborate architectural issues using attached spreadsheet. Use this column to elaborate details that aren't captured in the spreadsheet.*	*Reference the applicable IECSA Environment containing this data exchange. Only one environment per step.*
1.1	With every seasonal change or a change in the demand	Grid Operator	Requesting default plans registered	Grid operator requests Grid EMS to display the default plans registered, from the terminal of Grid EMS	Grid Operator	Grid EMS	Display Request of Default plans		
1.2	Upon Grid Operator's request	Grid EMS	Displaying default plans registered	Grid EMS displays default plans	Grid EMS	Grid Operator	Default plan for PSCBA		
1.3	Completion of displaying	Grid Operator	Default plan settings	Grid Operator Sets (add/delete/edit) Default plan.	Grid Operator	Grid EMS	Display Request of Default plans		
1.4	Completion of setting default plan	Grid EMS	Sending default plans	Grid EMS sends default plans (added/deleted/edited) to Battery SCADA	Grid EMS	Battery SCADA	Default plan for PSCBA	Open ADR+ (Open ADR with some extensions)	

[1] Note – A triggering event is not necessary if the completion of the prior step – leads to the transition of the following step.

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
1.5	Receiving default plan	Battery SCADA	Recording default plan	Battery SCADA receives default plan and records it.	Battery SCADA	Battery SCADA	Default plan for PSCBA		
2.1	By 2 pm. 1 day ahead	Battery SCADA	Sending Request for Schedule	Battery SCADA sends 'Request for Schedule' to Customer side EMS	Battery SCADA	Customer side EMS	Request for Schedule	Open ADR+	
2.2.a	Upon Receiving Request for Schedule	Customer side EMS	Sending Detail Schedule of Customer's Battery	Customer side EMS sends Detailed Schedule of Customer's Battery to Battery SCADA	Customer side EMS	Battery SCADA	Detail Schedule of Customer's Battery	Open ADR+	
2.2.b	Upon Receiving Request for Schedule	Customer side EMS	Sending Outline Schedule of Customer's Battery	Customer side EMS sends Outline schedule of Customer's Battery to Battery SCADA	Customer side EMS	Battery SCADA	Outline Schedule of Customer's Battery	Open ADR+	
2.2.c	Upon Receiving Request for Schedule	Customer side EMS	Sending Surplus schedule of Customer's Battery	Customer side EMS sends Surplus schedule of Customer's Battery to Battery SCADA	Customer side EMS	Battery SCADA	Surplus schedule of Customer's Battery	Open ADR+	
2.3	Upon receiving Detail/Outline/Surplus schedules	Battery SCADA	Recording Detail / Outline / Surplus schedules	Battery SCADA records Detail, Outline or Surplus schedules	Battery SCADA	Battery SCADA	Detail, Outline or Surplus Schedule of Customer's Battery		

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
2.4	Upon receiving Detail/Outline/Surplus schedules from all Customer side EMS	Battery SCADA	Calculation of the total surplus potential for each default plan and the schedule of batteries for each default Plans	Battery SCADA calculates the total surplus potential for each default plan and the schedule of batteries for each default plan.	Battery SCADA	Battery SCADA	The total surplus potential for the default plan and the schedule of batteries for the default plan		
2.5	Completion of calculation	Battery SCADA	Sending the total surplus potential for the default plan and the schedule of batteries for the default plan.	Battery SCADA sends the total surplus potential for the default plan and the schedule of batteries for the default plan to Grid EMS.	Battery SCADA	Grid EMS	The total surplus potential for the default plan and the schedule of batteries for the default plan	Open ADR+	
2.6	Receiving the total surplus potential for the default plan and the schedule of batteries for the default plan.	Grid EMS	Recording the total surplus potential for the default plan and the schedule of batteries for the default plan.	Grid EMS receives the total surplus potential for the default plan and the schedule of batteries for the default plan, and then records them.	Grid EMS	Grid EMS	The total surplus potential for the default plan and the schedule of batteries for the default plan		

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
2.7	Upon Grid Operator request	Grid Operator	Requesting the total surplus potential for the default plan	Grid Operator requests the total surplus potential for the default plan	Grid Operator	Grid EMS	Display Request of the total surplus potential for default plan		
2.8	Upon Receiving Grid Operator ‘s display request	Grid EMS	Displaying the total surplus potential for the default plan	Grid EMS displays the total surplus potential for the default plan	Grid EMS	Grid Operator	the total surplus potential for the default plan		
3.1	Upon Grid Operator request	Grid Operator	Requesting to calculate the total surplus potential for default plan	Grid Operator requests to calculate the total surplus potential for default plan	Grid Operator	Grid EMS	Calculation Request of the total surplus potential for default plant		
3.2	Upon Receiving Operator request	Grid EMS	Sending Calculation Request of the total surplus potential for default plant	Grid EMS Sends Calculation Request of the total surplus potential for default plan	Grid EMS	Battery SCADA	Calculation Request of the total surplus potential for default plant	Open ADR+	

