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ALGORITHM FOR OPTIMAL POWER FLOW SOLUTION OF A MICROGRID

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Abstract: **A microgrid will take part in a vital role in the future, since it will decrease the tension by the rising electricity demands, as compared to the constraints forced by power plants and transmission lines. Hence, identifying the optimal operating point of any distributed generators (DGs) in a microgrid leads them to identifying the optimal operation of any generator in them of cost minimization efficiency maximization. This paper proposes a novel algorithm to resolve the optimal operating point of distributed generators. In this algorithm, the new droop characteristic slopes (frequency vs. active power and voltage vs. reactive power) of the inverter will be detected of the optimized point. Conventionally, inverter based DGs droop characteristic slopes have a steady slope in their maximum and minimum capacity in the deferent function mode of microgrid. If any alter is necessary, the slope will be selected random. To reduce the deviation of droop characteristic slopes and the other objectives, the multi-objective optimization algorithm can be used. The multi-objective optimization is used in this paper, can give the logical choice to determine the new droop characteristic slopes in optimized point with least variation.**

Index Terms ***Microgrid, distributed generators (DGs), distributed energy resources (DERs), algorithm, droop characteristics etc***

I. INTRODUCTION

THIS paper provides information about future grid. The order for electricity has increased progressively over the previous few years due to fast people enlargement. This tendency will probably carry on over the next few decades [18]. Power production in huge centralized power plants such as nuclear, fossil fuel (coal, gas), etc. has had an impact on the induced price though; the consumers often live too distant from the generating point of electricity. Electric power systems and the power grid are now undergoing to reform due to a number of factors. These factors include: rising demand, increasing improbability caused by the mixing of irregular renewable energy sources and additional deregulation of the industry [5], [9].

Owing to a lot of inexpensive, practical and technical reasons, the power grid cannot give the required energy for the user. In providing an incident to the power shortage in many areas of order, it has happen to compulsory to look for an additional way to produce the power requisite by the user.

Any new choice to generate energy should be researched in similar with present grid supply systems. In the past, every one of the power plants has transferred energy throughout transmission lines. Though, limitations in transmission lines force the requirements of network plan which allows generators to be located close to their loads. In combination with the advances in power electronics, the small-scaled distributed power generation (non 50-60 HZ) is in the place to alter the usual power system [11]. Such alter includes the operation of renewable energy sources (RES) such as wind, solar, fuel cells, etc.

The power that is generated from natural resources such as wind, sunlight, rain, tides and geothermal heat has been named renewable energy (RE), where RE unit is an environmentally open way of generating power and a severe candidate to substituting of non renewable energies like coal and oil. Renewable energy can be second-hand for a wide range of environments as the resources of such environments say. Such environments comprise villages plus large rural areas. Green power refers to a division of renewable energy that characterized by lofty environmental profits. A huge number of research studies have been conducted in various countries for substituting usual energy with RES. For instance, it has been reported that from 1995 to 2000, the U.S. government had spent 1.456 billion dollars on renewable energy research [19], while Japan is the rising star of green power research. By adjusting their government policies and well-built state economic support, Japan has prepared full use of renewable energy. It has also made great achievements in wind, solar and ocean energy power generation [20]. Also, the use of green power has dispersed rapidly in Germany over the past few years, where it is likely that it will gradually replace the nuclear power generation in the next few years. [19].In our country, India it is on track to adopt Renewable energy sources to produce huge power.

II. MICROGRID

The decrease of fossil fuel sources, greenhouse gasses of the environment, constraints in transmission lines, and the reduced efficiency of energy drives us to a new kind of power production. These kinds of generators must be placed at the distribution voltage point and near housing districts. The types of generators in the distribution network produce power by means of renewable energy sources (RES). This kind of generator is known as distributed generator (DG) and its energy source is known as distributed energy resources (DERs).

A. *Distributed Energy Resources unit (DERs)*

Distributed generators are little choice power generators that are linked to the distribution network, or straight at the user request [2]. The DERs submit to all technologies which can be used to offer energy shut to the user [8]. The high diffusion of DGs in the network is capable to ease the stress on the electric system by feeding into branch of the neighboring load. DER units hold distributed generator (DG) and distributed storage (DS) with diverse rates of flow [13].

