Project Milestone Report

Microgrid Positioning

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MILESTONE M4.1.

List of Control Requirements within Microgrid

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Version	Author, Institution	Changes
01	Mateo Beus, FER-UNIZG	Final draft

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1. Introduction

In order to enable a microgrid controller to govern all components that exist within the microgrid, every microgrid component must satisfy certain control requirements. A microgrid controller will drive the operation of the microgrid based on both physical features and cost structure of microgrid components in accordance with price signals received from the local market. This document describes control requirements for each microgrid component.

2. List of Control Requirements within Microgrid

2.1. Switchgear equipment

Switchgear equipment has only one control requirement – a change in operating condition in accordance with signal received from the microgrid controller. In this regard, the microgrid controller can change the topology of the microgrid or connect/disconnect certain generating units to/from the microgrid.

2.2. Hydro generating unit

Hydro generating unit consists of both turbine governor and excitation system governor. The turbine governor controls the active power output of the hydro generating unit and is also in charge of primary P-f regulation. The excitation system governor controls reactive power output and is also responsible for U-Q regulation. Both governors are directly connected to the microgrid controller that can change active and reactive power set points. This enables microgrid controller to change power output of the hydro generating unit which is primary control requirement of the hydro generating unit.

2.3. Thermal generating unit

Thermal generating unit consists of both turbine governor and excitation system governor. Turbine governor controls the active power output of the thermal generating unit. This governor is also in charge of primary P-f regulation. Excitation system governor controls reactive power output and this governor is performs U-Q regulation. Both governors are directly connected with the microgrid controller that can change active and reactive power set points. Microgrid controller can thus change power output of the thermal generating unit which is primary control requirement of the thermal generating unit.

2.4. Battery storage

Battery storage is installed in the DC part of the microgrid. It consists of 32 battery cells. Capacity of each 3.2 V cell is 100 Ah. Battery storage is connected to the common DC bus of the microgrid using a DC/DC converter. This converter is bi-directional and directly connected to the microgrid controller so it can be used to control the operational mode of the battery storage. In this regard, the microgrid controller can decide, in accordance with price signals, when to charge or discharge batteries and at which power. This is primary control requirement of the battery storage.

2.5. PV power plant

PV power plant is installed in the DC part of the microgrid as well. The total installed capacity is 4.8 kW. PV power plant is connected to the common DC bus of the microgrid using a DC/DC converter suitable for photovoltaic applications. This controller is directly connected by the microgrid controller which can change power output set point value of the PV power plant. In this regard, microgrid controller can control active power output of the PV power plant.

2.6. AC/DC converters

Three AC/DC converters are used to connect AC and DC part of the microgrid. Each AC/DC converter has a rated power of 5 kW per phase. Converters are bi-directional and directly connected to the microgrid controller which can change both active and reactive power output set point value. In this regard, microgrid controller can control direction of power flows between AC and DC part of microgrid and the amount of electricity transmitted between AC and DC part of the microgrid.

2.7. AC load

Two AC loads are connected to the AC part of the microgrid. Every AC load has a rated consumption power of 8 kVA. Controller unit, which is a part of each AC load, is directly connected to the microgrid controller. This connection enables microgrid controller to change a set point value of the load consumption in accordance with price signals received from the market. This AC load is used to simulate demand response.

2.8. DC load

Two DC loads are connected to the DC part of the microgrid. Every DC load has a rated consumption power of 2.4 kW. Controller unit that is a part of DC load is directly connected to the microgrid controller. This connection enables microgrid controller to change a set point value of load consumption in accordance with price signals received from the market.

