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Enhance Power Loss in Distribution System Synergy Photovoltaic Power Plant

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***Abstract*— This paper presents an enhance power loss in distribution system synergy photovoltaic power plant. The enhance power loss is a factor in the efficiency of the power distribution system. Under technical constraints such as power flow and power loss. Modeling solution that uses the radius 33 bus. Distribution system with distributed generators (DG). It is therefore proposed in this paper to solve a solar power plant into the power distribution system problem based on a power loss synergy power flow algorithm. The results show that solar power plant can be enhance power loss on distribution system.**

Keywords— Power Loss, Photovoltaic, Distribution System

I. Introduction

Distributed generation is an approach that employs small-scale technologies to produce electricity close to the end users of power. DG technologies often consist of modular (and sometimes renewable-energy) generators, and they offer a number of potential benefits. For example, of DG such as wind, solar, fuel cells, hydrogen, and biogas show in Fig.1.

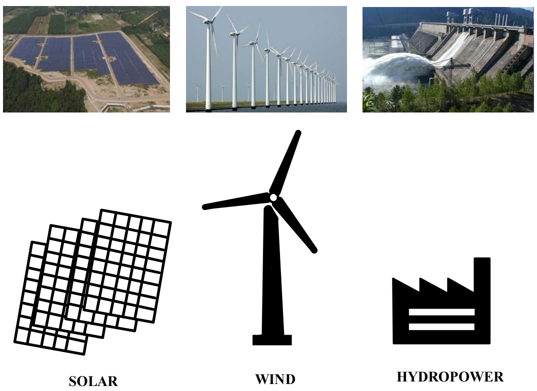

Fig.1. Type of distributed generation.

The DGs placement in distribution system to enhance power loss improvement by photovoltaic power plant on distribution system under the technical conditions, power flow equation, line capability. The experiment with the model of distribution system 33 buses [1] was evaluated to find the answer with the proposed technique enhance power loss in distribution system synergy photovoltaic power plant. Distributed system with DGs installation show in Fig.2.

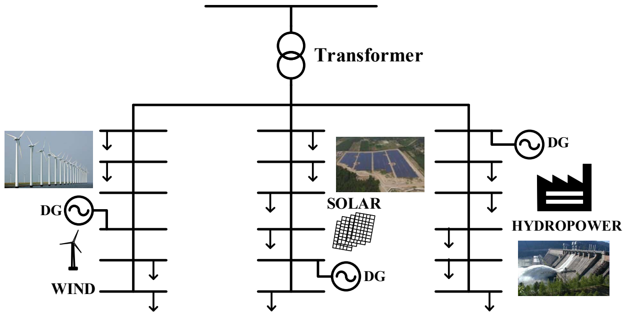

Fig.2. Distributed system with DGs installation.

In the grid-connected system, as all excess power is fed to the grid lines. except for small critical loads, such as the startup controls and the computers. The DC power is first converted into AC by the inverter, ripples are filtered and then only the filtered power is fed into the grid lines.

For photovoltaic (PV) applications, the inverter is a critical component, which converts the array DC power into AC for supplying the loads or interfacing with the grid. AC-PV modules, which integrates an inverter directly in the module. It provides utility grade 60Hz power directly from the module junction box. This greatly simplifies the PV system design.

Real power loss is an important index for the technical assessment of PV-DG placements. The total power loss at each load level after the PV-DG installations. The key component in the objective function to be minimized is the real power loss reduction after sitting DGs. Assume that a given number of available PV-DG units are planned for placement in the system and each unit is assigned with a maximum MW capacity. The search space of the PV-DG candidate busses usually is enormous [2].

Therefore, this research paper presents an enhance power loss in distribution system synergy photovoltaic power plant shown in Fig. 3. Using the with mathematical modeling solution that uses the radius 33 bus distribution system with distributed generators (DG).

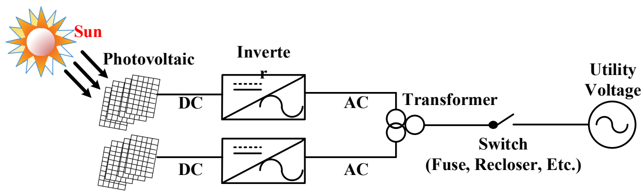

Fig. 3. Photovoltaic power generation system.

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The objective is to analysis enhance power loss in distribution system synergy photovoltaic power plant.

II. Power Loss

The power loss of distribution system analysis synergy photovoltaic. Load in distribution system could be indicated as.

$$S_L = P_L + jQ_L \tag{1}$$

where P_L is the active power of the load and Q_L is the reactive power of the load.

