MICROGRID ISLANDING OPERATION EXPERIENCE

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ABSTRACT

This paper describes the experience of islanding operation of a microgrid located in Provincial Electricity Authority (PEA)'s distribution network. The equipment for islanding operation and resynchronization were installed to enable the islanding operation of the microgrid. Moreover, the remote control equipment developed by PEA was installed to allow the remote operation from SCADA dispatching center. The experiment was set up to examine the performance of microgrid operation during the islanding and resynchronization process. The results show that the microgrid is capable of operation in both islanding and grid-connected modes without sacrificing the system stability and no power interruption.

1. INTRODUCTION

Microgrid is an innovative power system configuration providing higher reliability benefit compared to traditional radial power system configuration.

Many microgrid islanding operation strategies were studied [1]-[3]. The controls and operation aspects of microgrids were reviewed in [4]. Protection principle for future microgrid was proposed in [5].

This paper describes the experience of islanding operation of a microgrid located in the Provincial Electricity Authority (PEA)'s service territory.

2. MICROGRID COMPONENT

The microgrid as illustrated in Figure 1 is located in the north-eastern part of Thailand and is composed of a 115 kV/22 kV substation, Dansai substation, supplying five radial feeders with 5 MW peak demand. It incorporates a 5.11 MW run-of-river mini-hydro unit connected to F5-feeder.

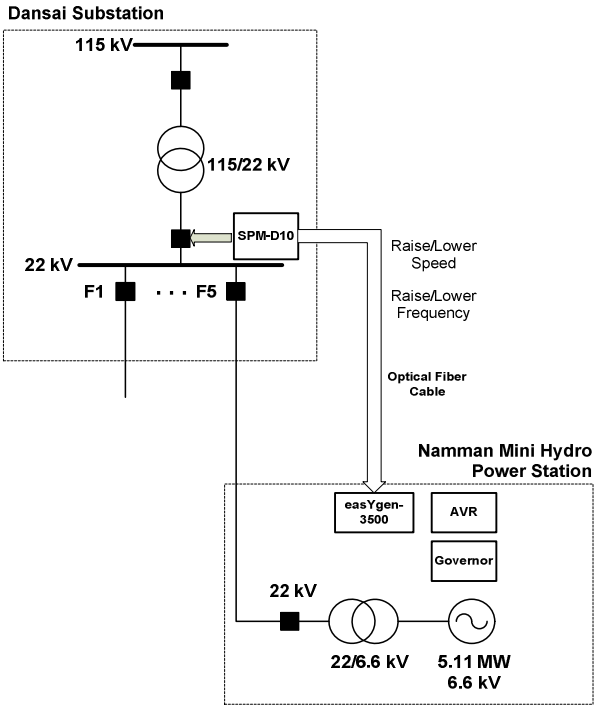

Figure 1 Microgrid Component

The mini-hydro unit, namely Namman power station, is located 10 km long from the substation. It consists of a synchronous generator with high capacity twin jet turgo impulse turbines. The generator's rating is 6,388 kVA, 0.8 power factor, 5,110 kW, 50 Hz. The terminal voltage of generator is 6.6 kV and is stepped up to 22 kV via a 6.6/22 kV transformer. The excitation and system is AC brushless type with Basler DECS 125 automatic voltage regulator (AVR). Woodward UG-8 hydraulic governor is used in the speed governing system.

Initially, the mini-hydro unit is designed to operate in the grid-connected mode only. If there is an outage occurred in the 115 kV system, the mini-hydro unit will be unloaded and shutdown. Hence, all loads supplied from the substation will be de-energized.

To maintain the continuity of supply during outages, microgrid islanding operation is required. An easYgen 3500 Woodward genset controller has been installed at Namman power station to manage the mini-hydro unit during grid-connected and islanded operation. Moreover, substation automation equipment developed by PEA has been installed to allow the remote control operation from the dispatching

center. Hence, black start operation, originally manually operate by operator, can perform remotely by dispatcher in the SCADA control center. An automatic synchronizer device, SPM-D10 Woodward synchronizer, has been installed at Dansai substation to have resynchronization capability via optical fiber communication between Dansai substation and Namman power station as shown in Figure 1. During the resynchronization process, the SPM-D10 Woodward synchronizing device matches the phases and voltage by sending the outputs for speed and voltage bias signal to easYgen 3500 genset controller through optical fiber cable. Feeder protection relays in Dansai substation have been replaced by new protection relays which have capability to change the setting when microgrid has switched from grid connected mode to islanding mode and vice versa.

