WRITE A SOFTWARE CONTROLLING AUTOMATICALLY THE GENERATOR PRIME MOVER (NOT LIMITING TO FOUR) TO KEEP UP WITH THE LOAD DEMAND (AUTOMATIC LOAD DISPATCH)

ZENO PAULUS

MAY 2006

"I hereby declared that this report is qualified in form of scope and quality to earn a graduation in Bachelor of Science in Electrical Engineering (Industrial Power)"

Signature : ....

Supervisor name : PM MD NOAH BIN JAMAL

Date : 4/5/06

DESIGN A SOFTWARE TO AUTOMATICALLY CONTROL THE GENERATOR PRIME MOVER (NOT LIMITING TO FOUR) TO MEET THE DEMAND (ECONOMIC LOAD DISPATCH)

ZENO PAULUS

This Report Is Submitted In Partial Fulfillment Of Requirements For The Degree of Bachelor In Electrical Engineering (Industry Power)

Fakulti Kejuruteraan Elektrik
Kolej Universiti Teknikal Kebangsaan Malaysia

MAY 2006

"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references"

Signature : ....
Student : ZENO PAULUS
Date : 04 MAY 2006

ACKNOWLEDGEMENTS

First of all, I thanked God for showering me with strength and faith for me to be able to complete this final year student project. Without His power I definitely will suffer a hard time to complete this task, thanks again for showing me the easy way to reach my goal.

This token of appreciation also goes to the Faculty of Electrical Engineering, Kolej Universiti Teknikal Kebangsaan Malaysia, especially my project supervisor Associate Professor MD Noah bin Jamal for his great guidance and practical instruction he gave me. This appreciation extended to all the lecturer and staff of FKE for who had helped me in any sort of way, directly or indirectly.

I also admire the willingness and commitment that Mr Bobby Ryxler gave to me in assisting me to learn and gain knowledge about the Visual Basic coding and system application design, without his guidance I certainly cannot fulfill the requirement asked

Lastly I would like to express my heartiest thanks to my beloved family, my colleagues, my housemate and my loved ones and whoever that have contribute in the process of realizing this project. Only God knows how to repay your kindness and compassion. Thanks again.

ABSTRACT

Consider a conventional method of controlling a power generator, with an operator to control the panel board and observe the overall system 24 hours a day, seven days a week. Although this method are effectively runs for most of the system, but there is still a limitation if a system like this are only managed by human. This project was developed to overcome the constraint of the conventional approached. This system, the Auto Control Generator System is able to withdraw the use of operator in managing the generator power control, although not hundred percent but still it can minimize the presence of such situation, and therefore the availability for a human work power can be utilize in other scope of work, resulting in cost reduction in long terms operation. This system is about controlling the generator prime mover to meet the load demand. Another explanation is, when the demand for load is increasing or decreasing the system will automatically detect the changes and come up with a solution whether to run another generator to cope with the increasing demand or to shut off a generator to provide an economic dispatch operation. This system are fully developed using the Microsoft Visual Basic 6.0, a high level programming language and yet, best for novice user to build up a semi- complex system. The system will rely on a database and for this purpose I use the Microsoft MS Access as the provider. Then by using the Data Control method which featured in the Microsoft Visual Basic 6.0 I can establish a connection between the system and the database. The system operation is simple, when it runs, the system will get the current time from the computer in which the system are being installed, record it and get the corresponding data (total loads in respective for that particular time) from the database then evaluate the data and lastly choose which generator should run and which should remain undisturbed.