Model establishing distribution system synergy photovoltaic access. The direction of power flow was usually the network side than the load side in the traditional distribution system without photovoltaic power access. The current flowing into the load side have the distance between the substation and the load side. Contrast with the traditional distribution system, the model of the distribution system synergy photovoltaic power access. The current flowing from the substation is the current flowing from the photovoltaic power, Is the distance between the substation and the photovoltaic power, and is the distance between the photovoltaic power and the load side [3].

To derive the transmission-loss equation in terms of power output of the plants, we consider a simple system consisting of substation, distributed generation and five loads. with the transmission network represented by its bus impedance matrix. When system loss is neglected, the transmission network is equivalent to a single node to which all generation and load is connected shown in Fig. 4.

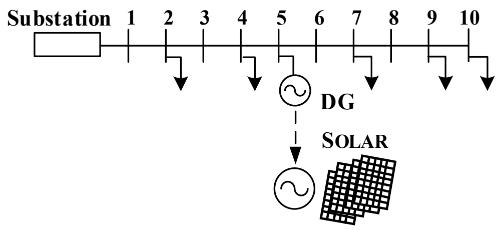

Fig. 4. Model of distribution system synergy photovoltaic.

III. Photovoltaic

Solar photovoltaic (PV) power generation uses renewable energy that is natural, safe and sustainable. PV is a device that converts sunlight into electricity using the intensity of solar. PV systems used for many photovoltaic farms connect to the grid everywhere, especially in developed countries with large markets [4]. A schematic diagram of solar photovoltaic (PV) system as show in Fig 5.

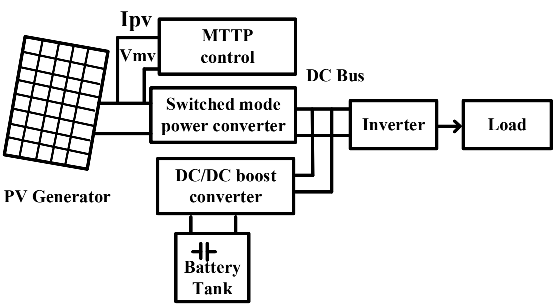

Fig. 5. Schematic diagram of a PV system.

Photovoltaic systems include PV array system which consists of two or more solar panel that converts sun light into electricity. Photovoltaic system is a non-conventional source of energy like wind turbine etc. It is used with dynamic voltage recover (DVR) system for energy storage. This system will provide energy to dc source which is used by inverter system to convert dc energy into ac energy for further applications of DVR system. The equivalent circuit model of photovoltaic cell is shown in Fig.6 [5].

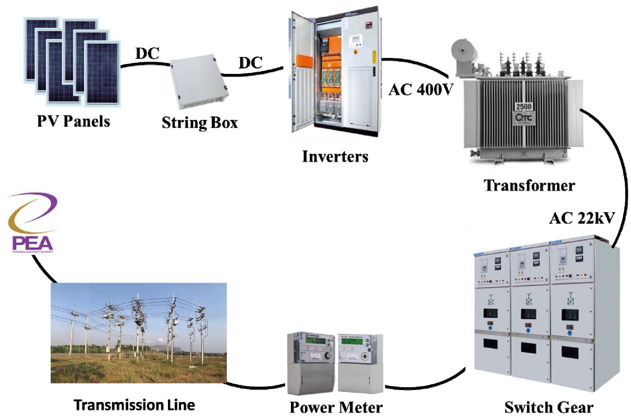

Fig. 6. Photovoltaic systems.

In recent years, all large-scale urban blackouts are due to transmission line overload which connected one or more distribution network with transmission network. Therefore, the energy control strategy which this article designed will satisfy the internal load demand of distribution network in maximal degree. And the thoughts of this strategy are reduced the long-distance power transmission, autarky and superfluous power feeding external. The photovoltaic diesel generator hybrid power supply system will be programmed as isolated island operation model which could access new energy maximum and will running at grid connected mode to send out extra solar energy [6].

IV. Mathematical Model

The load flow analysis in distribution networks is solved using backward forward sweep load flow method [7-8].

The single line diagram of a section of a distribution network is presented as shown in Fig. 7.

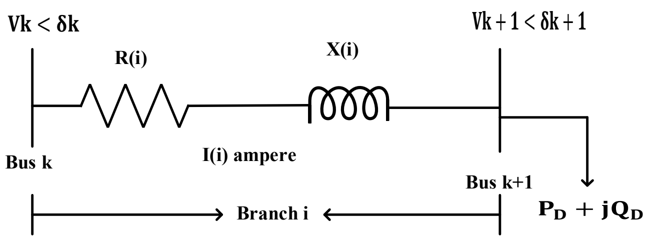

Fig. 7. Two-bus section in a radial distributed network.

which shows the two buses; k and k+1, connected through a branch line i. Resistance and reactance of the branch i are represented by *R*i and *X*i, respectively. Whereas, *I*(i) is the current that is flowing through the branch i. The power losses across the branch i can be calculated by eq. (2)-(3).

