Economic Dispatch In Power System

by

Mohd Sallehhudin Bin Ismail

5602

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Engineering (Hons)
(Electrical and Electronics Engineering)

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Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

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Approved by,

Herman Agustiawan

(DR HERMAN AGUSTIAWAN)
Project Supervisor

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

JUNE 2008

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

MOHD SALLEHHUDIN BIN ISMAIL

ABSTRACT

This project consists of the knowledge of Electrical and Electronics Engineering student like Newton-Raphson method, power flow solutions, optimization, and basic knowledge of power system. The objective of the project is to determine the optimum power flow in a power system that represents by a simple and modified model. Therefore, so many calculations involve in term to gain the result. Using manual calculation and simulation, those desired values can be obtained. The project also includes how I manage to design the model, doing calculation and come out with the desired output, which is optimal power flow. Starting from the power flow solution, cost of the generations, generator's selection and finish with the result of the optimization. The results show several steps on how I manage to get the output and the problems occupied when I am doing the calculations. I had made many mistakes in getting the output even in the calculations, inputs, and simulations. Instead of just try to get the result, the process of learning and studying actually absorbed to understand something by making the mistakes. The final result should be a optimum solution for the model that I had created.

ACKNOWLEDGEMENT

First of all, I want to thank the God for letting me finish this project even there are so many problems occurred and with the time constraint that really put me in the very tight schedule. Thanks to my supervisor, Dr. Herman Agustiawan for letting me finishes this project even I had created a lots of problems which gave him headaches. All of his efforts that more on motivating student had gave me courage to keep on doing the tasks even somehow I felt it was hard to solve. And also, I want to thank Mr. Fakhizan B. Romlie, lecturer of Electrical and Electronics Engineering toward his contributions for helping me finished this project. Not to forget, Mr. Fatimi, UTP Electrical Engineer for giving me the valuable data and sources. Last but not least for whom that ever helped me in any circumstances, I really appreciate all of those efforts. Thank you.

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CHAPTER 1

INTRODUCTION

1.1 Background Of Study

The economic dispatch and the minimum loss problem can be solved using the sequence of conventional Newton-Raphson power flow calculation. The main objective of this project is to using only Newton-Raphson for power flow optimization. So, the understanding about power flow studies and their components are very important. There have been many algorithms proposed for economic dispatch such as Merit Order Loading, Range Elimination, Binary Section and secant section and others related methods. As I mentioned before my project will involve only Newton-Raphson method and its components. The cost function can be optimized by finding the control variables on the systems. When the control variables have been found, the optimization can be done. In this project I am using my own methodology of finding the best solution for the optimization. But, the optimization cost function I was using is the existing one that I found in my research. But the model used in this project is a modified model with the load came from the real single line diagram for UTP's new academic block which includes the Pocket C and Pocket D. For the transmission line data, the generated data was used because the real data was not available.

1.2 Problem Statement

The factors influencing power generation at minimum cost are operating efficiencies of generators, fuel cost and transmission losses. What it means by minimum cost is the lowest cost to operate a generator to produce the electricity power in Watt. If there are many generators with different efficiencies we need to determine which one will cost the lowest with optimum power generations. The operating cost plays an important role in the economic scheduling and gives any changes in various demands of the power generation. In a power system network there will be a numbers of generator which are supplying the power to the system. Not to be neglected the network losses also occur in this situation. The generators also have their own limits in producing the power therefore we need to determine the limits of power generations. No matter how big is the network system, the same method optimization can be used.

1.3 Objectives

Objectives:

i) To show economic dispatch the simple network system without network losses and power generation limits.

ii) To show economic dispatch of the simple network system with power generation limits.

iii) To show economic dispatch of the simple network system with power generation limits and network losses.

CHAPTER 2

LITERATURE REVIEW

2.1 Theory

Optimization from mathematical term refers to the study of problems in which one seeks to minimize or maximize a real function by systematically choosing the values of real or integer variables from within an allowed set. Either to find the maximum or minimum values for certain function, the optimization technique is the best way to obtain the closest and accurate result. In this project the aim is to minimize the total cost generation respectively to the constraints of the operational generators. So, it is more about economic dispatch which is to determine the most efficient, low-cost and reliable operation of a power system by dispatching the available electricity generation resources to supply the load on the system

Power flow Study is an important tool involving numerical analysis applied to a power system. A power flow study focuses on various forms of AC power (reactive, real and apparent) rather than voltage and current. There are two types of analysis involved in this study which are fault analysis and economic analysis.

There are several different methods of solving the resulting nonlinear system of equations. The most popular is known as the Netwon-Raphson Method. This method begins with an initial guesses of all unknown variables (voltage magnitude and angles at Load Buses and voltage angles at Generator Buses). Next, a Taylor Series with the higher order terms ignored of each of the power balance equations included in the system of equations is written. The result is a linear system of equations that can be expressed as:

$$\begin{bmatrix} \Delta\theta \\ \Delta|V| \end{bmatrix} = -J^{-1} \begin{bmatrix} \Delta P \\ \Delta Q \end{bmatrix}$$

where ΔP and ΔQ are called the mismatch equations:

$$\Delta P_i = -P_i + \sum_{k=1}^{N} |V_i||V_k|(G_{ik}\cos\theta_{ik} + B_{ik}\sin\theta_{ik})$$

$$\Delta Q_i = -Q_i + \sum_{k=1}^{N} |V_i||V_k|(G_{ik}\sin\theta_{ik} - B_{ik}\cos\theta_{ik})$$

and J is a matrix of partial derivatives known as a Jacobian:

$$J = \begin{bmatrix} \frac{\delta\Delta P}{\delta\theta} & \frac{\delta\Delta P}{\delta|V|} \\ \frac{\delta\Delta Q}{\delta\theta} & \frac{\delta\Delta Q}{\delta|V|} \end{bmatrix}$$

