Grid Connected to Islanding Transition - Intentional

Version 1.2

March 11, 2014

1   Descriptions of Function

1.1   Function Name

Intentional Islanding Transition

1.2   Function ID

Microgrid Functional Use Case #F-3

1.3   Brief Description

This use case describes the function when a microgrid disconnects from the area power system (AEPS) in a planned manner when the AEPS is grid-connected and in a normal operating mode. The process by which the microgrid transitions from grid-connected operation to islanded operation is described.

MICROGRID FUNCTIONAL USE CASES

This is one of ten (10) use cases related to control and operations between the area Electric Power System (AEPS) and Advanced Microgrids in connected, transition and islanded modes. Microgrid operations and control is described in terms of functions.

The Functional Use Cases for Control and Operations of Advanced Microgrids are

1. Frequency control

2. Voltage control (grid-connected & islanding)

3. Grid-connected to islanding transition - Intentional

4. Grid-connected to islanding transition – Unintentional

5. Islanding to grid-connected transition

6. Energy management (grid-connected & islanding)

7. Protection

8. Ancillary services (Grid-connected)

9. Black start

10. User interface and data management

1.4 Narrative

A microgrid needs to be capable of disconnecting itself from the AEPS for the reasons such as economic operation, foreseen AEPS disturbances, maintenances, testing, etc. The microgrid needs to obtain permission from the AEPS for intentional islanding. The microgrid EMS and microgrid SCADA initiate the process of intentional islanding transition by dispatching islanding transition commands to the components in the microgrid. The microgrid EMS will estimate the microgrid load level and the available generation capacities, shed or reduce the loads with lower priorities, re-dispatch the real and reactive power outputs of each generator and energy storage unit so that there is no import/export of real/reactive power between the microgrid and the AEPS at PCC, and the microgrid components are managed in the islanded operation as well. After the islanding transition dispatch commands are executed, the power flow at the PCC is close to zero, and there is minimum impact on both the microgrid and the APS when the microgrid switch disconnects at this condition. After the microgrid is disconnected from the AEPS, it continues with the islanded operation. The microgrid EMS updates the islanded dispatch commands to manage the microgrid in the islanded operation. The microgrid SCADA and the primary sources perform the real-time control and operation to maintain microgrid system stability. Microgrid EMS can continue to participate in market activities by bidding into the daily/hourly-ahead energy market if it is known that the microgrid will be in grid-connected operation at that time.

1.5 Actor (Stakeholder) Roles

Grouping (Community) '		Group Description	
Actor Name Actor* - This use case.	**Actor Type (person, organization, device, system, or subsystem)**	**Actor Description**	
Area Electric Power System (AEPS) *	System	The electrical power system that normally supplies the microgrid through their point of common coupling.	
Area Natural Gas Supply (ANGS)	System	The natural gas pipeline system that supplies natural gas to the microgrid.	
Asset Switches (ASw)	Device	The ASw has the capability to disconnect assets within the microgrid (e.g. NCL) from the microgrid for control purposes. The ASw can receive control signals from the MC and can inform the MC of its status.	

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Grouping (Community) '		Group Description

Actor Name Actor* - This use case.	Actor Type (person, organization, device, system, or subsystem)	Actor Description
Centralized Protection Controller (CPC)	System	This is a central control that is able to communicate with protective devices. It can operate to update settings, or coordinate the operation of protection in real time. This can be a standalone function, or it could be a part of the MCC.
Critical Load (CL) *	Device	Loads within the microgrid having the highest priority of service. These loads will be served at the expense of all other loads in the microgrid and at the expense of any other service the microgrid could provide. The priority of loads within the critical loads is not distinguished.
Market Operator (MO) *	System	The MO accepts bids from assets, such as a MG, in its AEPS and dispatches these assets to provide energy and ancillary services to ensure reliability for the AEPS. The MO may be part of the AEPS or may be a separate entity.
Microgrid controller (MC) *	System	A control system that is able to dispatch the microgrid assets, e.g. opening/closing switches, changing control reference points, changing generation/consumption levels, etc. Other than the microgrid functions specifically referenced below, this Use Case does not specify the objective of any of the microgrid controller functions. This Use Case does not specify how the control signals are transferred or implemented in the microgrid assets.
Microgrid SCADA *	System	The communication and data acquisition of the microgrid controller. It collects real-time data from each individual microgrid actor, passes the data to the microgrid EMS for the calculation of economic dispatch, receives the economic dispatch commands from the microgrid EMS, and distributes them to the microgrid actors. It also controls and coordinates the sources and loads to maintain system stability.

