MICROGRID OPTIMIZATION USING PHOTOVOLTAIC SOLAR IN THE COASTAL AREA OF PANTAI LABU VILLAGE

by Fitra Zambak

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Abstract

The micro grid power generation system based on renewable power generation is proper to fulfill the availability and electricity needs in a small village, as an uninterruptible resource. This paper is designed by a DC micro system which consist of some diesel fuel of cel PV and battery that connect each other through the networking to fullfil in the 25 householder of electricity needs in coastal area of Pantai Labu . The maximum use for each family is 900 watts of power to get the peak load value that will adjust to the generator. The DC micro-network system is separate because the distance between people's houses is quite far so that each house has a micro-network. As the result, its more effective and efficient to reduce costs for electric cable and power loss in conductors.

1. INTRODUCTION

Conventional energy sources or fossil fuel energy are limited, so most countries are using renewable energy resources. In general, there are two methods of using energy for electricity generation. First, using non-renewable energy sources (coal, oil, gas), and second, electricity resources from renewable energy (solar, wind, water, tidal, biomass, geothermal). Untill now, the electric power generated by the larger generating units is operated centrally and connects to a grid. Most of these generators are located outside of big cities or close to energy sources.this units produce electricity resources by using conventional methods that actually cause radiation greenhouse effect and increasing oil prices instability.

Besides, many people in small areas such as the coastal Pantai Labu Village, Deli Serdang district does not have access to a source of electrical energy because it is far from the power grid center. It is not impossible to connect the electricity distribution network from the city to that area, moreover to planning a power plant system must consider the best decision and look at the investment to an area.

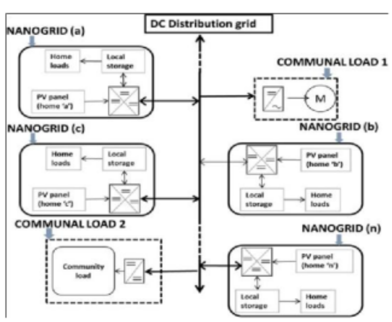
One of the systems to resolve this problem is a new conceptual power system that installation uses a lot of Distribution Generation (DG). Some adopt AC distribution and using conventional power systems, so DC microgrid is offering to find a better connection with a DC output type source that will be used as a photovoltaic (PV) system, fuel cells, secondary batteries, direct current micro (DC microgrid), photovoltaic or renewable energy for the solution to meet the energy shortage in disadvantaged areas, where the microgrid works optimally as needed. Microgrids are classified as a distributed energy source including renewable energy and energy storage systems that operate regularly or as required. Microgrids are classified as distributed energy sources include renewable energy and energy storage systems that operate locally. The proposed microgrid can produce good energy in photovoltaic solar and can directly convert solar energy into electrical energy which is DC power.

The advantage of the DC microgrid system is because the DC microgrid can combine PV and store the energy into a storage area, specifically a battery. DC microgrid is the Main solution where the energy source comes from photovoltaic.

This research focuses on the use of DC microgrid and solar photovoltaic as a solution to overcome energy shortages in the coastal area of Pantai Labu Village. The proposed DC Microgrid system based on solar PV will be connected to the power consumers need to become a single generator.

2. DC Microgrid System Design

The architecture of the DC Microgrid power generation system used by the coastal residents of Pantai Labu Village is a DC microgrid, that is a generator has interconnected or distributed to one another. According to that use, the design of the DC microgrid system is to build an efficient mechanism through distributed generation to channel excess energy.



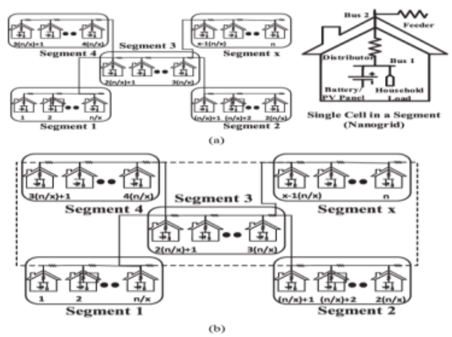
Picture 1. Microgrid architectural diagram with nanogrid or household contributions

A. Nano-Grid Model

Nano-grid is the basis of a DC microgrid building design that unites power in a measured way into a network where installed solar panels will be placed on top of a house or land. Some DC microgrid loads become battery storage. Power flow will be controlled through a converter called central power processing or CPPU. The CPPU system contains a microcontrolle that serves to convert DC-DC free MPPT (Micro Power Piunt Traking) and also serves as a maximum power point tracker.

