ANALYSIS OF BIOMASS POWER GENERATION POTENTIAL FOR FEED IN TARIFF (FIT)

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“hereby declare that I have read through this report entitle “Analysis Of Biomass Power Generation Potential For Feed In Tariff (FIT)” and found that it has been comply the partial fulfilment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power).

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ANALYSIS OF BIOMASS POWER GENERATION POTENTIAL FOR FEED IN TARIFF (FIT)

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A report submitted in partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering (Industrial Power)

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2016

I declare that this report entitle “Analysis Of Biomass Power Generation PotentialFor Feed In Tariff (FIT)” is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ………………………………….

Name : MOHAMAD NAJIB BIN SHAPEEI

Date :

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To my beloved mother and father

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ACKNOWLEDGEMENT

First of all, acknowledgement goes to Allah S.W.T for allowing me to study in a good condition and always give me a pink of health. Next, to my parents and my family that always support during my studies and completing this project and thesis. Then, thanks to En. Azhar bin Ahmad as my supervisor that always supervised and advised along the project until the end. My supervisor also gives motivation to burn up my spirit to complete my FYP project and also for contribution on guidance and generates an idea to improve my FYP project and my project clearance. Besides that, thanks to my friends that always give a hand when needed.

I acknowledge with gratitude to assistant manager at Felda Selancar 2B Palm Oil Factory and all workers at power department as my "respective teacher" who have always been sincere and helpful in making me understanding conceptual problems in my research.

Lastly, I don't claim all information in this term of research is included perfectly. There me be shortcoming, factual error, mistaken opinion which are all mine and I alone am responsible for those but I will try to give a better volume in future.

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ABSTARCT

The enforcement of the Renewable Energy Act 2011 (Act 725) on 1st December 2011 has allowed the Feed-in-Tariff (FiT) processes to be implemented in Malaysia providing for a sustainable for renewable energy (RE) growth base for the RE Industry in Malaysia including biomass and biogas. Both RE resources have shown promising development and it could be seen from the number of projects which has benefited from the FiT mechanism. Biomass coming from plantation sector especially from the palm oil industry waste such as empty fruit bunches (EFB) and palm oil mill effluent (POME) has a huge potential to be explored for power generation. SEDA Malaysia, being the agency responsible for facilitation of RE growth is playing its role to ensure installations especially those under the Feed-in Tariff (FiT) mechanism meet and complying to the international standards in terms of quality, reliability and safety which will indirectly impact the performance of the biomass power plants. This project uses Kilang Sawit Felda Chini as a place to do research on the Feed-in-Tariff (FiT) process based on the existing biomass generation in the plant. If FiT implemented in this plant, it can provide a great advantage due to the sale of electricity generated each day. However, the investment cost for the implementation of FiT on biomass generation is very high.

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ABSTRAK

Penguatkuasaan Akta tenaga boleh diperbaharui 2011 (Akta 725) pada 1 Disember 2011 telah membenarkan proses “Feed-in-Tariff” (FiT) yang akan dilaksanakan di Malaysia bagi menggalakkan pembangunan tenaga boleh diperbaharui (RE) yang asas dalam industri di Malaysia termasuk biomass dan biogas. Kedua-dua sumber tenaga boleh baharu ini telah menunjukkan perkembangan yang memberangsangkan dan ia dapat dilihat daripada jumlah projek yang telah mendapat manfaat daripada sistem FiT. Di Malaysia, biomass yang datang dari sektor perladangan terutamanya daripada bahan buangan industri minyak sawit seperti tandan buah kosong (EFB) dan kolam sisa buangan kilang kelapa sawit (POME) mempunyai potensi besar untuk diterokai bagi penjanaan kuasa. SEDA Malaysia, yang merupakan agensi bertanggungjawab ke atas fasilitasi kepada pertumbuhan tenaga boleh baharu memainkan peranannya bagi memastikan pemasangan berkenaan Feed-in Tariff (FiT) mekanisme memenuhi dan mematuhi piawaian antarabangsa dari segi kualiti, kebolehpercayaan dan Keselamatan yang akan memberi kesan yang langsung kepada prestasi penjanakuasa biomas. Projek ini menggunakan Kilang Sawit Felda Chini sebagai tempat untuk menjalankan penyelidikan tentang proses suapan dalam tariff (FiT) berdasarkan kepada janakuasa biomass yang sedia ada di kilang. Jika sesuai dilaksanakan di kilang ini, ia boleh memberikan kelebihan yang besar disebabkan oleh jualan tenaga elektrik yang dijana setiap hari. Walau bagaimanapun, kos pelaburan bagi pelaksanaan wajar mengenai penjanaan biomass adalah sangat tinggi

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CHAPTER 1

INTRODUCTION

1.1 Research Background

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In early 2004, the Feed-in Tariff mechanism start presented in Malaysia. In 9th Malaysia plan (2006-2010), China has been making dream to build renewable energy by linking to the power utility grid. Renewable energy development plan is to build a 300MW in Peninsular Malaysia and Sabah 50MW [1]. Later in the year 2011, Malaysia finally achieving a dream to apply this mechanism based on two FiT the laws that need to be observed towards sustainable energy's existing or new. Feed-in Tariff is a medium of the energy services to purchase renewable energy from the manufacturer at a bill scale on set depending on future profitable investment to a company, industry, and individuals.

Based on the title of the project "Analysis on Feed-in Tariff (FiT) rates in Malaysia for Biomass System at Palm oil factory", the term "Feed-in Tariff (FiT)" mean a tariff containing the tax return or the issuance of a payment from the Government subsidies to renewable energy sources (RES) producers per Kilowatt-hour (KWh) of electricity that has been produced in an area in a specified period of time [2]. And the word of "Biomass" means all biological materials such as firewood, firewood waste, agronomic residues and compost farming [3, 4], which is a fuel used for electricity generation through the concept of renewable energy worldwide.

Starting year 2000, the increase in demand of electricity biomass power generation factor is introduced based on the ability of the preparation bio residues in four Southeast

Asian Countries including Malaysia [5]. With a growing need for green technology research and development (RD) activities have low sulfur content and being carbon dioxide neutral over many fossil fuels. In addition, the limitation of fossil fuel is one aspect that led the Government to change the policy of energy conservation to other sources of energy [6]. After Indonesia, Malaysia is the second palm oil manufacturer in the world after and the resulting large quantity of palm oil waste are used as a boiler fuel to generate steam [7]. This can reflect the palm oil producer is one of the largest contributors in the development of biomass power generation. However, Biomass power is to be weaker in Malaysia than in the other countries.

1.2 Project Motivation

Today, Malaysia is looking forward to visualize the 2020 VISION and has undertake the challenges to support the worldwide policies on environmental issues and remedy it with renewable energy resources. Nowadays, green technologies ae needed to not only give benefits on environmental but also towards fighting the recycle waste product. Considering Malaysian, the waste fruit bunch as a fuel supply is the most significant sources of generating the electricity. Now, Malaysia is looking for FIT schemes that can promote for effective policies in order to make move on renewable energy and overcome the high investment risk. The goal of FIT is to such resources for the duration of the program and potentially pave the way for future growth [3]

1.3 Problem Statement

Malaysia's financial development is equally related with fossil energy resources, which is kept on belongings by the developing energy demand. The two power segment, industrial and transportation continued intensely dependent on oil and natural gas. High demand in electricity consumption also increased from year to year.

Based on these two major issues, the feed in tariff mechanism were be introduced to settle up this problem. By warranting access to the grid and set an encouraging price per unit of renewable energy such as biomass power generation, the FiT mechanism would guarantee that renewable energy turns into a suitable and as a long term investment for companies industries and similarly for individuals.

The most common issues is about biomass power generation commonly popular used in independent industrial user. So, the electricity that were be generate will use for electrical equipment in their factory. Commonly the power that be generated is higher than the energy consumption. The waste of energy that is not used can bring in real money by access to the Power Grid is assured since the utilities are legally obliged to accept all electricity generate by renewable energy private creator.

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1.4 Objectives

The objectives below should be effectivelyaccomplished so as to meet all condition of analysis due to Feed-in Tariff biomass power generation

1. To overview a biomass system power generation system with capacity of 1.6MW, by refer to the palm oil factory.

2. To analyze the net export capacity of renewable energy installation related to FiT rates.

3. To analyze the upcoming financial return as indicated by Malaysia FiT rates (Ringgit/KWh)

1.5 Scope

Approach of this project is to analyze the power system related to Malaysia FiT. There is a biomass power generation at Felda Selancar 2B Palm Oil Industries Sdn. Bhd as a place to evaluate the potential of power that were generated to sell it by follow the FiT concept. The data of electrical parameter that have been recorded is used to implement the proposed of Feed in Tariff.

This study will mainly focus on biomass system generation. For the first part, the study are focusing on observing and collect the data of a biomass power system circuit for low power consumption including specification of biomass fuel, boiler system, alternator ,genset , turbine and various load such as switch socket outlet, lighting, motors, and mechanical machine. For the second part, the study are focusing on analyzing the data in power generating and power consumption per hour. Next, the future financial return will be evaluate from the expected power that want to sell.

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CHAPTER 2

LITERATURE REVIEW

2.1 Economic of Distribution Resources

The procedure expected to assess the financial matters of both side of electrical by introduce on supply side and demand side need to investigate. Some of this useful engineering economic, the energy system that we have to assess including renewable energy in biomass methods and at time required uncommon points of view to effectively describe their economic circumstances. This section additionally incorporates the technologies, system, business sector to drive the FIT plan and energy intention to be survey.

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2.2 Feed-in Tarif

The FiT is Malaysia's new system under the renewable strategy and activity plan to funding the generation of renewable energy up to 30MW in size [1]. The renewable energy assets to be retailed to the power values at fixed quality cost for a particular term. The simple idea of FiT is that the distribution license pays the renewable energy power generator a best for clean energy that is produced. This permits holders to shift their clean energy to the distribution license for fixed number of years. The length of time is directed by the sort of the renewable energy utilized for power generation.

The encouragement to give a permanent fee from the power supplier for each kilowatt hour (KWh) of power created and an ensuredless fee for each kilowatt hour (KWh) traded to the grid. The Sustainable Energy Development Authority has been built up under the Act of Parliament to accomplish and supervise the operation of the FiT. The Act has been acknowledged by parliament in March 2011 and has been built up by April 2011.

The renewable energy properties that has been qualified for FiT were solar PV, biomass, small hydro, and biomass. The FiT rates in Malaysia were appeared as Table 2.1. It shows that, the maximum capacity of installation the renewable energy for FiT is 30MWp for compelling duration for 16 years [8].

