**1 Description of the Use Case**

**1.1 Name of Use Case: Microgrid Reconnection**

|  |  |  |
| --- | --- | --- |
| ***Use Case Identification*** | | |
| ***ID*** | ***Domain(s)/ Zone(s)*** | ***Name of Use Case*** |
|  |  | Microgrid Reconnection |

**1.2 Version Management**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ***Version Management*** | | | | |
| ***Version No.*** | ***Date*** | ***Name of Author(s)*** | ***Changes*** | ***Approval Status*** |
| 20161123a | 20161123 |  | 20161107 UML |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**1.3 Scope and Objectives of Use Case**

|  |  |
| --- | --- |
| ***Scope and Objectives of Use Case*** | |
| ***Scope*** | Reconnection of an islanded microgrid to the grid |
| ***Objective(s)*** | Seamlessly reconnect a low-inertia microgrid to the grid |
| ***Related business case(s)*** | Circuit Segment Optimization  Microgrid Unscheduled Islanding |

**1.4 Narrative of Use Case**

|  |
| --- |
| ***Narrative of Use Case*** |
| ***Short description*** |
| The business objective of this Microgrid Reconnection use case is to seamlessly transition a low-inertia microgrid from islanded to grid-connected mode. The microgrid PCC Coordination Service creates device schedules considering the status and capabilities of circuit segment actors over appropriate timeframes. These schedules maintain proper voltage, frequency, and power factor for safe, reliable operation, including switching the Primary Energy Storage System from voltage source inverter (VSI) isosynchronous (ISO) mode upon reconnection to the grid. |
| ***Complete description*** |
| The business objective of this Microgrid Reconnection use case is to seamlessly transition a low-inertia microgrid from islanded to grid-connected mode. Figure 1 shows the microgrid connected to a feeder and substation. The microgrid Point of Common Coupling (PCC), which is a motor operated switch, isolates the microgrid from the feeder and delineates two separate but coordinated, self-optimized layers, each with its own Coordination Service. The microgrid includes PV, multiple Energy Storage Systems, as well as controllable and uncontrollable loads. Within this OpenFMB reference implementation, the microgrid has the ability to independently seamlessly island and reconnect without interruption.    Figure 1: Microgrid Reconnection Use Case Single Line Diagram  Considering the status and capabilities of circuit segment actors over appropriate timeframes, schedules created by the microgrid PCC Coordination Service maintain proper voltage, frequency, and power factor for safe, reliable operation. Depending upon local conditions and objectives, multiple algorithms may satisfy local needs. This use case is agnostic to such differing algorithms and only addresses interactions between the use case actors. The microgrid PCC Coordination Service may also consider objectives such as:   * Import or export schedules * Economic dispatch * Solar smoothing to reduce circuit segment volatility * Volt-VAr for power factor optimization * Peak demand management by shaving / shifting   For a microgrid, such as shown in Figure 1, the general event-driven flow of information for transitioning a low-inertia microgrid from islanded to grid-connected mode is:   1. PCC Motor Operated Switch detects that grid power has returned and publishes anomaly event 2. Co-located PCC Coordination Service module subscribes to anomaly event from PCC Motor Operated Switch 3. Using readings from the Point of Interconnection (POI) and PCC sides of the Motor Operated Switch, co-located PCC Coordination Service develops, publishes, and has devices execute new schedules to bring microgrid PCC side readings to within tolerance of POI side readings    * When readings are within tolerance, PCC Coordination Services sends sync check control to PCC Motor Operated Switch while continuing to develop, publish, and have devices execute new schedules      + When readings are within tolerance, PCC Motor Operated Switch closes 4. PCC Coordination Service develops and publishes schedules for grid-connected mode 5. Primary ESS subscribes to and executes the schedule to change from VSI ISO mode 6. Other microgrid devices subscribe to and execute grid-connected mode schedules |

**1.5 General Remarks**

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

**2 Diagrams of Use Case**

|  |
| --- |
| ***Diagram(s) of Use Case*** |

|  |
| --- |
| Figure 2: Microgrid Reconnection Use Case    Figure 3: Grid Sync Use Case    Figure 4: Grid Connect Use Case |

