Kinmen Energy Management System Planning

(Power System Research Lab：Lai -Kai- You；Wang, Yung-Fu；Wu, Chen-Han；Liao, Ching-Jung；Hsu, Yen-Feng)

(I) Introduction:

Kinmen is an independent power system. As the renewable energy is growing, high penetration of renewable energy affects system scheduling and operation gradually. For this reason, the Power System Research Lab of TPRI built an energy storage system in Kinmen. The energy storage system can be categorized into two types: energy-type and power-type. Although adding energy storage can improve the operational flexibility, it also means that power system need to face more complicated situation in power dispatch. Therefore, this study schedules the operation of diesel units after considering the overall system status, renewable energy output and system load changes. In addition, the energy storage system is used as an auxiliary to make the optimal scheduling.

(II) EMS and energy storage system:

Kinmen Power System added two different types of energy storage systems in 2010 and 2011 respectively, and the penetration rate of renewable energy is also increasing. It has transformed from a single power generation to a hybrid power generation island. Therefore, an energy management system (EMS) is required to maintain the stability and smooth operation of the power system. The energy management system is an automated system. After collecting on-site measured data, it provides users with decision-making suggestions for different power sources through real-time monitoring, graphical display, and analysis tools.

The laboratory has built a PMU and measured the parameters of the generator. It not only obtained dynamic simulation parameters that conform to the characteristics of the Kinmen system, but also carried out regression analysis to obtain the calculation formula of the minimum frequency after the generator trip. With the above two actions, the laboratory has a good understanding of the dynamic response to plan software functions for Kinmen area.

The Kinmen EMS mainly integrates the status of the system information and protection in the Kinmen power system. The relevant values are calculated and provided to dispatchers for more real-time operation suggestions. The main page is shown in Figure1, which can display the power generation of diesel generators, wind power generators, 22.8 kV busbar voltage, power flow of transmission lines, load of each main transformer, and 11.4 kV feeder load on the one-line diagram. After obtaining the real-time electrical data of the PMU, it can display the total active and reactive power of diesel generators, the total power generation of the system, the reserve capacity of the hot engine (including energy storage), the single maximum output unit after tripping, estimation of minimum frequency and estimation of standby capacity of hot engine after a single maximum output unit trips, etc.