1) MPPT DC –DC converter to track maximum power points

The main factors that affect PV module output are the amount of irradiation or sunlight intensity received by the PV module surface, the amount of sunlight intensity due to weather, the placement of the photovoltaic module so that it affects the amount of output power. How much intensity of power is produced, it will be comparable and greater..

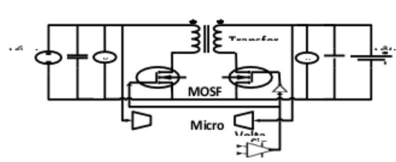


Picture 2.a Radial interconnection scheme with tungal design

b. Proposed overview of an interconnection.

2) Two way flay buck converter

Fly back converters are used to activate and distribute power from nano-grids to micro-grids where power flow is obtained through modified switches using conventional converters thath two-way flay back analysts are provided. The advantages of flay back counters are simple design with lower cost and also use fewer components, greater voltage range so it is suitable for micro-grid applications.



Picture 3. Two-way switch implementation and flyback converter control

c. Regional model with migrogrid connection

The typical area containing P as houses and divide into x segments with n / x with segments like the one in the second picture where the power is supplied by a load of each flay back in each house using the power supply cable. The second shows radial nano grid lowers the conductor power with one interconnecting system on the radial edges and using the ring as the main model, the ultimate reliability is achieved even at low voltage. Using the feeder and distributor resistance scores, based on the interconnection scheme and the small village configuration topology, the conductance matrix G can calculate to model it. For villages with n as houses, G is one of the order 2n × 2n, because each house contains two buses: 1) one busload in the distributor resistance interconnect and load buses, and 2) another bus in the feeder and distributor resistance interconnects. Thus, the elements of the conductance matrices Gij and G is written terms as individual conditionals

$$Gij = \left\{ \begin{array}{ll} \sum_{\substack{j=1 \\ j\neq i}}^{2n} gij & ; \forall i = j \\ -gij & ; \forall \ i \neq j \end{array} \right\}$$

$$G = \begin{bmatrix} G_{11} & G_{12} & \cdots & G_{1,2n} \\ G_{21} & G_{22} & \cdots & G_{2,2n} \\ \vdots & \vdots & \ddots & \vdots \\ G_{2n,1} & G_{2n,2} & \cdots & G_{2n,2n} \end{bmatrix}; G \in R^{2nx2n}$$

3. PROBLEMS AND DISCUSSION

To testing the proposal method, a typical developing country involves of 40 houses. Each house is given 250 WP PV capacity (the maximum power at standard input irradiation 1000 W / m 2), the battery capacity is 100 Ah (lead-acid), also 40 W DC load including lighting, fans. , and charging. The village divides into five segments and eight houses. The distance between successive cages (feeder) and the length of the internal cable (distributor) is 20 m, according to this situation in small villages as describes in developing countries.

Power flow analysis for optimal selection of voltage levels and conductor sizes

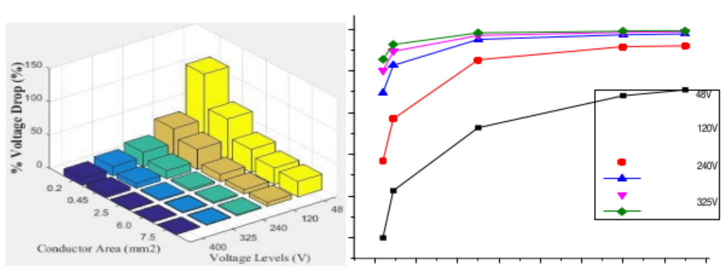
Power flow analysis operates by using the modified Newton Rapson method [12] to discover the critical elements of the system, especially in the lower weight, total path losses, and efficiency. The selection of optimal value is used as an indicator for DC microgrids.