$$P_{loss\,(i)} = R_{(i)} \times \frac{P_{k+1}^2 + Q_{k+1}^2}{|V_{k+1}|^2} \quad (2)$$

$$Q_{loss\,(i)} = X_{(i)} \times \frac{P_{k+1}^2 + Q_{k+1}^2}{|V_{k+1}|^2} \quad (3)$$

where, *P*loss(i) and *Q*loss(i) are the active and reactive power losses across the branch i. The total power losses in distribution network can be calculated by summing the active and reactive power losses of all the branches in the network. The total system losses can be calculated by eq. (4)

$$P_{loss\_total} = \sum_{i=1}^{no.of\ branc\,hes} P_{loss\,(i)} + Q_{loss\,(i)} \quad (4)$$

V. CASE STUDY

The study, enhance power loss using 33 buses distribution system model with PV as shown in Fig.8. The nine DG units are located at buses 10, 14, 18, 19, 23, 26, 29, 30 and 33 have the capacity of 300, 400, 100, 100, 100, 400, 100, 400 and 200 kW respectively. The total installed capacity of DGs is 1,000 kW. The system base 100 MVA and voltage base is 12.66 kV.

Each branch in the system has a separate switch to reconfigure. The data loaded in the Table AI and Table AII provide branch information [9].

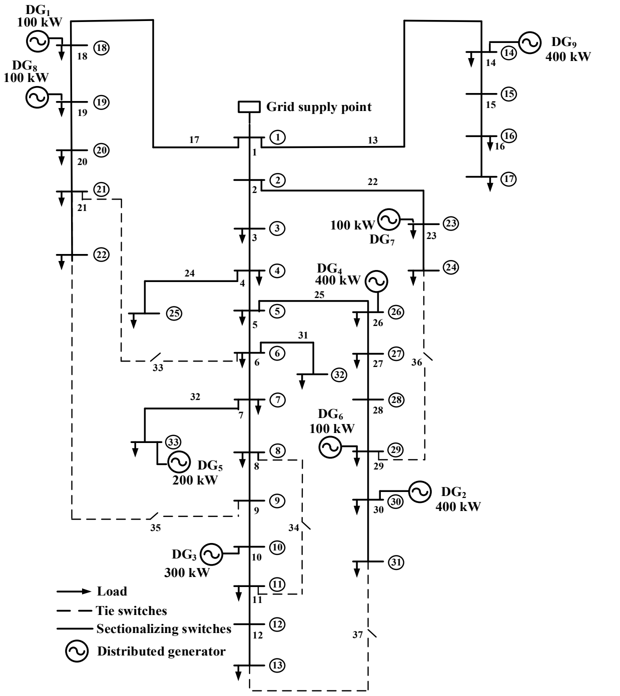

Fig. 8. Single-line diagram of 33-bus distribution system.

The switch number 1-32 are sectionalizing switches on a distribution feeder (normally close) and switch number 33-37 are tie switches (normally open). The total load for this test system are 1,718.37 kW and 1,226.90 kVAr. The voltages all buses are set at 0.95 and 1.05 p.u.

Four cases are examined as follows:

Case 1: Without DGs in distribution system. This case represents the base case.

Case 2: Installation DGs 3 is number of DGs installation in distribution system. Capacity of DGs 300 kW

Case 3: Installation DGs 6 is number of DGs installation in distribution system. Capacity of DGs 600 kW

Case 4: Installation DGs 9 is number of DGs installation in distribution system. Capacity of DGs 1000 kW

VI. RESULTS

The numerical results for the 4 cases are shown in Table I the total power loss of all for cases 1, 2, 3 and 4. As can be seen, the power loss is improved in cases 4 the presence of the DGs capacity 1000 kW. The results of voltage profile for cases 1 and 3 as shown in Fig. 9. and Fig. 10.

TABLE I. TEST REPORT POWER LOSS IN DISTRIBUTION SYSTEM SYNERGY PHOTOVOLTAIC POWER PLANT OF MODEL 33 BUS

Case	Vmin (p.u.)	PV at bus	Capacity of DGs	Total Power Loss (kW)
1	0.95	-	-	13.2316
2	0.95	10, 14, 18	300	10.4515
3	0.95	10, 14, 18, 19, 23, 26	600	9.5910
4	0.95	10, 14, 18, 19, 23, 26, 29, 30, 33	1000	5.6347

TABLE II. BUS AND CAPACITY OF DGS AT BUS TEST

Bus	10	14	18	19	23	26	29	30	33
Capacity of PV (kW)	100	100	100	100	100	100	100	100	200

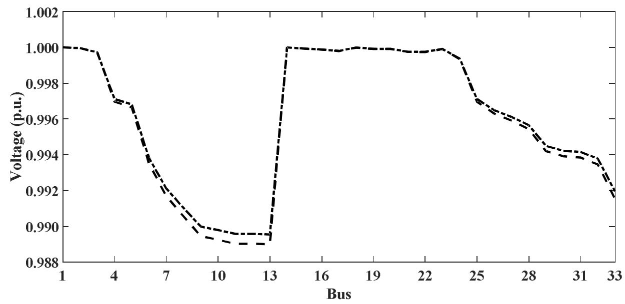

Fig. 9. Voltage profile without PV in distribution system.