**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 info*** |
| Devices | | | |
| Controllable Load | Device | Electrical components whose power consumption can be adjusted by a specified entity. |  |
| Energy Storage System | Device | Device that stores energy at one time to discharge it at a later time. Commonly includes power control system inverter / rectifier converting alternating current to or from battery direct current. |  |
| Load | Device | Electrical components whose power consumption is not under the control of the entity of concern. |  |
| Motor Operated Switch | Device | A switch which can be operated by activating its motor. |  |
| PCC | Device | Point of common coupling where a portion of the electrical grid under separate administration can disconnect from or reconnect to a portion of the larger electrical grid. |  |
| Solar Inverter | Device | Inverter providing AC current from photovoltaic panels. |  |
| Services | | | |
| PCC Coordination Service | Service | A system service that coordinates actions of devices on a portion of the grid under separate administration. Coordinates with POI Coordination Service. |  |
| PCC Optimizer | Service | Publishes requested schedule for a service provider defined period of time with time intervals ranging from minutes to several hours. |  |

**3.2 Triggering Event, Preconditions, Assumptions**

|  |  |  |  |
| --- | --- | --- | --- |
| ***Use Case Conditions*** | | | |
| ***Actor/System/Information/Contract*** | ***Triggering Event*** | ***Pre-conditions*** | ***Assumption*** |
| PCC Motor Operated Switch | PCC Motor Operated Switch detects that grid power has returned | PCC Motor Operated Switch operating |  |
| PCC Coordination Service | Coordination Service publishes planned grid-connected mode schedules | PCC Coordination Service operating |  |
| Other devices and Optimizer | Other devices and Optimizer respond to new schedules | Other devices and Optimizer operating |  |

**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 |  |

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

|  |
| --- |
| ***Classification Information*** |
| ***Relation to Other Use Cases*** |
| This use case may have been preceded by Microgrid Unscheduled Islanding use case |
| ***Level of Depth*** |
| Mid level |
| ***Prioritization*** |
| High |
| ***Generic, Regional or National Relation*** |
| Will be applied in a generic test at Duke test bed. |
| ***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 | Microgrid Reconnection | PCC Coordination Service | PCC Motor Operated Switch detects that grid power has returned | PCC Coordination Service, PCC Optimizer, and devices operating | Devices executing schedules in grid-connected mode  PCC Optimizer responds to schedule |

**4.2 Steps – Scenarios**

**4.2.1 Steps – Microgrid Reconnection**



Figure 5: Microgrid Reconnection Activity Diagram



Figure 6: Grid Sync Activity Diagram



Figure 7: Grid Connect Activity Diagram

**5 Information Exchanged**

See logical models designed based on the IEC CIM. Physical XSDs and IDLs are generated from the logical models listed below.

|  |
| --- |
| ***Name of Information and Description of Information Exchanged*** |
| **BreakerEventProfile** |
| **BreakerReadingProfile** |
| **BreakerStatusProfile** |
| **ESSControlProfile** |
| **ESSControlScheduleProfile** |
| **ESSEventProfile** |
| **ESSReadingProfile** |
| **ESSStatusProfile** |
| **GenerationControlProfile** |
| **GenerationControlScheduleProfile** |
| **GenerationEventProfile** |
| **GenerationForecastProfile** |
| **GenerationReadingProfile** |
| **GenerationStatusProfile** |
| **InterchangeScheduleProfile** |
| **PlannedInterconnectionScheduleProfile** |
| **RequestedInterconnectionScheduleProfile** |
| **LoadControlProfile** |
| **LoadControlScheduleProfile** |
| **LoadForecastProfile** |
| **LoadReadingProfile** |
| **LoadStatusProfile** |
| **MotorOperatedSwitchControlProfile** |
| **MotorOperatedSwitchControlScheduleProfile** |
| **MotorOperatedSwitchEventProfile** |
| **MotorOperatedSwitchReadingProfile** |
| **MotorOperatedSwitchStatusProfile** |
| **PlannedOptimizerScheduleProfile** |
| **RequestedOptimizerScheduleProfile** |
| **RecloserControlProfile** |
| **RecloserEventProfile** |
| **RecloserReadingProfile** |
| **RecloserStatusProfile** |
| **RegulatorControlScheduleProfile** |
| **RegulatorEventProfile** |
| **RegulatorReadingProfile** |
| **RegulatorStatusProfile** |
| **ResourceReadingProfile** |
| **ResourceStatusProfile** |
| **SecurityEventProfile** |
| **ShuntControlProfile** |
| **ShuntControlScheduleProfile** |
| **ShuntReadingProfile** |
| **ShuntStatusProfile** |
| **SolarCapabilityProfile** |
| **SolarControlProfile** |
| **SolarControlScheduleProfile** |
| **SolarEventProfile** |
| **SolarForecastProfile** |
| **SolarReadingProfile** |
| **SolarStatusProfile** |
| **WeatherDataProfile** |

**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** |
| NA |  |

**8 Custom Information (optional)**

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