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
3.3	Upon receiving calculation Request of the total surplus potential for default plant	Battery SCADA	Sending Request for Schedule	Battery SCADA sends 'Request for Schedule' to Customer side EMS	Battery SCADA	Customer side EMS	Request for Schedule	Open ADR+	
3.4.a	Upon Receiving Request for Schedule	Customer side EMS	Sending Detail Schedule of Customer's Battery	Customer side EMS sends Detail Schedule of Customer's Battery to Battery SCADA	Customer side EMS	Battery SCADA	Detail Schedule of Customer's Battery	Open ADR+	
3.4.b	Upon Receiving Request for Schedule	Customer side EMS	Sending Outline Schedule of Customer's Battery	Customer side EMS sends Outline schedule of Customer's Battery to Battery SCADA	Customer side EMS	Battery SCADA	Outline Schedule of Customer's Battery	Open ADR+	
3.4.c	Upon Receiving Request for Schedule	Customer side EMS	Sending Surplus schedule of Customer's Battery	Customer side EMS sends Surplus schedule of Customer's Battery to Battery SCADA	Customer side EMS	Battery SCADA	Surplus schedule of Customer's Battery	Open ADR+	
3.5	Upon receiving Detail/Outline/Surplus schedules	Battery SCADA	Recording Detail/Outline/Surplus schedules	Battery SCADA records Detail, Outline or Surplus schedules	Battery SCADA	Battery SCADA	Detail, Outline or Surplus Schedule of Customer's Battery		

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
3.6	Upon receiving Detail/Outline/Surplus schedules from all Customer side EMSs	Battery SCADA	Calculation of the total surplus potential for each default plan and the schedule of batteries for each default Plans	Battery SCADA calculates the total surplus potential for each default plan and the schedule of batteries for each default plan.	Battery SCADA	Battery SCADA	The total surplus potential for each default plan and the schedule of batteries for each default plan		
3.7	Completion of calculation the total surplus potential for each default plan	Battery SCADA	Sending the total surplus potential for each default plan and the schedule of batteries for each default Plans	Battery SCADA sends the total surplus potential for each default plan and the schedule of batteries for each default plans to Grid EMS	Battery SCADA	Grid EMS	The total surplus potential for each default plan and the schedule of batteries for each default plans	Open ADR+	
3.8	Upon Receiving the total surplus potential for each default plan	Grid EMS	Recording the total surplus potential for each default plan	Grid EMS receives the total surplus potential for each default plan and the schedule of batteries for each default plans and records them	Grid EMS	Grid EMS	The total surplus potential for each default plan and the schedule of batteries for each default Plans		

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
3.9	Completion Recording	Grid EMS	Displaying the total surplus potential for each default plan	Grid EMS displays the total surplus potential for each default plan	Grid EMS	Grid Operator	The total surplus potential for each default plan and the schedule of batteries for each default Plans		
4.1	Upon Grid Operator Request	Grid Operator	Setting the Plan for PSCBA	Grid Operator sets the Plan for PSCBA	Grid Operator	Grid EMS	The Plan for PSCBA		
4.2	Receiving Grid Operator's request	Grid EMS	Sending the Plan for PSCBA	Grid EMS sends the Plan for PSCBA to Battery SCADA	Grid EMS	Battery SCADA	The Plan for PSCBA	Open ADR+	
4.3	Upon receiving the Plan for PSCBA	Battery SCADA	Calculating the total surplus potential for the plan and the schedule of Batteries for the plan	Battery SCADA calculates the total surplus potential for the plan and the schedule of batteries for the plan	Battery SCADA	Battery SCADA	The total surplus potential for the plan The schedule of batteries for the plan		

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
4.4	Completion of calculating 'the total surplus potential for the plan'	Battery SCADA	Comparing the total surplus potential with the plan	Battery SCADA compares the total surplus potential with the plan	Battery SCADA	Battery SCADA	The Plan for PSCBA The total surplus potential for the plan	IF [the total surplus potential for the plan]< [The Plan for PSCBA], Then, move on to step #4.10.a.1, IF NOT, move on to step #4.5	
4.5	Completion of comparing the total surplus potential with the plan	Battery SCADA	Sending 'inquiry' command to Customer side EMS	Battery SCADA sends 'inquiry' command to Customer side EMS,	Battery SCADA	Customer side EMS	'Inquiry'	Open ADR+	
4.6	Completion of sending 'inquiry' command to Customer side EMS,	Battery SCADA	Waiting for response to inquiry from Customer side EMS,	Battery SCADA waits for response to the inquiry from the Customer side EMS,	Battery SCADA	Battery SCADA	'Inquiry'	If, time out occur during waiting, then move on to step #4.10a.1, IF NOT, move on to step #4.7.a.1 or step #4.7.b	
4.7.a.1	Upon receiving 'Inquiry' command	Customer side EMS	Sending 'Inquiry rejection'	Customer side EMS sends 'inquiry rejection' to Battery SCADA	Customer side EMS	Battery SCADA	Inquiry Rejection	Open ADR+	