3. MICROGRID ISLANDING OPERATION RESULTS

Various study cases of microgrid operation as given in Table1 have been experimented. A disturbance data recorder was installed at 22 kV bus of the power station to measure the voltages and frequency.

Table 1 Study Cases

Case No.	Test Description	Generation and Load before Islanding	
		Generation (MW)	Load (MW)
1	Islanding	2	2
2	Resynchronization		
3	Islanding	3	3
4	Resynchronization		
5	Islanding	4	3
6	Resynchronization		
7	Islanding	5	3
8	Resynchronization		

The following aspects are investigated to ensure that the microgrid operation from grid-connected mode to islanding mode and vice versa is viable.

- control and mitigation of transients during switching to islanding operation
- voltage and frequency control during islanding operation
- power balancing management of the island
- protection setting based on grid-connected and islanding modes
- resynchronization capability to connect the autonomous island to PEA main grid without interruption.

The results from experiments show that the microgrid is capable of operating in the grid-connected mode and islanding mode. The microgrid can switch from grid connected mode to islanding mode without sacrificing the system stability and no power interruption. Moreover, the resynchronization process is automatically done by SPM-D10 without unloading or shutdown the unit.

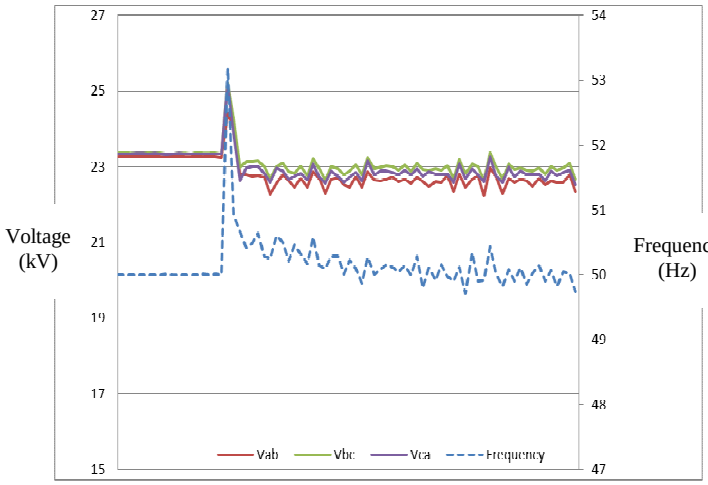

Figure 2 Voltages and Frequency during Islanding

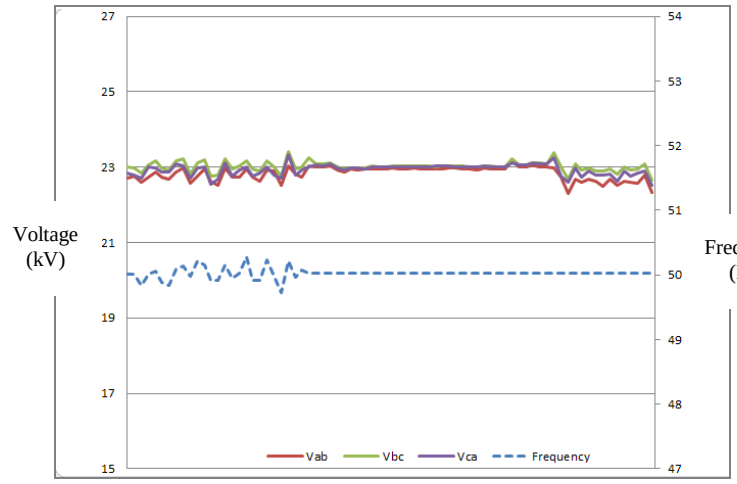

Figure 3 Voltages and Frequency during Resynchronization

Figures 2 illustrates that voltage and frequency during islanding operation are controlled within an acceptable limit. Moreover power balancing of the miocrogrid is managed smoothly. Protection setting is changed when the microgrid is in the islanding mode via group setting capability of relay. The voltages and frequency shown in Figures 3 indicates that the microgrid can resynchronize to connect the autonomous island to main grid without interruption

4. CONCLUSION

The results show that the microgrid is capable of operating in the grid-connected mode and islanding mode. The microgrid can switch from grid connected mode to islanding mode without sacrificing the system stability and no power

interruption. Moreover, the resynchronization process is automatically done by SPM-D10 without unloading or shutdown the unit. Hence, if there is an unplanned outage in the 115 kV system, the customers connected to Dansai substation will not be interrupted, thus enhancing the continuity of supply and reliability of system in this area. From various study cases, it has been proved that microgrid islanding operation can apply to other distributed generations (DGs) connected PEA distribution system in order to enhance the reliability and the continuity of power supply in PEA system.

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