IMPROVING RELIABILITY ON MV DISTRIBUTION LINE IN THE SYSTEM CONNECTED TO DISTRIBUTED GENERATOR IN SOUTH SUMATRA, INDONESIA, *A CASE STUDY*

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ABSTRACT

PT. PLN (Persero) Wilayah Sumatera Selatan, Jambi, dan Bengkulu, is one of the Service Region that provides electricity services and ensures the reliability and continuity and quality of delivery electricity to all customers in the region. In order to satisfy this obligation and fuel mix, PT. PLN (Persero) WS2JB purchases a part of the energy need from the Small Scale IPP connected to 20 kV Medium voltage line connected from the IPP direct to customer or via 20 Substation busbar. During the operation, the feeder supplied by the IPP experienced relatively low reliability affected by the overload, underload, or the misoperated relay. This paper discusses the problem that was investigated by Operational Performance Improvement (OPI) approach and shares the solution for the problem. It was found that 3 (three) major cause, namely, protection Scheme, Syncronization placement, and setting the capability curve of the machine was profound. To alleviate the Problem, the solution was conducted by resetting the protection scheme, rearranging the syncronization device in the busbar configuration and modifying the setting of relay. The additional corrective measure of maintaining the line properly is also discussed. After conducting the afromentioned modification the reliability increase significantly. The rate of feeder failure is down by 50 %.

INTRODUCTION

It is imperative for most modern utility to provide the electric power supply effectively and efficiently without compromising reliability and power quality. The term reliability covers the availibity and continuity of supply. To achieve it, PLN Wilayah Sumetra Selatan, Jambi, dan Bengkulu (PLN WS2JB) as one PLN Regional Unit, purchases the power in IPP Scheme with varoius of energy source. Until now, PLN S2JB has got a Power Purchase Agreement (PPA) with Microhydro Power Plant and Small scale Gas power plant. These IPPs are directly connected to distribution system in which the bus supplies to customer feeder and the tie feeder to the substation bus. Initially some of these IPPs were the sole energy supplier to an isolated system. Due to the expansion of the system regarding load growth and the need to provide the reliable system, the IPPs were connected to the sumatra system through a 20 kV MV bus in Substation The connection of a distributed generator to a distribution network will inevitably result in some local changes to the characteristics of the network. On the contrary to the latest purpose, this interconection led to the problem of outages caused by the failure of relay selectivty, by the overload of the line and the machine, or by the back syncronization of the line after recovery. This nuisance is worsened by the lack of coordination among the O& M operators of the IPPs, Distribution and substation. In addition to that some downfall of gas supply to IPPs caused the power shortage to the MV bus that would be able to disturb the stability of the system.

In the Musi II MV System, the relay selectivity tends to be the major problem. The sysmpatetic trip sometimes occured simultaneously in 20 kV Substaion bus. One feeder of the bus in substation was faulted leading to to the operation of tie feeder relays. The open tie feeder caused the overload of the incoming of bus IPP. All the feeders supplied by the IPP Bus was black out.

This paper shared some of the experience in operating the system with DG. It presented some problems in maintaining the reliability of the feeders in the bus connected to the DG. The scheme of protection installed in the system is explored. The problem resolution was discussed and reviewed. The most important activities, ie, the diminishing the outage cause also discussed. The next action covering augmentation of the new feeder that would shared the burden of the tie line was introduced.

OVER VIEW OF MUSI II DG TO THE PALEMBANG 20 KV MV SYSTEM

The configuration of the 20 kV MV system in Palembang basically was radial type system. The specific important customers, such as Hospital, Government regional office, are supplied by two feeders equipped with Automatic Transfer switch (spot type configuration). The distribution system was supplied from substation 70/20 kV and 150/20kV. In Palembang system There were two substation intertieing with DG belonging to IPP. These two IPPs were supplied by gas through the South Sumatra gas transmission piping. The single line of Musi II IPP connected to 20 kV distribution line was depicted in picture 1. This IPP was 4 Gas Turbines (3,5 MW each) and 1 combined cycle (6MW) with the total installed Capacity of 20,5 MW. Due to Gas supply limitation, the IPP could provide only 11,5 MW. Each of Gas Turbines had the step up transformer connected to common grounding 40 Ohm. For the combined cycle unit, the step up transformer was connected to 40 Ohm grounding. In the side of substation, the step down trasformer from 150 kV/20 kV, was equipped with 40 Ohm grounding. The output of transformer then was connected to 20kV bus line through bus protection breaker breaker. This bus initially supplied 3 feeders direct to customer in which total load 18 MW and 1 feeder connected to 20 kV bus substation. The substation bus supplied 4 feeders and one tie feeder. The 30 MVA substation transformer were equipped with 40 Ohm grounding in the 20 kV side.

