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*
20161107a	20161107	SGIP OpenFMB Priority Action Plan	20161107 UML	
20181231a	20181231	UCA OpenFMB Users Group	20181011a UML	
1.0.0	20190430	UCA OpenFMB Users Group	Section 5 Information Exchanged separated into supplemental document	

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.

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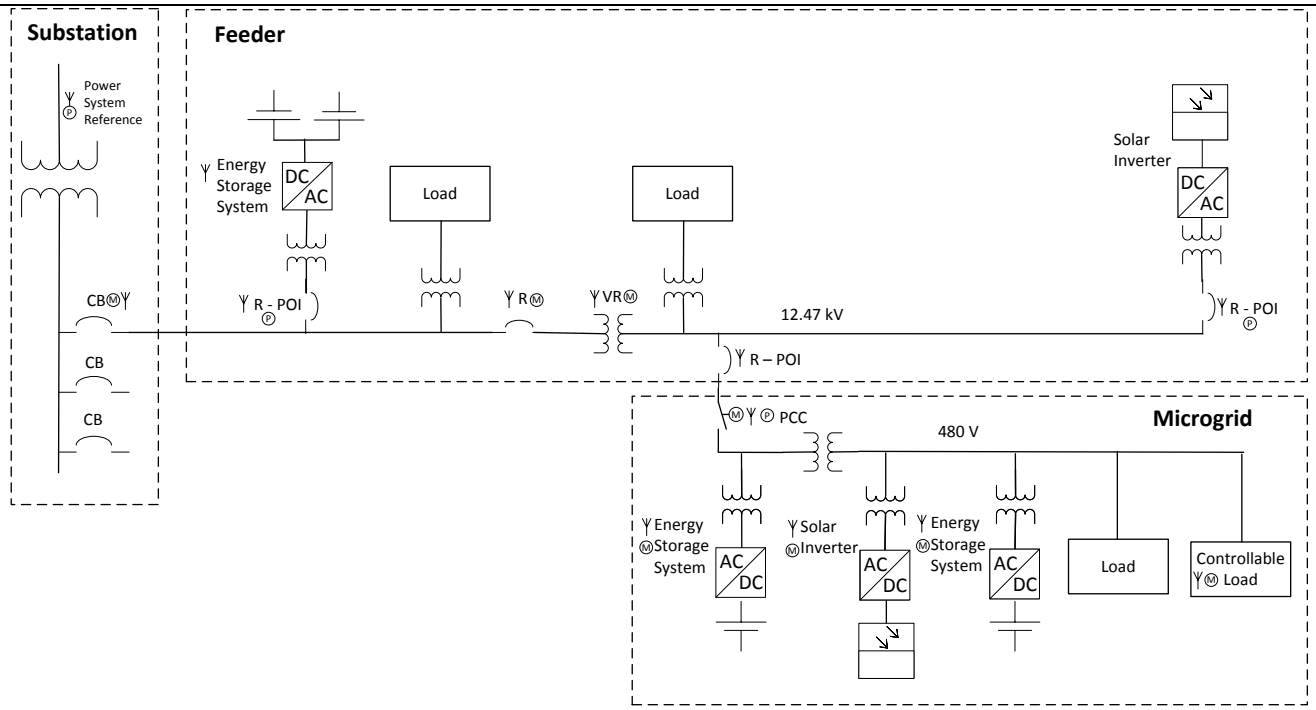