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Grouping (Community) ’		Group Description

Actor Name Actor* - This use case.	Actor Type (person, organization, device, system, or subsystem)	Actor Description
Microgrid Switch (MS) *	Device	A switch at the point of common coupling of the microgrid and the AEPS. The switch has the capability to detect the loss of power from the AEPS and disturbances in the AEPS. The MS can open and close automatically and on command from the MC and can inform the MC of its status.
Non-Critical Load (NCL) *	Device	Loads within the microgrid having the lowest priority of service. These loads may be left unserved in favor of Critical Loads. The priority of loads within the critical loads is not distinguished.
Other Resource (OR) *	Device	All energy resources in the microgrid except for the primary resources. OR could be a generator, energy storage system, or a load.
Point of Common Coupling (PCC) *		The electrical interface between the AEPS and the microgrid.
Primary Resource (PR) *	Device	The energy resources responsible for frequency and voltage regulation. PRs could be a generator, an energy storage system, or controllable load.
Protection device (PD, w-com) (with communications)	Device	This is a relay type device that is able to interrupt fault current and communicates with other devices or the MCC. An example would be a protective relay that has communication with the MCC.
Protection device (PD, w/o-com) (without communications)	Device	This is a relay type device that is able to interrupt fault current and operates in isolation. Examples include relays without the ability to communication, and fuses.
Protection relay (PR)	Device	The device to detect and clear a fault.
Switching device (SD, w-com) (with communications)	Device	This is a switching device that communicates with other devices or the MCC/CPC.
Switching device (SD, w/o-com) (without communications)	Device	This is a switching device that does not communicate with other devices or the MCC/CPC.

1.6   Information exchanged

Information Object Name	Information Object Description
Microgrid bid	The microgrid's bid for energy and/or ancillary services sent from the microgrid EMS to the market operator. It also contains information of the microgrid's availability to participate in the energy market when the microgrid is in different operation conditions.
Market dispatch	The dispatch from the market operator to the microgrid EMS. The microgrid incorporates this dispatch information into its optimization.
Microgrid economic dispatch	The dispatch signal sent from microgrid EMS to microgrid SCADA. It incorporates both the microgrid operation conditions and the market dispatch when the microgrid is available to participate in the energy market, or only considers the microgrid itself when it is unavailable to do so.
Measurements and status	Includes voltage, current and/or power measured at each actor, and the status of the actor, including on/off status, operation modes, and other actor operation status indicators.
Microgrid control commands	The control commands sent from microgrid SCADA to individual microgrid actors, including sources, loads, microgrid switch, and protection devices. The commands dispatch the economic dispatch from the microgrid EMS, and send control signals to the actors between the two economic dispatches to maintain the system stability during islanded operation mode. The commands include the microgrid source control mode commands, real and reactive power dispatch commands, and load levels for controllable loads. The source control mode commands determine if a microgrid source is operated as a primary source that controls the frequency and/or voltage of the microgrid during islanded operation condition or as other source. It also includes the frequency and voltage setting point.
Islanding request	A signal sent from microgrid SCADA to area power system requesting permission for intentional islanding
Islanding request response	The response of area power system to the islanding request. It can be yes (allow intentional

Information Object Name	Information Object Description
	islanding) or no (not allow).
Islanding commands	The commands sent by microgrid SCADA to microgrid actors to control the microgrid so that the power flow is minimized to specified ranges at the microgrid switch for intentional islanding transition.
Islanding commands response	After the actors have executed the islanding commands, the confirmation signal sent to the microgrid SCADA to indicate that intentional islanding conditions have been met.
Microgrid switch open command	A command sent by microgrid SCADA to microgrid switch to open the switch so that the microgrid is disconnected from area power system.
Microgrid switch status	A signal sent by microgrid switch indicating the status of the microgrid switch.

1.7 Activities/Services

Activity/Service Name	Activities/Services Provided
Critical Load Service	The microgrid will provide electrical power service to all critical loads.