In 2001, Professor Robert H.Lasseter from the University of Wisconsin-Madison wished-for the definition of the microgrid [14] and shaped a microgrid test bed. By this definition, the microgrid has a solitary unit function in a power system. It is defined as the microgrid acting as a collection of DER units in the same manner that distributed voltage can give electricity and/or heat a group of domestic load order [18]. The nearness of the generator and the load (heating and electrical) in the microgrid reduce the investment price and decrease the losses in the transmission lines. A usual constitution of microgrid is shown in Fig.1. The microgrid in Fig.1 can function in two ways:

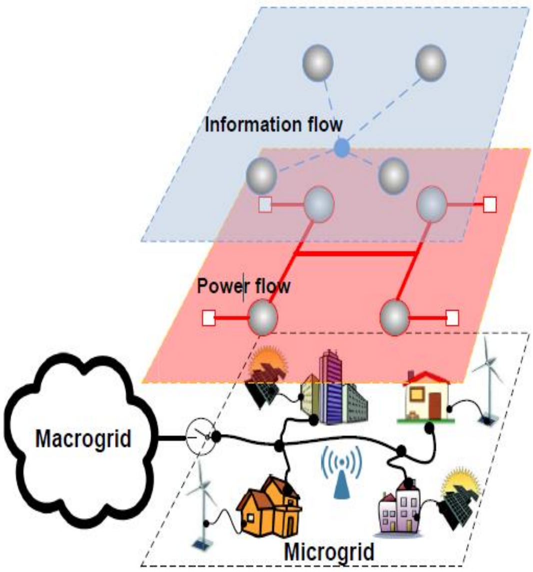


Figure 1. Microgrid constitution

In *first* way, the microgrid is linked to the grid where the grid and DER units share the production of power enough for customers in the microgrid section. In the *second* mode the microgrid is cut off from the grid and acts as an independent island in the microgrid. In this way all of the DER units that live in the microgrid offer the energy for the customer. There are several reasons for leaving with this way. The reasons can choice from dropped voltage in the grid, a lesser price of energy in the microgrid, in the incident of fault in the grid, and so on. In this case the microgrid can wait in stand-alone way without requiring some power from the grid. The microgrid unit has an electrical link point to the grid that is referred to as the point of common coupling (PCC).

B. *Power management strategies for microgrid*

The aim of this paper is to calculate the amount of power generated by any DER unit in the microgrid. To get this aim, a power management strategy (PMS) is necessary. In the microgrid, each DER unit has a diverse rate of flow with no leading DG in the autonomous way of microgrid [12]. Therefore, the PMS must consider every type of DER units and fashion a control tactic for energy flow in the microgrid in both ways (connected to and disconnected from the grid). In this control, the PMS must manage the active and reactive power flow with good stability and reliability in the system. The tactic for control must be to offer the peer-to-peer (P2P) and plug-and-play (PnP) concepts in the microgrid. In the situation of the microgrid, P2P means there is no master control for every DER unit, so if one DER unit is gone, the system can carry on its process with a further DER unit. PnP means, every DER units can be added in any place of the microgrid without redesigning new control tactics for the system.

III. OPTIMAL POWER FLOW (OPF)

A. Introduction

Optimal power flow was offered for the first time by Carpentier in 1962 [4]. OPF is an algorithm that optimizes the aim function, such as the whole price of power production, magnitude and phase angle variation of bus voltage, power losses, and release of pollutants, etc. The aim function can also be predefined by the customer. OPF get the optimal set end of the electrical system which convince the system power flow equations and all of the boundary, limitations, and incidents, connected with the power network.