Table 2.1 Feed in Tariff aimed at Biomass Power Generation

Description of qualifying renewable energy installation	FiT rates (RM per KWh)
a) Basic FiT rates having installed capacity of:	
Up to and including 10MW	0.3085
Above 10MW and up to and including 20MW	0.2886
Above 20MW and up to and including 30MW	0.2687
b) Bonus FiT rates having the following criteria (one or more)	
Use of gasification technology	+0.0199
Use of steam-based electricity generating system with overall efficiency of above 20%	+0.0100
Use of locally manufactured or assembled boiler or gasifier	+0.0500
Use of solid waste as fuel source	+0.0982

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It has payback period for a long time and the deviation rate of 8% every year. The client that attracted on this FIT plan can back without anyone else or even have title capital, there is punitive bank that may help to placed advances. This asset will reach is combined estimation of MY18.9 billion in 2030with the expanding on current electrical tax by 1% and the sum assembled into the FiT asset [9]. A few issues must be deliver by laws to guarantee the FiT plan work effectively in Malaysia. To begin with, the energy that created by biomass framework must joined with grid. Second, any nearby endorsement must be clear and reorganize. Third, the FiT plan must have the capacity to create return on benefit. Four, the FiT rate must be reformed for long stretch of business. Fifth, the FiT must have an adequate asset and a skill organization how can actualize the FiT.

2.2.1 The Advantages of Feed-in Tariff

There are many advantages of utilizing feed-in tariff as the financial support scheme. Firstly, the FIT scheme will encourage the development and implementation of RE in order to reduce the carbon emissions being emitted to the atmosphere. Besides that, FIT scheme does not only help the community to secure their own electricity supply but also help on improving global and domestic security of electricity supply. Finally, the rate of payment on the electricity is guaranteed including the electricity produced by RET and supply to the electricity grid. Moving to renewable and environmentally responsive energy resources will likewise support to produce a new 'green' industry, which in turn it will form extra of jobs

Furthermore, there will be added technologies driven inventions which are useful to community [9]. Countries like Germany, Canada, United States, Australia, Denmark and Spain have successfully implemented the FIT systems and the FIT system has verified to be one of the „green energy‟ programs towards global energy conservation.

The RET producers have to submit the application to get the agreement with the utilities to apply this FIT scheme. After that, the RETproducers are entitle for the FIT of which then they will get benefits on it. Some of the benefits are:

i. Generation tariff

ii. Export tariff

iii. Energy bill savings

2.2.1.1 Generation Tariff

The generation tariff remains the set of rates payment by the utilities for each kWh of electrical energy that generated by the RET producers [10]. The rate for RET producers is same for 20 to 25 years depends on the types of solar modules being used but the rate will change each year for new installment of RET to the FIT scheme.

2.2.1.2 Export Tariff

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The export tariff is the RET producers will receive amount of price by the utilities for further 3p/kWh for every kWh that supply to an electricity grid. The rate is same for all RET.

2.2.1.3 Energy Bill Saving

Energy bill saving is the post result of the FIT scheme implementation. The RET producers do not have to import the electricity from the utilities because of they have their own electricity supplier. So that, they do not have to pay any price of electricity usage to the utilities which means, they have making the saving on electricity bills.

2.3 Energy Economic

There are numerous techniques to figure the economic viability of distribution generation and energy efficiency projects. The cost of operation, the equipment, maintenance costs and other payments must be combined in some method so that an evaluation may be made with the cost of not doing the project. It is proposed to give a sensible begin to the budgetary assessment and enough at any rate to know whether the undertaking merits further, more watchful, examination [11].

2.3.1 Cash flow

The income is state to the development of money into or out of a record, a business or a speculation. At the point when a money inflow surpass money outlaw,this is for the most part consider to be a sign as great monetary good, both of individual and organization [12].

There are commonly have three types of cash flow.

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i. Operating cash flows is discuss to the money got or spent as an outcome of organization's business activities.
ii. Investment cash flow is state to money got or spend through investment activities. Basically acquiring and offering resource that will expand his total assets
iii. Financing cash flows is mention to the money got through debt obligation or paid out as obligation repayment [12]. For company, issuing stock, paying death debt and repurchasing offer would as component of financing income.

2.3.2 Return on assets

It is a measure of how gainful an organization is in respect to its benefits or the assets its own particular or controls. This measure permits the financial specialist to legitimize how proficiency administration is and utilizing organization resources for produce gaining [12]. For instance,Total assets of Company X on July 1, 2014and June 30, 2015 were RM2,132,000 and RM2,434,000 respectively. During the year ended June 30, 2015 it earned net income of RM213,00.So the average total assets is RM2,283,00 and the return on assets ratio is 0.09 or 9 %. Typical industry will have diverse ROA, assembling required bunches of assets and will have huge measure of advantages. Conversely, administrations organization like record firm will have not very many hard resources, consequently is ideal to contrast ROA and same industry.

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2.3.3 Return of investment

Return of investment (ROI) assists financiers with evaluating the execution of a speculation and relate it with the execution of their other venture. The ROI calculation is flexible and can be manipulated for different uses. A company may use the calculation to compare the ROI on different potential investments, while an investor could use it to calculate a return on a stock. For example, an investor buys $1,000 worth of stocks and sells the shares two years later for $1,200. The net profit from the investment would be RM200 and The ROI in the example above would be 20%. The calculation can be altered by deducting taxes and fees to get a more accurate picture of the total ROI.

2.3.4 Net Present Value

Net present is the estimation of a particular stream of future cash flows displayed in today's Ringgit Malaysia. The net present value can be computed by contrasting the starting cost of a project to aggregate estimation of future income the undertaking make. Net present value is have to decide climate a venture is worth doing [12]. Net present value is the value on a given date of a future payment or series of future payments, discounted to reflect the time value of money and investment risk. The analysis in which all future costs are converted into an equivalent present value of all saving revenue less the present value of all cost investment. In energy efficiency, the net present value calculation is by comparing the present value of all of those future energy savings (ΔA) with the extra first cost of the more efficient product (ΔP).

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2.3.5 Internal Rates of Return

One of the most main jobs of any company administration term is choosing which venture to reserve and which venture to overlook. Nothing forms shareholder value like investing cash and venture with positive financial return. Also nothing crush shareholder value quicker than wasting money on activities that can'tprocure that cost of the capital. Internal rate of return or IRR is standout among the most strategies of assessing potential project[12]. Let's look a venture that cost RM10000, yet in year 1 it drive return RM2000, year 2 is RM3000, year 4 RM40000 and final year 5 is RM4000.

2.4 Financial Analysis

To actualize the FIT plan, is to guarantee that the plan creates a decent return of speculation at sensible benefit. In monetary analysis, each financier must know the procedure of assessment business, resources, economics and projects with specific end goal to separate a company constancy for investment. Essentially, the financial analysis is utilized to examine the company weather is stable or not.

To categorize the relationship between the financial factorsthat material on biomass power generation be recognize [17].

i. C = installating cost
ii. F = Annual FIT income
iii. R = Annual Revenue
iv. TR = Total Revenue
v. M = maintance cost
vi. T = Contract duration
vii. TP = Total profit
viii. PP = Payback Period
ix. ROI = Average Annual Return on Investment

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2.4.1 Equation of financial Analysis

To comfort the control, a number of assumption need to be complete and to use those parameters assumed [12].

Table 2.2: Financial analysis formula

No.	Parameter
1	Annual revenue = annual Fit income – maintance cost R = F – M
2	Total revenue = annual revenue*contract duration TR = R*T

3	Total profit = Total revenue – installation cost TP = TR – C
4	Payback period = installation cost / annual cost PP = C/R
5	Return of investment = Total profit / (installation cost*contract duration) ROI = TP / (C*T)

2.5 Oil Palm Biomass Power Generation

Biomass is relied upon to end up the most noticeable renewable energy source with a four-fold increment to 23% of aggregate world essential energy by the year 2050.Interestingly, agricultural crops and forest residues are predicted to generate about half of the 15,000 million tonnes of biomass around the globe [13]. Renewable technologies therefore are a good option, butthey must engage the business sector, cost competitive and upheld by a significant arrangement system and asset base.In Malaysia, oil palm biomass power emerges as a promising innovation for adding to a more supportable clean energy market. As such, the escalation in energy consumption, conventional fuel market price uncertainty and global climate change obligations explain the urgent need for more green solutions to replace large-scale power generation plant and produce consistent power.

Accordingly, the improving in power utilization, fuel business sector value liability and worldwide environmental change clarify the critical requirement for more green answers for supplant huge scale power plant and create consistent power. Figure 2.1 will illustrate the oil palm biomass share the highest in Malaysia.

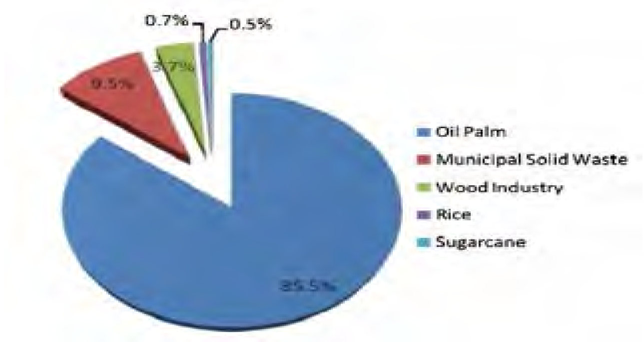

Fig. 2.1: Biomass share from various industries in Malaysia [15]

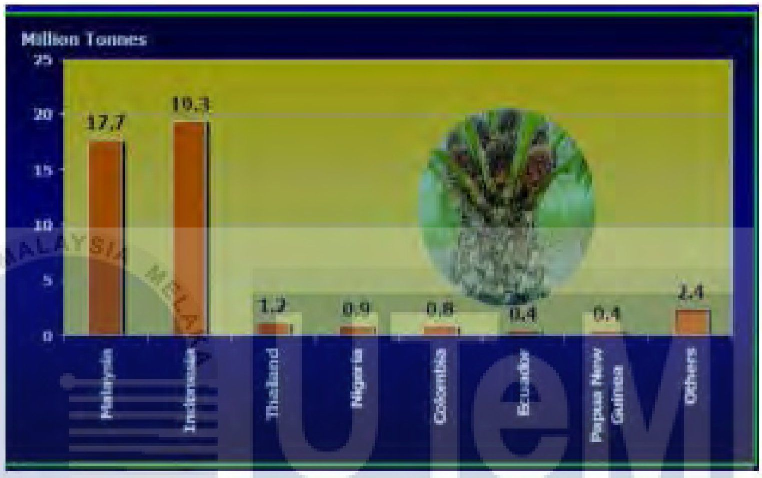

Figure 2.2: The world major of Oil Palm [14]

These figure 2.1 and 2.2 showed that Oil Palm producer do not have a big problem to continues generated an electricity by biomass power generation because of the stability of fuel from waste fruit or empty fruit bunch (EFF).

2.5.1 Basic process

This process mechanism into the rankine cycle. Firstly, the steam was formed in the boiler (usually by burning coal) is flow to the prime mover steam turbine. Then, the condensed steam is fed back to boiler again. After that, the steam turbine drives the alternator and produce electricity through the circuit breaker, transformer, and bus bar. Figure 2.3 shows the simple diagram process for the steam turbine.

