# 1 Description of the Use Case

## 1.1 Name of Use Case: Microgrid-Island to Grid-Connected Transition

| Use Case Identification | | |
|---|---|---|
| **ID** | **Domain(s)/ Zone(s)** | **Name of Use Case** |
| 001 | SGIP | Microgrid – Island to Grid-Connected Transition |

## 1.2 Version Management

| Version Management | | | | |
|---|---|---|---|---|
| **Version No.** | **Date** | **Name of Author(s)** | **Changes** | **Approval Status** |
| V001 | 2015-04-22 | D.Bradley, S.Laval, D.Lawrence | | Draft |
| V002 | 2015-04-27 | M. Joe Zhou | | Draft review |
| V003 | 2015-05-28 | S.Laval | | Draft review |
| V004 | 2015-09-28 | S.Laval | Updated diagrams based on UML | Draft |

## 1.3 Scope and Objectives of Use Case

| Scope and Objectives of Use Case | |
|---|---|
| **Scope** | Microgrid – Island to Grid-Connected Transition |
| **Objective(s)** | The optimizer matches the island voltage and frequency to the grid by managing the distributed generation resources to enable the island recloser to resynchronize and reconnect to the grid. |
| **Related business case(s)** | Microgrid – Unscheduled Islanding Transition, Microgrid – Optimization |

## 1.4 Narrative of Use Case

| Narrative of Use Case |
|---|
| **Short description** |
| The transition from Islanded to Grid-Connected Microgrid (Resynchronization and Reconnection). |
| **Complete description** |
| This use case deals with the resynchronization and reconnection transition behavior from islanded mode to grid-connected mode of the microgrid. In this scenario, power is restored to the grid and is detected by the island recloser (or switch) at the point of common coupling (PCC); this starts the resynchronization / reconnection (synch-check) activity, only if the DMS provides a confirmation status to the Optimizer of the restored power grid and also granting permission to the island recloser by removing its control block. The balancing of the grid side and island side voltage and frequency are managed by the optimizer in conjunction with the battery inverters. Once the recloser synch-check function criteria is met, the Microgrid is resynchronized and reconnected to the grid. Immediately, the Optimizer messages the battery inverters to switch from voltage-source “Sv” to current-source “Sc” mode. Additionally, the microgrid optimizer and the Utility SCADA receive the recloser close status to update their models.<br><br>There is one scenario to this use case: Grid Power Restored.<br><br><u>Grid Power Restored</u><br><br>Several steps are followed:<br>1. Island recloser detects return of power to the grid at PCC and publishes readings and status to Optimizer and DMS.<br>2. DMS sends confirmation status to Optimizer and also sends remove control block command to island recloser.<br>3. Optimizer receives readings and status of the island recloser and the confirmation status from DMS and begins the grid resynchronization and reconnection process<br>4. Optimizer publishes the synch-check command to the Island recloser and receives periodic statuses and readings from the solar inverter, batter inverter, and meters.<br>5. Island recloser receives the synch-check command and initiates the resynch process<br>6. Optimizer manages all battery inverters to match grid-side voltage and frequency by publishing desired setpoints<br>7. Battery inverters publish readings and status to the Optimizer |

8. Optimizer receives Battery inverter readings and status and adjusts setpoints to match grid
9. Island recloser resynchs and publishes readings and status to the Optimizer and Utility SCADA
10. Optimizer receives Island recloser status message
11. Optimizer publishes battery inverter change setting to current-source “Sc” mode
12. Battery iniverter receives command and switches to current-source “Sc” mode
13. Utility SCADA receives island recloser status message

The Microgrid Island to Grid-Connected Transition performs the following functions:

1) Trigger Battery Inverter to switch to current-source “Sc” mode
2) Notify microgrid optimizer and DMS of status
3) Controls battery inverter settings to balance voltage and frequency of island to grid
4) Ensure DMS provides permission
5) Optimizer activates recloser synch-check function