B. Formulation

In a power grid with *N busses*, if the voltage magnitude and the phase angle of the busses are calculated by using the OPF formula then all of the variables linked with the system, such as the active and reactive power transferred among the buses and also the quantity of the current in the lines, will be fulfilled. In the power system, there are three types of busses:
One is, The *PV* bus or generator bus, with at smallest amount one generator connected to the bus. Second is The *PQ* bus or load bus, where no generator is associated to the bus. And third is the *slack* bus or swing bus, this is defined by the reference for phase angle of the voltage and can give the essential active and reactive power for matching the system at the optimized result. If we assume the power system includes n busses and n_g generators, the dimension of the admittance matrix Y_{bus} will be an "$n \times n$" matrix and is symentric.
$S_{bus} = V_{bus}I_{bus}{}^{*}$ *with* $I_{bus} = Y_{bus}V_{bus}$
Where the V_{bus} is the vector of the bus voltage and I_{bus} is a vector and denotes the bus current injected in the bus.

$$S_{bus} = V_{bus}(Y_{bus}V_{bus})^{*}$$

$$S_{bus_i} = V_{bus_i}\left[\sum_{j=1}^{n}(y_{ij}V_{bus_j})\right]^{*} \qquad i,j = 1,2,\ldots,n$$

$$S_{bus_i} = \sum_{j=1}^{n}(V_{bus_i}V_{bus_j}^{*}y_{ij}^{*}) \qquad i,j = 1,2,\ldots,n$$

$$V_i = |V_i|e^{j\theta_i} \qquad V_j = |V_j|e^{j\theta_j} \qquad i,j = 1,2,\ldots,n$$

$$Y_{ij} = G_{ij} + jB_{ij} \qquad \theta_{ij} = \theta_i - \theta_j \qquad i,j = 1,2,\ldots,n$$

$$S_{bus_i} = \sum_{j=1}^{n}\left[|V_i||V_j|e^{j\theta_{ij}}(G_{ij} - jB_{ij})\right] \qquad i,j = 1,2,\ldots,n$$

where:

S_{bus_i} : The complex power injection in *bus i*.

$$S_{bus_i} = \sum_{j=1}^{n}[|V_i||V_j|(\cos\theta_{ij} + j\sin\theta_{ij})(G_{ij} - jB_{ij})] \qquad i,j = 1,2,\ldots,n$$

$$P_{bus_i} = \sum_{j=1}^{n}[|V_i||V_j|(G_{ij}\cos\theta_{ij} + B_{ij}\sin\theta_{ij})] \qquad i,j = 1,2,\ldots,n$$

$$Q_{bus_i} = \sum_{j=1}^{n}[|V_i||V_j|(G_{ij}\sin\theta_{ij} - B_{ij}\cos\theta_{ij})] \qquad i,j = 1,2,\ldots,n$$

where:

P_{bus_i} : The active power injection in *bus i*.

Q_{bus_i} : The reactive power injection in *bus i*.

In the power flow problem, the load is an identified variable. In situation up the formula, the active and reactive power insertion to every bus must consider the amount of the load and generation as given below:
$P_{busi} = P_{gi} - P_{Li} = f(V; \theta)$ $Q_{busi} = Q_{gi} - Q_{Li} = f(V; \theta)$
where: P_{gi} : The active power of the generator in the *bus i*.
Q_{gi} :The reactive power of the generator in the *bus i*.
P_{Li} : The active power of the load in the *bus i*.
Q_{Li} : : The reactive power of the load in the *bus i*.
According to the optional aim function and its constraints, substitute formulas can be obtainable. The OPF will resolve quadratic problem comprise minimizing a quadratic function subject to linear and nonlinear equality, inequality, that is of notice in this paper.
The formula in which the aim function minimizes the cost ($Ci(P)$, $i = 1; 2; :::; n_g$) or/and emissions (*Tot emission i* , $i = 1; 2; :::; n_g$) or/and total losses between the lines (*Tot losses*) in the system or/and any other objective function can be set up as follow:
Minimize: $\sum_i C_i(P)$, $i = 1; 2; :::; n_g$
Subjected to: inequality constraints:
$\theta_{min} \leq \theta_i \leq \theta_{max}$ $i = 1,2,\ldots\ldots n\text{-}1$
$V_{min} \leq V_i \leq V_{max}$ $i = 1,2,\ldots\ldots n$
$P_{mini} \leq P_{gi} \leq P_{maxi}$ $i = 1,2,\ldots\ldots ng$