Figure 1: Microgrid Reconnection Use Case Single Line Diagram

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

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2 Diagrams of Use Case

Diagram(s) of Use Case

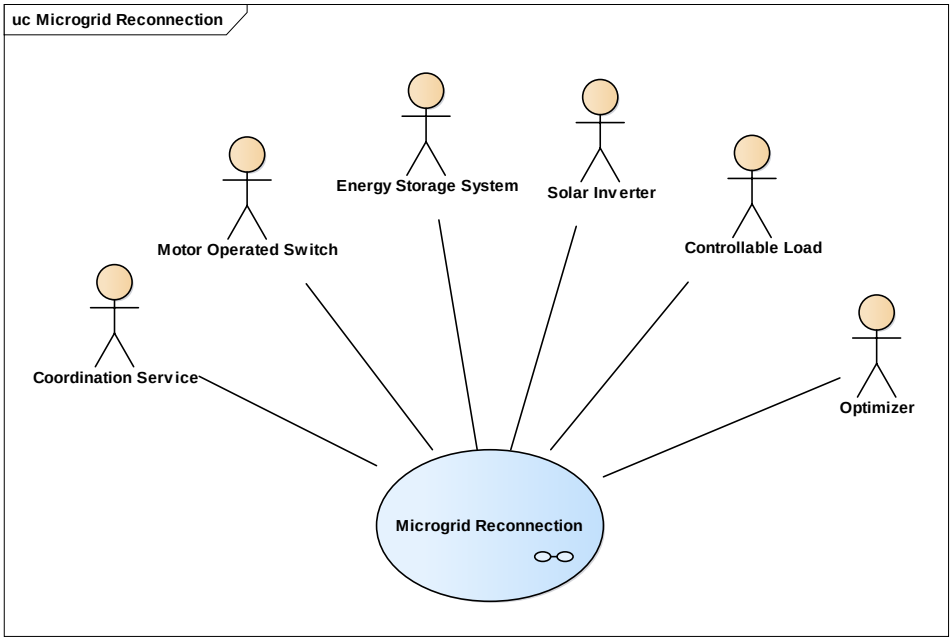

Figure 2: Microgrid Reconnection Use Case

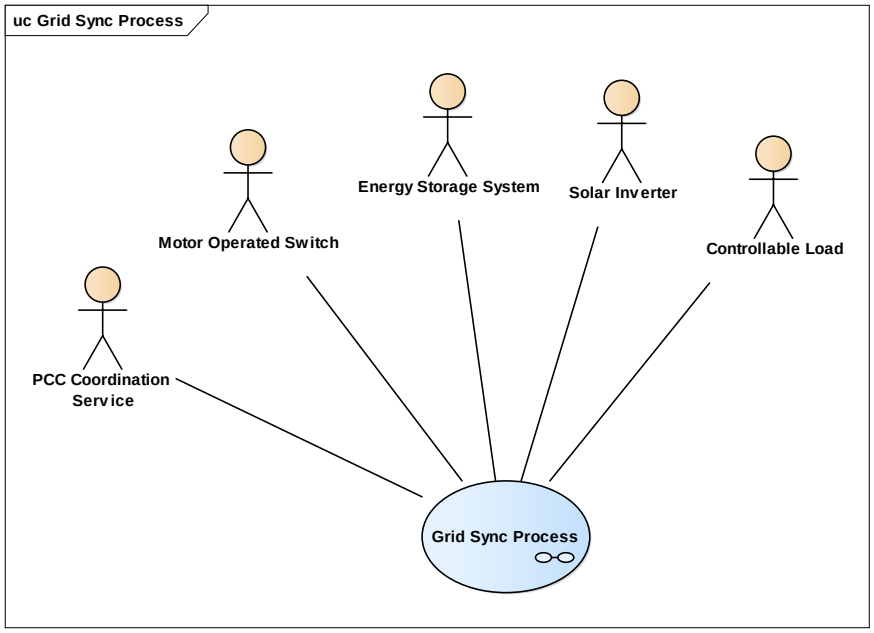

Figure 3: Grid Sync Use Case

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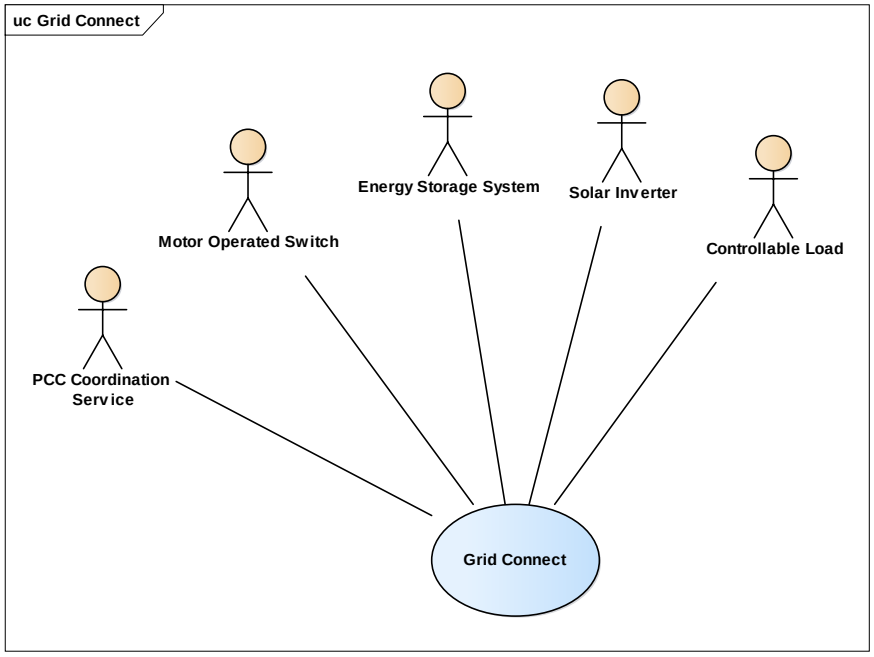