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
4.7.a.2	Upon receiving 'inquiry rejection'	Battery SCADA	Receiving 'Inquiry rejection' and updating the schedule of batteries for the plan	Battery SCADA receives 'Inquiry rejection' and updates the schedule of batteries for the plan (deleting rejecting customer's battery from the schedule)	Battery SCADA	Battery SCADA	Inquiry Rejection The schedule of batteries for the plan		
4.7.a.3	Completion of receiving 'inquiry rejection'	Battery SCADA	Checking the batteries schedule of batteries for the plan to select another Customer's battery	Battery SCADA checks the battery schedule for the plan to select other Customer's battery	Battery SCADA	Battery SCADA	The schedule of batteries for the plan	If no, another customer's battery is selected, then move on to step #4.10.a.1, Else move on to step #4.7.a.4	
4.7.a.4	Completion of checking the batteries schedule of batteries for the plan to select other Customer's battery	Battery SCADA	Sending 'inquiry' command to Customer side EMS	Battery SCADA sends 'inquiry' command to Customer side EMS,	Battery SCADA	Customer side EMS	'Inquiry'	Move on to step #4.6 Open ADR+	
4.7.b	Upon receiving 'Inquiry' command	Customer side EMS	Sending 'Inquiry acceptance'	Customer side EMS sends acceptance to Battery SCADA	Customer side EMS	Battery SCADA	Inquiry acceptance	Open ADR+	

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
4.8	Upon receiving 'Inquiry acceptance	Battery SCADA	Receiving 'Inquiry acceptance	Battery SCADA receives 'Inquiry acceptance	Battery SCADA	Battery SCADA	Inquiry acceptance		
4.9	Completion of receiving 'inquiry acceptance	Battery SCADA	Checking the batteries schedule of batteries for the plan whether or not receiving enough acceptances	Battery SCADA checks the battery schedule of batteries for the plan whether it has received or not received enough acceptances	Battery SCADA	Battery SCADA	Inquiry acceptance the batteries schedule of batteries for the plan	If Battery SCADA has not enough acceptances, then move on to step 4.6, Else, move on to step #4.10.b1	
4.10. a.1	In step #4.4, the total surplus is not enough, or in step #4.6, time out occurs, or in step #4.7.a.3, no other customer's battery is selected	Battery SCADA	Sending Message of lack of surplus for the plan to Grid EMS	Battery SCADA Sends Message of lack of surplus for the plan and the schedule of batteries for the plan to Grid EMS	Battery SCADA	Grid EMS	Message of lack of surplus for the plan and The schedule of batteries for the plan	Open ADR+	

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
4.10.a.2	Upon receiving Message of lack of surplus for the plan	Grid EMS	Receiving Message of lack of surplus for the plan and the schedule of batteries for the plan	Grid EMS receives Message of lack of surplus for the plan and the schedule of batteries for the plan	Grid EMS	Grid EMS	Message of lack of surplus for the plan and The schedule of batteries for the plan		
4.10a.3	Completion of receiving Message	Grid EMS	Display Message of lack of surplus for the plan and the schedule of batteries for the plan	Grid EMS displays Message of lack of surplus for the plan and the schedule of batteries for the plan	Grid EMS	Grid Operator	Message of lack of surplus for the plan The schedule of batteries for the plan	Move on to Exit, Or move on to step #3.1 to retry with another plan	
4.10.b.1	Upon all 'Inquiry acceptance'	Battery SCADA	Sending the schedule of batteries for the plan	Battery SCADA sends the schedule of batteries for the plan	Battery SCADA	Grid EMS	Schedule of batteries for the plan	Open ADR+	
4.10.b2	Upon receiving the schedule of batteries for the plan	Grid EMS	Display the schedule of batteries for the plan	Grid EMS displays the schedule of batteries for the plan	Grid EMS	Grid Operator	Schedule of batteries for the plan		