$Q_{min\,i} \leq Q_{gi} \leq Q_{max\,i}$ $i = 1,2,\ldots\ ng$
$S_{iFrom} \leq Rate$ $i; j = 1; 2; :::; n; i \neq j$
$S_{ijTo} \leq Rate$ $i; j = 1; 2; :::; n; i \neq j$
Where: $|S_{ijFrom}|$ and $|S_{ijTo}|$ are the magnitude of complex power which moves from *bus* (*i*) to *bus* (*j*) at the sending and receiving point.
Equality constraints:

$$P_{bus_i} = P_{gi} - P_{Li} = \sum_{j=1}^{n} [|V_i||V_j|(G_{ij}\cos\theta_{ij} + B_{ij}\sin\theta_{ij})]$$

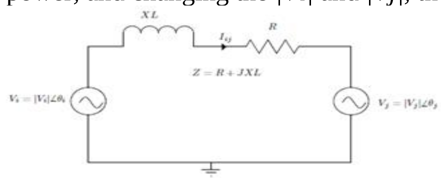
$$Q_{bus_i} = Q_{gi} - Q_{Li} = \sum_{j=1}^{n} [|V_i||V_j|(G_{ij}\sin\theta_{ij} - B_{ij}\cos\theta_{ij})]$$

IV. DROOP CONTROL

In the power system, active power and frequency are dependent on each other. In a revolving machine, raising the load will effect in a raise in torque. The torque is related to the rotational speed with relation to the frequency of the system. This means that the lesser the frequency, the higher the load will be. So PMS can try to resolve a way to direct the system with these characteristics when the DER unit in microgrid is interfaced to the system with an inverter.

A. Concept of droop control

To recognize the idea of droop control, we come back to the power system for delivering complex power through a transmission line among two buses.
From the below equation, the variation of the phase angle between two busses (θ_{ij}) is dependent on the active power delivered between the buses, and from equation the magnitude voltages ($|Vi|$ and $|Vj|$) in two buses is influenced by reactive power. This implies that by changing θ_{ij}, the active power, and changing the $|Vi|$ and $|Vj|$, the reactive power can be controlled.



$$S_{ij} = P_{ij} + jQ_{ij} \qquad \theta_{ij} = \theta_i - \theta_j$$

$$S_{ij} = V_i I_{ij}^*$$

$$S_{ij} = V_i \frac{(V_i - V_j)^*}{Z^*} \qquad S_{ij} = \frac{|V_i|^2 - |V_i||V_j|e^{\theta_{ij}}}{Z^*}$$

$$P_{ij} = \frac{|V_i|}{XL^2 + R^2}(R|V_i| - |V_j|\cos\theta_{ij} + |V_j|XL\sin\theta_{ij})$$

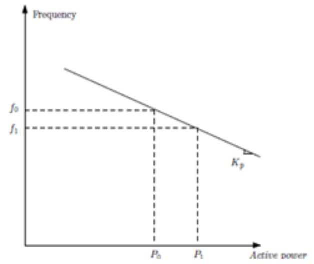
$$Q_{ij} = \frac{|V_i|}{XL^2 + R^2}(XL|V_i| - |V_j|\cos\theta_{ij} - |V_j|R\sin\theta_{ij})$$

$$P_{ij} = \frac{|V_i||V_j|}{XL}\sin\theta_{ij} \qquad Q_{ij} = \frac{|V_i|^2}{XL} - \frac{|V_i||V_j|}{XL}\cos\theta_{ij}$$

$$\sin\theta_{ij} \cong \theta_{ij} \cong \frac{XLP_{ij}}{|V_i||V_j|} \qquad |V_i|(|V_i| - |V_j|) \cong XLQ_{ij}$$

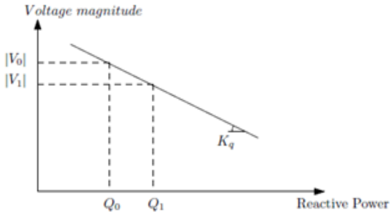
B. Droop in microgrid

In relation to droop control in the microgrid, the frequency is used instead of the phase angle for controlling the active power. The microgrid includes two or more DGs which use droop characteristics to share the active and reactive power,
These DGs are interfaced with the inverter. When the load in the microgrid is changed, PMS must have exact policy to determine the set point of every DG for the contribution of active and reactive power at the optimized point. Fig. shows the frequency droop characteristic. In this figure the f_0 is the nominal frequency and P_0 is the momentary set point for active power of the inverter



