THE ECONOMICAL WITH LESS POLLUTION LOAD DISPATCHUSING AN EVOLUTIONARY PROGRAMMING OPTIMIZATION APPROACH

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DECLARATION

I declare that this thesis entitled "The Economical with Less Pollution Load Dispatch via an Evolutionary Programming Optimization Approach" is the result of my own research except ascited in the references. The thesis has not been accepted for any degree and is not concurrentlysubmitted in candidature for any other degree.

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APPROVAL

I hereby declare that I have checked this report entitled "The Economical with Less Pollution Load Dispatch via An Evolutionary Programming Optimization Approach" and in my opinion, this thesis it compiles the partial fulfilment for awarding the award of Bachelor of Electrical Engineering with Honours.

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DEDICATIONS

To my beloved mother and
mother

Mohamed Noh Bin Mohamad

Salmi Binti Md.Din

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Alhamdulillah praise to Allah, I would like to thanks to Allah S.W.T, The Almighty, a place where I pray and pledge, who has given me a strength and ability to execute the project in time. The numerous trials and tribulations I have faced in preparing this project. But I am making this a very important lesson and experience for me. At this opportunity, I would like to take this opportunity to express my special thanksto my project supervisor, Dr Elia Erwani Binti Hassan for give me an encouragement, guidance, advice, and motivation during complete my project. Without the guidance and persistent help, this project would not be same as presented here. A million thanks also to my beloved parents who always give me a support, prayers, and encouragement. A thanks also to all my colleagues who do not fail to give me endless support to finish this project. Lastly, I hope report of this project will give a benefit to others researcher in the future.

ABSTARCT

Nowadays, economic load dispatch (ELD) become critical issue in our power system. ELD turns to more challenging when the generating unit need to be operated into power system generation to satisfy the load demand while minimizing overall cost of generator. For that reason, the evolutionary programming (EP) is introduced to overcome the ELD problem at the same time satisfy for system constraints. There are three objective functions of ELD which are minimize the total generation cost, minimize emission and minimize total losses with limitation of operational units for standard IEEE 26 bus system and IEEE 57 bus system. The EP is executed using 10,20 and 30 populations to minimize all three mentioned objective functions. All generators named as Pg2, Pg3, Pg4, Pg5, and Pg26 for 26 bus system while the generator for 57 bus system is known as Pg2, Pg3, Pg6, Pg8, Pg9, and Pg12 will be optimized to achieve the objective function. There are four major steps involves in EP which are initialization, mutation, combination, and selection phase. From the result obtained, the EP was able to minimize an objective function for 26 bus and 57 bus system.

ABSTRAK

Pada masa ini, penghantaran beban ekonomi (ELD) menjadi isu kritikal dalam sistem kuasa kita. ELD berubah menjadi lebih mencabar apabila unit penjana perlu dikendalikan menjadi penjanaan sistem kuasa untuk memenuhi permintaan beban sambil meminimumkan kos keseluruhan penjana. Atas sebab itu, pengaturcaraan evolusi (EP) diperkenalkan untuk mengatasi masalah ELD sekaligus memuaskan untuk kekangan sistem. Terdapat tiga fungsi objektif ELD iaitu meminimumkan jumlah kos penjanaan, meminimumkan pelepasan dan meminimumkan jumlah kerugian dengan pembatasan unit operasi untuk sistem bas IEEE 26 standard dan sistem bas IEEE 57. EP dijalankan menggunakan 10,20 dan 30 populasi untuk meminimumkan ketiga-tiga fungsi objektif yang disebutkan. Semua penjana yang dinamakan sebagai Pg2, Pg3, Pg4, Pg5, dan Pg26 untuk sistem bas 26 sementara penjana untuk sistem bas 57 dikenali sebagai Pg2, Pg3, Pg6, Pg8, Pg9, dan Pg12 akan dioptimumkan untuk mencapai fungsi objektif. Terdapat empat langkah utama yang melibatkan EP iaitu inisialisasi, mutasi, kombinasi, dan fasa pemilihan. Dari hasil yang diperoleh, EP dapat meminimumkan fungsi objektif untuk sistem bas 26 dan 57 bas.

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LIST OF SYMBOLS AND ABBREVIATIONS

CO	-	Carbon
CO2	-	Carbon Dioxide
NOx	-	Nitrogen Oxide
SOx	-	Sulphur Oxide
ELD	-	Economic Load Dispatch
EP	-	Evolutionary Programming
EA	-	Evolutionary Algorithm
OPF	-	Optimal Power Flow
UTeM	-	Universiti Teknikal Malaysia Melaka

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Recently, economic load dispatch (ELD) become critical aspect in our power system. ELD turns to more challenging when the generating unit need to be introduced into power system to satisfy the load demand while minimizing overall cost of generator. Today, ELD solution need cheapest possible price the minimum level of a pollution. Based on appendices A, Global Database's Malaysia, in August 2020 a Malaysia's Electricity's Malaysia Consumption data was reported at 12,380.475 kWh Mn compare in July 2020 which is only 12,339.904 kWh. Therefore, it is important for electric utilities in reducing carbon (CO), carbon dioxide (CO2), and nitrogen oxide NOx [1]. Hence, the power system needs to operate economically to make sure the system operates at the minimum cost.