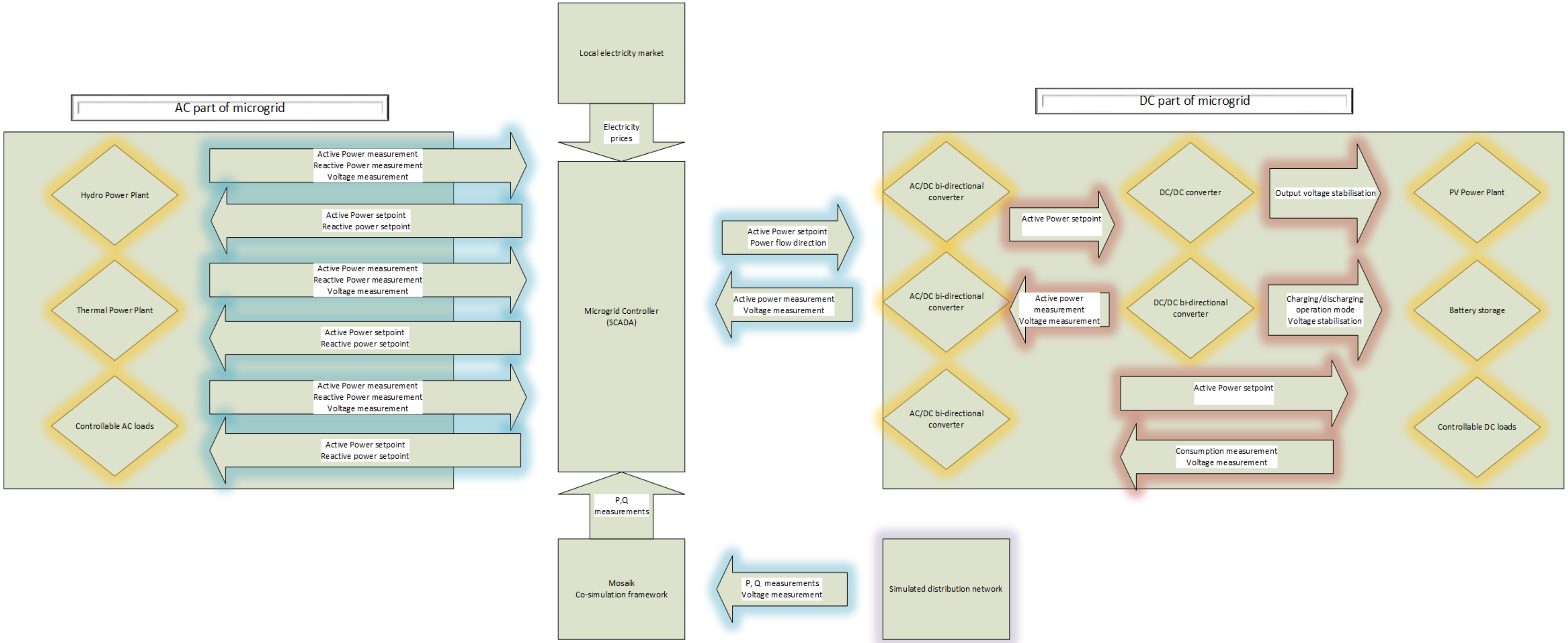
It is important to emphasize that every microgrid component has its own circuit breaker which is used to connect/disconnect component to the microgrid.

In the following table are given control requirements for each microgrid component.

	List of control requirements			
	Control of active power output/input	Control of reactive power output/input	Power flow control	Control of switchgear equipment that belongs to a particular microgrid component
Hydro generating unit	+	+	-	+
Thermal generating unit	+	+	-	+
AC/DC converter	+	+	+	-
Battery storage	+	-	+	+
PV power plant	+	-	-	+
AC load	+	+	-	+
DC load	+	-	-	+

2.9. Graphical presentation (flow chart) of control requirements within microgrid

The following figure represents the main control requirements within microgrid.



3. Conclusion

Control requirements defined in this report will be used as a basis for the development of optimal control strategies. Model Predictive Control (MPC) will be used as an optimal control strategy within this project. MPC involves formulation of an objective function quantifying the deviation from an estimated optimized system trajectory enabling the estimation of the overall system behaviour and performance. Each microgrid component (generators, consumers) will have its own local MPC controller that will receive set point values (future power output/input trajectories) from the main microgrid controller. Signals (set points) sent by main microgrid controller will be results of upper layer optimization which is based on market prices. The upper layer optimization concept is explained in detail in milestone report 2.1 which is related to WP2 of this project.