ABSTRAK

Pertimbangkan sebuah kaedah pengawalan konvensional untuk mengawal panjanaan kuasa, dengan seorang operator yang akan memantau sistem tersebut 24 jam jam sehari tiap-tiap minggu. Walaupun kaedah ini boleh diguna pakai dan masih berkesan namun masih terdapat halangan sekiranya sistem sebegini hanya di uruskan oleh manusia. Projek ini dibangunkan dengan tujuan untuk mengatasi kekangan yang dihadapi oleh pendekatan konvensional ini. Sistem ini akan berupaya untuk menghapuskan penggunaan operator dalam pengurusan penjanaan kuasa, walaupun tidak seratus peratus tetapi sistem ini akan dapat mengurangkan kewujudan situasi sedemikian., dan kemudiannya kekosongan sumber tenaga kerja tersebut boleh digunakan dalam skop kerja yang lain dan kesannnya, kos tenaga kerja dapat dikurangkan. Sistem yang dibangunkan ini adalah mengenai pangawalan *prime mover* penjana untuk menampung permintaan beban. Ataupun dengan kata lain, apabila permintaan beban semakin tinggi atau semakin menurun, sistem akan mengenalpasti perubahan ini secara automatik dan akan memberikan hasil sama ada hidupkan penjana baru untuk menampung beban yang semakin bertambah atau tutupkan penjana untuk kos operasi yang ekonomik. Sistem ini telah dibangunkan sepenuhnya menggunakan perisian Microsoft Visual Basic 6.0. Sstem ini akan bergantung kepada input dari pengkalan data dan untuk tujuan ini saya menggunkan MS Access sebagai pengkalan data. Seterusnya dengan menggunakan kaedah Data Control yang terdapat dalam VB , saya dapat menghasilkan hubungan antara pengkalan data dengan sistem. Operasi sistem adalah mudah. Sekirannya sistem dilancarkan, sistem akan mendapatkan masa semasa dari computer dimana sistem ini di pasang, rekod data tersebut dan mengambil data yang berkaitan dengan masa tadi (kuasa maksimum) dari pengkalan data dan menafsir data tersebut sebelum memilih penjana mana yang patut di hidupkan atau panjana yang tidak perlu diganggu.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	ABSTRAK	vi
	TABLE OF CONTENTS	vii
	LIST OF FIGURES	x
	LIST OF TABLES	xi
1	**PROJECT OVERVIEW**	
	1.1 Introduction	1
	1.2 Objective	2
	1.3 Problem Background Check	2
	1.4 Problem Statement	3
2	**LITERATURE REVIEW**	
	2.1 Power Generation	5
	2.2 Type of Generator	6
	2.2.1 Steam Unit	6
	2.2.2 Gas Unit	7
	2.2.3 Combined Cycle Unit	7
	2.2.4 Co-Generating Unit	8
	2.2.5 Other Unit	9
	2.3 Load Profile	9
	2.3.1 Producing A good Load Profile	11
	2.3.2 Load and Coincidence Factors	12
	2.4 Related Research	13
	2.4.1 Intelligent Generator Monitoring and Control	13
	2.4.2 Automatic Generation Control	20

	2.4.3 Power Control System 4000 Series	22
3	**METHODOLOGY**	25
	3.1 Project Methodologies	25
	3.2 Load Demand Profile	25
	3.3 The Visual Basic Environment	28
	3.3.1 Building the VB Application	29
	3.4 Project Design	29
	3.4.2 System Interface	29
	3.4.3 Draw the Interface	30
	3.4.4 Setting the Properties	32
	3.4.5 Writing the Codes	33
	3.4.6 The System Flow Chart	34
	3.4.7 Sub-Module Flow Chart	35
	3.5 Implementation and Testing	38
	3.5.1 Big Bang Testing	38
	3.5.2 Piecemeal Testing	38
	3.5.3 Alpha Testing	39
	3.5.4 Beta Testing	39
4	**RESULT, DISCUSSION AND RECOMMENDATION**	40
	4.1 Introduction	40
	4.2 Results	40
	4.3 Discussion of the System	41
	4.4 Future Recommendation	42
	4.4.1 Metering Meters	42
	4.4.2 Output signal	42
	4.4.3 Database	42
5	**CONCLUSION**	43
	5.1 Conclusion	