Figure 4: Grid Connect Use Case

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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

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Generic, Regional or National Relation
Will be applied in a generic test at Duke test bed.
Viewpoint
Technical
Further Keywords for Classification

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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

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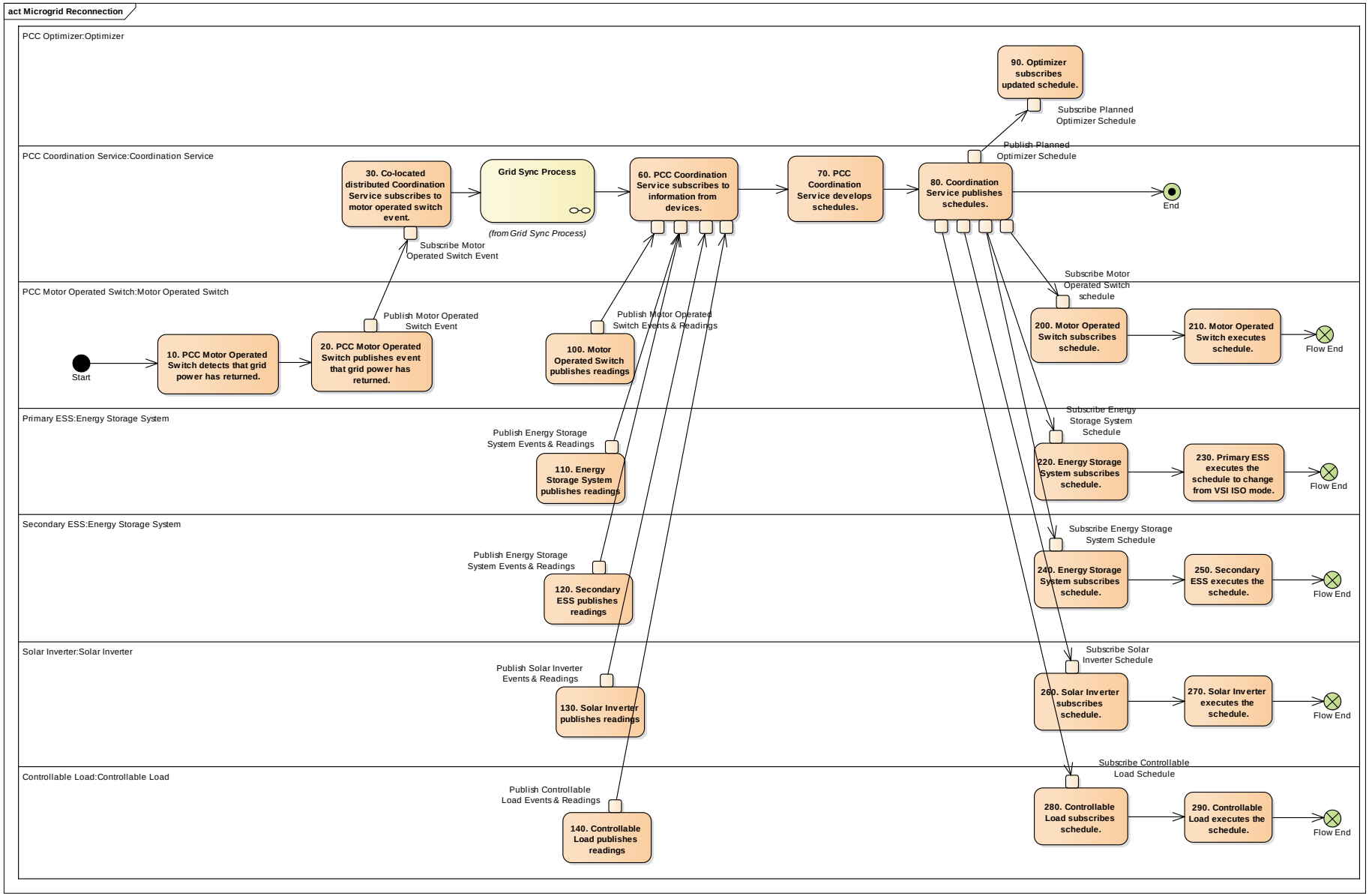