The linearized system of equations is solved to determine the next guess (m + 1) of voltage magnitude and angles based on:

$$\theta^{m+1} = \theta^{m}\Delta\theta$$

$$|V|^{m+1} = \theta^{m}\Delta|V|$$

The process continues until a stopping condition is met. A common stopping condition is to terminate if the norm of the mismatch equations are below a specified tolerance.

A rough outline of solution of the power flow problem is:

1) make an initial guess of all unknown voltage magnitudes and angles. It is common to use a "flat start" in which all voltage angles are set to zero and all voltage magnitudes are set to 1.0 p.u.

2) Solve the power balance equations using the most recent voltage angle and magnitude values.

3) Linearize the system around the most recent voltage angle and magnitude values

4) Solve for the change in voltage angle and magnitude

5) Update the voltage magnitude and angles

6) Check the stopping conditions, if met then terminate, else go to step 2.

Newton-Raphson Method:

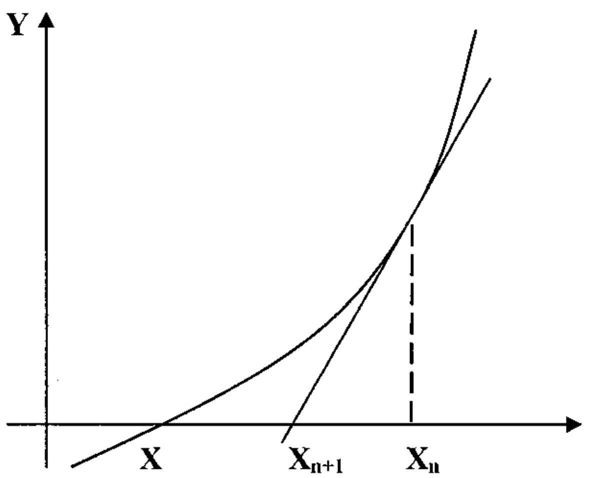

Figure 1: Root of an equation

The Newton-Raphson method can be presented by X_{n+1} and as we can see that the curve of X is converged closer with tangent X_{n+1} rather than direct guess of X_n. So, this method can give the closest root to the desired function. In the cost function which I gained earlier, I can find the variable controllers to optimize the equation. The variables can be the voltages or the phase angles. It also can be any others elements and components in the power flow transmissions. But there are still some weaknesses by using Newton-Raphson method. First, this method requires that the derivative be calculated directly. Then, the second one is that Newton-Raphson method would be failed to converge if the initial value is too far from the true zero. So, it is better to put an upper limit on the number of iterations and size of the iterations.

Optimization

In all practical cases, the fuel cost of generator I can be represented as a quadratic function of real power generation.

$$C_i = \alpha_i + \beta_i P_i + \gamma_i P_i^2$$

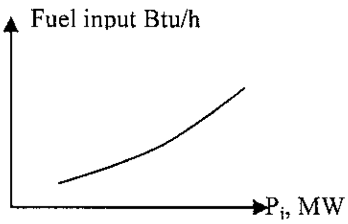

Figure 2: Heat-rate curve

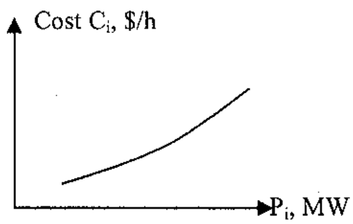

Figure 3: Fuel cost curve

Then we determine the derivative of above equation to obtain an important characteristic known as the incremental fuel-cost curve in figure below.

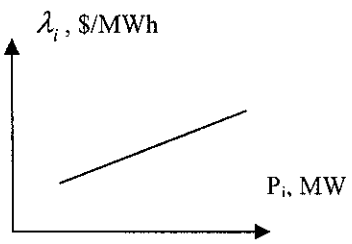

Figure 4: Typical incremental fuel-cost curve

$$\frac{dC_i}{dP_i} = 2\gamma_i P_i + \beta_i$$

Economic dispatch neglecting the losses and generator limits.

In order to make the economic dispatch much simple, we neglect the losses and generator limits. Therefore the model does not consider system configuration and line impedances.

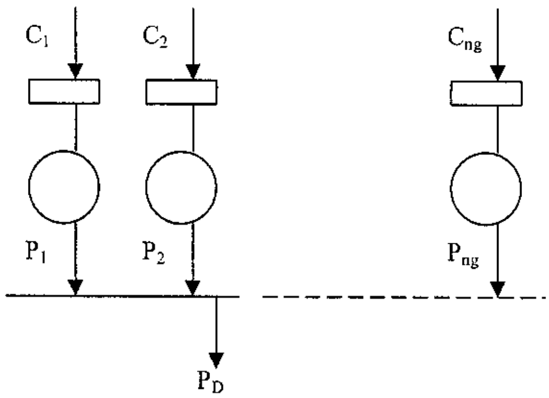

Figure 5: Plants connected to a common bus.