The flow of power in the tie feeder was from the substation to the 20 kV IPP Bus since the load were far bigger than ke capacity of the plant.

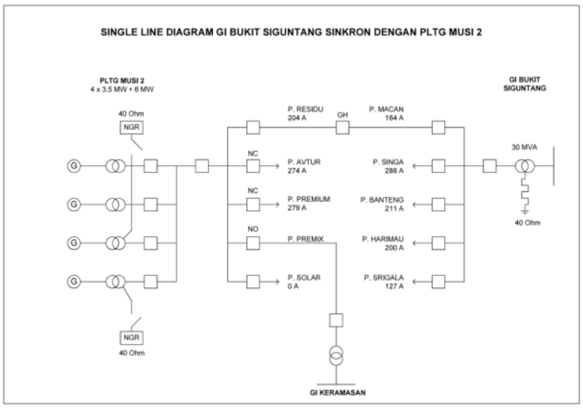

Figure 1 Single Line Diagram IPP Musi II

ELIMINATING THE ROOT CAUSE OF THE OUTAGES

In order to improve the performance of the operation of the distribution, the PLN WS2JB, has launched the Operational Performance Improvement Program (OPI) that using OPI (developed by Mc Kinsey) approach of 3 perspective of improvement method. It was (1) Technical System which handled the technical matter in network betterment. (2) Management Infrastructure which dealt with the performance management reporting, evaluation and analysis tool, (3) Mindset, Capabilities and leadership which stimulate the awareness of human resouce.

The second persperctive provided the careful and factual reporting system that exhibit the useful data of how many outages happened and what was the cause of the problem. Each outages was diagnosed and evaluated. The diagnotics overed a wide range of activities from conducting gap analysis, identifying main value of business and key drivers, to capturing opportunity. The diagnostic in the field was performed by careful and thorough the inspection using the thermovision. The Focus Group Discussion (FGD) was established.. The next step, The usage of RCPS (Root Cause Problem Solving and pareto chart was performed to find the most effective way to alleviate the problem.

The data of the outages showed three major causes of the outages, namely trees and vegetation (80 %), construction failures (10 %) and equipment failures (10 %) which dominated by fault on arresters.

In order to eliminate the problem of ROW, the maintenance team were instructed to do the the tree trimming and making the vegetation map. In certain area that was difficut to do the trimming, the team used tree guard by using paralon water pipe. Management Vegetation was introduced to maintain the right time for tree trimming. For the construction corrective action, the team changed some of the bended pin insulators and some strain insulator having hair-wreck in some part of the porcelein. Some bended cross arms were replaced. The overhead line sags was also improved by tightening and inserted with a new pole. The loose connection that was exhibited by thermorvision was coorected and replaced by joint sleeve. The old porcelein arresters in distribution transformer were replaced by the new polimers arresters with disconnector and the construction for the arrester in the distribution station was improved. It was placed near the transformer after the cut out seeing from the line. The use of the polimers was to prevent the probability of treeing breakdown of very thin wreck of the porcelin.

PROTECTION SCHEME IMPROVEMENT

The other cause of the outages of the feeder in the misoperation of the relay because of protection miscoordination. The reason for this errorness was that the distribution network was traditionally configured radially [1][2]. The protection scheme for radial network was very simple. It's not happening in the same way when DG sources are connected to the power system. The network became more complicated in terms of protection scheme coordination. Changes in the coordination of the protection scheme is not recognized by the IPP operator and power distribution engineer. From the evaluation results, it was found some as follows:

1. Sympathetic Trip of Macan Feeder with faulted Harimau Feeder caused the subsequent trip of the overload relay of Musi II Incoming 20 kV (3 Occurance). It resulted of the 3 Feeders out of Supplied.
2. The trip of Faulted Premium followed by tripping of Macan Feeder (6 Occurance). It caused the Incoming IPP Bus sensed the overload, and trip. It led to the system black out of the 3 Feeders.
3. The trip of Macan Feeder leading to tripping of incoming IPP Bus (1 occurance). The 3 feeders were out of supply.

