RELIABILITY ANALYSIS OF RANAU MICROGRID, SABAH, MALAYSIA

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Abstract - This paper presents the reliability analysis of Ranau microgrid, a standalone microgrid in the district of Ranau, Sabah. Power flow for IEEE 9 bus also performed and analyzed. Power flow is defined as an important tool involving numerical analysis applied to power system using the Power Factory DIGSilent 14 software to calculate the power flow. Reliability analysis depends on the spinning reserves of the system. Adequate spinning reserves enabled a system to have a reliable operation. It is the amount of generation capacity that can utilized in a given time to establish the balance between load and generation. After the simulations and calculations, the analysis of reliability of the Ranau microgrid were presented.

Keywords - Standalone Microgrid, Power Flow, Reliability Analysis.

I. INTRODUCTION

Microgrid operational reliability are depend on the spinning reserves of the system. The spinning reserves are important to assure an adequate level of system operational security, mainly related to contingencies or abnormal load demand. Inclusion of adequate spinning reserves into a system will cause an increase in the costs, but we have an efficient provision of spinning reserves, which are needed to ensure the operational reliability of the system. [1]
Microgrids are typically developed by governments agencies, private developers and NGOs as a means to provide access to electricity in areas of the world where it is financially, physically or institutionally difficult to extend the reach of the central grid[2]. In this case the central grid is the Sabah Grid.
This paper started with characteristics of standalone Ranau microgrid interconnected system, located in Sabah, Malaysia. This paper also introduces the basic principle and basic structure of Ranau microgrid and to analyze the power flow of a separate islanded mode high-voltage microgrid (MG) with various distributed resources (DRs).



Figure 1: District of Ranau, Sabah, Malaysia

In electrical power system, power flow also known as base case. Many software available to perform this serve this purpose. It analyzes the power system in normal steady state operation. Power flow studies are important for planning for future expansion of current power system and also for determining the best operation of existing systems. As to the large scale microgrid interconnection, new problems as main power grid plan and designation, dispatching and operation, protection and control will emerge due to the influence of microgrid upon the steady-state power flow distribution and the dynamic fault characteristics of the main power grid. [5]
In a typical microgrid, the microsources may be rotating generators or Distributed Energy Resources (DER) interfaced by power electronic inverters. The installed DERs may be biomass, fuel cells, geothermal, solar, wind, steam or gas turbines and reciprocation internal combustion engines. The overall efficiency may be improved by using combined heat and power sources. [6]
Analysis of this software using Newton-Raphson Method. The Newton-Raphson method is one of the most commonly used techniques for solving nonlinear algebraic equations, and presents better convergence than does the Gauss-Seidel method. Thus, it is popularly applied in power flow analysis. The iteration numbers of the Newton-Raphson approach is independent of the scale of system and can solve the problem through a few iterations.[7]

Spinning Reserves

Electrical energy provider (SESB) need to maintain the security and the quality of the supply of electricity throughout Sabah. In particular, control of the frequency requires that a certain amount of active power be kept in reserve to be able to re-establish the balance between load and generation at all times. In general, reserve can thus be defined as the amount of generation capacity that can be used to produce active power over a given period of time and which has not yet been committed to the production of energy during this period. In practice, different types of reserve services are required to respond to different types of events over different time frames.

II. DESCRIPTION OF THE MICROGRID

Voltage of 415 V and 11 kV are available on Ranau microgrid system.

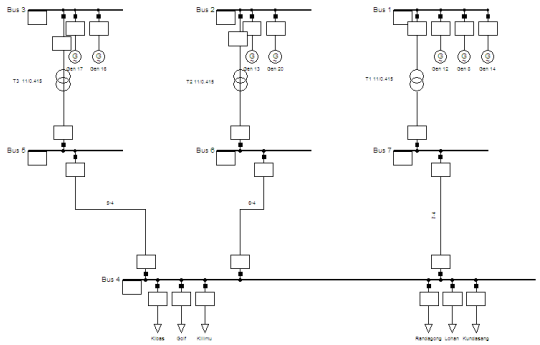


Figure 2: Ranau microgrid

These DRs include four 1500 kW Cummins diesel engine generators, four 500 kW Cat diesel generators, two 1000 kW Cat diesel generators and two 1500 kW and 950 kW hydroelectrics. However, not all the generators are available and ready for generation. Some of the generators are under maintenance due to scheduled preventive maintenance and corrective maintenance. There are six loads in Ranau microgrid, Kibas, Golf, Kilimu, Randagong, Lohan and Kundasang.