P_D can be assumed as total of power generation. A cost function C_i is assumed to be known for each plant. The problem is to find the real power generation for each such that the objective function (total production cost);

$$C_t = \sum_{i=1}^{ng} C_i$$

$$= \sum_{i=1}^{n} \alpha_i + \beta_i + \gamma_i P_i^2$$

With constraint to

$$\sum_{i=1}^{ng} P_i = P_D$$

Where C_t is the total production cost, C_i is the production cost of *i*th of generator, P_i is the generation of *i*th generator, P_D is the total load demand, and n_g is the total number of dispatchable generating power.

We use the Lagrange multipliers to augment the constraints into subject function.

$$L = C_t + \lambda\left(P_D - \sum_{i=1}^{ng} P_i\right)$$

The minimum of this unconstrained function is found at the point where the partials of the function to its variables are zero.

$$\frac{\partial L}{\partial P_i} = 0$$

$$\frac{\partial L}{\partial \lambda} = 0$$

Come to first condition, $\dfrac{\partial L}{\partial P_i} = 0$;

$$\frac{\partial C_t}{\partial P_i} + \lambda(0-1) = 0$$

Since

$$C_t = C_1 + C_2 + \ldots + C_{ng}$$

Then

$$\frac{\partial C_t}{\partial P_i} = \frac{\partial C_i}{\partial P_i} = \lambda$$

And for the condition for optimum dispatch is

$$\frac{dC_i}{dP_i} = \lambda \qquad i = 1, \ldots, n_g$$

Or

$$\beta_i + 2\gamma_i P_i = \lambda$$

And for condition $\frac{\partial L}{\partial \lambda} = 0$;

The equation $\sum_{i=1}^{ng} P_i = P_D$ is the equality constraint that was to be imposed. Without counting the losses and the generator limits, theoretically all generators must operate at equal incremental production cost while satisfying the equality constraint above.

By arranging the equation $\beta_i + 2\gamma_i P_i = \lambda$, we solve for

$$P_i = \frac{\lambda - \beta_i}{2\gamma_i}$$

The relation above called coordination equations. They are functions of λ. An analytical solution can be obtained for λ by substituting for P_i in that equation.

$$\sum_{i=1}^{ng} \frac{\lambda - \beta_i}{2\gamma_i} = P_D$$

$$\lambda = \frac{P_D + \sum_{i=1}^{ng} \frac{\beta_i}{2\gamma_i}}{\sum_{i=1}^{ng} \frac{1}{2\gamma_i}}$$

From this equation we found the value for λ to obtain the optimal scheduling of generation.

Economic dispatch including generator limits and neglecting losses.

Any generator has limit to produce output power. This is for efficiency and security of the generator itself. The generator should operate in the ranges that considered safe and gives the best performances. Therefore the inequality constraint been added to the cost function.

$$P_{i(\min)} \le P_i \le P_{i(\max)} \qquad i = 1,2\ldots,n$$

The necessary conditions for the optimal dispatch;

$$\frac{dC_i}{dP_i} = \lambda \qquad \text{for} \qquad P_{i(\min)} \le P_i \le P_{i(\max)}$$

$$\frac{dC_i}{dP_i} \le \lambda \qquad \text{for} \qquad P_i = P_{i(\max)}$$

$$\frac{dC_i}{dP_i} \ge \lambda \qquad \text{for} \qquad P_i = P_{i(\min)}$$

Economic dispatch including losses

In large interconnected network where power is transmitted over long distances with low load density areas, transmission losses are the major factor and affect the optimum dispatch of generation. In this model used, the distances covered only for Pocket C and Pocket D, so the losses not to be counted. If I were using the whole new academic blocks network configurations, the losses should be taken into the consideration.

The economic dispatching problem is to minimize the overall generating cost C_i, which is the function of generation output subject to the limits of the generators and inequality constraints;

$$C_t = \sum_{i=1}^{ng} C_i$$

$$= \sum_{i=1}^{n} \alpha_i + \beta_i P_i + \gamma_i P_i^2$$

With constraint;

$$\sum_{i=1}^{ng} P_i = P_D + P_L$$

Inequality constraints;

$$P_{i(\min)} \leq P_i \leq P_{i(\max)} \qquad \text{i} = 1,2\ldots,\text{n}$$

Using the Lagrange multiplier and adding additional terms to include the equality constraints;

$$L = C_t + \lambda\left(P_D + P_L - \sum_{i=1}^{ng} P_i\right) + \sum_{i=1}^{ng} \mu_{i(\max)}(P_i - P_{i(\max)}) + \sum_{i=1}^{ng} \mu_{i(\min)}(P_i - P_{i(\min)})$$

$\mu_{i(\max)} = 0$, when $P_i < P_{i(\max)}$

$\mu_{i(\min)} = 0$, when $P_i > P_{i(\min)}$

If the constraint is not violated, its associated μ variable is zero and can be eliminated from the above equation.