The total fuel cost is entirely different since the power plants are situated at various from the center of the load. The purpose of ELD is to configure generating unit's outputs to satisfy the load demand at the minimum cost [2]. ELD important in term to minimize the total generation cost with limitation of operational parameters and at the same time the constraints are also satisfied [3]. The ELD also known as a non-convex optimization problem. This is because linear discontinuous features, including the loading effect of the valve stage, prohibited operating zones and multi type fuel, exist [4].

There are two constraints need to be satisfied which are equality constraint and inequality constraint [1]. In 1970s, it was pointed those economic strategies are developed to minimize the emission and minimize the production cost subject to emission constraints to satisfy the load demand at minimum running cost subject to process operational constraints which is equality and inequality [4].

Mainly, total demand must be equivalent among of generating units. This economy dispatch has been solved before by others researcher via others optimization method such as newton method, linear programming, non-linear programming [5].

These three techniques are poor for solving the optimization problem with a non-convex, non- continuous and linear solution space [5]. These three method are not effective when thedispatch problem when the dispatch problem become more complex [6].

A new optimization to solve this complex optimization problems are discovered from year to year. One of the techniques that use to solve this problem of ELD is by using EP. EP is known as an evolution process that found in nature such as an initialization, mutation,and selection. The evolutionary programming is one of four major evolutionary algorithms which are genetic programming, differential programming, and evolutionary strategy. A simulation task are performed by using 26 bus system for 6 generator test system and 57 bus system for 7 generator test system respectively using MATLAB programming.

1.1 Objectives

- To minimize total generation cost with the limitation of operational constraints for standard IEEE 26 bus system and IEEE 57 bus system for 10,20 and 30 populations using MATLAB programming.

- To minimize less emission polluted of each generator with limitation of operational constraints for standard IEEE 26 bus system and IEEE 57 bus system for 10,20 and 30 populations using MATLAB programming.

- To determine power losses with the limitation of operational constraintsfor standard IEEE 26 bus system and IEEE 57 bus system for 10,20 and30 populations using MATLAB programming

1.2 Problem Statement

The ELD become to complexity from day to on a daily basic requirement. Most society does not concern about how to use energy efficiently in daily lives. Thus, ELD is crucial aspect of total electricity demand by considering operating efficiency of production. Fuel costs and lost transmission are the factors affecting power generation at the minimum cost. Thus,in operating power each unit for generator must minimize the total operational cost andtotal emission polluted are dispensed as well for minimum losses. The foremost efficientgenerator does not give a guarantee the cost could be a minimum because it could alsobe in a district where the fuel is higher. The transmission is considered higher when the power system is far away from load. Based on researcher before, it shows that theinstalled capacity in Malaysia increased 8.5 per cent to 33,023 MW in 2016 comparedto 30,439 MW in 2015[7]. Hence, the power each unit for generator need to be optimized while minimize the total operational cost and total emission polluted.

1.3 Motivation

Economy dispatch is important thing in power system. This ELD plays a very significant role in power economic aspect. For the reliable and efficient running of such alarge, it required careful research of the interconnected power system and the way of economically running. Therefore, in the electrical power grid, ELD managed to operate power systems economically with an efficient simulation tools [8]. The ELD ensures that the generator's actual and reactive capacity varies under certain limits and meets the demand for lower fuel costs. The constraints need to be satisfied when to achieve the objective function. The ELD helps to produce the electricity at the lowest cost and reduces the impact on environmental pollution.

1.4 Scope of Works

The economy dispatch is important to our power system. The power system needs to operate at high degree of economy systemto ensure the system operates at the minimum cost in order to achieve a cheapest price with the minimum levels of a pollution, the total cost generation, and the less emission polluted, and the power losses need to be determined. Thus, the scope of this projects is the implentation of EP using MATLAB programming is executed for total generation on IEEE 26 bus system and IEEE 57 bus system. The implentation of EP using MATLAB programming in the total emission on IEEE 26 bus system and IEEE 57 bus system minimisation for 10,20 and 30 populations. All the three objective function needs to determine as well constraints need to be satisfied.

1.5 Report Outline

The report of this project contains of five main chapter. The first chapter of this report are the introduction which is covers researched background, objectives, problem statement, motivation, scope of works and a report outline. Secondly, the reports will cover on research done by the previous researchers for the related results. Thirdly, the chapters are about methodology to solve the objective function of ELD using EP. The following part was the result discussion of EP. Finally, the chapter five is to conclude the finding of the research.