## 1.5 General Remarks

| *General Remarks* |
|---|
| Not Applicable |

## 2 Diagrams of Use Case

*Diagram(s) of Use Case*

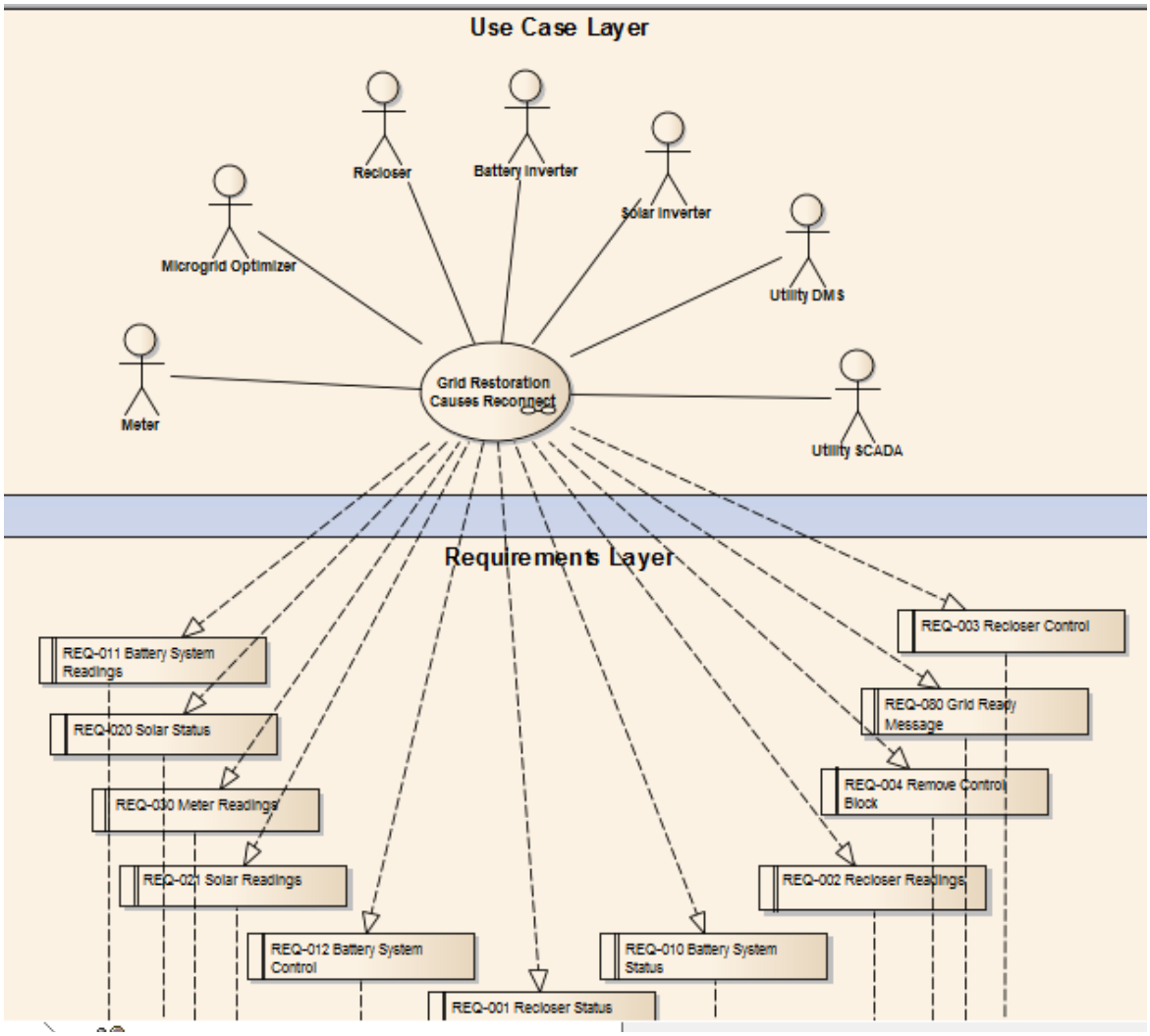


Figure 1 Use Case for Island to Grid-Connected Microgrid Transition

# 3 Technical Details

## 3.1 Actors

| Actors | | | |
|---|---|---|---|
| **Grouping** (e.g. domains, zones) | | **Group Description** | |
| | | | |
| **Actor Name** see Actor List | **Actor Type** see Actor List | **Actor Description** see Actor List | **Further information specific to thisUse-Case** |
| Microgrid Optimizer | System, application | Application which optimizes the resources included in the microgrid. Optimization is done using a constrained dynamic dispatch. | |
| Recloser | Device | This is the Point of Connection (common coupling) to the grid. Indicates whether microgrid is in grid-connected or Islanded mode of operation. | |
| Battery Inverter | Device | Inverter that connects battery to the microgrid. Assumed to be capable of operation as a rectifier. Controllable range of zero to current maximum capability of the battery. | |
| Solar Inverter | Device | Inverter that connects solar panel to the microgrid. Controllable range of zero to current maximum capability of solar panel. | |
| SCADA | System, application | SCADA applications including data acquisition, supervisory control, and user interface, and alarming. | |
| Utility DMS | System, application | System that manages and control the utility distribution grid that microgrids are connected to. | |
| Meter | device | Measuring device for Microgrid electrical measurements. | |