CHAPTER 3

METHODOLOGY

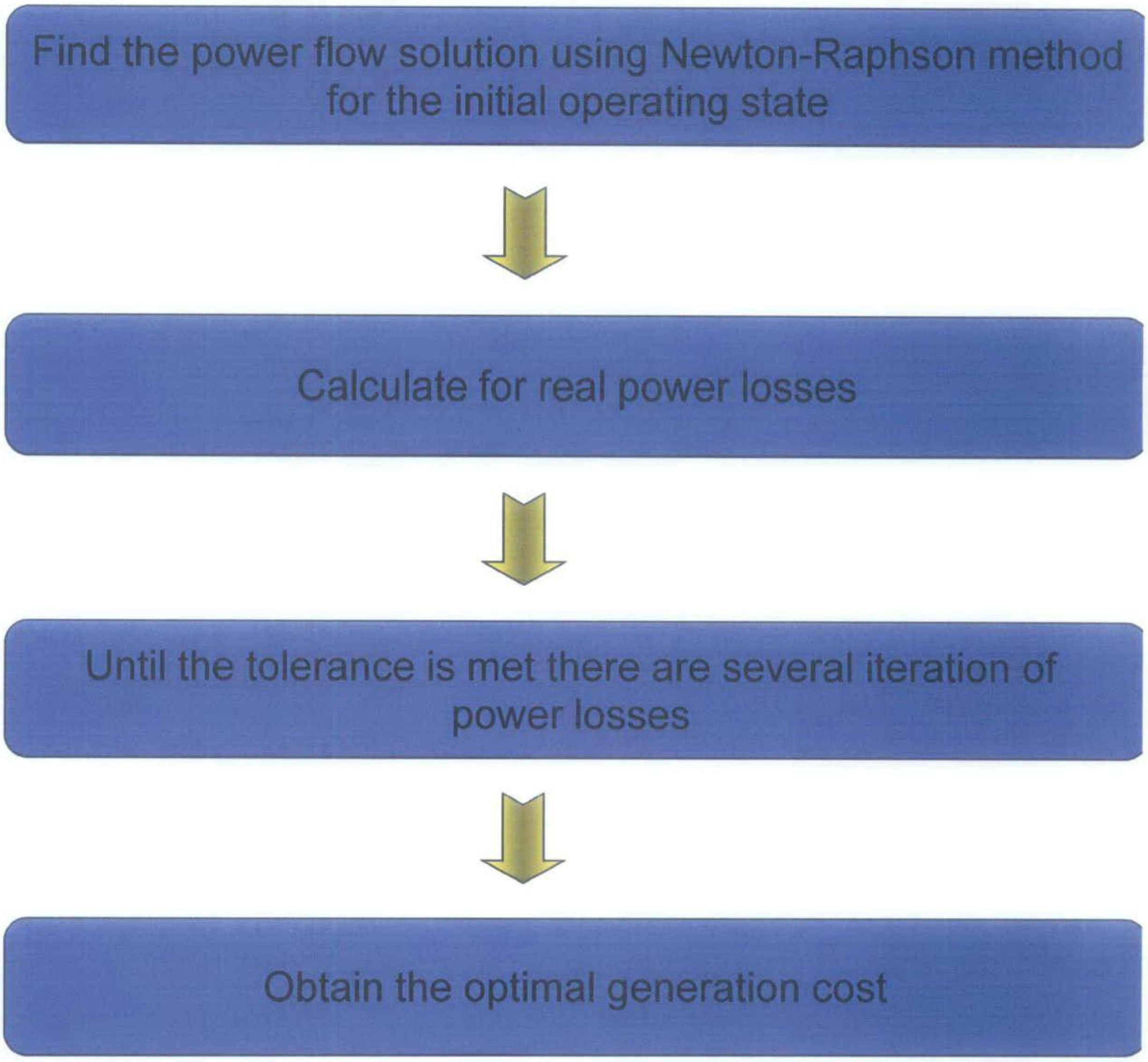

Figure 6: Economic dispatch simple flow

Case 1: Three generators

The fuel cost functions for three thermal plants in $/h are given by;

$$C_1 = 500 + 5.3P_1 + 0.004P_1^2$$
$$C_2 = 400 + 5.5P_2 + 0.006P_2^2$$
$$C_3 = 200 + 5.8P_3 + 0.009P_3^2$$

Where P_1, P_2, P_3 are in MW. The total load, P_D, is 800 MW. Without counting network losses and generation limits, we find the optimal dispatch and the total cost in $/h.

First we must find the λ and substitute it into the equation

$$\lambda = \frac{800 + \dfrac{5.3}{0.008} + \dfrac{5.5}{0.0.12} + \dfrac{5.8}{0.018}}{\dfrac{1}{0.008} + \dfrac{1}{0.012} + \dfrac{1}{0.018}}$$