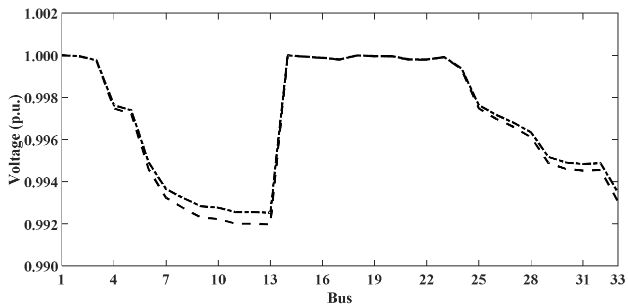

Fig. 10. Voltage profile with PV in distribution system.

From Fig. 9. The voltage profile without PV in distribution system. This case represents the base case. The total power loss 13.2316 kW in distribution system synergy photovoltaic power plant. and Fig. 10. The voltage profile with PV in distribution system. The capacity of PV 600 kW. The total power loss 9.5910 kW in distribution system synergy photovoltaic power plant decreased.

VII. CONCLUSION

This paper presents an enhance power loss in distribution system synergy photovoltaic power plant. Tested with a single-line diagram of 33-bus distribution system, which has performed four cases are examined as follows, Case 1: Without in distribution system, Case 2: Installation DGs 3 is number of DGs installation in distribution system, Case 3: Installation DGs 6 is number of DGs installation in distribution system, Case 4: Installation DGs 9 is number of DGs installation in distribution system. It was found that Case 1: Without in distribution system does not improve distribution system. But Case 2: Installation DGs 3 is number of DGs installation in distribution system, Case 3: Installation DGs 6 is number of DGs installation in distribution system, Case 4: Installation DGs 9 is number of DGs installation in distribution system.

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APPENDIX

TABLE AI
LOAD DATA OF 33-BUS DISTRIBUTION SYSTEM

Bus Number	P_L (kW)	Q_L (kVAr)	Bus Number	P_L (kW)	Q_L (kVAr)
3	2.60	2.20	20	24.00	17.00
4	75.00	54.00	21	24.00	17.00
5	30.00	22.00	22	1.20	1.00
6	145.00	104.00	23	6.00	4.30
7	145.00	104.00	24	39.22	26.30
8	8.00	5.00	25	384.70	274.50
11	114.00	81.00	26	384.70	274.50
13	14.00	10.00	27	3.60	2.70
14	26.00	18.60	29	4.35	3.50
16	14.00	10.00	30	24.00	17.20
17	6.00	4.00	31	100.00	72.00
18	26.00	18.55	32	32.00	23.00
19	26.00	18.55	33	59.00	42.00

TABLE AII
BRANCH DATA OF 33-BUS DISTRIBUTION SYSTEM

Branch Number	Sending end bus	Receiving end bus	R (Ω)	X (Ω)
1	1	2	0.0015	0.0036
2	2	3	0.0251	0.0294
3	3	4	0.3811	0.1941
4	4	5	0.0493	0.0251
5	5	6	0.8190	0.2707
6	6	7	0.7114	0.2351
7	7	8	1.0300	0.3400
8	8	9	1.0440	0.3450
9	9	10	0.1966	0.0650
10	10	11	0.2106	0.0690
11	11	12	0.0140	0.0046
12	12	13	0.3089	0.1021
13	1	14	0.0044	0.0108
14	14	15	0.3978	0.1315
15	15	16	0.3510	0.1160
16	16	17	1.7080	0.5646
17	1	18	0.0044	0.0108
18	18	19	0.0640	0.1565
19	19	20	0.0018	0.0021
20	20	21	0.3100	0.3623
21	21	22	0.0092	0.0116
22	2	23	0.0034	0.0084
23	23	24	0.0822	0.2011
24	4	25	0.0928	0.0473
25	5	26	0.1740	0.0886
26	26	27	0.2030	0.1034
27	27	28	0.2813	0.1433
28	28	29	0.7837	0.2630
29	29	30	0.3861	0.1172
30	30	31	0.1450	0.0738
31	6	32	0.2012	0.0611
32	7	33	0.7394	0.2444
		Tie line		
33	6	21	0.5000	0.5000
34	8	11	0.5000	0.5000
35	9	22	1.0000	0.5000
36	24	29	2.0000	1.0000
37	13	31	1.0000	0.5000