$$f_1 = f_0 + K_p(P_1 - P_0)$$

Figure Frequency droop characteristic



$$|V_1| = |V_0| + K_q(Q_1 - Q_0)$$

Figure Voltage droop characteristic

Load sharing through P-f control

In a microgrid with two or more DGs, varying the load in both modes (linked to the grid or detached from grid), PMS uses the frequency droop characteristics to change the set-up of the functional point to access the local power equilibrium in the new situation of loading. As an example, a microgrid which has three DGs with droop characteristics is shown in Fig. each DG has a dissimilar slope in frequency droop characteristics (Kp_1 , Kp_2 and Kp_3). When the microgrid is connected to the grid, the main grid is big and strong sufficient to balance any variation in the microgrid [11]. So the frequency in the microgrid will be the supposed frequency of the grid ($f0$). From Fig., their droop characteristics, the three DGs provide the load P_{L0} as follows:

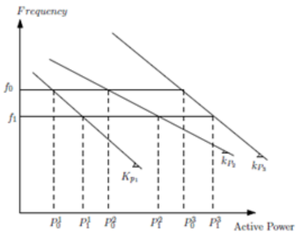


Figure: *Frequency droop characteristic for three DGs*

$$P_{L_0} = P_0^1 + P_0^2 + P_0^3$$

$$P_{L_0} = P_L - P_{grid}$$

$$P_{L_1} = P_1^1 + P_1^2 + P_1^3$$

Now if the microgrid for any reason is disconnected from the grid, $P_{L1} = P_L$

$$f_1 = f_0 + K_{p_i}(P_1^i - P_0^i)$$

$$P_{L_1} = \sum_{i=1}^{3} P_1^i \qquad P_{L_0} = \sum_{i=1}^{3} P_0^i \qquad \Delta P_L = P_{L_1} - P_{L_0}$$

The amount of power for every DG will be:

$$P_1^i = \frac{\Delta P_L \frac{1}{K_{P_i}}}{\sum_{i=1}^{3} \frac{1}{k_{p_i}}} + P_0^i$$

V. OPF WITH DROOP CONTROL

An investigational microgrid based on distributed generators (*DG*) consists of several modules: the utility power grid, inverters and loads. This chapter will speak to inverter management and control. Every inverter has autonomous droop control characteristics for contribution the active and reactive power between DGs to meet the load.

Mathematic model

The sum of the power is equal to the loads, but the reality the system is nonlinear and the losses should be considered as the equation will be:

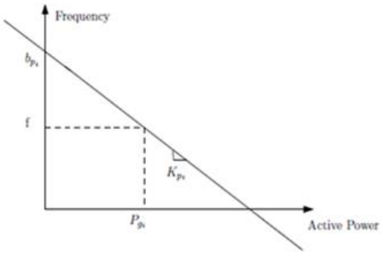


Figure : *Frequency droop characteristic for DG in bus i*

$$\sum_{i=1}^{n_g} P_{g_i} = P_{Load} + Losses$$

$$f = K_{pi} P_{gi} + b_{pi}$$

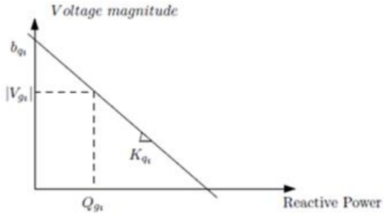


Figure : Voltage droop characteristic for DG in bus *i*

$$|V_{gi}| = K_{qi} Q_{gi} + b_{qi}$$

$Z_{ij} = R_{ij} + 2\pi f L_{ij}$ where: $f = 50$ Hz, $X_{ij} = 2\pi 50 Lij$ and $Z_{ij}(f) = R_{ij} + jX_{ij}f/50$

For a network with n independent busses, and n_g generators, the dimension of admittance matrix will be a "$n \times n$" and this matrix will be a function of f as given below

$$S_{bus} = V_{bus} I_{bus}^*$$

where I_{bus} is the bus current injection vector.