$$= \frac{800 + 1443.0555}{263.8889}$$

$$= 8.5 \text{ \$/MWh}$$

Simple coding using Matlab

```
% Iterative solution Using Newton method
alpha =[500; 400; 200];
beta = [5.3; 5.5; 5.8]; gama=[.004; .006; .009];
PD=800;
DelP = 10;            % Error in DelP is set to a high value
lambda = input('Enter estimated value of Lambda = ');
fprintf('\n ')
disp(['  Lambda     P1     P2     P3     DP'...
   '   grad    Delambda'])
iter = 0;                              % Iteration counter
while abs(DelP)  >= 0.001              % Test for convergence
iter = iter + 1;                       % No. of iterations
P = (lambda - beta)./(2*gama);
DelP =PD - sum(P);                           % Residual
J = sum( ones(length(gama), 1)./(2*gama));   % Gradient sum
Delambda = DelP/J;                     % Change in variable
disp([lambda, P(1), P(2), P(3), DelP, J, Delambda])
lambda = lambda + Delambda;            % Successive solution
end
totalcost = sum(alpha + beta.*P + gama.*P.^2)
%Graphical Demonstration of Example 7.4
```

```
axis([0 450  6.5 10.5]);
P1=250:10:450; P2 = 150:10:350; P3=100:10:250;
IC1= 5.3 + 0.008*P1;
IC2= 5.5 + 0.012*P2;
IC3= 5.8 + 0.018*P3;
Px = 0:100:400;
plot(P1, IC1, P2, IC2, P3, IC3, Px, lambda*ones(1, length(Px)),'-m'),
xlabel('P, MW'), ylabel(' $/MWh'), grid
```

```
Enter estimated value of Lambda = 8.5

  Lambda     P1      P2       P3      DP    grad     Delambda
 Columns 1 through 6

  8.5000  400.0000  250.0000  150.0000       0  263.8889

 Column 7
      0
totalcost =

  6.6825e+003
```

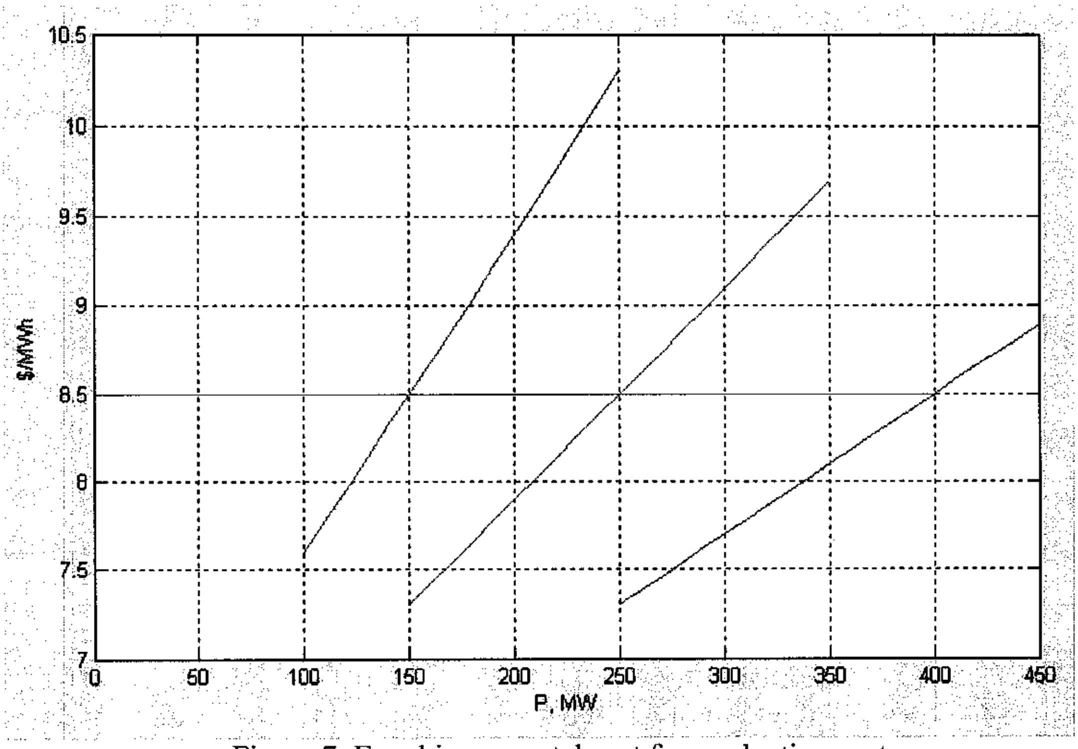

Figure 7: Equal incremental cost for production cost

CHAPTER 4

RESULT AND DISCUSSIONS

After doing some researches, the optimization power flow will base on three characteristic of the power transmissions behaviour. First is about power mismatch. Power mismatch consist of two types of powers which called scheduled power and actual power received at destination. Scheduled power is a power that should arrive at the destination as it has been setting earlier and power received is the actual power that measured at the destination or transmission lines. Actually to make this understanding become clearer, the scheduled power can be assumed as generated power and the actual power as the load power. The second constraint for this optimization is network losses. The power mismatch and network losses are very related to each other because the power mismatch can be affected by network losses. In this project, as it was mentioned before that the first step of the optimization is to determine the best cost production of the generators. Without counting the network losses and generator limits, I try to compare the different using several generators with different incremental cost functions.

The fuel cost functions for three generators in \$/h;

$$C_1 = 500 + 5.3P_1 + 0.004P_1^2$$
$$C_2 = 400 + 5.5P_2 + 0.006P_2^2$$
$$C_3 = 200 + 5.8P_3 + 0.009P_3^2$$

After that I used six generators to compare the effect of using more generators with various generation costs.

$$C_4 = 300 + 5.7P_4 + 0.007P_4^2$$
$$C_5 = 200 + 5.4P_5 + 0.004P_5^2$$
$$C_6 = 400 + 5.5P_6 + 0.006P_6^2$$

Table 1: Total cost generation by using 3 generators.