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
5.1	When Grid Operator review and approve The Schedule of Batteries for the Plan	Grid Operator	Notifying execution of the plan	Grid Operator notifies execution of the plan	Grid Operator	Grid EMS	Execution Notification		
5.2	Upon receiving Execution Notification	Grid EMS	Sending Execution Notification	Grid EMS sends Execution Notification to Battery SCADA.	Grid EMS	Battery SCADA	Execution Notification	Open ADR+	
5.3	Upon receiving Execution Notification	Battery SCADA	Sending Execution Notification	Battery SCADA sends Execution Notification to Customer side EMS	Battery SCADA	Customer side EMS	Execution Notification	Open ADR+	
6.1	Every 1second during conducting the plan for PSCBA	Battery SCADA	Sending Charging / Discharging command	Battery SCADA sends Charging/Discharge command to Stationary Battery according to the schedule of batteries for the plan	Battery SCADA	Stationary Battery	Charging / Discharging command	DNP3.0 mapping to IEC61850	

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
6.2	Upon receiving Charging / Discharging command	Stationary Battery	Charging or Discharging Sending Current Status	Stationary Batteries charge or discharge according Charging/Discharge command And sends Current Status to Battery SCADA	Stationary Battery	Battery SCADA	Current Status of each stationary battery	DNP3.0 mapping to IEC61850	
6.3	Upon receiving current Status of each stationary battery	Battery SCADA	Recording current Status of each stationary battery	Battery SCADA records current Status of each stationary battery	Battery SCADA	Battery SCADA	Current Status of each stationary battery		
7.1	Every 30 minutes	Battery SCADA	Sending 'request for current status of Customer's Battery'	Battery SCADA sends 'request for current status of Customer's Battery' to customers' EMSs	Battery SCADA	Customer side EMS	request for current status of Customer's Battery	Open ADR+	
7.2	Upon receiving 'request for current status of Customer's Battery'	Customer side EMS	Sending current status of each Customer's Battery	Customers' side EMS sends current status of each Customer's Battery	Customer side EMS	Battery SCADA	Current status of each Customer's Battery	Open ADR+	

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
7.3	Upon receiving current status	Battery SCADA	Receiving and recording current status of each Customer's Battery	Battery SCADA receives and records current status of each Customer's Battery	Battery SCADA	Battery SCADA	Current status of each Customer's Battery		
8.1	Every 1 second	Battery SCADA	Calculation of Current Status of Virtual Battery for PSCAB	Battery SCADA Calculates Current Status of Virtual Battery for PSCAB using Current Status of each Customer's Battery, Current Status of each Stationary Battery and the Schedule of Batteries for the Plan	Battery SCADA	Battery SCADA	Current Status of Virtual Battery for PSCAB		
8.2	Completion of calculating Current Status of Virtual Battery for PSCAB	Battery SCADA	Sending Current Status of Virtual Battery for PSCAB	Battery SCADA sending Current Status of Virtual Battery for PSCAB to Grid EMS	Battery SCADA	Grid EMS	Current Status of Virtual Battery for PSCAB	Open ADR+	
8.3	Receiving Current Status of Virtual Battery for PSCAB	Grid EMS	Recording Current Status of Virtual Battery for PSCAB	Grid EMS records Current Status of Virtual Battery for PSCAB	Grid EMS	Grid EMS	Current Status of Virtual Battery for PSCAB		

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
8.4	Upon Grid Operator request	EMS Operator	Requesting Display of Current Status of Virtual Battery for PSCAB	Grid Operator request display of Current Status of Virtual Battery for PSCAB	Grid Operator	Grid EMS	Display Request of Current Status of Virtual Battery for PSCAB		
8.5	Upon receiving Display Request	Grid EMS	Displaying Current Status of Virtual Battery for PSCAB	Grid EMS displays Current Status of Virtual Battery for PSCAB	Grid EMS	Grid Operator	Current Status of Virtual Battery for PSCAB		

2.1.4 Post-conditions and Significant Results

Describe any significant results from the Function

Actor/Activity	*Post-conditions Description and Results*
Grid Operator	Grid operator completed conducting the plan for Peak Shift Contribution by Battery Aggregation.
Grid EMS	Grid EMS continues to monitor the Grid.
Battery SCADA	Battery SCADA waits for a Grid Operator's request for another plan, such as peak shift or load leveling.
Stationary Battery	Stationary Battery waits to receive charging / discharging command from Battery SCADA.
Customer side EMS	Customer side EMS continues to control Customer's battery according to the customer's policy.

3 Auxiliary Issues

3.1 References and contacts

ID	Title or contact	Reference or contact information
[1]	CEMS2Battery SCADA Project	
[2]		

3.2 Revision History

No	Date	Author	Description
0.	08-09-2011	Y.Ebata	Draft for Review (version 1)
1	02-09-2011	Y.Ebata & H.Hayashi	Reviewed and revised (version 2)
3	10-01-2011	Jim Reilly	Reviewed and revised 3
4	10-04-2011	Y. Ebata & H. Hayashi	Reviewed and revised 4
5	10-05-2011	Jim Reilly	Reviewed and revised 5
6	10-05-2011	Y. Ebata & H. Hayashi	Reviewed and revised 6