1.8 Contracts/Regulations

Contract/Regulation	*Impact of Contract/Regulation on Function*
IEEE Std. 1547 Series	Standard for Interconnection to the area EPS at the PCC
Interconnection Agreement	Typical Provisions include: Construction, Interconnection, Operations, Safety & Maintenance, Access, Exterior AC Disconnect Switch / Isolation Device, Conflicts in Agreements, Disconnection, Customer Generator Billing & Payment, Insurance, Customer-Generator Indemnification, Limitation of Liability, Termination, Permanent Disconnection, Survival Rights, Assignment/Transfer of Ownership of the Customer-Generator Facility
Public Utility Net Metering Regulations	As applicable, where the microgrid exports to area EPS
ISO Market Rules	As applicable, where the microgrid participates in markets

Policy	*From Actor*	*May*	*Shall Not*	*Shall*	*Description (verb)*	*To Actor*
Obligation to serve	Area Electric Power System (AEPS)			X	Provide power on demand at PCC	Microgrid Operator

Constraint	Type	Description	Applies to

2   Step by Step Analysis of Function

2.1   Steps to implement function – Name of Sequence

2.1.1   Preconditions and Assumptions

Actor/System/Information/Contract	Preconditions or Assumptions

2.1.2   Steps – Name of Sequence

NOTE:

The step-by-step table and bubble diagram also show the operations before and after the intentional islanding transition.

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#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes
#	*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.*
0.0	Bid submission	Microgrid EMS			Microgrid EMS	Market Operator	Microgrid bid	
0.1	Receive market dispatch	Microgrid EMS			Market Operator	Microgrid EMS	Market dispatch	
0.2	Calculate microgrid economic dispatch	Microgrid EMS			Microgrid EMS	Microgrid EMS	Microgrid economic dispatch	
1.0	Update measurement	Microgrid SCADA			All microgrid actors	Microgrid SCADA	Measurements and status	

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

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#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes
1.1	Update microgrid economic dispatch	Microgrid SCADA			Microgrid EMS	Microgrid SCADA	Microgrid economic dispatch	
1.2	Update control commands	Microgrid SCADA			Microgrid SCADA	Microgrid SCADA	Microgrid control commands	
1.3	Send control commands	Microgrid SCADA			Microgrid SCADA	All microgrid actors	Microgrid control commands	
1.4	Execute control commands	All microgrid actors						
1.5	Update measurements	Microgrid SCADA			Microgrid SCADA	Microgrid EMS	Measurements and status	
2.0	Send islanding request	Microgrid SCADA			Microgrid SCADA	Area Power System	Islanding request	
2.1	Receive islanding request response	Microgrid SCADA			Area Power System	Microgrid SCADA	Islanding request response	

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#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes
3.0	Calculate islanding commands	Microgrid SCADA			Microgrid SCADA	Microgrid SCADA	Islanding commands	
3.1	Send islanding commands	Microgrid SCADA			Microgrid SCADA	Primary sources, other sources, loads	Islanding commands	
3.2	Execute islanding commands	Primary sources, other sources, loads						
3.3	Islanding commands response	Primary sources, other sources, loads			Primary sources, other sources, loads	Microgrid SCADA	Islanding commands response	
4.0	Send microgrid switch open command	Microgrid SCADA			Microgrid SCADA	Microgrid switch	Microgrid switch open command	
4.1	Microgrid switch opens							

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#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes
4.2	Send microgrid switch status to primary sources	Microgrid switch			Microgrid switch	Primary sources	Microgrid switch status	
4.3	Voltage and frequency control	Primary sources						
4.4	Confirm microgrid switch open	Microgrid switch			Microgrid switch	Microgrid SCADA	Microgrid switch status	
5.0	Bid submission	Microgrid EMS			Microgrid EMS	Market Operator	Microgrid bid	
5.1	Receive market dispatch	Microgrid EMS			Market Operator	Microgrid EMS	Market dispatch	
5.2	Calculate microgrid economic dispatch	Microgrid EMS			Microgrid EMS	Microgrid EMS	Microgrid economic dispatch	
6.0	Update measurement	Microgrid SCADA			All microgrid actors	Microgrid SCADA	Measurements and status	

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#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes
6.1	Update microgrid economic dispatch	Microgrid SCADA			Microgrid EMS	Microgrid SCADA	Microgrid economic dispatch	
6.2	Update control commands	Microgrid SCADA			Microgrid SCADA	Microgrid SCADA	Microgrid control commands	
6.3	Send control commands	Microgrid SCADA			Microgrid SCADA	All microgrid actors	Microgrid control commands	
6.4	Execute control commands	All microgrid actors						
6.5	Update measurements	Microgrid SCADA			Microgrid SCADA	Microgrid EMS	Measurements and status	