REFERENCE 44
APPENDICS 45

LIST OF FIGURES

NO	TITLE	PAGE
2.1	Schematic of generic thermal generator	6
2.2	Schematic of Gas Turbine	7
2.3	Schematic of combined cycle	8
2.4	Schematic of co-generating units	9
2.5	Sample weekly load profile of the total load	10
2.6	Sample for monthly load profile	10
2.7	Sample for good and poor profile	11
2.8	Example of parallel generator control system	17
2.9	Automatic Generation Control	21
2.10	Power Control System Panel Board	22
2.11	4000 Series Schematic Diagram	24
3.1	Graphical Illustration for the Load versus Time	27
3.2	The Visual Basic Environment	28
3.3	Main Menu Interface	30
3.4	Control Panel Interface	30
3.5	Edit Database Administrator Login Interface	31
3.6	Edit database Interface	31

LIST OF TABLES

NO	TITLE	PAGE
3.1	Data for load versus time	26
3.2	List of Parameter Setting	32
4.1	Testing Results	40

CHAPTER I

PROJECT OVERVIEW

1.1 INTRODUCTION

Electric power generators use a variety of prime movers and energy sources to generate electric energy. Prime movers are the engine, turbine, water wheel, or similar machines that drive an electric generator. Energy sources include combustion of fossil fuels, nuclear fission, kinetic energy in water or wind, chemical energy in a fuel cell, and sunlight. Wind, water, sunlight, geothermal energy, biomass, and waste products are renewable energy sources that are considered inexhaustible.

Generating units vary in size. Nuclear and fossil-fuel steam-electric units typically have large capacities with many over 1,000 megawatts (MW), while hydroelectric dams range from less than 1MW to thousands of MW at some of the large Federal dams. Gas turbines, combustion turbines, and combined-cycle units are typically less than 200 MW, but some are larger. Wind and solar plants are relatively small. Distributed generation, which can be installed at or near the customer's site, can be quite small, such as rooftop photovoltaic arrays or fuel cells ranging from several to a few hundred kilowatts.

The generating units operated by an electric utility vary by intended usage, that is, by the three major types of load (generally categorized as base, intermediate, and peak) requirements the utility must meet. A base-load generating unit is normally used to satisfy all or part of the minimum or base load of the system and, as a consequence, produces electricity at an essentially constant rate and runs continuously. Base-load units are generally the largest of the three types of units, but they cannot be brought on line or taken off line quickly. Peak-load generating units can be brought on line quickly and are used to meet requirements during the periods of greatest or peak load on the system. They are normally smaller plants using gas and combustion turbines. Intermediate-load generating units meet system requirements that are greater than base-load but less than peak load. Intermediate-load units are used during the transition between base-load and peak-load requirements.

1.2 OBJECTIVES

The main objectives of this project are;

- To provide software that will automatically control the generator prime mover to meet the load demand.
- To reduce profit losses by implementing the developed system

This software is able to control the rotation of the generator shaft, through the prime mover. Increment in load demand means more generators should be switched ON in one time to cope with the demand, and at time where the load is fairly low or stable the software are able to familiarize the load with the remainder generator to run in the very economic but high efficiency operation.

1.3 PROBLEM BACKGROUND CHECK

In the typical conventional power generation distribution usually there is a need for an operator (normally the Engine Driver with the required qualification) to manage and monitor the load progression in scope of the said distribution area. This conventional practice is not practical enough for nowadays consumer demand as it faces with many limitation and obstacles. Among the constraint faced is:

- Lack of control of the consumer needs (load demand)
- Non economic operating process

In the early days, when the load demand started to increased, and the operator started to notice the changed he will then do the next part which is to switch on another Genset or run the standby Genset as to meet the increasing demand from the consumer. Although these steps look easy but sometime the operator can make mistakes due to lack of concentration during working period. This consist of not able to synchronize the stand by Genset with the running Genset on time to meet the load demand which will then can caused blackouts or power disruption. The other reason why the conventional operator system is not practical is, it produced a non economic operation due to lack of knowledge of the operators about economic importance in power generations. For example when the consumer load is in low state or stable state, it also goes the same the generated power by the generator, which means smaller capacity of generators should run if the load demand is low, but we have to make sure that running Genset are able to cope with the current demand. To prevent economical losses this step is very important to be implemented in the software I was about to develop for my PSM project which is to reduce the profit losses by implementing the system.