Cost function Generator	α	β	γ	β/γ	1/γ
C1	500	5.3	0.004	662.5	125
C2	400	5.5	0.006	458.3333	83.33333
C3	200	5.8	0.009	322.2222	55.55556
				1443.056	263.8889

λ =	8.5	$/MWh
P1 =	400	
P2 =	250	
P3 =	150	
PD =	800	

	100	200	300	400	500	600
C1 =	1070	1720	2450	3260	4150	5120
C2 =	1010	1740	2590	3560	4650	5860
C3 =	870	1720	2750	3960	5350	6920

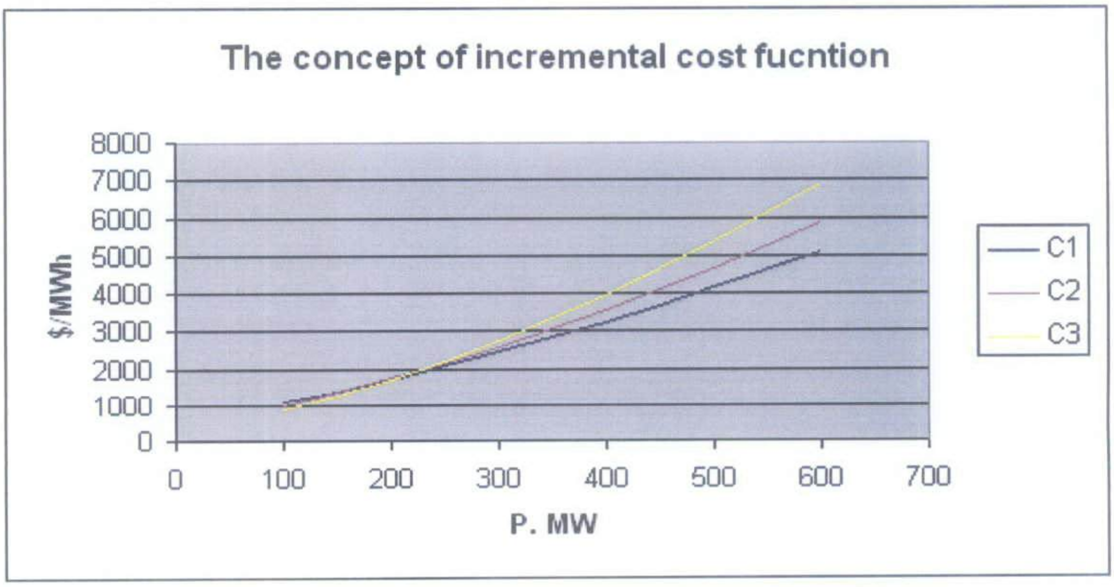

Figure 8: cost function for 3 generators

Total cost 6682.5 $/h

Table 2: Total cost generation for 6 generators

Cost function Generator	α	β	γ	β/γ	1/γ
C1	500	5.3	0.004	662.5	125
C2	400	5.5	0.006	458.3333	83.33333
C3	200	5.8	0.009	322.2222	55.55556
C4	300	5.7	0.007	407.1429	71.42857
C5	200	5.4	0.004	675	125
C6	400	5.5	0.006	458.3333	83.33333
				2983.532	543.6508

Total Demand =	800	
λ =	6.959489	$/MWh
P1 =	207.4361	
P2 =	121.6241	
P3 =	64.41606	
P4 =	89.9635	
P5 =	194.9361	
P6 =	121.6241	
Total PD	800	
C1 =	1771.53	
C2 =	1157.687	
C3 =	610.958	
C4 =	869.446	
C5 =	1404.655	
C6 =	1157.687	
Total cost =	6971.964	

After comparing the cost functions, I decided to use three generators which can produce higher output power with lowest cost.

Table 3: Cost of power produce by the generator per kW

	$/kW
P1	8.540125
P2	9.518567
P3	9.484560
P4	9.664430
P5	7.205722
P6	9.518567

From the table I can choose the best generators. My first assumption is that the more generators used the cost of producing power will be less, but from the previous calculations, it show that if the limits of the generators and network losses were neglected, the cost to generate power slightly increased if the power demand remains the same.

Table 4: Active power required by Pocket C and Pocket D

Load	Active Power (kW)	Description
Pocket C	552.8	AHU + Power + Lighting
	490.9	AHU + Power + Lighting
	1043.7	Total Load
	1132.5	AHU + Power + Lighting
	895.9	AHU + Power + Lighting
	2028.4	Total Load
Pocket D	1019.6	AHU + Power + Lighting
	1019.6	AHU + Power + Lighting
	568.2	AHU + Power + Lighting
	2607.4	Total Load
	880.2	AHU + Power + Lighting
	1103.6	AHU + Power + Lighting
	886.6	AHU + Power + Lighting
	2870.4	Total Load
	565.3	AHU + Power + Lighting
	282	AHU + Power + Lighting
	264	AHU + Power + Lighting
	1111.3	Total Load

The loads show the demand only required the active power because very low usage of the reactive power by those venues. As been mentioned before, I am going to install 3 generators in this model.