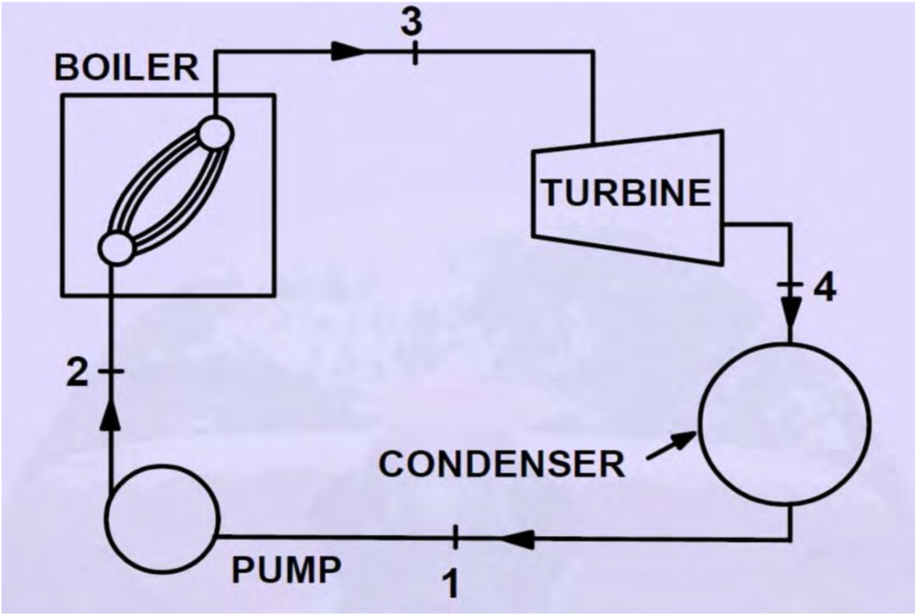

Figure 2.3: Rankine cycle.

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Based on the figure 2.3, the process was described as below:

<u>Process 1-2:</u>

Water from the condenser at low pressure is pumped into the boiler at high pressure. This process was called reversible adiabatic.

<u>Process 2-3:</u>

The water was converted into the steam at a constant pressure by the addition of heat in the boiler.

<u>Process 3-4:</u>

The next process was expansion of steam in the steam turbine through the reversible adiabatic.

<u>Process 4-1:</u>

The constant pressure of heat rejection in the condenser to convert condensate into water.

2.5.2 Layout of the system

The schematic preparation of a modern steam power can be divide into the resulting stages:-

Fuel and ash handling plant

The fuel is transported to power station by rail or street and put away in fuel storage plant and after that pulverized. Pulverized biomass fuel is sustained to feed to the boiler with conveyer. The biomass fuel gets blazed in the boiler and the ash remains produce is evacuated to the ashhandling plant.

Steam generating plant

The steam generating plant consist of a boiler for the making of steam and other supporting equipment for the operation of fuel gases.

Steam turbine

The dry and vapor steam from the boiler is served to the steam turbine. The heat energy of steam while through over the turbine is transformed into mechanical energy. After that, the steam is exhausted to the condenser which condenses the steam change into water again.

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Alternator

Steam turbine was coupled to an alternator which convert the mechanical energy to electrical energy. The electrical production of the alternator was supplied to the bus bar.

2.6 Combined heat and power

Combined heat and power (CHP) is a profoundly productive systemfor giving power and valuable thermal energy at the purpose of utilization with single fuel source [16]. By utilizing waste heat recovery technology to catch a significant segment of the heat made as a side effect of fuel use, CHP framework typically accomplish efficiencies of 60 to 80 percent.

The CHP system reduce quantity of whole fuel needed to produce electricity and thermal energy related to equivalent separate heat and power system. From a smaller amount of fuel is combusted, greenhouse gas was released, such as carbon dioxide (CO2) as a criteria of air pollution like nitrogen oxides (NOx) and sulphur dioxide (SO2) are minimized.

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2.6.1 Equation of combined heat and power

This equation is as assumption of energy satisfied of the fuel used by CHP [16]

Fchp = (CHPe/EEchp)*3412

Where:

Fchp = Fuel used by the CHP system (Btu)

CHPe = CHP system electricity output (KWh)

EEchp = Electricity efficiency of the CHP system (percentage in decimal form)

3412 = Conversion factor between KWh and Btu

2.7 History of Felda Palm Industries Sdn. Bhd

Felda Palm Industries Sdn. Bhd. Is a limited company in collection schemes. It is the largest contributor to the national economynamely crude palm oil and palm contents. Incorporation of the corporation: On December 31, 1995, the Corporation factory felda disbanded under section 43 (4) of the Land Development Act 1996. Thus the process of alliances, all functions and net assets the corporation has been dissolved taken over by corporations namely Felda Palm Industries Sdn. Bhd. That is incorporated under the Act 1965 on 1st January 1996. The first oil refinery established in Malaysia's Palm Oil is Jerangau in Terengganu. Now the number of mills (FPISB) in Malaysia has increased, and 64 in each of the peninsula 6 units in Sabah and one in Sarawak with the ability 48/28 ton of oil processed fruit (FFB) per day. Refinery utilization rate compared with the actual capacity is 73% compared with 72% achieved in the previous year.

Level Refinery utilization is measured based on actual usage compared with capacity of processing plant capacity by the total number of milking machine (Press) is between 40 tons up to 64 tons per hour.

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2.7.1 Background of Felda selancar 2B Palm Oil Industries Sdn. Bhd.

Felda Selancar 2B Palm Oil factory, is a subsidiary one of Felda Palm Oil Industries Sdn. Bhd. Felda Selancar 2B Palm Oil Factory was commercialized and began in operate in 1995. The factory is built near farms palm oil in order to reduce transportation cost. The main goal of this factory is to obtain good results, quality and production costs can be minimize. Capacity or capability of this plant is to process 54 Mt / hour.

The total number of employees who used to run namely two shift operation. The first shift from 8:00 am to 4:00 pm while the second shift starting from 4.00 pm to 12.00 pm. Operation hours also depends on the acceptance of fruits or fresh fruit bunches (BTS) sent by the supplier to the factory.It has the capacity to process in 2 parts. The fresh fruit bunches exactly is received from the Felda settlers in line with the original purpose of the main objectives of FPISB Oil Refinery Selancar 2B is was set up to process fresh fruit bunches (FFB).

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CHAPTER 3

RESEARCH METHODOLOGY

3.1 Principle of the Method

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This first phase of this project is to learning and accepting the concept of Feed-in Tariff based on biomass power generation at Felda Selancar 2B Palm Oil Industries Sdn. Bhd. More books, articles and journal must to analyze in order to ensure the potential or development of biomass power generation in Malaysia. Besides that, the relative of this project connected to the net export power capacity based on performance of biomass generation at this factory.

For the second phase, the evaluation of biomass system in term of technology study need to be deployed. Another evaluation on biomass generation system is in economic study of the system. When these evaluations are done, the data related to power system and performance of biomass system were be recorded. Besides that, interview session was conducted towards assistant manager and factory workers to obtain information.

After the data has been collected from recorded and interview, the energy consumption for total load can be calculated and the power generation for the biomass power generation have been regonized. The financial analysis due to feed-in tariff also can be reviewed. The result can be obtain to prove that FiT mechanism can help the factory in term of investment. The analysis can be proceed depends on the data that were get. Figure 3.1 will show how the flow of this project.

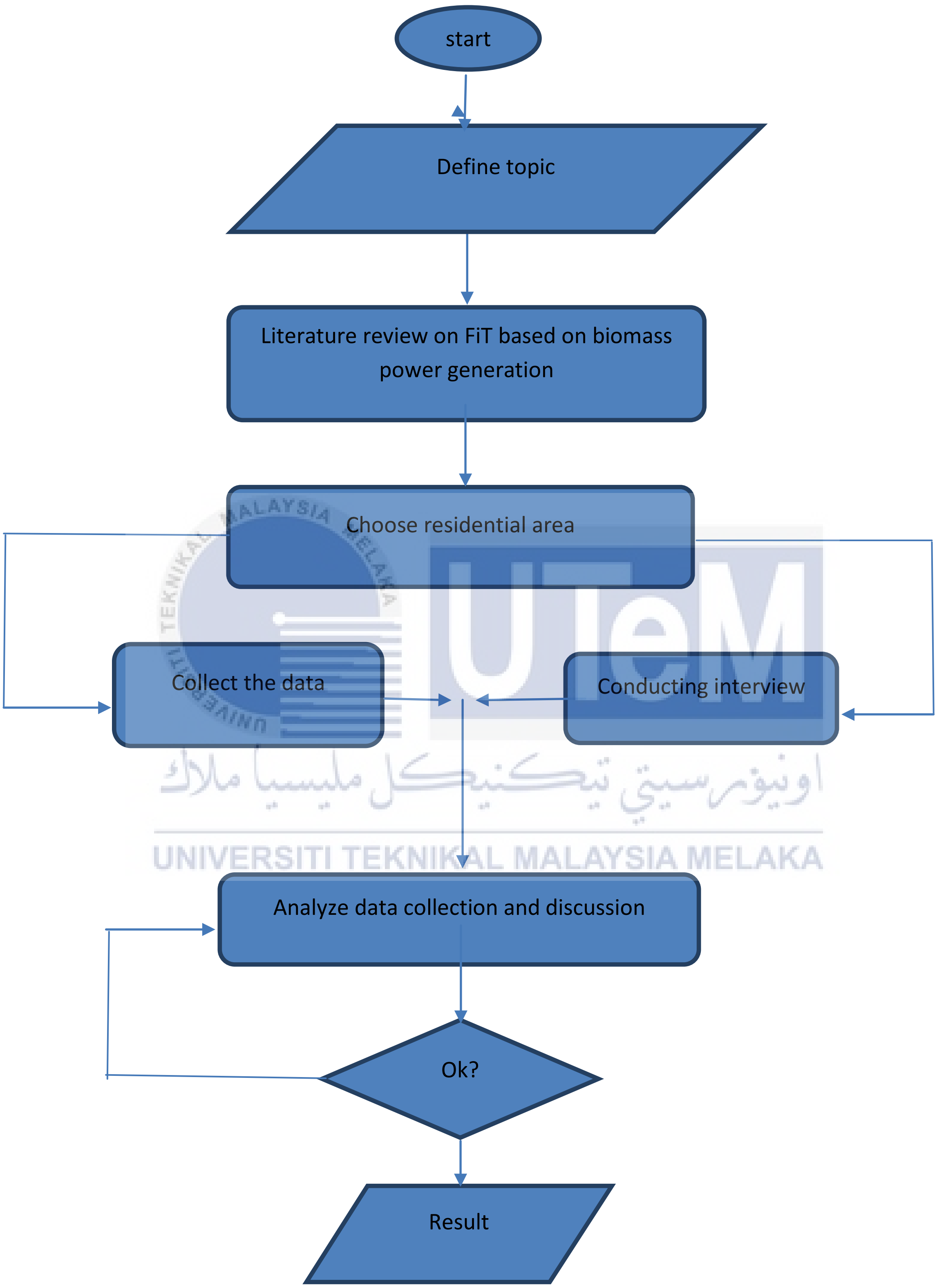

Figure 3.1: Flow Chart for This Project

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3.2 Technical analysis

In this section, there are several type of technical specification going to explain such as empty fruit bunch, boiler, generator, distribution system, and diesel generator.