## 3.2 Triggering Event, Preconditions, Assumptions

| Use Case Conditions | | | |
|---|---|---|---|
| **Actor/System/Information/Contract** | **Triggering Event** | **Pre-conditions** | **Assumption** |
| Microgrid Optimizer | Dispatching is done on a periodic basis that is set during system configuration and event driven by recloser and DMS messages. | Microgrid Optimizer dispatching is always on. | Resource attributes are prepopulated in Microgrid Optimizer. Assumption is that microgrid optimizer publishes and subscribes to the open field message bus. |
| Recloser | Power system disturbance is detected by relaying protection scheme that operates system. | Reconnecting the microgrid to the grid from islanded mode is the objective of protection scheme. Protection scheme requires sensing of voltage on grid side and the ability to communicate with Optimizer and DMS. | Reconnection of microgrid were part of design of microgrid protection scheme. Assumption is that recloser publishes and subscribes to the open field message bus and is polled by SCADA. |
| Battery Inverter | Always on. Microgrid Optimizer can dispatch inverter up to current maximum capability of battery. | | Resource attributes are prepopulated in Microgrid Optimizer. Assumption is that battery inverter publishes and subscribes to the open |

| | | | |
|---|---|---|---|
| | | | field message bus. |
| Utility DMS | Always on during daylight. Receives readings from recloser and provides permission to reconnect to grid | DMS receives data from SCADA | Resource attributes are prepopulated in DMS. |

### 3.3 References

| *References* | | | | | | |
|---|---|---|---|---|---|---|
| ***No.*** | ***References Type*** | ***Reference*** | ***Status*** | ***Impact on Use Case*** | ***Originator / Organisation*** | ***Link*** |
| 1 | IEC | 62559-2 | | Utilized use-case narrative template | Omnetric, Jim Waight | |
| 2 | ORNL | ERPI MicroGrid use case: ONRL-F5 | | Similar to current usecase | Oakridge National Laboratory, Tennesse | |

### 3.4 Further Information to the Use Case for Classification / Mapping

| *Classification Information* |
|---|
| ***Relation to Other Use Cases*** |
| There are other use cases related to the optimization of the microgrid and its reconnection. |
| ***Level of Depth*** |
| Mid level |
| ***Prioritisation*** |
| High |
| ***Generic, Regional or National Relation*** |
| Will be applied in a generic test at Duke, CPS Energy, NREL, and SCE test beds. |
| ***Viewpoint*** |
| Technical |
| ***Further Keywords for Classification*** |
| |

## 4 Step by Step Analysis of Use Case

### 4.1 Steps – Scenario Name

| **Scenario Conditions** | | | | | |
|---|---|---|---|---|---|
| **No.** | **Scenario Name** | **Primary Actor** | **Triggering Event** | **Pre-Condition** | **Post-Condition** |
| 1 | Grid power restoration and permission from DMS causes islanded microgrid to reconnect with the grid | Island recloser at PCC | Grid power restoration | Recloser set up, tested and control block is removed. | Grid-connected from island transition |

### 4.2 Steps – Scenarios

## 5 Information Exchanged

See Model Output IDL or XSD for a detailed CIM data description.

| *Information Exchanged* | | |
|---|---|---|
| ***Name of Information (ID)*** | ***Description of Information Exchanged*** | ***Requirements to information data*** |
| Recloser Status | timeStamp<br>normalOpen<br>isLockedOut<br>isOpen | Recloser Status (open or closed) |
| Recloser Readings | timestamp<br>value<br>flowDirection<br>multiplier<br>name<br>phases<br>unit | Reading and Reading Type defined in CIM |
| Battery Inverter Status | timestamp<br>isCharging<br>isConnected | Battery Inverter Status (charging or discharging, Sv or Sc mode) |
| Battery Inverter Control | timeStamp<br>eventOrAction – Mode Control --<br>type<br>controlType – SetPoint Control --<br>unitMultiplier<br>unitSymbol<br>value | Battery Inverter Control (CIM End Device Control) |
| Solar Inverter Status | timestamp<br>isConnected | Solar Inverter Status (connected or disconnected) |
| Solar Inverter Control | timeStamp<br>controlType – SetPoint Control --<br>unitMultiplier<br>unitSymbol<br>value | Solar Inverter Control (CIM End Device Control) |
| SCADA | timestamp<br>value<br>flowDirection<br>multiplier<br>name<br>phases<br>unit | Reading and Reading Type defined in CIM |
| Utility DMS | timestamp<br>value<br>flowDirection<br>multiplier<br>name<br>phases<br>unit | Reading and Reading Type defined in CIM |
| Meter Readings | timestamp<br>value<br>flowDirection<br>multiplier<br>name<br>phases<br>unit | Reading and Reading Type defined in CIM |

## 6 Requirements (optional)

| Requirements (optional) | |
|---|---|
| **Categories for Requirements** | **Category Description** |
| NA | |
| **Requirement ID** | **Requirement Description** |
| NA | |
| | |

## 7 Common Terms and Definitions

| Common Terms and Definitions | |
|---|---|
| **Term** | **Definition** |
| | |

## 8 Custom Information (optional)

| *Custom Information (optional)* | | |
|---|---|---|
| ***Key*** | ***Value*** | ***Refers to Section*** |
| NA | | |
| | | |