$$S_{bus} = V_{bus}[Y_{bus}(f)V_{bus}]^*$$

$$S_{bus_i} = V_{bus_i}\left[\sum_{j=1}^{n}[y_{ij}(f)V_{bus_j}]\right]^* \qquad i,j = 1,2,...,n$$

$$S_{bus_i} = \sum_{j=1}^{n}[V_{bus_i}V_{bus_j}^* y_{ij}^*(f)] \qquad i,j = 1,2,...,n$$

$$V_i = |V_i|e^{j\theta_i} \qquad V_j = |V_j|e^{j\theta_j} \qquad i,j = 1,2,...,n$$

$$Y_{ij}(f) = G_{ij}(f) + jB_{ij}(f) \qquad \theta_{ij} = \theta_i - \theta_j \qquad i,j = 1,2,...,n$$

$$S_{bus_i} = \sum_{j=1}^{n}\left[|V_i||V_j|e^{j\theta_{ij}}[G_{ij}(f) - jB_{ij}(f)]\right] \qquad i,j = 1,2,...,n$$

$$S_{bus_i} = \sum_{j=1}^{n}[|V_i||V_j|(\cos\theta_{ij} + j\sin\theta_{ij})(G_{ij}(f) - jB_{ij}(f))] \qquad i,j = 1,2,...,n$$

$$P_{bus_i} = \sum_{j=1}^{n}[|V_i||V_j|(G_{ij}(f)\cos\theta_{ij} + B_{ij}(f)\sin\theta_{ij})] \qquad i,j = 1,2,...,n$$

$$Q_{bus_i} = \sum_{j=1}^{n}[|V_i||V_j|(G_{ij}(f)\sin\theta_{ij} - B_{ij}(f)\cos\theta_{ij})] \qquad i,j = 1,2,...,n$$

$$P_{bus_i} = P_{gi} - P_{Li} = f(V,\theta,f) \qquad Q_{bus_i} = Q_{gi} - Q_{Li} = f(V,\theta,f)$$

$$P_{gi} = \frac{f - b_{pi}}{K_{pi}} \qquad Q_{gi} = \frac{|V_{gi}| - b_{qi}}{K_{qi}}$$

Mathematical formula for optimization is given below:

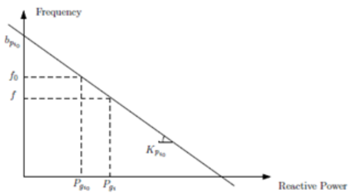


Figure: *Frequency droop characteristics for DG in bus i in different load*

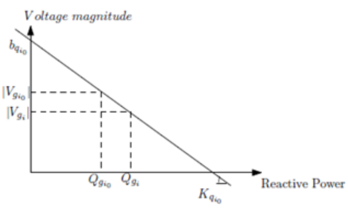


Figure: *Voltage droop characteristics for DG in bus i in different load*

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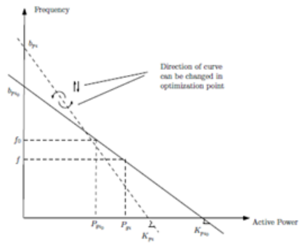

Figure: *Direction of frequency droop characteristics changing for DG in bus i for different load*

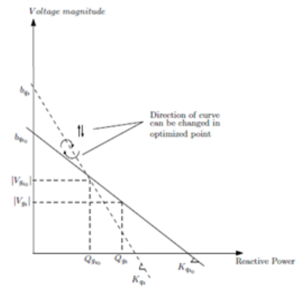

Figure: *Direction of voltage droop characteristics changing for DG in bus i for different load*

$$\text{Minimize:} \quad (\Delta K_{pi}^2, \Delta b_{pi}^2, \Delta K_{qi}^2, \Delta b_{qi}^2) \qquad i = 1, 2, ..., n_g$$