3.2.1 Empty Fruit bunch and boiler

Capacity or capability of this plant is to process 54 Mt / hour. 17 % from capability of this process become empty fruit bunch. Empty fruit bunch is a fuel for heating system to generate electricity. This factory need to maintain the numbers of produce waste fruit or empty fruit bunch with fix power generate

on. Empty fruit bunch as a fuel should be produced continuously to ensure that the resulting steam is always enough with constant electricity production. Based on capability of this plant data, the total shaft power are calculated.The total assumption due to fuel and burning system will be evaluated.This equation is as an assumption of energy content of the fuel used by boiler from the biomass electrical output [16].

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Fchp = (CHPe/EEchp)*3412 (1)

Where :

Fchp = Fuel used by the CHP system (Btu)

CHPe = CHP system electricity output (KWh)

EEchp = Electricity efficiency of the CHP system (percentage in decimal form)

3412 = Conversion factor between KWh and Btu

Shaft power = (m x Cv x Effc x Efft x Effh x Effcomb) / 3600 (2)

Where:

Effc = Cycle Efficiency

Efft=Turbine Efficiency

Effh =Boiler heat transfer efficiency

Effcomb = Combustion efficiency

M = Mass of fuel

Cv =Calorific value

3.2.2 Specification of output data at this factory

The capability in and out of steam generated shall be identified to assess the level of performance of for this system.

I. Turbine speed (RPM)
II. Power consumption (KW)
III. Power factor
IV. Frequency (Hz)
V. Voltage (V)

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Overview of electrical parameter to get the data between power consumption and power generation. The capacity of energy need to export can be obtained.

$$Average\ power, Pave = \frac{Total\ power\ \ in\ 8\ hour}{8} \qquad (3)$$

Export power 1 = Power generation (hour) – maximum power consumption (hour) (4)

Profit Fit = Power*hours*FiT rates (5)

This is several formulas that have been use to identified the flexibility of this power generation can export their power to the TNB. Tariff Dfor industrial are used for calculating the cost since this factory is under tariff D low voltage Industrial Tariff.

Table 3.1: Tariff D for low voltage Industrial Tariff from TNB

TARIFF CATEGORY	**CURRENT RATE (1 JAN 2014)**
Tariff D - Low Voltage Industrial Tariff	
For the first 200 kWh (1 - 200 kWh) per month	38.00 sen/kWh
For the next kWh (201 kWh onwards) per month	44.10 sen/kWh
The minimum monthly charge is RM7.20	

Table 3.2: Description of qualifying renewable energy installation [18]

Description of qualifying renewable energy installation **a) Basic FiT rates having installed capacity of:**	**FiT rates (RM per KWh)**
Up to and including 10MW	0.3085
Above 10MW and up to and including 20MW	0.2886
Above 20MW and up to and including 30MW	0.2687
b) Bonus FiT rates having the following criteria (one or more)	
Use of gasification technology	+0.0199
Use of steam-based electricity generating system with overall efficiency of above 20%	+0.0100
Use of locally manufactured or assembled boiler or gasifier	+0.0500
Use of solid waste as fuel source	+0.0982

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3.2.3 Design the single line diagram

Two method have been used to identify the best way to get the highest profit FIT. This two method will give two different situation in term of connection in term of plan diagram. Electrical transient analyze protection (ETAP) software have been used to design single line diagram for FIT system but not consider in term of protection system. This software functionality can be customized to fit from small to large power systems.

Figure 3.2: Electrical transient analyzer protection software

3.3 Financial analysis

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To follow the FiT mechanism, investor need to guarantee that the system produce an upright return of investment at realistic profit. For each financier must know the procedure of assessment business.

To identify the relationship between the monetary bound, that material on Biomass system must be identified[17].

i. C = installating cost
ii. F = Annual FIT income
iii. R = Annual Revenue
iv. TR = Total Revenue
v. M = maintance cost
vi. T = Contract duration

vii. TP = Total profit

viii. PP = Payback Period

ix. ROI = Average Annual Return on Investment

To comfort the calculation, a number of assumption must be completed and to use those parameters given [12].

Table 3.3: Financial analysis formula

No.	Parameter
1	Annual revenue = annual Fit income – maintance cost R = F – M
2	Total revenue = annual revenue*contract duration TR = R*T
3	Total profit = Total revenue – installation cost TP = TR – C
4	Payback period = installation cost / annual cost PP = C/R
5	Return of investment = Total profit / (installation cost*contract duration) ROI = TP / (C*T)

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3.3.1 Cost in term of power system studies (PSS)

Before applying for the FiT application, the interested party is required to contact the Distribution Licensee (DL).For grid-connection, PSS are necessary to assess the potential impact of the distributed generation on the planning and operation of the DL's distribution system. The studies shall be conducted by the DL or its appointed consultant. Table 3.4 shows the costing in term FIT equipment.

Table 3.4: Net export capacity of power system cost [18]

No	Net export capacity of RE Installation	Cost (RM)	Completion period
1	Above 425KW and up to and including 1MW	20,000 per installation	30 days
2	Above 1MW and up to and including 10MW	40,000 per installation	40 days
3	Above 10MW and up to and including 30MW	60,000 per installation	50 days
4	Above 425kW and up to and including 1MW for housing development or individual application on the solar PV to be connected to the same distribution substation	500 per installation	60 days

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CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Process Flow

Figure 4.1 shows the analogy about process in term of biomass power generation area at Felda Selancar 2B Palm Oil Factory.

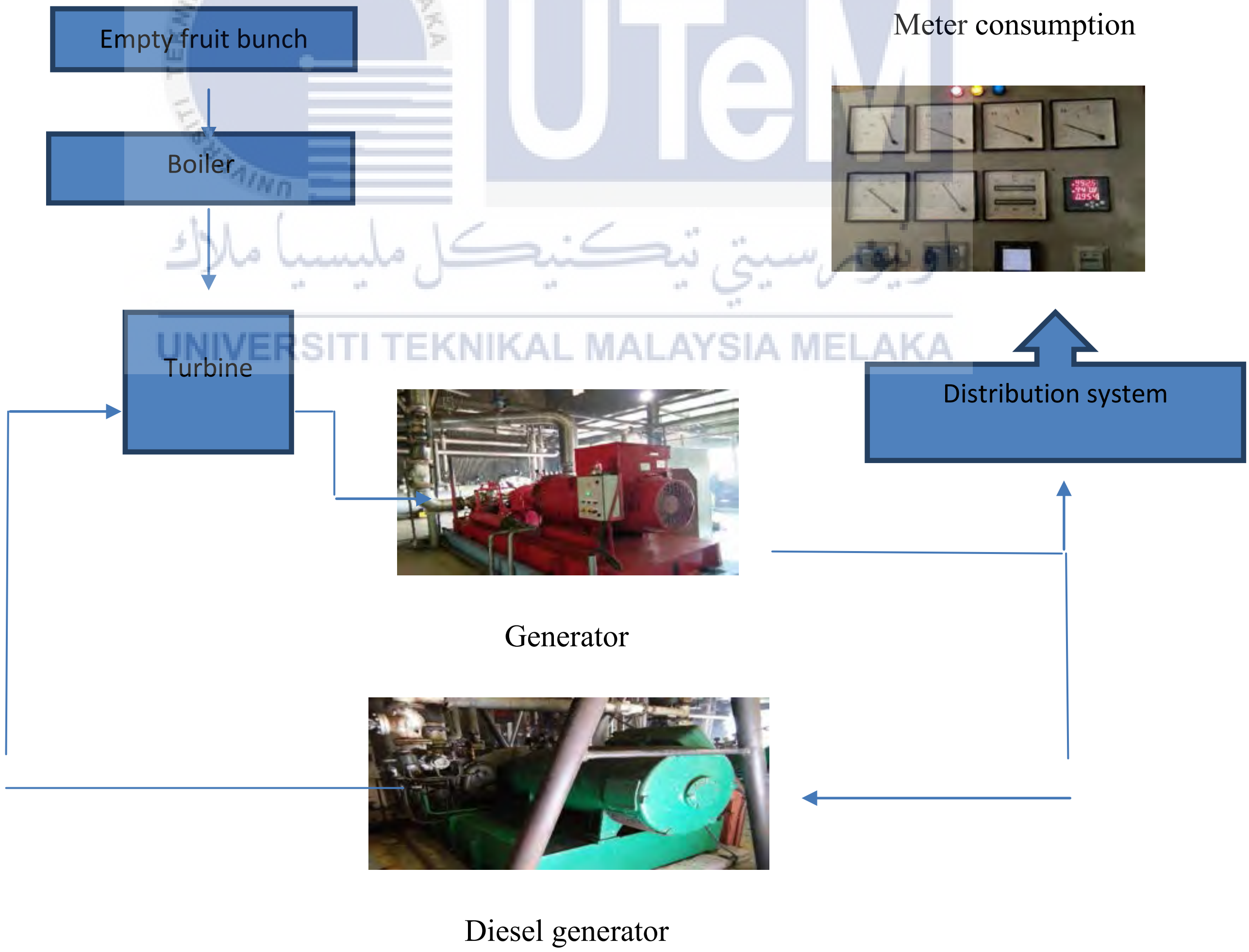

Figure 4.1: Process of Biomass power generation system

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4.1.1 Specification of Generator

A Stamford synchronous ac generator that produce the power between 1.55MW and 1.6MW. All the detail taken at this factory.

Figure 4.2: Generator at Palm Oil Factory

Table 4.1 Specification of Generator

Manufacture/model	STAMFORD / p 1734G2
Power rating (MW)	1.6
Weight (KG)	4022.00
Voltage (V)	415
Frequency	50 Hz
Revolution per minute (RPM)	1500
Power factor	0.8
Insulation class	Class H

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4.1.2 Empty Fruit Bunch

Interview section

Capacity or capability of process flow at Felda Selancar 2B Palm Oil Factory. Figure 4.3 shows the empty fruit bunch of palm oil fruit.

Figure 4.3: The empty fruit bunch

Table 4.2: Capability of empty fruit bunch

Data	Value
Overall of Capacity /capability	54 Ton / Hour
Capability become empty fruit bunch	9.18 Ton / Hour

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Assumption of energy content of the fuel used by boiler from the biomass electrical output is 1 ton/hour of empty fruit bunch to generate 1.6 MW. So, in term of fuel burnt as a prime mover for heating process, it is not a problem to generate electricity continuously.

Analysis Section

The calculated combustion rate is present in equation 1.