1.4 PROBLEM STATEMENT

Improper management of the power generation means blackout can occurred .Blackouts often result when generation is separated from load. The grid typically will withstand any single event (single generator failure or single transmission-line failure) under worst-case conditions. But the system can collapse if several failures take place in rapid succession when the grid is already stressed. Among the factors that cause blackouts are:

- Multiple lightning strikes
- Falling trees
- Equipment failure
- Human error
- Wires sagging into underbrush
- Overloads, voltage sags, frequency deviations
- Sabotage
- Fire

Since electricity cannot be effectively stored in large quantities, there must be perfect balance between electricity supply and demand. More electricity must be produced to meet the added demand every time a light switches on. Sudden changes in this balance can produce instabilities that ripple throughout the grid and spread (or "cascade") a blackout. So there is a need to develop software that can automatically control the prime mover as to switch on the respective generator and can cope with the increasing load demand.

CHAPTER II

LITERATURE REVIEW

2.1 Power Generation

Generation is defined as the production of electric energy from other energy sources. Transmission is the delivery of electric energy over high-voltage lines from the power plants to the distribution areas. Distribution includes the local system of lower voltage lines, substations, and transformers which are used to deliver the electricity to end-use consumers [1].

Each generator prime mover must have an over speed device that is independent of the normal operating governor and adjusted so that the speed cannot exceed the maximum rated speed by more than 15 percent. Each prime mover must shut down automatically upon loss of lubricating pressure to the generator bearings if the generator is directly coupled to the engine. If the generator is operating from a power take-off, such as a shaft driven generator on a main propulsion engine, the generator must automatically declutch (disconnect) from the prime mover upon loss of lubricating pressure to generator bearings.

There are many types of generator for power generation in nowadays industrial need. This type of generator depends on the need of consumer or often based on the power usage of consumer. Generally the list below are the type of generator with respective of their prime mover that drive the generator shaft.

2.2 Types of Generators

2.2.1 Steam Units

Steam-electric (thermal) generating units are typically the large base load plants. Steam produced in a boiler turns a turbine to drive an electric generator .Fossil fuels (coal, petroleum and petroleum products, natural gas or other gaseous fuels) and other combustible fuels, such as biomass and waste products, are burned in a boiler to produce the steam. Nuclear plants use nuclear fission as the heat source to make steam. Geothermal or solar thermal energy also produce steam. The thermal efficiency of fossil-fueled steam-electric plants is about 33 to 35 percent. The waste heat is emitted from the plant either directly into the atmosphere, through a cooling tower, or sent to a lake for cooling. A water pump brings the residual water from the condenser back to the boiler [1].