$$\theta_{min} \le \theta_i \le \theta_{max} \qquad i = 1, 2, ..., n$$

$$V_{min} \le |V_i| \le V_{max} \qquad i = 1, 2, ..., n$$

$$P_{min_i} \le P_{gi} \le P_{max_i} \qquad i = 1, 2, ..., n_g$$

$$Q_{min_i} \le Q_{gi} \le Q_{max_i} \qquad i = 1, 2, ..., n_g$$

$$f_{min} \le f \le f_{max}$$

$$K_{p_{min}} \le K_{p_i} \le K_{p_{max}} \qquad i = 1, 2, ..., n_g$$

$$K_{q_{min}} \le K_{q_i} \le K_{q_{max}} \qquad i = 1, 2, ..., n_g$$

$$b_{p_{min}} \le b_{p_i} \le b_{p_{max}} \qquad i = 1, 2, ..., n_g$$

$$b_{q_{min}} \le b_{q_i} \le b_{q_{max}} \qquad i = 1, 2, ..., n_g$$

$$|S_{ij_{From}}| \le Rate \qquad i, j = 1, 2, ..., n, i \ne j$$

$$|S_{ij_{To}}| \le Rate \qquad i, j = 1, 2, ..., n, i \ne j$$

$$P_{bus_i} = P_{gi} - P_{Li} = \sum_{j=1}^{n} [|V_i||V_j|(G_{ij}(f)\cos\theta_{ij} + B_{ij}(f)\sin\theta_{ij})]$$

$$Q_{bus_i} = Q_{gi} - Q_{Li} = \sum_{j=1}^{n} [|V_i||V_j|(G_{ij}(f)\sin\theta_{ij} - B_{ij}(f)\cos\theta_{ij})]$$

$$P_{gi} = \frac{f - b_{pi}}{K_{pi}} \qquad i = 1, 2, ..., n_g$$

$$Q_{gi} = \frac{|V_{gi}| - b_{qi}}{K_{qi}} \qquad i = 1, 2, ..., n_g$$

$$\Delta K_{pi} = K_{pi} - K_{pi_0} \qquad i = 1, 2, ..., n_g$$

$$\Delta K_{qi} = K_{qi} - K_{qi_0} \qquad i = 1, 2, ..., n_g$$

$$\Delta b_{pi} = b_{pi} - b_{pi_0} \qquad i = 1, 2, ..., n_g$$

$$\Delta b_{qi} = b_{qi} - b_{qi_0} \qquad i = 1, 2, ..., n_g$$

$$F = W_1F_1 + W_2F_2 + ... + W_iF_i \qquad i = 1, 2, ..., 4n_g + 1$$

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where: $F_1 = \sum_{i=1}^{n_g} C_i(P),$

$F_2 = \Delta K_{p_1}^2, \qquad F_3 = \Delta K_{q_1}^2,$

$F_4 = \Delta b_{p_1}^2, \qquad F_5 = \Delta b_{q_1}^2$

$\cdots \qquad \cdots$

$F_{4i-2} = \Delta K_{p_i}^2, \qquad F_{4i-1} = \Delta K_{q_i}^2$

$F_{4i} = \Delta b_{p_i}^2, \qquad F_{4i+1} = \Delta b_{q_i}^2$

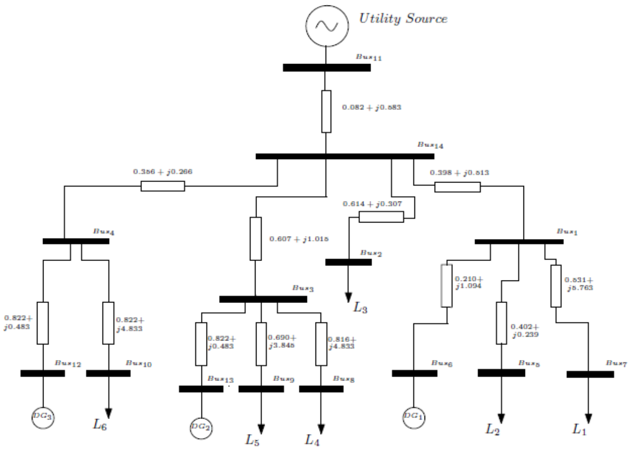
and,

$$W_1 + W_2 + W_3 + \ldots + W_{4i+1} = 1$$

VI. SYSTEM CONSIDERED AND RESULTS

The case that we chosen up for this learn is shown in the Fig.