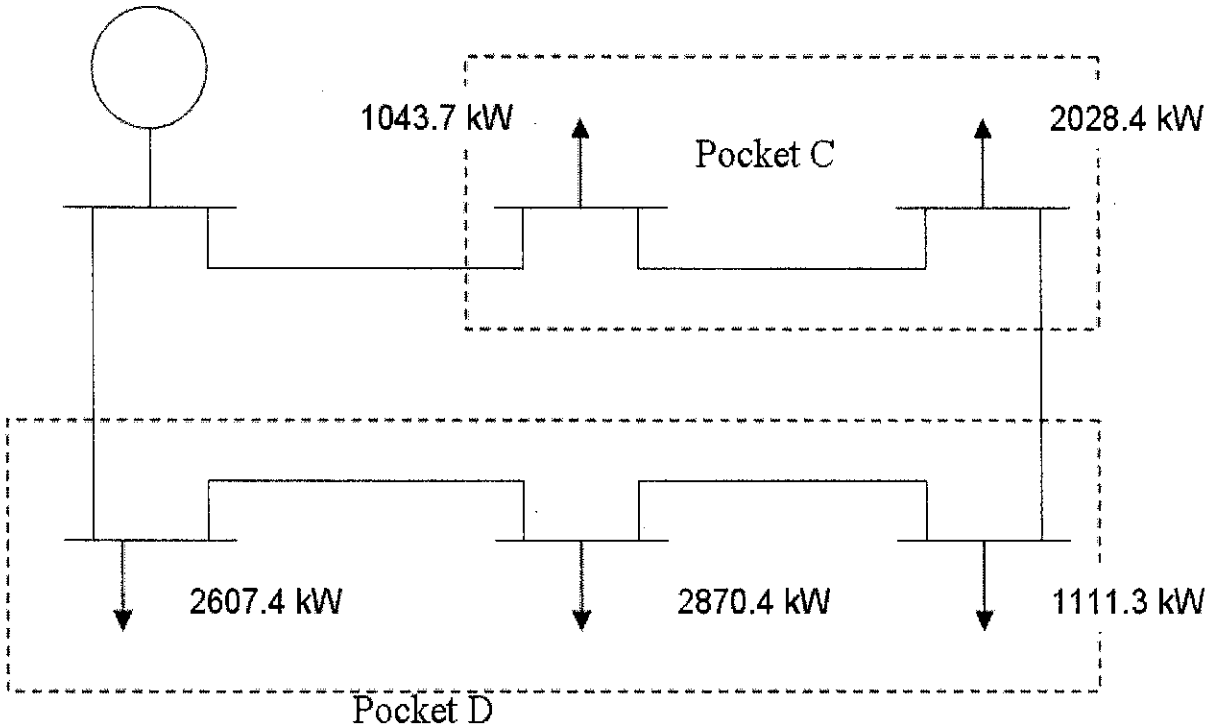

Figure 9: Simple model without generator

Table 5: Total load demand

Bus 2	1043.7	kW
Bus 3	2028.4	kW
Bus 6	2607.4	kW
Bus 5	2870.4	kW
Bus 4	1111.3	kW
Total	9661.2	kW

The total power demand is 9661.2 kW, so the power generation should be at least equal or higher than the demand. For this project, due to the generator limits and the network losses, the power generation should be greater than the demand.