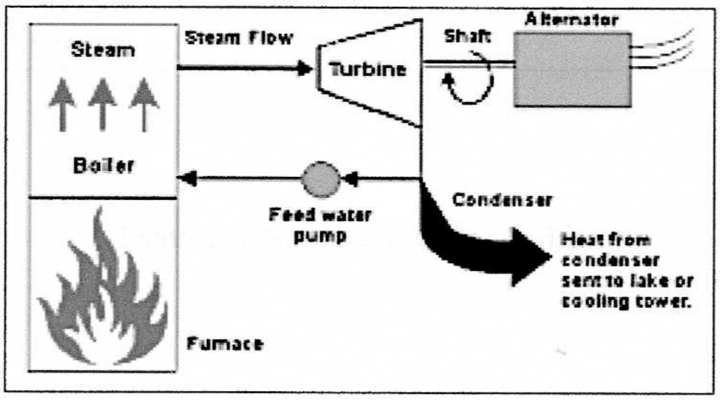

Figure 2.1: Schematic of generic thermal generator

2.2.2 Gas Unit

Gas turbines and combustion engines use the hot gas from burning fossil fuels, rather than steam, to turn a turbine that drives the generator. These plants can be brought up quickly, and so are used as peaking plants. The number of gas turbines is growing as technological advances in gas turbine design and declining gas prices have made the gas turbine competitive with the large steam-electric plants. However, thermal efficiency is slightly less than that of the large steam-electric plants. The gas wastes are disposed of through an exhaust stack [1].

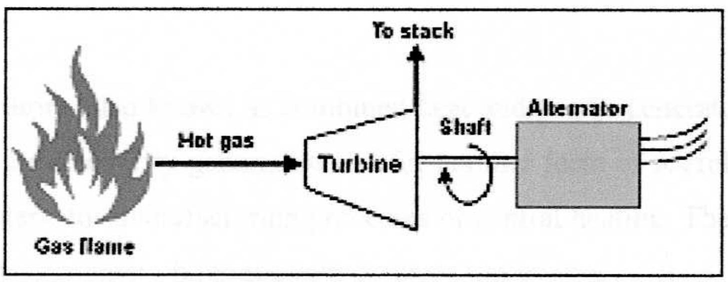

Figure 2.2: Schematic of Gas Turbine

2.2.3 Combined-Cycle Units

Combined cycle plants first use gas turbines to generate power and then use the waste heat in a steam-electric generator to produce more electricity. Thus, combined-cycle plants make more efficient use of the heat energy in fossil fuels. New technology is improving the thermal efficiency of combined-cycle plants, with some reports of 50 to 60 percent thermal efficiency [1].

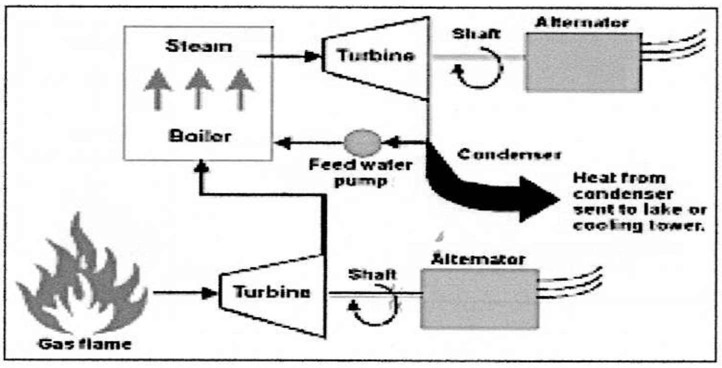

Figure 2.3: Schematic of combined cycle

2.2.3 Co-generating Units

Co-generators, also known as combined heat and power generators, are facilities that utilize heat for electricity generation and for another form of useful thermal energy (steam or hot water), for manufacturing processes or central heating. There are two types of cogeneration systems: bottom-cycling and top-cycling. In a bottom-cycling configuration, a manufacturing process uses high temperature steam first and a waste-heat recovery boiler recaptures the unused energy and uses it to drive a steam turbine generator to produce electricity. In one of two top-cycling configurations, a boiler produces steam to drive a turbine-generator to produce electricity, and steam leaving the turbine is used in thermal applications such as space heating or food preparation. In another top-cycling configuration, a combustion turbine or diesel engine burns fuel to spin a shaft connected to a generator to produce electricity, and the waste heat from the burning fuel is recaptured in a waste-heat recovery boiler for use in direct heating or producing steam for thermal applications [1].