4.RESULTS AND DISCUSSION

To test the methodology used an area consisting of 40 houses to consider where each house has a PV generator with a capacity of 250 wp with a maximum radiation power of 1000 watts / m2, the capacity of each battery used is 100 Ah (lead acid) where the battery can drive DC loads ranging between 40 watts including lamps, fans, chargers where each house is divided into 5 segments, the internal cable length ranges from 20 m consecutively according to the situation in the area [13]

a. The results of the power flow simulation with the interconnection scheme, the optimal voltage, and the size of the conductors used.

A critical aspect of a grid micro is the choice of voltage because that can affect the protection and control system, protection, and safety. High volt DC that can be considered for analysis purposes is 48 V, 120 V, 230 V, 400 V the conductor used is wire 0.2 mm 2 0.45mm2,2.5mm2 6mm2 7.5mm2



Conductor area mm^2

Picture 4 The percentage of voltage drop across voltages that have a different conductor to the radial system..

Picture 5. Decreased voltage percentage voltage with different conductors and various peak loads in the main scheme.

			Radial migro grid			Ring main migro grid	
Distribution (v)	Conductor Mm^2	LL_g %	VDg %	N %	LL_g %	VD_g %	N(%)
48	2,5	23,5	34,4	76,41	17,9	27,1	82,1
120	2,5	7,34	10,9	92,46	4,82	3,38	95,18
400	2,5	0,83	1,23	99,17	0,51	0,77	99,19

Picture of table 1

Figure 1 shows when voltage is increased from 48 V to 120 v there is a significant increase in distribution and satisfy the requirements of protection and the safety level voltage that does not require grownding or additional protective conductor that is low voltage is 120 V, percentage losses are lower at the time of the middle moved from 120 v to 400 then the level of security will be lower . The voltage is not suitable for distribution is low voltage in 48 v because there is a decrease in the higher than 15%, distribution of 400v is compatible to use than the distribution of 200 v. For reliable operation can be performed interconnection between rings and feeders and also reduce conductor costs and add reducance. From the observations above showed that the parameters selected can affect the distribution loss of less than 3% that is at the middle of 400 w, the main scheme used for optimal interconnection and operation of the migro grid is the specification of the considered area, which is 120 V where the conductor of 2.5 mm2 analysis is proposed to produce a tengangan other than 120 v and can be used for load specifications in other areas depending on the tade of between loss and cost of protection.

Parameter used:

Migrogrid Parameter	900m
Number of homes in disadvantaged areas	40
The value of energy use in each home	960 wh
Communal load watershed value	400
Household operations	24w
Operation of the kumunal load	6 jam
Pv panels in each household	250w
Batteries in every household	1,2kwh

Operating System Costs

The cost of generating PV	IDR 700 000
The cost of storing batteries	IDR 700 000
CPU fee	IDR 400 000
Protection conductor fee	IDR 200 000
Operating costs	IDR 400 000
Electricity cost analyst	IDR 1660 000
Power parameters durability:	20 years
Number of battery:	3
Replacment of CPPU :	2
The unexpected cost:	2.000 000 Rupiah
Number of units produced:	3723 MWh during operation
The cost of electricity used:	0.099 kWh

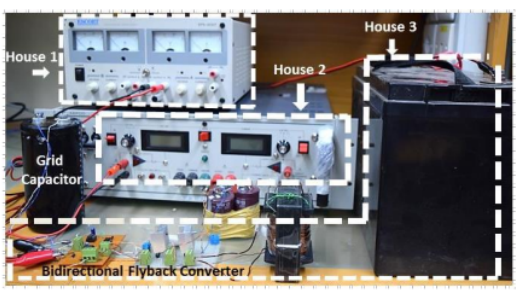
The specification of CPU depends on the level of use, the size of the conductor, the photovoltaic panel, and the size of the battery, by doing the analysis, you can find out the basic evaluation that we use, system operation costs, cycle costs and electricity costs used, system components, WP PV panels, protection, and distribution that we use to estimate the cost[8]. the cost of converter and battery is usually different [14] because's the difference in technology in distribution voltage and tools. Counting Lcoe for 20 hours with price rates Rp 1386 /kWh by using DDDGSA to ensure optimally.

b. A reduced hardware implementation used to analyze DC power flow.