2.1.3 Post-conditions and Significant Results

Describe conditions that must exist at the conclusion of the Function. Identify significant items similar to that in the preconditions section.
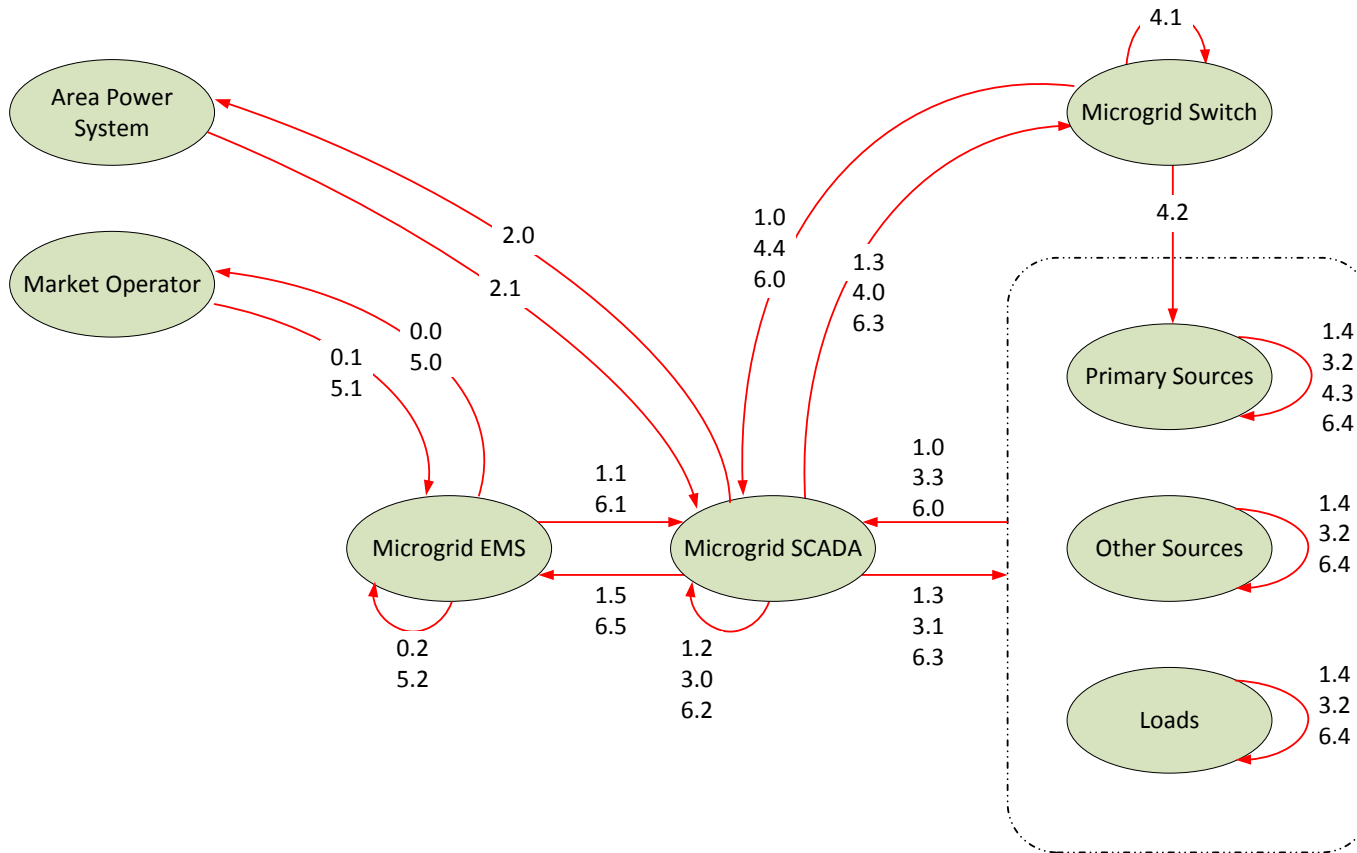
Actor/Activity	Post-conditions Description and Results

2.2   Architectural Issues in Interactions

FUTURE USE

2.3   Diagram

3   Auxiliary Issues

3.1   References and contacts

ID	Title or contact	Reference or contact information
[1]		
[2]		

3.2   Action Item List

FUTURE USE

ID	Description	Status
[1]		
[2]		

3.3   Revision History

No	Date	Author	Description
1.0	15 Jul 13	Y. Xu	Initial use case
1.1	2 Feb 14	J. Reilly	1.3 (insert), 1.7, 1.8
1.2	11 Mar 14	Y. Xu	1.6 Information Exchanged