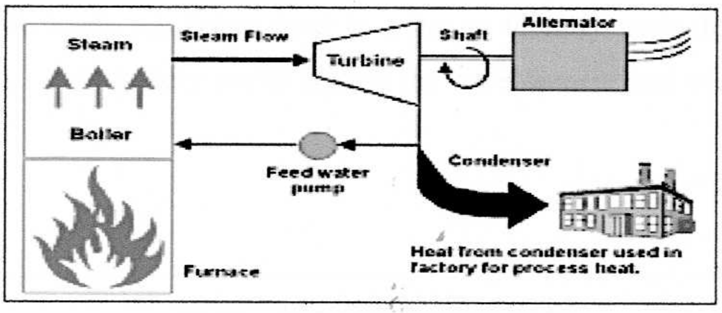

Figure 2.4: Schematic of co-generating units

2.2.5 Other Units

The kinetic energy in moving water and wind is used to turn turbines at hydroelectric plants and wind facilities to produce electricity. Other types of energy conversion include photovoltaic (solar) panels that convert light energy directly to electrical energy, and fuel cells that convert chemical energy directly to electrical energy [1].

2.3 Load profile

A load profile is a graphical plot of the power consumption for a specified time period (day, week or month). Load profile is also defined as the energy usage pattern of a customer who does not use meters capable of measuring short-term usage. Two vital fundamentals can be obtained from a load profile graph which is the maximum amount of power consumed (termed Maximum Demand),the peak point of the greatest power consumption for the period under consideration and the sum of the area under the profile is the amount of energy that is consumed. Load profiles also provide an indication of the times that specific loads are being used in order to identify peak demand areas and production hours. This is very useful during the development and evaluation of tariff structures [1].