To solve he problem, some action was takenas follows;

1. Taking out the NGR when Musi II IPP operating in the grid mode. This was performed because the standard of the earthing system in South Sumatra was 40 Ohm resistance. The protection departement in Substation used the calculation of earth fault in 40 Ohm basis. So the set all the pick up current in the 40 Ohm basis. If the ground system in GT and ST was connected the resistance would be 40.3 Ohm.
2. Removing the relay function in 20 kV Musi II incoming, since the relay in Musi II Incoming always tripped when the intertie feeder tripping. It also seemed excessive protection and placing it would make the protection cooordination tedious and hardly to be achieved
3. Resetting the relay of Macan and Residu Feeder in order to create system relay coordination to all feeders. It would allow the clearence of the faulted feeder and maintaining the intertie. The setting was done in such away that still below the limit of substation transformer incoming setting.

Table 1 Relay Setting in Musi II Feeder

RESIDU (600 A / 5A)	OCR (50/51)	(A)	400	2800	400	1260
		mS	160	50	310	300
	GFR (50/51N)	(A)	60	120	60	630
		mS	250	50	680	300
PREMIUM (300 A / 5A)	OCR (50/51)	(A)	300	1200	1200	1200
		mS	100	50	50	50
	GFR (50/51N)	(A)	30	240	240	240
		mS	100	50	50	50

Table 2 Relay Setting in Feeder of SS Feeder

PENYULANG	CT		OCR	OCR INSTAN	OCN	OCN INSTAN
MACAN	400 / 5	(A)	320	1600	32	TIDAK AKTIF
		mS	150		160	
BANTENG	400 / 5	(A)	320	1440	32	TIDAK AKTIF
		mS	100		120	

THE OPERATIONAL IMPROVEMENT OF GT AND ST

The other problem that would jeoperdize the reliability service was to take off some of the on-Feeder due to the syncronization need of the machine to the Grid. It always happened when the intertie feeder was out due to the fault or mantaining purpose. This occured because Musi II IPP was only equipped with machine syncronous device not back syncron device in the feeder. In addtion to that, after the relay of the Musi II incoming disable, maintaining the load balance of the IPPs was cumpulsory preventing the black out of the all machine.

To overcome the problem, some action below were taken:

1. Installing the Back-Syncron device for Residu Feeder. This was done by the Musi II IPP. The installment of the back syncron device had provided the easement of machine operator. All the unnecessry taking off the healthy feeder was avoided.
2. Installing the Under Frequency Relay (UFR) relay in Premium Feeder preventing of the machine overload
3. Operating Premix Feeder in normally open (NO) status and connected in to the othe substation (GI Keramasan) in order to balance the load.
4. Resetting the GT to the KW control mode allowing the some ramping of the load due the open of one feeder.

In addition to afromentioned action, for the future plan, it was planned to augmenting the new parallel feeder to Residu feeder. This new paralel feeder would enable loading the all the feeder in Musi II 20 kV bus if there was any outage of the IPP due to maintance or reducing power cause by gas shortage. It was also proposed to replace the overcurrent relay in intertie feeder with the directional relay.

CONCLUSION

Introducing DG in distribution networks resulted in the complexity of the protection scheme. The other problem to be appeared in operation perspective included the distribution of load and syncronization in the bus after outages. Improving the reliability for MV distribution network needed holistically some aspects in arranging protection scheme and setting all the relays that connected directly to DG System. The action to be performed also had to cover the system load balancing and strengthening the network. The other important things is to eliminate the root source of the fault.

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BIOGRAPHY

Bob Saril was born in Palembang, Indonesia in 1968. He graduated from Sriwijaya University - Palembang in 1993 and served as electrical engineer in PLN since 1994. During his duty and career, he completed numbers of expertise trainings in electro technical engineering. He also completed his Master Degree in New South Wales University - Australia, in 2002 and awarded M.Eng.Sc. degree. He is currently working as Distribution Manager of PLN S2JB Region. He is currently active as member of organizing commitee of Indonesian Engineers Association

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