According to IEEE 1547-4 [3], microgrids are expected to satisfy the security requirements that allow these grids to operate in a secure way for any unexpected power requirement. In most cases, this security scheme is represented by a spinning reserve. This reserve represents one of the most important economic dispatch constraints in a microgrid, because it allows the system frequency to be driven to a steady state after the occurrence of an event [3].

III. RESULTS AND ANALYSIS

Power flow analysis were performed on Ranau microgrid.

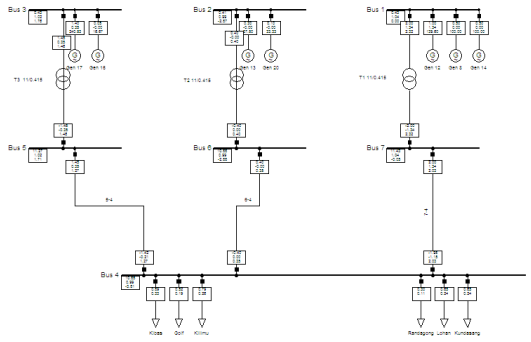


Figure 3: RanauMicrogid power flow

Total Generation: 3.85 MW
Grid Losses: 0.05 MW
Installed Capacity: 4.01 MW
Spinning Reserve:0.15 MW
Total Load: 3.80 MW

Total Power Factor:
Generation: 0.92 [-]
Load:0.94 [-]

IEEE 9 bus system has 9 bus, six transmission lines, 3 transformers, 9 branches, 3 loads, 3 generators.
Ranau microgrid system has 7 bus, 3 transmission lines, 3 transformers, 6 loads, 3 generators.
Analysis of selected bus in Ranau Microgrid.

Kibas Load
Active power consumed by Kibas is 0.89 MW and the reactive power is 0.33 Mvar. Power factor is 0.94 for this load with 0.05 kA current.

Golf Load
Active power consumed by Golf is 0.52 MW and the reactive power is 0.19 Mvar. Power factor is 0.94 for this load with 0.03 kA current.

Kilimu Load
Active power consumed by Kilimu is 0.79 MW and the reactive power is 0.26 Mvar. Power factor is 0.95 for this load with 0.04 kA current.

Randagong Load
Active power consumed by Randagong is 0.30 MW and the reactive power is 0.11 Mvar. Power factor is 0.94 for this load with 0.02 kA current.

Lohan Load
Active power consumed by Lohan is 0.65 MW and the reactive power is 0.24 Mvar. Power factor is 0.94 for this load with 0.04 kA current.

Kundasang Load
Active power consumed by Kundasang is 0.65 MW and the reactive power is 0.24 Mvar. Power factor is 0.94 for this load with 0.04 kA current.

Grid Losses
Transmitting electricity at high voltage reduces the fraction of energy lost to resistance, which averages around 7%. Losses are estimated from the discrepancy between energy produced (as reported by power plants) and energy sold to end customers; the difference between what is produced and what is consumed constitute transmission and distribution losses, assuming no theft of utility occurs. The inductance and capacitance of the phase conductors can be significant.

The currents that flow in these components of the circuit impedance constitute reactive power, which transmits no energy to the load. Reactive current causes extra losses in the transmission circuit.

Grid Losses	0.05MW
Installed Capacity	4.01MW
Ratio	1.247%

Table 1: Grid Losses and ratio for Ranau microgrid

The analysis show 0.05 MW losses in Ranau microgrid, represents 1.247% losses with respect to the installed capacity. Primarily the sources of grid losses are line/transmission losses and meter consumption. Losses lead to poor state of operation of the power provider or utilities. Utilities would benefit greatly from being able to locate losses and address the problem directly.

IV. CONCLUSION

Power flow analysis is an important analysis for planning for future expansion of current power system and also for determining the best operation of existing systems.PowerFactoryDIGSilent software used in this project to analyze power flow of Ranau Microgrid.

Generation capacity that is on-line but unloaded and that can respond within 10 minutes to compensate for generation or transmission outages. "Frequency-responsive" spinning reserve responds within 10 seconds to maintain system frequency. Spinning reserves are considered for the reliability of the system. Ranau microgrid have lagging power factor.

Spinning Reserves	0.15 MW
Ratio	3.74%

Table 2: Spinning reserves for Ranau microgrid

Spinning reserves / Installed Capacity ratio is (3.74%) for Ranau microgrid. It has more extra generating capacity that is available by increasing the power output of generators that are already connected to the power system.

Higher load fluctuations will be more tolerable and manageable with higher reliability.

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