Figure 5: Microgrid Reconnection Activity Diagram

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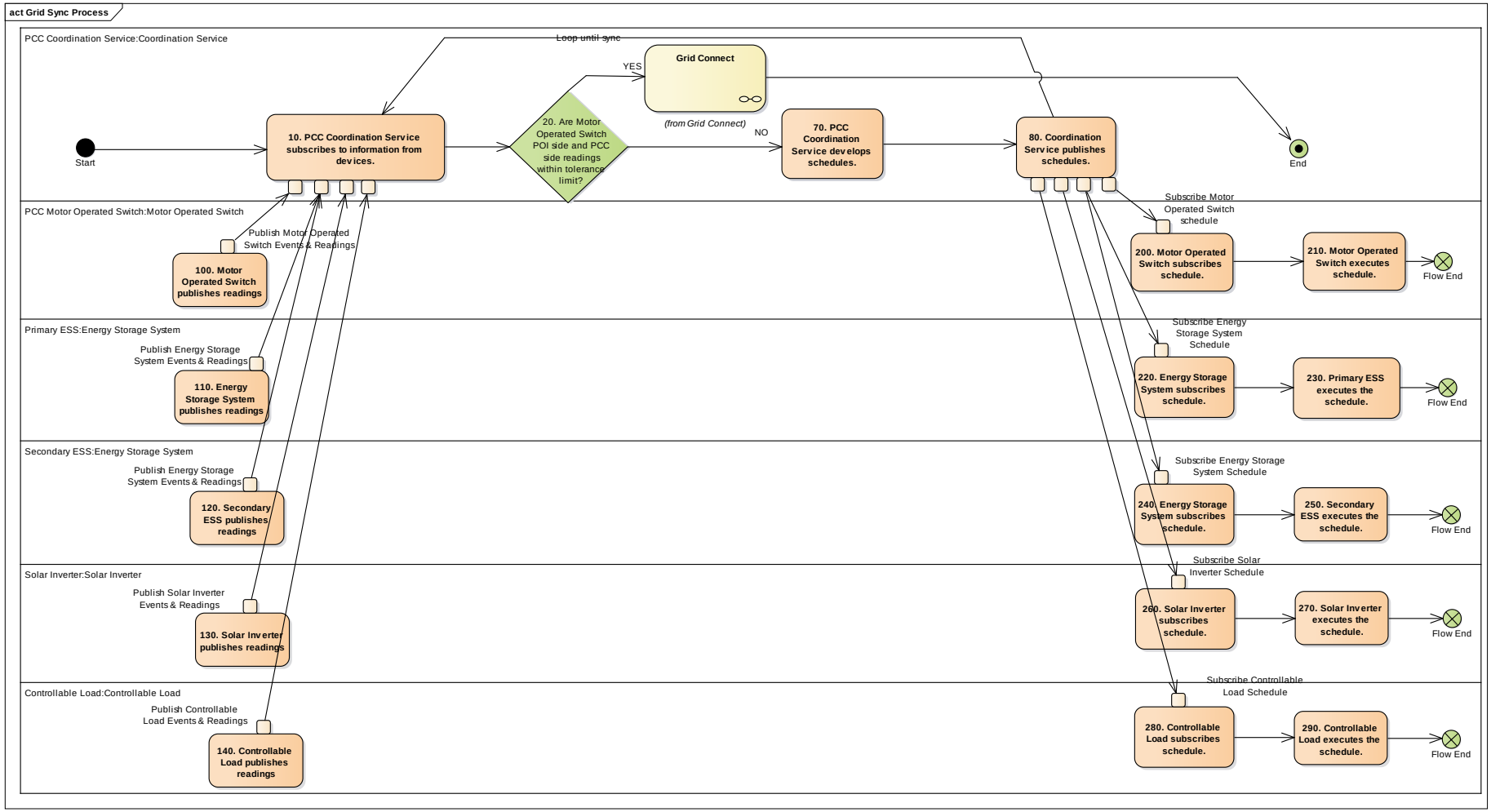