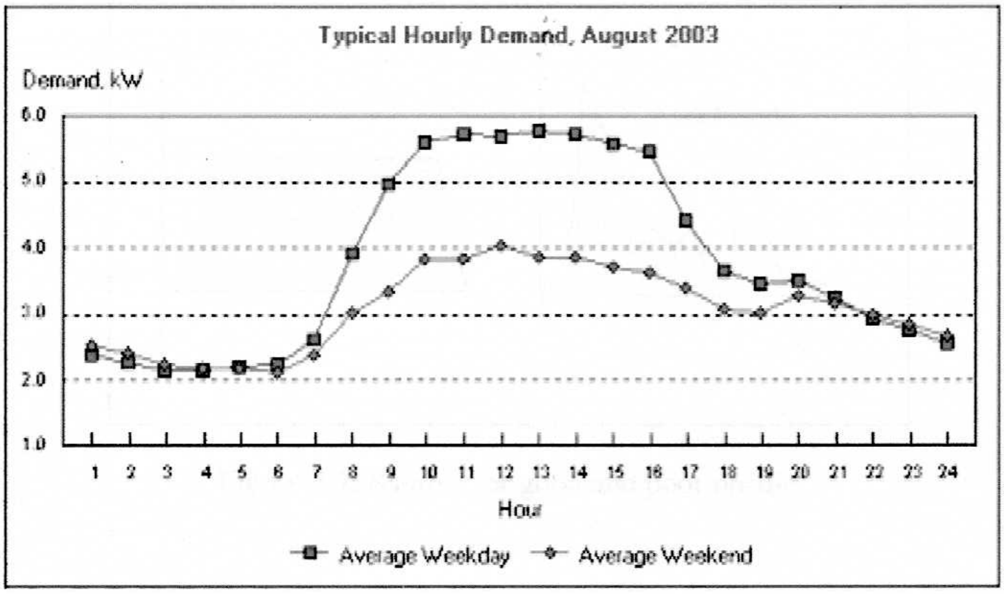

Figure 2.5: Sample weekly load profile of the total load

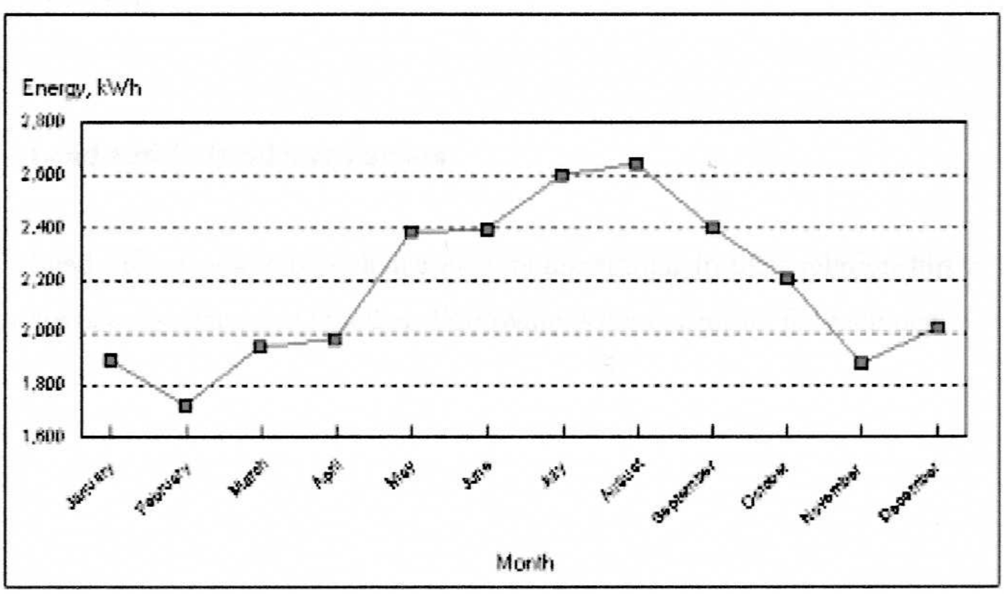

Figure 2.6: Sample for monthly load profile

2.3.1 Producing a Good Load Profile

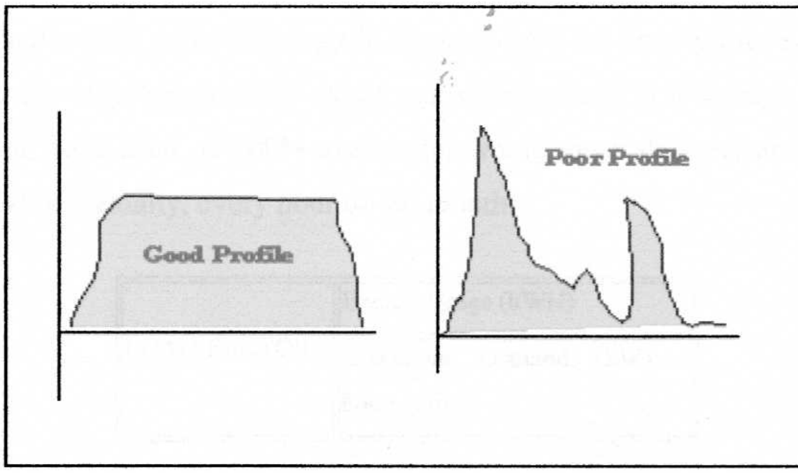

Figure 2.7: Sample for good and poor profile

Producing a good load profile is very important as it is the key to look in your billing and electricity tariffs. The higher your load factor the better your load profile and the lower will be the price you pay for energy. The load factor will be discussed more later in this report [2].

2.3.2 Load and Coincidence Factors

Load Factors and Coincidence Factors are similar in their relationship to usage, as they are usually discussed together. Following is the definition for each one.

Load Factor (L.F.)

This is calculated as the ratio of energy to demand for a set time frame. Load factor is a measure of usage efficiency usually expressed in percentage. It is what you used versus what you could have used. A 100% load factor would mean that you are using a given amount of load perpetually, every hour of the month.

LOAD FACTOR=	Energy Usage (kWH)
	Maximum Demand (kW) x hours/period

The load factor based on maximum demand will always be between 0 and 1.

Coincidence Factor

The coincidence factor is the ratio of coincident demand to maximum demand. This will always be between 0 and 1 because coincident demand should always be less than or equal to maximum demand.

Both the load factor and the coincidence factors are the important value to be measure especially in billing terms.