Combustion Rate (Cr) = Total Mass of fuel burnt / burning time (equation 4.1)

= 1000 kg / 1 hour

= 1000kg/hour

Therefore the average throughput per hour is 1000kg/hour

The power produced from burning the Empty fruit bunch

Shaft power = (m x Cv x Effc x Efft x Effh x Effcomb) / 3600 (equation 4.2)

The following parameters are taking into consideration

Cycle Efficiency (Effc) = 46%

Turbine Efficiency (Efft) = 90 %

Boiler heat transfer efficiency (Effh) =85%

Combustion efficiency (Effcomb) = 95 %

Calorific value Cv = 19250 KJ/kg

Mass of fuel m = 1000kg

Shaft power = (1000 x 19250 x 0.46 x 0.9 x 0.85 x0.95) / 3600

= 1787.6 KW

= 1.79 MW

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From this analysis, Felda Selancar 2B Palm Oil Factory managed to produce about 19.8 tons per hour of empty fruit bunch which is a fuel for electricity generation process of 1.6MW in the factory. Target fuel needed at least 1 tons per hour to ensure the stability of generation electricity. In theoretically, 1 tons per hour can generate 1.79MW per hour. The factory still has excess fuel according to expected result. In a conclusion, Felda Selancar 2B palm oil factory have no problem in term of fuel.

4.1.3 Synopsis of process flow at Felda Selancar 2B Palm oil Factory

Biomass power plants at this factory use direct-fired combustion systems. They burn empty fruit bunch directly to produce high-pressure steam that drives a turbine generator to make electricity. In an addition, the spent steam from the power plant is also used for processes to produce oil. These combined heat and power (CHP) systems greatly increase overall energy efficiency to approximately 80%, from the standard biomass electricity. Direct combustion systems feed an empty fruit bunch into a combustor or furnace, where the biomass is burned with excess air to heat water in a boiler to create steam. Steam from the boiler is then expanded through a steam turbine, which spins to run a generator and produce electricity.

In a direct combustion system, biomass is burned in a combustor or furnace to generate hot gas, which is fed into a boiler to generate steam, which is expanded through a steam turbine or steam engine to produce mechanical or electrical energy. Diesel generator as a backup generator if the burning process at boiler have some trouble to produce steam.

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4.2 Specification of data output at this factory

The data were recorded to analyze the power consumption at this factory and also to review the performance of biomass generation in one day.

4.2.1 Performances data for one day at Felda Selancar 2B Palm Oil Factory

The Turbine speed, power factor, frequency and voltage were be recorded to identify the performances for this generation at this factory.

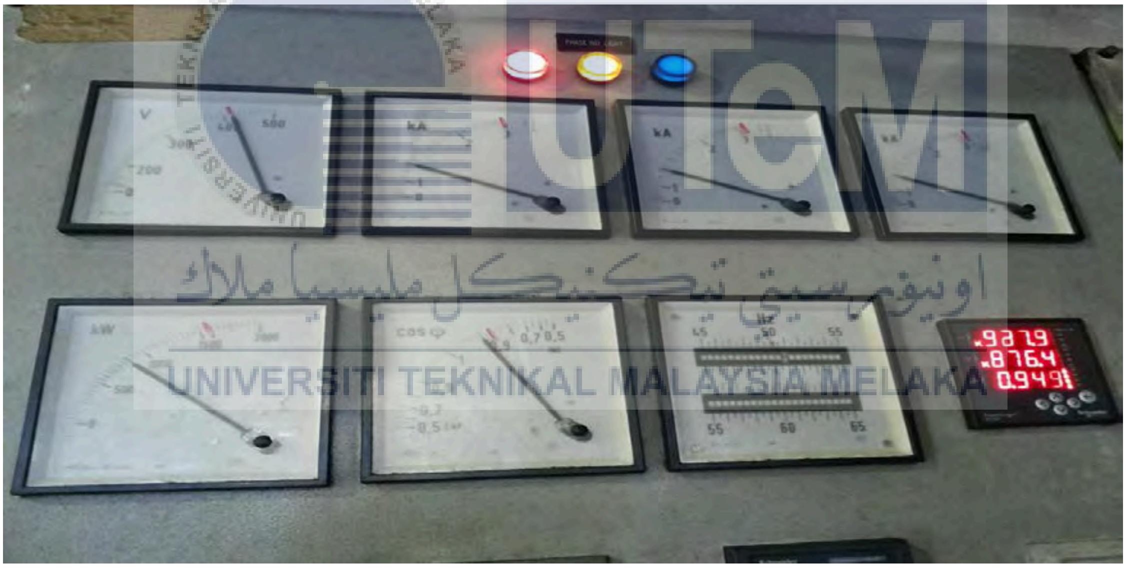

Figure 4.4: measurement system

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Table 4.3: performances data for one day at Palm Oil Factory

Hours	Turbine speed (rpm)	Power factor	Frequency (Hz)	Voltage (v)
0400	5445	0.9	50	415
0500	5441	0.9	50	415
0600	5452	0.9	50	415
0700	5461	0.9	50	415
0800	5449	0.9	50	415
0900	5459	0.9	50	415
1000	5465	0.9	50	415
1100	5451	0.9	50	415
1200	5435	0.9	50	415
1300	5444	0.9	50	415
1400	5449	0.9	50	415
1500	5441	0.9	50	415
1600	5447	0.9	50	415
1700	5433	0.9	50	415
1800	5454	0.9	50	415
1900	5458	0.9	50	415
2000	5438	0.9	50	415
2100	5441	0.9	50	415
2200	5439	0.9	50	415

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From data collected clearly shows the real state of the power generation process happens in a palm oil factory. The resulting power of 1.6MW each time the plant is operating. The data clearly show lasting power performance plan was identically in good condition. This data are already recorded by the worker when the power generation were operate. The range of turbine speed is between 5433 to 5465 revolution per minute (rpm) were be recorded.

Regarding to the result of power that were be generated, this range of turbine speed still can generate 1.6MW and it will be estimate as a good condition in term of performances and full output will be achieved at a this speed. The effect will be to increase capacity factor, hence earnings will be greater. Besides that, the value of power factor, frequency and voltage supply also constant.

4.3 The power consumption analysis

Table 4.4: The average power and maximum power consumption in 7 days

Days	Average Power Consumption per hour of days (KW)	Maximum power consumption of the day (KW)
1	890	915
2	900	940
3	893	912
4	897	920
5	882	915
6	892	923
7	883	910

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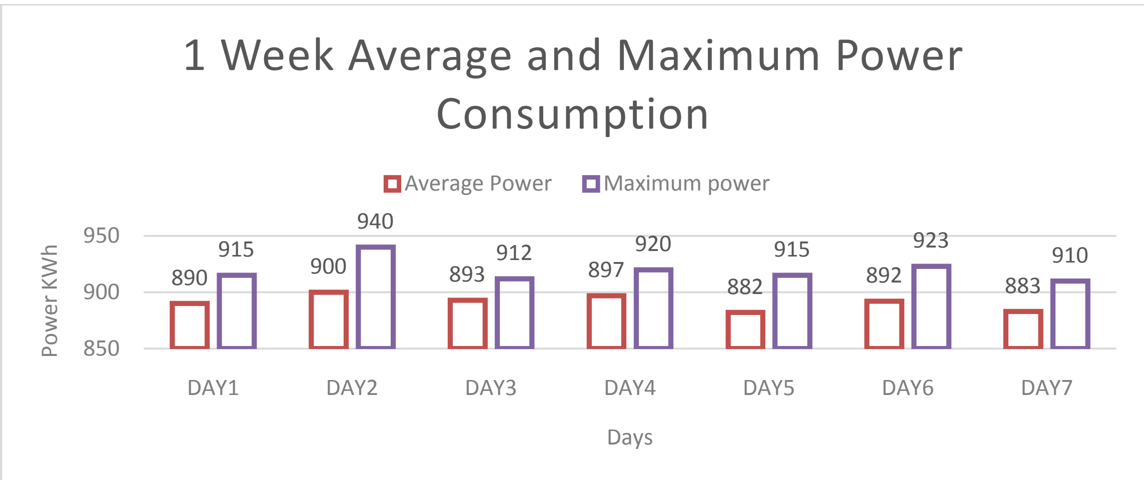

Figure 4.5: The average power consumption

From figure 4.4, the data clearly details a trend of average power and maximum power consumption at this factory on 1 week observation. The highest amount of average and maximum power on the day 2 of 900kW per hour and 940kW per hour. Generally, the power that be used not be the same value on every day depends on the load that be use for processing and others equipment. The sample of data were be collected as a reference to identify a suitable net export power to be sell in term of feed in tariff(FIT) procedure. In the future,this factory still can make their product but the FiT system as an additional method to change the wasted power that were be generated.

Table 4.5: The power consumption per day

Days	Power Consumption (8 hours per day) (KW)
1	5980
2	6300
3	6132
4	6129
5	5891
6	5921
7	5873

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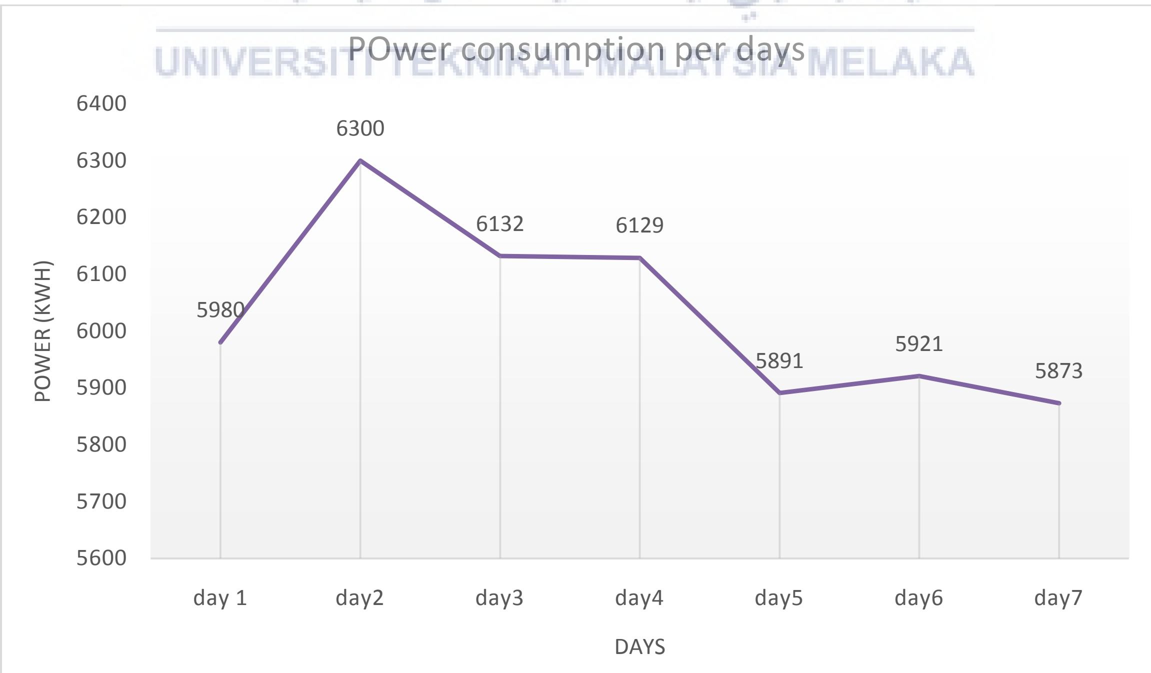

Figure 4.6: The power consumption per day

From figure 4.5, the power consumption 8 hours per day were be figured out. The range of power that be used is 6300kwh to 5873kwh per day. During the interview section, the highest for power that be used per day is around 6400kwh. The power that were be generate by biomass power plant is 12.8MW per day. Clearly can conclude that, this factory have wasted or surplus power from generation plant that can supply energy to the Tenaga Nasional Berhad by connected to the grid. However, the total export power must be as a fixed output power that want to be sell. The suitable value of export for this factory is around 650kW or 1600kW.