CHAPTER 2

LITERATURE REVIEW

2.1 Energy Consumption in Malaysia

Energy sector in Malaysia is based on non-renewable fuel [9]. For example, the most popular one is fossil fuel and natural gas. They are constant growth for the electricity supply in industry due to the advances in technology that have fully geared the industry to the world that now does not work under conventional supply theory follows demand [11]. Economic development also related to the energy consumption due to the increasing of economic development when the energy consumed in Malaysia are higher [10]. In Malaysia, a carbon emission is targeted to be reduced until 40% by government of Malaysia [11].

A fundamental question is whether the goals of increased economic growth and enhanced environmental sustainability (lower emission) are mutually exclusive. The type of fossil fuel use for the electricity are sulfur oxide (Sox), nitrogen oxide (NOx) and carbon dioxide (CO2). This fossil fuel is releasing several contaminants inour atmospheric. The one of major obstacles for electric utilities are reducing the atmospheric pollution [12]. The power sector is the one of the types of major sources of energy consumption and CO2 emissions. For greenhouse cases, the CO2 emissions are responsible for more than 60% of greenhouse effect [11]. This effect can cause a global climate change. Hence, the limiting of CO2 emissions become an important concern for securing renewable resources and minimizing the effect of climate.

A power system with such an appropriate power capacity of 100MW, the CO2 reduction will be achieved at 1% reduction in fuel consumption due to the adopting appropriate operational of optimization and the maintenance [13]. Hence, the research of administrative of optimization is essential for the generation of power in power system which is produce the pollutant gases.

2.2 Economic load dispatch

Economic load dispatch (ELD) is an important optimization task in operation of power system [14]. This ELD is crucial for allocating the generation units to the appropriate combination of generation levels. Therefore, the demand mechanism process can be provided entirely and most economically [15]. Today, ELD problem is including the reduction of NOx and SO2 of emission which is added as an objective function of ELD [16]. There is three objective function to overcome the problem of ELD in power system. The three objective function is minimizing the total generation cost, minimize the total emission and minimize the total system loss while satisfying constraints.

2.2.1 Total generation minimum cost

The most objective in ELD is the minimization of the total generation cost of fuel consumed for produce the electric power. The cost of output depends on the amount of fuel consumed by the generating unit to produce sufficient power to satisfy the load demand [17]. This total generating cost are assumed to be a function and known by quadratic curves of second order [1]. This objective can be expressed by the equation of [18]

$$C_{Total} = \sum_{i=1}^{Ng} Ci\ (Pgi) \quad \text{dollar per hour (\$/ h)} \qquad (2\text{-}1)$$

$$Ci\ (Pgi) = ai + biPgi + CiPgi^2$$

Where:

C_{Total}= sum function for each generating unit Ng

C_iP_{gi}= cost of generation in terms of unit i

P_{gi}= power generated in terms of unit i

a_i, b_i, c_i = cost of coefficient in terms of unit i

2.2.2 Total Emission Minimization

The total of emission is reduced by minimizing the three major pollutants which is NOx, Sox, and CO2 [19]. The objective can be expressed as an equation below [18]

$$E_{Total} = \sum_{i=1}^{Ng} (\gamma_i \, P_{gi}{}^2 + \beta_i P_i + \alpha_i) * (10^{-2}) + \varepsilon_i \exp(\lambda_i P_{gi}) \quad (2\text{-}2)$$

Where:

E_{Total} = Total function for each generating emission unit Ng

α_i, β_i, λ_i, ε, = Emission coefficient in unit i

P_{gi} = power generated in terms of unit i

2.2.3 Total system loss minimization

The last objective function of ELD is the generation cost is minimizing the total system losses [19]. The objective can be expressed as an equation below [18]

$$T_{loss} = \sum_{i=1}^{Ng} P_{gi} - P_{load} \quad (2\text{-}3)$$

Where:

T_{loss}= Total of system losses in demand

P_{gi} = Power generated in terms of unit i

P_{load}= Total of load in system demand

2.3 Operational Constraint

The constraint needs to satisfy to ensure the total generation cost in under the limitations [1]. There are two types of constraint which are equality constraint and inequality constraint [1]. Equality constrains mainly focus on power flow balance and inequality constraint are focusing on upper and lower limits of system [20].

2.3.1 Equality Constraint

Equality constraint is necessary for generation deliver the load demand and losses in transmission lines when minimize the objective function of economic load dispatch. The equation is expressed as a [18]:

$$\sum_{i=1}^{Ng} P\text{gi} = P_{load} + T_{loss} \quad (2\text{-}4)$$

where:

$P_{load=}$ Total of load in system demand

$T_{loss=}$ Total of losses in system demand

2.3.2 Inequality Constraint

Inequality constraint is the limit in power system to ensure system security. Itcan be expressed as a in [18];

$$P_{min} \leq P_{gi} \leq P_{max} \quad (2\text{-}5)$$

where:

P_{min} = the minimum real power of generation in terms of i

P_{max} = the maximum real power of generation in terms of i

P_{gi} = Power generated in terms of unit i