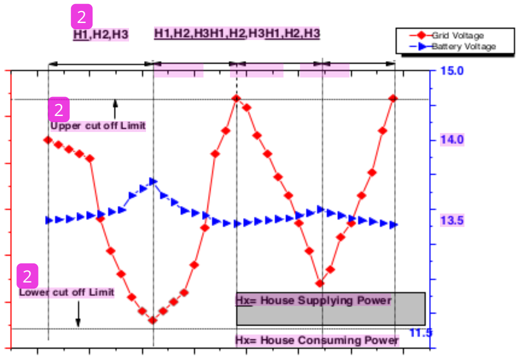
To test the used model that will propose is by minimized the 40 houses and 3 house of them is using as practical implementation by using different scenarios so that each house consume 40 W to implement the generating capacity of each house measured through a single power ESCORT EPS3030T and DC (LABTECH LEMSPL) that used to load consumption capability.

c. Implementation of the DGDSA-based nano grid into the microgrid

The load distribution for home is using VB 12V and for VG is rated at 120 V. To implement a DC grid micro is by using 5000μF capacitor, pay attention to charging and operation every time. The first house is modeled with one DC power [15] one Four quadratic bipolar power is modeled for a second house that acts as a power source [16] and a bidirectional flay back converter and battery is modeled for a third house. In region one, the first house is supplied by the second and third houses that use the electricity grid. If you use the algorithm, the first house supplies less power than the second house, the network voltage decreases. When the voltage drops below from VGmin = 117.5V, the load on second is turned off, the power from batteries to third house first house and the second house will charge the network automatically to increase the voltage to 120 V. When a voltage above 120 V is set to 125 V the load is turned on with the proposed algorithm. In region 3, the second and the first house provide power to meet the battery in the third house. As in Picture 7 where the system is not fixed at 120 V VGmax = 122.5 and VG min = 117.5 V has maintained around the lower and upper cut-off limits during operation the stability of the network will be balanced between the two directions.



Picture 6. Implementation of nano grids into migro grid



Picture 7. The results of implementing a typical micro grid voltage into various power sharing scenarios.

d. The respons for the architectural offered deposit

Although the pictured offered makes good use of distributed resources, the bigger challenges are exist. High distribution challenges can makes a problems, safety, and protection. That cause is short circuits within the microgrid network. To increase the safety are need micro-operation of perspective drop-down control can be reduce. The large-scale DGSA control layer needing additional controls that can ensure enhanced stability of the microgrid during operation.

The selection of the optimal size of the components in the picture, including PV generating capacity components, large of conductors, battery storage capacity, temperature and regional specifications are of the most important concern in the future. In our opinion that the profile of a region can be very important to ensure, optimal planning, and efficient utilization of resources. The role of micro financing of villages or disadvantaged areas becomes an important role in the operation of migrogrid. [17] Technical innovations were united with businesses for equitable energy absorptions. and the role of the private sector increased over the last few years.

5. Conclusion

The results of the analysis showed that the proposed distributed storage plan can increase attribution efficiency by 5% of LVDC. If the proposed DGSA measured in its design and operation, the advantages obtained from efficiency, stability, achieved through an interconnection of each house which contributes (nano grid) with its distribution control achieved from the solar drop voltage. PV distributed by a plant and storage allows the sharing of power that is conjungated. With the arrangement of disadvantaged areas or a growing area with the number of houses about 40 houses 96% efficiency can be achieved for conductors 2.5 mm2 even distributed low in 120 V.

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