Export power 2 = Power generation

= 1.6 MW per hour

Export power 1 = Power generation (hour) – maximum power consumption (hour) in 7 days

= 1.6MW – 950KW = 650 KW

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4.4 Calculation in term of FIT analysis

In this section, the estimation in term of FIT profit for 1 week will be explained. From the data of power consumption, the export power will be get by refer to the wasted power during the generation of power supply. Table 4.6 shows the value of export power obtained. Table 4.7 and 4.8 shows the tariff D for industrial low voltage and the description for FIT rates by TNB. For this factory, basic FIT rates having installed capacity of power up to and including 10MW, overall efficiency of above 20%, use of locally manufactured and use of solid waste as fuel source. Two method will be used to identify which is the best solution for installation procedure.

Power generation for 8 hours per day	12.8MW

Table 4.6: Export power

Days	Power consumption for 1 day (kw)	Export Power for per day (kw)
1	5980	5200
2	6300	5200
3	6132	5200
4	6129	5200
5	5891	5200
6	5921	5200
7	5873	5200

Table 4.7: Tariff D for low voltage Industrial Tariff from TNB

TARIFF CATEGORY	CURRENT RATE (1 JAN 2014)
Tariff D - Low Voltage Industrial Tariff	
For the first 200 kWh (1 - 200 kWh) per month	38.00 sen/kWh
For the next kWh (201 kWh onwards) per month	44.10 sen/kWh
The minimum monthly charge is RM7.20	

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Table 4.8: Description of qualifying renewable energy installation [18]

Description of qualifying renewable energy installation c) Basic FiT rates having installed capacity of:	FiT rates (RM per KWh)
Up to and including 10MW	0.3085
Above 10MW and up to and including 20MW	0.2886
Above 20MW and up to and including 30MW	0.2687
d) Bonus FiT rates having the following criteria (one or more)	
Use of gasification technology	+0.0199
Use of steam-based electricity generating system with overall efficiency of above 20%	+0.0100
Use of locally manufactured or assembled boiler or gasifier	+0.0500
Use of solid waste as fuel source	+0.0982

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4.4.1 Method A

This method is used to maintain the original condition of the plant but only add the equipment related to export powerthat will be supply to the grid.

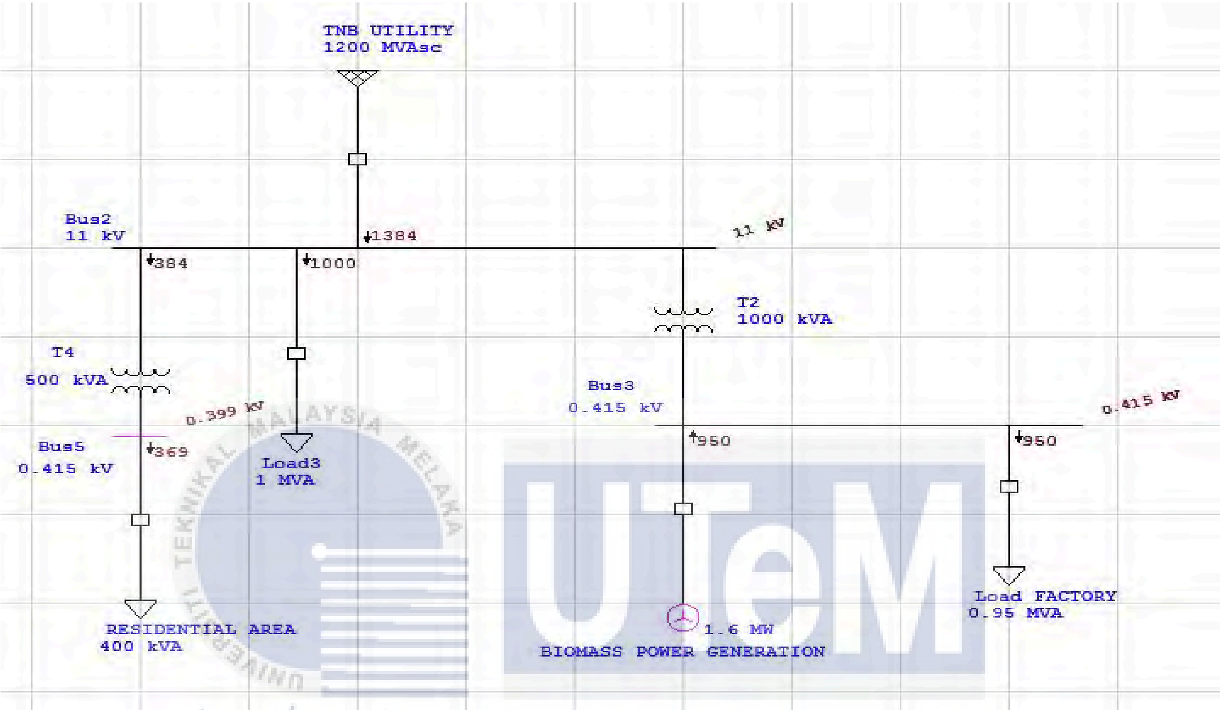

Figure 4.7: single line diagram for FiT A

Figure 4.6 show the design of single line diagram for biomass power generation connected to the grid by using electrical transient analyzer program (ETAP). This design were related to the method A of selling wasted power only. The biomass power generation still distribute the power to their load at the factory.

Total Export power = 5200KW (7)

= 36400 KW {total export power for 1 week or 56 hours}

FiT rates = 0.3085+0.0100+0.0500+0.0982

=0.4667 (RM/KWh) {by referring to the qualifying renewable energy installation}

Profit Fit = Power*hours*FiT rates

= 36400KW (0.4667)

= **RM 16 987.88 {the net profit}**

4.4.2 Method B

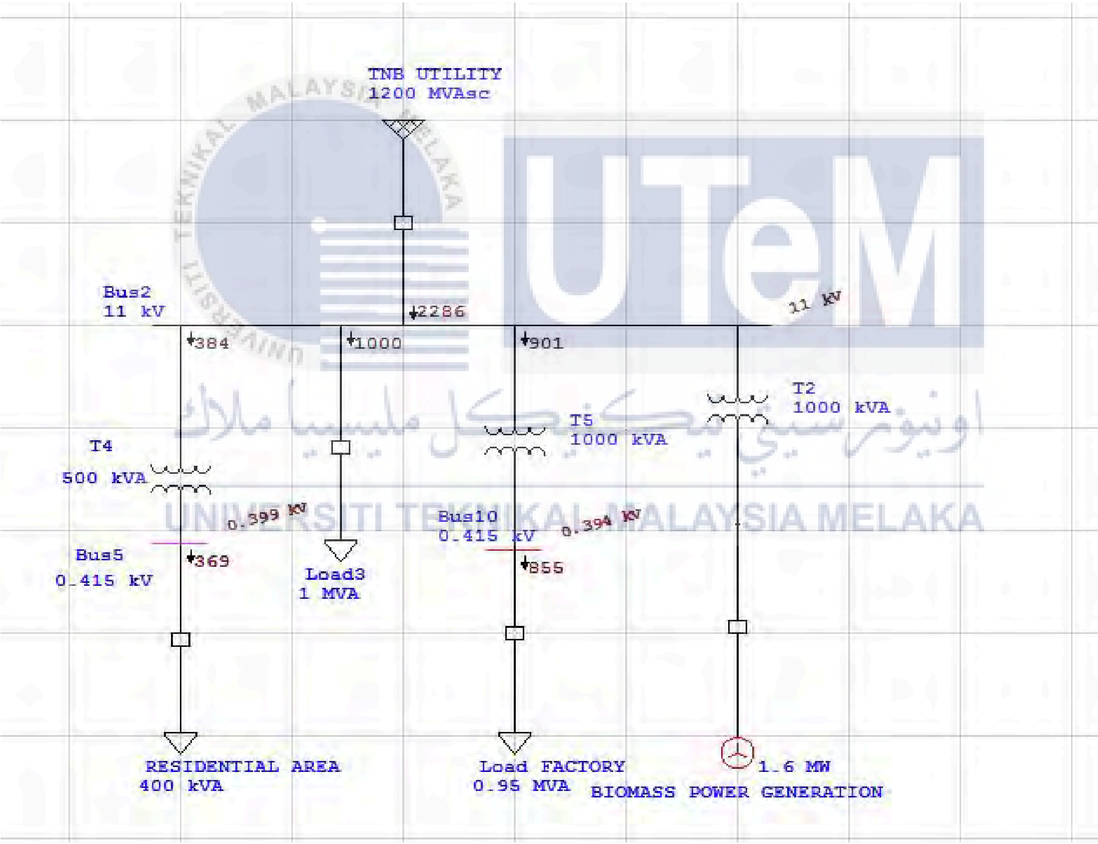

Figure 4.8: single line diagram for FIT B

Figure 4.6 show the design of single line diagram for biomass power generation connected to the grid by using electrical transient analyzer program (ETAP). This design were related to the method B of selling all power that have been generated. This factory must buy back electricity from TNB by follow to the industrial tariff.

Profit Fit = Power*hours*FiT rates

= 1.6M(8*7) (0.4667)

= RM 41816.32

Total Power Consumption = 5980 + 6300 + 6132 + 6129 + 5891 + 5921 + 5873

= 42226 kW {total load power in this factory for 1 week}

For the first 200 kW = 200 x 0.38

= RM 76.00

For the next (201 KW) = 42026 x 0.441

= RM 18 533.466

Total power consumption = RM 18 533.466 + RM 76.00

= RM 18609.466 {the industrial tariff for 1 week}

So, profit for this investment = Profit Fit – power consumption

= Rm41816.32 – RM 18609.466

=RM 23 206.854 {net profit}

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4.4.3 Comparison between method A and Method B

Table 4.6: the profit FIT for two method

type	Profit per week
Method A	RM 16 987.88
Method B	RM 23 206.85

From the result, the profit of method B is higher than method A. Method B is the genius of the tariffs and not only to save money from importing less electricity but actually get paid for the energy were be generated. This method automatically will cause the distribution part and generation part will be separated. The generation part only need a fuel (empty fruit bunch) for generation power system and the factory do their routine process but get the electricity from TNB. This factory can even increase their own savings by being more energy efficient in term of their equipment. The less electricity have been used, the more can be export back into the grid, for which this factory will receive payments. Method B is the best solution in term of profit, routine process and value in long term period.