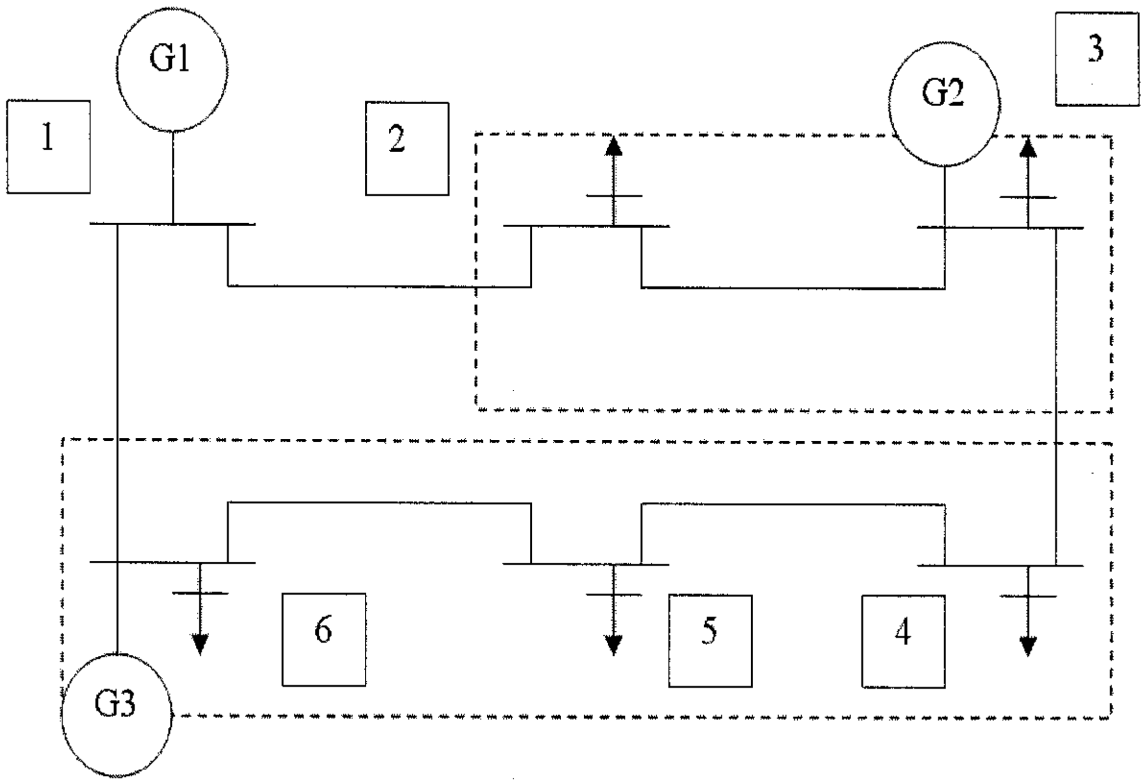

Figure 10: Simple model with the generators

Total load = 9661.2 kW

Estimation for losses = 20%,

$$= \frac{20\%}{100\%} x9661.2kW$$

$$= 1932.24\ kW$$

Total power generation = 1932.24 kW + 9661.2 kW

= 11.6 MW

Each generator should produce minimum;

$$\frac{11.6MW}{3} = 3.9MW$$

The value for the power generation should be lower because the load actually connected in shunt connection but for this simulation, I assumed they are connected as the model above. Furthermore, the current used for this load was very low due to the less usage of rotating mechanism and any other electromagnetic generation equipments.

By using the assumed transmission lines data;

Table 6: Transmission lines data

Transmission Line From	Transmission Line End	Resistance	Inductance
1	2	0.02	j0.04
2	3	0.02	j0.03
3	4	0.04	j0.025
4	5	0.04	j0.01
5	6	0.02	j0.03
6	1	0.02	j0.02

Change impedance to admittance;

Table 7: Impedance to admittance

Impedance, z	Admittance, y = 1/z
0.02 + j0.04	12 - j16
0.02 + j0.03	15.3 - j23
0.04 + j0.025	18 - j11.2
0.04 + j0.01	23 - j5.9
0.02 + j0.03	15.3 - j23
0.02 + j0.02	25 - j25

Creating the bus admittance matrix,

$$Y_{bus} = \begin{pmatrix} Y_{11} & Y_{12} & Y_{13} & Y_{14} & Y_{15} & Y_{16} \\ Y_{21} & Y_{22} & Y_{23} & Y_{24} & Y_{25} & Y_{26} \\ Y_{31} & Y_{32} & Y_{33} & Y_{34} & Y_{35} & Y_{36} \\ Y_{41} & Y_{42} & Y_{43} & Y_{44} & Y_{45} & Y_{46} \\ Y_{51} & Y_{52} & Y_{53} & Y_{54} & Y_{55} & Y_{56} \\ Y_{61} & Y_{62} & Y_{63} & Y_{64} & Y_{65} & Y_{66} \end{pmatrix}$$

$$
Y_{bus} = \begin{pmatrix} 37-j41 & -12+j16 & 0 & 0 & 0 & -25+j25 \\ -15.3+j23 & 27.3-j39 & -15.3+j23 & 0 & 0 & 0 \\ 0 & -15.3+j23 & 33.3-j34.2 & -18+j11.2 & 0 & 0 \\ 0 & 0 & -18+j11.2 & 41-j17.1 & -23+j5.9 & 0 \\ 0 & 0 & 0 & -23+j5.9 & 38.3-j28.9 & -15.3+j23 \\ -25+j25 & 0 & 0 & 0 & -15.3+j23 & 40.3+j48 \end{pmatrix}
$$

In the middle of the calculation of this model, the final result of this input parameters failed to be achieved since the iteration of this method was very huge. To find the final result, it is advised to use the real input data and not by combining the real and assumption data.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

There are some concerns about the execution process of the project regarding the understanding level; there might be changes in the method used throughout the project. But the objective and the target of the project are still remaining the same, to show some economic dispatch in power system. The importance of doing any project is to understand the objective and reason doing the project instead of only concern about the progress without knowing the goal. If we know exactly what we want, there is always a solution to achieve it. This project needs me to have a good understanding of the power flow algorithms and its entire component. I also have to develop my mathematical skills to understand Newton's method completely. Nevertheless, this project can be a basic or fundamental for other students to start their optimization or continuing this project to another level. Last but not least, This project can be a reference to start a optimal power flow or economic dispatch. It is always learning process either to start his project or to finish this project. So, the result of this project is to show the economic dispatch of the model chosen and the objectives were achieved.

To do the optimization there are several things to consider before starting and doing it

1. The optimization concept and theory.
    - The student should strongly understand the whole thing about the optimization and the power flow systems. They must be guided to achieve the objectives to avoid confusion and misunderstanding toward the project.
    - This project need the student to understand the algorithm of the power flow system and the best method used to solve the problems.
2. Choose the best method.
    - Firstly, it is required to understand the problem before doing any further study and research.
    - Once the problems and the roots have been determined, choose the best method that will solve the problems.
    - Student should know at least what is the outcome and output for the project before deciding on which way is the best solution to make the process of achieving the objectives become easier.
3. Reliable data sources
    - The data mostly are confidential for certain company and party. Therefore, it is advisable for student to get the data as soon as possible as a preparation for the worst case scenario which the desired input or information failed to reach.
    - If this situation occupied by the student, the project still can be conducted using other methods or even can be modified earlier in order to finish the tasks.

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