Figure 6: Grid Sync Activity Diagram

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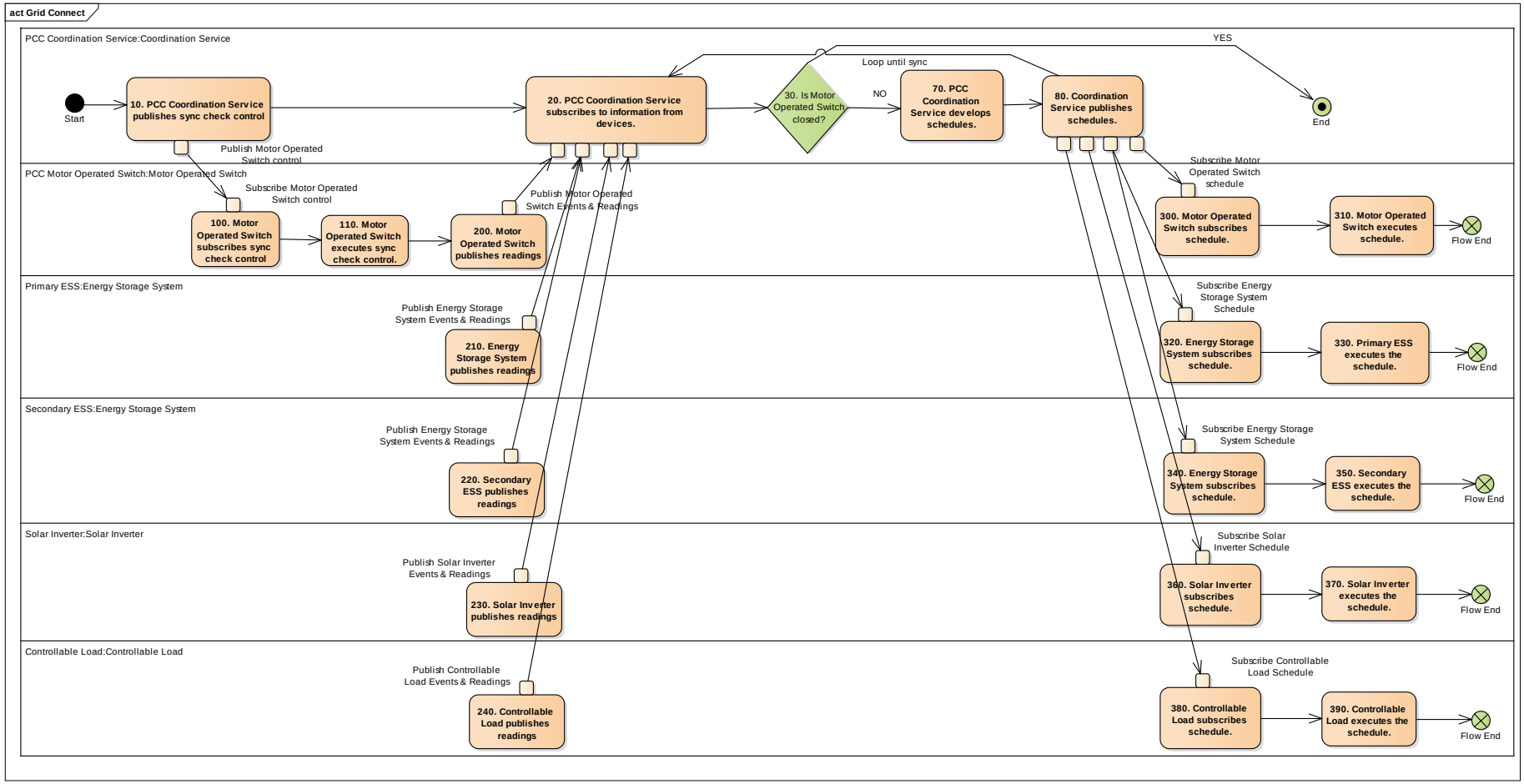

Figure 7: Grid Connect Activity Diagram

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5 Information Exchanged

See OpenFMB Information Exchanged supplementary document.

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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		

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