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4.5 Financial analysis

The financial investment exactly depends on net export capacity. Sustainable Energy Development Tenaga Nasional Berhad.Before applying for the FiT application, the interested party is required to contact the Distribution Licensee (DL) for Power Systems Study (PSS)for any RE installation more than 425 kW and above.

Table 4.7: Net export capacity of power system study cost [18]

No	Net export capacity of RE Installation	Cost (RM)	Completion period
1	Above 425KW and up to and including 1MW	20,000 per installation	30 days
2	Above 1MW and up to and including 10MW	40,000 per installation	40 days
3	Above 10MW and up to and including 30MW	60,000 per installation	50 days
4	Above 425kW and up to and including 1MW for housing development or individual application on the solar PV to be connected to the same distribution substation	500 per installation	60 days

The net export capacity of installation is above 1MW and up to and including 10MW as a qualification for the smallest capacity for biomass power plant. Basically this installation is a bigger investment mechanism as a storage to selling power that have been generate and Fit meter installation.

Initial investment and maintenance cost for this factory in term of power generation have been shown in table 4.8 that already get from Selancar 2B factory.

Table 4.8 Initial and maintenance cost for Felda Selancar Palm Oil factory

Asset	Asset description	Cost (RM)
1	2U pressure recorder c/w chart	3 600.00
2	Rototherm pressure recorder	1 155.00
3	Penggadang abu dandang no 1 and 2	1 780.00
4	Jambatan konkrit depan boiler 1st	50.00
5	Jambatan konkrit depan boiler 2nd	150.00
6	Boiler tube cleaner	5 245.00
7	Air compressor 10hp	9 245.00
8	Boiler Fuel Balancing control system	9 200.00

9	Puma air compressor 10hp model :TK100-300	99 500.00
10	6” Varimex cast steel globe valve (for boiler)	9 600.00
11	6” varimex cast steel globe valve (for boiler)	2 380.00
12	Photain smoke density equipment	14 000.00
13	Thermal dearator	363 044.82
14	Continuous emission monitoring system (CEMS)	12 500.00
15	1u blowdown chamber	5 000.00
/16	Goodway tube cleaner model: AWT-100x	16 900.00
17	40MT/HR water tube boiler	6 415 620.53
18	2U 250KW diesel Gen sets	156 500.00
19	2U steam turbo alternator	206 814.00
20	1u mega ohm meter M240513	387.00
21	All electrical engineering	505 731.35
22	Power capacitor national	2 983.00
23	Coppus turbine M/RLA- (for boiler pump)	58 000.00
24	11kv TNB substation	466 116.00
25	1600KW Turbo Alternator	1 007 136.66
26	Steam piping, electrical and civil work	610 075.47

Total = 12 126 106.41

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4.5.1 Financial Calculation

Basically, the investment made for new only on installation capacity in addition to existing power plant. For the initial investment and maintenance is the capital before doing FIT mechanism. However, for this financial calculation is to show this FIT way can cover up the capital cost for power generation at this factory. This result already get by using this formula.

Average monthly = profit per week x 4

Total profit = Total revenue – installation cost

Payback period = installation cost / annual cost

Return of investment = Total profit / (installation cost*contract duration)

Table 4.9: Data of financial FIT

Area	Capacity installed	Initial investment And maintenance	monthly FIT profit
Biomass power generation	RM 40 000 (for 1MW and above)	RM 12 126 106.41	RM 92 827.416

Table 4.10: The result in term of FIT investment

Payback period	Total profit	Return of investment
10 years 9 month	RM 11 052 177.42	0.0567

The agreement of FIT for biomass power generation states that 16 years is a time that TNB must buy the power from the owner of FIT. From table 4.9 and 4.10, the capacity installed and initial investment as a costing installation. Duration and costing installation is the main data to verify the financial analysis value. Payback period for this project is around 10 years and 9 month. It is mean that, the profit from FIT investment can cover the initial investment for this power plan around 10 years and 9 month. After that is the profit for this investment. The total profit is RM 11052 177.42 and Rate of investment is 0.057.

CHAPTER 5

CONCLUSION

There are many criteria need to consider for analysis of feed in tariff biomass system power generation. In palm oil industries, exactly biomass (empty fruit bunch) as a fuel to conduct the power system at this factory by heating process. The steam have been produced will remain as a prime mover to produce electricity.

The analysis about export power due to FiT need can be calculated by to ensure the power flow at this factory. There have two method to export the energy. First, sell all power generation and buy again for power supply to this factory. Second is the energy that is not used will be as export energy for FiT plan.

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The initial investment is to construct the facilities for the FiT process and the profit can be determine by using calculation. Exactly FiT is a one medium for renewable energy producer to gain profit in this era.

In my opinion, this factory should take an advantage in term of this FIT mechanism as a long term value investment. As long as FIT system can support this factory in 16 years period of time, the problem due to maintain and the equipment need to upgrade can be solved by the profit that will be get by export the power to TNB.

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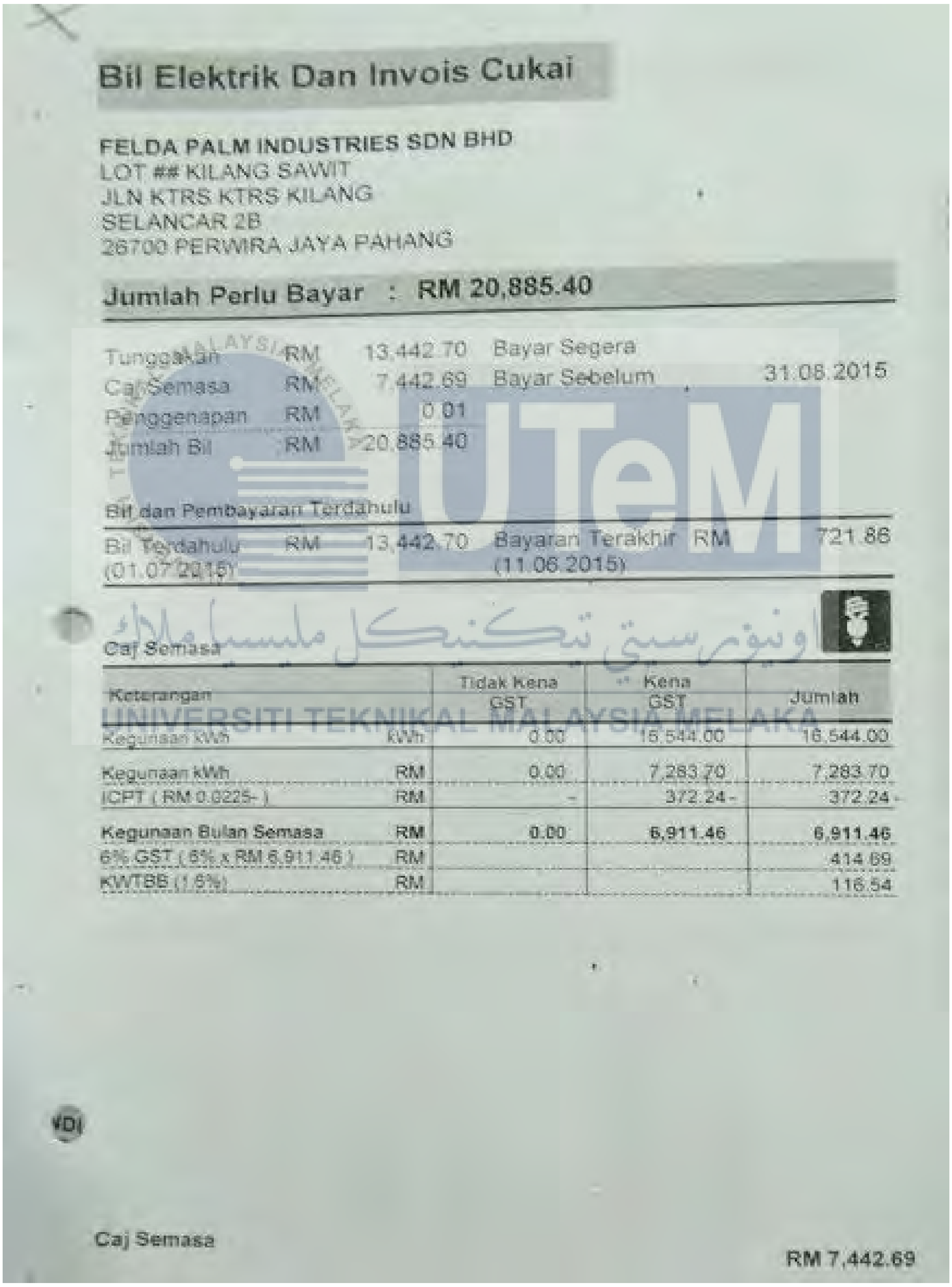
APPENDIX A

Electrical Tariff bill for Palm Oil Felda Selancar 2B Industries



Bil Elektrik Dan Invois Cukai

FELDA PALM INDUSTRIES SDN BHD
LOT ## KILANG SAWIT
JLN KTRS KTRS KILANG
SELANCAR 2B
26700 PERWIRA JAYA PAHANG

Jumlah Perlu Bayar : RM 20,885.40

Tunggakan	RM	13,442.70	Bayar Segera	
Caj Semasa	RM	7,442.69	Bayar Sebelum	31.08.2015
Penggenapan	RM	0.01		
Jumlah Bil	RM	20,885.40		

Bil dan Pembayaran Terdahulu

Bil Terdahulu (01.07.2015)	RM	13,442.70	Bayaran Terakhir RM (11.06.2015)	721.86

Caj Semasa

Keterangan		Tidak Kena GST	Kena GST	Jumlah
Kegunaan kWh	kWh	0.00	16,544.00	16,544.00
Kegunaan kWh	RM	0.00	7,283.70	7,283.70
ICPT (RM 0.0225-)	RM	-	372.24 -	372.24 -
Kegunaan Bulan Semasa	RM	0.00	6,911.46	6,911.46
6% GST (6% x RM 6,911.46)	RM			414.69
KWTBB (1.6%)	RM			116.54

Caj Semasa RM 7,442.69

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Maklumat Terperinci Penggunaan Elektrik

Jenis Bacaan   Bacaan Sebenar

Pengiraan Penggunaan Elektrik Semasa

Keterangan	Kegunaan	Kadar (RM)	Amaun (RM)
200	200.00	0.380	76.00
> 200	16,344.00	0.441	7,207.70
Caj Penggunaan Semasa		1	7,283.70

Bacaan Meter

No Meter	Keterangan	Faktor Meter	Bacaan Dahulu	Bacaan Semasa	Kegunaan
M 212563278	kWh	1.0000	565520	582064	16,544.00
M 212563278	kVARh	1.0000	129700	133846	4,146.00