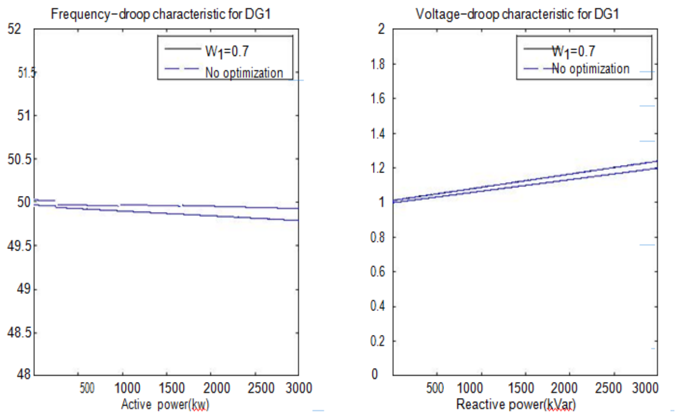
In fig, is a single-diagram of a 13.8-KV distribution system used to examine a achievable microgrid PMS. This system has three DG units, with different rating, ie.,DG1 (1.8MVA), DG2 (2.5-MVA) and DG3 (1.5-MVA). All of the DG units can be dispatched [12]. To study this case, all of the buses for the loads and DGs are shown in Fig.



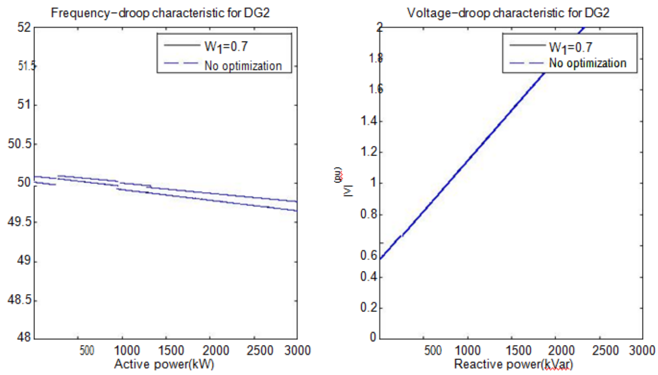
This system has fourteen buses, and three DGs: $DG1$, $DG2$ and $DG3$ connect respectively to $Bus6$, $Bus13$, and $Bus12$. The values of the impedance between the lines are stated in Table

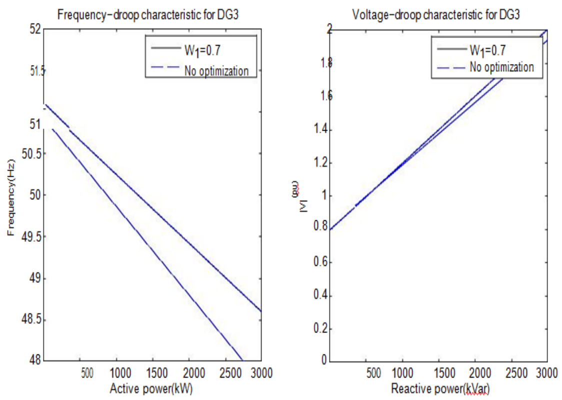
Bus_i	Bus_j	R_{ij}	XL_{ij}
1	7	0.5314	5.7635
1	5	0.4022	0.2395
1	6	0.21	1.094
1	14	0.3976	0.5127
2	14	0.6141	0.3066
3	14	0.6065	1.015
3	8	0.816	4.8332
3	9	0.6903	0.000
14	11	0.0818	0.5826
12	4	0.822	0.48332
13	3	0.822	0.48332
4	14	0.3564	0.2661
10	4	0.822	4.8332

Droop characteristics for DG1 is shown below:



Droop characteristics for DG2 is shown below:





VII. CONCLUSION

This study has presented a tactic for formative optimal power flow in a microgrid in a steady state, for whichever one of two modes of operation, i.e., connected to the grid and disconnected from the grid, acting as a standalone isolated microgrid. This study develops an algorithm which defines the droop characteristic parameters of an inverter. The goal is to find the output in determining the optimal power to the user. This algorithm assists the user to dispatch power in the microgrid. If the load vary in the microgrid, this results in changes in the droop characteristics in both the slope (*Kp* and *Kq*) and the Y-intersect (*bp* and *bq*) deviating at the optimized point. In addition, when the microgrid is disconnected from the grid, the frequency is changed from the frequency of the grid. From the frequency-droop characteristics the amount of power of DG will be altered. The droop characteristic parameters of the inverter-based DGs has calculated to achieve correct load sharing at optimized point rather than to be used a set value. The power essential for the system is provided by the optimal power flow that minimizes the cost of fuel.

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