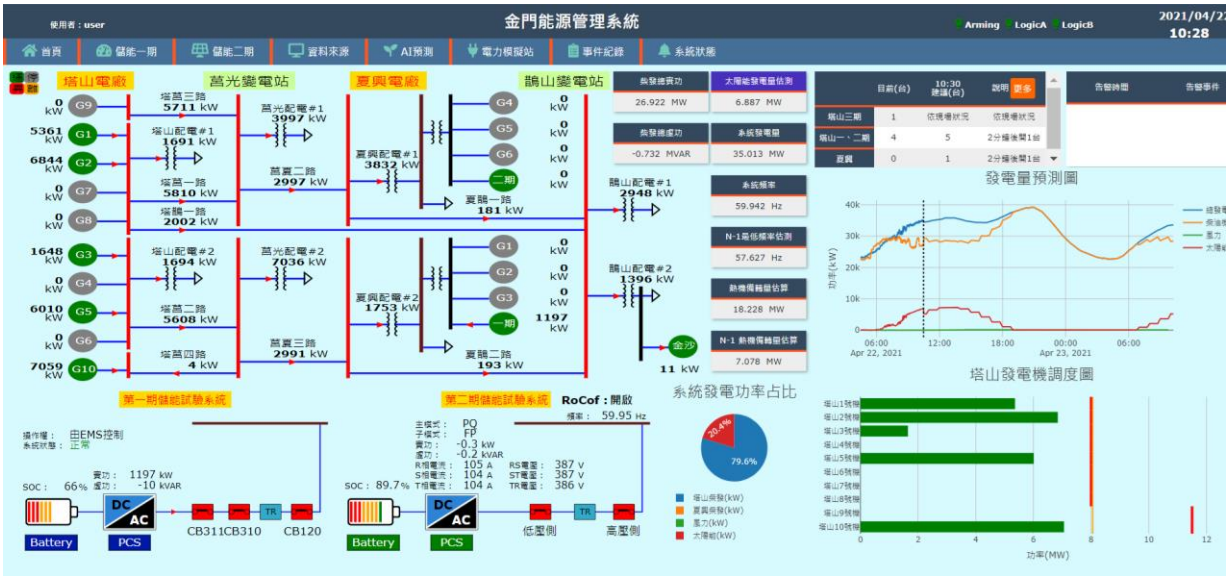

Figure1 Kinmen energy management system

The energy management system and two energy storage systems use the IEC 61850 communication protocol for bidirectional data transmission, which not only obtains operation information, but also issues commands. Therefore, the energy management system can control the two energy storage systems.

（I） Energy-type storage system control

The energy-type storage system information is shown as Figure2, which can display the relevant circuit breaker status, maximum charge and discharge capacity, upper and lower limits of operable reactive power, SOC status, and current active and reactive power status. The maximum charge and discharge capacity and the maximum operable reactive power are provided by the internal calculation of the energy storage management system, and the active and reactive power status of the past two hours are displayed on the right side of Figure2. In the system control part, take Figure3 as an example, input 1000 kW in the active power field of main mode, which means that the energy-based energy storage system is given a discharge 1000 kW control command, and the reactive power field is also the same.

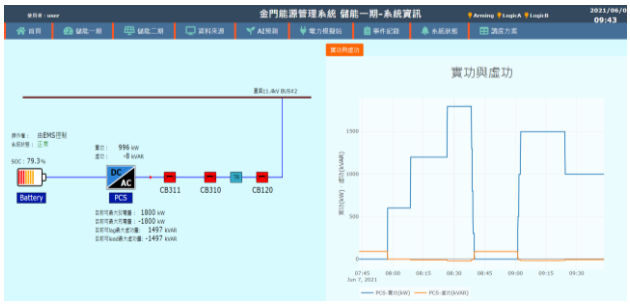

Figure2 energy-type energy storage system

Figure3 energy-type storage system control page

(II) Power-type storage system control

The power-type energy storage system information is shown as **錯誤！找不到參照來源。**, which can display the real-time status of the power-type energy storage system, such as related circuit breaker status, operation mode status, active and reactive power status, SOC status, voltage and current, and communication status, etc. On the right side of Figure4, the active and reactive power status

of the past two hours can be displayed. The system control part is shown as **錯誤！找不到參照來源。**. It can control PCS activation, PCS reset, main mode selection, sub-mode selection, trip control mode selection and renewable energy smoothing function activation. Here, the energy management system only selects the operation mode, and the automatic control in each mode will judge and react by itself.

The main mode can choose PQ mode or PF mode. When the PQ mode is selected, active and reactive power can be input by itself; if PF mode is selected, after inputting the leading or lagging power factor, it will be performed according to the apparent power of the power storage. The sub-mode selection can be FP, VQ or VQ+FP mode. When the above mode is selected, the charging and discharging or reactive power compensation will be performed according to the system frequency and voltage.

The trip mode control can choose trip mode or RoCoF mode. When trip mode is selected, if the generation of any unit in operation drops to 0 MW, it will discharge according to the trip control start value; If RoCoF mode is selected, when the frequency falling slope reaches the set value, discharge will be performed.

Figure4　power-type storage system

Figure5 power-type storage system control page

(III) Conclusion:

The relevant software application functions of the energy management system have been built in the Kinmen area, integrated the power generation source and information system to provide on-site dispatcher the system real-time operating status, and also provided forecast status for future operation scheduling suggestions. It can achieve the purpose of energy management by reducing the operating cost of the unit. The system control part can initially control active and reactive power for the two types of energy storage systems. If the charge and discharge are properly adjusted, the trip of the units can be reduced.