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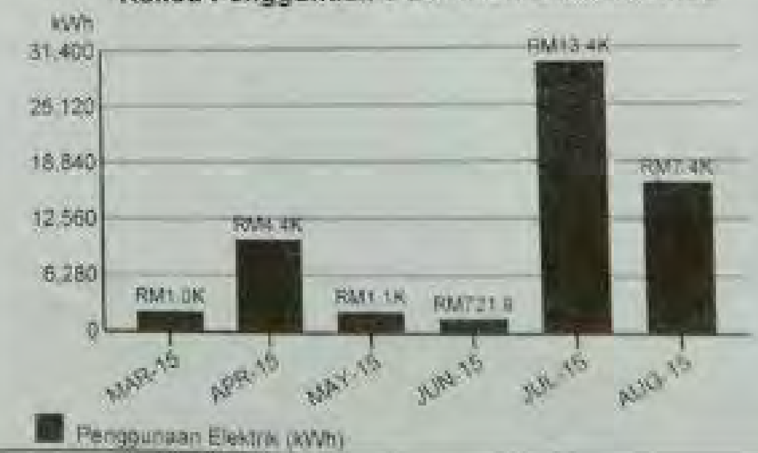
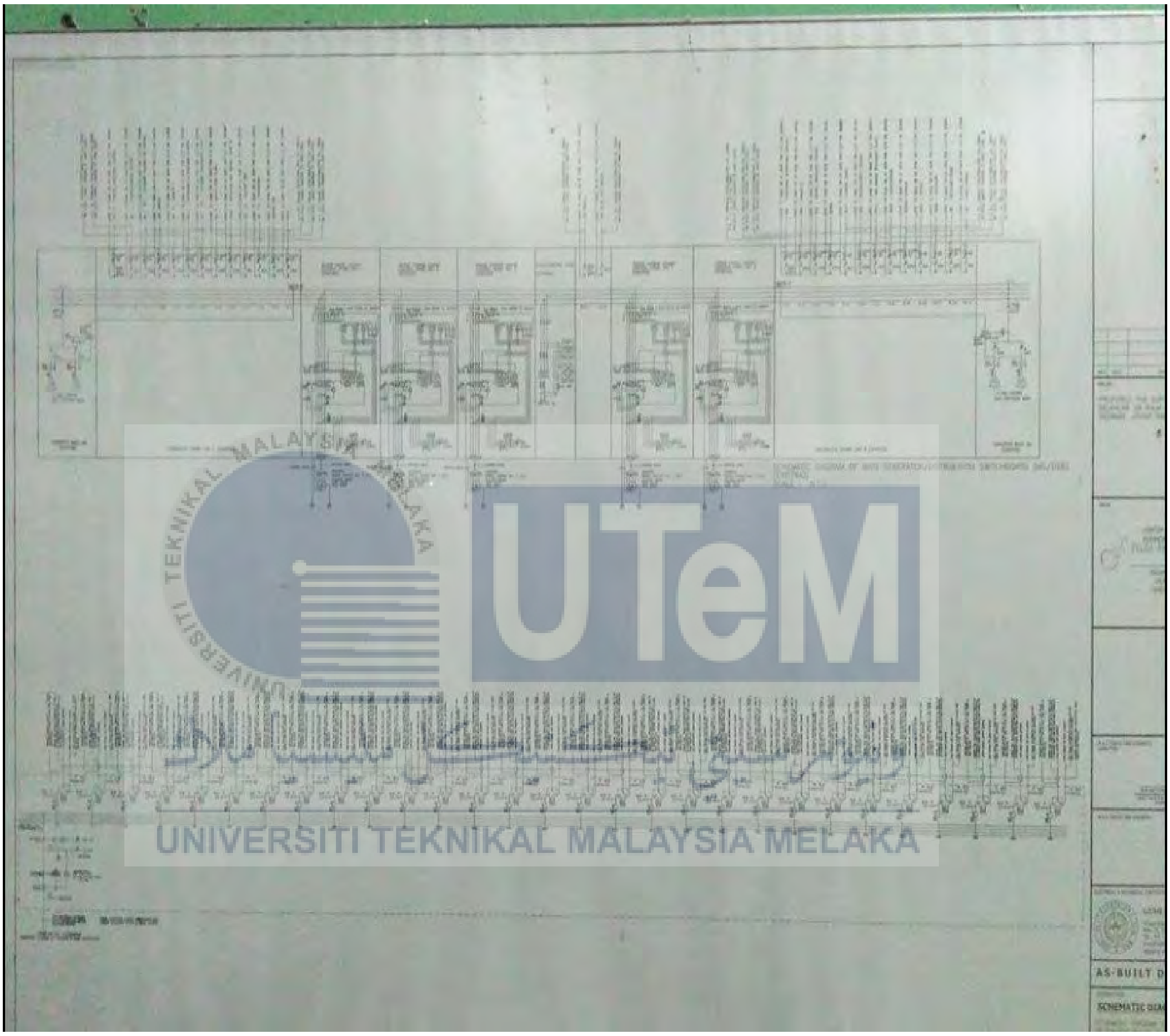
Rekod Penggunaan 6 Bulan Bil Elektrik Anda



APPENDIX B

Circuit Drawing for Biomass Plant at Palm Oil Felda Selancar Factory



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APPENDIX C

Industrial Tariffs from Tenaga Nasional Berhad

TARIFF CATEGORY	CURRENT RATE (1 JAN 2014)
Tariff D - Low Voltage Industrial Tariff	
For the first 200 kWh (1 -200 kWh) per month	38.00 sen/kWh
For the next kWh (201 kWh onwards) per month	44.10 sen/kWh
The minimum monthly charge is RM7.20	
Tariff Ds – Special Industrial Tariff (for consumers who qualify only)	
For all kWh	42.70 sen/kWh
The minimum monthly charge is RM7.20	

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Net export capacity of power system study cost

No	Net export capacity of RE Installation	Cost (RM)	Completion period
1	Above 425KW and up to and including 1MW	20,000 per installation	30 days
2	Above 1MW and up to and including 10MW	40,000 per installation	40 days
3	Above 10MW and up to and including 30MW	60,000 per installation	50 days

APPENDIX D

Initial investment and maintenance in term of biomass power plan

Asset Balances - 01

Report date: 31.12.2015 - Created on: 30.05.2016

Asset	SNo.	Capitalized on	Deact.Date	Asset description	Σ Acquis.val.	Σ Accum.dep.	Σ
2300010895	0	01.08.1985		2U 250KW DIESEL GEN SETS	156,500.00	156,500.00-	
2300010896	0	01.12.1985		2U STEAM TURBO ALTERNATORS	206,814.00	206,814.00-	
2300010897	0	01.12.1991		1U MEGA OHM METER M240513	387.00	379.26-	
2300010898	0	01.08.1985		ALL ELECTRICAL ENGINEERING	505,731.35	505,731.35-	
2300010899	0	01.05.1994		POWER CAPACITOR NATIONAL	2,983.00	2,923.34-	
2300017055	0	12.02.2004		COPPUS TURBINE M/RLA16- UTK BOILER PUMP	58,000.00	34,642.55-	
2300022158	0	04.02.2013		11KV TNB SUBSTATION	466,116.00	64,712.43-	
2300022736	0	31.08.2013		1600KW TURBO ALTERNATOR	1,007,136.66	118,331.34-	
2300022736	1	30.11.2015		STEAM PIPING, ELECTRICAL & CIVIL WORKS	610,075.47	64,769.68-	
					• 3,013,743.48	• 1,154,803.95-	• 1,8
					•• 3,013,743.48	•• 1,154,803.95-	•• 1,8
					••• 3,013,74...	••• 1,154,80...-	••• 1

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Asset Balances - 01

Report date: 31.12.2015 - Created on: 30.05.2016

Asset	SNo.	Capitalized on	Deact.Date	Asset description	Σ Acquis.val.	Σ Accum.dep.
2300010918	0	01.12.1992		2U PRESSURE RECORDER C/W CHART	3,600.00	3,528.00-
2300010919	0	01.11.1994		ROTOTHERM PRESSURE RECORDER	1,155.00	1,131.90-
2300010920	0	01.01.1995		PENGGADANG ABU DANDANG NO: 1 & 2	1,780.00	1,744.40-
2300010921	0	01.01.1995		JAMBATAN KONKRIT DEPAN BOILER	50.00	49.00-
2300010922	0	01.01.1995		JAMBATAN KONKRIT DEPAN BOILER	150.00	147.00-
2300010923	0	01.01.1996		BOILER TUBE CLEANER	5,245.00	5,127.65-
2300017747	0	14.07.2006		AIR COMPRESSOR 10HP	9,200.00	4,245.03-
2300018777	0	31.03.2009		BOILER FUEL BALANCING CONTROL SYSTEM	99,500.00	32,909.63-
2300019014	0	04.05.2009		PUMA AIR COMPRESSOR 10HP MODEL: TK100-300	9,600.00	3,096.80-
2300019363	0	20.08.2009		6" VARIMEX CAST STEEL GLOBE VALVE (UTK BOILER)	2,380.00	738.59-
2300019364	0	20.08.2009		6" VARIMEX CAST STEEL GLOBE VALVE (UTK BOILER)	2,380.00	738.59-
2300019486	0	06.04.2010		PHOTAIN SMOKE DENSITY EQUIPMENT	14,000.00	3,887.33-
2300019515	0	14.10.2009		THERMAL DEARATOR	363,044.82	109,700.06-
2300019694	0	30.04.2010		CONTINUOUS EMISSION MONITORING SYSTEM (CEMS)	12,500.00	3,470.83-
2300020020	0	01.07.1992		1U BLOWDOWN CHAMBER	5,000.00	4,826.89-
2300020737	0	06.05.2011		GOODWAY TUBE CLEANER MODEL: AWT-100X	16,900.00	3,795.46-
2300021866	0	31.07.2012		40MT/HR WATER TUBE BOILER	6,415,620.53	1,074,081.82-
					• 9,112,362.93	• 3,307,437.20- •
					•• 9,112,362.93	•• 3,307,437.20- ••
					••• 9,112,36...	••• 3,307,43...- •••

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Bus Input Data

Bus			Initial Voltage		Load: Constant kVA		Load: Constant Z		Load: Constant I		Load: Generic	
ID	kV	Sub-sys	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar
Bus2	11.000	1	100.0	0.0			0.009	1.000				
Bus3	0.415	1	100.0	0.0			0.009	0.950				
Bus5	0.415	1	100.0	0.0			0.004	0.400				
Total Number of Buses: 3					0.000	0.000	0.021	2.350	0.000	0.000	0.000	0.000

Generation Bus				Voltage		Generation			Mvar Limits	
ID	kV	Type	Sub-sys	% Mag.	Angle	MW	Mvar	% PF	Max	Min
Bus2	11.000	Swing	1	100.0	0.0					
Bus3	0.415	Swing	1	100.0	0.0					
						0.000	0.000			

Method of Solution: Adaptive Newton-Raphson Method

Maximum No. of Iteration: 99

Precision of Solution: 0.0001000

System Frequency: 60.00 Hz

Unit System: English

Project Filename: BIOMASS POWER GENERATION

Output Filename: C:\ETAP 1260\BIOMASS POWER GENERATION\NAJIB.lfr

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